# THE ENVIRONMENTAL PROTECTION AGENCY ACT, 1992 [URBAN WASTE WATER TREATMENT] REGULATIONS, 1994

# A HANDBOOK ON IMPLEMENTATION FOR SANITARY AUTHORITIES

**Environmental Protection Agency**
Headquarters, Ardcavan, Wexford.
Telephone: +353-53-47120 Fax: +353-53-47119.

**The Environmental Protection Agency Act, 1992**
**[Urban Waste Water Treatment] Regulations, 1994**
**A HANDBOOK ON IMPLEMENTATION FOR SANITARY AUTHORITIES**

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## NOTICE

This handbook has been compiled with the aim of giving guidance to sanitary authorities charged with the implementation of the Environmental Protection Agency Act, 1992, [Urban Waste Water Treatment] Regulations, 1994, made by the Minister for the Environment. It is not a legal document; the only definitive documents relating to the topic herein covered are the Regulations and the European Union Directive with which it is associated. In all cases of doubt or possible ambiguity reference should be made to the Regulations.

# 1. INTRODUCTION

1.1 The Regulations covered in this handbook have been made under the provisions of the Environmental Protection Agency Act, 1992, and they relate to areas in which the Agency [EPA] has a significant degree of responsibility. Sections 60 and 61 of this Act set out the duties of the Agency in relation to sewage treatment, and to sanitary authorities' effluents, respectively.

1.2 The specific requirements of Section 60 (which relate to the specification and publication of criteria and procedures relevant to the "management, maintenance, supervision, operation or use of all or specified classes of plant, sewers or drainage pipes vested in or controlled or used by a sanitary authority") are discussed below, and it may just be noted at this point that the present Handbook has been prepared in accordance with this provision of the Act. The Handbook is also germane to Section 61 which contains detailed provisions regarding the monitoring of effluent from sanitary authority treatment plants.

1.3 The primary functions of implementing the Regulations are the responsibility of the sanitary authorities which undertake all urban waste water treatment in the country. This handbook has been prepared by the EPA in order to assist the many authorities dealing with urban waste water treatment and to facilitate the necessary liaison between authorities and the Agency in the proper discharge of the responsibilities created by the Regulations. Accordingly, it is a primary aim of the handbook to outline procedures by which the various EPA responsibilities can be harmonized with those of the authorities.

1.4 The EPA has, as mentioned, a statutory function in relation to the monitoring of the environmental protection activities of sanitary authorities, and a major responsibility is its obligation [to meet the requirement originating in Article 16 of the Urban Waste Water Directive (91/271/EEC)] to publish reports on an on-going basis on the disposal of urban waste water. Further, Section 61 (3) of the EPA Act requires that the Agency shall publish reports on the waste water treatment activities of the sanitary authorities at intervals not exceeding two years.

1.5 There is a satisfactory national precedent for this approach. For some years past the EPA has been carrying out its statutory function of preparing and publishing annual reports on the quality of drinking water in Ireland, based wholly on the monitoring activities of the sanitary authorities whose duty it is to carry out all sampling and analysis. The results of their monitoring activities are submitted by the sanitary authorities to the EPA which then compiles and publishes a comprehensive national report every year. It is intended that the requisite two-yearly reports on urban waste water treatment shall be prepared in a similar manner.

1.6 While the major effort on the part of the sanitary authorities will naturally relate to monitoring programmes, the task of preparing and collating data for transmission to the EPA is not insignificant. To facilitate both the authorities in this regard and the EPA in its subsequent processing of the data, the Agency is developing convenient computerised formats for issue to sanitary authorities to assist them in the preparation of data returns.

1.7 The present Handbook is intended to cover practical aspects of the implementation of the Regulations, and, accordingly, it deals as appropriate with such key topics as sampling methods and frequency, sampling locations, maintenance of sample integrity, methods and

frequency of analysis and the like. It does not contain, however, a comprehensive treatment of the many detailed aspects of analysis, a very wide field which is beyond its scope.

1.8 While the Regulations are the only legal, and complete, source of information on the range of duties and obligations which fall to the authorities, the present volume discusses as appropriate the salient points in regard to these requirements. Thus, it is intended to be a practical compendium of information for all those in sanitary authorities who are engaged in the treatment and disposal of urban waste water.

# 2. ENVIRONMENTAL PROTECTION AGENCY ACT, [URBAN WASTE WATER TREATMENT] REGULATIONS

## 2.1 Introduction

2.1.1 The Environmental Protection Agency Act, 1992, [Urban Waste Water Treatment] Regulations, 1994, were made by the Minister for the Environment on 14 December 1994, under Section 59 of the EPA Act, in order to give effect to EU Council Directive 91/271/EEC of 21 May 1991. Their provisions cover various requirements in relation to the collection and treatment of urban waste water. Further provisions relate to the environmental monitoring requirements relevant to treatment plants, and to the pretreatment needs for industrial waste waters ultimately reaching urban waste water plants. The most important definitions contained in the Regulations are set out in Appendix D.

## 2.2 The Main Provisions

### PROVISION OF COLLECTING SYSTEMS

2.2.1 The first requirement [in Section 3(1)] is for sanitary authorities to provide collecting systems for urban waste water, as follows, such systems fulfilling the criteria specified in the First Schedule [cf Appendix A, which contains all five Schedules]:

2.2.1.1 by 31 December 1998 for every agglomeration with a population equivalent of more than 10,000 which discharges into any of the sensitive areas specified in the Third Schedule or into the relevant catchment areas of such sensitive areas [Article 3(1)(a)],

2.2.1.2 by 31 December 2000 for every agglomeration with a population equivalent of more than 15,000 [Article 3(1)(b)],

2.2.1.3 by 31 December 2005 for every agglomeration with a population equivalent between 2,000 and 15,000 [Article 3(1)(c)].

2.2.2 However, there is no requirement to provide a collecting system where this would not be justified either because it would produce no environmental benefit or its cost would be excessive. This is provided that the sanitary authority is satisfied that the same degree of environmental protection can be achieved by "individual systems or other appropriate systems" [Article 3(3)].

### TREATMENT OF URBAN WASTE WATER

2.2.3 As regards treatment for urban waste water entering collecting systems, sanitary authorities are required to provide plants "which provide for secondary treatment or an equivalent treatment" as follows [Article 4(1)]:

2.2.3.1 by 31 December 2000, or such later date, not being later than 31 December 2005, as the EU Commission may agree to in response to a request made under Article 8 of the Directive, "in respect of all discharges from agglomerations with a population equivalent of more than 15,000" [Article 4(1)(a)],

2.2.3.2 by 31 December 2005 "in respect of all discharges from agglomerations with a population equivalent of between 10,000 and 15,000" [Article 4(1)(b)],

2.2.3.3 by 31 December 2005 "in respect of all discharges to fresh waters and estuaries from agglomerations with a population equivalent of between 2,000 and 10,000" [Article 4(1)(c)].

In general, such plants must satisfy the performance requirements specified in Part 1 of the Second Schedule to the Regulations.

2.2.4 These performance requirements, i.e. concentration limits for key parameters in the effluents from secondary treatment plants, are as follows:

*BOD: 25 mg/l $O_2$; COD: 125 mg/l $O_2$; SS [Suspended solids]: 35 mg/l.*

Two of these parameters, BOD [Biochemical Oxygen Demand] and SS, respectively, have constituted the long-established "Royal Commission Standards" of "20/30" [i.e. an effluent with BOD 20 mg/l $O_2$ or less, and SS 30 mg/l or less], which evolved from the deliberations of the 1912 Royal Commission on Sewage Disposal, and which have for years been standard practice criteria in the design of waste water treatment plants, but which are now superseded.

2.2.5 The third parameter, for which a concentration limit is introduced for the first time, is COD [Chemical Oxygen Demand] which is an invaluable (and generally very reproducible) indicator of organic strength. As the Department of the Environment [DoE] circular *[Ref: WP 3/95]* issued with the Regulations indicates, COD is particularly useful in the determination of the characteristics of raw waste water, especially if there is an industrial component in the waste. It is discussed further below.

2.2.6 Notwithstanding the provisions set out in Paragraph 2.2.1 above, sanitary authorities must provide, by 31 December 1998, treatment plants "which provide more stringent treatment than secondary treatment or an equivalent treatment" for all discharges from agglomerations with a population equivalent greater than 10,000 "into sensitive areas or into the relevant catchment areas of sensitive areas where the discharges contribute to the pollution of these areas" [Article 4(2)]. As mentioned in Paragraph 2.2.3 above, such plants must satisfy the performance requirements specified in the Second Schedule to the Regulations [Article 4(3)].

2.2.7 There is, however, no such requirement for greater stringency in treatment where a sanitary authority is satisfied "that the minimum percentage reduction of the overall load entering all urban waste water treatment plants in a sensitive area is at least 75% for total phosphorus and for total nitrogen" [Article 4(4)].

2.2.8 It is important to note that, notwithstanding the treatment requirements mentioned in the above paragraphs, more stringent treatment may be needed "to ensure that the receiving waters satisfy any other relevant Community Directives" [Article 5].

2.2.9 The Third Schedule identifies ten sensitive areas for the purposes of the Regulations [Article 6(1)]. Where, following review, additional areas are identified as sensitive by the Minister for the Environment, the provisions of the Regulations in regard to stringency of treatment, as discussed above, will apply not later than 7 years from the date of identification of the area(s) as sensitive [Article 6(2)].

2.2.10 Sanitary authorities are required [Article 7] to ensure by 31 December 2005 that urban waste water entering a collecting system "shall before discharge be subject to appropriate treatment":

2.2.10.1 in respect of discharges to freshwater and estuaries from agglomerations with a population equivalent of less than 2,000 [Article 7(a)];

2.2.10.2 in respect of discharges to coastal waters from agglomerations with a population equivalent of less than 10,000 [Article 7(b)].

## PERFORMANCE AND DESIGN OF TREATMENT PLANTS

2.2.11 As regards the nature of treatment plants provided in accordance with the Regulations, sanitary authorities are obliged to ensure that such plants are "designed, constructed, operated and maintained to ensure sufficient performance under all normal local climatic conditions" [Article 8(1)]. The design must take into account seasonal variations of the load [Article 8(2)], and the plants must be such, by design or modification, that "representative samples can be obtained of the incoming waste water and of treated effluent before discharge to receiving waters" [Article 8(3)]. Further, the effluent discharge point must be chosen so as to "minimize the adverse effects on the receiving environment" [Article 8(4)].

2.2.12 Under Section 60 of its Act, the EPA "may, and shall if so directed by the Minister [for the Environment], specify and publish criteria and procedures, which in the opinion of the Agency are reasonable and desirable for the purposes of environmental protection, in relation to the management, maintenance, supervision, operation or use of all or specified classes of plant, sewers or drainage pipes vested in or controlled or used by a sanitary authority for the treatment of drinking water or for the treatment or disposal of any sewage or other effluent to any waters and a sanitary authority shall, in the performance of its functions, have regard to such criteria and procedures."

2.2.13 In accordance with this provision, the Agency has undertaken the production of a series of modular manuals each dealing with a particular topic relevant to the general areas listed in the Act. Each manual is intended to assist sanitary authorities in dealing with the often complex technical questions which arise in regard to such areas. The first waste water manual - *Preliminary Treatment* - has already been published.

## TREATMENT OF INDUSTRIAL WASTE WATERS

2.2.14 The Fourth Schedule to the Regulations provides that industrial waste waters entering collecting systems and urban waste water treatment plants shall be subject to such pretreatment as is required to protect the health of staff, to protect the fabric and operation of

collecting systems and treatment plants, and to safeguard the environment. Under the Regulations, and in accordance with various other legislative provisions, sanitary authorities must ensure that the requirements of this Schedule are met "with respect to the discharge of industrial waste water and shall review, and if necessary revise, any licence concerned at regular intervals" [Article 9].

### MONITORING PROVISIONS

2.2.15 On the question of monitoring the Regulations [Article 10(1)] require sanitary authorities to monitor or have monitored:

2.2.15.1 discharges from urban waste water treatment plants in accordance with the procedures set out in the Fifth Schedule in order to verify compliance with the requirements of the Regulations [Article 10(1)(a)];

2.2.15.2 waters subject to a discharge from an urban waste water treatment plant where it can be expected that the receiving waters will be significantly affected [Article 10(1)(b)].

The results of this monitoring must be transmitted to the EPA [Article 10(2)].

## 2.3 Implications of the Regulations for Sanitary Authorities

2.3.1 The Regulations are accompanied by a brief explanatory note which is not a formal part of the statutory instrument. As circulated to the sanitary authorities, the Regulations were accompanied by the detailed explanatory circular *[Ref: WP 3/95]* mentioned earlier. The contents of this useful document have been taken into account in the preparation of the following discussion which treats the various provisions in the order in which they appear in the Regulations. However, not all such provisions need or receive comment below.

### CRITERIA FOR COLLECTING SYSTEMS

2.3.2 The criteria for collecting systems referred to in Paragraph 2.2.1 above refer to the design, construction and maintenance of such systems. The requirements which apply to collecting systems are set out in the First Schedule to the Regulations, which specifies that the design, construction and maintenance of collecting systems must be undertaken in accordance with the best technical knowledge not entailing excessive costs, notably regarding the prevention of leaks, and the limitation of pollution of receiving waters due to storm water overflows. The DoE circular adverts to these and advises that "volume and characteristics used for design purposes should be carefully assessed to avoid entailing excessive costs, and have due regard to waste minimization, water conservation, and be based on realistic projections."

2.3.3 The circular refers to the "traditional" minimum setting for storm water overflows [6 times DWF (dry weather flow)] but recommends an alternative method of calculation for such setting. The suggested alternative calculation procedure is described in a paper entitled

"Procedures and Criteria in Relation to Storm Water Overflows", circulated by DoE. It is also pointed out that "only in special cases should [the traditional] minimum setting be exceeded", such cases being supported by economic and environmental analysis.

## REQUIREMENTS FOR THE PROVISION OF TREATMENT PLANTS

2.3.4 The several requirements of the Regulations relating to the provision of treatment plant are clear-cut and require little comment. These requirements are summarised in Table I, and are presented graphically in Figure I below.

*Table I*

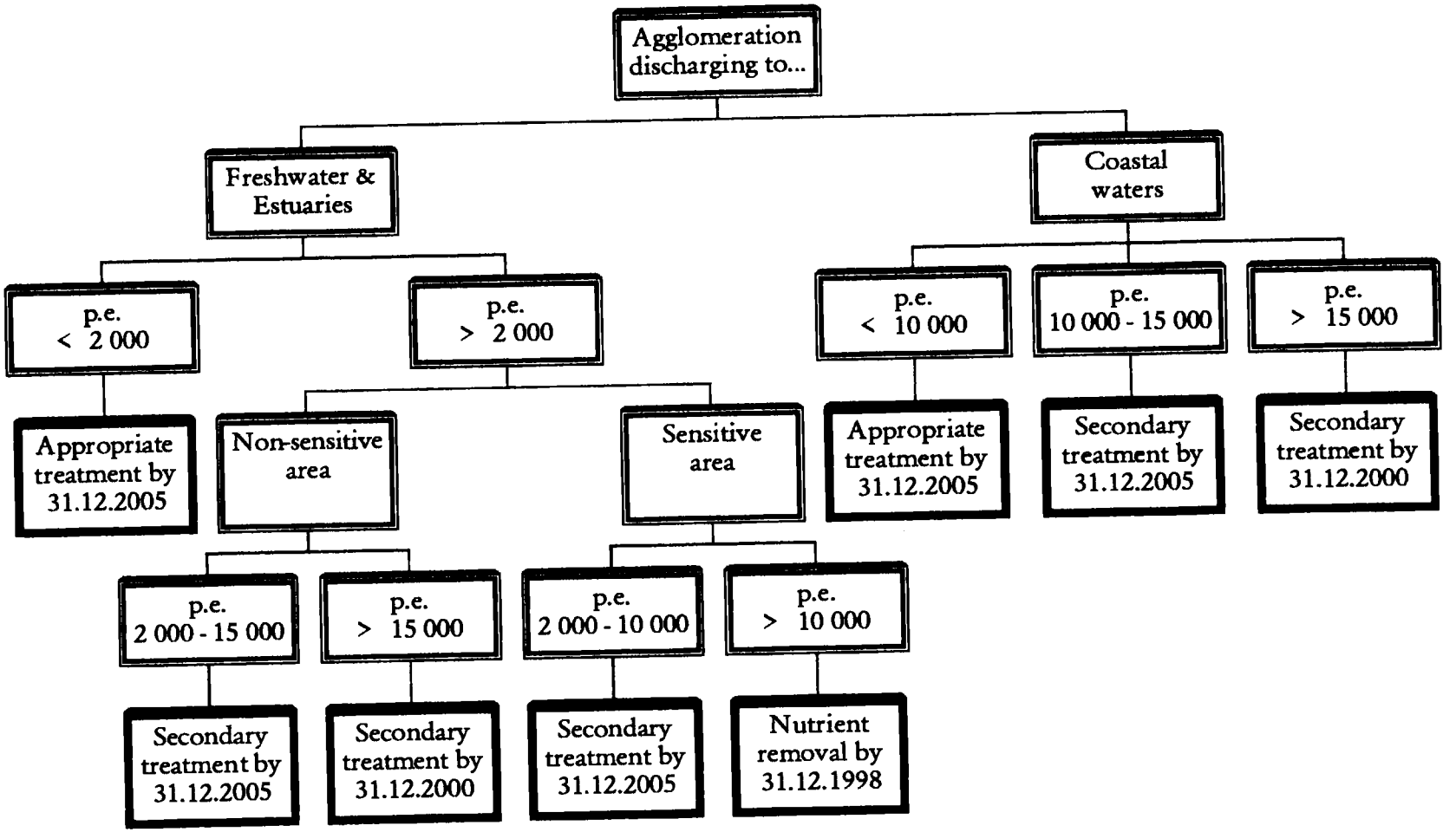
**DATES BY WHICH TREATMENT REQUIRED BY REGULATIONS MUST BE PROVIDED**

| Population Equivalents [p.e.] | Receiving Waters[1] Sensitive Area | Freshwater | Estuary | Coastal |
|---|---|---|---|---|
| | *Provision of Secondary Treatment*[2] | | | |
| > 15,000 | 31 Dec 1998 | 31 Dec 2000 | 31 Dec 2000 | 31 Dec 2000 |
| > 10,000 - 15,000 | 31 Dec 1998 | 31 Dec 2005 | 31 Dec 2005 | 31 Dec 2005 |
| 2,000 - 10,000 | Not applicable | 31 Dec 2005 | 31 Dec 2005 | Not applicable |
| | *Provision of Appropriate Treatment*[3] | | | |
| 2,000 - 10,000 | 31 Dec 2005 | Not applicable | Not applicable | 31 Dec 2005 |
| < 2,000 | 31 Dec 2005 | 31 Dec 2005 | 31 Dec 2005 | 31 Dec 2005 |
| | *Provision of Nutrient Reduction*[4] | | | |
| > 10,000 | 31 Dec 1998 | Not applicable | Not applicable | Not applicable |

*NOTES*

1. Sensitive, freshwater, estuary and coastal, as specified in Third Schedule to the Regulations.

2. The term *secondary treatment* denotes: treatment of urban waste water by a process generally involving biological treatment with a secondary settlement or other process in which the requirements established in Part 1 of the Second Schedule [to the Regulations] are respected.


Agglomeration discharging to...
Freshwater & Estuaries
Coastal waters
p.e. < 2 000
p.e. > 2 000
p.e. < 10 000
p.e. 10 000 - 15 000
p.e. > 15 000
Appropriate treatment by 31.12.2005
Non-sensitive area
Sensitive area
Appropriate treatment by 31.12.2005
Secondary treatment by 31.12.2005
Secondary treatment by 31.12.2000
p.e. 2 000 - 15 000
p.e. > 15 000
p.e. 2 000 - 10 000
p.e. > 10 000
Secondary treatment by 31.12.2005
Secondary treatment by 31.12.2000
Secondary treatment by 31.12.2005
Nutrient removal by 31.12.1998

3. The term *appropriate treatment* means treatment of urban waste water by any process and/or disposal system which after discharge allows the receiving waters to meet the relevant quality objectives and the relevant provisions of the [Urban Waste Water Treatment] Directive and of other Community Directives.

4. The Regulations [Article 4(2)] refer to the provision of "more stringent treatment than secondary treatment or an equivalent treatment in respect of all discharges from agglomerations with a population equivalent of more than 10,000 into sensitive areas or into the relevant catchment areas of sensitive areas where the discharges contribute to the pollution of these areas."

2.3.5 The main points of note are that **secondary treatment is the basic requirement for urban waste water discharges above the minimum thresholds identified in Paragraph 2.2.3,** and that the only exception to the prescribed deadlines which is permitted applies to cases where requests for a time extension are made under Article 8 of the Directive. Such requests may only be made "in exceptional cases where technical problems arise and for geographically defined population groups." The circular notes that "because an extension cannot run beyond end-December 2005, this provision is only relevant to the 2000 deadline, which otherwise applies to agglomerations in excess of 15,000 p.e.

2.3.6 It is important to note that, while the Second Schedule of the Regulations (which sets out the treatment plant performance requirements for compliance; cf Paragraph 2.2.4 above) gives the option of using either concentration values for the respective parameters or, alternatively, the percentage reduction in loading for these parameters, *the Department of the Environment strongly commends the use of the former approach, as does the Agency.*

2.3.7 As outlined in Paragraph 2.2.10 above, while secondary treatment is not prescribed for discharges from agglomerations of less than 2,000 p.e. to fresh waters and estuaries, and for discharges to coastal waters from agglomerations of p.e. less than 10,000, there is nonetheless an obligation to provide "appropriate treatment" in respect of such discharges by the end of December 2005 [Article 7]. Such treatment, as the DoE circular notes, "will vary from simple physical processes to physical/biological or physical/chemical processes with varying performance standards depending on the quality objectives of the receiving waters." The question of "appropriate treatment" is being addressed by the EPA in the manuals referred to in Paragraph 2.2.13.

2.3.8 The treatment methods used in Ireland include biological processes such as conventional aeration, extended aeration, biological filtration, rotating biological contactors, and comparable systems. For agglomerations less than 2,000 p.e. physical/biological processes which are reliable and robust are generally used. Guidance on small-scale treatment systems will be issued by the Agency, probably in 1997, on completion of a research project commenced in August 1995. Criteria and procedures for secondary treatment will be prepared by the Agency in 1996 and will provide additional guidance.

## SENSITIVE AREAS

2.3.9 The identification of sensitive areas is carried out in accordance with criteria set out in Annex II of the Urban Waste Water Treatment Directive. In such areas, or in their catchments, where there are discharges from agglomerations of 10,000 p.e. or more, treatment which is more stringent than secondary treatment must be provided by the end of December

1998. Besides the quality limits/percentage reductions relating to BOD, COD and SS, mentioned in Paragraph 2.3.6, the Regulations specify similar constraints on the discharge of nutrients [phosphorus/nitrogen]. Elevated levels of these nutrients can lead to or accelerate the eutrophication [over-enrichment] of receiving waters, as noted below. The list of currently designated sensitive areas is set out in Table II.

*Table II*

**SENSITIVE AREAS**

*Their Extent and the Associated Towns as shown in Regulations*

| Receiving Water | Extent of Sensitive Area | Associated Towns |
|---|---|---|
| ***River Boyne*** County Meath | 6.5 km section downstream of sewage treatment works outfall at Blackcastle, Navan, County Meath. | Navan |
| ***River Camlin*** County Longford | From sewage treatment works at Longford to entry into the River Shannon. | Longford |
| ***River Castlebar*** County Mayo | Downstream of sewage treatment works outfall at Knockthomas to entry into Lough Cullin. | Castlebar |
| ***River Liffey*** County Kildare | Downstream of Osberstown sewage treatment works to Leixlip reservoir, County Kildare. | Osberstown [sic] |
| ***River Nenagh*** County Tipperary | Downstream of sewage treatment works outfall in Nenagh to entry into Lough Derg. | Nenagh |
| ***River Tullamore*** County Offaly | 0.5 km section downstream of sewage treatment works outfall in Tullamore. | Tullamore |
| ***Lough Derg*** on the River Shannon | Whole lake | Athlone, Nenagh and Tullamore |
| ***Lough Leane*** County Kerry | Whole lake | Killarney |
| ***Lough Oughter*** County Cavan | Whole lake | Cavan |
| ***Lough Ree*** on the River Shannon | Whole lake | Longford |

2.3.10 However, the Regulations provide [cf Paragraph 2.2.7 above] for the non-application, in respect of individual treatment plants, of the treatment requirements associated with a sensitive area where a sanitary authority is satisfied that the minimum percentage of reduction of the overall load entering all urban waste water treatment plants in a sensitive area is at least 75% for the limiting nutrient [i.e. phosphorus or nitrogen] [Article 4(4)]. The DoE circular considers this as "unlikely to be relevant in an Irish context" and notes that, in 9 of the 10 areas so far identified as sensitive under the Regulations, there is only a single agglomeration of 10,000 p.e. or more in each case, as set out in Table II.

2.3.11 Paragraph 2.2.6 refers to the possibility that, according to the Regulations, more stringent treatment requirements than those prescribed in the Second Schedule [Parts I & II] may be required to ensure that the receiving waters satisfy any other relevant Community Directives. Directives of immediate relevance are the following:

| | | |
|---|---|---|
| i | Freshwater Fish Directive | [78/659/EEC] - standards in S.I. 293 of 1988, |
| ii | Shellfish Directive | [79/923/EEC] - standards in S.I. 200 of 1994, |
| iii | Bathing Water Directive | [76/160/EEC] - standards in S.I. 155 of 1992, |
| iv | Surface Water Directive | [75/440/EEC] - standards in S.I. 294 of 1989. |

Attention is called to the need for compliance with these as well as the objectives of Water Quality Management plans encompassing the sensitive areas.

## MONITORING REQUIREMENTS

2.3.12 In regard to monitoring the circular makes the point that the requirements must be applied to "both new plant and existing treatment plants" which fall within the scope of the Regulations (i.e. as regards the p.e. thresholds), and adds that "monitoring below these thresholds will be dictated by local circumstances, e.g. quality of receiving waters, nature of effluent." As noted in Paragraph 2.2.10.2 above, ambient monitoring of waters subject to a discharge is required by the Regulations "where it can be expected that the receiving waters will be significantly affected" [Article 10(1)(b)].

2.3.13 It is a requirement that treatment plants shall be designed (or modified) so that sampling of influents and effluents is practicable. It is remarked in the DoE circular that "given that concentration values will normally be adopted as opposed to percentage reduction values, sanitary authorities should use their own discretion on the need for, and level of, monitoring to be applied to incoming waste waters." This question is addressed further in Section 2.4 below.

2.3.14 Turning to industrial waste waters, the Regulations [cf Paragraph 2.2.9 above, and Appendix A below] require that "industrial waste water entering collecting systems and urban waste water treatment plants shall be subject to such pretreatment as is required" in order to ensure, *inter alia*, (i) the efficient and safe operation of collecting systems and treatment plants and (ii) the environmentally sensitive disposal of treated effluent and sludge. Sanitary authorities are enjoined to ensure that the aims of such pretreatment are fulfilled. It is the intent that this should be achieved by use of the licensing procedures [under the Water Pollution Acts, 1977 and 1990, and, under the EPA Act, for Integrated Pollution Control Licensing] for discharges of industrial waste waters, appropriate conditions being imposed on the discharger by the licence granted.

## 2.4 Practical Aspects of Implementation of the Regulations

### MONITORING IMPLICATIONS

2.4.1 While it is clear that the major implications of implementing the Regulations will lie in the area of the provision of new, or the extension or modification of existing, treatment plants, this topic is not considered appropriate for discussion in the present context. The issues involved will be largely financial and they are likely to have considerable policy implications as well. They are therefore matters for resolution by the Department of the Environment.

2.4.2 Instead, it is the intention of this Section to consider the environmental protection implications of the various requirements imposed on sanitary authorities by the Regulations, in keeping with the interpretations contained in the DoE circular. It is important to note at the outset that, in the following discussion *it is assumed that sanitary authorities will, in line with the DoE recommendation, adopt the concentration limit rather than the percentage reduction approach for the relevant parameters.* As is implicit in the circular, this is clearly the more straightforward approach, a view shared by the Agency.

2.4.3 At first glance, the requirements of the Regulations do not appear to be unduly onerous [possible treatment plant needs excepted]. Some sanitary authorities are likely to be carrying out a significant part of the required activities already. Accordingly, a degree of refocussing of emphasis or slight extension of effort will probably suffice for such authorities in order to meet the needs of the Regulations. For the remaining authorities, however, it will be necessary to develop and expand existing monitoring programmes.

### POPULATION EQUIVALENTS

2.4.4 A most important aspect of the Regulations is their reliance on the *population equivalent* as the unit of waste loading. This is defined in the Regulations [Article 2] as:

> a measure of organic biodegradable load and a population equivalent of 1 [1 p.e.] means the organic biodegradable load having a five-day biochemical oxygen demand [$BOD_5$] of 60g of oxygen per day - the load [being] calculated on the basis of the maximum average weekly load entering the treatment plant during the year, excluding unusual situations such as those due to heavy rain.

It is necessary for sanitary authorities to exercise care in the use of this unit to categorize discharges in p.e. terms.

### UNUSUAL OR ABNORMAL SITUATIONS

2.4.5 It should be noted here that the term "unusual situations" in the p.e. definition just quoted may reasonably be applied by sanitary authorities to such circumstances as arise because of industrial disputes, accidental spillages, mechanical breakdown, power failure, heavy rain or other unusual weather conditions, stoppages for essential maintenance, and the

like. However, where such situations arise and have a consequent influence on the computation of p.e. figures, the circumstances pertaining should be recorded in detail.

## CALCULATION OF AGGLOMERATION LOADS

2.4.6 In principle, where an authority could be certain that a given discharge from a given collecting system, serving a given population, consisted of domestic waste water without admixture of any other type of waste water, the agglomeration load would simply be the product of 1 p.e. unit and the total population served. In such cases the only monitoring necessary at the treatment plant would be of the final effluent. However, this situation rarely obtains and experience has shown that the agglomeration load for a town, which has normal commercial activities, but is without extensive industry, may be significantly higher in p.e. terms than the resident population figure.

2.4.7 Indeed, it is quite often the case that the true agglomeration load will, expressed as p.e., markedly exceed the resident population figure. (This may be due to such factors as the washing of biodegradable materials deposited on road surfaces into the collecting system during normal rainfall conditions.) The p.e. should be calculated from the results of sampling and from flow measurements for individual schemes.

2.4.8 The picture is much more complicated where waste waters other than domestic enter the treatment plant. Depending on the strength of the non-domestic waste waters the overall agglomeration concentration reaching the treatment plant may be higher or lower than if domestic wastes only were involved. If, for example, a non-domestic waste water comprises mainly cooling or slightly contaminated wash water there will be an overall dilution of the domestic waste (although the volume will, of course, be increased as well as, to some degree, the total loading). In contrast, where the former is of a higher organic strength than the latter the average organic concentration of the waste water entering the plant will be increased much more markedly. A waste water characterization survey should be completed to establish the p.e. of such plants.

2.4.9 The point to note is that, if p.e. units are to be applied meaningfully, sanitary authorities must be aware, firstly, of the proportion of non-domestic waste waters entering the collecting system and, secondly (and more importantly), be fully informed as to the volume and organic concentration of such wastes. The exercise of their statutory functions by the sanitary authorities, primarily in regard to the licensing of discharges, will in most cases result in adequate knowledge on the part of the authorities of the nature, volume and strength of waste waters entering their collecting systems.

2.4.10 Nonetheless, it is conceivable (although probably unlikely) that an unlicensed, previously unknown waste water, of strength markedly above that of domestic waste water, could reach a collecting system without the knowledge of a sanitary authority. This could have two possible implications. Firstly, it could result in an overload on the treatment plant, resulting in an imbalance leading to a deterioration of effluent quality, and, secondly, it could necessitate the overall agglomeration discharge being reclassified in a higher load group, with possible requirements for the provision of additional treatment capacity.

2.4.11 Should a sanitary authority find itself in such a situation it must take prompt investigatory action. A survey of all non-domestic waste waters should be undertaken in order

to verify that each such waste water is documented and licensed as appropriate. This action may involve the determination through monitoring of both the strength and the volume of such waste water(s) and the calculation of the load in terms of p.e. which enters the collecting system and ultimately the treatment plant. In addition, monitoring (discussed below) should be carried out of the influent to the treatment plant, in order to ascertain the true loading on the plant in terms of p.e.

## TREATMENT PLANT PERFORMANCE

2.4.12 Once the load of the discharge from an agglomeration has been determined and verified, it follows that, in normal conditions, the principal variation affecting effluent quality will be the performance of the treatment plant. It should be remembered, however, that seasonal variations, reflecting the influences of climate and of tourist numbers, for example, may also be significant. Factors such as the latter will be reflected directly in the composition of the plant influent which, accordingly, will vary greatly in strength over time.

2.4.13 While it is difficult to deduce meaningful relationships between the analytical data for influent samples, taken at given times, and for effluent samples taken concurrently (because of plant operational factors such as retention time and the like), the EPA is of the firm view that monitoring of plant performance should, if at all practicable, incorporate sampling and analysis of the influent as well as the effluent, in addition to the receiving water, as discussed later.

2.4.14 Detailed information on the influent can be of value to the plant operator, especially if problems arise, and, in any event, it is a vital part of the plant "fingerprint." It must be remembered that plant performance is dependent to a great extent on the characteristics of the influent, the monitoring of which - especially if carried out automatically on an on-going basis - may be the only way in which changes in influent composition may be discerned before operational problems arise.

2.4.15 Sampling at the plant must include the effluent, in order to determine both the performance of the plant and the constancy of the organic load discharged to the receiving waters. Further, as has been indicated above, where such waters may be expected to be affected by the discharge, the sanitary authority is required to monitor them as well.

2.4.16 In fact, for some authorities and bodies engaged in monitoring of effluent discharges, it has virtually become standard practice for samples of the receiving water above and below the discharge point, *clear of the mixing zone*, to be taken in conjunction with samples of the effluent (and, where appropriate, the influent). *It is strongly recommended that this practice be maintained, or if appropriate adopted, even if there is no reason to expect deterioration of the receiving water, as minimal additional effort is required.*

## MIXING ZONES

2.4.17 The concept of a "mixing zone" is one which has caused much debate among those concerned with the aquatic environment, and it is one which merits discussion in the present context. The mixing zone may be defined as:

> that volumetric part of the receiving water channel in which an inflowing waste stream is mixed with the receiving water, the necessary agitation normally being provided by the flow of the latter. By definition, the concentrations of the constituents of the influent added to the receiving water are not constant in the mixing zone, the limit of which is defined as the down-stream point nearest to the inflow at which concentrations of all parameters are uniform throughout a transect of the receiving water.

The importance of defining a mixing zone arises because quality standards for the receiving water apply "at the boundary of the mixing zone."

2.4.18 There is a body of opinion which rejects the concept of a mixing zone, but, while it is certainly the case that misapplication of the concept is possible, logic dictates that, where two non-identical liquid streams (no matter how similar they may be) meet, there *must* be a reach down-stream in which the concentrations of parameters in both streams equilibrate in order to reach levels which are constant. *The key to valid application of the concept lies in the minimization of the extent of the reach in which mixing occurs.*

2.4.19 Unfortunately, few, if any, mixing zones are identical. Factors which influence their magnitude (either in length or volume terms) include the relative volumes of inflowing and receiving streams, the physical contours of the receiving water channel, the flow velocity of both streams, the angle relative to the receiving water flow at which the influent stream enters, and the like. A major influence on the characteristics of a mixing zone is the placement of the waste outfall point, i.e. whether it is located in mid-stream or at one or other side of the receiving water channel.

2.4.20 While this picture of a fast-flowing, well-mixed river channel swirling past a discharge point is representative of very many cases, it must be borne in mind that there are most important exceptions. For example, the receiving water may be a broad, slow-flowing river, the flow in which is vast relative to that of the inflowing discharge. In this latter instance, the means of influent discharge is critical. The highest degree of mixing will be obtained if the waste water is discharged across the bed of the river, at an optimum velocity. In contrast, if the discharge is merely allowed to trickle from a single outlet on one bank, at an acute angle relative to the flow, it is very likely that the influent liquid will simply stream unmixed along the bank, perhaps for miles, as has been established in some cases. Clearly, in the latter instances the basic notion of a mixing zone is simply not applicable.

2.4.21 Again, the waste discharge may be to an estuarine reach of a river system, where a major factor influencing mixing is tidal movement of receiving water up- and down-stream past the discharge point. There is no simple approach to such a situation and mathematical modelling of tidal movements is used to simulate the position, and ascertain optimum discharge conditions, prior to the authorisation of any discharge.

2.4.22 Lakes may also be receptors of influent flows, which is generally undesirable, as they represent a special case where particular care must be taken to ensure that complete mixing occurs. This applies to open lakes (the main water body) with unindented shorelines, but it is even more important in lakes where discharges may be to bay areas in which there is minimal water movement. If special care is not taken, such areas of virtually stagnant water will become increasingly polluted.

2.4.23 It is essential in a mixing zone that the non-steady state conditions should apply only over a short reach, and for as short a time as possible. The permissible time for mixing

should be well below that necessary for transient concentrations of undesirable parameters to exert any harmful effects on the receiving environment (including its fauna and flora). Thus the deoxygenating effect of an organic load, for example, should not be exerted until complete mixing has occurred, in which case the residual effect of the fully mixed organic material (provided that the discharge criteria for such loads reaching a receiving water have been observed) should be within the tolerance of the receiving water.

2.4.24 Likewise, the mixing zone conditions should be such that, even if the applicable standards for the receiving water at the boundary of the zone are met, there are no undesirable environmental consequences occurring within and in the immediate down-stream vicinity of the zone. Examples of such unacceptable consequences of a discharge include injury to or mortality of flora and/or fauna, and the promotion of slime growths (so-called "sewage fungus"). Where there are significant slime growths, for example, the "affected zone" may be far more extensive than the mixing zone.

2.4.25 In very many cases of waste water discharges to inland receiving waters in Ireland it is the organic load which will exert the main effects on the environment. Certainly, this is true of the majority of effluents from urban waste water treatment plants. In other words, it is the exertion of the BOD of the mixed discharged matter which will have the principal environmental effect, if any. However, although the very opposite of a conservative parameter, BOD does not have an instantaneous exertion effect, and the first manifestations of effects (either as reduction of the residual BOD or of the dissolved oxygen in the mixed stream) will occur at a distance below the discharge point. In particular cases the effects may not be apparent for some time, perhaps hours, after discharge or for some considerable distance, possibly several kilometers, down-stream of the edge of the mixing zone.

2.4.26 An important consideration in Irish receiving waters is eutrophication (or over-enrichment) which is caused by excessive levels of nutrients. The primary nutrients are phosphorus and nitrogen (as phosphates and nitrate, respectively). The former is the main eutrophication agent in fresh waters while the latter is the key factor leading to eutrophication of estuarine and coastal waters.

2.4.27 The problem of eutrophication is likely to be most acute in lakes, where algal growths and "blooms" can be a major problem, but in rivers there is a growing problem of excessive plant growth, attributed to the presence of excess levels of phosphates. It should be noted that sewage effluents (treated or not) are rich in phosphorus. Care must accordingly be taken that there are no excessive amounts of nutrients in mixing zones, although it should be noted that down-stream effects should be avoidable by adherence to the applicable standards at the boundary of the zones.

2.4.28 It follows from the above discussion that, strictly, the extent and limits of each mixing zone should be established individually. This may be carried out by sampling and measurement for a relevant constituent or indicator parameter ("tracer") at grids of points across and down through the receiving water channel, at close intervals along the latter. The measurement is continued until steady state concentrations are established. The picture obtained will be definitive - but only under the flow conditions (of both influent and receiving streams) applying at the time of measurement. Under different conditions a new determination of the extent of the mixing zone will be necessary. The most critical time is when receiving water flows (or volumes) are low.

2.4.29 In practice, an empirical approach is taken when sampling receiving waters. This is to a great extent based on the apparent flow, and especially the turbulence, of the receiving water, and is quite valid for very many, perhaps the majority, of discharges to Irish rivers and streams which, under normal conditions, are shallow, turbulent and fast flowing, and often are relatively narrow.

2.4.30 The rigorous approach mentioned in paragraph 2.4.28 may be justified (and, indeed, essential) in the cases of major discharges to receiving waters of magnitude. However, as mentioned, in the many cases where there is very rapid mixing and where the need for diffusers or other means of dispersed disposal is clearly not necessary, the empirical approach referred to will consist of the taking of samples from the receptor channel at, say, 100, 150 and 250 metres down-stream of the discharge point. Experience is likely to show that a single down-stream sample taken 150 or 250 metres below the discharge will meet requirements adequately. However, if any doubt arises, samples should be taken at all three distances down-stream (and at intervals across the stream) and submitted to the laboratory for an initial check determination prior to the normal analysis. This point is discussed further in Paragraph 2.4.50 below.

2.4.31 *Should this empirical approach indicate that complete mixing has not occurred at a transect 250 metres from the discharge point consideration must be given to the question of increasing mixing by modification of the discharge outfall in order to reduce the extent of the zone.* This necessity arises because it is likely that a mixing zone of greater length than 250 metres will result in unacceptable environmental conditions arising within the zone.

## SPECIFIC SAMPLING REQUIREMENTS

2.4.32 The Regulations [Second and Fifth Schedules] contain specific requirements in regard to sampling and analysis. Not just the frequency of sampling is specified but also the type required. Specifically, "flow-proportional or time-based 24-hour samples shall be collected at the same well-defined point in the outlet and if necessary in the inlet of the treatment plant, in order to monitor compliance with the requirements for discharged waste water specified in these Regulations" [Fifth Schedule, Paragraph 2].

2.4.33 The use of some form of automatic sampler is therefore essential. Although the employment of such equipment in the environment at large (e.g. on river banks or other unprotected sites) can be problematical (with considerations of security of both equipment and samples, reliability of power supply, housing etc featuring prominently) this should not be the case within a sanitary authority treatment plant.

## AUTOMATIC SAMPLERS

2.4.34 There are various types of automatic sampling equipment which can be used. However, they fall into two groups - those which are time-based or those which are flow-proportional - and within these groups are further divisions between those which are portable and those which are fixed, and between those which take a simple sample and those which take sample aliquots. The present is not the context for a full discussion of the various

sampler types, and attention is concentrated on the types considered optimal for sanitary authorities under the Regulations.

2.4.35 A time-based sampler is one which will sample from a liquid stream at a fixed interval (say, hourly) for a pre-determined length of time (one or more minutes, usually, depending on circumstances). Depending on its sophistication, it will either store the sample aliquots as a composite or as single portions, and it may be portable. However, except where samples are being taken from a stream of constant flow - as for instance within an industrial process - time-based samples are not very representative of true conditions. Certainly, they are not well suited to highly flow-variable urban waste water streams, influent or effluent.

2.4.36 In contrast, flow-proportional samplers will sample liquid streams at intervals, the extent of such sampling periods being proportional to the flows at the respective intervals. Again, samples may be retained as discrete portions or as a single composite. However, the composition of the latter will reflect quite accurately the overall influent to or discharge from the treatment plant over the sampling period. *Accordingly, flow-proportional samplers are strongly recommended for the implementation of the Regulations.* Where flow-proportional sampling is carried out, flow measurement is required and hence this recommendation applies specifically to those plants where flow measurement facilities are already in place. The topic of samplers is discussed further below.

## MAINTAINING THE INTEGRITY OF SAMPLES

2.4.37 Perhaps the main point of practical difficulty for sanitary authorities will be in connection with the requirement in the Regulations [Fifth Schedule, Paragraph 2] that:

> *good international laboratory practices aiming at minimizing the degradation of samples between collection and analysis shall be applied.*

The main factor influencing the integrity [i.e. its stability of composition] of a sample after it has been taken is temperature, which if even slightly elevated above ambient, can favour microbiological activity which induces changes in the composition of the sample. Assuming that flow-proportional samplers, are used, operating at hourly intervals, the periods for which the sample portions will stand after collection (whether composited or not), prior to transport to the laboratory, will vary from 0 to 23 hours.

2.4.38 Ideally, each hourly sample portion (whether of influent or effluent) should be stored immediately it is taken, *under refrigeration*, until the 24-hour composite is completed. Every effort should be made to achieve this, and suitable automatic samplers with built-in refrigeration are available on the market. There are some disadvantages associated with such equipment, one of which is the considerable added expense of refrigerated over non-refrigerated units. Another is that such units are fixed rather than portable, and that two such units must be employed where influent and effluent sampling is required.

2.4.39 It would be unreasonable to expect sanitary authorities to retrospectively equip all their treatment plants with two refrigerated flow-proportional samplers, especially in the case of smaller works where less frequent sampling is required. However, *in the case of large urban waste water treatment facilities, serving agglomerations >15,000 p.e. (and this category will undoubtedly include all future plants], it is recommended that such dual equipment capacity*

*should be provided,* on two grounds. Firstly, the costs of providing, installing and commissioning flow-proportional samplers will be quite insignificant in the context of the overall financing of such large treatment plants, and, secondly and more importantly, the larger the plant the greater is the need for accurate compositional information on influent and effluent streams, as an adjunct to optimum operation.

2.4.40 *For all other plants it is recommended that a single, portable flow-proportional automatic sampler be obtained for use alternately on the influent and effluent streams,* for suitable periods, in order to ensure either that the sampling requirements of the Regulations are met (where the plant size is such that the Regulations apply), or to provide sanitary authorities with invaluable information for the efficient operation of their plants. Where plant sizes and locations are suitable the sanitary authorities concerned could use a single portable sampler on more than one plant in its area, provided that the equipment was always transported with the necessary care. For maximum convenience, the samplers used should be of the type which take a single composite sample over the whole sampling cycle, thereby eliminating the need for manual compositing. This approach would give the authorities a high degree of flexibility at minimal cost.

2.4.41 Such portable equipment would not have a sample refrigeration facility but it is considered that an acceptable compromise procedure would be as follows. In order to minimise the effects of elevated temperature on sample fractions taken during daylight hours, the sampling equipment should be protected from sunlight. The starting point of the 24-hour sampling cycle should also be fixed so as to respect the integrity of the samples. Thus, the day from 00.01 to 24.00 hours should be avoided. It would be much more practical for the individual hourly samples to be taken from 10.00 to 09.00 hours, the following day. Then just after 09.00 the 24-hour single composite sample would be transported straightaway (in a cooler box) to the laboratory *for immediate analysis,* as previously agreed with the laboratory.

2.4.42 Much has been written about the absolute need in some cases (e.g. in the case of samples for very high-sensitivity analysis of metals in, say, drinking water) for the preservation of samples by the use of specific additives, and, indeed, without such precautionary measures samples may deteriorate so much in the interval between sampling and reaching the laboratory that the results of analysis may well be meaningless. Previous Handbooks (dealing with the implementation of the Drinking Water and Surface Water Regulations) have covered in detail the topic of sample preservation.

2.4.43 It is important to remember always that preservatives are very specific in their use - both with respect to the parameters which are to be determined, and as regards the nature of the samples being taken. The present discussion in no way contradicts the requirements detailed in the Drinking Water and Surface Water Handbooks, as it applies to samples of a vastly different nature. In the case of surface and drinking waters, there are many individual parameters for which concentration limits (often very strict) have been set by Regulation.

2.4.44 In contrast, in the case of urban waste water treatment plant influents and effluents, the analyses are for comparatively very large concentrations of determinands which are termed "bulk parameters." This designation is applied as in virtually all cases the analysis, whether for BOD or COD or SS, is for a determinand which will consist of a host of individual sub-determinands which are not analysed for individually. In the case of BOD, for example, no attempt is ever made routinely to ascertain what are the (perhaps innumerable) individual compounts which comprise the BOD of a sample.

2.4.45 The higher is the concentration of the constituents in a sample, the less likely is its composition to vary within a reasonable short period. This is illustrated by the fact that, in an analytical laboratory, the working solutions of reagents (which are generally very dilute) are so unstable that they must be prepared immediately before use, from so-called "stock solutions". The latter are identical in all respects with the working solutions save concentration. Normally, they are up to 1,000 times more concentrated than the former and they are quite stable if stored correctly.

2.4.46 Taking all the factors discussed into account, it is therefore reasonable that, where circumstances such as a modest sampling frequency, small size of plant, financial, practical or technical factors, and the like dictate, sanitary authorities should use portable, single (composite) sample, flow-proportional automatic samplers which do not have a built in refrigeration capability, provided that the procedural recommendations made above are followed.

## INFLUENT AND RECEIVING WATER SAMPLING

2.4.47 It is the position that, unless the percentage reduction approach (as an indicator of treatment plant performance) is being followed, there is no *formal* requirement for samples to be taken systematically from the influent channel. However, *regular sampling of the influent to treatment plant should be regarded by sanitary authorities as a key element of their plant monitoring.* It is good practice and is of great value in waste water characterization and plant management. As discussed earlier, in the case of large plants [>15,000 p.e.] the best approach is to use the automatic samplers concurrently on both influent and effluent channels.

2.4.48 For smaller plants [<15,000 p.e. downwards], alternate sampling of the influent and effluent at seasonal intervals, would be the most practical approach, again using the portable sampler type recommended above.

2.4.49 The composite waste water sample(s) should be accompanied to the laboratory by the samples, usually two in number, of the receiving water above and below the discharge, the latter outside the boundary of the mixing zone, as discussed earlier. The samples from the receiving water will be simple grab samples. *These should be taken immediately prior to transport to the laboratory, and not earlier, as no preservation will be used.*

2.4.50 Where doubts have arisen in regard to the lineal extent of the mixing zone (as mentioned above), and additional samples of the receiving water down-stream have been taken, the laboratory could be requested to make a simple initial check determination on the samples. Measurement of the conductivity (which may be performed very rapidly) on all receiving water samples will show when steady-state conditions have been attained down-stream.

2.4.51 Following determination of the extent of the mixing zone, future analysis should be carried out on the down-stream sample which shows the steady-state conductivity value and which was taken nearest to the discharge point. This approach may also indicate at times that the extent of the mixing zone is rather greater than had been anticipated.

## MONITORING REQUIREMENTS

2.4.52 The Fifth Schedule to the Regulations prescribes a minimum frequency of sampling, at regular intervals, as set out in Table III. The level of sampling is not unduly onerous and sanitary authorities are recommended to consider carrying out additional sampling if at all practicable.

*Table III*

### ANNUAL SAMPLING REQUIREMENTS

*[By agglomeration size]*

| Agglomeration | Annual Sampling Requirement |
|---|---|
| 2,000 to 9,999 p.e. | 12 samples during the first year. Four samples in subsequent years if it can be shown that the water during the first year complies with the provisions of these Regulations; if one sample of the four fails, 12 samples must be taken in the year that follows. |
| 10,000 to 49,999 p.e. | 12 samples |
| 50,000 p.e. or over | 24 samples. |

2.4.53 Notwithstanding the formal provisions of the Regulations which, it will be recalled, set out *minimum* sampling and analysis requirements, it is recommended that, if at all possible, *all* sanitary authority waste water treatment plants should be monitored regularly, *without there being a minimum p.e. cut-off point.* The rationale underlying this is that, if an area has a discharged waste water load sufficient to warrant the provision of a treatment plant, and of a collecting system, both of which imply that a minimum threshold in regard to technical and economic criteria has been exceeded, it follows that such a plant will be of sufficient (even if undefined) capacity to warrant monitoring.

2.4.54 However, as the requirement to provide appropriate treatment for urban waste water discharges to fresh waters and estuarine waters from agglomerations of less than 2,000 p.e. (and less than 10,000 p.e. to coastal waters), has a deadline for implementation as late as the end of the year 2005, it is recognised that the inclusion of smaller plants is not a matter of immediate urgency and it is suggested that the monitoring of these smaller plants could be carried out on a phased basis, commencing in 1997 with discharges from agglomerations between 1,000 and 2,000 p.e., extending to agglomerations between 500 and 1,000 p.e. in 1998, and thence to agglomerations less than 500 p.e. in 1999.

2.4.55 The following tables give an overall summary of the analytical recommendations by the Agency for discharges to both sensitive and non-sensitive areas, the latter being sub-divided into riverine and lake discharges.

*Table IV*

## RECOMMENDED ANALYSES: NON-SENSITIVE AREAS

| Parameter | Influent | Effluent | RWUS | RWDS | Note(s) |
|---|---|---|---|---|---|
| $BOD_5$ @ 20°C* | Yes | Yes | Yes | Yes | - |
| COD | Yes | Yes | No | [Yes] | a |
| Total S Solids [105°C] | [No] | Yes | Yes | [Yes] | b, c |

***ABBREVIATIONS***

*RWUS* *Receiving water above [US] discharge point,*
*RWDS* *Receiving water below [DS] discharge point, clear of the mixing zone.*

***KEY***

* *With inhibition of nitrification during analysis*
*[ ]* *Denotes a qualified "Yes" or "No".*

***NOTES***

a *The COD test is not suited to very clean waters and is not usually carried out on such samples. However, a provision is made in the table for the carrying out of the test on down-stream receiving waters visibly affected by discharge(s).*
b *In view of the often unpleasant nature of influent samples it is considered that suspended solids measurement need not be mandatory on such samples.*
c *The measurement of suspended solids in waters of apparent clarity is of little practical value, and it is proposed that their determination be confined to those down-stream samples of receiving water on which it is considered the COD should be determined (see a above).*

*Table V*

## RECOMMENDED ANALYSES: SENSITIVE AREAS - RIVERS

| Parameter | Influent | Effluent | RWUS | RWDS | Note(s) |
|---|---|---|---|---|---|
| $BOD_5$ @ 20°C* | Yes | Yes | Yes | Yes | - |
| COD | Yes | Yes | No | [Yes] | a |
| Total S Solids [105°C] | [No] | Yes | Yes | [Yes] | b, c |
| Total Phosphorus | Yes | Yes | Yes | Yes | d |
| Tot Oxidised Nitrogen | No | Yes | Yes | Yes | d, e |
| Tot Kjeldahl Nitrogen | Yes | Yes | No | No | d, e |
| Ammonia | No | No | Yes | Yes | e |

***ABBREVIATIONS***

*RWUS* *Receiving water above [US] discharge point,*
*RWDS* *Receiving water below [DS] discharge point, clear of the mixing zone.*

***KEY***

* *With inhibition of nitrification during analysis*
[ ] *Denotes a qualified "Yes" or "No".*

***NOTES***

a *The COD test is not suited to very clean waters and is not usually carried out on such samples. However, a provision is made in the table for the carrying out of the test on down-stream receiving waters visibly affected by discharge(s).*
b *In view of the often unpleasant nature of influent samples it is considered that suspended solids measurement need not be mandatory on such samples.*
c *The measurement of suspended solids in waters of apparent clarity is of little practical value, and it is proposed that their determination be confined to those down-stream samples of receiving water on which it is considered the COD should be determined (see a above).*
d. *The measurement of nutrients is essential in sensitive areas. Although phosphorus is the key element concerning the eutrophication of fresh waters, nitrogen is very often determined routinely on such waters, hence its recommended inclusion in programmes.*
e. *Total Oxidised Nitrogen comprises nitrate and nitrite. The Total Kjeldahl Nitrogen [TKN] determination includes the measurement of ammonia. The measurement of TKN is not particularly suited to unpolluted (or mildly polluted) receiving waters and, accordingly, it is considered that the determination of ammonia instead of TKN on such waters is more practicable.*

*Table VI*

## RECOMMENDED ANALYSES: SENSITIVE AREAS - LAKES

| Parameter | Influent | Effluent | LWGA | LWLB | Note(s) |
|---|---|---|---|---|---|
| $BOD_5$ @ 20°C* | Yes | Yes | No | No | a |
| COD | Yes | Yes | No | No | b |
| Total S Solids [105°C] | [No] | Yes | No | No | c |
| Total Phosphorus | Yes | Yes | Yes | Yes | d |
| Tot Oxidised Nitrogen | Yes | Yes | Yes | Yes | d |
| Tot Kjeldahl Nitrogen | Yes | Yes | Yes | Yes | d |

***ABBREVIATIONS***

*LWGA* *Lake water in the general area of the discharge*
*LWLB* *Lake water in the general body of the lake, in representative area(s) away from immediate influence of discharge.*

***KEY***

* *With inhibition of nitrification during analysis*
[ ] *Denotes a qualified "Yes" or "No".*

***NOTES***

a *The BOD test is not a routine determination on lake waters.*
b *The COD test is rarely if ever carried out on lake water samples.*
c *The test for Suspended Solids would be relevant only in cases of significant algal presence, for which the determination of chlorophyll is a more meaningful routine test.*
d *These are the key tests on lake waters.*

## CONFORMING WITH THE QUALITY STANDARDS

2.4.56 The Fifth Schedule also sets out the following important points:

The treated waste water shall be assumed to conform to the relevant parameters if, for each relevant parameter considered individually, samples of the waste water show that it complies with the relevant parametric value in the following way:

(a) for the parameters specified in Part I of the Second Schedule [i.e. BOD/COD/SS], a maximum number of samples which are allowed to fail the requirements, expressed in concentrations and/or percentage reductions in Part I of the Second Schedule, is set out in the Table to this Schedule;

(b) for the parameters in Part I of the Second Schedule expressed in concentrations, the failing samples taken under normal operating conditions must not deviate from the parametric values by more than 100% but, for the parametric value in concentration relating to total suspended solids, deviations of up to 150% may be accepted;

(c) for those parameters specified in Part II of the Second Schedule the annual mean of the samples for each parameter shall conform to the relevant parametric values.

The table referred to in indent (a) sets out the permissible numbers of samples failing (from 1-25) corresponding to the numbers of samples taken (in bands up to 365 samples a year).

2.4.57 In practical terms, these requirements permit a limited number of samples to fail, provided that in the cases of BOD, COD and SS, respectively, the limits 50 mg/l $O_2$, 250 mg/l $O_2$ and 87.5 mg/l are not exceeded. For the parameters total phosphorus and total nitrogen the average annual values must conform to the limits shown in Part II of the Second Schedule [cf Appendix A].

*Table VII*

**PERMISSIBLE SAMPLE FAILURE RATE**

| Corresponding Agglomeration [p.e.] | Mandatory Annual Sampling | Maximum permitted number of samples which fail to conform |
|---|---|---|
| 2,000 to 9,999 | 12* | 2 |
| 2,000 to 9,999 | 4** | 1 |
| 10,000 to 49,999 | 12 | 2 |
| 50,000 p.e. or over | 24 | 3 |

* First year of sampling

** Four samples in subsequent years if it can be shown that the water during the first year complies with the provisions of these Regulations; if one sample of the four fails, 12 samples must be taken in the year that follows.

## ANALYTICAL PROCEDURES

2.4.58 The Regulations pay corresponding attention to the related topic of analysis, and the requirements are set out in both Parts of the Second Schedule. As is usual in such cases the methods of analysis presented are so-called "Reference Methods", alternatives to which may be used provided they give the same precision and accuracy of the reference procedures. Of the three parameters covered by Part I, BOD/COD/SS, the methods are straightforward and will be familiar to analysts.

2.4.59 BOD is to be determined by the standard, long-established procedure, but with the addition to samples of an inhibiting agent to prevent the uptake of oxygen by nitrification during the 5-day incubation period. The schedule requires that this analysis, as that for COD, shall be carried out on a "homogenized, unfiltered, undecanted sample." In other words, *the portion of sample taken for analysis must be fully representative of the whole sample as taken at the treatment plant.*

2.4.60 The test for COD is used primarily in new works and it has several factors to recommend it, mainly its general applicability to a wide range of organic matter, its reproducibility and, consequent on the relatively recent introduction of micro-scale "COD kits", its convenience and greater safety. The use of kits is strongly recommended over the former reflux oxidation procedure, as kits eliminate the requirement for complex distillation set-ups and, more importantly, do away with a potentially hazardous laboratory activity.

2.4.61 The determination of SS is gravimetric, with drying of filtered material at 105°C. However, in order to achieve the necessary standardization of filtration procedures, the use of a 0.45 um membrane filter is now prescribed. Neither this nor the other requirements should pose difficulties for sanitary authorities.

2.4.62 Where the effluents are discharged from plants with an agglomeration load of 10,000 p.e. or more, to sensitive areas or their catchments, or where phosphorus reduction facilities are otherwise provided, analyses must be carried out for total phosphorus. Here, the specified procedure for either is given as "molecular absorption spectrophotometry", commonly the sensitive determination of a reagent-induced colour by a spectrophotometer operating at a wave-length in the visible spectrum. However, this is only part, although an important one, of the complete analytical process. What is not specified is the route by which the determinand is brought to the spectrophotometric stage.

2.4.63 The first element in the analysis of a "representative sample" for total phosphorus (and total nitrogen) analysis is a digestion, separate for each parameter, under the conditions of which organically-bound nitrogen and phosphorus are released as simple inorganic entities which are then reacted with a colour reagent to give the species which is determined spectrophotometrically. This (digestion) stage of the determination procedure may well prove problematical for basic laboratories, in which case the analysis should be referred to a laboratory of greater capability.

2.4.64 The final determination of the concentrations of the determinands (which are in proportion to the degree of colour developed by the reagent) is most unlikely to prove a problem, as the anticipated levels of phosphorus and/or nitrogen in treated sewage effluents are relatively large, even when significantly below the permitted limits.

2.4.65 The analytical procedure just summarized covers all stages in the determination of total phosphorus, but in the case of nitrogen the result obtained is for the partial parameter "Kjeldahl nitrogen" rather than for total nitrogen, as required by the Regulations. *The Kjeldahl nitrogen analysis covers organic nitrogen and ammonia only, and it must therefore be supplemented by analyses for nitrate-nitrogen and nitrite-nitrogen, the combination of all four species constituting the required total nitrogen.*

2.4.66 In summary, therefore, the Part II [Second Schedule] analyses actually required comprise:

| | |
|---|---|
| total phosphorus: | [digestion followed by spectrophotometry] |
| Kjeldahl nitrogen: | [digestion followed by spectrophotometry] |
| nitrate-nitrogen: | [conversion of nitrate to nitrite followed by determination of nitrite-nitrogen] |
| nitrite-nitrogen: | [spectrophotometry]. |

In practice, because nitrate-nitrogen is converted to nitrite-nitrogen, duly increasing the background concentration of the latter in the sample, a single determination for "total oxidized nitrogen" (i.e. nitrate- plus nitrite-nitrogen) may be carried out instead of the two individual analyses. The concentration of the determinand "total nitrogen" thus consists of the sum of the concentrations of Kjeldahl nitrogen, nitrate-nitrogen and nitrite-nitrogen (or total oxidised nitrogen, if this test is used for nitrate/nitrite).

## FUNCTIONS OF THE EPA

2.4.67 As the DoE circular notes, the EPA "has a supervisory and reporting role in relation to the monitoring programmes carried out by sanitary authorities under these Regulations." Further:

> As a consequence, sanitary authorities are required...to transmit the results of monitoring, including monitoring of existing plants, to the Agency in such manner and at such times as the Agency shall direct.

2.4.68 The EPA will publish two-yearly reports on the ongoing monitoring by sanitary authorities of their urban waste water treatment plants, ideally within the half-year following a monitoring cycle. The returns and results concerning the monitoring will therefore be required as soon as is practicable after the completion of a years sampling and analysis. In order to facilitate the transmission of the data required to the EPA, the Agency (as mentioned in Paragraph 1.6) is developing computerised formats to facilitate the returning of the necesssary data.

# *APPENDICES*

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## Appendix A

## SCHEDULES TO THE ENVIRONMENTAL PROTECTION AGENCY ACT, 1992 [URBAN WASTE WATER TREATMENT] REGULATIONS, 1994

*First Schedule*

### COLLECTING SYSTEMS

A collecting system shall take into account waste water treatment requirements.

The design, construction and maintenance of a collecting system shall be undertaken in accordance with the best technical knowledge not entailing excessive costs, notably regarding:

- volume and characteristics of urban waste water
- prevention of leaks
- limitation of pollution of receiving waters due to storm water overflows.

*Second Schedule*

### PART I

*Requirements for discharges from urban waste water treatment plants to other than sensitive areas. The values for concentrations or for the percentage of reduction shall apply.*

| Parameters | Concentration | Minimum percentage reduction [1] | Reference method of measurement |
|---|---|---|---|
| Biochemical oxygen demand [$BOD_5$ at 20°C] without nitrification [2] | 25 mg/l $O_2$ | 70 - 90 | Homogenized, unfiltered, undecanted sample. Determination of dissolved oxygen before and after five-day incubation at 20°C ± 1°C, in complete darkness. Addition of a nitrification inhibitor. |
| Chemical oxygen demand [COD] | 125 mg/l $O_2$ | 75 | Homogenized, unfiltered, undecanted sample. Potassium dichromate. |
| Total suspended solids | 35 mg/l | 90<br>[or] | Filtering of a representative sample through a 0.45 um filter membrane. Drying at 105°C and weighing. |

*Appendix A : Continued*

| Parameters | Concentration | Minimum percentage reduction [1] | Reference method of measurement |
|---|---|---|---|
| | | | Centrifuging of a representive sample [for at least five mins with mean acceleration of 2,800 to 3,200 g], drying at 105°C and weighing. |

*[1] Reduction in relation to the load of the influent.*
*[2] The parameter can be replaced by another parameter: total organic carbon [TOC] or total oxygen demand [TOD] if a relationship can be established between $BOD_5$ and the substitute parameter.*

## PART II

*Requirements for discharges from urban waste water treatment plants to sensitive areas which are subject to eutrophication. One or both parameters may be applied depending on the local situation. The values for concentrations or for the percentage of reduction shall apply.*

| Parameters | Concentration | Minimum percentage reduction [1] | Reference method of measurement |
|---|---|---|---|
| Total phosphorus | 2 mg/l P *[10,000-100,000 p.e.]*<br>1 mg/l P *[more than 100,000 p.e.]* | 80 | Molecular absorption spectrophotometry |
| Total nitrogen [2] | 15 mg/l N *[10,000-100,000 p.e.]*<br>10 mg/l N *[more than 100,000 p.e.]* | 70 - 80 | Molecular absorption spectrophotometry |

*[1] Reduction in relation to the load of the influent.*
*[2] Total nitrogen means: the sum of total Kjeldahl nitrogen [organic nitrogen + $NH_3$], nitrate [$NO_3$] - nitrogen and nitrite [$NO_2$] - nitrogen.*

*Appendix A : Continued*

*Third Schedule*

## SENSITIVE AREAS

*River Boyne,* County Meath - 6.5 km section downstream of sewage treatment works outfall at Blackcastle, Navan, County Meath.

*River Camlin,* County Longford - from sewage treatment works at Longford to entry into the River Shannon.

*River Castlebar,* County Mayo - down-stream of sewage treatment works outfall at Knock-thomas to entry into Lough Cullin.

*River Liffey* - down-stream of Osberstown sewage treatment works to Leixlip reservoir, County Kildare.

*River Nenagh,* County Tipperary - down-stream of sewage treatment works outfall in Nenagh to entry into Lough Derg.

*River Tullamore,* County Offaly - 0.5 km section down-stream of sewage treatment works out-fall in Tullamore.

*Lough Derg* on the River Shannon.

*Lough Leane,* County Kerry.

*Lough Oughter,* County Cavan.

*Lough Ree* on the River Shannon.

*Fourth Schedule*

## INDUSTRIAL WASTE WATER

Industrial waste water entering collecting systems and urban waste water treatment plants shall be subject to such pretreatment as is required in order to:

- protect the health of staff working in collecting systems and treatment plants;
- ensure that the collecting systems, waste water treatment plants and associated equip-ment are not damaged;
- ensure that the operation of a waste water treatment plant and the treatment of sludge are not impeded;
- ensure that discharges from treatment plants do not adversely affect the environment or prevent receiving waters from complying with other Community Directives;
- ensure that sludge can be disposed of safely in an environmentally acceptable manner.

*Appendix A : Continued*

*Fifth Schedule*

## REFERENCE METHODS

## FOR MONITORING AND EVALUATION OF RESULTS

1. Sanitary authorities shall ensure that a monitoring method is applied which corresponds at least with the level of requirements described below. Alternative methods to those mentioned in paragraphs 2, 3 and 4 may be used provided that it can be demonstrated that equivalent results are obtained.

2. Flow-proportional or time-based 24-hour samples shall be collected at the same well defined point in the outlet and if necessary in the inlet of the treatment plant, in order to monitor compliance with the requirements for discharged waste water specified in these Regulations. Good international laboratory practices aiming at minimizing the degradation of samples between collection and analysis shall be applied.

3. The minimum annual number of samples shall be determined according to the size of the treatment plant and be collected at regular intervals during the year:

- *2,000 to 9,999* p.e.: 12 samples during the first year. Four samples in subsequent years if it can be shown that the water during the first year complies with the provisions of these Regulations; if one sample of the four fails, 12 samples must be taken in the year that follows.
- *10,000 to 49,999* p.e.: 12 samples.
- *50,000 p.e. or over:* 24 samples.

4. The treated waste water shall be assumed to conform to the relevant parameters if, for each relevant parameter considered individually, samples of the water show that it complies with the relevant parametric value in the following way:

(a) for the parameters specified in Part I of the Second Schedule, a maximum number of samples which are allowed to fail the requirements, expressed in concentrations and/or percentage reductions in Part I of the Second Schedule, is set out in the Table to this Schedule;

(b) for the parameters in Part I of the Second Schedule expressed in concentrations, the failing samples taken under normal operating conditions must not deviate from the parametric value by more than 100% but, for the parametric value in concentration relating to total suspended solids, deviations of up to 150% may be accepted;

(c) for those parameters specified in Part II of the Second Schedule the annual mean of the samples for each parameter shall conform to the relevant parametric values.

5. 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.

*Appendix A : Continued*

## PERMITTED NUMBERS OF FAILURES TO CONFORM

| Series of samples taken in any year | Max. permitted number of samples which fail to conform | Series of samples taken in any year | Max. permitted number of samples which fail to conform |
|---|---|---|---|
| 4-7 | 1 | 172-187 | 14 |
| 8-16 | 2 | 188-203 | 15 |
| 17-28 | 3 | 204-219 | 16 |
| 29-40 | 4 | 220-235 | 17 |
| 41-53 | 5 | 236-251 | 18 |
| 54-67 | 6 | 252-268 | 19 |
| 68-81 | 7 | 269-284 | 20 |
| 82-95 | 8 | 285-300 | 21 |
| 96-110 | 9 | 301-317 | 22 |
| 111-125 | 10 | 318-334 | 23 |
| 126-140 | 11 | 335-350 | 24 |
| 141-155 | 12 | 351-365 | 25 |
| 156-171 | 13 | | |

# Appendix B

## DEFINITIONS CONTAINED IN THE REGULATIONS

The detailed content of the Regulations, which have been published as S.I. No 419 of 1994, is prefaced by a series of definitions which are quoted here for convenience:

"In these Regulations -

*agglomeration* means an area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected and conducted to an urban waste water treatment plant or to a final discharge point;

*appropriate treatment* means treatment of urban waste water by any process and/or disposal system which after discharge allows the receiving waters to meet the relevant quality objectives and the relevant provisions of the Directive and of other Community Directives;

*coastal waters* means the waters outside the low-water line or the outer limit of an estuary;

*collecting system* means a system of conduits which collects and conducts urban waste water;

*domestic waste water* means waste water from residential settlements and services which originates predominantly from the human metabolism and from household activities;

*estuary* means the transitional area at the mouth of a river between freshwater and coastal waters;

*eutrophication* means: the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of the organisms present in the water and to the quality of the water concerned;

*industrial waste water* means any waste water which is discharged from premises used for carrying on any trade or industry, other than domestic waste water and run-off rain water;

*population equivalent* is a measurement of organic biodegradable load, and a population equivalent of 1 [1 p.e.] means the organic biodegradable load having a five-day biochemical oxygen demand [$BOD_5$] of 60g of oxygen per day - the load shall be calculated on the basis of the maximum average weekly load entering the plant during the year, excluding unusual situations such as those due to heavy rain;

*secondary treatment* means treatment of urban waste water by a process generally involving biological treatment with a secondary settlement or other process in which the requirements established in Part I of the Second Schedule are respected;

*sensitive areas* means those areas specified in the Third Schedule and such other areas as may be identified pursuant to Article 5 of the Directive;

*Appendix B : Continued*

*sludge* means residual sludge, whether treated or untreated, from urban waste water treatment plants;

*the Directive* means Council Directive 91/271/EEC of 21 May 1991 concerning urban waste water treatment, and references to other Community Directives are references to Directives other than Council Directive 91/271/EEC;

*urban waste water* means domestic waste water or the mixture of domestic waste water with industrial waste water and/or run-off rain water."

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