4. ALTERNATIVES.

4.1 OUTLINE.

The process leading to the conclusion that a single treatment works at Ringsend is the best option has been extensive. This section of the EIS summarises alternatives to the proposed development under the following headings:

* Do Nothing
* City-wide Alternatives
* Ringsend Alternatives
* Outfalls
* Procurement

4.2 DO NOTHING.

The present treatment works at Ringsend which treats discharges from the City, Dodder Valley and Ringsend catchments and provides primary treatment does not comply with any of the objectives and statutory requirements outlined in Section 3.1. Discharges from the North Dublin Catchment off the nose of Howth which receive no treatment similarly fail to meet these requirements. Accordingly the alternative of 'Do-nothing' and continue as presently operating is not valid and cannot be considered by Dublin Corporation.

4.3 CITY-WIDE ALTERNATIVES.

4.3.1 Sewage Treatment.

In developing the proposals which constitute the Dublin Bay Project, Dublin Corporation have examined a number of alternatives regarding the geographical location of Treatment Works in the city.

In 1991, as part of the Dublin Main Drainage Scheme, Dublin Corporation awarded a number of briefs to examine particular projects.

The Dublin Main Drainage Briefs comprised:

*	Brief No. 1	Ringsend Sewage Treatment Works Expansion	McCarthy Acer Consultants Ltd. (MACL)
*	Brief No. 2	Sludge Treatment and Disposal Study	ESBI/Atkins - Acer Environmental
*	Brief No. 3	North Dublin Drainage Scheme Sewage Treatment Works	MCP-Kruger
*	Brief No. 4	North Dublin Drainage Scheme Catchment Area Study	MC O'Sullivan & Co. Ltd.
*	Brief No. 5	Rathmines/Pembroke and City Centre Catchment Area Studies	Dublin Corporation

Briefs No. 1 and No. 3 in particular relate to treatment works alternatives. The Consultants submitted their reports to Brief No. 1 in 1993[(6)] and Brief No. 3 in 1994[(7)].

Brief No. 1 concluded that the existing Treatment Works at Ringsend could be expanded to accommodate a 2015 flow from the combined Main Lift Pumping Station, Dodder Valley Drainage Scheme and Dun Laoghaire Drainage catchment of 1.37 Million p.e. Brief No. 3, having examined combinations of Treatment Works processes and locations in North County Dublin, concluded that a New Treatment Works could be located at Baldoyle West to treat a 2015 population of 600,000 p.e.

Because the sludge treatment facilities should ideally be sited as close as possible to the sewage treatment works so as to be close to the source of sludge production and so that process liquors can be returned directly to Ringsend STW, Brief No. 2[(8)] recommended that sludge treatment for both works be centralised at Ringsend.

Of the 1.37 Million p.e. design population in the Brief No. 1 report 609,000 represented the industrial component. As stated in 3.3.4 above discussion between Dublin Corporation and industrial dischargers to the sewerage system regarding the response to a charging policy led Dublin Corporation to revise downwards their projections for industrial loading on the Ringsend Treatment Works. The volume of industrial discharge would remain unchanged. The consequences of this revision would be that the size and capital cost of Ringsend STW would essentially be unchanged while the running cost and sludge production would be reduced.

Subsequently in May 1995 Dublin Corporation commissioned MACL to prepare a Supplementary Report to assess whether the North Dublin and Ringsend catchments could be treated in a combined Treatment Works at Ringsend. MACL submitted their report in October 1995[9] concluding that the combined catchments with a design population of 1.69 million p.e. (including 561,000 p.e. industrial contribution) could be treated at Ringsend with full secondary treatment and tertiary treatment for ammonia removal and disinfection.

4.3.2 Sewage Transfer.

Other EIS's - Sutton Pumping Station and Dublin Bay Submarine Pipeline in the Dublin Bay Project series examine in detail the alternatives in relation to the transfer of North Dublin Catchment sewage to the various works options.

4.3.3 Sludge Transfer.

Brief No. 2 considered options for the transfer of sludge from Baldoyle to Ringsend. A significant consequence of the centralisation of a single treatment works at Ringsend would be that no inter-site sludge transportation would be required. Concurrent with and subsequent to the Supplementary Report on sewage treatment reports were prepared by ESBI/Atkins International on the interim sludge management 1998 - 2000[10] and beyond 2000[11].

4.3.4 Option Comparison.

Dublin Corporation examined the total costs, capital and running, and taking cognisance of the benefits associated with the operation and maintenance of a single plant against two plants (possibly involving different processes and incompatible machinery and parts) concluded that a single plant, all other things being equal, offered the optimum result.

4.4 RINGSEND ALTERNATIVES.

4.4.1 Sites and Sewage Treatment.

In preparing the 1993 Preliminary Report on the Expansion of Ringsend STW at Ringsend the Consultants examined a number of sites to accommodate an enlarged treatment works. These are highlighted on the enclosed Figure 4.1.

Feasible treatment works options using the selection criteria outlined in 3.5.4 indicated that workable configurations could be achieved on 3 options.

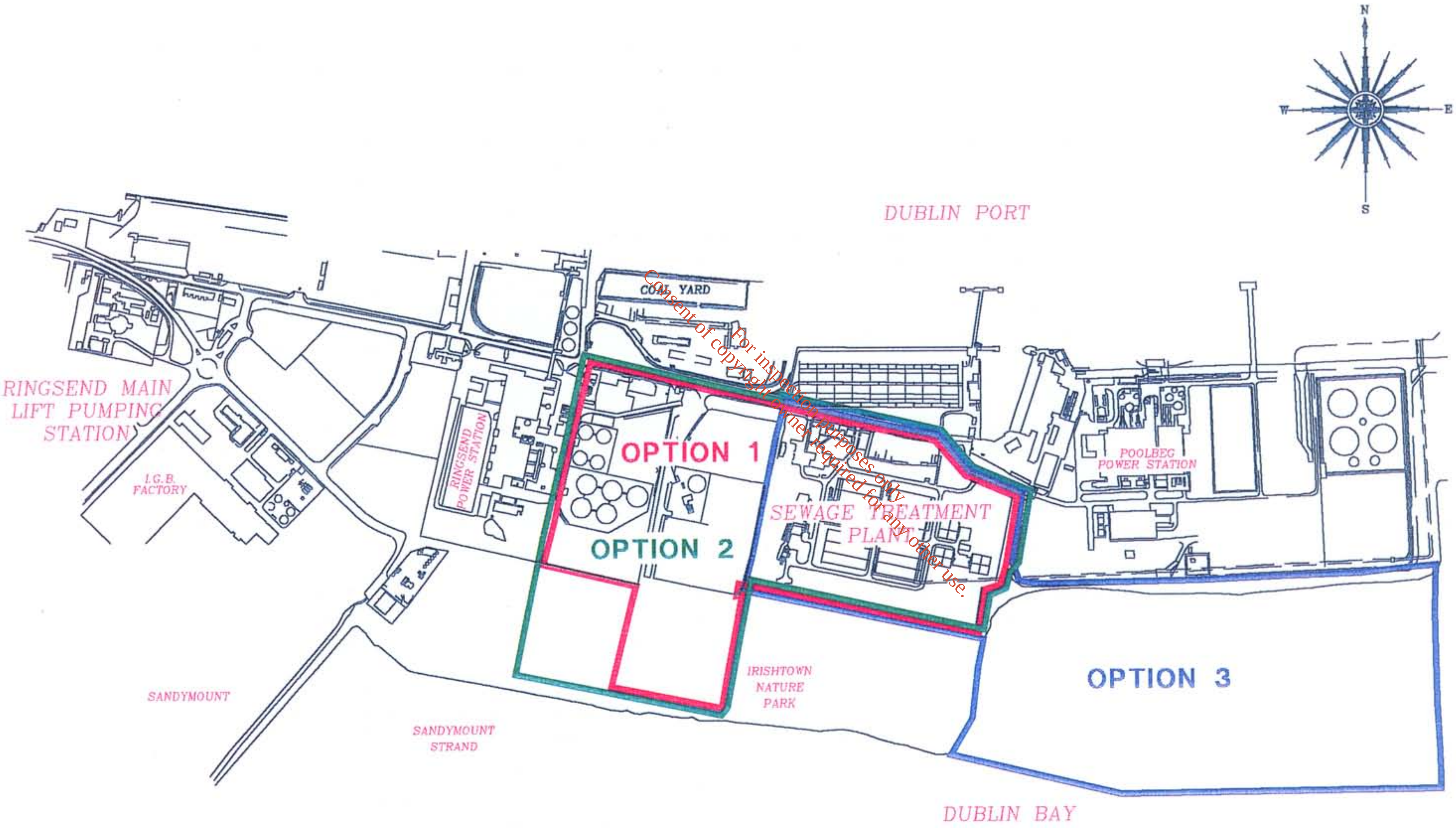
Option 1	32 ha.
Option 2	36 ha.
Option 3	43 ha.

Cost penalties associated with an original Option 1 resulting from deep excavations led to a re-evaluation of options. Option 2 followed from this taking a greater land area. This option was abandoned when it was found that sites were unavailable due to developments planned by their owner Dublin Port and Docks Board. As a consequence the proposed expansion to Ringsend STW would have occupied an area of 28 ha. to be reclaimed from Dublin Bay.

This EIS commenced on the premise that the development was to be based on the 28 ha. reclamation as shown on the enclosed Figure 4.2.

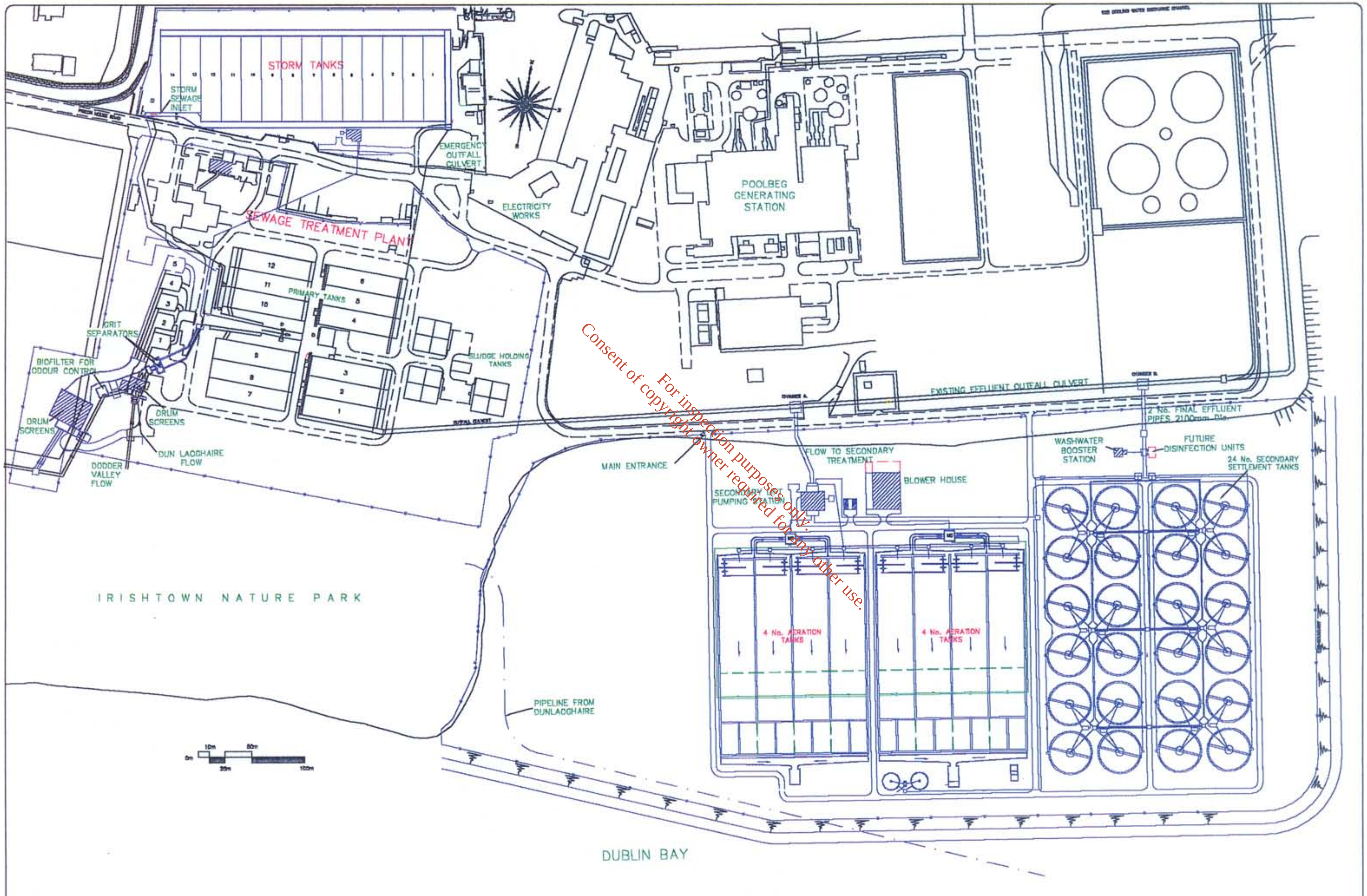
A baseline study of the intertidal area described the marine flora and fauna in the area of the proposed reclamation and the greater intertidal area to the south of the Great South Wall.

In the context of the area's designation under the 'Birds Directive (Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds) and the 'Habitats' Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora) it was felt that an application for reclamation from the Minister for the Marine could only be made with the agreement of the then National Parks and Wildlife Service of the Office of Public Works. Such agreement would be dependent on showing that the proposed site was not of significance in relation to bird populations and that there was no reasonable alternative to reclaiming the land. The



ALTERNATIVE SITE OPTIONS
PRELIMINARY STAGE

FIGURE 4.1



ORIGINAL DEVELOPMENT PROPOSAL

FIGURE 4.2

baseline study indicated that such agreement might not be readily forthcoming as the impacts of reclaiming the site might be significant and consequently the proposal was not pursued further.

The selection criteria, in particular that relating to 'satisfactory demonstration on comparable scale', were subsequently reviewed. A number of new management and implementation methods had been developed by process and contracting companies in Europe and world-wide. These methods gave a new impetus to more traditional processes and permitted the construction of large plants with smaller land requirement. As a consequence of the review it was acknowledged that a compact plant could be constructed within the curtilage of the Existing Treatment Works at Ringsend. This effectively removed any requirement for the purchase of land, compulsorily or otherwise, or reclamation in relation to Ringsend STW.

4.4.2 Alternative Sludge Treatment Options.

During the development of the Sludge Management Plan a number of alternative treatment processes were examined against a range of selection criteria. The selection criteria included issues such as satisfactory application at similar scale, cost and area requirement. Alternative treatment processes included:

Bio-stabilisation Processes:	Composting
Thermal Processes:	Incineration
	Oil from Sludge
	Vitrification
	Ventec Gasification
Chemical Processes:	Vertech Wet Oxidation

Oil from Sludge, Vitrification, Ventec Gasification and Vertech Wet Oxidation were considered not to be sufficiently established to meet the selection criteria at this time. Treatment by composting had proved problematic at large scale works elsewhere. These treatment processes, therefore, were not considered appropriate for Ringsend sludges.

Of the alternative treatment options examined in detail, only incineration of wet sludge cake was considered to be viable for Ringsend. Dedicated incineration of wet sludge cake provides the most significant volume reduction but was ruled out for a number of reasons, principally cost and long lead-in time. Co-incineration (the incineration of sewage sludge with municipal solid waste) is carried out at a number of locations in the EU and elsewhere. However, as no municipal solid waste incinerators exist in Ireland co-incineration is not a tenable option at the present time. In view of the relative proportions of materials, opportunities for co-incineration would in any case be addressed from the municipal waste viewpoint.

4.5 OUTFALLS.

The principal outfall configuration examined was the existing outfall via the power stations' cooling water discharge. All of the discharge standards required in the Liffey Estuary and in Dublin Bay can be achieved via this route. Options involving the construction of long sea outfalls into Dublin Bay were examined. These extended 4.2 and 5.1km respectively from the existing outfall into the deep waters of Dublin Bay. The locations are shown on Figure 4.3.

The shorter outfall was excluded on financial grounds as the modelling work carried out indicated that the nitrification (ammonia removal) of effluent would remain a requirement. The modelling on the longer outfall suggested that neither disinfection nor nitrification would be required. However the cost of this option was estimated to be higher than the cost of the provision of disinfection and nitrification at Ringsend STW. Furthermore in the event of the adoption of stricter treatment standards requiring disinfection or ammonia removal the disadvantage would be greater.

The existing outfall offers the most cost effective solution at no additional environmental cost.

4.6 PROCUREMENT PROCEDURES.

Cognisant of the possibility that a single works would be adequate for their needs Dublin Corporation examined procurement and funding alternatives for their development. These included:

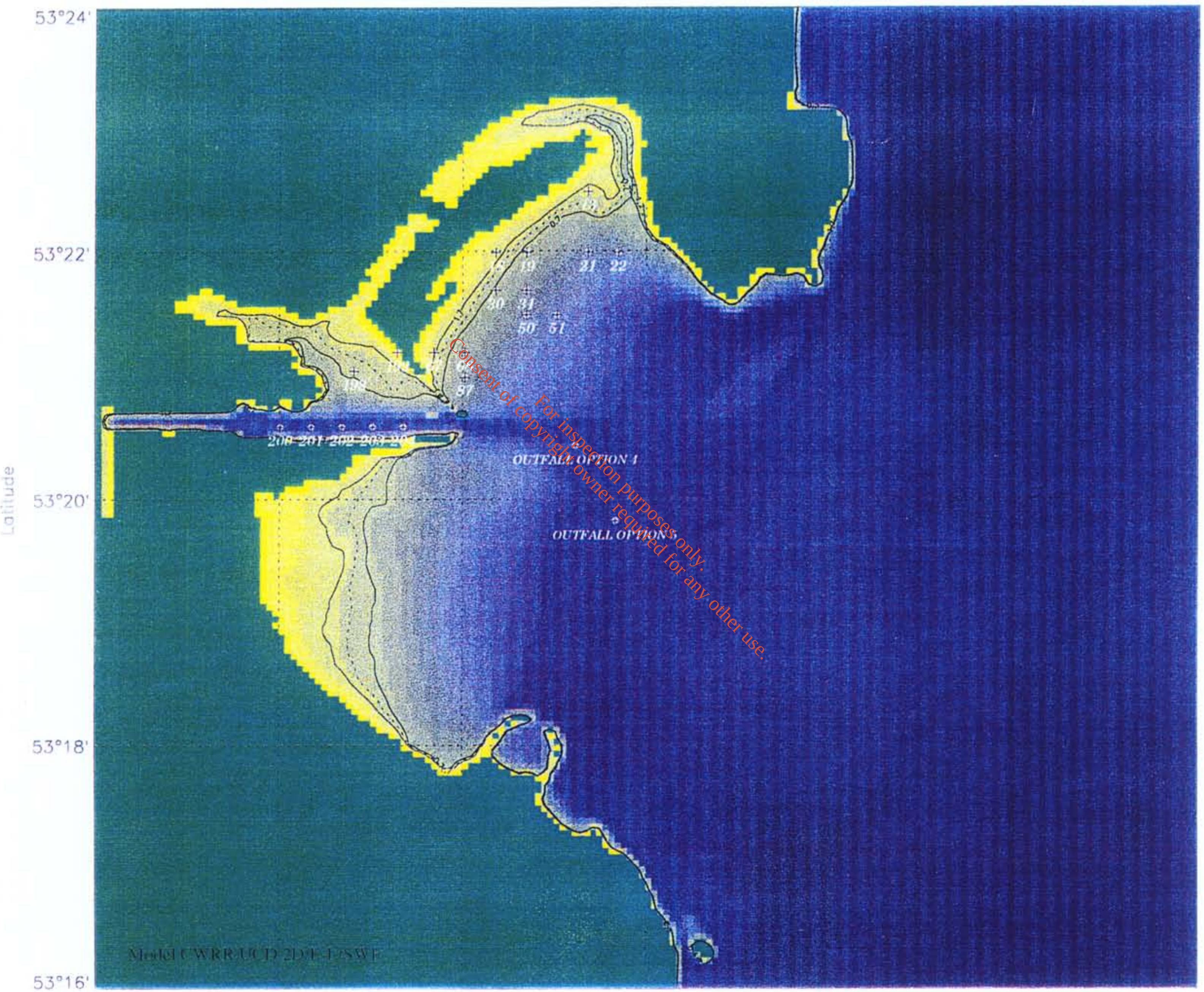

53°24'
53°22'
53°20'
53°18'
53°16'
Latitude
19
21
22
30
31
50
51
87
200
201
202
203
OUTFALL OPTION 4
OUTFALL OPTION 5
Model CWRR-UCD 2D/E-T/SWE

FIGURE 4.3

* Traditional Procurement
* Design and Build
* Design Build and Operate (DBO)
* Design Build Own Operate (dBOO)
* Design Build Own Operate and Transfer (dBOOT)

Traditional Procurement.

This essentially would involve Dublin Corporation commissioning a Consulting Engineer to design, put out to tender and supervise construction of Ringsend STW on their behalf. This would result in a recommended scheme including all forms of sludge and sewage treatment, operation and maintenance being chosen prior to tender. Capital costs would be shared between government and EU grants and commercial and industrial financial contributions and running costs borne by Dublin Corporation.

Design and Build.

Under this method Dublin Corporation would commission one firm to design and build the plant. Commissioning would be awarded on the basis of a tender involving the achievement set consent criteria for effluent discharges. The processes and methods to achieve the consent levels would be chosen by the Tenderers. The method would allow new management methods and process innovations developed by specific companies to be put forward as being suitable for Ringsend STW. Costs and funding would be as for traditional procurement. Operation of the plant would be by Dublin Corporation.

Design Build and Operate.

This would be as the previous alternative but that Contractor would operate the plant. The period of operation could be fixed, indefinite or subject to periodic review. Funding would also be as the previous alternatives with the addition that operation costs would be charged to Dublin Corporation rather than borne directly by them.

Design Build Own Operate.

This alternative varies from the previous in relation to the funding and ownership of the plant. Funding would be by the developer (Contractor) and the running costs and charges to Dublin Corporation would reflect the costs of servicing the construction and financing of Ringsend STW.

Design Build Own Operate Transfer.

This is a further development of the previous alternative in that after a fixed period the ownership of Ringsend STW would revert to Dublin Corporation. A consideration might or might not apply at the time of transfer and whether or not it did would affect the annual running costs associated with Ringsend STW.

4.6.1 Conclusion.

On the basis of the funding available, the likely running cost mechanism and the requirement that whoever designs the plant should be responsible for its maintenance and operation it is considered that the DBO option with fixed period of operation of 20 years is the most appropriate procurement route for the development of Ringsend STW.

4.7 CHOSEN ALTERNATIVE.

Having regard to the availability of the existing site at Ringsend, that a single works will have a number of operational benefits over two works, that a single works is not cost disadvantageous to two works, that no new land purchase is required, that a single works is amenable to DBO procurement and that the design criteria for discharge could be accommodated at the existing discharge to the Liffey it was decided that locating the works at Ringsend is the most appropriate solution and that the treated effluent from Ringsend STW will continue to be discharged to the Liffey via the power station cooling water channel.

5. DIFFICULTIES ENCOUNTERED.

In the context of Paragraph 3(g) of the Second Schedule to SI 349 of 1989 the following difficulties are presented as being encountered in compiling this Statement:

Modelling of the effects of storm water discharges is based upon an effluent flow rate of up to $10.9m^3/s$ through the proposed storm water tanks. However at present a number of storm water overflows discharge directly to the River Liffey upstream of the storm discharge, contributing to the pollution of the River Liffey to the estuary, and to a lesser extent the Bay beyond. The new regime will deliver a greater flow to the plant for preliminary treatment and storm water retention prior to discharge. It is anticipated that this will relieve sewer overload in the City system and reduce the incidence of storm water overflow and consequent pollution. As the levels of incidence of sewer overflows and the quantities of water discharged is not known nor the behaviour of the complex system of sewers fully understood, the impact of the improvement cannot be estimated. Given that these overflow events will be further complicated by the flow patterns of the river and tidal conditions the difficulty in estimating the extent of positive water quality impact is further accentuated.

The scheme provides for storm overflows where the discharge from the Ringsend Catchment exceeds $9m^3/s$. The rainfall events associated with this quantity (intensity and duration) and the relationship between flow and water quality are not known.

6. WATER QUALITY ASPECTS.

6.1 INTRODUCTION.

This section considers the water quality impacts of the effluent discharges from the proposed STW at Ringsend. In order to determine these impacts the following are reviewed:

- Legislative requirements in terms of water quality.
- Baseline water quality conditions in the bay and estuary.
- Data on the existing STW effluent discharge levels.

The discharge loads from the proposed works are then summarised based on the Supplementary Report to the Preliminary Report for the Ringsend STW produced for the combined catchment by McCarthy Acer Consultants Ltd.

A mathematical model of the estuary and bay has been used to assist in the evaluation of the impacts of the various waste discharges from the proposed scheme. The waste parameters considered are Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Ammoniacal Nitrogen, Nitrates, Faecal Coliforms and Faecal Streptococci.

Discharge consent standards are set where appropriate to minimise the impacts of the proposed scheme on the water quality of the estuary and bay.

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

6.2 BACKGROUND DATA.

6.2.1 Water Quality Legislative Requirements.

The proposed works treating the combined waste water flows and loads must be designed to discharge an effluent which will be in compliance with the EU Urban Waste Water Treatment Directive (91/271/EEC). Effluent quality must also be such that it will not cause non-compliance of adjacent bathing waters with respect to the EU Bathing Water Directive. Dublin's Local Authorities have now adopted the Dublin Bay Water

Quality Management Plan (DBWQMP) and the effluent from the proposed Works must also comply with the Plan's requirements. These various standards are discussed below, with particular reference to the implications of the Urban Waste Water Treatment Directive for future treatment standards at Ringsend.

The effluent discharged from the proposed Ringsend works must comply with the provisions of the EU Urban Waste Water Treatment Directive and Bathing Water Directive. Statutory Instruments S.I. 154 and 155 of 1992 and 145 of 1994 transpose the requirements of the Bathing Water Directive, while S.I. 419 of 1994 transposes the Urban Waste Water Treatment Directive in Irish law.

Provisions in the Bathing Water Directive relate to viral and bacterial standards in bathing waters and to the identification of waters so designated. The microbial standards do not apply to the works effluent itself, but the effluent must be treated to a sufficient standard to ensure that it does not cause failure of the standard at the site of the designated bathing water.

With regard to bacterial standards, S.I. 155 of 1992 sets a Faecal Coliform (FC) standard of 1000FC/100ml to be conformed with by 80% of samples and 2000FC/100ml to be conformed with by 95% of samples and not exceeded by any two consecutive samples.

The Urban Waste Water Treatment Directive along with S.I. 419 of 1994 sets out effluent quality requirements for Ringsend STW. The discharge will be required to reach a standard of 25mg BOD/l, 125mg COD/l and 35mg TSS/l. An alternative of achieving a given percentage removal of pollutant prior to discharge is allowed. However, this is much more difficult to monitor and it is considered likely that the regulatory authorities will prefer to enforce the quoted numerical effluent standards.

S.I. 419 of 1994 also stipulates the minimum number of samples to be taken per year for monitoring purposes, which is related to the BOD population equivalent of the works. For Ringsend STW the minimum number of samples would be 24 per year. The Fifth Schedule in S.I. 419 indicates that three sample failures for 24 samples would be permitted per year. The look-up table in the Fifth Schedule is generally taken to statistically represent compliance for 95 per cent of the samples analysed. It is assumed therefore that the standard of 25mg BOD/l, 35mg TSS/l and 125mg COD/l is to be applied as a 95 percentile standard. To monitor compliance with the Regulations samples are to be flow proportional or time-based 24-hour samples.

In the case of samples failing the 95 percentile BOD, COD and TSS standards S.I. 419 also quotes the maximum amount by which the standards may be exceeded in any sample "under normal operating conditions" as stated in the Fifth Schedule, Article 4(b). The Fifth Schedule, Article 5 also states "Extreme values for the water quality in question shall not be taken into consideration when they are the result of unusual situations such as those due to heavy rain". The numerical values of these upper tiers, or 100 percentile standards have been set at 50mg BOD/l, 250mg COD/l and 87.5mg TSS/l, since 100% excess is allowed for BOD and COD and 150% excess for TSS over 95 percentile standards.

6.2.2 Baseline Water Quality Conditions in Dublin Bay.

Technical Paper No. 5 of the Dublin Bay Water Quality Management Plan (DBWQMP) gives an account of the water quality in Dublin Bay, including the Liffey Estuary. It is based mainly on surveys carried out in 1986, 1987 and 1988 specifically for the DBWQMP. These surveys were carried out "with the intention of updating and expanding the existing database on the water quality situation in the Dublin Bay system, to detect any recent changes compared with the previous assessments and to indicate those areas where water quality is unsatisfactory".

Dublin Bay is one of the few natural harbours on the east coast of Ireland. It is protected by a number of ridges at the mouth of the bay which include the Burford Bank and the Rosbeg Bank. The bay is broad, with generally shallow water depths, mainly less than 10m. It has extensive intertidal areas including broad strands and sandflats.

Three principal rivers discharge to the bay, the Liffey, the Dodder and the Tolka. In addition several small streams flow from the surrounding areas into the bay.

The shorelines of the inner bay, including the Liffey and Tolka estuaries have changed considerably down the centuries as a result of harbour works and land reclamation. Harbour works include the Great South Wall and the Bull Wall, which resulted in the development, during the last century, of the North Bull Island, now a major feature of the bay.

The DBWQMP, which was published in draft form in May 1991 examined and reported on the quality of water in the bay. The principal periods of the studies for the Plan were 1989 and 1990.

For the purposes of assessing water quality the Plan treated the water body in the bay in four separate zones as follows:

* the inflowing rivers and streams
* the estuary (ie. waters enclosed by the harbour mouth)
* the shoreline waters (as sampled from the shore)
* the offshore waters (the main body of water in the bay)

With regards to inflowing river quality the Plan reported that eutrophication is the main effect in evidence above the tidal limits. Biological assessments of the Camac and Tolka indicated that serious pollution occurs on an intermittent basis. The small streams showed much greater levels of contamination on occasion. The effluent from Ringsend STW does not impact on the water quality of the rivers and streams discharging to the bay other than in the mixing zone at the effluent outfall and the lower Liffey Estuary.

The Plan reported that there has been an appreciable improvement in conditions in the estuary since the early 1970's, notably in relation to deoxygenation, BOD and ammonia levels. The existing effluent from Ringsend STW continues however to cause high levels of BOD and ammonia at the vicinity of Ringsend STW outfall. Chlorophyll levels in the estuary were found to be low. The level of contamination with faecal bacteria was however appreciable throughout the estuary. The effluent from the existing works at Ringsend therefore has a significant impact on the estuary waters.

The Plan found that the quality of the shoreline waters with respect to physico-chemical parameters was generally within the limits set in the Bathing Water Regulations. The Plan also found that compliance with the limits for total and faecal coliforms was achieved marginally.

The Plan reported that the offshore waters as compared to the estuary and shoreline waters generally indicate least impact from water discharges, including Ringsend STW effluent. Maximum nutrient levels were higher than in the open Irish Sea. Chlorophyll levels show little difference from levels in the open sea, which indicates that enrichment of the bay's waters is not leading to increased growth of planktonic algae.

The DBWQMP also examined and reported on the following:

* Sediments and Benthos of the Deepwater Zone of the Plan area,
* Quality of the Intertidal Zone
* Green Macro - Algae
* Intertidal Sediment Quality
* The Ectocarpus Problem
* Litter and Aesthetic Quality

The sediments in the deeper parts of the bay consist of well sorted clean fine sands with low organic carbon content, indicating a hydrodynamically active area, where any material deposited is rapidly re-suspended. There is therefore no organic impact on the benthos from Ringsend STW.

With respect to metals, mercury was below detection limits. Cadmium and zinc mirrored the distribution of silt clay. Copper, nickel and chromium were uniformly distributed over the Plan area with only chromium concentrations slightly exceeding suggested likely baseline levels. These results, uniform over the whole Plan area show no relationship between the Ringsend effluent and levels of metals in the benthos.

The significant conclusion with regard to the development of a secondary sewage treatment facility at Ringsend, is that the waste discharges from the city and adjacent areas have a significant impact on the water quality of the estuary and bay. Particular attention is drawn to faecal bacterial and nutrient contamination. Technical Report No. 5 - Water Quality Surveys of the DBWQMP goes on to conclude that the impacts due to sewage are relatively moderate and "on the basis of accepted criteria do not constitute a serious threat to public health or the survival of indigenous flora and fauna, although they are sufficient to downgrade the environmental quality of the area compared to that of other recreational waters more remote from waste discharges".

6.2.3 Existing STW Effluent Discharge Levels.

In order to consider the water quality impacts of the proposed secondary treatment works, it is necessary to look at the impact of the existing works in terms of effluent discharges on water quality in the estuary and bay. A convenient way to achieve this is to tabulate the major sources of waste discharges to the bay and compare their relative levels. In Table 6.1 the daily discharged load of critical water quality parameters from the existing works and the other major sources is compared.

Table 6.1

Summary of Significant Waste Discharge Parameters to the Bay 1986 - 1988 (DBWQMP - Technical Report 5)

Point Discharge	BOD		TSS		Total N		Ammonia	
	kg/d	% of Total	kg/d	% of Total	kg/d	% of Total	kg/d	% of Total
Ringsend *	56,300	90.2	32,800	46.8	11,510	62.6	5,219	95.6
Bullock Harbour	810	1.3	940	1.3	140	0.7	** 60	1.1
Coliemore Harbour	50	0.1	57	0.1	8	0.1	** 3	0.1
River Liffey	3,900	6.3	27,000	38.5	5,300	28.8	140	2.6
River Tolka	830	1.3	4,800	6.9	460	2.5	11	0.2
River Dodder	480	0.8	4,500	6.4	980	5.3	24	0.4
Total	**62,370**	**100**	**70,097**	**100**	**18,398**	**100**	**5,457**	**100**

* Includes West Pier

** Estimated

From the above table it is clear that Ringsend STW is the main source of waste discharges to the estuary and the bay. The discharges of TSS loads vary significantly both for the river and from Ringsend STW. Ringsend STW contributes in the order of 45-50% of the total TSS load discharged to the bay, which, of the parameters considered in Table 6.1, is the lowest percentage discharge level. Foul sewer overflows contribute a certain level of the pollution load attributable to the rivers, although the level of this contribution is indeterminate. The average flow to full treatment at the existing works for 1994 was 3.76m³/s.

Faecal coliforms were not considered as a waste load in Technical Report No. 5 in terms of exerting a waste pressure on the water body, however, data from Dublin Corporation for the existing primary works at Ringsend shows that the level of total and faecal coliforms is very variable. Discharge levels are in the range of 2.1×10^6 - 3.9×10^7 Total Coliforms per 100ml and 1.3×10^5 - 8.3×10^6 Faecal Coliforms (FC) per 100ml.

6.3 PROPOSED WORKS DISCHARGE LOADS.

The proposed scheme design parameters have been defined in the Supplementary Report (SR) to the Ringsend STW Preliminary Report produced in October 1995 by McCarthy Acer Consultants Ltd. (MACL). Table 6.2 is a summary of the influent and effluent flows and loads as defined in the SR.

Table 6.2

Proposed Works Design Influent and Effluent Flows and Loads

	Design Year 2015			
	Influent			Effluent
	Ringsend	N. Dublin	Total	Total
DWF (m^3/s)	3.60	1.10	4.70	4.70
Average Flow (m^3/s)	4.50	1.38	5.88	5.88
Max. Flow to Treatment (m^3/s)	9.00	2.25	11.25	11.25
BOD (kg/d)	68,216	33,009	101,225	6,350
TSS (kg/d)	67,793	31,279	99,072	8,890
Total N. (kg/d)	10,495	4,803	15,298	15,298

Note: Effluent loads are based on the average flow and average discharge levels.

6.4 WATER QUALITY MODELLING OF DISCHARGE LOADS.

To assist in evaluating the impacts of the effluent loads discharged by the proposed STW on the waters of the estuary and the bay a mathematical model has been used. A selection of different model runs have been carried out to investigate the impacts of BOD, Ammoniacal Nitrogen, Nitrates, Faecal Coliforms (FC) and Faecal Streptococci. (FS). Volume 3 of this EIS contains a description of the mathematical model, the coefficients used, the model runs, the flows and loads and the model outputs.

The aim of the model runs was to simulate the discharge loads of the proposed works and to investigate their impact on the water quality of the estuary and bay. Different levels of treatment were investigated for different parameters so that possible adverse impacts could be evaluated. Input loads were varied for each of the runs to reflect the different levels of treatment. For example faecal coliforms (FC) were modelled at a 96% reduction from raw sewage levels and the impacts of this were considered. Further reductions were then modelled so that a satisfactory faecal coliform concentration in the effluent could be determined to meet the required bathing water quality.

Rivers and streams also contribute a significant part of the total pollutant loads in the estuary and bay. Information on these sources has been taken predominantly from the DBWQMP. An additional intermittent input is that from the estimated storm overflows from Dublin's sewerage system which occur during critical storm events. However information on these overflows is considered insufficient to allow for calculation of actual pollutant loads from this source. Input data for the modelling work is given in Section A, Volume 3.

6.5 WATER QUALITY IMPACTS.

6.5.1 Biological Oxygen Demand (BOD).

The primary source of discharge of BOD into Dublin Bay is from the existing primary STW at Ringsend which, as can be seen from Table 6.3, is discharging in the order of 90% of the total load. The proposed works at Ringsend has a discharge consent of 25 mg BOD/l on a 95 percentile basis as required under the Urban Waste Water Directive. The average daily load of BOD based on the average design flow of 5.88m^3/s (see Table 6.2) will be 6,350kg. This is almost a nine fold decrease in average daily BOD loads discharged from the STW and reduces the total daily BOD load discharged to the Bay by some 81% (see Table 6.3 below).

Table 6.3

Sources of BOD loading - Dublin Bay

Point Discharge	Present Situation DBWQMP		2015 Design Situation	
	kg/d	% of Total	kg/d	% Reduction
Ringsend *	56,300	90.2	6,350	88.7
Bullock Harbour	810	1.3	Included above	100.0
Coliemore Harbour	50	0.1	Included above	100.0
River Liffey	3,900	6.3	3,900	--
River Tolka	830	1.3	830	--
River Dodder	480	0.8	480	--
Total	**62,370**	**100**	**11,560**	**81.5**

* Includes West Pier

The DBWQMP sets a BOD water quality standard for estuarine waters of not more than 4mg BOD/l in 95% of samples (provisional). No level is set for the Bay. Reviewing the water quality surveys carried out during the DBWQMP studies it is evident that generally the peak BOD levels in the estuary are well below the 4mg BOD/l maximum set in the Plan, however the median BOD concentrations were above the 2mg/l at many stations indicating non compliance with the DBWQMP requirement. The maximum levels recorded that exceed the 4mg BOD/l standard occur at Sampling Station 14 and downstream, ie. in the area nearest the Ringsend effluent discharge point. The highest recorded concentration of 17.9mg/l was measured in a sample taken from the surface at the right hand side of the channel at Station 17, just downstream of the outfall, within the mixing zone.

Reviewing effluent discharge BOD concentrations from Ringsend STW for 1994 indicates that the average concentration is 165mg BOD/l with a peak of 284.5mg BOD/l. Upon commissioning of the new works the average discharge concentrations will be approximately 12.5mg BOD/l with 95 percentile peaks of 25mg BOD/l. These figures indicate that there will be reductions in BOD concentrations of the order of 11 to 13 times the existing levels at the discharge point to the estuary. Given these reductions it is to be expected that peak BOD concentrations will be significantly reduced in the lower estuary. Concentrations above 4mg BOD/l would not be expected outside the direct mixing zone unless background levels in the river were particularly high. The 4mg BOD/l level does not apply within the mixing zone and is a 95 percentile standard allowing for 5% of peaks greater than 4mg BOD/l.

The plots generated from the model simulations to predict likely BOD levels in the estuary and bay are shown in Section E, Volume 3. It can be seen from the plots (see frames 52 - 73, Run 2a), that under average and maximum flow conditions of discharge, the BOD levels in the estuary and bay do not exceed 2mg/l apart from the immediate vicinity of the outfall. The BOD concentration does exceed 2mg/l following a storm event (see frames 61 - 70, Run 3a). As the effluent plume moves seaward on the ebb tide, the concentrations in the centre of the plume exceed 2mg/l. After about 12 hours the concentrations decline below 2mg/l.

Upstream of the discharge in the River Liffey the model predicts BOD concentrations in excess of 2mg/l. These concentrations in the Liffey were not seen to be related to the effluent from Ringsend STW.

In summary there will be a significant reduction in the daily load of BOD discharged to the estuary and bay which will be reflected in the discharge concentrations. Model simulations of this reduced loading indicate that the DBWQMP requirement will be satisfied as Ringsend STW is the primary source of BOD discharges to the bay.

Storm events may cause exceedence of the requirement in the estuary, however, due to the difficulty in assessing storm flows and relating this to overflows and discharges at Ringsend STW, it is not possible to quantify such exceedences. The storm event simulated in the model runs is a severe event as it is based on the maximum capacity of the sewers discharging to Ringsend. Therefore it is considered an acceptable level of exceedence.

The impact of these reductions in BOD will be favourable in terms of water quality conditions in the estuary and the bay and meets the DBWQMP objective as described earlier.

6.5.2 Total Suspended Solids (TSS) and Aesthetic Quality.

There is no level set for the removal of TSS in the DBWQMP. Under the priority objectives, objective (d) states that with regard to sewage solids the requirement is for "improving the aesthetic quality of the beaches and shoreline waters of the Plan area by measures such as the interception of plastics and other solids of sewage origin".

The proposed works at Ringsend has a discharge consent of 35mg TSS/l on a 95 percentile basis as required under the Urban Waste Water Directive. Table 6.4 shows the expected reductions in TSS when the proposed works reaches its design capacity. It is evident from the 73% reduction in TSS that the DBWQMP objective is being complied with. Larger solids such as plastics etc. will be removed by the preliminary screening of both the full flow to treatment and storm flows. No mathematical modelling of TSS was undertaken.

Table 6.4

TSS Discharged from the Present and Proposed STW

Point Discharge	**Present Situation DBWQMP**		**2015 Design Situation**	
	kg/d	**% of Total**	**kg/d**	**% Reduction**
Ringsend *	32,800 *	46.8	8,890	72.9
Bullock Harbour	940	1.3	Included above	100.0
Coliemore Harbour	57	0.1	Included above	100.0
River Liffey	27,000	38.5	27,000	--
River Tolka	4,800	6.9	4,800	--
River Dodder	4,500	6.4	5,500	--
Total	**70,097**	**100**	**46,190**	**34.1**

* The TSS discharge from the existing works varies significantly the average daily load for 1994 is 39,656kg.

The DBWQMP also states that all water should be free from substances attributable to waste water or other discharges that:

- settle to form objectionable solids
- float as debris, scum, oil foam or foam nuisance
- produce objectionable colour, odour or turbidity

It is therefore important that design consideration is given to the removal of fats, oils and grease from the effluent before discharge to the estuary and bay.

The reductions in TSS also meet the Plan's objective 'whereby the particulate content of significant waste discharges is to be reduced as far as is economically practicable'. This objective arose from the studies on macro-algal growth which led to the hypothesis that these arise from particulate organic matter as carriers of nutrients.

As noted in Section 6.5.6 a high proportion of viruses are associated with solids in sewage so that reductions in the levels of TSS being discharged to the estuary and bay will have a beneficial impact on virus discharges although the extent of this is indeterminate.

6.5.3 Faecal Coliforms and Bathing Water Quality.

There are no requirements under legislation for an effluent consent level for faecal coliforms. The requirements are for water quality conditions at designated bathing areas. It is therefore necessary to quantify the expected reductions in faecal coliforms through the proposed works and investigate their impact on the bathing water quality with the aim of setting an effluent discharge level. There are many variables involved in modelling bacterial concentrations with complex interactions as noted in Section 6.5.4 with the result that a number of model runs were required to develop a satisfactory understanding of the particular conditions in Dublin Bay.

The mathematical model has been used to assess the impacts of the faecal coliforms (FC) discharged in the final effluent. Initially secondary treatment with 96% reduction in influent faecal coliform levels was simulated. As this was considered to be non-compliant further modelling was undertaken so that a faecal coliform discharge consent could be set that would achieve compliance with both the bathing water and blue flag requirements.

Dollymount Strand and Seapoint are the only designated bathing beaches within Dublin Bay. It is worth noting however that Dollymount Strand is the primary location affected by the Ringsend effluent discharge due to the tidal circulation in the bay and is therefore the focus of these studies.

The standards applicable to the bathing water area in terms of coliform bacteria are those outlined in the Quality of Bathing Water Regulations, 1992 (S.I. 155 of 1992). For faecal coliforms the levels in the bathing water should not exceed either a concentration of 1000 FC/100ml for 80% of samples or 2,000 FC/100ml for 95% of samples taken during the bathing season and should not be exceeded by any two consecutive samples. The bathing season is defined as extending from mid-May until the end of August.

In aiming to achieve Blue Flag Award status for Dollymount Strand the faecal coliform standard to be reached is not more than 100 FC/100ml in 80% of samples, which is significantly more stringent than the Quality of Bathing Water Regulations, 1992.

No numerical limit is given in the Regulations for the seaward boundary of the bathing water. In the UK, the Regulatory Authority, the National Rivers Authority (NRA) have generally adopted a seaward boundary for bathing water extending 200m beyond the mark of the tide at that time. Inside this boundary the bathing water should comply with the required standard. For design purposes the bathing water should comply along its entire length and not just in the vicinity of the designated sampling point. This is the general approach adopted by the NRA in England and Wales. However, it should be borne in mind that Dublin Bay is a shallow shelving bay and that the depth of water is in the range of 1.5m to 2.0m up to 500m from the mean low water springs, which is approximately 1.5km from the high water mark. This therefore would suggest that the 200m definition of the bathing water area is too restrictive and this factor should be borne in mind when interpreting the results.

The predicted dispersion of faecal coliforms from the proposed secondary treatment facility at Ringsend under different conditions is shown by the plots from Runs No. 2a, 2b, 3a, 3b, 4 and 5 (Section C, Volume 3).

The computer output (see frames 10 to 26 of Run 2a) indicates that with an average flow and no onshore wind the concentration of faecal coliforms in the bathing water by Dollymount Strand, within 200m from the water line, would remain below 1000 FC/100ml. However it is clear from these frames that high coliform concentrations greater than 5000 FC/100ml, and at times greater than 10,000 FC/100ml are located close to the bathing area. It is not possible, within the accuracy of the model, to state with certainty that these high faecal coliform levels would not impact on the immediate bathing area. With an increase in flow of up to 2.5 x DWF concentrations will exceed 1000 FC/100ml toward the south-end of Dollymount Strand (See Frames 58 and 61 of Run 2a).

Contours for Run 2a representing 2000 FC/100ml on a 95 percentile and 1000 FC/100ml on a 80 percentile basis (the Quality of Bathing Water Regulations, 1992, levels) are shown in Section B, Volume 3. These contours indicate that with the Run 2a flow and faecal coliform concentration conditions, compliance with the 1992 Regulations would not be achieved.

Numerical faecal coliform concentrations on an 80 percentile basis for Points 13, 19, 30, 31, 50 and 68 are given in Section I, Volume 3. These confirm non-compliance with the Quality of Bathing Water Regulations, 1992, for Run 2a. The variation, in concentration at specific points for days 2 and 14 is shown graphically in Section H, Volume 3.

Onshore winds have a dual effect, on the one hand helping to accelerate dispersion, but on the other pushing water containing high concentrations of faecal coliforms closer to the shore. In the case of the maximum flow condition with the provision of an 11 knot onshore wind, concentrations considerably in excess of 1000 faecal coliforms per 100ml could be found in or in close proximity to the bathing water at Dollymount Strand (see frames 58 to 70, Run 2b, Section C, Volume 3).

For Run 2c the T_{90} was reduced to a constant 10 hours, with the faecal coliform load held the same as for Run 2a. This was in order to examine the effect of a higher bacterial die-off rate on the bathing water. From frames 52 - 70, Section C, Volume 3, the model indicates that the risk of non-compliance with the 1992 Regulations is much lower than for Run 2a. However Frames 58 and 61 suggest non-compliance. The contour plots for 2000 FC/100ml on a 95 percentile basis and 1000 FC/100ml on an 80 percentile basis, see Section B, Volume 3, show a smaller area at these concentrations than for Run 2a. The 2000 FC/100ml, 95 percentile in particular indicates non-compliance.

Run No. 3a includes a storm discharge. In the estuary the area with concentrations in excess of 10,000 faecal coliforms per 100ml is increased (see frames 52 to 70 of Run No. 3a). On the ebb tide the effluent plume moves seaward towards the area of interest. For a period of time (see frame 70 of Run 3a) concentrations will exceed 1000 FC/100ml in the vicinity of Dollymount Strand. This run was undertaken with no wind applied and the period of non-compliance would be greater if an onshore wind were applied (see frames 58 to 70 of Run 2b).

Sensitivity analysis in terms of T_{90} values was again tested in Run 3b, but whereas in Run 2c the T_{90} was low and at a constant level, in Run 3b a varying T_{90} was used but with a day-time decay rate of 8 hours increasing at night-time to a rate of 60 hours. The flow and load conditions were identical to Run 2a. For Run 2a the day-time T_{90} was 12 hours, increasing to 60 hours at night.

Comparison of Runs 2a and 3b can be made with reference to frames 52 to 70. This sensitivity testing for the midday T_{90} values does not highlight any significant differences in the predicted faecal coliform concentrations. The 80 percentile contour for 1000 FC/100ml and the 95 percentile contour for 2000 FC/100ml are very similar to those of Run 2a.

In Run 4, observed variability in the existing Ringsend effluent is allowed for in the average load and a variable wind field has been applied. For the average flow condition, the faecal coliform concentrations at Dollymount Strand do not exceed 1000 FC/100ml even with a light onshore wind of about 7 knots (see frames 18 to 37 of Run 4), although this level is observed a short distance offshore (see Frames 11, 12, 13, 23, 37). The maximum flow condition, which occurs on day four of the simulation followed by increases in the average effluent flow and concentration on day five, gives rise to concentrations considerably in excess of 1000 FC/100ml in the bathing water (see frame 83 of Run 4).

The contours for 1000 FC/100ml on an 80 percentile basis and 2000 FC/100ml on 95 percentile basis for Run 4 are shown in Section B, Volume 3. Data for Points 19, 30, 31, 50 and 68 indicate that the Quality of Bathing Water Regulations, 1992, would be contravened (See Section I, Volume 3).

Given the above findings further modelling was undertaken. It was decided to select a discharge faecal coliform concentration and apply it to the effluent flows rather than basing the discharge concentrations on a percentage reduction through the works thus simulating disinfection. The following runs were carried out:

(i) Apply a 1,000 FC/100ml standard to the DWF, flows above DWF being discharged with concentrations varying between 3 x 10^5 FC/100ml and 1.2 x 10^6 FC/100ml.

(ii) Apply a 10,000 FC/100ml to the full flow to treatment through the works.

(iii) Apply a 100,000 FC/100ml to the full flow to treatment through the works.

It was established from the first of the above runs that the flows above DWF caused non-compliance with the water quality requirements for the blue flag standard and that the peaking of flows was the source of the non-compliance. It was therefore decided to apply a consent level to the full flow to treatment discharged from Ringsend STW. The two runs for 10,000 and 100,000 FC/100ml were aimed at determining an appropriate discharge level. It is indicated from the plots of Run 5 (iii above) (Section C, Volume 3) and the contour prints (Section B, Volume 3) that a level of 100,000 FC/100ml is adequate to meet bathing water requirements and should also satisfy the blue flag standard. Consideration has therefore been given to an appropriate discharge and percentile level for faecal coliforms and based on the modelling carried out a level of 100,000 FC/100ml on an 80 percentile basis has been selected. This level applies to the full flow to treatment commencing two weeks before the bathing season. It is considered that this level will achieve the bathing water and Blue Flag requirements, particularly as the peaking factor has been removed by treating the full flow to treatment.

It is likely that disinfection will be required to achieve this consent level for faecal coliform. Although through careful design of the secondary treatment process and hydraulics in the proposed works the designers may achieve the required standard.

Bacteriological effluent discharge parameters are difficult to quantify with regard to bathing water quality standards as they apply to a remote body of water and not directly to the effluent. The provision of the proposed works will greatly reduce the numbers of faecal coliforms being discharged. The discharge level of 100,000 FC/100ml on an 80 percentile basis should ensure bathing water quality and provide for Blue Flag status at Dollymount Strand and enhance the bacteriological water quality in the estuary and bay generally. Other non-designated bathing areas that are at present affected by the Ringsend effluent will also benefit from these reductions in discharges of faecal coliforms. In particular the bathing area within the estuary along the North Bull Wall should have significant improvements in bathing water quality (see Section C, Volume 3, Run 5 plots) and the modelling suggests that bathing water standards will be achieved at this location.

6.5.4 Faecal Streptococci.

There is currently no mandatory bathing water level for faecal streptococci in Ireland. However under certain conditions (see discussion in Section A - 1.5.4, Volume 3) a level of 300 FS/100ml on a 95 percentile basis could be a requirement of the Quality of Bathing Water Regulations, 1992. A contour for this concentration, shown in Section B, Volume 3, indicates non-compliance at the bathing water for a discharge concentration of 3.4×10^4 FS/100ml equivalent to a reduction of 96% from raw sewage levels. The contour for 100 FS/100ml on 90 percentile basis indicates the extent of non-compliance with the Blue Flag Award level. Colour plots showing faecal streptococci concentrations are shown in Section G, Volume 3.

It was therefore decided to model a 10,000 FS/100ml discharge level. Reviewing the contour plots for this level (Run 5, Section B, Volume 3) indicates compliance with the bathing water requirements and marginal non-compliance with the Blue Flag standard.

It should be borne in mind when considering the above results that mathematical modelling of bacterial concentrations is a complex task with many variables that affect the final result as follows:

- raw sewage with significantly variable concentrations
- variable reductions through a STW
- receiving water conditions such as salinity, temperature, pH and transparency
- environmental conditions such as wind and in particular sunlight intensity

The discharge standard for faecal coliforms of 100,000 FC/100ml requires a reduction in the order of 99.6% from raw sewage levels. A similar level of reduction would be expected for faecal streptococci. This would equate to 6,000 FS/100ml discharge level based on the higher end of the raw sewage faecal streptococci levels. This is less than the 10,000 FS/100ml modelled. It is considered therefore that applying the faecal coliform consent standard will reduce the faecal streptococci sufficiently to meet the Blue Flag standard requirement at Dollymount Strand given the marginal non-compliance shown by the modelling.

Proposals for a new Bathing Water Directive have been approved by the European Commission in February 1994, member states will have a period of time to consider the proposals before negotiations on the requirements of the proposed Directive are entered into. The proposal contains an imperative standard for faecal streptococci of no more than 400 FS/100ml based on a 95 percentile basis. It is uncertain whether this level will be adopted, however as it is less stringent than either the existing non mandatory Bathing Water Directive and the Blue Flag standard it is reasonably certain that it would be met if adopted, given the modelling results.

In the light of this and the above discussion it has been decided therefore not to set a final effluent discharge standard for faecal streptococci in this instance.

It is recommended that a comprehensive sampling programme be established so that usefully correlatable data are available between effluent discharge concentrations and receiving and bathing water levels for faecal streptococci. This data can then be used in setting meaningful effluent faecal streptococci discharge levels if and when they become necessary.

6.5.5 Ammoniacal Nitrogen and Nitrate.

The DBWQMP quotes standards for ammoniacal nitrogen of not more than 0.8mg Amm.N/l for the estuary and 0.3mg Amm.N/l for the coastal waters in 95 percent of samples. These standards are set primarily to protect migratory fish and also because ammonia in its un-oxidised form is considered to be generally toxic to aquatic life when occurring above certain levels.

The water quality surveys show that the present levels of ammonia in the estuary and bay are below the standards set in the Plan. A waste water treatment works will convert organic nitrogen to ammonia and then to nitrite and nitrates if so designed.

Table 6.5 shows the expected increases in discharge levels of ammonia to the estuary and bay if a secondary treatment works with carbonaceous treatment, which converts organic nitrogen to ammonia, is provided. It was decided to carry out model runs to determine whether carbonaceous treatment would meet the DBWQMP standard or if a further level of treatment was required to convert the ammonia to nitrites and nitrates.

Table 6.5

Sources of Ammonia Loading - Dublin Bay

Point Discharge	**Present Situation DBWQMP**		**2015 Design Situation**	
	kg/d	**% of Total**	**kg/d**	**% Increase**
Ringsend	5,219	95.6	15,298	293 *
Bullock Harbour	60	1.1	Included above	--
Coliemore Harbour	3	0.1	Included above	--
River Liffey	140	2.6	140	--
River Tolka	11	0.2	11	--
River Dodder	24	0.4	24	--
Total	**5,457**	**100**	**15,473**	**284**

* Assumes complete conversion of organic nitrogen to ammonia and no nitrification/ denitrification and includes a 5% allowance for return liqueurs.

The plots for Runs 2a, 2b and 3a (Section D, Volume 3) show the predicted levels of ammoniacal nitrogen that would result from different input loads and wind conditions. These runs assume a carbonaceous secondary treatment process producing an effluent with an average ammoniacal nitrogen load of 16,103kg/d which includes a 5% allowance for return liquors and is a projection based on measured 1994 nitrogen levels at Ringsend STW which at average flow would contain a mean concentration of 32mg/l ammoniacal nitrogen. Some dilution was assumed with increasing flows, such that, for flows up to 2.5 x DWF the total daily load input remained the same.

The results indicate that under both no wind (see frames 52 to 70 from Run 2a) and onshore wind conditions (see frames 52 to 70 from Run 2b), for average flows and flows up to 2.5 x DWF, the identified standards would be exceeded in both the estuary and bay for most of the tides. The impact on the receiving waters is intensified if a storm discharge occurs (see frames 61 to 70, from Run 3a). Contour plots representing 0.3mg Amm.N/l on 95 percentile basis for Runs 2a and 2b are shown in Section B, Volume 3.

Run 8 was carried out to determine the maximum concentration of Amm.N which would ensure compliance with the DBWQMP. Frames 52 to 71 indicate levels of ammoniacal nitrogen below 0.3mg/l in the bay and 0.8mg/l in the estuary. The contour plots for 0.3mg/l and 0.8mg/l respectively on a 95 percentile basis indicate general compliance with the DBWQMP, although concentrations above 0.8mg/l occur around the outfall mixing zone. These results show that an average discharge of 7.5mg Amm.N/l (18.75mg Amm. N/l on 95 percentile basis) would ensure that the DBWQMP limit for Amm. N was not contravened in the bay, while compliance with the DBWQMP limit in the harbour would be achieved except in the area adjacent to the outfall mixing zone.

If no denitrification was carried out, levels of nitrate in the estuary would exceed 1.5mg/l at various stages of the tide (see Section F, Volume 3, Frames 52-68 for Run 8). The DBWQMP states that no standards are set for oxidised nitrogen pending further research on dissolved nutrients in the bay. The UK Foundation for Water Research has suggested a limit of 1.5 mg/l for nitrate. Since more research is needed in this area it is not yet possible to quantify the level of risk imposed on the estuary by this concentration of nitrate. It is not proposed at this stage that denitrification of the effluent should be carried out. However, it is recommended that both hydraulic capacity and space requirements be provided at the proposed works for future denitrification of the effluent. In practice it is not usual (or desirable in some cases) to design treatment plants to achieve a 95 percentile Amm.N standard of 18.75 mg/l and it is probable that the plant would operate with a greater degree of nitrification, consequently producing a higher nitrate concentration which would further increase the nitrate level in the receiving waters. In addition, mandatory total nitrogen levels could be imposed if the bay was to be classified as a 'sensitive' receiving water in the future. In this case the total N standard would be 10 mg N/l as an annual mean, and denitrification would be required to achieve this.

For this study the impact on the receiving waters of two levels of Amm.N load in the Ringsend effluent has been assessed. In Runs 2a, 3a and 4 it was assumed that effluent was discharged from a conventional carbonaceous secondary treatment process. In this case all the nitrogen was assumed to be discharged as Amm.N. Results for these runs showed non-compliance with the Amm.N limits set in the DBWQMP. It was therefore considered that a level of nitrification would be required, prior to discharge of the effluent. This level has been set at 18.75mg Amm.N/l on a 95 percentile basis, so that compliance with DBWQMP can be achieved in order to protect migratory fish and other aquatic life.

6.5.6 Entero-viruses.

Entero-viruses (namely polio-, coxsackie- and ECHO-viruses) are difficult to evaluate in terms of sewage effluent discharges and have not been modelled for the following reasons:

- The concentrations of entero-viruses in sewage are variable and are related to the health of the population served by the sewerage system. Viruses are only excreted when persons are infected, therefore they can occur sporadically in sewage.

- Although viruses are unable to multiply in the aquatic environment, they may be quite resistant to environmental degradation. Entero-virus mortality rates are less well understood and T_{90} values in the literature range from 1.4 days up to 12 days in seawater.

- Adsorption to sediments is the most significant factor affecting virus survival in the environment. A high proportion of viruses are associated with solids in sewage, and following discharge into coastal waters, they settle from the water column to form a loose layer over the compact bottom sediment. Both the number of viruses and the length of time they persist in sediments are significantly greater than in the equivalent volume of overlying water column. There is possibility of re-suspension of the sediments and the viruses in the water column and this could not be accounted for in the water quality model.

The Imperative Standard in the EU Bathing Waters Directive is the absence of entero-viruses in ten litres of seawater. In the Quality of Bathing Water Regulations, 1992, this standard is included in the Second Schedule, Part 2, which is not mandatory but as for faecal streptococci may be required under certain conditions (see Section A - 1.5.4, Volume 3). Compliance with this 'zero' standard would be difficult to demonstrate with water quality modelling due to the points raised above. In addition background sources of entero-viruses from riverine inputs and even bathers would be very difficult to quantify hence compliance with the non-mandatory 'zero' standard would not be possible to guarantee based on Ringsend STW effluent discharges.

The Blue Flag award does not require compliance with the Bathing Water Directive for entero-viruses. It is expected with the increased level of treatment being provided both in terms of TSS reductions and the discharge level set for faecal coliforms that there will be reductions in entero-viruses discharge levels which will be beneficial although the level of this benefit is indeterminate.

6.5.7 Sewage Sludge.

Sewage sludge from the existing STW is not dumped within the bay area but at a location more than 13 kilometres east of Killiney Head. Dumping of sewage sludge at sea is planned to cease by the end of the year 1998 in advance of the provision of the proposed works. For both of these reasons sewage sludge is not considered as having an impact on the water quality of Dublin Bay.

6.6 CONCLUSIONS.

The existing STW is the primary source of waste discharges to and bacterial contamination of the estuary and bay. The provision of the proposed works at Ringsend will have a significant positive impact on the receiving waters, as there will be significant reduction in BOD, TSS and bacteriological contamination. Discharge levels of ammonia will be controlled so to achieve compliance with the DBWQMP requirements for ammonia levels in the receiving waters.

The DBWQMP details 16 priority objectives in the main report under the section on Water Quality Management Strategies. These relate to different locations within the estuary and bay and detail particular water quality requirements for each location. The provision of the proposed works is one of the options for the treatment of the Ringsend sewage discharge "that appear fully to meet the priority goals of the Plan and to conform to the basic requirement of the Directive on Urban Waste Water Treatment". It is therefore considered that the proposed works at Ringsend is a welcome development and will significantly reduce the waste discharges to the estuary and bay, thereby improving water quality and assisting in the further development of the estuary and bay environmentally and for recreational uses by providing bathing water quality that will satisfy Blue Flag standards.

The consent standards required of the final effluent discharged from the proposed scheme are 25 mg BOD/l, 35mg TSS/l, 125mg COD/l, 18.75mg/Amm.N/l on a 95 percentile basis and 100,000 FC/100ml to be achieved during the bathing season on a 80 percentile basis. These standards are set to meet the required water quality objectives in the DBWQMP and to meet the requirements of the Urban Waste Water Treatment Directive, Bathing Water Directive and blue flag standards.