5.5.3 Noise

Noise is generally defined as sound with an intensity greater than the ambient or background sound pressure level (SPL). SPL is determined by measuring the noise emissions in terms of sound pressure in a relationship defined as a decibel (dB). The type of decibel unit commonly used in sound level measurements is the A-weighted decibel dB(A). This scale is almost universally used to describe environmental noise because it simulates the variation with frequency through the audible range of the sensitivity to sound of the typically healthy human ear (Cunniff 1977, Kryter 1970, May 1978).

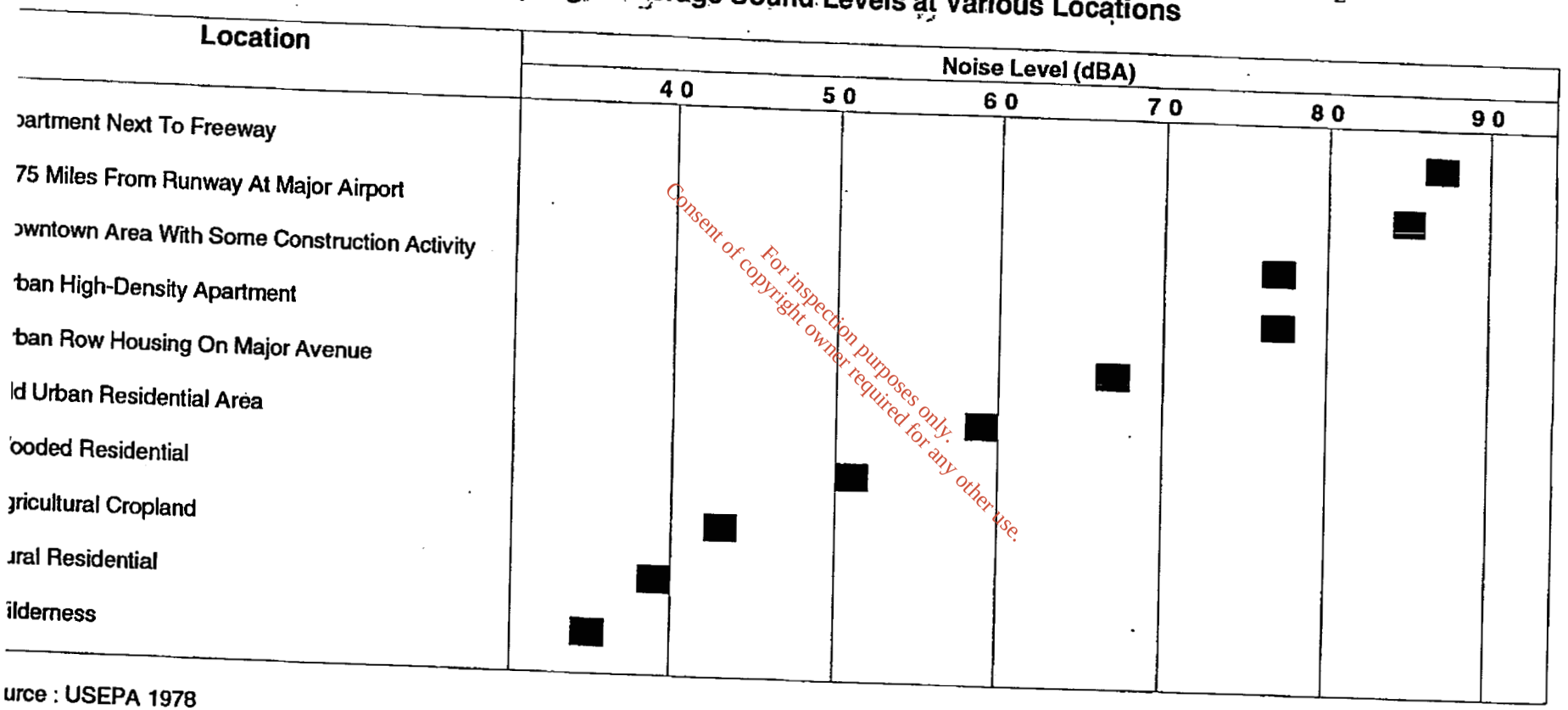
Outdoor noise levels change continually because of the temporal and spatial variations of noise sources. The temporal variation in the resulting sound levels is described by statistical levels in the form L_x, where L_x designates a sound that exceeds the level L for x percent of the sampling duration, or by equivalent sound levels in the form L_{eq}, defined as the stationary (constant) level with the same acoustic energy as the actual time-varying sound level over the given sampling period.

Areas that will be traversed by the proposed collection sewers include urban, commercial, industrial, and rural residential lands. Typical outdoor sound levels for these areas are shown in Fig. 5.5.1. As the figure indicates, ambient sound levels in the land uses that will be affected by construction of the sewers range from 38 dBA in rural residential areas to 79 dBA in heavily urbanised areas.

The proposed treatment plant site is located on pastureland; adjacent and nearby land uses include rural residential, light industrial, and recreational golf courses. The nearest noise-sensitive areas to the proposed treatment plant site are residences located approximately 200m from the nearest treatment plant unit. In addition, golfers on the golf course to the north of the site would be considered temporary noise-sensitive receptors as they would only be present during daylight hours.

Noise measurements were conducted at the nearest residence to the proposed treatment plant site at Carrigrenan on17th.-18th. December 1992 and 21st.-22nd. December 1992. The wind speed was stronger than that acceptable for noise measurements during most of the first 11 or 12 measurement hours on Thursday 17th December. The recorded values were therefore not taken into consideration. The measurement microphone was approx. 1.5m above ground level at 12m from the front of the residence. An integrating sound level meter, Cirrus model type

Figure 5.5.1
Outdoor Day-Night Average Sound Levels at Various Locations



urce : USEPA 1978

E.G.Pettit & Co.

CRL 702 (serial No. 16487), an outdoor microphone, type MK425, and sound level calibrator, type SIID, were used for the measurements. Values of the Leq for the day (07h-20h), intermediate period (6-7h, 20-22h) and night 22h-06h) are shown on Table 5.5.1 for the 24 hour period starting at 10h on 21.12.'92. These time-averaged measurements indicate background noise levels (leq) of 45.0 dBA during the day and 39.3 dBA during the night. Fig No.s 5.5.2 and 5.5.3 present the calculated hourly values of the Leq, L1, L10, and L95 for the period of measurement. Plots of the Leq are shown on Fig. No.s 5.5.2 and 5.5.3 for the period of measurement on the 17-18 December '92 and 21-22 December 92 respectively.

Table 5.5.1

Noise Measurements (Leq) at the nearest noise sensitive receptor to the Treatment Plant Site at Carrigrenan

Period	Leq (dBA)
Day (0700-2000)	45.0
Intermediate (0600 - 0700 2000 - 2200)	40.2
Night (2200-0600)	39.3

Source: Department of Civil and Environmental Engineering, University College, Cork, 1992.

TABLE 5.5.2

Calculated Hourly Noise Values (dBA) from Baseline Noise Measurements (17/18 December '92)

Period	Leq	s	L1	L10	L95
1h 00mn	48.8	2.9	56.0	51.1	44.0
2h 00mn	48.4	3.2	56.5	50.4	43.7
3h 00mn	48.6	2.9	56.5	50.7	44.0
4h 00mn	51.6	3.5	61.5	53.1	46.5
5h 00mn	52.1	3.7	60.8	54.1	46.1
6h 0mn	49.9	3.7	59.8	51.7	44.3
7h 00mn	50.4	2.9	57.6	52.6	45.1
8h 00mn	52.0	3.2	60.3	54.5	46.8
9h 00mn	52.5	3.6	60.9	54.7	46.4
10h 00mn	49.1	3.9	57.7	51.4	42.2
11h 00mn	43.0	5.7	52.9	44.3	35.6
12h 00mn	56.9	20.5	71.9	39.4	35.6
13h 00mn	39.3	4.1	51.3	35.6	35.6
14h 00mn	36.9	1.6	35.8	35.6	35.6
15h 00mn	35.9	0.8	36.2	35.6	35.6
16h 00mn	38.5	3.0	35.7	35.6	35.6
17h 00mn	35.7	0.5	37.1	35.6	35.6
18h 00mn	38.4	2.9	37.4	35.6	35.6
19h 00mn	35.6	0.2	35.6	35.6	35.6
Overall	**49.5 dBA**				

Source: Department of Civil and Environmental Engineering, University College, Cork 1992

Table 5.5.3

Calculated Hourly Noise Values (dBA) from Baseline Noise Measurements - (21/22 December '92)

Period	Leq	s	L1	L10	L95
11h 04mn	39.3	3.7	46.6	38.3	35.6
12h 04mn	36.5	1.2	39.1	35.7	35.6
13h 04mn	41.5	6.0	52.7	36.5	35.6
14h 04mn	44.1	8.5	52.2	35.7	35.6
15h 04mn	44.7	8.8	59.6	38.2	35.6
16h 05mn	43.7	8.0	58.6	37.2	35.6
17h 04mn	43.4	7.7	55.4	35.7	35.6
18h 04mn	49.7	13.5	64.4	38.2	35.6
19h 04mn	44.1	8.4	56.4	36.4	35.6
20h 04mn	42.7	7.0	54.9	38.6	35.6
21h 04mn	40.9	5.4	53.0	36.0	35.6
22h 04mn	41.4	5.8	51.6	35.8	35.6
23h 04mn	38.5	3.1	39.7	35.6	35.6
0h 04mn	36.6	1.5	41.3	35.6	35.6
1h 04mn	38.6	3.2	35.8	35.6	35.6
2h 04mn	35.6	0.1	35.7	35.6	35.6
3h 04mn	40.5	5.0	43.0	35.6	35.6
4h 04mn	38.2	2.9	40.1	35.6	35.6
5h 04mn	40.0	4.5	44.8	35.6	35.6
6h 04mn	36.7	1.7	41.5	35.6	35.6
7h 04mn	43.8	8.0	55.7	38.2	35.6
8h 04mn	46.4	10.0	59.4	44.1	35.6
Overall;	**42.8**	**dBA**			

Source Department of of Civil and Environmental Engineering, University College Cork 1992.

No. of channels: 1
No. of Leqs: 43229
Elementary duration: 2 s
start: 10h 04mn01s 21/12/1992
end: 10h 04mn59s 22/12/1992
Channel 1: Civ. Eng.Dept,UCC dBA min: 35 max: 95.
Code 3: Pause

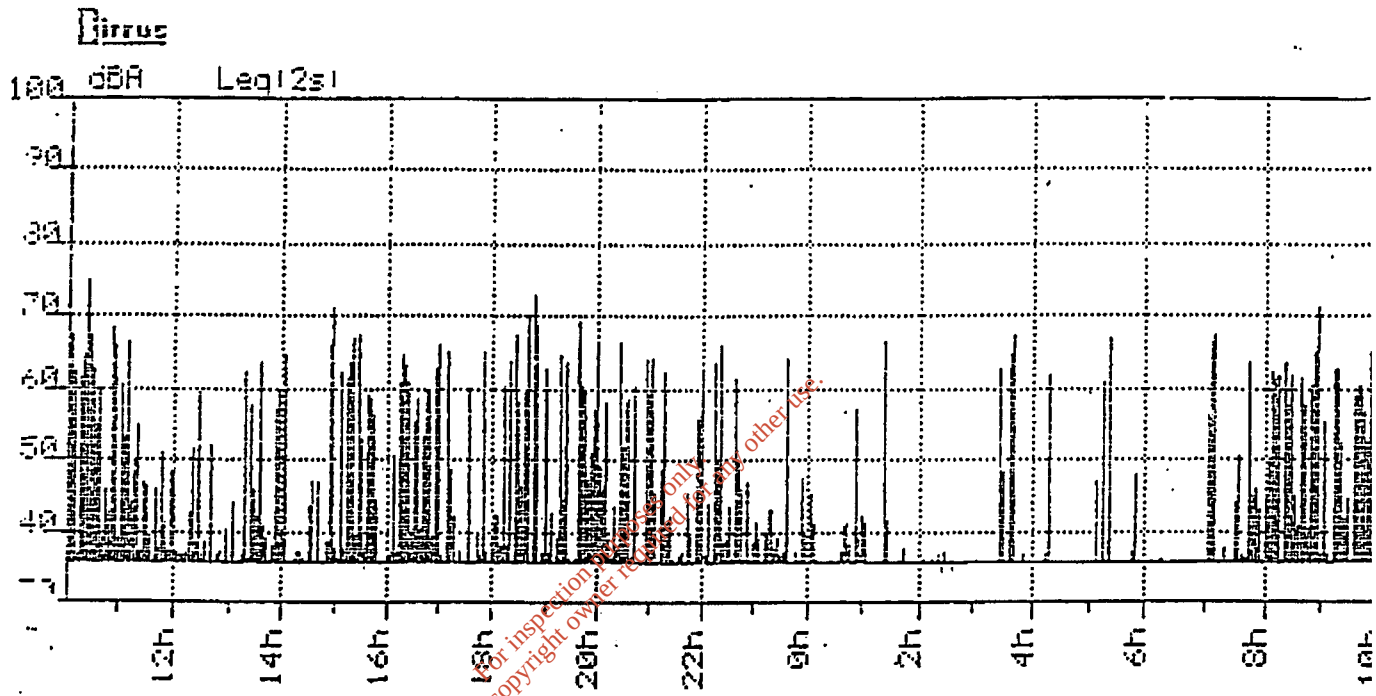
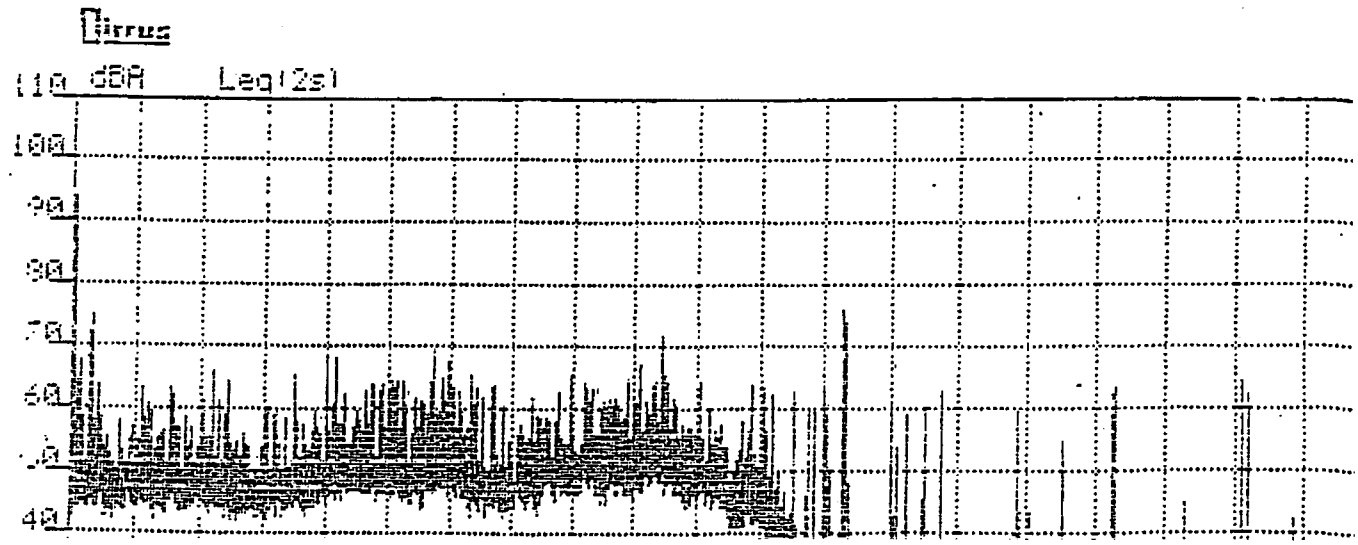


Fig 5.5.2 Plot of Leq 21/22 - 12 - 1

No. of channels: 1
No. of Leqs: 36403
Elementary duration: 2 s
start: 11.00 Thursday 17/12/1992
end: 07.00 Friday 18/12/1992
Channel 1: Civ.Eng.Dept,UCC. dBA min: 35 max: 110



5.5.4 Odours

Ambient odours in the project vicinity include hydrocarbon emissions from internal combustion engines (particularly from diesel-driven vehicles), which are most noticeable in Cork City and along major roads. Burning of coal in fireplaces and furnaces also produces widespread sulphurous odours, most noticeable during cold periods. Emissions of organic compounds from chemical and pharmaceutical manufacturing plants on Little Island and Marino Point also generate detectable odours in the Lough Mahon vicinity. In addition, naturally occurring sulphurous odours emanate from the expansive mud flats throughout Lough Mahon when exposed during low tides, especially during warm conditions (Bailey 1992). The proposed treatment site at Carrigrenan is surrounded on three sides by extensive mud flats.

A detailed odours study, including air quality dispersion modelling, for the proposed treatment plant was carried out. This report is included as Appendix 4 .

5.6 Landscape

The purpose of this section of the EIS is to describe the context and character of the project area, its significance, and its vulnerability to visual impacts. This section focuses primarily on the treatment plant site at Carrigrenan in that this is the primary part of the proposed scheme with any significant aboveground structures that may influence existing aesthetic resources. Reference is also made to the Atlantic Pond Pumping Station.

The Atlantic Pond site, near the Marina, has a low situation and is suitably located between the City and the Upper Estuary of the Harbour. The site is bounded by the Old Passage Railway line on the northern perimeter and by private residential property on the southern perimeter. The site is low lying and is disused. The area of disuse extends eastwards parallel to the Old Railway Line beyond the extent of the proposed site, amounting to 1.5 hectares. The envisaged site for the proposed pumping station is 1.2 ha. in area.

The Carrigrenan site is located at the south eastern tip of Little Island and is surrounded on the west, south, and east by Lough Mahon. Little Island is flat to gently rolling in nature and characterised by a predominance of industrial uses and open space with scattered residential development. Much of the open space consists of grazing lands and two golf courses. The land area throughout Little Island is, however, not used as extensively for agricultural and grazing purposes as other areas within the Cork region.

Given the location of the site, both the context of the area and the character of the site are heavily influenced by Lough Mahon and the upper Cork Harbour. In this area, Lough Mahon dominates the

landscape and tends to diminish the visual and aesthetic conspicuousness of specific terrestrial resources.

The character of the Carrigrenan site itself is defined by a rolling topography and a mixture of vegetation types and habitats, and provides aesthetically pleasing views to the west and southwest. Within the boundaries of the site are the remains of Carrigrenan House, which are surrounded and sheltered by mature vegetation. The predominant topographic feature of the site is a hillock approx. 22m in elevation that allows views of Cork Harbour in all directions.

The following provides a more detailed discussion of the prominent components of the landscape.

5.6.1 Topography

The topography of the Carrigrenan site is as previously illustrated in Map 4.5.1. As shown, the site is rolling in nature, with elevations ranging from less than 2m to approx. 22m. Topographic relief of the site is dominated by two hillocks: one of approximately 16m in elevation located in the centre portion of the site, and the second, more dominant feature, being approx. 22m high located in the southern portion of the site. Due to its proximity to the edge of the site along Lough Mahon, the shoreline in this area is composed of cliffs approx. 12m in elevation.

5.6.2 Natural Feature

The predominant natural features of the site are:

- Topographic relief that provides an area of high ground at the southern end of the site.
- The extensive waterfront boundary on three sides of the site.
- A low area (less than 2m) at the northern portion of the site that is covered by spring tides.
- The range of natural habitats ranging from open fields to mature trees and intertidal zones.

It should be noted, however, that the range of habitats is due, in part, to the development and use of the site for agricultural and grazing purposes. This diversity of habitat is reflective of the sites use, which is common throughout the Cork region, and as such is not considered unusual or highly significant.

5.6.3 Man-Made Features

The site is bordered on the north side by a local service road serving several private houses. Tower View Cottage, located near the southeastern corner of the area covered by spring tides, is occupied. Other significant man-made features within the site vicinity are dwellings and industrial/commercial uses along the road from Ballytrasna to Clashavodig, golf courses to the north and northwest of the site, and the IFI plant located south of the site on Marino Point.

Man-made features on the proposed site include Carrigrenan House and associated outbuildings located in the centre of the site. Carrigrenan House is in an advanced state of disrepair and is not inhabited. A stone tower is also located along the rocky shoreline at the extreme westernmost point of the site. These man-made structures are addressed in further detail in Section 5.7 (Cultural Heritage) of this EIS.

5.6.4 Aesthetic Resources

The aesthetic resources of the site, as with any area, are a subjective component of the landscape. As opposed to the more objective nature of the topography or natural and man-made features of the site, the aesthetic or visual resources are somewhat dependent upon individual perceptions and responses. Aesthetic resources can be discussed in terms of internal (i.e. within the site) and external (i.e. off-site) views. External views include views from the site to other areas, and from other areas toward the site.

Aesthetic resources within the confines of the site are somewhat limited and unremarkable given the context of the site in relation to the remainder of Little Island and the Cork area. Due to the topographic relief, views from any particular point within the site are limited in scope. The entire Carrigrenan site is not completely visible from any one point. The aesthetic resources present within the site include rolling open fields with scattered trees and hedgerows. The aesthetic quality of the site itself is common to the semi-rural landscape of much of the Cork area and as such is not considered significant.

Existing views from the Carrigrenan site to areas off site are more aesthetically pleasing, particularly given the presence of Lough Mahon which adds the water element to the rolling residential/agricultural patchwork that comprises the countryside within the existing viewshed.

Views from the site to the south include the IFI Fertiliser plant at Marino Point, a view past Passage toward the lower harbour, and the gently rolling countryside above Marino Point and Passage. In this latter direction, the IFI plant dominates the view.

Views from the site to the west are across Lough Mahon toward Hop Island and Mahon. Due to the relatively large distance between the sites and these land forms (nearly 3km), they are not dominant features of the visual landscape (in fact, Hop Island is barely distinguishable from the background relief of Rochestown). The mouth of the Douglas River is also barely visible. Cork City is located over 5km to the west and is not readily visible from the Carrigrenan site.

Views to the north of the Carrigrenan site, towards the remainder of Little Island, are dependent on where the viewer is situated on the site (i.e. his or her elevation). From much of the site, views to the north are limited and extend only to the hedgerow along the northern part of the site. From the highest point of the site, other parts of Little Island are visible, but the view of this area is dominated by scattered industrial facilities. As such, the aesthetic value of this portion of the viewshed is limited.

Views to the east of the Carrigrenan site are obtainable only from the eastern portion of the site. Notable features in this direction are the railroad lines across the mouth of the Belvelly River, a Martello Tower, storage yards for the IFI Fertiliser plant, and portions of Fota Island. Fota Castle is barely visible from the extreme northeastern corner of the site.

Views of the Carrigrenan site are available from areas around Lough Mahon. In general, the scale of these views is highly influenced by distance across an expanse of water, which tends to focus aesthetic perceptions on larger features such as hills, large open fields, and wooded areas rather than on specific features such as individual houses or structures. The Carrigrenan site is most visibly apparent, at a distance where the scale allows recognition of specific features, from points along the amenity walkway between Hop Island and Passage (1 to 2km) and from the railway line between the Belvelly River and Marino Point (900m). While views of the site from these areas are notable, there is no existing feature at the site that significantly contributes to or dominates the visual or aesthetic nature of the Little Island shoreline. The site appears as an open area with some trees. The topographic

relief provided by the promontory at the southern part of the site is distinguishable from many points within Lough Mahon.

Much of the Carrigrenan site is visible from the adjacent area to the north of the site. This area includes several residential houses and a portion of the Harbour Point Golf Course. In particular, views of the site from these areas extend from the sloped area between the ruins of Carrigrenan House outbuildings to the east to the 22-metre-high promontory to the west. It should be noted, however, that due to the heights of the existing hedgerow in this area, the density of the existing natural vegetation and maintaining an embankment along the northern side of the developed site, grade-level views from the road into the site are severely limited and restricted to only a few isolated locations - (Ref. Sectional Elevation A-A - Fig. 4.5.3).

In general, the aesthetic resources and scenic views both toward the site and from the site are considered attractive due to the interrelationship of water (Lough Mahon) and land (Little Island, Mahon, Rochestown). However, the distance between viewpoints, particularly across Lough Mahon, tends to influence the scale of visual resources so that the visual landscape is dominated by large land forms and features and specific sites or areas appear less noticeable. While aesthetic resources of Lough Mahon/Carrigrenan are considered valuable assets to local landscape, they are not of an unusual, unique, or highly significant nature.

5.7 Cultural Heritage

Despite its accessibility and extent, Cork Harbour has never been the site of any significant military or naval exploit; consequently, its historical associations are of less national interest and importance than other protected harbours of County Cork, such as Bantry Bay and Kinsale Harbour. Nonetheless, Cork Harbour has been an important centre for trade and commerce for more than 800 years (Coleman 1914).

A 1975 inventory of existing archaeological monuments lists 96 sites within 176 square miles of land surrounding Cork Harbour (O'Kelly and Shea 1976). These sites range in date from the Late Neolithic (c. 2000 B.C.) to the 19th. Century, and include ringforts, churches, castles, shell middens, and 17th to 19th. century fortifications and towers. The *County Cork Sites and Monuments Record* (Cork Archaeological Survey) of the Office of Public Works, 1988 is more comprehensive, including less significant sites such as walls, gates, piers, and wells.

Historical references to the townlands were checked in the Journal of Cork Historical and Archaeological Society, *"Cork Harbour Archaeology"*

by the Department of Archaeology U.C.C., and in *"Cork and County Cork in the 20th. Century"* by Hodges and Pike. Based on these sources, 19 sites are located within 1km of the proposed facilities.

Notable cultural resources within close proximity of the proposed collection mains include Blackrock Castle (1829) and Ringmahon Castle (age unknown), both located in the Townland of Mahon; a shell midden at Harty's Quay near the Tramore Valley Pumping Station; and a circular tower (17th to 19th century) on Hop Island (Coleman 1914; O;Kelly and Shea 1976; Office of Public Works 1988).

Several well-preserved towers from the 17th to 19th century are located in the vicinity of the proposed treatment plant at Carrigrenan, due to the site's strategic location within the upper harbour. A circular tower with an attached rectangular structure is located on the northwestern shore of Carrigrenan at the cove near the access road. In the vicinity, a well-preserved Martello Tower and Foaty Castle are both located across Foaty Channel to the east of Carrigrenan, approx. 800m and 1km from the site, respectively.

The proposed treatment plant will include the site currently occupied by Carrigrenan House, an abandoned 19th century farmhouse and associated outbuilding. This site is not included in the *County Cork Sites and Monuments Record or in "Cork and County Cork in the 20th Century"* due to its relatively recent age. Cultural resources of this sort are common in the region and generally not considered of major cultural importance.

As defined by the 1987 National Monuments (Amendment) Act, a "historic monument" is defined as "a prehistoric monument and any monument associated with the commercial, cultural, economic, industrial, military, religious, or social history of the place where it is situated or of the country and also includes all monuments in existence before 1700 AD or such later date as the Minister may appoint by regulations". In terms of this Act, there are no known archaeological monuments at the site of the treatment plant.

The occurrence of shell midden all around Cork Harbour dating from prehistoric times to the 19th Century was recorded by McCarthy (1987 unpublished M.A. thesis UCC), and by the Department of Archaeology UCC Cork Harbour Study (1976). A known prehistoric shell midden is located along the western shore of the Carrigrenan site, south of the stone tower. The date of this midden is not known, but the site does merit protection. Field reconnaissance identified another area of shell

(predominantly clam and scallop) deposition at the extreme southern tip of Carrigrenan Point to the west of the quay. The origins of this shell deposition are not known, as it is not identified as a shell midden in work conducted by McCarthy (1987) or the Department of Archaeology UCC. The determination of this area as a shell midden should be made by a qualified archaeologist. Due to its location at the Carrigrenan site, this area will not be affected by construction or operation of the facility.

No known archaeological sites, monuments or historic structures will be directly impacted (i.e. removed) by the collection mains or outfall main.

5.8 Material Assets

In general, the identification of specific material assets is open to interpretation, and there is little consensus on components of the environment that may be regarded by society as being of value for production, development, maintenance, recreation, and well-being (Bradley, Walsh, and Skehan 1991). For the purpose of the proposed Cork Main Drainage Scheme, significant material assets include sustainable development and severance.

5.8.1 Sustainable Development

The concept of sustainable development is advocated in the report of the World Commission on Environment and Development (The Brundtland Report),. These principles are:

- Concept of Sustainable Development as advocated in the Report of the World Commission on Environment and Development (the Brundtland Report). This concept envisages a reasonable balance in man's interest between development and nature.

- The principle of precautionary action even where there is no definite scientific evidence of both emissions or discharges with detrimental environmental effects.

- The integration of environmental considerations in all policy areas.

In the context of the Cork Harbour area, sustainable development must have its basis on the development plans of the local authorities and on the LUTS Review, as these documents contain the most solid information on existing conditions and strategies for future development.

If the Cork Main Drainage Scheme is to contribute positively to sustainable development in the greater Cork area, the treatment plant should be located as far downstream as is economically feasible. The reasons for this are:

- The area likely to benefit most from a development viewpoint is that in the Little Island/Glounthaune/Carrigtwohill corridor

- Location of the site in the limited available land bank in the city area would interfere with projected development proposals initiated in the City Development Plan (i.e. Mahon) and in the County Development Plan (i.e. Douglas/Rochestown area).

The following paragraphs from the LUTS Review 1991 are relevant:

East Harbour Area

The main employment potential lies in the corridor extending from Tivoli and Little Island to Midleton. Careful management of this area will be required to ensure that its potential is not destroyed through commercial strip development along the existing road. (The need for such control also arises in relation to new roads on the study area, particularly near junctions). Little Island has potential to benefit from the new road through the creation of a wholesaling/industrial support services park. Housing development should be carefully controlled to avoid compromising privately owned land which may be suitable for industry in the longer term. Little Island has potential for accommodating a major industry requiring 100 acres or so, and a reservation for this purpose is proposed.

Carrigtwohill may also have potential for a major stand-alone industry and land should be reserved for this, using agricultural/possible (longer term) industry zoning to keep the options open. Carrigtwohill also has some 80 acres of publicly owned industrial land, capable of accommodating several significant industries. An extension of the City and Harbour Water Scheme is likely to be required in the short to medium term to allow for water-using industry. There may be savings in coordinating the extension of the scheme from Little Island to Carrigtwohill with the construction of the corresponding section of the N.25 road improvement.

5.8.2 Severance

Severance deals with the possibility that a development may disrupt activities, linkage between activities, such as journeys to work or shopping trips, or divide land to the detriment of the whole. Particularly for pedestrians, severance may be a psychological feeling and thus difficult to define (Cork Corporation 1991).

Regarding the proposed Cork Main Drainage Scheme, the issue of severance is potentially relevant regarding the treatment plant site and the collection mains. Severance impacts of the proposed scheme are addressed in detail in Section 6.8.2 of this EIS.

5.8.2.1 Treatment Plant Site

The preferred treatment plant site is located at the southernmost tip of Little Island. The site is surrounded on the east, south, and west by Lough Mahon, and on the north by terrestrial portions of Little Island. Although the foreshore area around Carrigrenan Point is accessible to the general public, it is not heavily used due to its distance from more developed areas, the lack of a public walkway (as found around the Mahon site), and the rocky nature of the shoreline to the southwest portion of the site (which makes access more difficult).

Other resources potentially susceptible to severance-related impacts in the vicinity of the treatment plant site include the residential dwellings located along the access road and other developed and undeveloped lands in the vicinity, in particular future roadway access/connection to the Courtstown Industrial Estate located on the eastern side of Little Island.

Severance impacts of large development can be both short-and long-term in duration and can be mitigated in most instances.

5.8.2.2 Collection Mains

Due to the location of collection mains on the Lough Mahon shoreline, a potential exists that pedestrian activities and linkages to the waterfront may be disrupted. This could be particularly pronounced where a collection main follows the route of an existing walkway or path utilised by pedestrians (i.e. Blackrock/Mahon area).

Clearly, construction of the collection mains would also disrupt road surfaces and traffic flows in some areas and thus temporarily restrict or

block access to such places as work, shopping, etc. It is in these areas where construction will be overtly apparent to pedestrians and motorists that severance-related impacts may be perceived to be the greatest.

Chapter 6

ENVIRONMENTAL IMPACT

CHAPTER 6

Environmental Impacts

This section describes the impacts that could result from the construction and operation of the Cork Main Drainage Scheme. Ameliorative measures are identified and discussed in Chapter 7.

6.1 Human Environment

6.1.1 Land Use

Construction and operation of the wastewater treatment plant will result in a change in the existing use of the Carrigrenan townland site. The entire 32 ha will not be directly affected because the northern portion of the site affected by spring tides (approx. 7 ha) and the 22m hillock at the extreme southern tip of the site will remain undeveloped. However, approximately 20 ha. of the site will be permanently converted to use as an urban wastewater treatment plant facility.

The planning objectives for the site as expressed in the County Development Plan and the LUTS Review of 1991 call for industrial usage, particularly harbour or waterfront-related industry that will utilise the deepwater channel at Marino Point. The wastewater treatment plant will utilise the deepwater channel at Marino Point. In addition, the plant will facilitate the industrial development of Little Island. As such, the treatment plant is compatible with land use policies and objectives regarding industrial land use at Little Island.

The proposed treatment plant is consistent with the predominantly industrial and manufacturing uses on Little Island. However, the location of approximately 12 residential dwellings at over 100m from the site does provide a generally noncompatible land-use mix. In selecting a site for the treatment plant, a concerted effort was made to avoid residential areas to the maximum extent practical, and in particular to avoid densely developed residential areas. Although these 12 dwellings in their current context are not considered a high-density residential area, their existence is a concern that will be addressed and ameliorated to the extent practical.

These residential houses are all located along the north side of the access road from Clashavodig to Tower View Cottage. At the closest point, the nearest treatment plant unit will be more than 200m from the

nearest residence. Tower View Cottage, which is located on the 32 ha. Carrigrenan site, will need to be purchased.

From a land-use perspective, the construction and operation of the treatment plant will not impact the future use of either the Harbour Point Golf Course or the Little Island Golf Course. In addition, it will not adversely affect the operation of industrial or manufacturing uses in Little Island.

The construction of the proposed collection mains will result in temporary disturbances to land uses directly traversed (i.e. roads, amenity walkways, mudflats), but these disturbances will cease with the termination of construction and subsequent restoration activities. Operation of the collection mains will not affect land use or land use patterns except that future permanent structures (i.e. houses, buildings) will not be permitted directly above the mains for obvious safety and maintenance reasons.

Construction and operation of the proposed outfall main from the Carrigrenan site to the outfall at Marino Point will not affect land use given the current route of the main east of the man-made quay along the southern boundary of the site.

Construction and operation of the Atlantic Pond Pump Station will result in the conversion of 1.2 ha. of undeveloped land to an urban use comprising pumphouse service building and administration building. This use is consistent with the existing fabric of this part of Cork City. Although the access road to this facility will traverse the public amenity walkway (i.e. old railway line), operation of the pump station will not adversely affect the use of the walkway by the public.

In addition to the Atlantic Pond Pump Station, ten other pump stations will be required as part of the Cork City Main Drainage Scheme. Of these, five are existing wastewater pump stations or septic tank facilities that will only be upgraded. The remaining five will require new construction encompassing 0.1 hectares - 0.2 hectares. These pump stations are located throughout Cork City, Blackrock, Mahon, Tivoli and Little Island, and each is located in an area of urban or industrial development. Additional information regarding these pump stations, including specific locations and sizes, is provided in Section 2.2.2.2 (Associated Developments) of this EIS.

6.1.2 Population and Housing

The construction and operation of the proposed Cork City Main Drainage Scheme will not result in any significant impacts to current population or projected population growth patterns for Cork City, Cork County, or Little Island. The treatment plant has been designed to accommodate a population equivalent of 448,350 which will account for population growth for the next 30 years.

Construction and operation of the proposed treatment plant will result in adverse impacts to the approximately 12 residential dwellings located at over 100m from the proposed plant and to new residential construction in the area. These impacts would likely include a reduction of new home construction in the immediate vicinity due to a reduced desirability to live in close proximity to a wastewater treatment plant. It should be noted, however, that residential land use in general on Little Island is currently affected by the predominance of significant industry and manufacturing uses there. In addition, it should be noted that new residential construction on Little Island is not entirely consistent with the County Development Plan and the LUTS Study, which call for encouraging industrial use and developments on Little Island.

Construction of the treatment plant will require that Tower View Cottage be purchased from its current owner and demolished. As such, the proposed action will result in the direct loss of one active residence.

Construction and operation of pumping stations will not impact on population and housing resources.

Construction and operation of the collection mains and treated effluent outfall will not impact population or housing resources.

Measures to ameliorate potential impacts to these housing units are addressed in Section 7 of this EIS.

6.1.3 Recreation

Construction and operation of the Main Drainage Scheme is not anticipated to result in any significant adverse impacts to recreational activities or opportunities in the Cork area.

Construction will result in the temporary disturbance of foreshore areas and part of the public amenity walkway (Old Railway Line), which will result in the temporary loss of access and/or visual impacts and thereby affect the recreational (i.e. aesthetic) value of the area. However, these

impacts would be temporary and would last for the duration of construction only, and the amenities would be fully restored following construction.

6.1.4 Transportation

Construction of the treatment plant at the Carrigrenan site will result in an increase in traffic in the vicinity of the site as a result of construction workers and construction vehicles (i.e. trucks, graders, etc.) accessing the site. Access to the site will be via an extension of the existing Industrial Estate Road from Courtstown Industrial Estate to Carrigrenan. As existing traffic levels are low, this increase in traffic will likely be significant. Traffic flow will be particularly heavy in the morning (8am to 9am) from the Industrial Estate Road south to Carrigrenan and in the late afternoon (5pm to 6pm) from Carrigrenan north to the Industrial Estate Road. This new road will be designed to accommodate the types of heavy vehicles associated with industrial development.

Actual traffic flows resulting from construction of the wastewater treatment plant are dependent on the specifics of the construction plan (i.e. phasing, timing of activities, methods of construction etc), and as such are difficult to accurately predict at this time. It should be noted that actual traffic flow increases will vary over the period of construction depending on ongoing construction activities. Any increases in traffic associated with construction workers and vehicles will be short term, temporary, and occur only for the duration of construction.

Space will be adequate for construction workers to park automobiles on the Carrigrenan site so as not to block the road or restrict access to the existing houses. The parking area should accommodate one vehicle per worker.

Actual traffic flow per day to and from the wastewater treatment plant after construction is estimated to be 11 automobiles for workers and an estimated 2 heavy vehicles for sludge/grit/screening transportation off site, and sufficient parking area to accommodate these vehicles on the Carrigrenan site is provided.

Construction of the collection mains will result in traffic-related impacts to existing roadways that will severely limit vehicle access. In some instances, a road may be closed to allow for safe and efficient

construction. In all cases where vehicle access will be restricted or prohibited, detour routes will be clearly marked.

Construction in roadways will be temporary, and following surface reinstatement, vehicle movement will be restored. Specific roads to be impacted, appropriate detour routes, and a projected timeframe for construction in these areas will be developed during the final design phase.

Operation of the wastewater treatment plant will result in a minimal traffic increase. Due to the extensive automation of the plant a maximum of 11 employees will be required. As such, access to the site by these employees should not be significant. Actual projections as outlined above, are one vehicle per employee.

Operation of the plant will also produce sludge residue (from the thermal drying process and also screenings and grit which will need to be removed. It is estimated that approximately 18m^3 per day of sludge product (16.7 t/d at 93% TS) , 4/5m^3 screenings and 4/5m^3 of grit would need to be disposed of off site. This volume would be removed every one to two days by 2 no. trucks. As such, operation of the plant will result in the long-term increase in large truck traffic on Little Island. This increased volume is not significant given the other industries and associated truck traffic on Little Island.

Many of these traffic-related impacts along the access road from Carrigrenan to Ballytrasna (i.e. traffic congestion, large vehicles, noise, etc) will be avoided due to the extension of the Industrial Estate Road from its current terminus at the Courtstown Industrial Estate to the Carrigrenan site as proposed in the Cork County Development Plan (Cork Co. Council 1989). The extension of this widened and improved roadway would provide excellent site access for employees and truck traffic, avoid the residential areas near Clashavodig, and promote industrial development in the area between Courtstown Industrial Estate and Carrigrenan.

Public Transportation

Construction and operation of the proposed wastewater treatment plant will not affect the availability of public transportation modes. Bus traffic may be affected by construction of collection mains in roadways, but this would be neither long term nor significant. Buses would merely follow

established detour routes.

Cork Harbour and Shipping

Construction of the collection main across Lough Mahon from Mahon to Carrigrenan and across the River Lee at Kennedy's Quay may result in temporary inconveniences to shipping traffic due to the presence of construction barges and trenching equipment. However, this construction can be conducted so as to avoid times when ship traffic to Cork City is anticipated. Inconveniences would only result in the crossing of the dredged channel at high tide when shipping traffic is more likely to occur. Following completion of these river/harbour crossings, operation of the collection mains will not affect shipping activities.

Construction and operation of pumping stations will not affect shipping or harbour activities.

Construction and operation of the treatment plant will not affect shipping or harbour activities.

6.2 Flora and Fauna

This section discusses the potential effects on flora and fauna caused by the construction and operation of the proposed Cork Main Drainage Scheme. The discussion addresses the effects on both terrestrial and marine resources.

6.2.1 Terrestrial Environment

Construction and operation of the proposed facilities will result in both long-and short-term minor impacts to terrestrial flora and fauna. Construction of the proposed treatment plant will require the permanent removal of approx. 20 ha. of native vegetation at the proposed treatment plant site. This impact will be relatively minor due to the previously altered nature of the existing plant communities (Active pastureland, hedgerows, and ornamental trees) and the relative abundance of similar habitat in the general vicinity of the treatment plant site. The proposed facility will be configured and sited so as to minimise clearing of large trees near the southern end of the site. In addition, woody hedgerows bordering the site will be retained to the best degree possible to minimise ecological and aesthetic impacts. Following construction of the treatment plant, open spaces remaining within the site will be revegetated with grass, consequently, a significant portion of the present grassland will be functionally replaced.

Construction of the proposed wastewater transmission mains and pumping stations will have

minor temporary effects on terrestrial vegetation. Most of the mains will follow existing roads and wayleaves and will not require clearing of vegetation. Where mains traverse early successional fields and hedgerows on Little Island and Mahon, approximately 3.0 ha. of vegetation will be removed. Because of the local predominance of these types of vegetational communities, impacts to flora will be minor. In addition, the vegetation will be allowed to revert to its original condition following construction.

Construction of the proposed facilities will have minor short-and long-term impacts of fauna habitat, causing localised impacts to fauna populations. During construction, the clearing and grading of the treatment plant site, pumping stations' sites and transmission main wayleaves will result in a loss of vegetative cover that could cause limited mortality to less mobile forms of wildlife, such as small rodents, which are unable to escape the construction area. In addition, physical disturbance of the site and noise from construction activities will likely cause the temporary displacement of most fauna from the immediate vicinity of the construction zone and adjacent areas. Following construction, displaced species are expected to resume their normal habits consistent with the availability of post-construction habitats.

Construction of the treatment plant on the 20-hectare site will result in the long-term conversion of native vegetation to maintained industrial use. This will preclude the use of this area for some fauna. Small rodents, rabbits, and songbirds may continue to derive benefit from the maintained grassy areas and early-successional hedges retained around the perimeter of the site. Demolition of Carrigrenan House and clearing of adjacent trees at the treatment plant site will remove potential roosting sites for bats. However, the stand of large trees near Carrigrenan Point will be retained as a visual buffer and may provide suitable roosting locations for bat populations. Other mammal species currently occupying the site will be able to find suitable undeveloped habitat generally found in abundance adjacent to the disturbance area.

Of the protected species that may occur in the project vicinity, only the pygmy shrew is likely to be affected by construction and operation of the proposed facilities. Some mortality may occur during construction of the wastewater mains and treatment plant. Loss of habitat will be temporary, and post-construction revegetation of construction areas will provide prime habitat for recolonisation.

6.2.2 Marine Environment

Implementation of the proposed Cork Main Drainage Scheme will have short-term minor adverse effects and long-term beneficial effects on marine flora and fauna.

The new wastewater transmission main that will convey wastewater from the proposed head chamber at Mahon to the treatment plant at Carrigrenan will cause short-term impacts to littoral and pelagic marine resources and the waterfowl that utilise these resources. This transmission main will traverse approx. 3.5km of the floor of Lough Mahon, including the dredged navigation channel.

Operation of heavy equipment for trenching and pipe installation during construction will result in direct and indirect impacts to benthic fauna such as polychaetes, molluscs, and crustaceans. Sedentary organisms such as mussels, oysters, clams, snails, limpets and various algae will experience direct mortality and disruption-of-substrate impacts.

Nearby benthic and pelagic communities may be affected by sedimentation resulting from disturbance and suspension of marine sediments in the water column. Increased sedimentation may smother fauna and sedentary epifauna located adjacent to the dredging area.

Suspended sediment particles may clog the tentacles, fine filters, and gills of suspension feeders and may lead to localised reductions in population of these species (Gay et al 1991). In addition, increased turbidity can cause attenuation of light, thus lowering the rate of photosynthesis by macroalgae and phytoplankton.

However, such effects of suspended solids on benthos are generally restricted to areas that experience extremely high turbidity for a prolonged period of time. Most marine benthic organisms can withstand exposure to high concentrations of suspended solids for short time periods (Saila et al 1972).

Sediment plumes resulting from construction will have a minor effect on demersal and pelagic finfish. High concentrations of very fine sediment particles can coat the respiratory epithelium of fishes, thereby interfering with respiration (Sherk et al 1974).

In addition, suspended solids can affect juvenile and larval fish and cause siltation of spawning beds. However, unlike most benthic fauna,

finfish are highly mobile and can avoid areas they find unsuitable. In general, potential suspended solids impacts are expected to be minimal.

Depending upon the degree of wind and wave energy, intertidal foreshore areas are subject to frequent natural physical disturbance. For this reason, many of the benthic faunal species occupying the littoral zone have developed adaptations to withstand frequent disturbance. Due to this inherent resiliency, marine benthos are expected to recolonise the foreshore area shortly after cessation of construction activities. Recolonisation by benthos after dredging operations has been shown to be very rapid, on a scale of weeks to about two years, depending upon the magnitude and season of dredging (Wildfish and Thomas 1985; Jones 1986). Studies of the rocky intertidal zone of Bantry Bay, County Cork, were conducted to provide information regarding the sequence and duration of ecological recovery following human disturbance of the intertidal zone. Shores cleared of flora and fauna during the summer of 1978 were found to have nearly full recolonisation by August 1979 (Cross and Southgate 1982). Similar recolonisation can be expected to occur in Lough Mahon.

The treated effluent discharge main will convey treated effluent to a discharge point downstream of Lough Mahon. The discharge main will traverse approx. 1km across the floor of Lough Mahon to an effluent outfall point at the deepwater channel near Marino Point at the head of West Passage. This portion of the effluent transmission main will be entrenched into the sediments, thus causing localised direct physical impacts to marine benthos and plumes of suspended sediments. Impacts to benthic organisms resulting from disruption of substrate and sediment plumes are expected to be similar to those described above for the intertidal construction-related disturbance. No commercial shellfish beds or maricultural operations are located in Lough Mahon or Upper West Passage. Consequently, no impacts will occur to commercial shellfishing interests. Impacts to benthic populations will be limited as far as is practicable by minimising the extent and duration of bottom disturbances. In addition, construction of transmission and discharge mains will be scheduled to avoid periods of peak salmonid migrations (April through September) to minimise adverse impacts to recreationally important fish species from degraded water quality.

Construction activities associated with installation of the wastewater transmission and discharge mains in the foreshore will have insignificant effects on waterfowl populations. Operation of heavy equipment will cause temporary avoidance of the construction area. Birds quickly adapt to noise and movement at construction sites. Consequently,

construction operations are not expected to significantly alter feeding behaviour. In addition, construction will move sequentially across the foreshore, affecting local areas only for a short period of the total duration of construction.

Temporary, localised reductions in prey populations due to construction in the foreshore will have an inconsequential impact on the waterfowl carrying capacity of the area because only a small proportion of Cork Harbour's mudflats will be affected, and high-tide roosting habitat- (non feeding habitat) - is the limiting factor in waterfowl abundance and distribution in Cork Harbour (O'Halloran 1992). The proposed project will not result in any loss or disturbance to known high-tide roosting habitats.

The construction and operation of the main pumping station at Atlantic Pond will not impact on the marine environment. This also applies to the minor pumping stations.

Night-lighting at the proposed wastewater treatment plant will not adversely affect bird behaviour. Some waterfowl species are known to use night-lighting to their benefit to aid in night-time feeding (Goodwillie 1991).

Although the wastewater will be subjected to secondary treatment to remove the majority of BOD/COD, suspended solids, to effect some reduction in nutrient and bacteriological loadings, some localised impact to marine flora and fauna may occur. Increased nutrient concentrations in the vicinity of the outfall may result in a shift in normal phytoplankton populations or community structure, which may include minor algal blooms. Such effects are expected to be minimal due to the degree of water flushing in the passage and the expected lowering of the overall ambient nutrient levels in the estuary caused by the proposed action.

Suspended solids and organic matter contained in the treated effluent will tend to flocculate and precipitate in the effluent/seawater mixing zones. This precipitation may cause localised smothering of sediments and increases in benthic BOD, thereby reducing dissolved oxygen (Gay et al 1991). This effect is expected to be minor due to the proposed diffuser structures that will facilitate dispersion and mixing of the treated effluent. Furthermore, the treated effluent will be generally warmer than the receiving waters, thus forming a buoyant plume carrying the effluent to the surface where wind-driven agitation will occur (Tchobanoglous and Schroeder 1985).

Although a significant amount of bacteria and viruses in the waste-water will be removed by treatment, all microorganisms cannot be removed economically and, thus, some will be discharged with the effluent.

Although commercial shellfish and bathing/swimming areas are susceptible to adverse impacts from degraded bacteriological quality, these areas are limited in Cork Harbour. The nearest commercial shellfish beds are located more than 6km from the proposed outfall in the eastern part of North Channel. The closest bathing beach is located in Lough Beg, more than 7.5km from the proposed outfall. Mathematical modelling of bacteria concentrations in Lough Mahon, including the vicinity of the outfall, was conducted based on the expected quality of the effluent and the mixing and circulation patterns of the estuary determined through a recent hydrographic survey.

The cessation of untreated wastewater discharge from the outfalls at Penrose and Kennedy Quays and Tramore Valley will have long-term beneficial impacts on the marine flora and fauna of lower River Lee and Lough Mahon. Improvements to water quality resulting from the cessation of untreated effluent discharge (see Section 6.4) will promote a more diversified and productive benthic community, which in turn will increase the carrying capacity of the upper harbour for benthic feeding fauna, including waterfowl, and fish. In addition to improving water quality in upper Cork Harbour, the proposed discharge of secondarily treated effluent will not significantly degrade the quality of water in West Passage or lower Cork Harbour.

6.3 Geology and Soils

Grading, trenching, excavation, blasting, and backfilling during construction of the proposed facilities will disturb soil horizons. However, many of the areas traversed by the proposed sewer lines consist of fill material that has covered the original soil horizons. No soil-dependent land uses, such as croplands and pastureland, will be traversed by the sewer lines. Consequently, trenching and backfilling during the installation of pipelines will not have any significant impact on soils.

Construction of the proposed wastewater treatment plant will require extensive grading of the Carrigrenan site to achieve necessary elevations and even contours. This disturbance to previously undisturbed soils will adversely impact soil productivity. However, since the proposed action will permanently convert the present agricultural grazing land use to an industrial use, this impact to soils is inconsequential.

Clearing of vegetation, excavation of existing soils, and site grading may result in erosion and sedimentation in the vicinity of the construction

area, including the Carrigrenan site and the collection mains. Without proper mitigation, erosion of topsoil and resultant sedimentation in either Lough Mahon or in the 7-ha. area covered by spring tides could be significant. Sedimentation will be controlled by implementing mitigative practices, such as the installation of sediment fences. Impacts resulting from construction activities will also be minimised by revegetating all disturbed areas as quickly as possible.

Operation of the proposed wastewater treatment plant and associated facilities will result in no significant soil erosion and sedimentation.

The construction of the pumping stations will have no impact on the geology or soils of the locations concerned.

The geology of the area is suitable for supporting large structures and facilities and will not be adversely affected by their construction and operation.

6.4 Hydrology and Water Quality

Construction of the land-based components of the scheme may result in some temporary degradation to Cork Harbour water quality in the immediate vicinity of the construction activities. This impact would be caused primarily by overland storm water flow transporting disturbed soil particles into adjacent receiving waters. This impact would be minimised by implementation of sedimentation and erosion-control measures and limited to the period of construction. Groundwater resources are not expected to be affected by the proposed action.

Construction of the submarine portions of the wastewater transmission main and the treated effluent outfall main will require dredging of approx. 3.5km of the foreshore and harbour bottom within Lough Mahon. Dredging operations will cause temporary minor impacts to water quality, primarily from the suspension of disturbed sediments into the water column.

Disturbance and suspension of sediments will cause temporary localised increases in turbidity and BOD, and may also release nutrients from interstitial water of organically-enriched sediments. Suspension of sediments also has the potential to release sediment-sorbed contaminants, such as heavy metals and synthetic organic compounds, into the water column. However, sediments which could be disturbed by installation of the submarine sewer mains in Lough Mahon do not appear to be significantly contaminated by such metals or compounds.

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Impacts resulting from construction-related sediment plumes would have

the greatest effect on flora and fauna in the immediate vicinity of the disturbance. Such impacts are discussed in Chapter 5 Flora and Fauna. Overall impacts to water quality will be minor and related primarily to the period of construction and shortly thereafter, until the sediments have stabilised.

Operation of barges and construction equipment within the harbour during installation of the submarine transmission and outfall mains may result in minor accidental releases of petroleum products, such as lubricating oil, diesel, or gasoline. Such incidences cannot be anticipated, but if spills or leaks occur, localised impacts to water and sediment quality could result. In relation to similar contamination from shipping activities in the harbour, only a major spill from the construction equipment would be significant in terms of harbour-wide water quality.

The proposed Cork Main Drainage Scheme will involve secondary treatment of urban wastewater to current EC guidelines, thus reflecting a reduction in excess of 90% in BOD, suspended solids, and 90% reduction in total coliform bacterial and approx. 25% reduction in nutrient levels. In addition to achieving significant bacteria reductions, secondary treatment of wastewater has been shown to result in an average 98.8% reduction in human enteric viruses contained in typical urban wastewater (Slade and Ford 1983). Since the Cork City discharge constitutes the major portion of the total anthropogenic pollution input into upper Cork Harbour, the proposed action will result in a significant reduction in anthropogenic pollutant inputs.

In addition to removing a substantial amount of pollution loading, the proposed action will also involve discharging the treated effluent in a zone determined through exhaustive hydrographic and mathematical investigation to have advantageous water circulation characteristics, thus improving initial dilution, dilution due to dispersion, and the material decay by chemical, biological, and physical means of the remaining wastewater constituents.

Discharge of treated effluent to bottom waters, which tend to be of higher quality than surface waters, will provide a greater assimilative capacity and result in better mixing as the warm effluent will rise, mixing with colder, overlying waters.

The combination of reducing pollution loading and improving mixing and dispersion will result in an overall improvement to water quality in the upper harbour and the Cork Harbour ecosystem as a whole.

Areas of the lower Lee Estuary and Lough Mahon will experience

improved water quality with regard to levels of total coliform bacteria, DO and BOD. Mathematical modelling of the response of the harbour to treated effluent discharges at the Marino Point outfall site were conducted to predict total coliform and BOD concentrations at specific locations in the harbour. The results of the modelling show worst-case scenario concentrations of 3,000 total coliforms/100 ml and 0.3 mg/l BOD at the point of discharge. These values are well within the EC mandatory levels for bathing waters and the National Water Quality Guideline limits.

Although the predicted values for total coliform bacteria concentrations and BOD are quite low, they have been determined as a direct result of the treated effluent discharge only. The mathematical models do not estimate existing background levels of total coliforms due to other potential sources including non-point source run-off and urban wastewater discharges not incorporated in this scheme. However, since the majority of wastewater entering the upper harbour is derived from the Cork City discharge, the predicted total coliform concentrations from the treated effluent combined with background levels as determined in the Water Quality Study undertaken as part of the preparatary work for this Statement, are expected to equilibrate at a level below the mandatory EC Standard for Bathing Waters.

6.5 Climate and Air Quality

6.5.1 Climate

The proposed Cork Main Drainage Scheme will not impact the local climate. The climatological conditions will affect the potential for odour nuisance arising from the wastewater treatment plant. This influence is discussed in Section 6.5.4

6.5.2 Air Quality

In general, impacts of the proposed project on air quality will be short-term and minor. Operation of construction equipment will result in crankcase emissions, exhaust, and fugitive dust being released. Construction equipment utilised will primarily produce emissions of nitrogen oxides (NO_x), hydrocarbons, and suspended particulates along with limited quantities of sulphur dioxide (SO_2), which will result from the use of diesel fuel. However, the overall amount of pollutants emitted will be low and result in a negligible impact to ambient air quality conditions.

During extensive dry periods, fugitive dust emissions will result from clearing and grading activities at the treatment plant site and from wind erosion prior to revegetation of disturbed areas. In addition, fugitive dust may be produced during trenching and backfilling activities in conjunction with the construction of the treatment plant, pumping stations and terrestrial portions of the collection mains. If prolonged dry periods result in extensive fugitive dust emissions (i.e. lowered visibility along roads), water will be applied to exposed soil to suppress the dust.

6.5.3 Noise

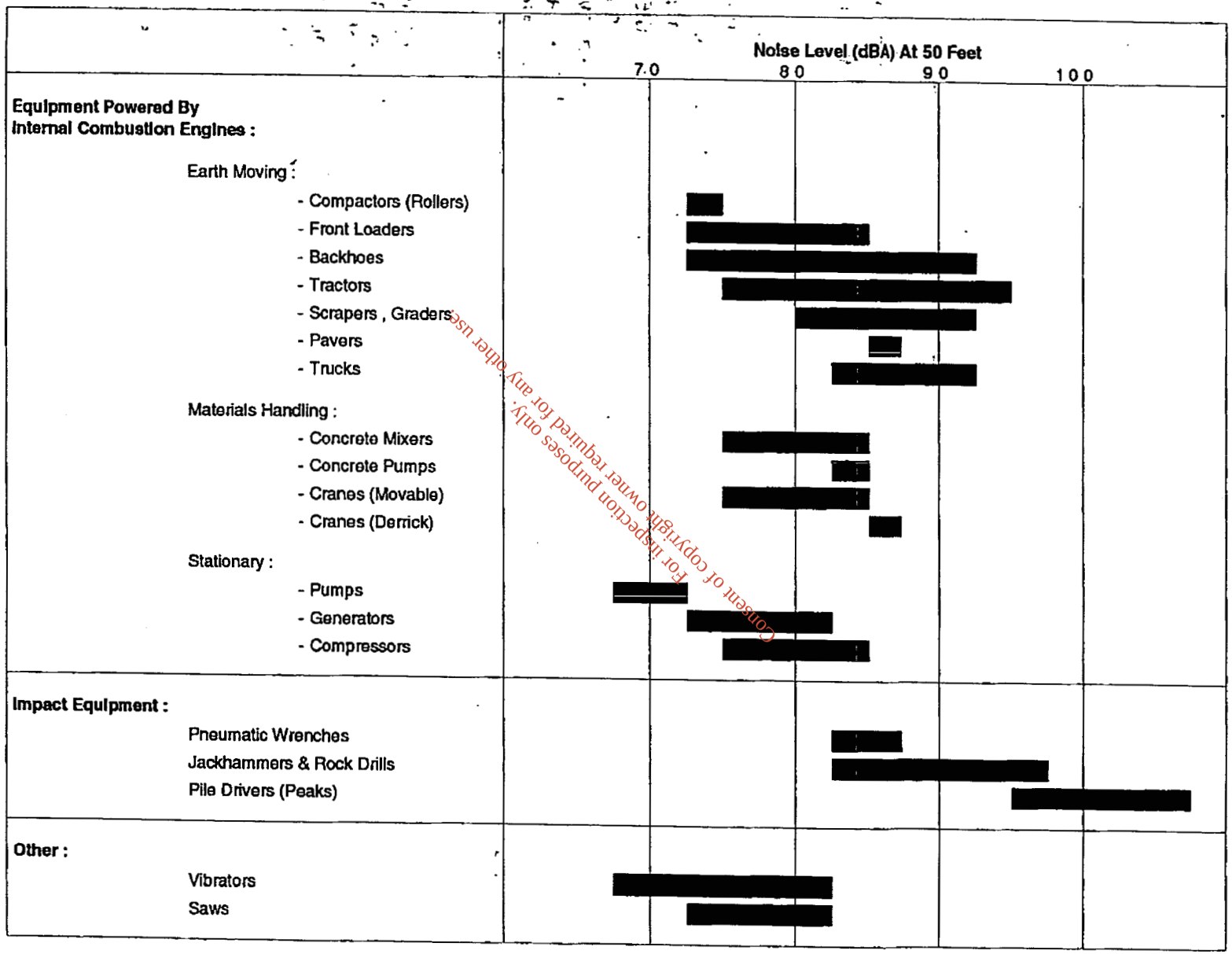
Construction of the proposed wastewater treatment plant and collection sewers will cause temporary, localised increases in the ambient sound environment. The specific impact will depend on the method of construction and the equipment used. Noise emission levels for the equipment typically used in sewer line construction are shown on Fig. 6.5.1 Noise levels during construction typically may be expected to range from 68 to 95 dB(A), measured at 16m with the occasional exception of impact equipment or blasting, which can cause noise levels up to 105 dB(A).

The noise levels emitted during construction of the proposed facilities will exceed the levels that currently characterise most of the project area. At the present time, L_{10} (which is the noise level exceeded only 10% of the time and hence an indication of noise intrusion) is likely to be in the vicinity of 43 to 59 dB(A) along most of the sewer line routes. Fig. 6.5.1 shows that dB(A) levels from construction equipment will range from 70 dB(A) to over 100 dB(A), a noticeable but temporary increase over existing conditions. However, in Cork City, ambient sound levels are likely to range between 66 and 78 dB(A). Therefore, noise associated with construction of the sewer lines in the more urbanised areas of the city will be less noticeable than in rural areas.

Regardless, because construction activities will proceed along the proposed sewer line routes, noise intrusion will be short-term at any given location. The only exception will be the construction of the treatment plant, which will result in comparatively greater noise impacts because of the relatively longer construction period required and the more rural nature of the area. The principal noise sources associated with those construction activities will be heavy equipment, such as bulldozers, scrapers, and trucks.

A primary factor in determining noise impact is the number of people exposed to the sound. Fig. 6.5.2 indicates the degree of potential

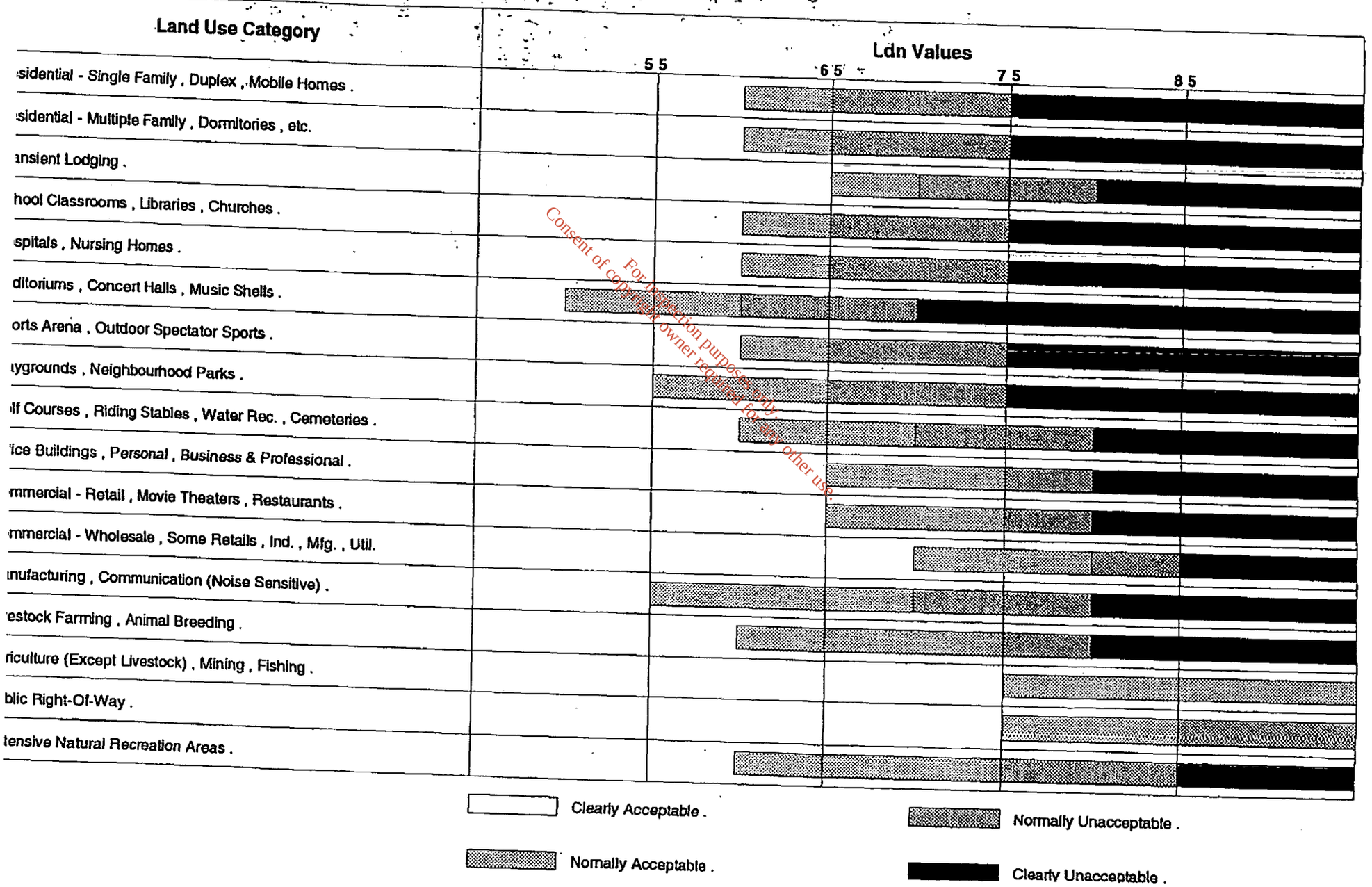
Figure 6.5.1
Construction Equipment Noise Ranges



Source : USEPA 1971

NOTE : Based on limited available data samples

Figure 6.5.2
Land Use Compatibility Guidelines



impact on surrounding land uses for a range of noise levels. Noise threshold levels for land uses traversed by the proposed sewer lines generally range from 65 to 75 dB(A). Thus, noise generated by construction activities will have a temporary impact for the duration of construction.

Further, because noise levels diminish at least 6 dB per doubling of distance from the source, noise emissions will be localised. As an example, construction equipment noise of 90 dB(A) (typical for an excavator or grader) measured at 16m would be reduced to 60 dB(A) within 500m and to 54 dB(A) within 1km. These noise levels would probably be further reduced due to ground and atmospheric absorption Therefore, the regional impact resulting from construction noise will be minimal, and any significant noise impacts will be highly localised and temporary.

Noise generated by operation of the proposed facility will be limited to that emanating from the wastewater treatment plant at Carrigrenan. No State or international (including European Community) statutory limits for environmental noise emissions are currently in effect. However, ISO Standard 1996-1982 provides guidelines for evaluating noise based on the acceptability of absolute levels. Because noise emissions from the treatment facility will be continuous, night-time limits (which are more restrictive than daytime limits) should be used as the appropriate noise criteria for evaluating potential impacts to noise sensitive receptors.

The night-time noise guideline for a "green field" site is usually 40 dBA at local residences. The baseline night-time measurement at the nearest residence to the proposed treatment plant (39.3dBA) was nearly equal to this criterion. However, given that the site is located in a mixed land use area (industrial, residential, recreational, agricultural), the "green field" guideline may not be entirely appropriate. As night-time criterion of 45 dBA is considered more appropriate given the presence of nearby industrial operations.

Most significant noise from wastewater treatment plants emanates from exterior mechanical aerators or from diffused air blowers housed indoors but with exposed inlets (United States Environmental Protection Agency {USEPA} 1976). Other potential noise sources include fans, compressors, pumps, valves, vents, grinders, centrifuges, conveyors, hoppers, lifts, turbines, engines, boilers, transformers, and electrical motors. Vehicles used to deliver chemicals and haul sludge represent intermittent noise sources.

Although noise emissions from the treatment plant are dependent on the specific equipment, plant layout, and noise controls used, typical noise

levels may be predicted from similar wastewater treatment facilities. A typical example is a similar wastewater treatment plant in Arlington, Jacksonville, Florida, USA, where a noise model indicated noise levels of 48 to 57 dBA at 360 metres (from the centre of the treatment plant site) with no noise controls. (This is the distance from the centre of the Carrigrenan site to the nearest residence). The nearest noist sensitive receptor to a treatment unit at the Arlington Plant is 210m, which is also similar to the proposed plant at Carrigrenan. With mitigative measures applied, noise levels at that distance were estimated at 44 to 47 dBA (USEPA 1975). The operation of the plant has not given rise to any complaints from local residents with regard to noise. The Arlington Plant consists of similar treatment processes to that envisaged for the proposed Cork Main Drainage Plant, e.g. screening, grit removal activated sludge secondary treatment. The plant has a design capacity of 36,400 m^3/day with single stream treatment being utilised. The ultimate design of the Cork Plant is 112,000 m^3/day utilising 3 main stream treatment in parallel i.e. 37,333 m^3/day, Given the planned implementation of similar mitigative measures at the Carrigrenan facility (see Chapter 7), an increase of 5 to 8 dBA in background nighttime noise levels at the nearest residences can be expected. Daytime noise levels would not change appreciably.

As designed, the treatment plant will meet the selected night-time criterion of 45 dBA, thereby minimising impacts of noise emission.

Because the pumping stations are envisaged to be submersible below ground stations, with overhead buildings, noise levels emanating from the stations will be minimal and below the night-time criterion of 45dBA. Blowers will also be housed in a building, with consequent low noise emission.

6.5.4 Odours

Odours associated with the proposed project will be primarily those produced by operation of the wastewater treatment plant. Although hydrocarbon emissions from operation of construction equipment will create some odours, these will be temporary and localised. Such odours are common in the project area.

The main factors affecting the potential impact of odours emanating from the proposed treatment plant are the proximity of odour-sensitive receptors (i.e. people) and climatic conditions. Residences and a golf course are located at over 200m from the northern most unit of the treatment plant and represent the closest odour-sensitive receptors. As discussed in Section 5.5.1 prevailing winds are from the northwest and will tend to disperse possible odours away from these receptors approx. 32% of the time. However, onshore sea breezes from the south and southwest, which occur primarily during summer daytime periods, may expose receptors to possible odours generated by the treatment plant. These wind conditions historically occur during 40% of the year but

generally only during daylight hours, at night, winds are reversed and will disperse odours away from the residences.

Consequently, the potential impact from odours associated with operation of the treatment plant will be limited to a relatively few number of people and will be temporary and infrequent. In addition, the design of the plant will incorporate air-tight covers on odour-generating facilities to minimise the amount of odorous compounds released to the atmosphere. All sludge treatment and handling areas including screens, screenings treatment/grit treatment and primary sedimentation tanks will be enclosed/covered and biological scrubbers will be used to treat extracted air/gases, thereby minimising odour emissions to the atmosphere. The granulated byproduct of the proposed advanced sludge treatment process (i.e. thermal drying) is basically odourless, which will result in a significant decrease in sludge-related odours compared to other methods of sludge handling and treatment. Results of the air quality dispersion modelling study carried out for this site (Appendix 4) reveal that wind patterns and the proposed design features of the plant including operation will render odour related impacts insignificant.

The design of the treatment plant incorporates parallel stream treatment, i.e. a number of wastewater streams operating in parallel through the modular type plant layout. It is proposed to utilise four streams in parallel through the screening plant. Two streams through the grit/grease removal system, a splitter flow arrangement to each of the primary sedimentation tanks and three wastewater streams through the secondary treatment stage. Facilities for diverting flows to each of the treatment units i.e. screening cells, final clarifiers etc. will be provided. The above will ensure flexible operation of the overall plant with associated ease of maintenance and isolation of individual units should breakdown occur without affecting the overall treatment efficiency of the plant. The latter is achievable by incorporating sufficient process capacity in the plant design to facilitate same.

Similarly the design of the sludge treatment system incorporates facilities for diverting flows to each of the individual units. The units can be isolated when required without affecting the overall process operation of the plant.

A loop power supply will be provided to the plant, this together with the power generation equipment on site (Combined Heat and Power plant CHP) and standby generation capacity, will satisfactorily cater for power outage periods, should same occur.

Proper operation and maintenance of the treatment facilities will also serve to minimise odour emission.

The pumping stations will include for standby pumps to provide for continuous operation in the event of pump failure and maintenance. All sewers will be vented to prevent the build up of sewer gases, which

would be hazardous by nature.

For the main pumping station at Atlantic Pond, ventilation will be provided by the installation of blowers to ensure that there will be adequate air changes at all times in conformance with Safety Regulations. All electrical switchgear will be specified to be explosion proof to avoid the risk of sparks occurring in the event of a localised build up of sewer gases.

Vent gas emissions from the pump sump will be conveyed directly to odour removal facilities prior to discharge to the atmosphere. Proper operation and maintenance of the pumping station will serve to reduce odour emission.

The head chamber at Mahon will consist of discharge chambers constructed within a building. Emissions from the chambers will be treated before discharge to the atmosphere. Proper operation and maintenance of the treatment system will serve to reduce odour emissions.

6.6 Landscape

6.6.1 Topography

The existing topography of the Carrigrenan site will be significantly altered as a result of the cutting and filling required to provide appropriate elevations to allow gravity flow of wastewater through the plant and to the outfall. The site, which is currently rolling in nature, will be graded to provide a more linear slope. The 22m hillock located at the southern tip of the site will, however, remain intact.

The hillock (approx. 16m) located in the central portion of the site will be regraded. As illustrated in Fig. 4.5.1 the proposed slope of the site will be gradual, ranging from a maximum elevation of approx. 11m at the northern boundary of the treatment plant along the area affected by spring tides to approx. 8m at the proposed outfall location east of the quay facing Marino Point.

Approx. 200,000m^3 of soil and rock will be cut from the 16m hillock and will subsequently be used as fill to raise the elevation of lower portions of the site. The northern part of the site covered by spring tides (approx. 7 ha) will not be affected.

The overall effect of the required regrading is that the site will have a more uniform slope. The site will slope away from the residential homes along the access road north of the site, toward the south-southeast.

The lowering of the 16m hillock will also make this portion of the site less visually noticeable from areas across Lough Mahon because

the topographic contrast will be lessened.

6.6.2 Natural Features

As noted in Section 5.6.2 of this EIS, four primary natural features are present at the Carrigrenan site, including topographic relief (including the 22m hillock) the waterfront boundary, the low area covered by spring tides and the diversity of habitats.

As noted in Section 5.6.1 (Topography), construction and operation of the wastewater treatment plant will significantly alter the natural topographic relief of the site. The primary topographic feature (22m hillock) will remain in its existing undeveloped condition.

In that no reclamation or long-term changes to the shoreline around the perimeter of the treatment plant is proposed, no significant long-term impacts to the shoreline will result. Construction of the incoming collection mains and the discharge mains will result in short-term impacts to the waterfront area. Sensitive reclamation of these areas will result in minimal long-term impacts. The incoming mains will be located near the existing road to the site within the natural cove north of the Stone Tower, and the discharge main will be located east of the man-made quay along the southern boundary of the site. Temporary impacts in this area will include loss of existing vegetation and excavation from the foreshore through the near shore, past the high water mark and through the natural beachfront vegetation.

The third primary natural feature of the site, the low-lying area covered by spring tides, will not be affected by the proposed treatment plant or collection and discharge mains. This area will be kept in its currently natural condition so as to provide adequate buffer and distance between the treatment plant and nearby residential areas. No development will be permitted in this area.

The range of natural habitats currently located on the Carrigrenan site will be somewhat affected by the construction and operation of the facility. Impacts will include loss of some mature trees, loss of hedgerow habitats, and loss of open fields. Although these features will be lost or otherwise compromised, these impacts can be ameliorated (Chapter 7).

In addition, the impact on these site-specific natural features is insignificant on a regional scale in that these are very common natural features throughout Little Island and the Cork area. As such, their loss in this instance is not considered significant.

The pumping station site at Atlantic Pond is low-lying wet meadow. The construction and operation of the Pumping Station will significantly alter the present topographical relief of the sites. Filling will be used to raise the site level to 1.5m OD. This level will be lower than The Marina and

the amenity walkway. Landscaping of the site will be carried out after construction as an enhancement.

Construction of the collection mains and outfall main will result in temporary impacts to natural features such as mud flats and Lough Mahon in general. These impacts will occur during construction only and thus are considered short term. Following reclamation of disturbed areas, operation of the collection and discharge mains will not significantly impact natural features in the Cork Harbour area.

6.6.3 Man-Made Features

Construction and operation of the treatment plant will result in the demolition of the ruins of Carrigrenan House and associated outbuildings, but this is not considered significant due to the condition of the structures, their age, and lack of cultural heritage significance. Due to its proximity to the proposed treatment plant, Tower View Cottage would also be purchased from its current owner and likely demolished.

The stone tower located along the rocky shoreline at the extreme western point of the site near the existing access road will not be affected because no permanent land disturbance or structure will be located within 50m of it.

Construction and operation of the treatment plant at Carrigrenan will not result in any impacts to man-made features in the vicinity (i.e. Little Island) that would negatively affect the landscape of the area.

While construction of the collection mains will result in adverse temporary impacts to man-made features (i.e. roadways), these impacts will be short-term and will not occur following restoration activities.

The future access road to the Pumping Station at the Atlantic Pond will intersect the existing amenity walkway (Old Railway Line)

6.6.4 Aesthetic Resources

Construction and operation of the wastewater treatment plant will result in significant impacts on the aesthetic resources present within the confines of the site (i.e. internal views). Extensive site grading, loss of mature trees, and the construction of permanent structures will dramatically alter the existing visual resources, which are dominated by natural vegetation and rolling topography. Due to the limited use of the site by the general public, existing internal aesthetic resources are not accessible. With future accessibility to the general public restricted to a greater extent, the impacts to internal aesthetic resources will not be readily perceptible and thus not considered as a significant loss of publicly recognised views.

Of greater sensitivity is the effect of the treatment plant on the aesthetic

and visual resources of Lough Mahon as viewed from other locations, particularly locations of greater public use. Although views of Carrigrenan Point are available from many areas around Lough Mahon, the scale of these views is highly determined by distance, which tends to focus aesthetic perceptions on larger features such as hills, open fields, and wooded areas rather than individual facilities. As noted in Section 5.6.4 of this EIS, the Carrigrenan site is most visible at a distance at which the scale allows recognition of the features of the site, including the area along the public amenity walkway between Hop Island and Passage and from the railway line between the Belvelly River and Marino Point.

From these two areas in particular, the location of a treatment plant at the Carrigrenan site would create visible focus that would draw attention to the site. However, the cumulative visual impact of the treatment plant will be less significant due to the abundance of other industrial facilities within the visual context of Little Island. The visual and aesthetic views of Little Island from Mahon, Blackrock, Rochestown, Passage, etc. are heavily influenced by industrial facilities and structures. As such, the cumulative visual impact of the treatment plant at Carrigrenan will not be significant.

The regrading of the Carrigrenan site to a lower elevation will serve to reduce its visual obtrusiveness in that structures at a lower elevation, as perceived over distance, are generally less perceptible.

The most significant visual impacts caused by the treatment plant will be adjacent to the treatment plant. In particular, those residences located along the northern side of the access road will have their existing views altered. It should be noted, however, that much of the view into the site from along this road will be limited by the height and density of the existing flora along the wall/hedgerow on the southern side of this road and preservation of the existing high ground level at the Treatment Plant screening line on the northern side of the site (Fig. 4.5.3). While these will continue to provide a visual buffer to much of this area, views of the treatment plant cannot be completely avoided.

The treatment plant will also be visible from parts of the Harbour Point Golf Course. Although some may find this view objectionable, it will not directly affect the operation of the golf course. This would not be the only industrial area visible from this course or from the Little Island Golf Course.

Regarding the visual context of the general vicinity, the IFI plant at Marino Point will continue to dominate the visual landscape of this part of Lough Mahon. This structure, as with many industrial uses in the area, has tall emission stacks (ranging to 40m) that are highly visible. The maximum height of any specific structure at the treatment plant will not exceed a height of 10m above ground level.

In order to reduce the potential aesthetic impacts of the treatment plant, ameliorative measures can be implemented. As addressed in Chapter 7 of this EIS, ameliorative measures may include use of appropriate colour and textures, partially submerging tanks and other structures, effective use of landscaping, and sensitive site layout. In particular, the retention of the 22m hillock of the southern tip of the site will create a visual buffer to facilities located "behind" it and will also create a perception of a natural landscape that will diminish the obtrusiveness of the treatment plant.

The Atlantic Pond Pumping Station, due to its location and scope will not have a significant visual impact on the surrounding area. Permanent landscaping will enhance the visual aspect of the site.

Construction and operation of the collection mains and treated effluent outfall will not result in any significant adverse impacts to aesthetic resources.

The header chamber building at Mahon will have a visual impact, being a new building. However, the design of the superstructure will ensure its compatability with the future development of the area.

6.7 Cultural Heritage

Review of County Cork records for cultural resources has revealed 19 known significant cultural resources in the general vicinity of the proposed Cork Main Drainage Scheme. However, no known significant cultural heritage resources will be directly affected by construction or operation of the proposed facilities.

Construction of the proposed wastewater treatment plant will require demolition of an abandoned 19th. century farmhouse (Carrigrenan House). This structure and associated farmyard buildings do not have any major cultural importance, architectural merit, or amenity significance. Prior to demolition, however, all standing structures at the Carrigrenan site will be surveyed, photographed and documented.

The stone tower located in the northwestern portion of the Carrigrenan site will not be directly impacted by the design and layout of the treatment plant. To ensure that no impacts result to this tower, no construction activities or permanent structures will be located within 50m of it.

The known prehistoric shell midden located 30 to 40m south of the tower could be significantly impacted as a result of construction activities. Any additional disturbance of this area could effectively destroy its value for additional research. As with the tower, construction activities and permanent structures will not therefore be located 50m from the shell midden. Due to the size of the Carrigrenan townland site (32ha.) and the required area for the treatment plant (20 ha.), sufficient land area is

available to ensure that this buffer is maintained.

The stone tower located in the south eastern corner of the Atlantic Pond Pumping Station site will not be directly impacted by the design and layout of the Pumping Station.

No matter how comprehensive an investigation is carried out, a possibility still remains that stray finds or chance discoveries (i.e. shell middens, ring forts, tidal water mills, earthworks, etc) will be made in the course of earth removal and excavation. For this reason, a suitably qualified archaeologist will be retained to monitor all areas of construction or excavation. In the unlikely event of the discovery of archaeological remains or objects, the National Museum of Ireland and the Office of Public Works will be notified immediately and provision made to allow for, and make resources available to mount, a limited archaeological excavation.

Aboveground components of the treatment plant will have no major negative aesthetic impact on surrounding known cultural heritage resources. A vegetation buffer will shield the treatment facilities from the perspective of the Martello Tower, located approx. 800m across Foaty Channel, and from Fota Castle, located approx. 1km to the northeast across Foaty Channel.

6.8 Material Assets

6.8.1 Sustainable Development

Construction and operation of the proposed wastewater treatment plant and collection mains will not result in any adverse impacts to the concept of sustainable development in the Cork area. In fact, implementation of the scheme as proposed will promote sustainable development by providing a mechanism for accommodating future growth and development (i.e. residential, industrial, and commercial) throughout the Cork area, including the City Centre, Glanmire, Glounthaune, Mahon, Little Island and Tramore Valley.

Land use objectives as stated in the County Development Plan and the LUTS Study would be encouraged and facilitated. The scheme would allow for continued industrial development throughout Little Island and would not adversely impact planned residential development in the eastern suburbs of Cork City.

A key objective to promoting sustainable development is to locate the treatment plant as far downstream of the city as possible so that a larger area can benefit by connecting proposed developments to the scheme and so that the plant will not impact proposed developments in the more heavily developed areas (i.e. Cork, Mahon, Douglas, Blackrock). This objective is satisfied by locating the treatment plant at the Carrigrenan Site, which is as far downstream of the potential catchment area as

possible.

Location of the treatment plant at Carrigrenan is seen as contributing to the potential development in Little Island and Carrigtwohill while at the same time not affecting proposed developments in Mahon or Cork City.

6.8.2 Severance

Construction of the wastewater treatment plant will not result in significant long-term severance impacts in the vicinity of Carrigrenan Point. Although public access to the plant will not be permitted without proper authorisation, public access to the shoreline will be permitted.

Construction and operation of the treatment plant will not restrict access to the residential dwellings located along the public road to the north of the site. Although movement of construction vehicles may temporarily restrict traffic flow, such impacts will be short-term and insignificant due to the low traffic volume along this road. Access to these units will not be restricted by operation of the treatment plant.

The eventual extension of the Industrial Estate Road from the Courtstown Industrial Estate to Carrigrenan will improve access to the site and to other future industrial lands on Little Island.

Construction of the collection mains will result in temporary restrictions in access, particularly in areas where the mains are being constructed in roads or the public walkway. Depending on the extent of construction and diameter of the main, roads may be temporarily closed and automobile and pedestrian traffic rerouted. These restrictions will be temporary. During construction, public access onto the wayleave (up to 50m) will be restricted for obvious security and safety reasons.

It is in these areas (roads, public walkways) where construction of the collection mains will be overtly apparent to pedestrians and motorists and severance-related impacts will be perceived to be the greatest. However, severance impacts associated with the collection mains will be short term and will continue for the duration of construction only.

Construction of the minor pumping stations will not cause severance. Construction of the header chamber at Mahon will not involve severance.

Construction of the Atlantic Pond Pumping Station will involve temporary restrictions to access to public walkway (Old Railway Line).

Chapter 7

IMPACT AMELIORATION

CHAPTER 7

Impact Amelioration

As with any project of this scope and magnitude, environmental impacts will result. These impacts can typically vary from insignificant to highly significant, and from short-term to long-term. In addition, some impacts cannot be entirely evaluated until construction or operation of the project is ongoing. Nearly all impacts can, however, be mitigated through the implementation of effective ameliorative measures.

Effective ameliorative or mitigative measures are those that are designed to reduce the known or predicted impacts of specific activities (i.e. trenching or excavating activities).

Mitigative measures can only be effective if they are implemented and, following implementation, periodically monitored to ensure that the measure is resulting in its intended effect.

In many cases, mitigative measures cannot fully avoid all impacts. However, mitigation measures are critical to ensure that construction and operation of the proposed Cork City Main Drainage Scheme will result in minimal environmental impacts.

Implementation of the following ameliorative measures emphasises the commitment of the Local Authority to minimising any negative impacts.

7.1 Human Environment

- No permanent element of the Treatment Plant will be located less than 200m from the nearest residence.

- Public access to the entire shoreline area around Carrigrenan Point will be retained for public recreational purposes.

- The road will be extended from the Courtstown Industrial Estate to the treatment plant site as proposed in the County Development Plan to provide for access to and from the treatment plant without using the relatively narrow existing road. The improved road to the site will allow for truck access and thereby facilitate the removal of sludge residue without utilising local roadways or impacting nearby residential

areas.

- An adequate parking area will be provided on the Carrigrenan site to accommodate construction workers so that vehicles do not block or restrict access to the existing houses.

7.2 Flora and Fauna

- Impacts to terrestrial flora and fauna will be ameliorated by minimising the area and duration of disturbance, by retaining the maximum amount of vegetative cover possible, and completing construction activities in a timely manner.

- A vegetation buffer will be planted along the perimeter of the treatment plant site to serve both as a visual buffer and provide a travel corridor for small mammals that may continue to use the site.

- Following construction, topsoil will be restored across disturbed areas of terrestrial wayleaves and the treatment plant site, and these areas will be seeded and fertilised to establish an acceptable herbaceous community.

- Impacts to estuarine flora and fauna will be largely ameliorated by a combination of timing restrictions, minimisation of disturbed area, and implementation of environmentally sound construction practices.

- Construction of submarine transmission and outfall mains will be scheduled as far as possible for autumn and winter months to avoid water-quality impacts that could adversely affect salmonid migrations through Cork Harbour, which occur primarily during April through September.

- Although construction will occur during the migration of, and over wintering periods for, most waterfowl in the Cork Harbour area, construction activities are not anticipated to significantly affect bird populations.

- Construction in the foreshore area will be conducted only during periods of low tide to minimise disruption of sediments and creation of turbidity plumes. Tracked equipment will be used to excavate the trench, the pipeline will be installed, and the trench will be backfilled each day before flood tide in order to minimise turbidity and sedimentation impacts to marine flora and fauna.

- Impacts to intertidal flora and fauna will also be minimised by reducing the area of disturbance to that essential for safe operation of equipment and stockpiling of trench spoil.

- Construction access in the foreshore will be limited to specific, well-defined corridors, and construction materials and equipment will be stored outside of the intertidal zone in order to minimise habitat disturbance.

- Construction in the foreshore will be completed as promptly as possible and the areas of disturbance restored to original contours to promote recolonisation of disturbed areas. Shingle cobbles, and boulders will be replaced to approximate preconstruction conditions in order to provide attachment sites for epiphytes and epifauna.

- Potential long-term impacts to estuarine benthos in the vicinity of the effluent outfall will be ameliorated by installation of a diffuser structure or structures that will facilitate energy dissipation and dispersion and natural assimilation of the effluent.

- Localised impacts to estuarine flora and fauna resulting from treated effluent discharge will be largely ameliorated by the high quality of treatment that the wastewater will receive. These localised impacts will be compensated for by widespread improvement in habitat quality following the cessation of untreated wastewater discharges to other areas of upper Cork Harbour.

7.3 Geology and Soils

- Potential soil erosion will be minimised by ensuring that all ground disturbances or excavations are completed and revegetated as

soon as practical. Erosion-control measures during construction will include use of hay bales and silt curtains placed so as to reduce the potential for sediments to be carried off site or into Lough Mahon.

- Blasting of bedrock will only be utilised when other conventional means are not feasible. Blasting will only be conducted by qualified and experienced personnel, and all standard safety practices will be adhered to. Also, blasting in the foreshore will only be done at low tide.

7.4 Hydrology and Water Quality

- Impacts to Cork Harbour water quality caused by potential overland storm water transport of disturbed soil particles will be minimised by employing sound erosion-control and soil-conservation practices during construction. Such practises include installation of silt fencing or hay bales around disturbed areas, installation of sediment retention basins, and revegetation with a seed mixture containing a quick cover component.

- Water-quality impacts to Cork Harbour resulting from construction activities in the foreshore will be minimised by employing actions discussed to ameliorate impacts to estuarine flora and fauna.

- Potential minor, localised impacts to water quality in the immediate vicinity of the treated-effluent outfall will be minimised by installation of a diffuser to maximise mixing and dilution. Any minor, localised water-quality degradation in the West Passage area will be vastly offset by the overall improvement in the water quality of upper Cork Harbour anticipated as a result of the proposed scheme.

- Construction equipment will not be refuelled or serviced adjacent to or within the foreshore or harbour area in order to avoid water quality impacts from potential spills or leaks of fuel or lubricants.

7.5 Climate, Air Quality, and Noise

- All facilities will be constructed such that they will reduce potential impacts to air quality and noise ambience. Noise impacts will be minimised by limiting construction activities to the daytime, when people are less sensitive to noise intrusion.

- Noise control measures will be implemented to minimise impacts to nearby noise sensitive areas. These measures include selection of low noise equipment, utilisation of silencers and attenuators, modifications to design specifications (low noise level ventilation fans, sound-absorbing roll-up doors, total enclosure of all motors, blowers equipped with inlet filter silencers, and enclosure of the screening facilities/covering the grit chamber and modifications of operational practices (keeping all openings on buildings closed and scheduling truck traffic during peak background noise periods).

- A post-operational noise survey will be performed at the nearest residence(s) to identify any unacceptable noise impacts. If necessary recommendations for appropriate noise control measures will be made.

- Noise impacts will also be mitigated by providing acoustic hoods on exposed motors, by maintaining a grassed earth embankment on the northern side of the plant (Fig. 4.5.3) and by planting a heavy evergreen vegetation barrier as close to the noise forces as possible, which measures, combined with the normal attenuation of sound with distance, will ensure that noise levels will be minimised.

- The screening plant, screenings treatment, grit treatment and sludge dewatering/thermal drying will be housed and all sludge thickening/holding tanks including sedimentation tanks will be covered. The positively extracted air/gases will be treated in biological scrubbers (bioscrubbers) prior to discharge to the atmosphere.

- A regular maintenance schedule will be adhered to so that the treatment plant is continually operated in an effective manner. This will ensure that improper plant operation will not result in increased odour emission.

7.6 Landscape

- The 22m hillock at the southern tip of the site will be retained as is.

- Maintain an embankment at the northern side of developed site.

- Tanks where possible will be constructed substantially below ground level which will allow the ground level to appear more naturally sloped and the tanks to appear less visibly obtrusive.

- Also to minimise visual impacts, the outside surface of tanks and other structures will be treated or otherwise prepared in

appropriate colour and texture to blend with the surrounding landscape of the Carrigrenan site. Appropriate colours would be various shades of green, brown, or tan. Administrative facilities should be of brick or stone appearance rather than a more modern design of glass and steel,

- Appropriate landscaping will be utilised around the perimeter of the site and around all buildings and structures for which landscaping would not affect the proper operation and maintenance of the specific facility. Native plant species that are suitable to provide appropriate visual buffering of structures will be used to the maximum extent practicable. A detailed landscaping drawing for the developed site has been prepared for display purposes.

7.7 Cultural Heritage

- No construction activities or ground disturbances will occur within 50m of the tower or shell midden located along the western side of the site or the potential shell midden located at the southern tip of the site. These areas will be protected by flagging a 50m boundary around each site.

- Although Carrigrenan House is not considered unique or highly significant, a comprehensive photographic record of the farm house and outbuildings will be carried out prior to its demolition.

- Due to the possibility that unknown historic/prehistoric finds or discoveries (I.E. Middens, Burial Grounds etc.) will be made in the course of earth removal, the construction of the wastewater treatment plant and terrestrial portions of the collection mains will be monitored by a suitably-qualified archaeologist. In the event of the discovery of buried archaeological remains or objects, the National Museum of Ireland and the Office of Public Works will be notified immediately and provisions made to allow for, and make resources available to mount, a limited archaeological excavation.

- The Local Authority will encourage further study and investigation of the two shell middens by qualified archaeologists by allowing these persons access to the middens for purposes of such study. Access to these sites by unqualified persons intending to explore or excavate them and thus destroy their value or significance, will be strictly prohibited.

7.8 Material Assets

- To promote sustainable development throughout the Cork City area, the Local Authority will give due consideration to including other areas (i.e. Carrigtwohill) that express an interest in joining into the scheme in order to promote further growth and development.

- To avoid severance of the shoreline around Carrigrenan Point, access will be permitted along the shore only. Access will not be permitted through the site for obvious operational and security reasons.

7.9 Implementation

The Local Authority will ensure that, during the design and construction stage, appropriate arrangements will be put into place to secure adequate implementation of the ameliorative measures described above.

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APPENDICES

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APPENDIX 1

MATHMATICAL MODELLING OF CORK HARBOUR

APPENDIX 1

Table of Contents

MATHEMATICAL MODELS

Introduction

In conjunction with the preparation of the Environmental Impact Statement for the Cork Main Drainage Scheme, computer based mathematical modelling of Cork Harbour and the River Lee has been carried out. The modelling procedure adopted for the Study was based on the development of the following models:

- A two dimensional low resolution mathematical model of the Upper and Lower Harbour.
- A two dimensional high resolution mathematical model of the Upper Harbour.
- A two dimensional high resolution mathematical model of the North and South Channels of the River Lee.

The models relating to the Upper and Lower Harbour were developed with the aims of fulfilling the following objectives:

- To aid in determining the optimum location for the point of outfall from the proposed wastewater treatment plant.
- To predict the likely changes in water quality in Cork Harbour as a result of the proposed scheme.
- To determine the necessity or otherwise of providing disinfection facilities at the proposed wastewater treatment plant.
- To assist in assessing the requirement or otherwise of providing nutrient removal facilities at the treatment plant.
- To assess the implications on water quality associated with a separate (partially treated) discharge from the Little Island Industries.

The high resolution River Model was developed with the aim of:

- Predicting the impact on the receiving waters of the North and South Channels due to the discharges from Storm Overflows within the City Sewer catchment.

The Harbour Models

The hydrodynamics for both the high resolution and low resolution harbour models were calibrated against the hydrodynamic data recorded during the hydrographic survey of Cork Harbour. The high resolution model which comprises a two dimensional horizontal grid of 50 m spacing over the Inner Harbour was used primarily to model the dispersion and decay of pathogenic organisms associated with the discharge of treated or untreated wastewater to the harbour. The low resolution model which is based on a two dimensional horizontal grid of 100 m spacing over the entire harbour was used to predict the distributions of the principal chemical constituents associated with treated or untreated wastewater discharges to the harbour.

To achieve the desired objectives of the harbour models it was necessary to examine three basic input loading cases. These loading cases can be outlined as follows:

Case 1 - Cork City, Tramore Valley, Glanmire/Little Island sewerage schemes including the Little Island industries combined in a single treatment facility discharging secondary treated wastewater to a location in Lough Mahon or at Marino Point.

Case 2 - Cork City, Tramore Valley, Glanmire/Little Island sewerage schemes combined in a single treatment facility discharging secondary treated wastewater to Marino Point: Partially treated wastewater from the Little Island industries discharging to Lough Mahon via the existing IDA and Courtstown Industrial Estate outfalls.

Case 3 - Cork City, Tramore Valley, Glanmire/Little Island sewerage schemes and the Little Island Industries separately discharging untreated and partially treated wastewater to the river and harbour through existing outfalls, i.e. existing wastewater discharge conditions.

A number of variations on each of the three basic loading cases were also examined. Firstly, both present and future design discharge loads were applied in all three cases. Secondly, the dispersion and decay of the bacteriological and chemical constitutents of the wastewater were assessed over repeating neap and repeating spring tides in all three cases.

Tabulation of the input data as applied to the three loading cases is outlined in Tables 1.1 to 1.3

Outfall Location

The determination of the optimum location for the proposed outfall, from an environmental viewpoint, has been based on comparing the likely impacts on water quality resulting from two alternative discharge locations. The mathematical models prepared for Cork Harbour have been used to simulate the discharge of a treated effluent, firstly to a location in Lough Mahon and then to a location in the vicinity of Marino Point. The dispersion and decay of the bacteriological and chemical constituents of the treated effluent have been modelled at both locations over a full range of tidal conditions and for present and future loadings.

Figures 1.1 and 1.2 are pictorial representations of the predicted maximum BOD concentrations occurring in the Harbour due to a continuous treated effluent discharge to Lough Mahon and Marino Point respectively. For each option the treated wastewater load from the Cork City, Tramore Valley, Glanmire and Little Island combined scheme discharges at a design standard of 25 mg/l BOD.

Figures 1.3 and 1.4 are pictorial representations of the predicted maximum total coliform concentrations in the Harbour for the two outfall options. The calculation of the total coliform concentrations discharged in each case study is based on an initial domestic and commercial wastewater concentration of 1×10^7 total coliforms/100 ml. Following secondary treatment this concentration is taken to be reduced by 90% to 1×10^8 total coliforms/100 ml. The industrial wastewater contribution is assumed to have no bacteriological content. A T_{90} decay constant of 12 hours has been used to model the mortality of the total coliforms following discharge. The basis for adopting the specified concentration and decay constant is outlined in the next section.

Table 1.4 is a direct comparison of the maximum predicted BOD levels for the Lough Mahon and Marino Point outfall options. Maximum levels at 7 key locations between the Custom House and Roches Point have been extracted to aid in determining localised impacts associated with the two options. Table 1.5 is the corresponding comparison of the maximum predicted total coliform levels at five locations between Blackrock and Cobh. In each case the maximum levels have been quantified on a neap tide at low water.

Table 1.1
Input Data for Harbour Mathematical Models .
Load Case 1
Cork City / Tramore Valley & Glanmire / Little Island Combined .

Parameter	Units	Discharge Under Present Loading	Discharge Under Present Loading
Dry Weather Flow	m3 / day	67,395	112,630
BOD	kg / day	1,685	2,816
BODult	kg / day	2,804	4,686
COD	kg / day	8,424	14,079
SS	kg / day	2,359	3,942
Total P	kg / day	560	774
Organic N	kg / day	283	383
Amoniacal N	kg / day	1,618	2,230
Nitrate	kg / day	23.6	28.2
Total Coli *	Counts / day	5.58×10^{14}	8.24×10^{14}
Co-Ordinates of Outfall Options .		(A) 175135 E 70175 N (Lough Mahon) . (B) 176940 E 69475 N (Marino Point) .	

Table 1.2
Input Data for Harbour Mathematical Models .
Load Case 2
Cork City / Tramore Valley & Glanmire / Little Island Sewerage Scheme.
(Little Island Industrial Estates Discharging Separately .)

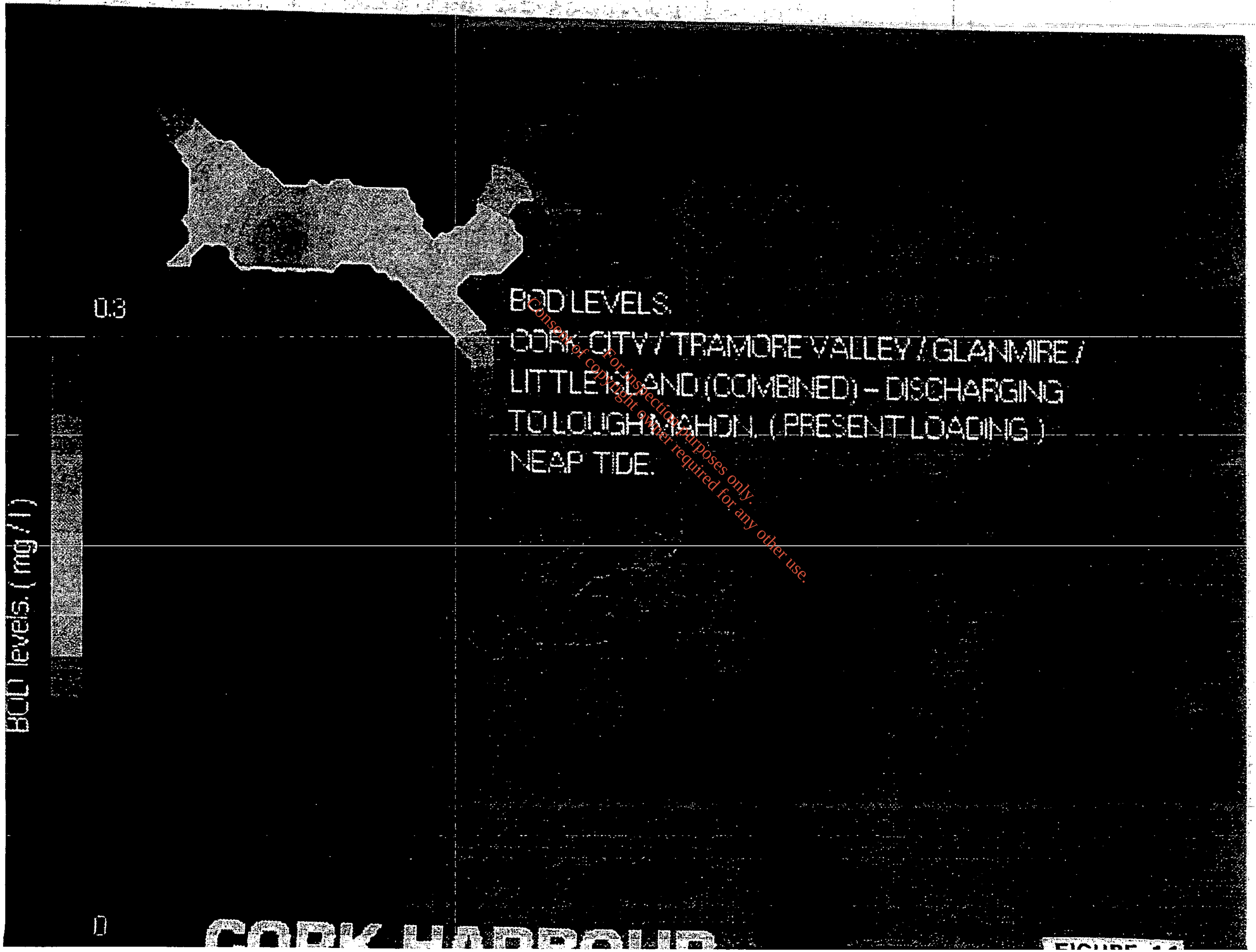
Parameter	Units	Cork City / Tramore Valley & Glanmire / Little Island Sewerage Scheme.		I.D.A. Industrial Estate Little Island		Courtstown Industrial Estate Little Island.	
		Discharge Under Present Loading	Discharge Under Future Loading	Discharge Under Present Loading	Discharge Under Future Loading	Discharge Under Present Loading	Discharge Under Future Loading
Dry Weather Flow	m3 / day	63,606	104,833	3,420	7,038	369	75
BOD	kg / day	1,509	2,620	1,945	2,508	17.4	2
BODult	kg / day	2,646	4,360	2,123	2,738	19	2
COD	kg / day	7,950	13,103	4,298	5,471	80	10
SS	kg / day	2,226	3,668	773	999	39	5
Total P	kg / day	604	865	99	175	---	
Organic N	kg / day	264	352	40	70	---	---
Amoniacal N	kg / day	1,519	2,044	59	105	---	---
Nitrate	kg / day	22.3	25.2	0.62	0.85	---	---
Total Coli *	Counts / day	5.58×10^{14}	8.24×10^{14}	---	---	---	---
Co-Ordinates of Outfall Options .		(A) 175135 E 70175 N (Lough Mahon) . (B) 176040 E 60475 N (Marino Point) .		174280 E 70850 N (Existing)		177550 E 71350 N (Existing)	

* : T 90 = 12 hrs.

Table 1.3
Input Data for Harbour Mathematical Models .
Load Case 3
Discharge Loads from Existing Outfalls (Reference Case) .

meter	Units	Penrose Quay (City North)		Albert Quay (City South)		Tramore Valley		Glanmire / Little Island		I.D.A. Ind. Estate Little Island		Courtstown Ind. Estate Little Island	
		Present	Future	Present	Future	Present	Future	Present	Future	Present	Future	Present	Future
MF	m / day	28,656	42,432	28,056	39,384	5000	17,000	1,894	6,017	3,420	7,038	369	759
OD	kg / day	7,823	10,722	7,398	8,629	1331	3,300	612.6	1,483	1,945	2,508	17.4	22
Dult	kg / day	8,539	11,697	8,076	9,420	1453	3,603	669	1,619	2,123	2,738	19	24
OD	kg / day	15,267	20,623	14,385	16,556	2800	6,930	1,312	3,126	4,298	5,471	80	102
S	kg / day	7,546	9,932	7,634	8,711	1547	3,850	634	1,591	773	999	39	51
nic N	kg / day	472	614	431	476	101	253	35	76	40	70	---	---
iacal N	kg / day	709	922	646	714	152	380	53	114	59	105	---	---
rate	kg / day	11.5	12.7	9.1	7.8	2.5	5.3	0.9	1.3	0.6	0.9	---	---
al P	kg / day	301	391	301	339	65	161	21	50	12	25	---	1
Coli *	Counts / day	2.6×10^{14}	3.5×10^{14}	2.4×10^{14}	2.9×10^{14}	0.5×10^{14}	1.2×10^{14}	1.13×10^{14}	5.8×10^{14}	---	---	---	---
linates isting alls .		68300 E 72010 N		68310 E 71863 N		72500 E 69675 N		175105 E 70195 N		174280 E 70850 N		177550 E 71350 N	

* : T 90 – 6 hrs



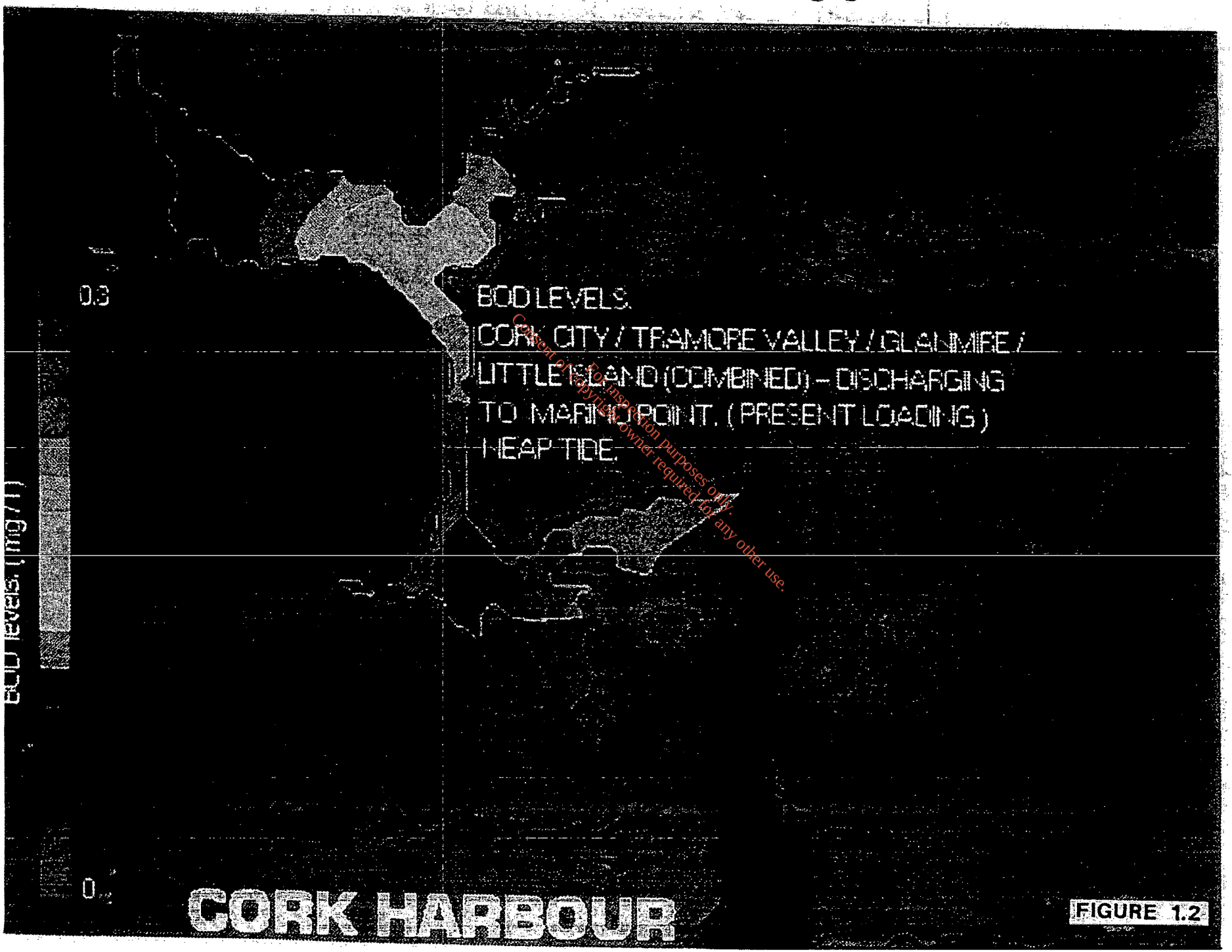


FIGURE 1.2

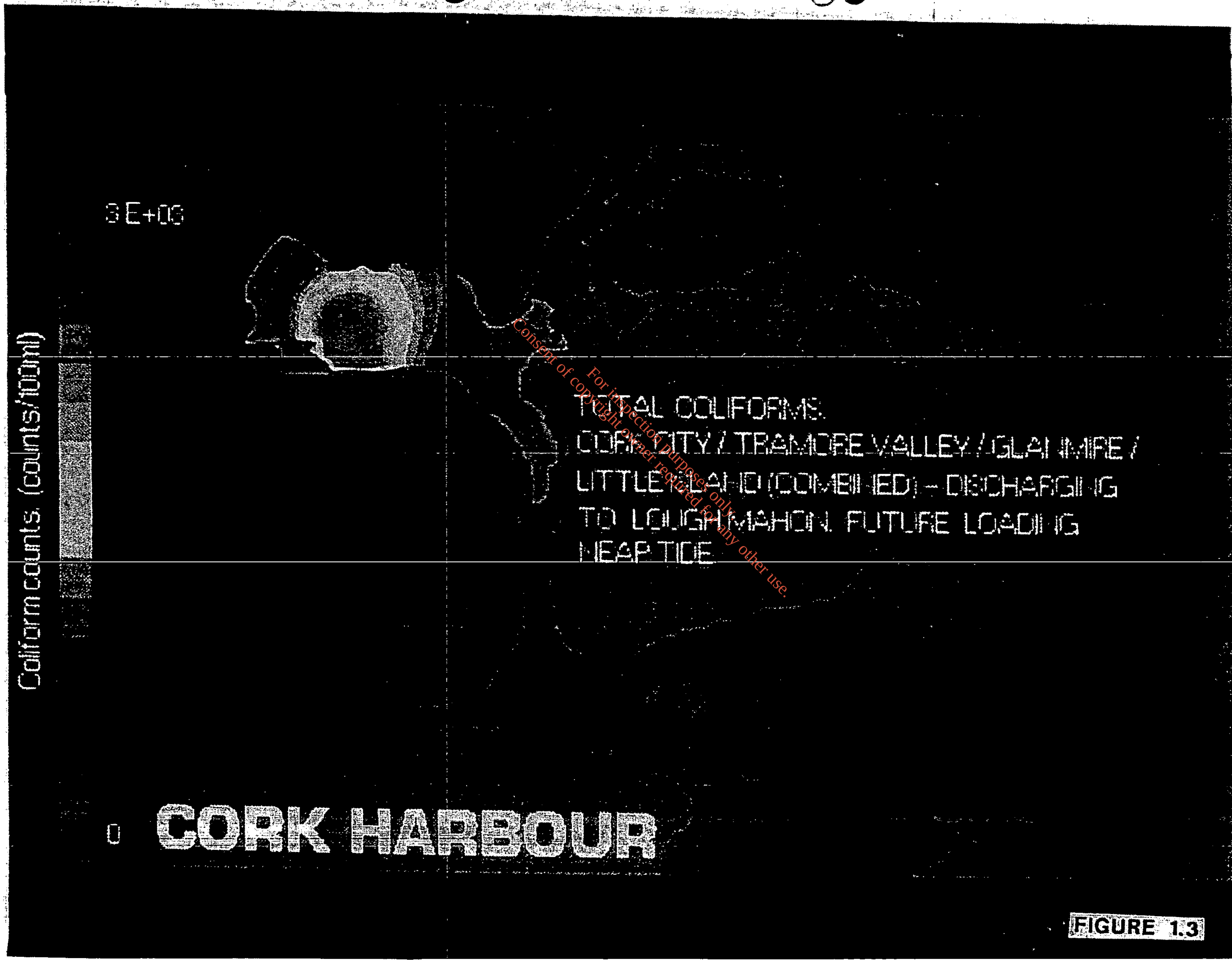


FIGURE 1.3

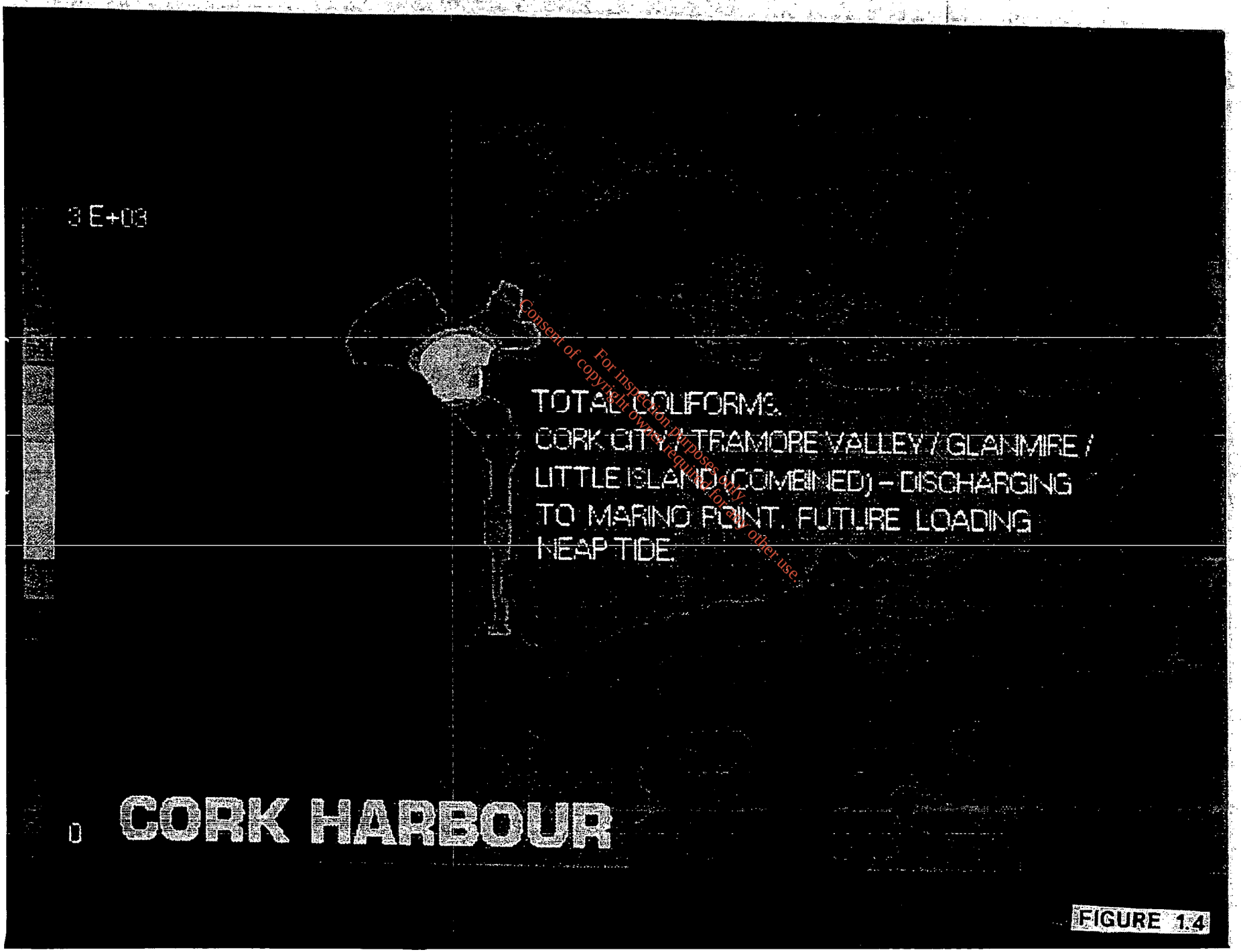


FIGURE 1.4

Table 1.4

Comparisons of Maximum Predicted Concentrations of BOD (mg/l) at Locations in Cork Harbour . Lough Mahon Outfall / Marino Point Outfall - Neap Tide .

Location	Present Loads		Future Loads	
	Discharge to Lough Mahon	Discharge to Marino Point	Discharge to Lough Mahon	Discharge to Marino Point
1. Monkstown	0.09	0.13	0.14	0.22
2. Rathcoursey	0.00	0.01	0.00	0.01
3. L.Mahon Lr.	0.21	0.15	0.35	0.25
4. L.Mahon Ur.	0.20	0.08	0.33	0.13
5. Custom Hse.	0.03	0.01	0.05	0.02
6. Fort Davis	0.00	0.01	0.01	0.01
7. Roches Point	0.00	0.00	0.00	0.01
8.Point of Discharge	0.30	0.20	0.50	0.33

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Table 1.5

Comparisons of Maximum Predicted Concentrations of Total Coliforms (Counts / 100 ml) at Locations in Cork Harbour . Lough Mahon Outfall / Marino Point Outfall - Neap Tide .

Location	Present Loads		Future Loads	
	Discharge to Lough Mahon	Discharge to Marino Point	Discharge to Lough Mahon	Discharge to Marino Point
1. Monkstown	18	240	27	355
2. North Channel	0	0	0	0
3. L.Mahon Lr.	1,450	800	2,146	1,148
4. L.Mahon Ur.	2,000	380	2,960	562
5. Blackrock	0	0	0	0
6. Cobh	0	2	0	3
7.Point of Discharge	4,000	2,000	5,920	2,960

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CHANGES IN HARBOUR WATER QUALITY

Basis for Quantification

The changes in water quality which may be expected to occur within Cork Harbour following implementation of the proposed Cork Main Drainage Scheme have been quantified by comparing the results obtained from modelling both the existing and proposed scheme discharges. It is important to note that the application of the mathematical models will only predict the changes in water quality as opposed to predicting ultimate levels of the individual pollutant constitutents. The models do not take into account background chemical or bacteriological levels which may exist due to other contributing factors, e.g. run-off from farm lands and ship discharges. From the results of the Harbour Water Quality Survey carried out in September 1991 however, estimates of existing baseline and background levels have been obtained which may be added to the levels predicted by the models.

Discharge from the proposed Cork Main Drainage Scheme will involve a single point source of treated wastewater entering Cork Harbour via a submerged outfall at a location in the vicinity of Marino Point. The model results for this load case therefore represent the direct impact on water quality due to this discharge alone. In the case of the existing scheme the results are an estimation of the proportion of the existing baseline constituent levels which can be attributed to the discharge of untreated and partially treated wastewaters from Cork City, the Tramore Valley and the Glanmire/Little Island Sewerage Schemes. A direct comparison of both simulations will therefore yield a quantative assessment of the net changes in the Harbour Water Quality.

For the purpose of this assessment, quantification of the net changes in harbour water quality is based primarily on a comparison of the predicted BOD_5 and total coliform levels. The net changes in nutrient levels within the harbour are discussed in Chapter 6 in relation to the requirement or otherwise of providing nutrient removal facilities at the proposed treatment plant. The parameters BOD_5 and Total Coliforms have been taken as the basis for comparison because the dispersion and decay of these parameters can be modelled more accurately than the other constitutents and their resultant levels can more readily be assessed for compliance with relevant EC Directives and Department of Environment Water Quality Guidelines.

Simulation of the existing scheme (hereafter referred to as the **reference case**) is based on a continuous untreated dry weather discharge from each of the existing main outfalls within the City, Tramore Valley, Glanmire and Little Island area. The BOD_5 loads discharging from each outfall have been established in accordance with the wastewater loading assessment of the individual areas as presented in Volume 2. The concentration of BOD_5 varies from outfall to outfall but the overall mean value is 285 mg/l under present loading and 234 mg/l under future design loading. The quantity of total coliforms discharging at each of the existing outfalls has been quantified according to a raw wastewater concentration of 1×10^7 total coliforms/100 ml. This concentration is only applicable to the domestic and commercial portion of the total wastewater loads. The industrial contribution is assumed to have no bacteriological content.

The 1×10^7 counts/100 ml concentration for total coliforms in raw domestic wastewater has been taken as a representative average concentration following a review of literature on this subject. Although the concentration of coliforms in raw wastewater has been shown in literature to vary considerably a report detailing a number of British coastal sites showed a clear seasonal trend with an average total coliform concentration of about 5×10^6 counts/100 ml in Winter to 50×10^7 counts/100 ml in Summer [1]. Furthermore, previous studies involving mathematical modelling of the dispersion and decay of coliforms in Irish coastal waters have found good agreement with measured coliform levels when using an initial total coliform concentration of 1×10^7 counts/100 ml. The mortality of coliforms in sea water is, amongst other factor function of temperature, solar radiation, sedimentation and nutrient related effects. The rate of decay of coliforms is generally expressed as a T_{90}, i.e. the time taken for 90% of the micro-organisms to die in the sea. Reviews of a number of studies have shown that, with few exceptions the T_{90} value is never less than four hours [1].Again, wide variations in decay rates for raw wastewater are found in literature [1][2]. The greater the T_{90} value the greater the possibility of coliforms existing in the Harbour a long distance from the source. For the purpose of the present study a T_{90} value of 6 hours has been used as the decay rate for the raw wastewater which can be regarded as being conservative [3].

The decay of BOD following release to the receiving waters is modelled in the same manner as the decay of total coliforms. The rate of decay of BOD in seawater is not as variable as that for coliforms and generally ranges beween 0.15 and 0.20/day. A decay co-efficient of 0.2/day has been used for this study which can be regarded as being typical of dry Summer conditions.

Simulation of the proposed scheme is based on a single treated wastewater discharge to the harbour in the vicinity of Marino Point. Although the total dry weather flows (present and future) discharging to the harbour under the proposed scheme will be equivalent to those for the reference case, the pollutant loads will be considerably reduced following treatment and will be discharged as a single point source to Marino Point. Modelling of the proposed scheme assumes full secondary treatment of the total wastewater load from the City, Tramore Valley, Glanmire and Little Island (including industries). Nutrient removal or disinfection of the wastewater has not been included in the determination of the final discharge loads.

Following full secondary treatment the concentration of BOD ultimately discharging from the proposed plant will be 20 mg/l under both present and future conditions. However in accordance with the EC Directive concerning Urban Wastewater Treatment a design discharge value of 25 mg/l BOD has been used in running the models. In terms of total coliforms it can be expected that full secondary treatment will result in a 90% reduction in concentration. The initial 1×10^7 counts/100 ml concentration associated with the raw domestic and commercial wastewaters is therefore reduced to 1×10^6 counts/100 ml at the outfall from the proposed treatment plant. Full secondary treatment however will have the effect of increasing significantly the T_{90} value of the remaining coliform bacteria. Through the secondary treatment process only the weaker organisms are killed off and it is estimated that the T_{90} value for the remaining organisms is doubled. For the purposes of this investigation a T_{90} value of 12 hours is used to model the decay of total coliforms associated with a secondary treated wastewater.

Interpretation of Model Results

For both the reference case and proposed case models, present and future design loading conditions were assessed under tidal regimes characterised by a repeating neap or repeating Spring cycle. Output from the model runs as presented in this discussion is in the form of pictorial ('snap shot') representations of the resultant concentration of BOD and total coliforms occurring in the harbour at low water on neap tides. Time series plots of the variations of BOD and total coliforms at a number of key locations within the Harbour have also been obtained. The locations at which time series plots have been obtained are show in Figures 1.5 and 1.6.

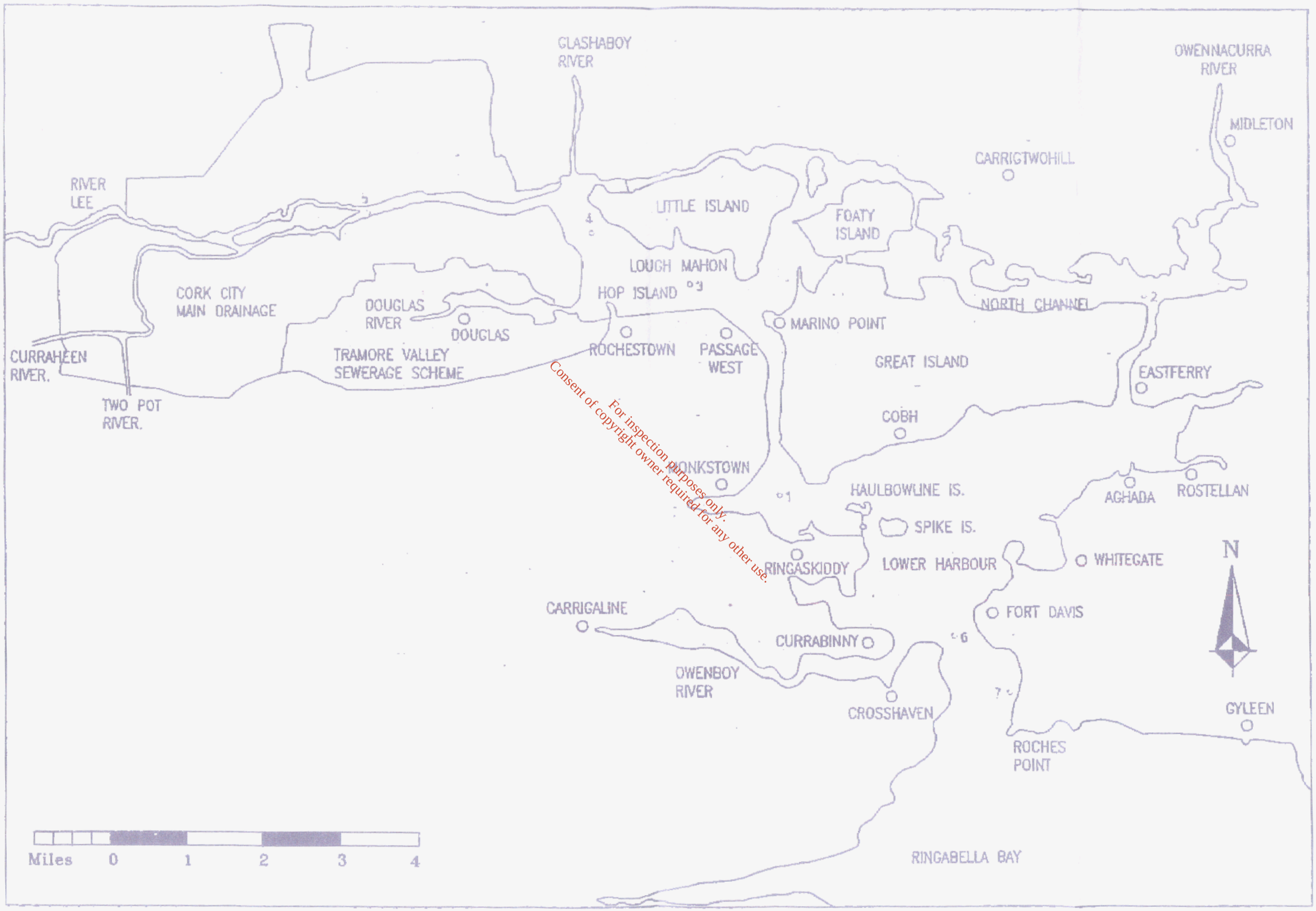

Figure 1.5 Station locations for Model Water Quality Predictions – B.O.D.

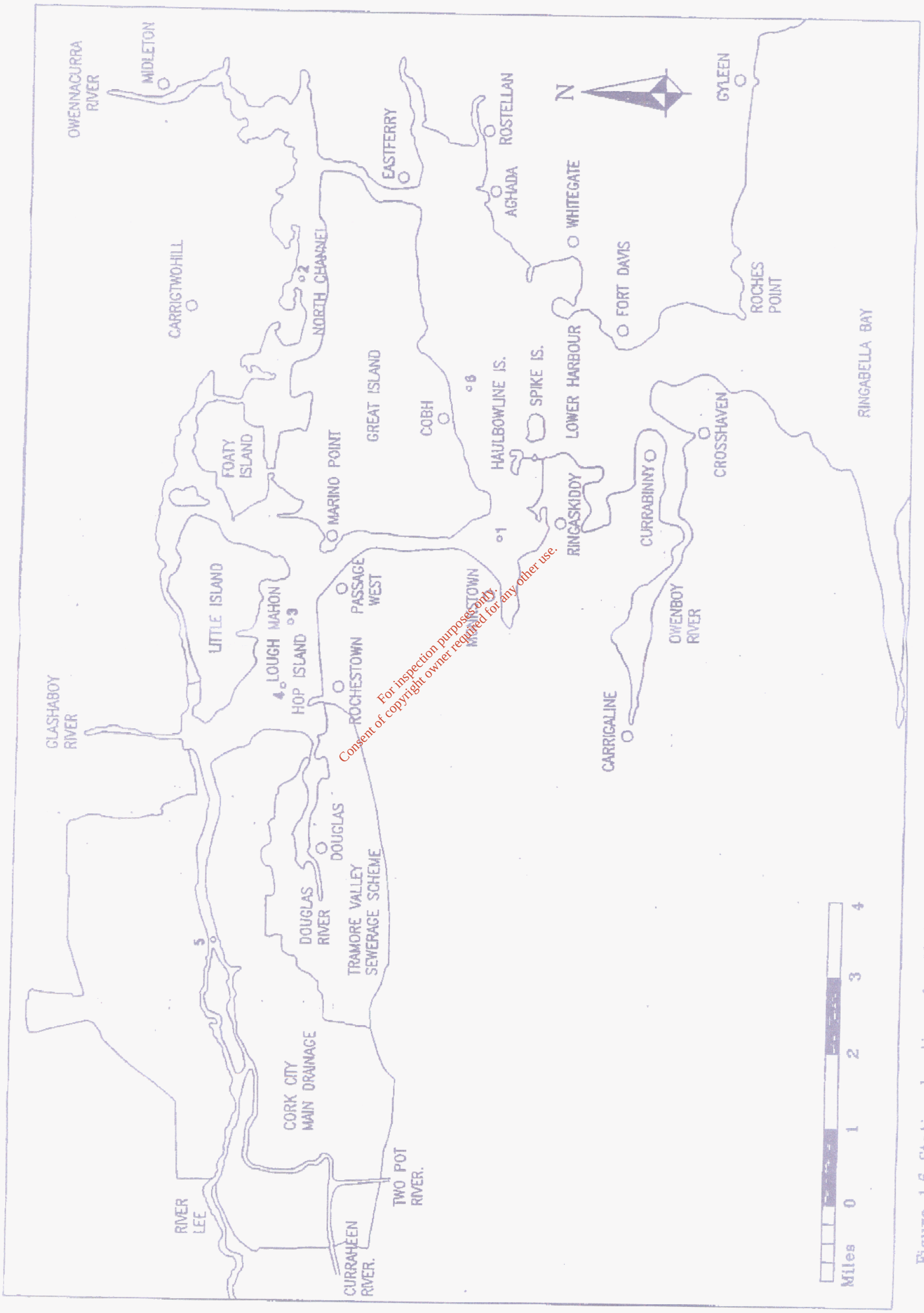

Figure 1.6 Station locations for Model Water Quality Predictions – Total Coliforms.

BOD Levels

Figure 1.7 is a 'snap-shot' of the predicted distributions of BOD for the reference case model under future loading conditions at low water on a neap tide. Again, it should be emphasised that the predicted levels as presented do not include background levels which may exist due to other contributing factors. Essentially, Figure 1.7 represents the future levels of BOD (excluding background) which might be expected to occur in Cork Harbour if the discharges of untreated wastewater from the City, Tramore Valley, Glanmire and Little Island were to continue to the design year 2020.

Figure 1.8 represents the predicted BOD levels within Cork Harbour which may be attributed to discharging treated wastewater from the City, Tramore Valley, Glanmire and Little Island to Marino Point, under future design loads. Again the 'snap-shot' corresponds to low water conditions on a neap tide. Table 1.6 is a direct comparison of the maximum predicted BOD levels for the existing and proposed schemes under present and future load conditions. Maximum BOD levels at 7 key locations between the Custom House and Roches Point have been extracted from inspection of the time series plots developed at each location for each load case.

Table 1.7 includes an estimate of the resultant BOD levels, including background values, which might be expected to prevail in the harbour following implementation of the proposed scheme. The existing background BOD values at each of the 7 key locations have been calculated by subtracting the values predicted by modelling the existing scheme from the baseline values measured during the water quality surveys conducted in September 91 and February 92. Both the measured and predicted values for this exercise have been taken at low water neap tide conditions to ensure uniformity. The estimated final BOD levels at the seven locations have been established by adding the values predicted by modelling the proposed scheme to the calculated background levels.

Conclusions

The following is a summary of the main conclusions which can be drawn regarding the likely changes in BOD levels as determined by the mathematical models.

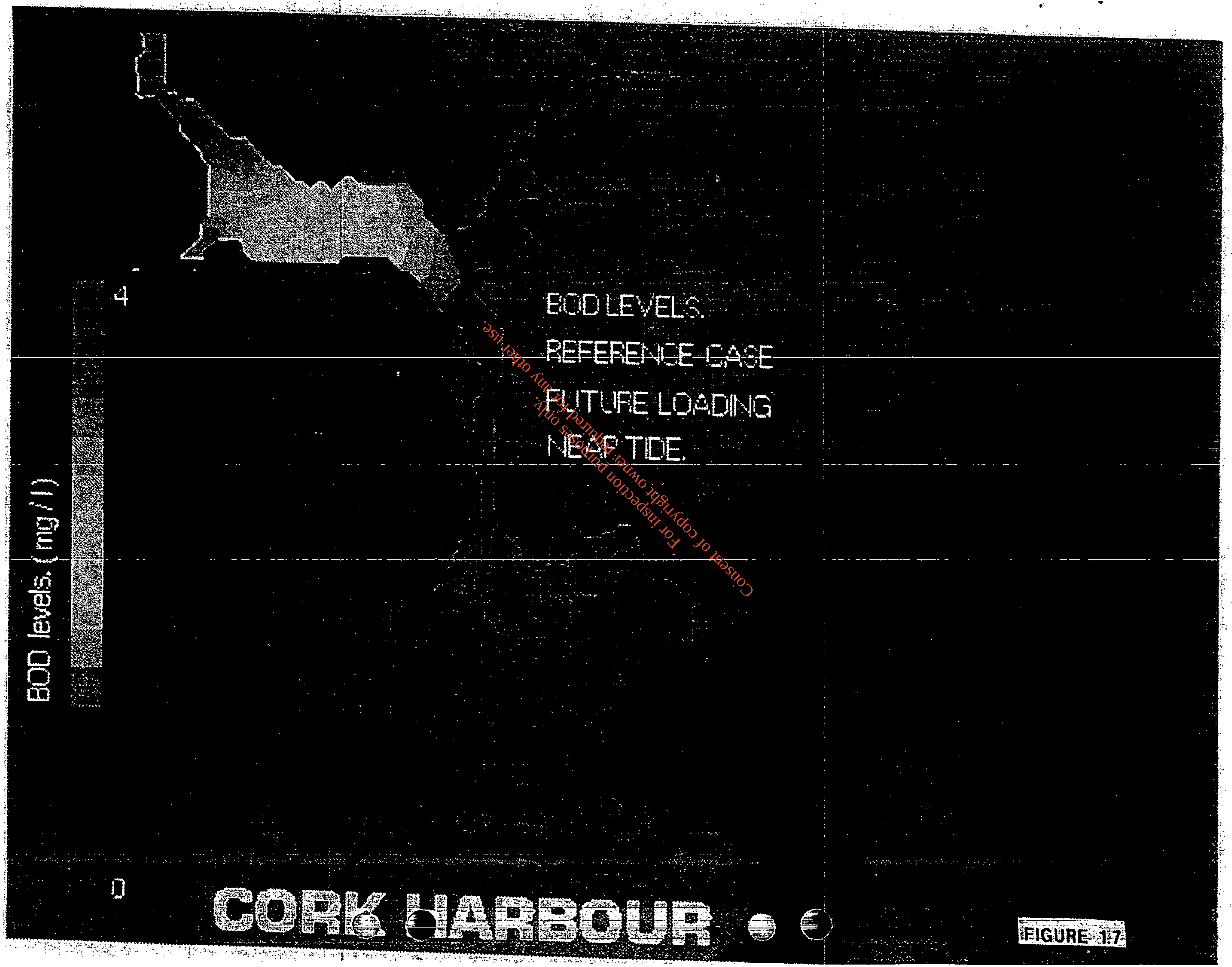

FIGURE 1.7

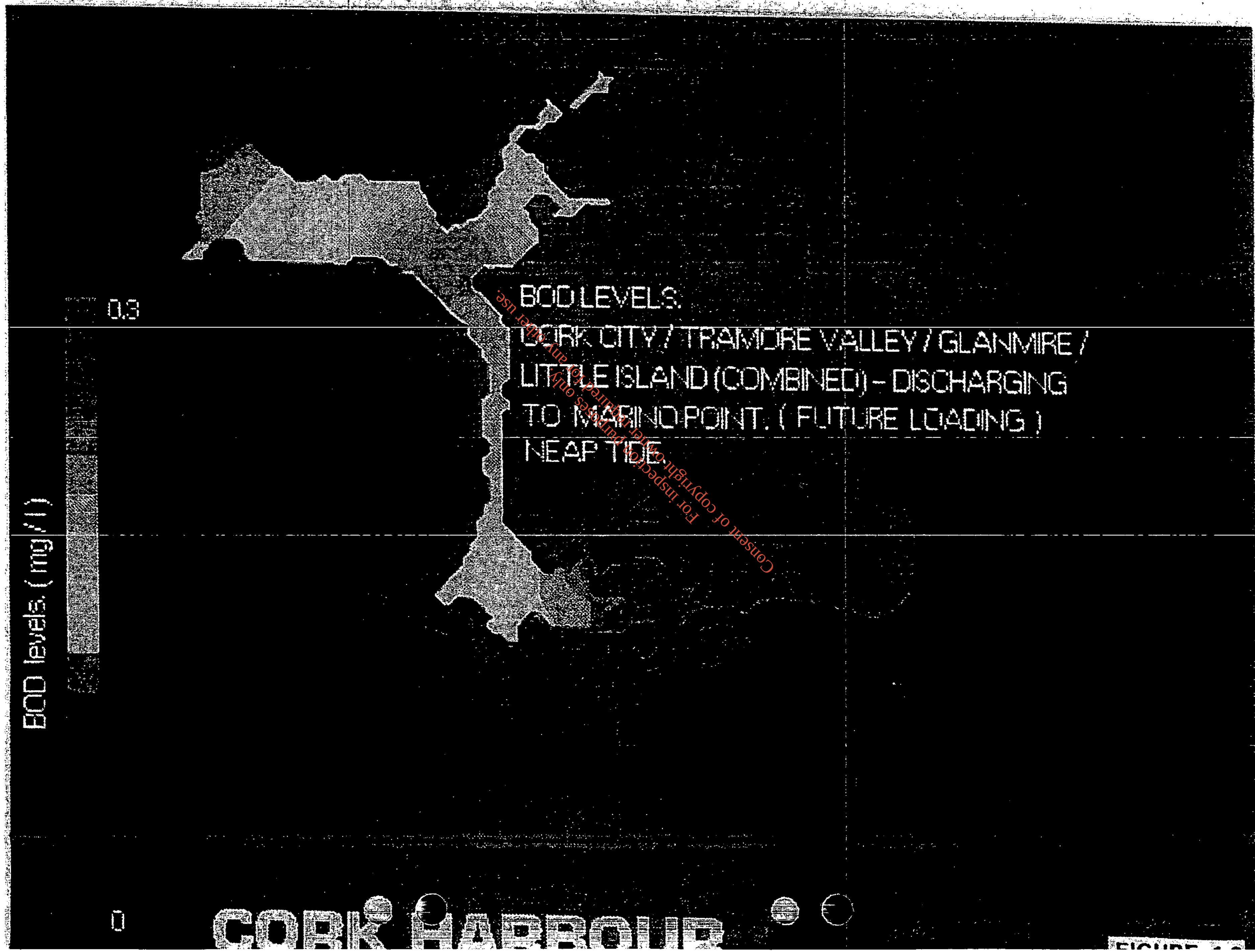

Table 1.6

Comparisons of Maximum Predicted Concentrations of BOD (mg/l) at Locations in Cork Harbour . Existing Scheme / Proposed Scheme - Neap Tide .

Location	Present Loads		Future Loads	
	Existing Scheme Untreated Wastewater Existing Outfalls	Proposed Scheme Treated Wastewater Marino Pt. Outfall	Existing Scheme Untreated Wastewater Existing Outfalls	Proposed Scheme Treated Wastewater Marino Pt. Outfall
1. Monkstown	0.36	0.13	0.60	0.22
2. Rathcoursey	0.01	0.01	0.02	0.01
3. L.Mahon Lr.	1.20	0.15	1.80	0.25
4. L.Mahon Ur.	2.00	0.08	4.00	0.13
5. Custom Hse.	10.00	0.01	13.00	0.02
6. Fort Davis	0.02	0.01	0.02	0.01
7. Roches Point	0.01	0.00	0.02	0.01

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Table 1.7

Estimate of Resultant BOD Levels (mg/l) at Locations in Cork Harbour Following the Completion of Proposed Scheme . Neap Tide - Low Water .

Locations	Measured BOD Levels Cork Harbour Neap Tide Low Water	Existing Scheme Untreated Wastewater Existing Outfall	Estimated Background Levels	Proposed Scheme Treated Wastewater Marino Pt. Outfall
1. Monkstown	2.53	0.36	2.17	0.13
2. Rathcoursey	2.63	0.01	2.62	0.01
3. L.Mahon Lr.	3.35	1.20	2.15	0.15
4. L.Mahon Ur.	4.20	2.00	2.20	0.08
5. Custom Hse.	12.73	10.00	2.73	0.01
6. Fort Davis	2.90	0.02	2.88	0.01
7. Roches Point	2.56	0.01	2.55	0.00

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a) Implementation of the proposed scheme will result in an improvement in BOD levels through the harbour.

b) A significant improvement will occur between the Custom House and Upper Lough Mahon. Existing levels which range between 4 mg/l at Upper Lough Mahon and 13 mg/l at the Custom House should reduce to baseline levels of 2.3 mg/l and 2.7 mg/l respectively.

c) No BOD increase greater than 1 mg/l will occur within the Harbour as a result of the proposed treated wastewater discharge. The maximum increase will be in the region of 0.33 mg/l occurring at the point of discharge under future design conditions.

d) The mean background BOD level in the Harbour has been calculated at 2.5 mg/l. Implementation of the proposed scheme will not result in baseline levels exceeding 4 mg/l at any location in the harbour.

e) The existing background levels in the outer harbour are relatively high and are due to contributing factors other than wastewater discharges from the existing scheme. The proposed treated wastewater discharge will not adversely impact on these values.

Total Coliform Levels

Figure 1.9 is a pictorial representation of the total coliform distributions for the reference case model under present loading conditons at low water on a neap tide. The resultant levels represent an estimate of the extent to which the existing scheme discharges contribute to the present baseline total coliform levels in the Harbour.

Figure 1.10 represents the predicted total coliform levels within the harbour which may be attributed to discharging treated wastewater from the City, Tramore Valley, Glanmire and Little Island to Marino Point under present design loads.

Table 1.8 is a direct comparison of the maximum predicted total coliform levels for the existing and proposed schemes under present load conditions. The predicted levels resulting from the proposed scheme under future load conditions are also included. Maximum total coliform levels at 5 key locations between Blackrock and Cobh have been calculated based on time series output generated at each point.

Conclusions

The following is a summary of the main conclusions which can be drawn regarding the likely changes in total coliform levels as determined by the mathematical models;

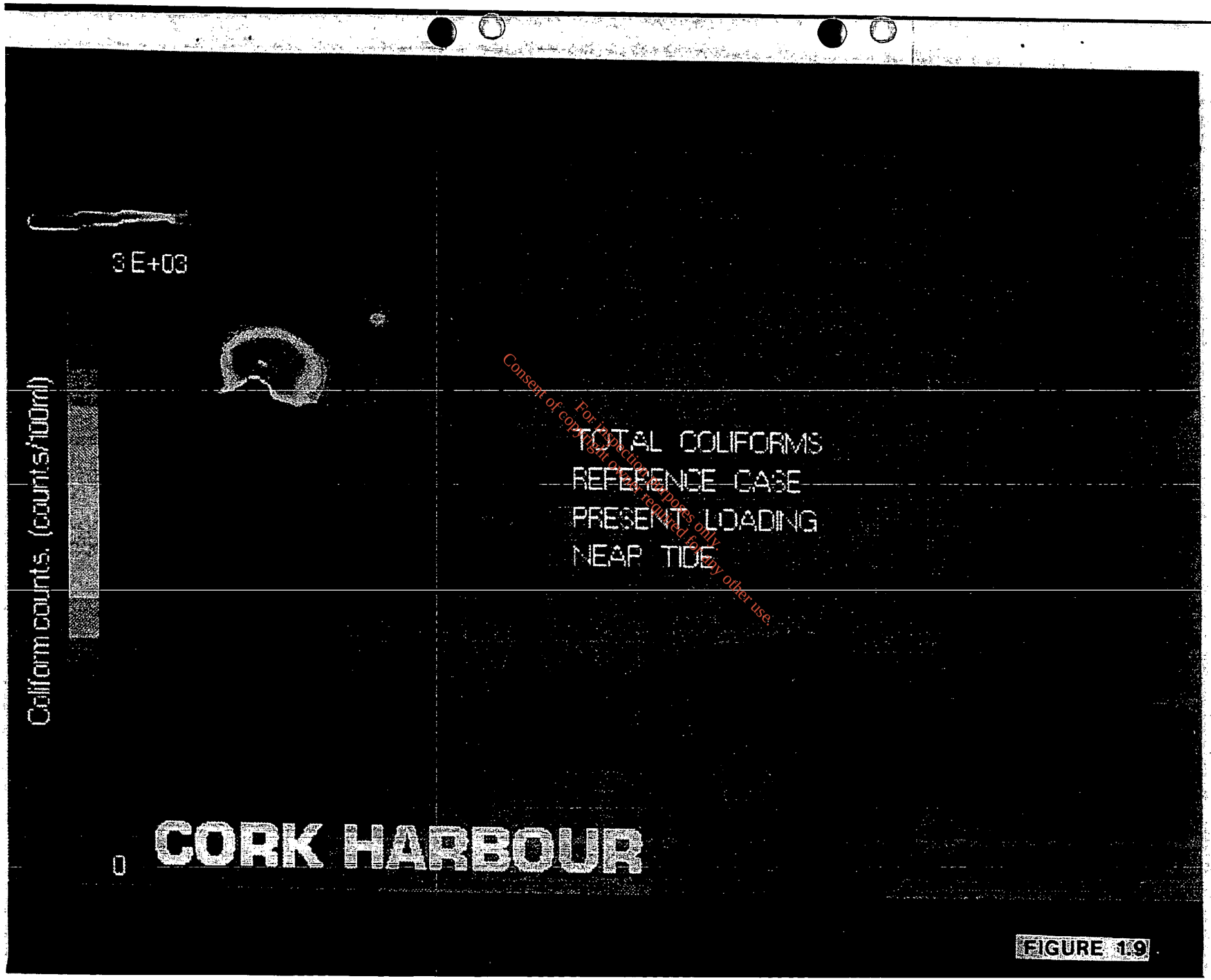

FIGURE 1.9

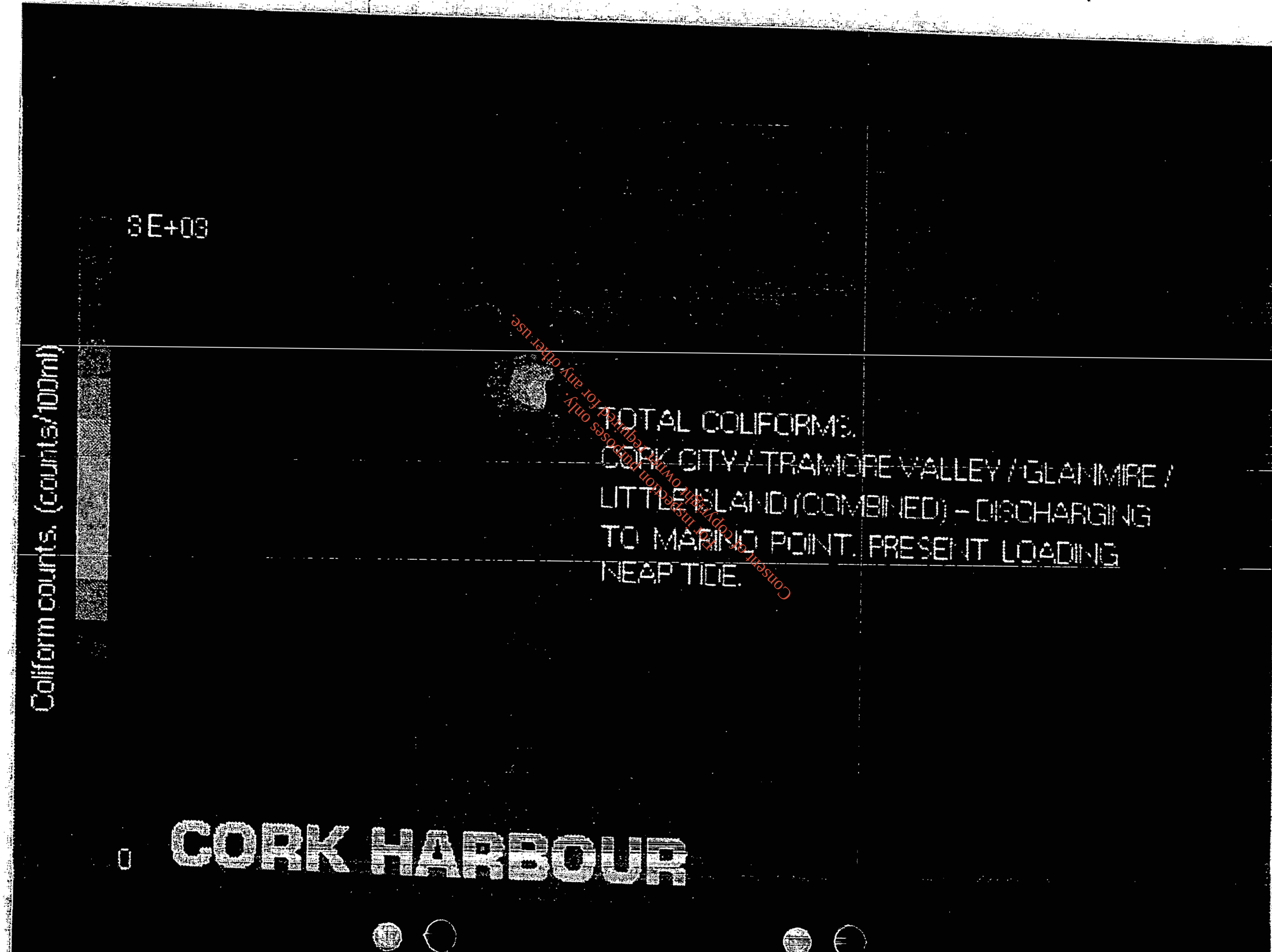

FIGURE 1.10

Table 1.8

Comparisons of Maximum Predicted Concentrations of Total Coliforms (Counts / 100 ml) at Locations in Cork Harbour . Existing Scheme / Proposed Scheme - Neap Tide .

Location	Present Loads		Future Loads
	Existing Scheme Untreated Wastewater Existing Outfalls	Proposed Scheme Treated Wastewater Marino Pt. Outfall	Proposed Scheme Treated Wastewater Marino Pt. Outfall
1. Monkstown	1	240	355
2. North Channel	0	0	0
3. L.Mahon Lr.	420	800	1,184
4. L.Mahon Ur.	1,500	300	562
5. Blackrock	63,000	0	0
6. Cobh	0	2	3

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(a) Implementation of the proposed scheme will result in a considerable improvement in the zone extending from Mid Lough Mahon to the Custom House. A concentration of 63,000 total coliforms/100 ml. at Blackrock Castle due to existing untreated discharges will reduce to trace values under the proposed scheme. In Upper Lough Mahon existing concentrations of about 1,500 total coliforms/100ml due to the untreated wastewater discharges will be reduced by about 80%.

(b) A slight disimprovement in quality may occur in the zone between Mid Lough Mahon and Monkstown, i.e. immediately upstream and downstream of the proposed point of discharge at Marino Point. In Lower Lough Mahon it is estimated that the contribution to the baseline levels under the proposed scheme (future loads) will be about 1200 total coliforms/100ml. The contribution at this location due to the existing scheme is estimated to be about 420 total coliforms/100ml. At Monkstown existing baseline total coliform levels are not impacted upon by the untreated wastewater discharges from the City. Under the proposed scheme at future load conditions an increase of about 350 total coliforms/100ml might be expected at this location.

(c) Downstream of Monkstown towards the Outer Harbour the impact of the proposed scheme will have little or no effect on the baseline total coliform levels.

(d) The predicted future levels of total coliforms occurring in Cork Harbour as a direct result of the proposed treated wastewater discharge will be well within the mandatory limit of 10,000 total coliforms/100ml stipulated in the EC Bathing Waters Directive. In the immediate vicinity of the proposed discharge point, maximum levels of 3000 counts/100ml may occur at low water conditions. Taking into account the existing baseline levels measured during the harbour survey it can be anticipated that the mandatory bathing water level will not be exceeded at any location in the harbour following implementation of the proposed scheme.

(e) The results of the mathematical models further indicate that the shell-fish producing waters in the North Channel will not be adversely impacted upon by the proposed treated effluent discharge. The maximum predicted total coliform concentration at the entrance to the Belvelly Channel is 250 counts/100 ml which only occurs at high water on a Spring Tide. Within the North Channel this maximum value decreases to 200 at Weir Island. To the east of Weir Island towards the shell-fish producing waters, the results of the mathematical model indicate that the proposed discharge will have no impact on background coliform levels.

APPENDIX 2

INDUSTRIAL WASTEWATER SURVEY

APPENDIX 2

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INDUSTRIAL WASTEWATER SURVEY

Objective

The main objective of the industrial wastewater survey was to enable a quantitative figure for the present total industrial load, both organic and hydraulic, to be determined. The figures obtained were reconciled with population and industrial development in the particular catchments.

Method

The survey comprised circulation of detailed questionnaires requiring information on industrial processes utilised, water consumption, historical data on wastewater flows and composition, inventory of all chemicals used and the extent of on-site treatment and monitoring facilities. In addition to the questionnaires on-site flow monitoring and sampling surveys were carried out at selected industries over their working day.

All licenced dischargers within the respective catchment areas were circularised and visited.

Certain unlicenced discharges were circularised to complement the information obtained from the licenced dischargers. These dischargers were located from business directories, local knowledge, rates lists and water consumption lists provided by Cork Corporation and Cork County Council.

The detailed questionnaire and the extent of parameters chosen for the chemical analysis of samples of the wastewaters had the primary objectives of identifying the presence of inhibitors to a biological treatment system and also the level of nutrients present. A 100% response was received from industries.

The discharges were divided into 13 categories and the major dischargers in each catergory were surveyed. Flow proportional composite samples were taken from all the companies.

Results

The results of the industrial wastewater survey are given in the following tables in terms of:

- The total load for the entire scheme (Table 2.1).
- Loading for each catchment area (Table 2.2).
- Loading for each category (Table 2.3)

TABLE 2.1
CORK MAIN DRAINAGE SCHEME
INDUSTRIAL WASTEWATER SURVEY

OVERALL TOTAL - INDUSTRIAL LOAD - FOR SCHEME

PARAMETER		TOTAL
WASTEWATER FLOW	m3/d	11699. 0
BOD	kg/d	6968. 0
COD	kg/d	12886. 0
SS	kg/d	3882. 0
TOTAL P	kg/d	111. 0
ORTHOP	kg/d	27. 0
KJEL N	kg/d	379. 0
F.O.G.	kg/d	353. 0
T.H.M.	kg/d	17. 0
SURFACTANTS	kg/d	26. 0
AMMONIA	kg/d	88. 0
LEAD	kg/d	0. 668
ZINC	kg/d	0. 68
CADMIUM	kg/d	0. 008
CHROMIUM	kg/d	0. 14
MERCURY	kg/d	0. 02
SILVER	kg/d	0. 3
NITRATES	kg/d	350. 0
COPPER	kg/d	0. 17
ALUMINIUM	kg/d	7. 0
NICKEL	kg/d	0. 5
ARSENIC	kg/d	0. 00002
ANTIMONY	kg/d	0. 00002
SOLVENT	kg/d	20. 44
TRICHLOROETHYLENE	kg/d	2. 4
SULPHATE	kg/d	7145. 0
PHENOL	kg/d	3. 4607
CYANIDE	kg/d	0. 17
CHLORIDE	kg/d	1775. 0
PYRADINE	kg/d	68. 0
DIEMETYLSULPHATE	kg/d	0. 35
ORGANIC SOLVENT	kg/d	1. 25
ORGANOHALOGEN	kg/d	1. 25
BROMIDE	kg/d	50. 0
SODIUM BROMIDE	kg/d	260. 0
BIOSULPHATE	kg/d	26. 0
HYDROCARBON OIL	kg/d	7. 5
CHLORIDE RESIDUAL	kg/d	0. 075

TABLE 2.2
CORK MAIN DRAINAGE SCHEME
INDUSTRIAL WASTEWATER SURVEY

INDUSTRIAL LOADS - AREA TOTALS

PARAMETERS		CITY NORTH	CITY SOUTH	LITTLE ISLAND	TRAMORE VALLEY	GLANMIRE/ GLOUNTHAUNE	TOTAL
WASTEWATER FLOW	m3/d	2970	4138.61	4283	40.4	266.85	11699. 0
BOD	kg/d	2412.1	2331	2099	11.19	115.21	6968. 0
COD	kg/d	3861.4	3690	5085	28.43	221.4	12886. 0
SS	kg/d	1212.23	1628.97	948	6.89	83.42	3882. 0
TOTAL P	kg/d	31.714	53.2	24.4	0.056	2.3582	111. 0
ORTHOP	kg/d	7.107	16.6	3.04	0.018	0.622	27. 0
KJEL N	kg/d	129.168	102	131.8	0.506	15.59	379. 0
F.O.G.	kg/d	163.318	105.84	64.34	1.1	19.17	353. 0
T.H.M.	kg/d	3.5	1.67	11.5	0.01	0.12	17. 0
SURFACTANTS	kg/d	9.42	14.47		0.68	1.64	26. 0
AMMONIA	kg/d	13.026	20.345	51.04	0.048	2.26	88. 0
LEAD	kg/d	0.036	0.083	0.54	0.003	0.006	0. 668
ZINC	kg/d	0.0226	0.29	0.36	0.0015	0.007	0. 68
CADMIUM	kg/d	0.00002	0.0001	0.007	0.001		0. 008
CHROMIUM	kg/d	0.01	0.041	0.09	0.001		0. 14
MERCURY	kg/d	0.00002		0.0002	0.001		0. 02
SILVER	kg/d	0.071	0.17	0.009	0.001	0.024	0. 3
NITRATES	kg/d		0.006	350	0.001		350. 0
COPPER	kg/d	0.023	0.067	0.075	0.0025	0.007	0. 17
ALUMINIUM	kg/d		0.25	7.18	0.001		7. 0
NICKEL	kg/d	0.00002		0.04			0. 5
ARSENIC	kg/d	0.00002					0. 00002
ANTIMONY	kg/d	0.00002					0. 00002
SOLVENT	kg/d			20.44			20. 44
TRICHLOROETHYLENE	kg/d			2.4			2. 4
SULPHATE	kg/d			7145			7145. 0
PHENOL	kg/d	0.0007		3.46			3. 4607
CYANIDE	kg/d			0.17			0. 17
CHLORIDE	kg/d			1775			1775. 0
PYRADINE	kg/d			68			68. 0
DIEMETYLSULPHATE	kg/d			0.35			0. 35
ORGANIC SOLVENT	kg/d			1.25			1. 25
ORGANOHALOGEN	kg/d			1.25			1. 25
BROMIDE	kg/d			50			50. 0
SODIUM BROMIDE	kg/d			260			260. 0
BIOSULPHATE	kg/d			26			26. 0
HYDROCARBON OIL	kg/d			7.5			7. 5
CHLORIDE RESIDUAL	kg/d			0.075			0. 075

TABLE 2.3
CORK MAIN DRAINAGE SCHEME
INDUSTRIAL WASTEWATER SURVEY

INDUSTRIAL LOADS - CATEGORY TOTALS

PARAMETER		BREWERIES	FOOD RELATED	MILLING	HOSPITALS	ABATTOIRS	METAL RELATED	COMPUTERS
WASTEWATER FLOW	m3/d	2419	1615.32	22.3	1568	48.2	98.74	142.2
BOD	kg/d	2937	697.89	20.31	379.6	33.98	6.66	42.65
COD	kg/d	4271	1002.59	18.57	763.08	67.41	44.46	97.9
SS	kg/d	1427	417.77	1.65	381.55	25.78	7.7	25.64
TOTAL P	kg/d	50.3	9.664	0.424	12.02	0.83	0.01	3.44
ORTHOP	kg/d	13.8	2.808	0.202	5.1	0.189	0.002	0.29
KJEL N	kg/d	62.03	44.89	3.538	73.14	6.19		9.56
F.O.G.	kg/d	12.9	81.51	0.318	81.96	8.09	0.94	6.76
T.H.M.	kg/d		0.6		1.25		0.76002	0.267
SURFACTANTS	kg/d				7.16			2.4
AMMONIA	kg/d	2	7.157	2	15.6	0.79	0.05	2.15
LEAD	kg/d				0.066		0.043	0.012
ZINC	kg/d				0.077		0.04	0.2006
CADMIUM	kg/d						0.00012	
CHROMIUM	kg/d						0.011	0.04
MERCURY	kg/d						0.00002	
SILVER	kg/d				0.174		0.091	
NITRATES	kg/d						0.006	
COPPER	kg/d				0.062		0.03	0.002
ALUMINIUM	kg/d				0.25		0.08	0.012
NICKEL	kg/d						0.00002	
ARSENIC	kg/d						0.00002	
ANTIMONY	kg/d						0.00002	
PHENOL	kg/d						0.0007	
SOLVENT	kg/d							
TRICHLOROETHYLENE	kg/d							
SULPHATE	kg/d							
CYANIDE	kg/d							
CHLORIDE	kg/d							
PYRADINE	kg/d							
DIEMETYLSULPHATE	kg/d							
ORGANIC SOLVENT	kg/d							
ORGANOHALOGEN	kg/d							
BROMIDE	kg/d							
SODIUM BROMIDE	kg/d							
BIOSULPHATE	kg/d							
HYDROCARBON OIL	kg/d							
CHLORIDE RESIDUAL	kg/d							

TABLE 2.3 (CONTD.)
CORK MAIN DRAINAGE SCHEME
INDUSTRIAL WASTEWATER SURVEY

INDUSTRIAL LOADS - CATEGORY TOTALS

PARAMETER		GARAGES	LAUNDRIES	CHEMICAL	HOTELS	MISC.	COSMETICS	TOTAL
WASTEWATER FLOW	m3/d	200.55	770.4	2698.4	511.45	1440	164.3	11699
BOD	kg/d	79.53	378.16	1912	209.92	191.86	78.8	6968
COD	kg/d	245.94	732	4574	400.18	482	180.7	12880
SS	kg/d	29.14	171.9	707.2	372.59	166.5	147.2	3882
TOTAL P	kg/d	0.1172	7.12	17.23	5.867	1.3	0.4	109
ORTHOP	kg/d	0.02044	0.31	2	2.515	0.12	0.04	27
KJEL N	kg/d	7	24.8	100.05	20.476	20.8	5.64	378
F.O.G.	kg/d	6.95	28.33	43.46	57.51	6.82	17.4	353
T.H.M.	kg/d	3.00006		9.91		1.004		17
SURFACTANTS	kg/d	4.3784		0.05	11.88	0.35		26
AMMONIA	kg/d	0.2253	7.23	46.8	3.248	0.32	0.16	88
LEAD	kg/d	0.00623		0.321		0.22		0.668
ZINC	kg/d	0.003307		0.331		0.03		0.682
CADMIUM	kg/d			0.005		0.003		0.008
CHROMIUM	kg/d			0.071				0.122
MERCURY	kg/d			0.0003		0.02		0.020
SILVER	kg/d			0.005		0.076		0.346
NITRATES	kg/d			350				350
COPPER	kg/d	0.00492		0.051		0.025		0.175
ALUMINIUM	kg/d			6.7				7.042
NICKEL	kg/d			0.004		0.48		0.484
ARSENIC	kg/d							0.00002
ANTIMONY	kg/d							0.00002
PHENOL	kg/d			3.46				3.46
SOLVENT	kg/d			20.44				20.44
TRICHLOROETHYLENE	kg/d			2.4				2.40
SULPHATE	kg/d			7145				7145.00
CYANIDE	kg/d			0.17				0.17
CHLORIDE	kg/d			1775				1775.00
PYRADINE	kg/d			68				68.00
DIEMETYLSULPHATE	kg/d			0.35				0.35
ORGANIC SOLVENT	kg/d			1.25				1.25
ORGANOHALOGEN	kg/d			1.25				1.25
BROMIDE	kg/d			50				50.00
SODIUM BROMIDE	kg/d			260				260.00
BIOSULPHATE	kg/d			26				26.00
HYDROCARBON OIL	kg/d					7.5		7.50
CHLORIDE RESIDUAL	kg/d					0.075		0.0750

APPENDIX 3

STORMWATER OVERFLOW ASSESSMENT

APPENDIX 3

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IMPACTS OF STORM OVERFLOW DISCHARGES

Basis for Quantification

The continued discharge of storm generated waste water is essential so as to prevent potentially large storm flows entering the main interceptor network and ultimately from being carried to the proposed treatment facility. Since 1965, 36 storm overflow chambers have been constructed and are currently in operation within the existing collection system.

The impacts associated with the continued discharge from the existing storm overflows to the River Lee have been quantified with the aid of individual 1-dimensional mathematical models of the North and South channels of the River Lee. The models were successfully utilised to model the response of the Channels and to generate the required output data.

Input data for the 1-dimensional river models was generated using a separate computer based simulation of the existing collection system and storm overflows. The in-house Mouse computer programme for Urban Sewer Modelling was utilised to model the simultaneous operation of all the storm overflows within the City catchment. For a series of 4 design rainfall events storm overflow discharge data was processed and transferred directly as input data for running the river models.

Development and Application of the Mouse Model

Development of the sewer network or Mouse Model involved the input of extensive information relating to the catchments, pipelines, storm overflow structures, rain data, wastewater data, hydrological data and hydraulic data associated with the existing network. All input pertaining to the pipelines, interceptor sewers and storm overflow structures was obtained from the 'as constructed' drawings of the existing Cork Main Drainage Scheme. Information regarding individual subcatchments and impermeable areas, population equivalents and wastewater loading and all hydrological and hydraulic data was derived from Appendix F of the 1965 Preliminary Report.

The basis for running the Mouse Model is the application of a single rainfall event or series of rainfall events to the predefined catchment and pipe network. For the purpose of the present investigation, 4 individual rainfall events were applied to the City sewer network model. The 4 storm events which were considered can be defined as follows:

Storm 1	10 week return period, 30 minutes duration
Storm 2	10 week return period, 60 minutes duration
Storm 3	1 year return period, 60 minutes duration
Storm 4	1 year return period, 30 minutes duration

Each of the above events is represented as a synthetic rain profile which has been developed by applying the methods outlined in the Flood Studies Report. The rain profiles associated with each storm are site-specific for Cork and are based on a number of constant data values read from meteorological maps.

The storm durations and return periods have been selected such that the impact associated with relatively frequent short storms which result in high concentrations and low discharge volumes, can be compared with infrequent longer storms which cause higher discharge volumes at lower concentrations.

For each event the response of the sewer network and in particular the response of the 36 storm overflow structures therein was analysed.

The foul wastewater flows associated with each storm overflow were included as a constant dry weather flow at the location of each chamber. The quantity overflowed from each chamber under storm conditions therefore has a certain 'foul' wastewater content. the Mouse Model quantifies the total load of individual pollutant constituents discharged at each chamber for each storm event. In the present investigation the constituents BOD and total coliforms were identified as the key parameters for assessing the impact on the receiving waters and are therefore the parameters quantified in the application of the Mouse Model.

Output from the Mouse Model of the City sewer network was in the following format:

- Duration of discharge from each storm overflow for each rainfall event.
- Total quantity (volume) of wastewater discharged from each storm overflow for each rainfall event.
- Total quantity (number) of total coliforms discharged from each storm overflow for each rainfall event.
- Location of point of entry to River Lee for each stormwater discharge.

This data was then used as direct input to the 1-dimensional river models to assess the response of the channels to multiple storm overflow discharges.

Development and Application of the River Models

The North and South Channels of the River Lee have been modelled separately over a distance of 3,750m from the Water Works Weir to the point of confluence at the Custom House.

In order to interpret the impact of the large number of overflows, they have been grouped into 5 discharges on the North Channel and 4 discharges on the South Channel by combining overflows within 100m of each other. Figure 3.1 shows the groups of storm overflows labelled N1 to N5 on the North Channel and S1 to S4 on the South Channel.

In applying the Model to the predefined input data it is assumed that the length of channel which is impacted upon by each storm overflow group is so short that a constant cross-sectional area, tidal exclusion and dispersion coefficient may be used in each case. The duration of each storm is also ignored by concentrating each input as an instantaneous or 'spike' discharge at the beginning of each storm.

Since the cross-sectional area of the channels at the points of discharge varies over the tidal cycle, an average value corresponding to half tide has been applied at each location. Furthermore it is assumed that all inputs are mixed instantaneously across each section at each discharge point.

Base flow in the river has been taken as $5m^3$/sec which corresponds to low flow at the Water Works Weir. Division of this flow between the two channels as determined by the initial cross-sectional areas results in a flow of $4m^3$ /sec down the North Channel and $1m^3$/sec down the South Channel.

In modelling the dispersion and decay of the pollutants associated with the storm overflow discharges, a T_{90} value of 6 hours has been taken for the total coliforms and a decay rate of 0.2 per day for BOD. These values are consistent with those used in the Mathematical Modelling of water quality in the Harbour.

For each rainfall event, resultant BOD and total coliform levels are quantified along the length of each channel at intervals after the end of the storm. The following is an assessment of the principal results obtained. The implications of the storm overflow discharges on the river water quality are discussed in relation to the development of a

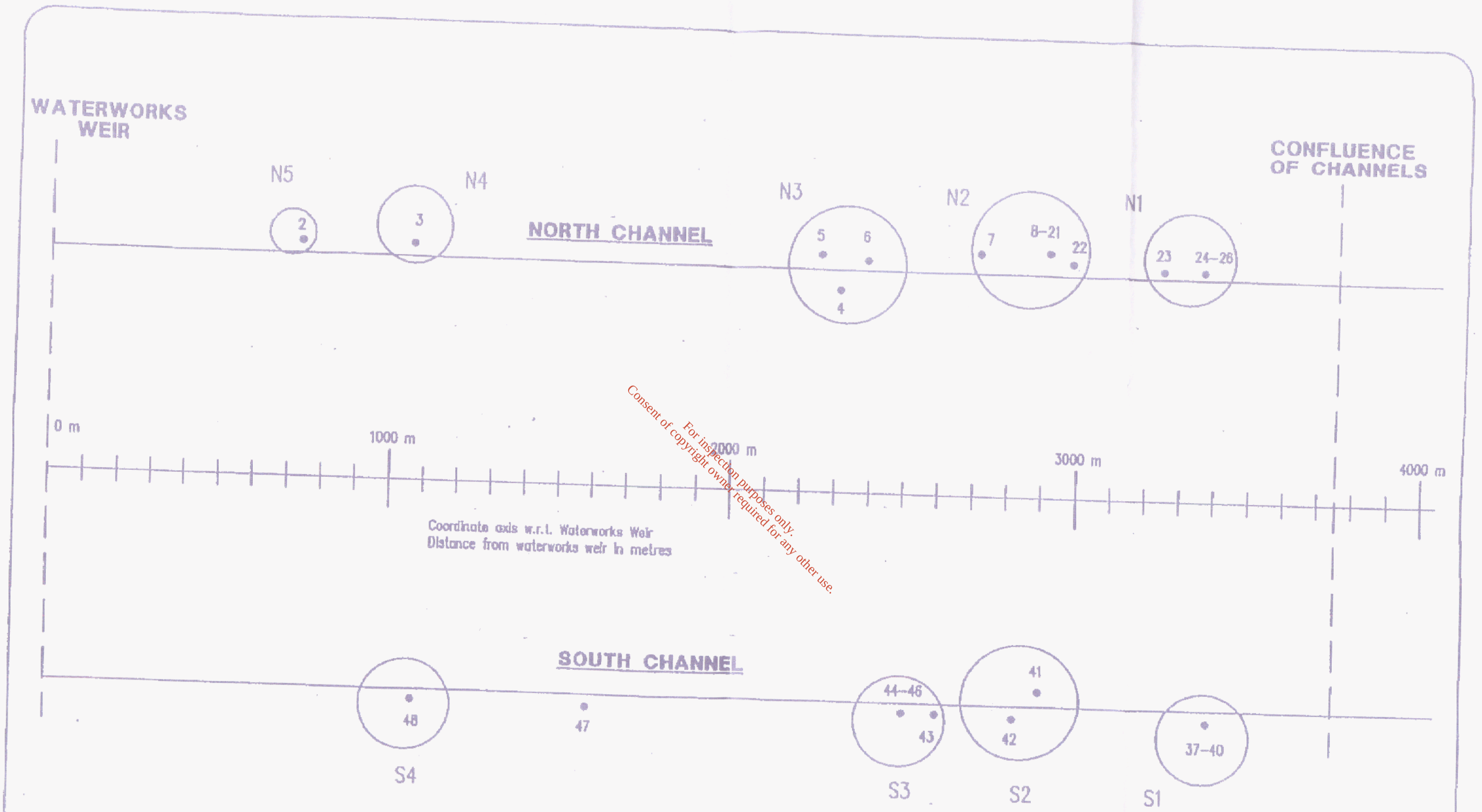

FIGURE 3.1

LOCATIONS OF STORM OVERFLOW GROUPS RELATIVE TO WATERWORKS WEIR AND CONFLUENCE OF CHANNELS

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PROJECT & CONSTRUCTION MANAGEMENT
ECONOMICS, COST CONTROL & ENVIRONMENTAL CONSULTANTS
CONSULTING ENGINEERS & ARCHITECTS

programme for pollution control.

Interpretation of River Model Results

Target Values

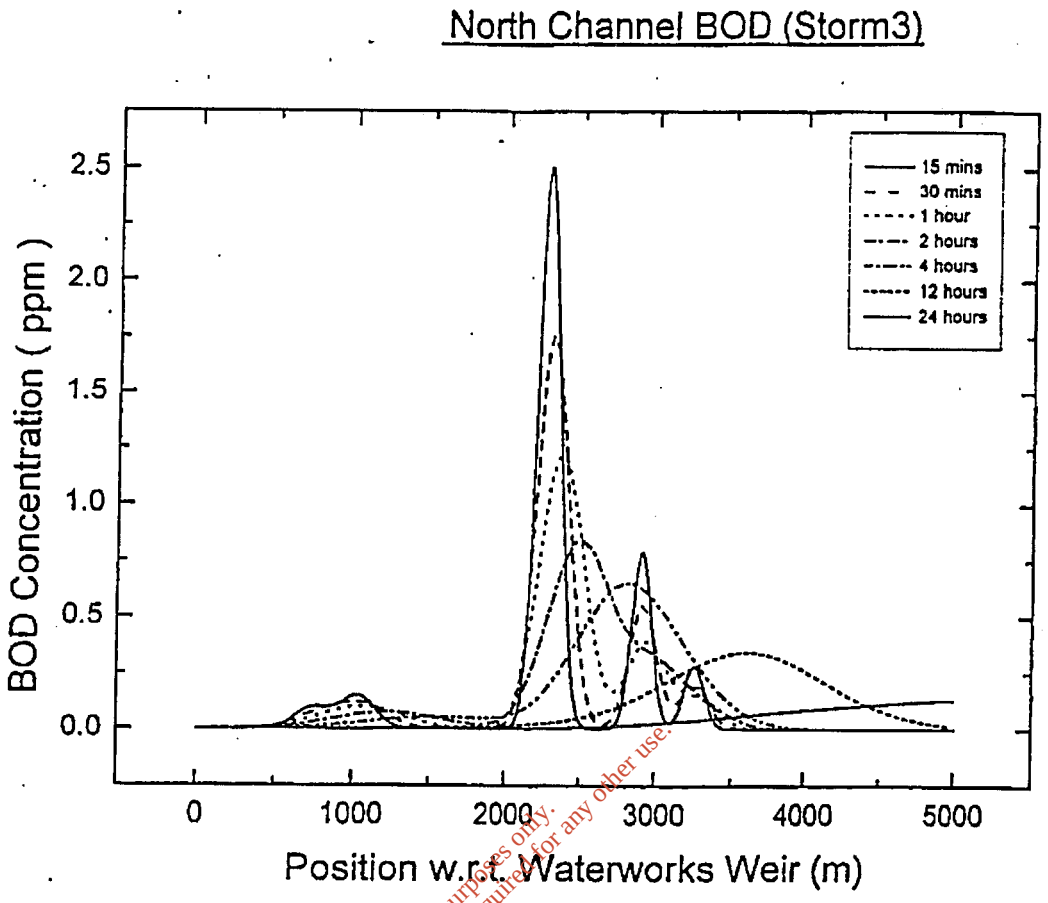
The EC Directive concerning Urban Wastewater Treatment does not stipulate mandatory or guideline limits for storm overflow discharges. The standard that is most commonly adopted in Ireland however is that of the Technical Committees's Report on Effluent and Water Quality Guidelines Memorandum No. 1 which states that "discharges which are calculated to raise the BOD_5 of the receiving water, outside the mixing zone, by more than 1 mg/l should be discouraged".

The other constituent of domestic wastewater on which water quality standards are most commonly based is pathogenic organisms in the form of E.Coli, faecal coliforms or total coliforms. The EC Directive concerning the quality of designated bathing waters for example stipulates a mandatory 95 percentile level of 10,000 total coliforms per 100 ml and a guideline 95 percentile level of 500 total coliforms per 100 ml. The immediate receiving waters of the River Lee are not at present identified as designated bathing waters. The mandatory limits for coliform concentrations specified in the Bathing Waters Directive however, can be taken as a guide to the standard of water quality which could realistically be achieved under the proposed scheme and as such should be used as target values.

The development of a programme for pollution limitation due to storm overflow discharges is therefore based on limiting increases of BOD and total coliforms as much as possible to the target values outlined above. Realistically it may not be possible to restrict storm discharges such that the desired levels are never exceeded. Consideration must therefore be given to the frequency of occurrence of events which cause levels to exceed the target values and the period of time for which the target values are exceeded.

BOD Levels

Figure 3.2 shows the predicted levels of BOD in the North and South Channels at intervals after the commencement of the 1 year 60 minute rainstorm. It is important to note that because the total BOD load is input instantaneously as a 'spike' at the start of each storm, the levels predicted within the duration of the storm are an overestimation of the likely impact. The maximum levels predicted at the end of the storm duration i.e. after 30 minutes or 60 minutes are more representative of the maximum likely BOD impacts.



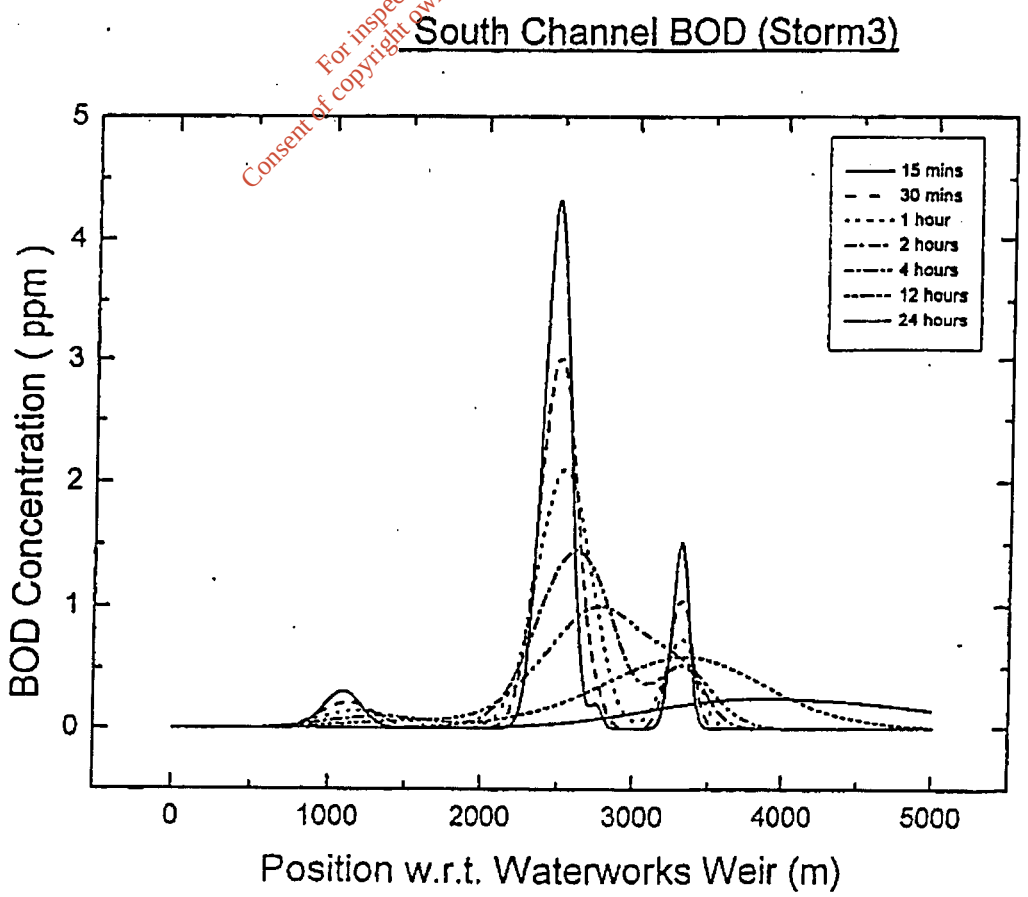


FIGURE 3.2

PREDICTED LEVELS OF B.O.D. IN THE NORTH AND SOUTH CHANNELS AT INTERVALS

Table 3.1 is a tabulation of the maximum predicted concentrations of BOD in the North and South Channels calculated at the end of each storm. The peaks of BOD occurring along the length of each channel have been matched with the group of storm overflows identified as causing the increases in concentration.

Conclusions

Analysis of the principal results yield the following conclusions:-

(a) The storm overflow groups contributing the highest BOD load to the river are not necessarily the groups causing the most adverse impact. In the South Channel for example, the BOD response to S3 exceeds 2mg/l after Storm 3. This is the maximum response in the South Channel event though S3 is not the maximum input. The input load at S1 is twice that at S3 yet the increase in BOD at S1 is less than 1 mg/l. This occurs because the assimilative capacity of the river at S1 is 8 times that at S3 thus mitigating the impact of the larger load.

(b) Of the 4 storm events analysed, Storm 3 causes the greatest impact on the receiving waters i.e. the storm of greater return period and duration.

(c) N3 is the only storm overflow group discharging to the North Channel which raises the BOD by greater than 1 mg/l. This occurs for Storms 2, 3 and 4 but not for Storm 1. The maximum increase predicted is 1.25 mg/l occurring after Storm 3.

(d) The impact due to N3 decreases below 1 mg/l 2 hours after the start of the Storm, i.e. 1 hour after the end of the Storm.

(e) The BOD increase greater than 1 mg/l due to the N3 discharge will extend over a length of approximately 200m of the North Channel.

(f) The maximum impact at all other locations in the North Channel is less than 0.5 mg/l.

(g) S3 is the only storm overflow group discharging to the South Channel which raises the BOD by greater than 1 mg/l. This occurs for all 4 storms. The maximum increase predicted is 2.16 mg/l occurring after Storm 3.

(h) The impact due to S3 decreases below 1 mg/l 4 hours after the start of the storm i.e. 3 hours after the end of the storm.

Table 3.1

Maximum Predicted Concentrations of BOD in the N & S Channels (mg/l) at the End of Each Rainstorm .

Location	Storm 1 30 min. Duration 10 Week Return Period	Storm 2 60 min. Duration 10 Week Return Period	Storm 3 60 min. Duration 1 Year Return Period	Storm 4 30 min. Duration 1 Year Return Period
N 1	0.09	0.11	0.14	0.13
N 2	0.26	0.32	0.40	0.37
N 3	0.86	1.09	1.25	1.12
N 4	0.06	0.04	0.07	0.17
N 5	0.30	0.39	0.05	0.23
S 1	0.53	0.69	0.76	0.64
S 2	0.07	0.08	0.09	0.09
S 3	1.55	1.92	2.16	1.80
S 4	0.12	0.14	0.15	0.12

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(i) The BOD increase greater than 1 mg/l due to the S3 discharge will extend over a length of approximately 400m of the South Channel.

Total Coliform Levels

Figure 3.3 shows the predicted levels of total coliforms in the North and South Channels at intervals after the commencement of the 1 year 60 minute rain storm. Again, the total input loads have been applied as a 'spike' at the start of each storm thus resulting in an overestimate of the likely impacts during the early part of the storms. The maximum levels predicted at the end of each storm can be considered more representative of the maximum likely total coliform impacts.

Table 3.2 is a tabulation of the maximum predicted concentrations of total coliforms in the North and South Channels at the end of each storm. Again the peak concentrations occurring along the length of each Channel have been matched with the group of storm overflows identified as causing the impact.

Analysis of the principal results for total coliforms yields the following conclusions:-

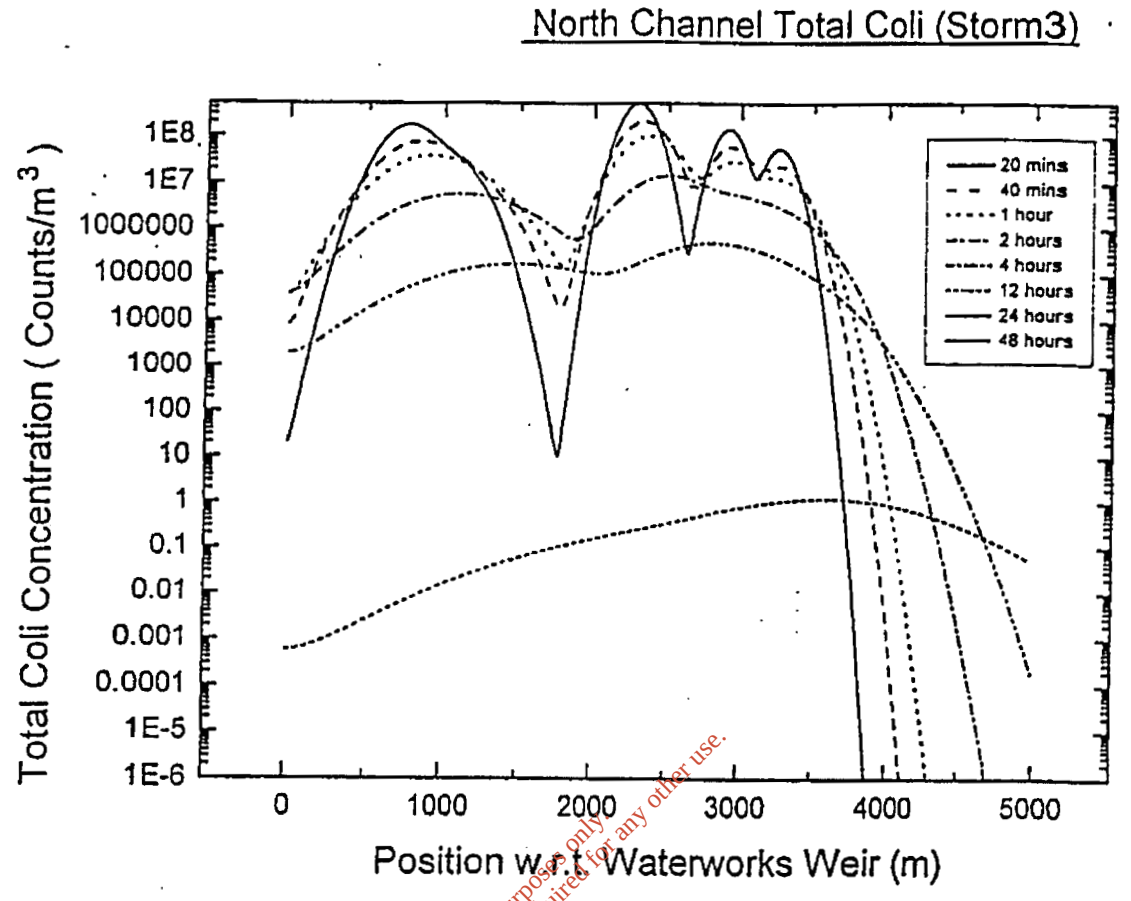
(a) Of the 4 storm events analysed, Storm 4 causes the greatest increase in total coliform levels in the receiving water.

(b) The storm overflow group N3 discharging to the North Channel raised the total coliform concentration in the immediate receiving waters to a level in excess of the EC Bathing Waters mandatory level of 10,000 TC/100ml for all 4 storms. The maximum increase predicted is 40,000 tc/100ml occurring after storm 4.

(c) The dispersion and decay of the total coliforms proceeds quite rapidly upon mixing with the receiving waters. For all storm events the impact due to N3 should decrease below 10,000 TC/100ml within 1 hour of the end of the storm.

(d) The total coliform increases greater than 10,000 TC/100 ml due to the N3 discharge will extend over a length of approximately 300m of the North Channel.

(e) Both the N2 and N5 discharges result is total coliform levels slightly in excess of the mandatory Bathing Waters limit for one of the 4 storms only. These levels exist for only a very short period of time and over a short section of the Channel. Both the N2 and N5 storm overflow groups therefore are not deemed to be



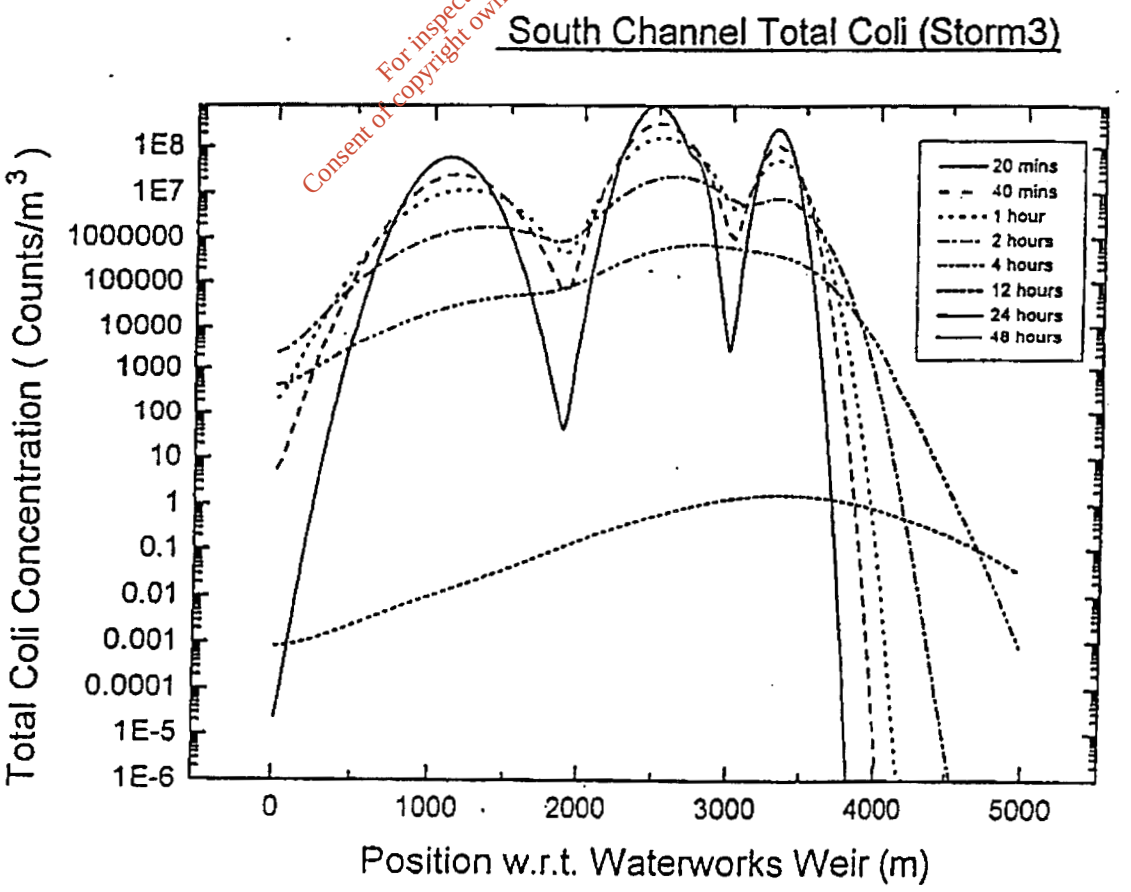


FIGURE 3.3

PREDICTED LEVELS OF TOTAL COLIFORMS IN THE NORTH AND SOUTH CHANNELS AT

Table 3.2

Maximum Predicted Concentrations of Total Coliforms in the N & S Channels (counts/100 ml) at the End of Each Rainstorm .

Location	Storm 1 30 min. Duration 10 Week Return Period	Storm 2 60 min. Duration 10 Week Return Period	Storm 3 60 min. Duration 1 Year Return Period	Storm 4 30 min. Duration 1 Year Return Period
N 1	3,414	2,827	3,791	4,250
N 2	9,270	9,272	9,806	11,134
N 3	26,144	25,530	34,023	39,309
N 4	1,885	1,100	1,893	5,430
N 5	9,065	9,718	11,662	7,215
S 1	15,376	17,022	17,431	22,233
S 2	2,115	2,211	2,458	2,379
S 3	50,611	50,025	53,693	59,503
S 4	3,744	2,841	3,934	3,988

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critical in terms of bacteriological releases to the North Channel.

(f) Both the S1 and S3 storm overflow groups discharging to the South Channel raise the total coliform concentration of the immediate receiving waters by more than 10,000 TC/100 ml. This occurs for all 4 storms . The maximum increases predicted are 60,000 TC/100 ml due to S3 and 22,000 TC/100 ml due to S1.

(g) The impact due to the combined S3 and S1 discharges decreases below 10,000 TC/100 ml within 1 hour of the end of the storm.

(h) The total coliform increases greater than 10,000 TC/100 ml due to the S3 and S1 discharges will extend over lengths of approximately 500m and 200m respectively in the South Channel.

Programme for Pollution Control

Analysis of the results of the river model has identified 3 storm overflow groups whose discharges cause significant impacts on the receiving waters under storm conditions. Table 3.3 ranks the 3 groups in the order of magnitude of their impacts and lists the maximum likely increases in BOD and total coliforms in the immediate receiving waters.

An assessment of all the storm overflows within each of the 3 storm overflow groups reveals that 1 overflow in particular is responsible for the majority of the discharged pollutant load in each case. The largest contributing storm overflow associated with each group is identified in Table 3.3

Storm Overflow Group	Max. BOD Increase (mg/l)	Max. Total Coliform Increase (Counts/100 ml)	Critical Storm Overflow in Group
S3	2.16	60,000	No.46 Bishop Street
N3	1.25	40,000	No.5 Rock Cottages
S1	0.76	22,000	No.38 Southern Rd.

Table 3.3 Ranked Storm Overflow Groups.

From the preceding investigations it can be concluded that a programme of pollution control for the existing storm overflows in the city catchment must be based on limiting the discharges from the 3 critical overflows

located at Bishop Street, Rock Cottages and Southern Road.

To aid in the development of a control programme, a more detailed analysis of the 3 individual storm overflows has been carried out using the Mouse Computer simulation. The Samba model which is a sub programme of Mouse has been used to generate extensive statistical information on the operational characteristics of the 3 overflows.

The implementation of the Samba model requires the application of historical rainfall data to the combined sewer network model. Based on the flows generated by the combination of recorded rainfall events and the established foul dry weather flows, statistical output on the discharge characteristics of the storm overflows can be obtained.

For the purpose of the Cork Main Drainage Scheme, 15 years (1975 - 1989) of hourly rainfall data recorded at Cork Airport was obtained from the Meteorological Office. 1 hour rainfall data however proved insufficiently precise for the operation of the Samba model. To improve the precision therefore the 1 hourly data was disaggregated into 5 minute intervals using a technique developed by the Wallingford Research Centre. From the resultant data base, the 1,006 events with a rainfall greater than 5mm were selected for application in the Samba model.

Output from the Samba model was obtained in the form of statistical variations and distributions of the following parameters

- Number of overflow occurrences
- Duration of overflow
- Discharged mass of BOD
- Discharged quantity of total coliforms.

For each of these parameters the chronological variation per year over a 15 year period has been developed for the 3 storm overflows being examined.

Figure 3.4 shows the variations of the total number of overflows per year, the total duration of overflow per year, the total mass of BOD discharged per year and the total number of total coliforms discharged per year for storm overflow No. 5 at Rock Cottages. Figures 3.5 and 3.6 are the corresponding yearly variations for the storm overflows at Southern Road and Bishop Street respectively.

As outlined earlier it will not, in practice, be possible to limit the discharges from the 3 critical storm overflow to the extent that the resultant increases in BOD and total coliforms in the receiving waters

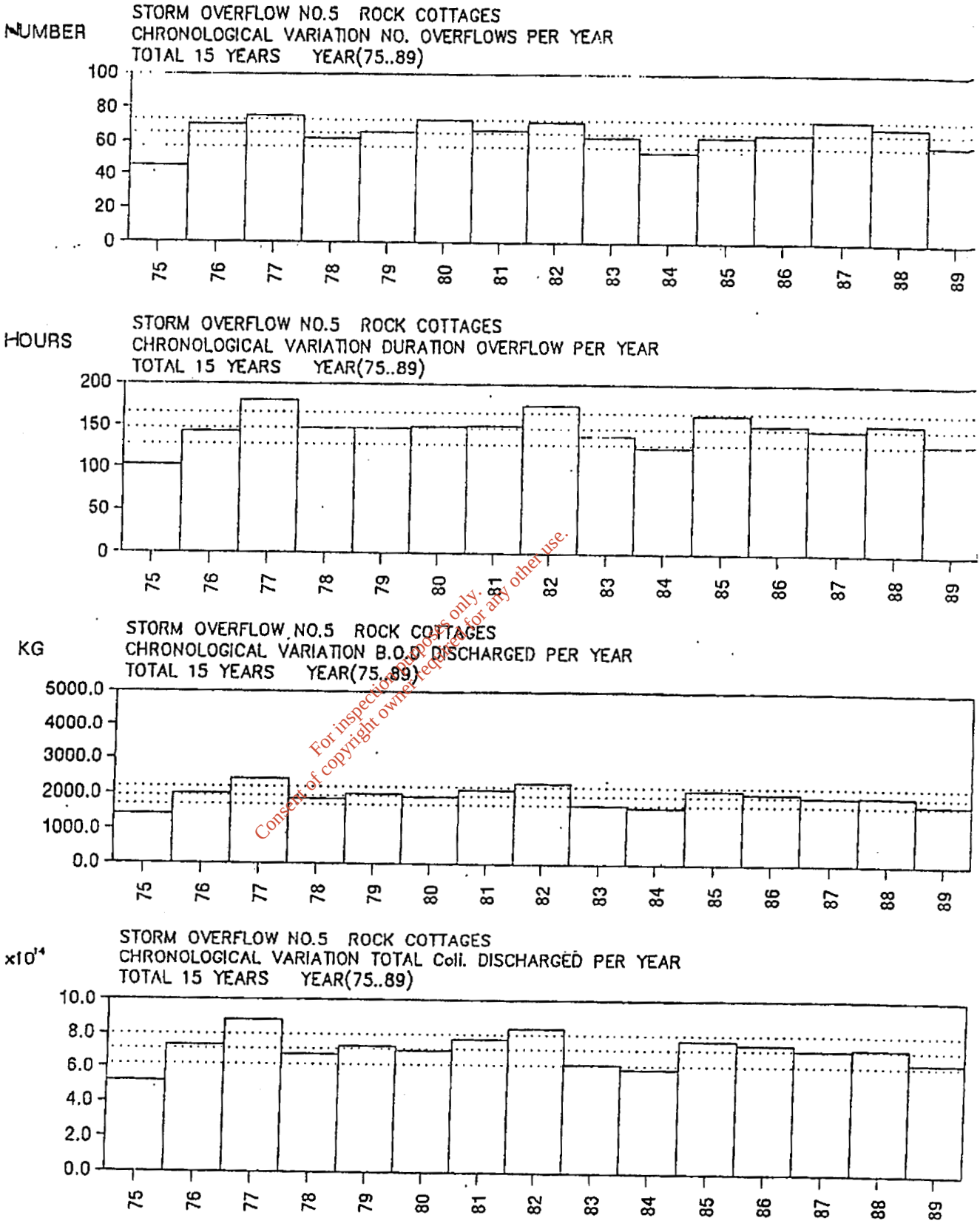


FIGURE 3.4 · HISTORICAL DISCHARGE DATA FOR STORM OVERFLOW NO. 5 AT ROCK COTTAGES.

AIR QUALITY DISPERSION MODELLING

A. AIR QUALITY IMPACT OF PROPOSED URBAN WASTEWATER TREATMENT PLANT, LOCATED AT CARRIGRENAN SITE.

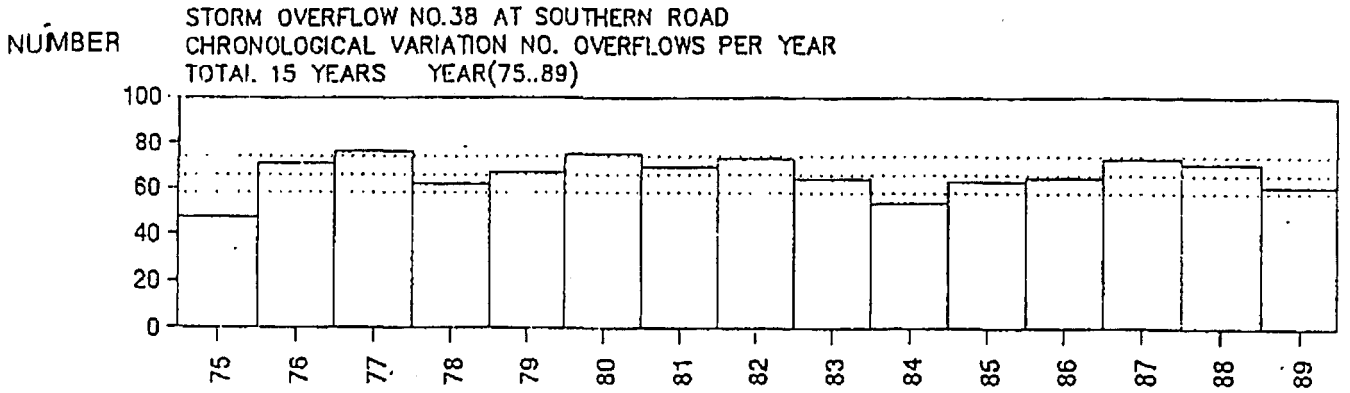
General

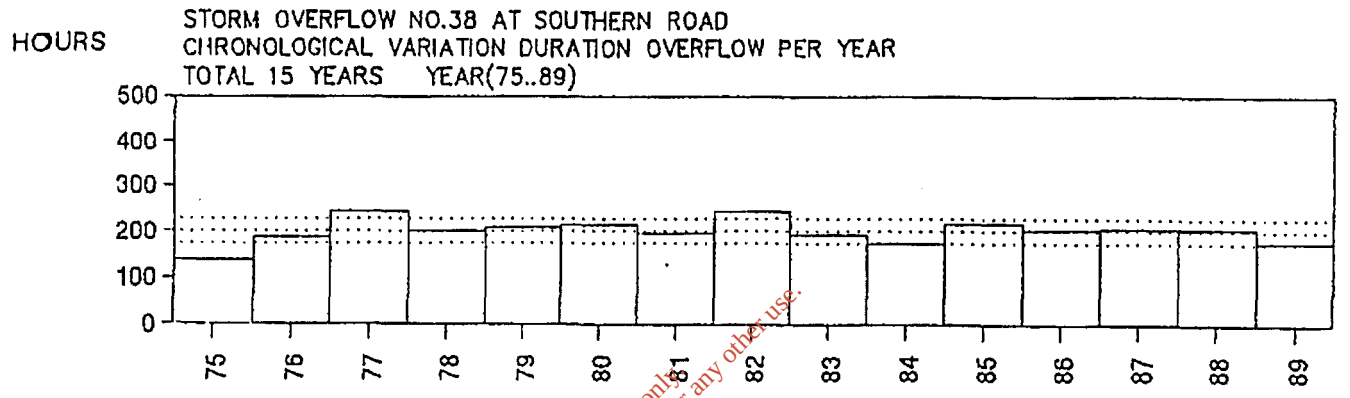
The assessment for odour potential due to air emissions from the proposed urban wastewater treatment plant at Carrigrenan, Little Island for the treatment of wastewater from the Cork Main Drainage Scheme was carried out by examining local climatological characteristics, plant design and air dispersion modelling estimates. The proposed facility will treat all domestic, commercial and industrial wastewater from the catchment area which currently discharges directly into the river and Cork Harbour.

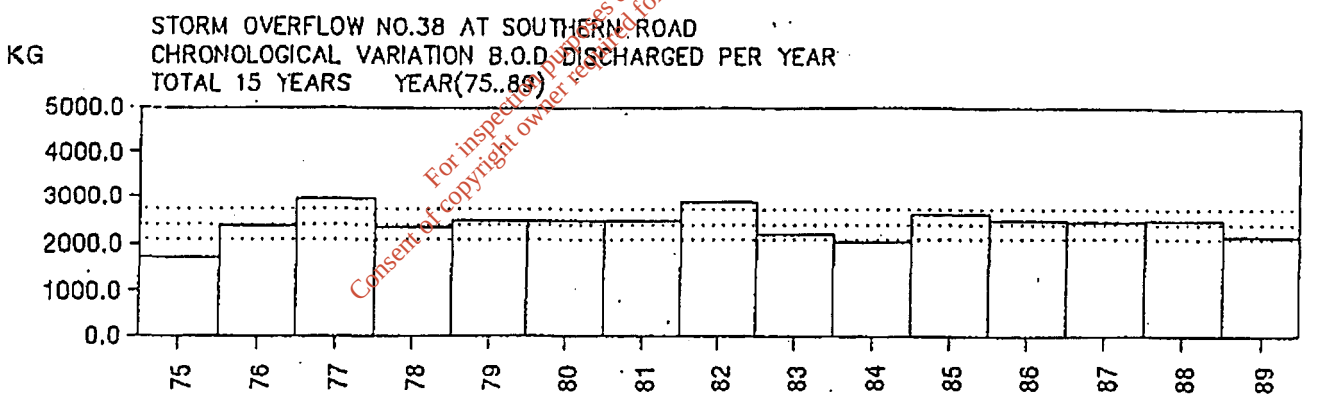
Introduction

Odours normally associated with wastewater treatment plants are highly pungent and may be identified at very low air concentrations. For example hydrogen sulphide with the characteristic smell of rotten eggs has an odour detection limit of the order of about 0.2 $\mu g/m^3$. The public perception of treatment plants is based in most cases on problems of old treatment plants where the operational procedures are inadequate to prevent anaerobic conditions occurring that can create an odour nuisance or where de-sludging activities are carried out in open tanks. Many developments such as containment of sludge in enclosed sludge digesters, monitoring of effluent flows through the works, prevention of clogging of channels or sludge chambers and regular maintenance of grit traps and screens have greatly helped to reduce odour nuisance.

The rate of emissions of potentially odorous inorganic and organic compounds from wastewater treatment tanks depend on the volatility of the compounds and the evaporation rate from the tank. The latter is a function of the wind speed, air temperature and turbulence of the liquid. The rate of anaerobic activity within the effluent is also affected by weather conditions such as air temperature and humidity so that odours tend to be greatest during dry warm weather conditions. These conditions may also be associated with periods of low effluent flow through the plant which can significantly affect the efficiency of the plant. It is virtually impossible to ensure that odours are never detected beyond the boundary fence of a treatment plant. This is because of the nature of the material being handled. The aim however, is to prevent an odour nuisance occurring on a regular basis. This requires good plant







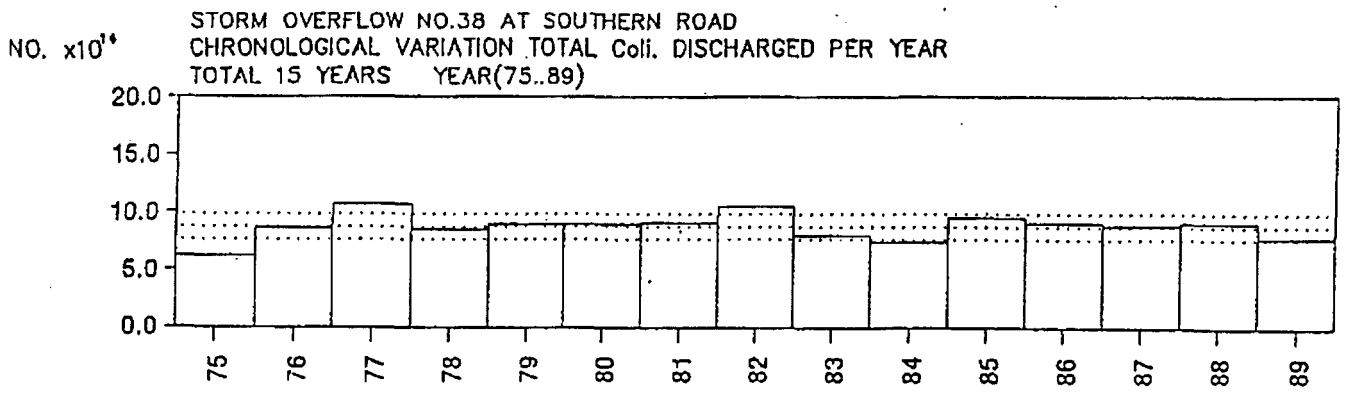
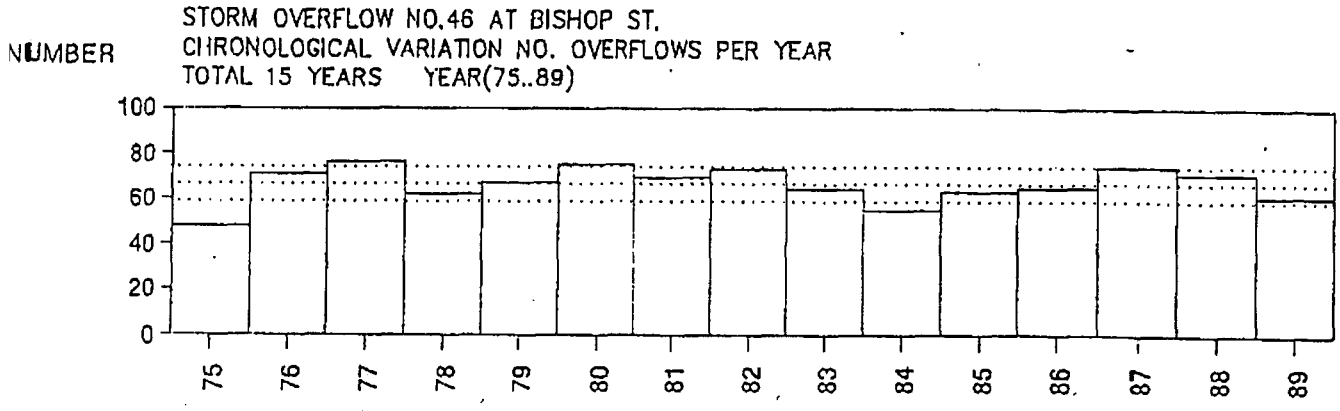
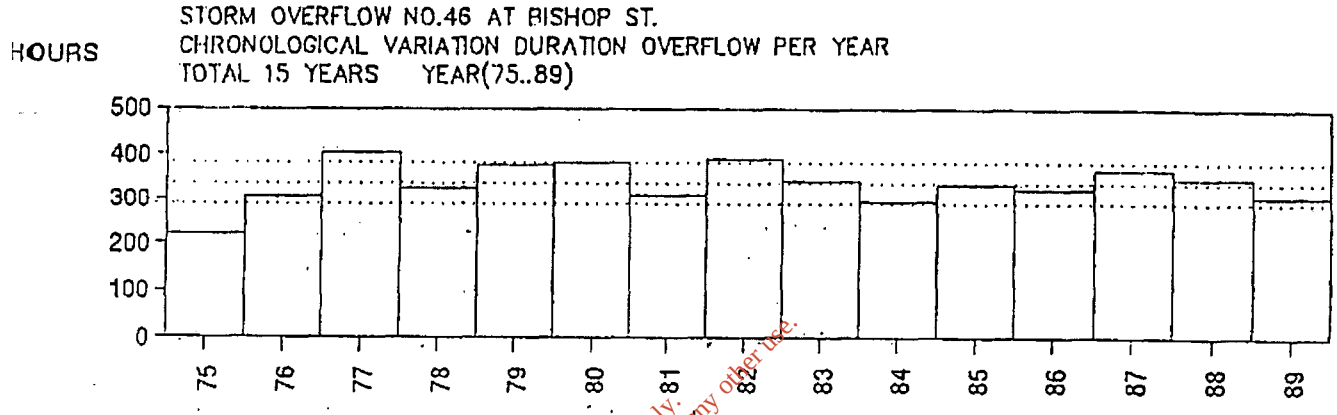
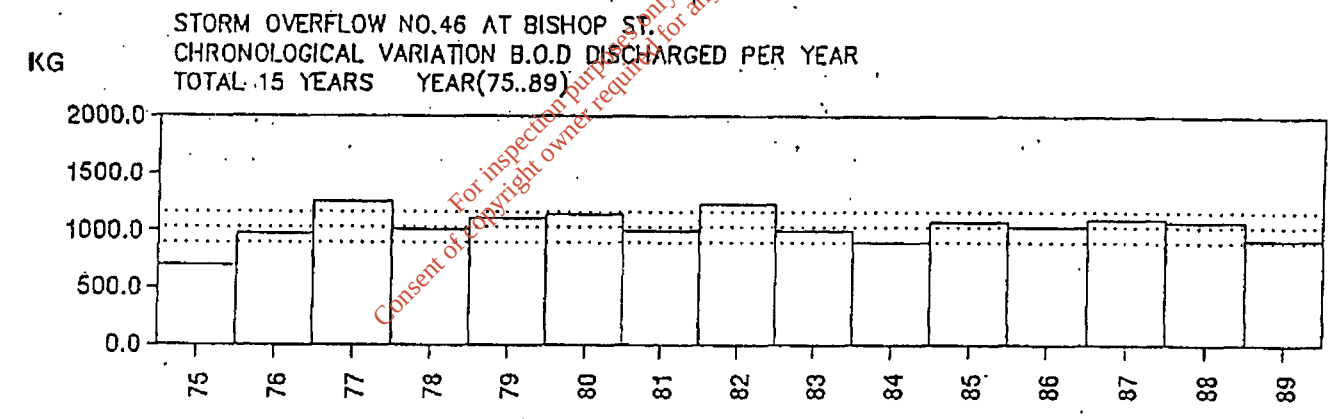


FIGURE 3.3.4.5 HISTORICAL DISCHARGE DATA FOR STORM OVERFLOW NO. 38 AT SOUTHERN ROAD.







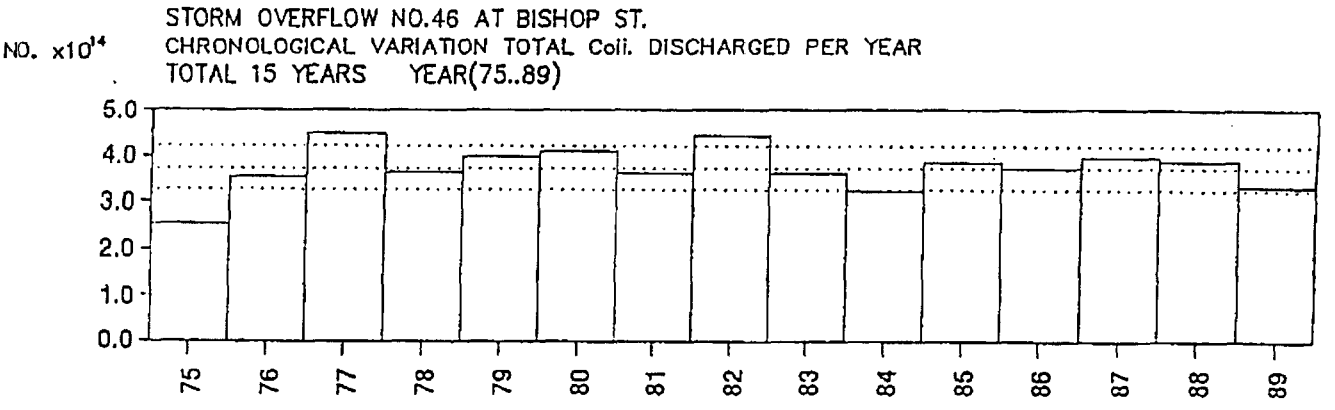


FIGURE 3.6 HISTORICAL DISCHARGE DATA FOR STORM OVERFLOW NO. 46 AT BISHOP ST.

never exceed the target values of 1 mg/l and 10,000 TC/100 ml respectively. The statistical information derived for the 3 overflows using the Samba model however may now be used to determine measures to ensure the non exceedance of acceptable limits on the number of overflow occurrences per year, the duration of overflows per year, the discharge mass of BOD per year and the discharge quantity of total coliforms per year in compliance with the strategy outlined in the EC Directive.

The limitation of pollution due to discharges from the 3 storm overflows will necessitate alterations to be carried out to the weirs and throttle pipes in each chamber. This action will result in a larger proportion of the total load arriving at each chamber being retained in the system and a smaller proportion being discharged, thus reducing the impact on the receiving waters. An alternative to modifying the existing weirs and throttle pipes would be the installation of the "Hydro-brake" system in each chamber. The "Hydro-brake" system can be installed in existing chambers to replace the throttle pipe and overflow weir as the means of flow separation. The main advantage associated with the "Hydro-brake" system is that the risk of blockage is considerably lower than that for the conventional throttle pipe system. Furthermore, the fact that the units can be installed in existing chambers means that capital costs can be minimised.

APPENDIX 4

AIR QUALITY DISPERSION MODELLING

SECTION A

AIR QUALITY IMPACT OF PROPOSED URBAN WASTEWATER TREATMENT PLANT LOCATED AT CARRIGRENAN