3. PROJECT DESCRIPTION.

3.1 OBJECTIVES.

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

* Dublin Bay Water Quality Management Plan (DBWQMP).

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

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

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

Chapter 6 examines the requirements for complying with these objectives. The conclusion to Chapter 6 sets consent standards for achieving the objectives.

3.2 OVERVIEW.

The principal elements of the development will consist of:

* **Sewage Treatment.**

  - Preliminary Treatment of all flows including storm waters.
    Removal of materials by means of screening and settlement.

  - Primary Settlement.
    Processes which cause the settlement of suspended solids from raw sewage and permit its removal as sludge.

- Secondary Treatment.
  Biological processes which cause organic matter to be broken down and/or be incorporated into biological cells and then be removed as sludge.

- Tertiary Treatment.
  General grouping of processes which provide a higher level of treatment than Secondary Treatment.

* **Sludge Treatment.**

- Treatment of combined primary (if present) and secondary sludges for the post year 2000 will comprise some or all of the following (or similar) processes. Processes incorporating energy recovery will be encouraged.

  * Screening
  * Thickening
  * Anaerobic Digestion
  * Dewatering,
  * Thermal Drying
  * Alkaline Stabilisation

- Treatment is proposed for the primary sludge from the existing works at Ringsend for the period 1998 to 2000.

* **Storm Sewage Treatment.**

Provision for the treatment of additional flows caused by rainfall on the catchment.

- Preliminary treatment of all flows.
- Up to 11.25m³/s treated as foul sewage.

* **Development Works.**

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

3.3 DESIGN POPULATION.

3.3.1 Population Equivalents.

For the purposes of sewage treatment design and comparison sewage flows are considered in terms of population equivalent (p.e.). Effectively this gives a means of relating industrial, commercial and other flows to domestic flows. The basis of this relationship is the assumption that a Biochemical Oxygen Demand (BOD) of 60g per day represents 1 p.e.

3.3.2 Residential Population.

The baseline for the domestic populations in the Preliminary Design Reports was the 1991 Census of Population[(3)]. Populations have been projected forward to the years 2015 and 2040 as the immediate and long-term design horizons for Ringsend STW. Based upon the forecasts of the Central Statistics Office (CSO) report 'Population and Labour Force Projections 1996 - 2026'[(4)] populations have been projected as follows:

Fertility	:	Decline in Total Fertility Rate (TFR) at a constant rate from 1.93 in 1993 to 1.8 in 2026.
Inwards Migration	:	35,000 in 1991/1996 7,500 per annum in 1996/2006. Zero migration during 2006/26.

For the combined catchments discharging to Ringsend STW this equates to an average growth rate of 0.44% per annum.

On this basis the design residential populations for the Ringsend Treatment Works are projected as follows:

Table 3.1 - Residential Populations

Year	1991	2015	2040
Population p.e.	871,942	1,061,500	1,185,000

Note: The 2015 and 2040 populations are projected from a 1991 population which includes areas not connected in 1991 but which are expected to be connected by 2015.

3.3.3 Commercial, Institutional, Commuter Populations.

Commercial and institutional sources such as universities, colleges, prisons, hotels and guest houses have been included in the residential population figures. The date of the Census in Dublin City has been generally chosen during the month of April, following the Easter Holidays, to coincide with a period when population movements are at a minimum and consequently the figures closely approximate to those of the normally resident population (including the student population).

Tourism provides an additional holiday population in Dublin City, the peak occurring during the summer period. Investigations carried out on the student and tourist population in Dublin City indicate that the exodus of students from Dublin during the summer holidays more than counterbalances the peak tourist influx during this period. Permanent residents who holiday outside the catchment area would also assist in reducing the effect of tourism. It is therefore considered that the net effect of this population on the flows to Ringsend STW is insignificant.

The number of hospital bed places in principal hospitals in the combined drainage area is approximately 4,200 consequently a population equivalent of 4,200 p.e. has been included for this source.

As assessment of the number of commuters who travel into the Ringsend drainage area was made using traffic survey data supplied by Dublin Corporation. It was estimated that approximately 20,000 people commute to the drainage area on a daily basis. It is estimated that this number of commuters equates to a population equivalent of 6,700 p.e.

Assuming an increase of 10% from 2015 to 2040 the contributing populations are projected as follows:

Table 3.2 - Commercial Institutional and Commuter Populations

Year	1991	2015	2040
Population p.e.	10,900	10,900	12,000

3.3.4 Industrial Contributions.

The basis for the estimation of industrial contributions to Ringsend STW are the 1991 licensed discharges. Following discussions with the twenty largest industrial contributors to Ringsend STW Dublin Corporation has decided that the design industrial BOD and SS loading for years 2015 and 2040 should be reduced to 60% of the 1991 licensed loads. This figure is based on a target reduction of industrial load of 50% with a 10% margin to allow for difficulties in precisely identifying what load each industry will discharge. It should be noted that this level of reduction must be achieved by the time of commissioning of the new works. The principal reason for the reduction in load is that Dublin Corporation's new charging policy will incorporate the recovery of the capital cost for the industrial element of Ringsend STW from the contributing industrial sector. Industry's response to Dublin Corporation was that they would choose to reduce considerably their effluent discharges. This would be achieved by improved housekeeping practices, recovering product from waste-streams and in some cases pre-treatment of effluent.

It should be noted that it is considered that the volumes of industrial flows will remain at the 1991 licensed level.

On this basis the industrial contributions (p.e.) may be summarised as follows:

Table 3.3 - Industrial Populations

Year	1991	2015	2040
Population p.e.	900,100	561,050	561,050

3.3.5 Design Population.

On the basis of the information in Section 3.3.1 to 3.3.4 making an allowance of 5% of the non-industrial contribution for design contingency the design population for Ringsend STW is as follows:

Table 3.4 - Design Population

Year	1991	2015	2040
Residential	871,942	1,061,500	1,185,000
Commercial etc.	10,900	10,900	12,000
Industrial	900,100	561,050	561,050
5% Contingency	--	53,620	59,850
TOTAL	**1,782,942**	**1,687,070**	**1,818,000**

Accordingly the scheme proposes the construction of a treatment works with a capacity of 1.69 million p.e.

3.4 WASTE WATER CHARACTERISTICS.

Flow to the existing Ringsend STW is delivered in three streams at present:

* From the Main Lift Pumping Station at Ringsend (MLPS).
* By siphon from Belfield carrying flows from the Dodder Valley Catchment (DVDS).
* By rising main under Dublin Bay from the West Pier at Dun Laoghaire (DLD).

The quantity and quality of the flow into Ringsend STW is measured continually by Dublin Corporation and as a consequence the constituents of the sewage and their variability is known. The constituents of the 1994 flow to treatment at Ringsend are tabulated in Table 3.5.

In 1994 the average discharge from the works had a Biochemical Oxygen Demand of 168mg BOD/l and a Suspended Solids concentration of 128mg SS/l.

Flows from the North Dublin Catchment discharge off the nose of Howth. By comparison with Ringsend STW there is little analytical data for the existing North Dublin Catchment.

The design load for Ringsend STW is arrived at by the addition of the predicted North City Catchment loads with the predicted Ringsend Catchment figures as calibrated by the comparison of measured and predicted 1994 discharges to Ringsend STW.

Utilising the design populations and industrial and commercial loadings the projected characteristics of the waste water into the Ringsend STW for the design horizons of 2015 and 2040 are as tabulated below:

Table 3.5 - Ringsend Wastewater Characteristics

	1994	Design Year 2015			Design Horizon 2040
	Ringsend	Ringsend	North Dublin	Total	Total
Dry Weather Flow (DWF) (m^3/s)	2.71	3.60	1.10	4.70	4.91
Average Flow (m^3/s)	3.76	4.50	1.38	5.88	6.14
Max. Flow to Treatment (m^3/s)	8.06	9.00	2.25	11.25	12.63
BOD (kg/d)	71,004	68,216	33,009	101,225	
BOD @ DWF (mg/l)	224	219	347	249	
TSS (kg/d)	89,417	67,793	31,279	99,072	
TSS @ DWF (mg/l)	281	218	329	243	
Total N (kg/d)	4,695	10,495	4,803	15,298	
Total N @ DWF (mg/l)	43	34	51	38	

3.5 SEWAGE TREATMENT

3.5.1 General.

As outlined in Section 3.2 sewage treatment comprises four principal elements:

* Preliminary Treatment
* Primary Settlement
* Secondary Treatment
* Tertiary Treatment

The extents and elements of each of these are described in the context of this development.

3.5.2 Preliminary Treatment.

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

* Fats, oils and grease (FOG)
* Plastics and rags
* Grit, silt and sand

and the main processes utilised to achieve this are screening and grit removal.

3.5.2.1 Screening.

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

Coarse screens have apertures greater than 50mm in size and their purpose is to protect equipment from large objects such as logs of wood etc. In the context of Ringsend STW all the flows will be delivered by pump or by siphon. All of these will be protected by coarse screens and consequently it is not envisaged that such screens will be required in the upgraded works. Medium screens have an aperture in the range 15 to 50mm but mostly in the range 15 to 25mm. In general the screens will comprise curved bars, vertical straight bars or inclined straight bars and will incorporate a raking mechanism. Screens such as these are presently in place on the Dodder Valley and Dun Laoghaire streams in the treatment works. However the level of treatment associated with medium screens is no longer to the standards required and as a consequence it is likely that screening in the treatment works will be '**fine**' in nature.

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

3.5.2.2 Screenings Conditioning.

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

3.5.2.3 General Maintenance.

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

3.5.2.4 Grit Removal.

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

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

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

Any or all of these methods could be utilised.

The present operation of Ringsend STW utilises a number of cross flow detritors. The Preliminary Report for Ringsend STW expansion envisaged the utilisation of additional detritors allied to the introduction of Vortex separators. It is likely that the new configuration will adopt a similar philosophy.

Grit once collected requires to be washed to remove any organic matter which may have adhered to the grit particles and thereafter sieved and collected for disposal. It is estimated that efficient removal of grit will result in the collection of between 0.0125 and 0.125 kg of grit/m^3 of flow. The actual quantity will depend on the nature of the flow to Ringsend STW and in particular the extent to which storm flows are included in the discharge to the works. In the context of Ringsend STW with high levels of combined sewer discharges to the works it can be expected that at times, particularly following prolonged dry spells, that the higher level above will be obtained.

On the basis of an average removal of 0.025kg/m^3 it can be estimated that a grit removal rate of 11 tonnes per day can be expected rising to 66 tonnes per day at occasional peaks. This grit will be removed to landfill.

3.5.3 Primary Settlement.

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

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

These include:

* Horizontal Flow Tanks
* Radial Flow Tanks
* Upward Flow Tanks

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

In general it can be summarised that the progression from Horizontal Flow to Upward Flow through Radial Flow is consistent with a decreasing works size. Being a large plant it is therefore hardly surprising that the existing Treatment Works possesses 12 Horizontal Flow Tanks. Utilisation varies from 8 in the summer to 9 or 10 in winter.

The existing tanks are unlikely to be adequate on their own for the treatment of the flow envisaged. Allied to the likelihood of the land occupied by some of the existing tanks being required for other treatment processes, forms of enhanced settlement are likely to be required on the site.

Processes to reduce the area required to achieve the desired primary settlement include Lamella Separators, Chemical Precipitation or a combination of both. Lamella Separators consist of multiple inclined parallel plates or tubes inserted inside a tank. In this instance the existing horizontal flow tanks could be utilised. Settlement of solids occurs in the liquid between surfaces and the height for settlement is a small fraction of that required in a standard tank. For a given area of tank the settlement rate is considerably higher in the Lamella Separators than in the Horizontal Flow Tank.

Similarly Chemical Precipitants which attach themselves to the suspended solids in the sewage will enhance the settlement characteristics of the solids and ensure a faster settlement rate as against the Horizontal Flow Tank on its own. This process can be allied to the Lamella Separators to provide the required settlement rate.

3.5.4 Secondary Treatment.

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

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

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

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

These include:

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

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

Processes which may be classified under this heading include:

* Trickling Filters
* Rotating Biological Contactor (RBC)
* Biological Aerated Filter (BAF)

A commentary on the nature and characteristics of the viable processes for the Dublin Bay Project is given in Volume 2, Appendix C.

However given the size of Ringsend STW and the land constraints associated with the development not all these processes will be appropriate for Ringsend STW.

The final choice of treatment process for Ringsend STW will be made in the context of the selection of the winning tender for the design and construction of Ringsend STW.

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

* Process suitability for treatment objectives as further discussed in Chapter 6
* Satisfactory demonstration on a comparable scale
* Operational complexity
* Ease of uprating for increased throughput
* Ease of uprating for stricter effluent standards
* Sludge production and characteristics
* Process reliability, flexibility of operation and standby requirement
* Land requirement
* Hydraulic head requirement
* Construction aspects

In the course of the examination of the feasibility of redeveloping Ringsend STW on the existing site a number of submissions were received by Dublin Corporation suggesting processes which could be utilised to achieve this objective. These submissions generally described three possible processes: Activated Sludge (AS), Sequencing Batch Reactor (SBR) and Biological Aerated Filter (BAF). It is considered likely that the final works will incorporate one of these secondary treatment processes or variations thereof.

Figures 3.1, 3.2 and 3.3 show possible layout configurations for these three secondary treatment options each with a possible associated sludge treatment process. The sludge processes shown are not necessarily exclusive to the secondary treatment process. Drying and digestion can be associated with AS as well with BAF.

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

3.5.5 Tertiary Treatment.

The IWEM (now CIWEM, Chartered Institution of Water and Environment Management) Handbook of UK Waste Water Practice(5) defines Tertiary Treatment as:

"The further treatment of sewage which has already been treated to a standard achievable by biological treatment. This may be to further reduce suspended solids, biochemical oxygen demand, chemical oxygen demand, ammoniacal nitrogen, total nitrogen or micro-organisms".

The treatment processes which come under the Tertiary Treatment banner are numerous and many will provide improvements over a number of parameters including Biochemical Oxygen Demand (BOD), Suspended Solids (SS), Ammonia, Nutrients and Disinfection.

In the context of the Ringsend Treatment Works theparticular requirements for Tertiary Treatment relate to Disinfection and Ammonia.

3.5.5.1 Disinfection Processes.

Disinfection is the term used to denote the further reduction of indicator organisms with the objective of eliminating or reducing to an acceptable level any pathogenic organisms which are present in effluent.

Techniques for the disinfection of effluent fall into three main categories:

(a) Chemical
(b) Physical
(c) Irradiation

(a) Chemical Techniques.

Chlorine.

Chlorine in gaseous and hypochlorite form is a strong oxidising agent and has been used extensively in the disinfection of drinking water. The materials are hazardous and require rigorous safety procedures in their use. Given the extensive past and current experience with chlorine in drinking water plants its use with treated effluent would not be problematic. However, concerns exist regarding the use of chlorine for effluent disinfection as a consequence of the knowledge that halogenated compounds are created by the reaction of chlorine with organic matter.

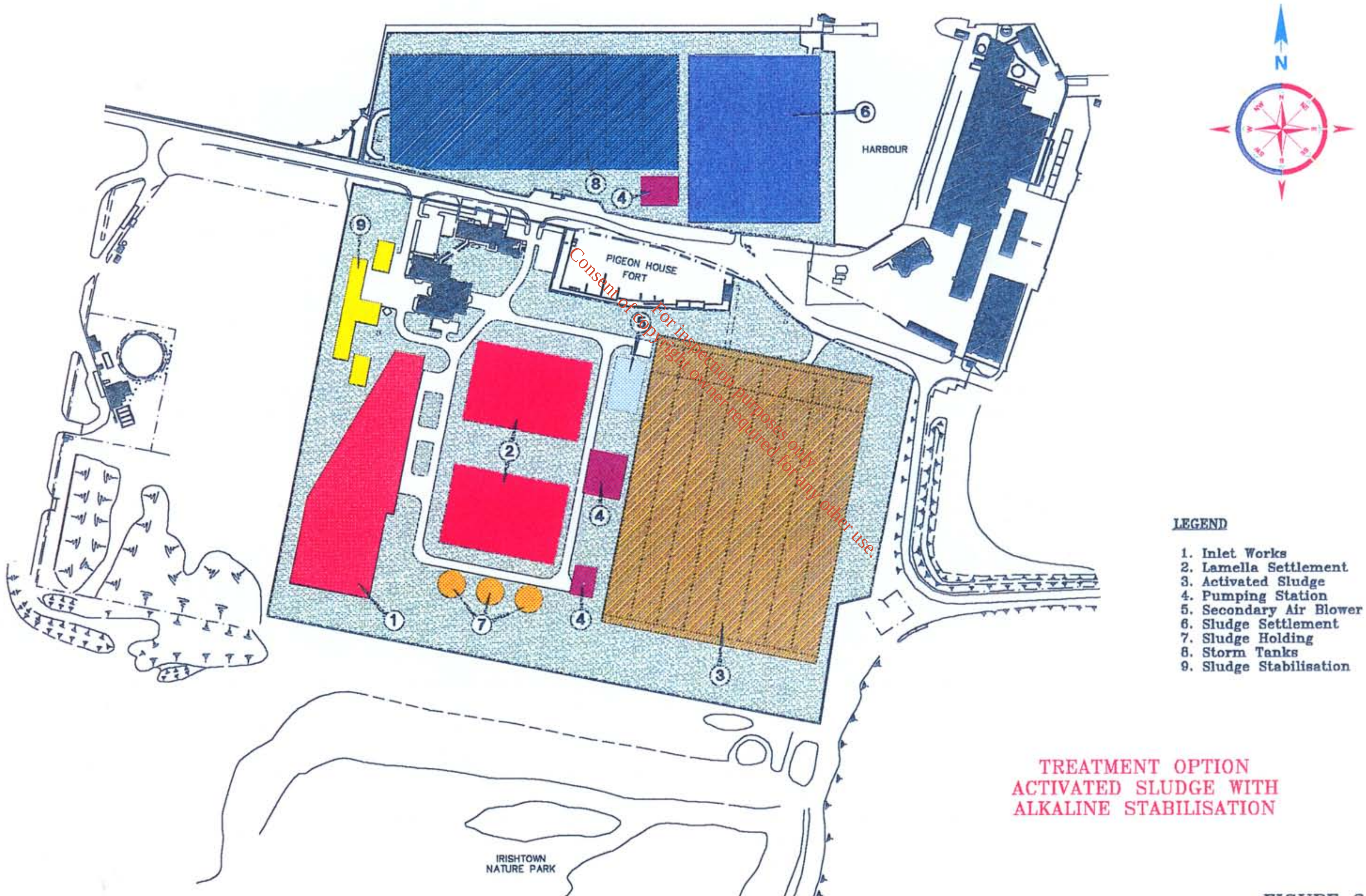
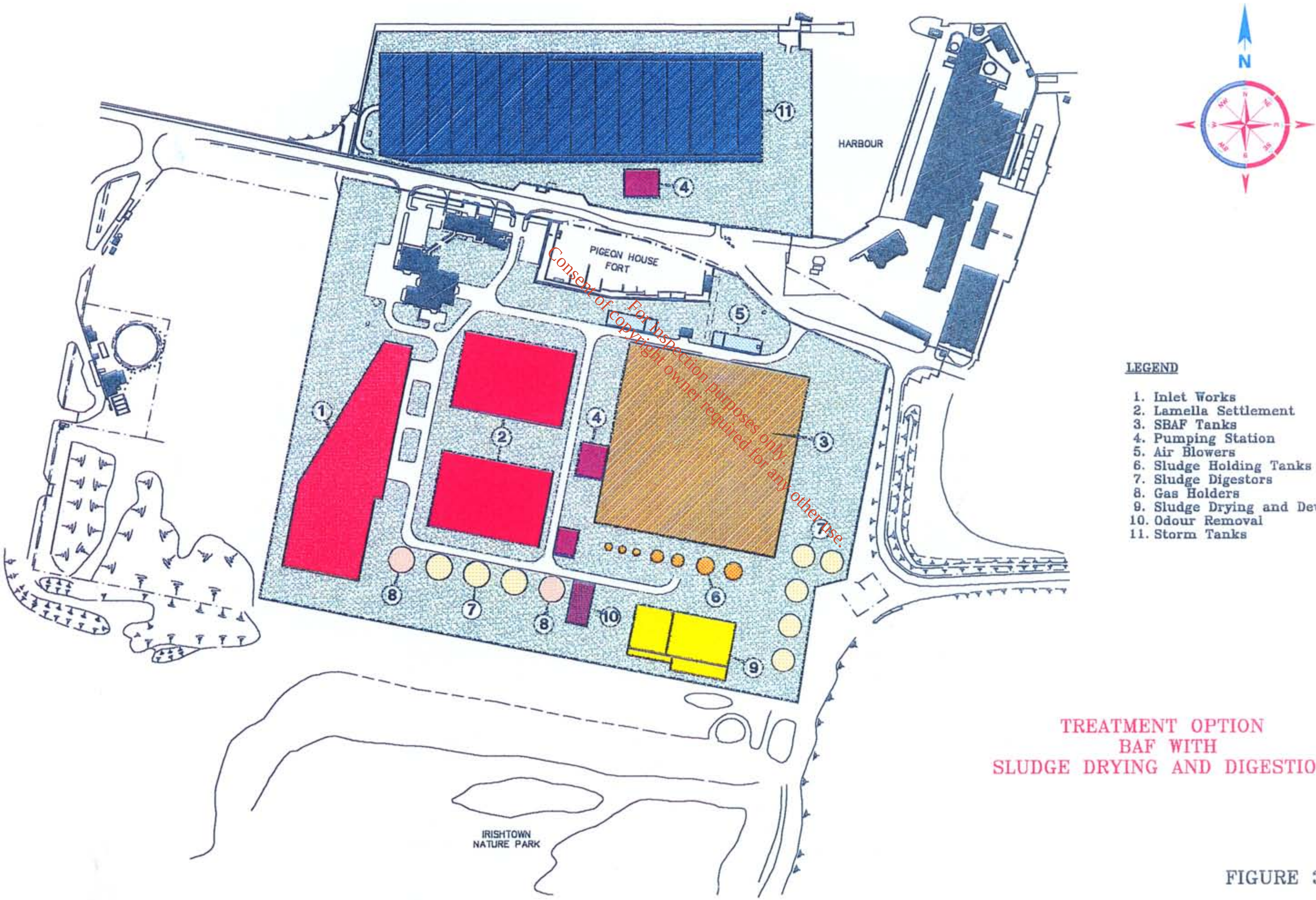

HARBOUR
PIGEON HOUSE FORT
IRISHTOWN NATURE PARK
N
LEGEND
1. Inlet Works
2. Lamella Settlement
3. Activated Sludge
4. Pumping Station
5. Secondary Air Blower
6. Sludge Settlement
7. Sludge Holding
8. Storm Tanks
9. Sludge Stabilisation
TREATMENT OPTION
ACTIVATED SLUDGE WITH
ALKALINE STABILISATION

FIGURE 3.1

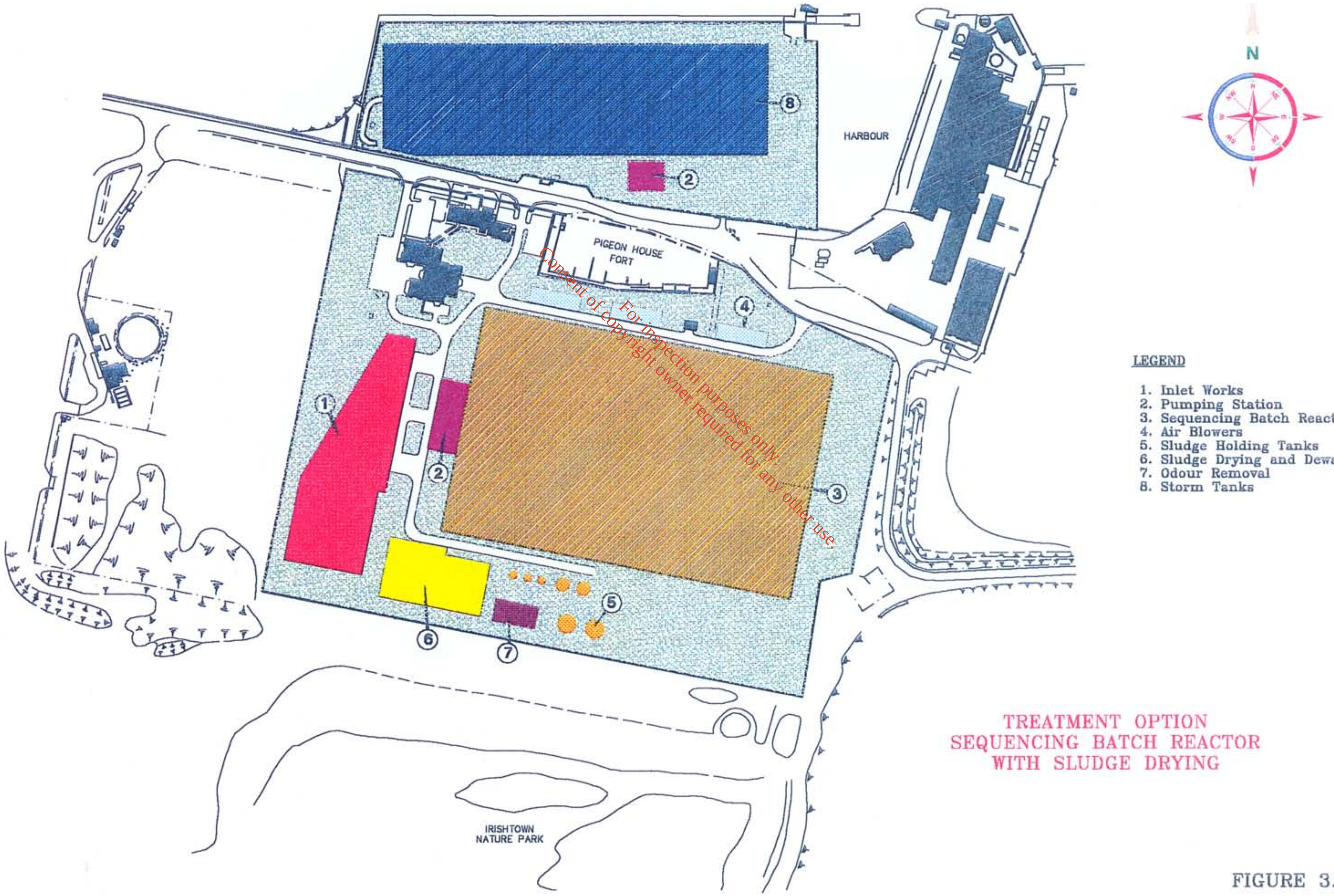


LEGEND

1. Inlet Works
2. Lamella Settlement
3. SBAF Tanks
4. Pumping Station
5. Air Blowers
6. Sludge Holding Tanks
7. Sludge Digestors
8. Gas Holders
9. Sludge Drying and Dewatering
10. Odour Removal
11. Storm Tanks

TREATMENT OPTION
BAF WITH
SLUDGE DRYING AND DIGESTION

FIGURE 3.2



LEGEND

1. Inlet Works
2. Pumping Station
3. Sequencing Batch Reactors
4. Air Blowers
5. Sludge Holding Tanks
6. Sludge Drying and Dewatering
7. Odour Removal
8. Storm Tanks

TREATMENT OPTION
SEQUENCING BATCH REACTOR
WITH SLUDGE DRYING

FIGURE 3.3

Some halogenated hydrocarbon compounds are known to be (combinations of some or all of) carcinogenic, mutagenic, toxic.

Given the disquiet surrounding the by-products of its use it is unlikely that disinfection by chlorine dosing will be incorporated in Ringsend STW unless adequate safeguards are presented to avoid the discharge of harmful by-products including a track record in the use of the methods and investigations into the appropriateness of the Ringsend discharge to these methods.

Peracetic Acid (PAA).

Peracetic acid is a powerful oxidising agent and disinfectant. While effective against indication organisms (coliforms) it is ineffective against viruses. Allied to this is the negative effect which PAA has on BOD. Given its relative disadvantages and cost PAA is unlikely to be the process employed at Ringsend.

(b) Physical Techniques.

In the context of Ringsend STW the possible physical techniques for the disinfection of the treated effluents are classified as microfiltration. These techniques pass the effluent through fine pores generally of the order of 0.1 - 1.0 um. Such processes are efficient in the removal of bacteria and although theoretically pore sizes in the filters should allow viruses to pass practice has shown microfiltration processes to be effective in virus removal. The process has the advantage that there are no residual products in the treated effluent and hence lower environmental impact.

(c) Irradiation.

Ionising radiation in the form of ultraviolet light (UV) can destroy bacteria and viruses by interfering with their chemical structure, particularly DNA molecules.

The most effective wavelength for disinfection is 254mm and this is irradiated using two types of lamp: low and medium pressure. The system relies on a series of frame mounted lamps which is immersed in a channel carrying the effluent. A high quality effluent is required as high levels of suspended solids would block irradiating light from penetrating through all the flow.

Additionally the lamps tend to become coated and the rate of coating is a function of the quality of effluent. Recent developments in UV technology deal with such difficulties systematically and give a high level of reliability in achieving disinfection.

The criteria for the suitability for inclusion of any of the above or other similar processes in Ringsend STW will be the achievement of a faecal coliform level of 100,000 FC/100ml on an 80 percentile basis and a similar reduction in faecal streptococci, a viruscidal capability and the absence of harmful residues in the treated effluent.

3.5.5.2 Ammonia.

The achievement of ammonia reduction and/or removal is primarily brought about by adjustment of the secondary treatment process. **As such the ability to reduce ammonia levels to a 95 percentile level of 18.75mg/l will form an element of the selection criteria outlined in Section 3.5.4.**

3.6 OUTFALL.

It is proposed to continue the present practice whereby treated effluent is discharged via the ESB cooling water discharge channel.

3.7 SLUDGE QUANTITIES.

At present only primary sludge is produced at Ringsend from the treatment of sewage collected in the Central and South Dublin catchments, no secondary sludge is generated. In the future, sewage from the North Dublin Catchment will be pumped to Ringsend.

The present estimated annual mean primary sludge production is 11,675t expressed as dry solids and is produced at a concentration of 4% dry solids (ds), corresponding to an annual sludge volume of 291,875m^3.

Estimation of the sludge production for the year 2015 depends upon the assumptions concerning the sewage treatment processes employed. It is assumed that primary treatment and secondary treatment to partially remove ammonia will be provided, which, for medium performance parameters, give annual sludge production of estimated 40,533t ds (21,697t ds primary, 18,836t ds secondary). The calculated sludge production figures range from 37,149t ds to 43,178t ds per annum.

The quantities of treated sludge produced under the various treatment options under consideration are shown in Table 3.6.

Table 3.6

Treated Sludge Quantities

Sludge Product	Dry Solids (%)	Sludge Mass (t/d)	Sludge Volume (m^3/d)	% of Initial Cake Volume
Undigested Dried Granules	95	117	167	41
Digested Dried Granules	95	85	121	30
Alk. Stabil. Sludge (Cl.A)	55	505	485	120
Alk. Stabil. Sludge (Cl.B)	45	617	424	105

Notes:

(a) Primary Sludge 21,697t ds per annum, Secondary Sludge 18,836t ds per annum, Total Sludge 40,533t ds per annum.

(b) Mixed Primary and Secondary Sludge cake at 25%.

(c) Bulk densities: dried 0.7 t/m^3; Ash 1.7t/m^3.

(d) Anaerobic digestion assumed to convert 30% primary sludge solids and 25% secondary sludge solids to biogas.

(e) Alkaline stabilisation(Class A): 1.5t proprietary additive x is required per tonne sludge dry solids, bulk density 1.05t/m^3.

Alkaline stabilisation(Class B): 1.5t proprietary additive y is required per tonne sludge dry solids, bulk density 1.45t/m^3.

3.8 SLUDGE CHARACTERISTICS.

Results from sample analysis indicate the presence of a range of heavy metals and persistent organic chemicals such as pesticides in the primary sludge. However the concentration of these contaminants is low.

Historical data shows that persistent organics are generally present at low concentrations and in some instances are below the level of analytical detection employed. Occasionally organochlorine pesticides and polychlorinated biphenyls

(PCB's) have been detected at levels up to 45ppb (µg/kg) in wet sludge for 1989-1991 samples, but values are inconsistent and fluctuate considerably.

More typically for 1991 average pesticide levels expressed as parts per billion (ppb) dry sludge contents were 200 Hexachlorocyclohexane (HCH) (α, β + γ) commonly known as lindane, 150 total drins (Aldrin, Dieldrin, Endrin) and 280 DDTs.

The 1994 data for heavy metals indicated that all concentrations were considerably less than the concentration set down in the European Communities (Use of Sewage Sludge in Agriculture) Regulations, SI 183 of 1991. Volume 2, Appendix D compares the heavy metal levels in the primary sludge in the present works with statutory units and other sludges.

Heavy metals become incorporated into the secondary sludge, typically at lower concentrations than in primary sludge. The combined primary and secondary sludge will therefore have lower heavy metal concentrations than the primary sludge exhibits at present.

Inorganic ash content for Ringsend primary sludge is 20%, indicating that the sludge solids have quite a high volatile organic content at 80%. Average values for total N and P in the primary sludge at Ringsend for 1993 are 3.2% N and 0.58% P (dry solids basis).

Pilot plant studies are currently underway which will provide essential information on the treatability and character of the sludge produced at Ringsend and will allow the sludge production to be quantified under operating conditions.

Analysis has not been carried out at North Dublin as sludge is not yet separated from the sewage there.

3.9 SLUDGE TREATMENT OPTIONS CONSIDERED.

3.9.1 General.

Sludge reuse disposal options require an appropriately treated 'clean' sludge relatively free of contaminants acceptable for the disposal routes available.

The treatment options considered to offer realistic potential for Ringsend sludge are:

* Thickening
* Dewatering
* Mesophilic Anaerobic Digestion
* Thermal Drying
* Alkaline Stabilisation

Combinations of these treatment processes which could provide adequately treated sludge were then considered, as set out below:

Table 3.7

Treatment Methods and Sludge Products

Treatment Combinations	Sludge Product
• Thickening - Dewatering	Raw dewatered cake
• Thickening - Digestion - Dewatering	Digested dewatered cake
• Thickening - Dewatering - Drying	Raw dried granules/pellets
• Thickening - Digestion - Dewatering - Drying	Digested dried granules/pellets
• Dewatering - Alkaline Stabilisation	Alk. Stab. Sludge

Interim and longer term sludge management plans (SMP's) have been recommended, covering respectively the period 1998-2000 and the post 2000 situation.

* **Interim Sludge Management Plan.**
  The interim sludge management plan for the primary sludge at Ringsend is:

  - Screening

  and

  - Dewatering

  Followed by:

  - Alkaline Stabilisation

  or

  - Thickening and Thermal Drying

* **Long-Term Sludge Management Plan.**

  The sludge management plan for Ringsend (post 2000) is one or all of the processes below or similar equivalent:

  - Screening
  - Thickening
  - Dewatering
  - Digestion
  - Thermal Drying to Granular or Pellet Form
  - Alkaline Stabilisation

3.10 SLUDGE TREATMENT PROCESS OUTLINES.

3.10.1 General.

Sludge produced from sewage treatment contains a large proportion of water. Volume reduction by the removal of water is necessary therefore at medium and larger sized works.

Sludge also contains significant amounts of putrescible material which degrades under the action of micro-organisms and can produce unpleasant odours. Pathogenic organisms tend to be associated with the solids fraction in sewage and are present in high concentrations in raw sludge. Treatment processes are selected to significantly reduce the numbers of pathogens in sludge, e.g. greater than 90% removal.

Treatment processes are chosen to stabilise sludge i.e. to render it biologically less active by chemically reacting with, or reducing or destroying the putrescible organic fraction. Pathogen reduction may also be required to facilitate secure disposal of the sludge.

3.10.2 Screening.

Fine screening of sludge for removal of sewage debris such as plastics and other non-biodegradable materials is an important first stage of treatment where sludge reuse is proposed. Otherwise, this material will reduce the quality of sludge destined for reuse.

Effective screening of the liquid sludge to remove debris is particularly important before drying as such material would be visible on the surface of sludge granules and would be detrimental to product quality and perception.

Screens with 3-5mm perforations are used successfully for this purpose.

3.10.3 Thickening.

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

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

At Ringsend, mechanical thickening of secondary sludge is likely to be the favoured option given the throughput envisaged and because of the reduced area required. Gravity thickening would be satisfactory for primary sludge with mechanical thickening required only where high solids digestion is considered.

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

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

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

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

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

Mechanical Thickening.

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

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

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

3.10.4 Dewatering.

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

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

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

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

Filter presses may be of two types, the solid recessed plate type and the membrane plate press. Both types are similar in arrangement, each having a series of 30 to 100 plates compressed together by means of hydraulic rams. When in this closed position, the plates form a continuous series of chambers connected together by a central feed port through which the conditioned sludge is fed. Each plate is covered by a filter cloth. Solids are retained on the cloths while filtrate passes through to be returned to the sewage treatment plant. Sludge is fed to the presses by means of positive displacement pumps. Membrane filter presses are capable of achieving the highest cake dryness of all the dewatering machines. Filtrate produced from dewatering is returned to the sewage works inlet.

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

3.10.5 Thermal Drying.

Thermal drying reduces the quantity of sludge to the maximum extent possible, with the exception of thermal destruction processes such as incineration. The dried material is stabilised and is suitable for use in a range of reuse outlets. Thermal drying achieves pathogen reduction to levels below that achieved by most sludge processes in common use. The material retains some odour, but this is not considered to limit the potential for reuse.

Dryers may be characterised as direct or indirect depending upon whether or not the sludge comes into intimate contact with the heating medium. Direct dryers require that the necessary heat is transferred to the product by a gaseous medium which is in intimate contact with the product. Evaporated water vapour is mixed with the drying medium and the total exhaust gas from the dryer consists of the drying gas plus the evaporated water. Indirect dryers operate by transferring heat across an intermediate heat transfer surface to the product. The heating medium is never in contact with the product. The exhaust gas leaving the dryer is solely the evaporated water. Indirect dryers offer advantages such as lower material throughput as no backmixing is necessary, lower exhaust volumes and lower fire risk.

Most drying processes produce granular particles in the size range 2-6mm although some produce very fine, dusty material which requires a pelletiser to produce material suitable for reuse.

The degree to which sludge is dried depends on the intended use for the product. Drying to 80-95% ds is practised to achieve a stable, storable product for reuse.

Dryers are sized according to the design rate of water evaporation i.e. tonnes water evaporated per hour. For Ringsend, the evaporation rate required would be in the range 12-16t H_2O/hr. Overall thermal efficiency is in the range 70% to 80%. The heat input required is approximately 900kWh/t water evaporated. Fuels commonly used include biogas, natural gas and fuel oil. The total water evaporation capacity required is provided by a number of dryers operating in parallel.

Dried sludge can begin to smoulder at about 60°C (which could give rise to a potential fire hazard) so it is important that it be cooled to 30°C before long term storage.

A typical drying configuration is outlined on Figure 3.3.

3.10.6 Anaerobic Digestion.

Anaerobic digestion of sludge is a biochemical process involving several groups of organisms which assimilate and break down organic matter. Digestion is carried out at elevated temperatures in the range 33-37°C (mesophyllic range) usually for a period of 15-20 days.

The process is carried out in completely enclosed tanks (primary digesters) where slow but complete mixing is achieved. Digested sludge is then transferred to open tanks (secondary digesters) without heating or mixing and retained for about 15 days. This two stage approach is considered necessary for effective pathogen reduction.

Sludge is fed to the digester either continuously if possible, or by frequent low volume pumping operations.

Anaerobic digestion reduces the mass of dry solids by 30-40% and produces biogas which is used partly to fulfil the energy requirements of the digestion process. Excess biogas can be used as an energy source for further sludge processing.

Biogas can be stored in low pressure gas holders with floating covers or may be stored in spherical double membrane gas holders. Storage capacity for 12-24 hours production of biogas is typically provided.

Digester operation can be adversely affected or even inhibited entirely if substances toxic to the anaerobic bacteria are present in significant concentrations in the feed sludge. Sludges from some secondary treatment processes including Extended Aeration and SBR are not readily amenable to digestion.

Digestion plant elements and configuration are shown on Figure 3.2.

3.10.7 Alkaline Stabilisation.

Treatment of sewage sludge using alkaline materials is practised to reduce the fermentability of the sludge by increasing the pH under controlled conditions. All such processes eliminate odours and significantly reduce the number of pathogens present by raising the pH. In addition, some also increase the temperature of the sludge to bring about a further reduction in pathogens and produce a highly stabilised material. It is further claimed that reinfection is unlikely as the product remains hostile to pathogens.

There are a number of such plants operating in Germany and the US. With some exceptions these are generally smaller than that which would be required for the Ringsend sludge.

Processes that use alkaline materials may be categorised according to their complexity and the degree of stabilisation achieved, particularly with respect to pathogen removal.

Sludge treatment processes are categorised by the USEPA into two groups, (i) Class B - those that significantly reduce pathogens(PSRP) and (ii) Class A - processes to further reduce pathogens(PFRP)-the highest treatment standard. Alkaline processes relying on pH elevation only are categorised as PSRP, as is anaerobic digestion. Processes involving pH increase and temperature elevation are categorised as PFRP as is thermal drying. Both categories of alkaline process are likely to be fully acceptable under Irish legislation governing the use of sludge in agriculture.

A number of patented processes are available using reactive alkaline substances such as quicklime(CaO), hydrated lime($Ca(OH)_2$), silicates or cement in mixtures with waste materials such as pulverised fuel ash (PFA), gypsum, lime kiln dust (LKD) and cement kiln dust (CKD).

It is possible that four or five months production would be stored over the winter, requiring large storage areas at the treatment site or elsewhere.

Alkaline stabilisation processes are relatively straightforward requiring simple plant such as sludge cake and product conveyors, storage silos for alkaline admixtures, admixture feeder screws, ploughshare mixers, ammonia scrubber and control equipment.

Alkaline stabilisation requires only dewatering of the raw sludge to a cake having dryness of 20-30% dry solids. The dewatered sludge cake is then mixed with the alkaline admixture under controlled conditions in a pug-mill or ploughshare mixer. The sludge cake moisture content is an important factor in determining the quantity of admixture required for each of the processes.

A possible AS configuration is indicated on Figure 3.1.

3.11 STORM OVERFLOWS.

3.11.1 Introduction.

In addition to foul wastes many of the sewers contributing to the flow to the Ringsend STW carry storm water run-off and are classified as 'combined'. Consequently when it rains over the City the flow in the sewers is augmented by the rainwater run-off. Other than where storm overflows occur upstream in the sewerage system all this combined flow is collected for treatment. It is estimated that the total capacity available for delivery to Ringsend STW excluding the North Dublin Catchment is $20m^3/s$. The treatment of storm flows for the North Dublin Catchment is considered in EIS No. 2 Sutton Pumping Station. As stated in 3.4 above and Table 3.5 the maximum flow from the Ringsend Catchment to secondary treatment is $9.00m^3/s$ (approx. 2.5 DWF) leaving $11m^3/s$ peak storm flow to be discharged.

3.11.2 Treatment of Storm Flow.

3.11.2.1 Preliminary Treatment.

All flows arriving at Ringsend STW will be subjected to preliminary treatment as described in 3.5.2 above ensuring the removal of all aesthetically objectionable materials.

3.11.2.2 Quality of Storm Water Overflows.

Modelling of storm overflow discharges assumes a coliform concentration of 3×10^6 FC/100ml (Chapter 6). This represent a 90% reduction in the concentration of coliforms in raw sewage and is the maximum allowable level for discharge from Ringsend STW.

3.11.2.3 Treatment of Storm Overflows.

Experience in the operation and maintenance of sewerage systems and waste water treatment has determined that the first flush associated with a storm event contains a high strength sewage and that the discharge of such materials would in all likelihood be deleterious to the receiving water. The poor quality of the first flush ranges with the seasons and will be a function of many parameters including oils on roads, animal faeces on footpaths, decaying leaves, salted grit etc.

The interception and holding of this first flush for treatment when the storm flow has abated is a feasible option for Ringsend STW. As it is likely to require the greatest area of land it has been shown in a number of configurations on Figures 3.1 to 3.3. Construction of 59,400m³ of storage would provide 1½ hours storage for the flow of 11m³/s. This storage could be accommodated on the location of the disused 1906 tanks. This 59,400m³ of storm water would be returned for full treatment in Ringsend STW with ultimate discharge at the consent standards highlighted in Chapter 6. In the event of the storm holding tanks being full storm overflow would then discharge to the River Liffey with a water quality at or better than the standard described in 3.11.2.2 above.

Another possible option for the treatment of storm overflows is the use of vortex separators. Such separators operate by separating the flow into a small high strength flow and a large flow comparable in character to the treated effluent being discharged from the present treatment works. Other treatment systems providing an equivalent level of treatment may also be incorporated.

3.12 DEVELOPMENT WORKS

3.12.1 Description.

The works on the Ringsend site will comprise the buildings and structures to accommodate the processes described in 3.5 to 3.11 above, the roads to provide access to the process buildings, the pumps and pipework delivering sewage from one process to the next and the general landscaping associated with the development.

Figures 3.1 to 3.3 show in plan the range of structures likely to be constructed using DBO procurement depending on the secondary treatment and sludge treatment processes adopted. Tables 3.8 to 3.10 hereafter describe the buildings shown on these figures. The DBO Contractor will be required to comply with the sizes and finishes, or similar equivalent, shown.

The site will be landscaped to provide grassed areas and screening as discussed in Chapters 8 and 9.

Table 3.8 - Building Dimensions

Extended Aeration and Alkaline Stabilisation

	Width (m)	Length (m)	Height Above Ground (m)	Finish
Inlet Works (1)	55 60	55 120	18 18	Concrete and Metal Cladding Colour Banding
Primary Lamella (2) Settlement	70	80	4	Concrete Open
Secondary Activated (3) Sludge Aeration	155	200	8	Concrete
Main Pumping Station (4)	25	35	12	Concrete/Blockwork. Metal Cladding/Roof. Colour Banding
Storm Pumping Station (4)	20	25	12	Do
Sludge Pumping Station (4)	15	20	10	Do
Air Blower Building (5)	20	35	12	Do
Secondary Sludge (6) Settlement	90	105	3.5	Concrete Open
Sludge Holding (7)	19mØ	---	6	Non Reflecting Steel-Grey
Storm Holding Tanks (8)	80	200	0	Concrete
Sludge Stabilisation (9)	10 15	70 10	3.5 13	Metal Cladding. Colour Banding

Note: Figures in brackets refer to legend headings on Figure 3.1.

Table 3.9 - Building Dimensions

BAF with Sludge Drying and Digestion

	Width (m)	Length (m)	Height Above Ground (m)	Finish
Inlet Works (1)	55 60	55 120	18 18	Concrete and Metal Cladding Colour Banding
Primary Lamella (2) Settlement	70	80	4	Concrete Open
Secondary BAF Tanks (3)	130	130	6	Concrete - Open or Metal
Main Pumping Station (4)	25	35	12	Concrete/Blockwork. Metal Cladding/Roof. Colour Banding
Storm Pumping Station (4)	25	25	12	Do
Sludge Pumping Station (4)	15	20	10	Do
Air Blower Building (5)	10	35	9	Do
Sludge Holding Tanks (6)	6mØ 10mØ 13.5mØ		7 10 7.5	Non Reflecting Steel - Grey
Sludge Digestors (7)	19mØ 17mØ		27 9	Do
Gas Holders (8)	19mØ		22	Do
Sludge Drying and Dewatering (9)	55 50 40	35 15 40	15 22 12	Metal Cladding Colour Banding
Odour Removal (10)	15	30	6	Metal Cladding
Storm Holding Tanks (11)	80	265	0	Concrete

Note: Figures in brackets refer to legend headings on Figure 3.2.

Table 3.10 - Building Dimensions

Sequencing Batch Reactor with Sludge Drying

	Width (m)	Length (m)	Height Above Ground (m)	Finish
Inlet Works (1)	55 60	55 120	18 18	Concrete and Metal Cladding Colour Banding
Main Pumping Station (2)	50	25	12	Concrete/Blockwork Metal Cladding - Colour Banding
Storm Pumping Station (2)	25	25	12	Do
Secondary Sequencing Batch Reactors (3)	160	250	20	Do
Air Blowers (4)	18	35	9	Do
Sludge Holding Tanks (5)	6mØ 10mØ 13.5mØ		7 10 7.5	Non Reflecting Steel Grey
Sludge Drying and Dewatering (6)	55 50 40	35 15 40	15 22 12	Metal Cladding Colour Banding
Odour Removal (7)	15	30	6	Metal Cladding
Storm Holding Tanks (8)	80	265	0	Concrete.

Note: Figures in brackets refer to legend headings on Figure 3.3.