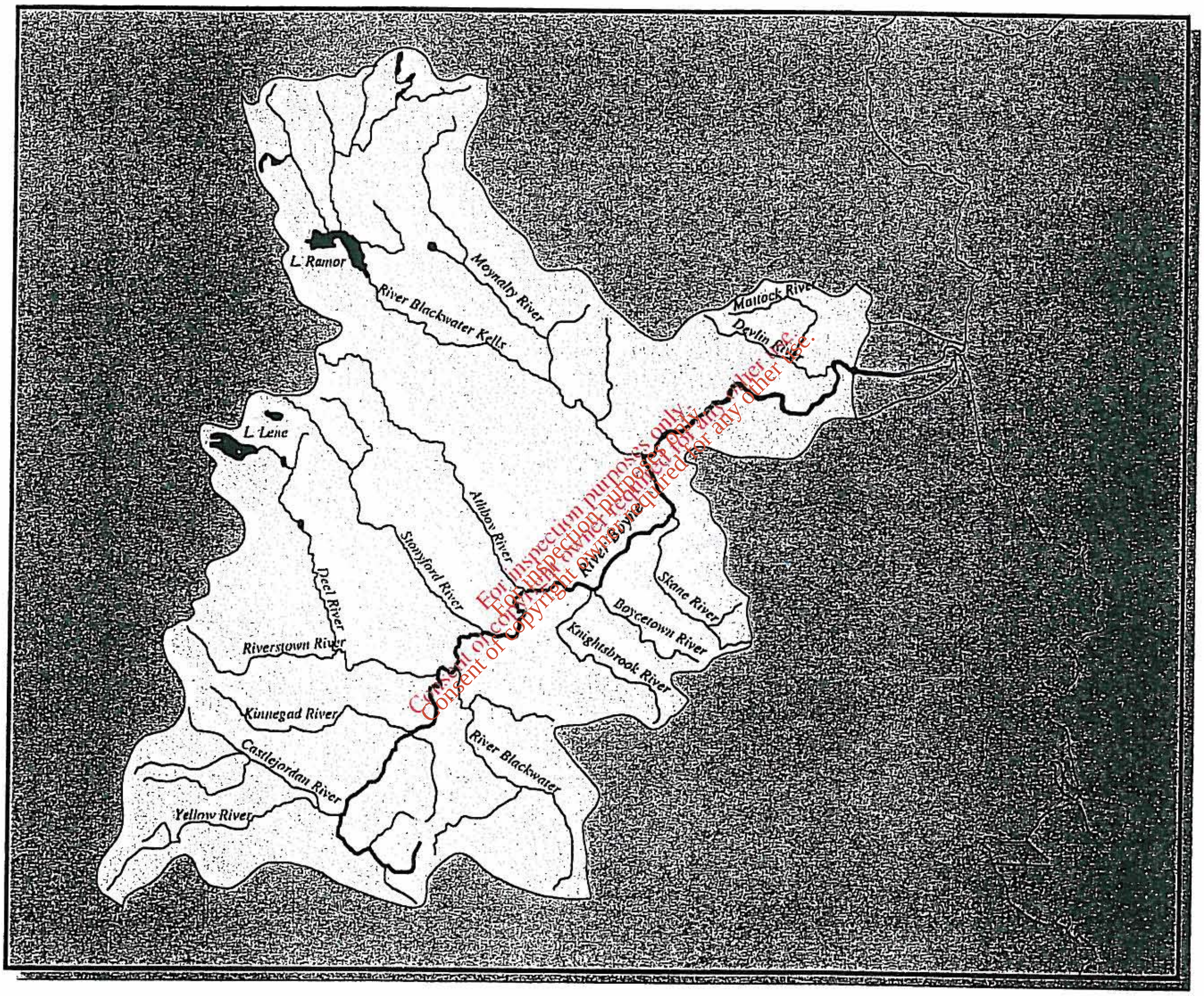
RIVER BOYNE

WATER QUALITY MANAGEMENT PLAN

THE PLAN



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River Boyne Water Quality Management Plan
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1.0 Introduction

River Boyne Water Quality Management Plan

1. *Introduction*

1.1 Background

Systematic management of water resources is necessary to ensure the required balance between development pressures and the safeguarding of the natural and built environment for future generations.

The Local Government (Water Pollution) Acts, 1977 - 90 and subsequent regulations provide for the control of water pollution by means of a licensing system for all trade effluent and domestic effluents over 5m^3 in 24 hours and allows for the development of Water Quality Management Plans on a river catchment basis.

Under Section 15 of the 1977 Act, provision is made for the preparation of Water Quality Management Plans to provide an essential tool to assist policy makers in the management of water bodies. The plan takes account of present and potential future beneficial uses and sets water quality objectives to meet and sustain these demands. Key elements of the plan include:-

- *An understanding of the river system and it's water resources*
- *The present water quality status*
- *Existing land use and management issues arising*
- *Water quality objectives and associated standards and criteria*
- *Future water quality management issues and their integration into a coherent overall plan*

The publication by the Minister for the Environment of the document 'Managing Ireland's Rivers and Lakes - "A Catchment Based Strategy Against Eutrophication" in May, 1997 sets out national policy for improvement in water quality in Ireland's Rivers and Lakes. It sets out interim standards for Rivers and Lakes to be achieved at the latest by the year 2007.

The following principles underpin current National and E.U. Policy:-

- ***Concept of sustainable development ;*** *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

- ***Principle of precautionary action ;*** *The reduction of risks to the environment by taking avoiding action before any problem arises.*

- ***Integration of environmental considerations*** *; envisages a holistic environmental appraisal of issues to produce integrated environmental management practices for positive environmental benefit*

- **"Polluter Pays" Principle** ; requires that the cost of preventing and repairing environmental damage should be borne by the polluter.

The protection of the quality of water is a vital part of this process, having regard to the conflicting pressures of increased water demand on the one hand and the need to dispose of greater quantities of waste on the other.

Historically, Ireland was spared the large scale pollution which was associated with the industrial revolution in Britain and elsewhere. However, since the 1960's, considerable environmental pressures on water resources have been experienced associated with:-

- *Population growth and, in particular, increased urbanisation in Irish society*

- *Accelerated industrial growth with consequences for water consumption and effluent discharge*

- *Increased agricultural production and changed farming methods with pollution arising from farmyard waste discharges associated with intensive husbandry, silage effluent discharges and organic run-off from land due to increased spreading of farmyard slurries and artificial fertilisers*

- *Economic growth and increased prosperity ; resulting in increased consumption of water resources in both domestic and general commercial use and the consequent increase in effluent discharge*

These forces have resulted in diminished water quality associated with localised point discharges and general diffuse inputs. To offset these pressures, a systematic approach is required to water resources management and conservation.

1.2 River Boyne Catchment - Overview

The catchment of the River Boyne extends to some 2694km^2 in total (Ordnance Survey of Ireland - Rivers and their Catchment Basins - 1958). The catchment is shown in **Fig. 1** and comprises the bulk of Co. Meath, the southern part of Co. Louth (Mattock Catchment), an area in the south-east of Co. Cavan (Lough Ramor catchment), the eastern area of Co. Westmeath (River Deel catchment), an area in the north-west of Co. Kildare where the River Boyne has its source and a small area of Co. Offaly including Edenderry, Rhode and the Yellow River catchment.

The principal towns in the catchment are Trim, Navan and Kells in Co. Meath, Virginia and Bailieboro in Co. Cavan, Kinnegad in Co. Westmeath, Edenderry in Co. Offaly and Drogheda in Louth at the head of the Boyne estuary. The main channel is some 113km long from its source near Newbury Hall in Co. Kildare to its outlet to the Irish Sea at Mornington, east of Drogheda. The elevation of the source is approximately 140m O.D., giving the average main channel gradient as 1.24m per kilometre.

The catchment of the River Boyne, therefore, is relatively flat and primarily pasture. Water quality trends indicate a diminished standard over the last 20-25 years based on EPA biological sampling (formerly an Foras Forbortha) - ERU.

The river network to which the plan relates is illustrated in Fig. 1 and comprises the main Boyne channel and the significant tributaries which are covered by the E.P.A. monitoring programme. It refers to the freshwater river system upstream of the tidal estuary at Drogheda (Obelisk Bridge). From its source in Co. Kildare, the main channel flows westwards towards Edenderry in Co. Offaly and then in a north-westerly direction towards Rahan, where it enters Co. Meath. It flows in a north-east direction towards Trim, intercepting the Longwood Blackwater, the Yellow River, the Kinnegad River, the River Deel, Stonyford and Athboy tributaries.

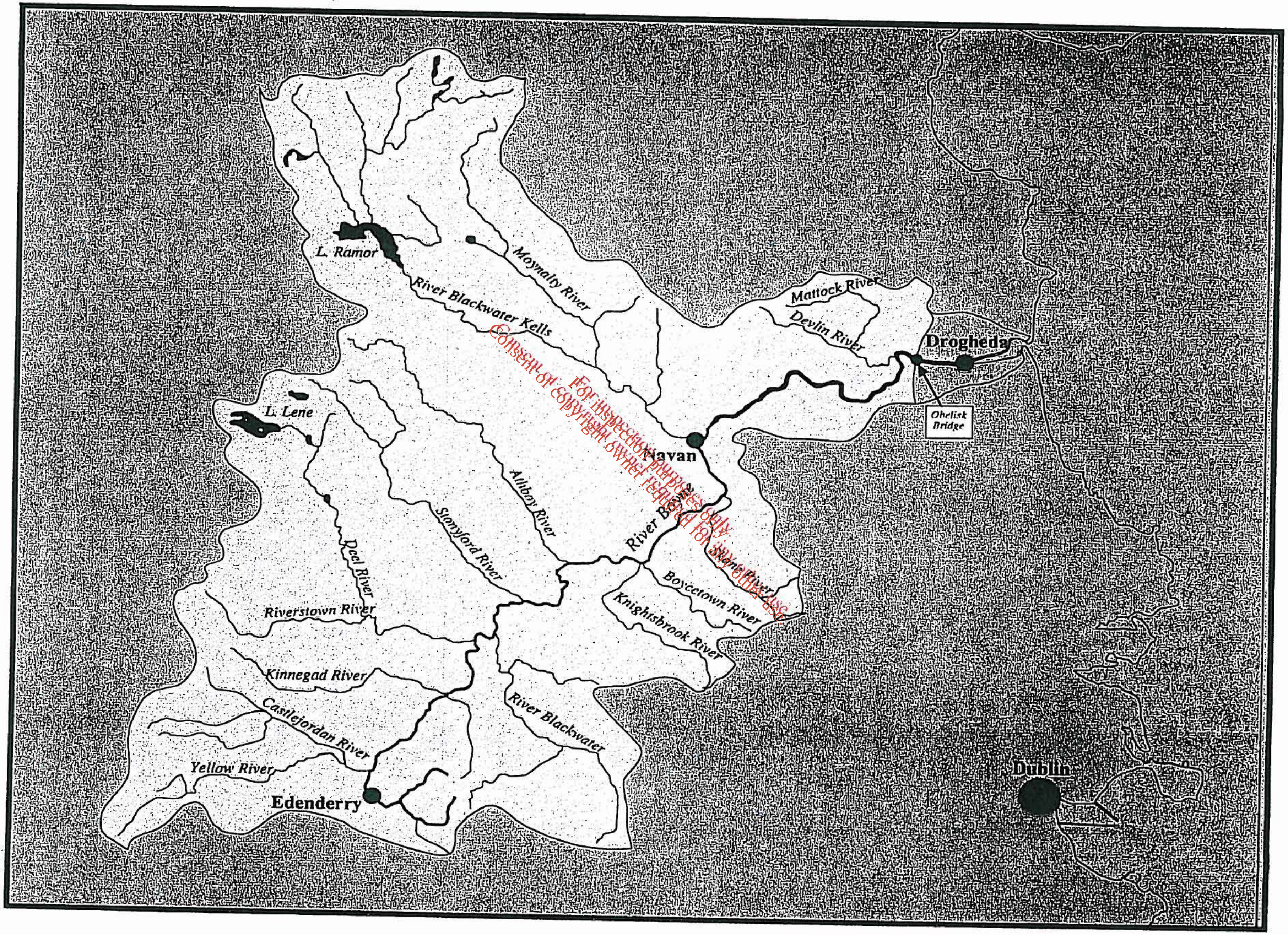

Fig. 1 : River Boyne Catchment and River System

Continuing north-east to Navan, the river is joined by a major tributary, the Kells Blackwater, before continuing in a generally easterly direction to Slane and Drogheda. The Kells Blackwater is the largest tributary of the River Boyne rising in Co. Cavan north of Bailieboro and flowing south to Virginia and Lough Ramor and then in a south-easterly direction via Kells to join the main river downstream of Navan. In the context of a Water Quality Management Plan for the River Boyne, the following aspects of the River and it's catchment require consideration:-

- *The Office of Public Works (OPW) carried out an arterial drainage scheme on the River Boyne between the late 1960's and the early 1980's and continue to provide maintenance upkeep of the channel*
- *The main channel of the River Boyne is a designated salmonid water under the European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. 293/1988)*
- *The River Boyne is an important source of potable water requiring compliance with the European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989 (S.I. No.294/1989)*

1.3 Water Quality Management Plan - Objectives

The main objectives of the Water Quality Management Plan for the Boyne Catchment are:-

- *To protect water quality for abstraction as a primary beneficial use*
- *To protect and conserve water quality in the Boyne river system to protect fish life*
- *To conserve the natural habitats within the river system as far as possible and to conserve visual amenity*
- *To maintain and develop the amenity potential of the River Boyne and it's tributaries for recreation including water-based recreational use*
- *To provide for the disposal of effluents from existing and future development within the required water quality parameters*

1.4 Plan Development Methodology

The development of the Water Quality Management Plan requires the carrying out of a Study in the context of the declared objectives and the development of draft proposals to form the basis of the plan for adoption by the Local Authorities responsible for the catchment. In the preparation of the plan, the following methodology was adopted:-

- *Available basic data on water quality and quantity was collected and tabulated*
- *The available quality data was analysed and the characteristic elements which primarily determine water quality in lakes and along the main river channels were selected*

- *The beneficial water uses (existing and future) to be protected within the catchment were identified*

- *The desired river water quality considered necessary to support these various beneficial uses was defined*

- *Assessments of the capacity of the river to receive effluent discharges within the desired quality ranges were determined (assimilative capacity). This capacity is a measure of the ability of the river to absorb waste without breaching the Water Quality Standards appropriate to the specified uses*

- *Estimates of existing waste loads were compiled, with projections of future generated loads*

- *Consideration of proposals for the treatment of existing and future waste discharges were made and compared with the estimates of assimilative capacity*

- *Those sections of rivers and lakes presently overloaded by waste discharges were identified. Water quality trends in these sections were also examined and consideration was given to how these areas might be rectified*

- *In relation to future development, criteria for laying down future effluent quality standards were developed*

- *Inevitably, this process results in priorities for capital investment in both public and private wastewater treatment facilities*

The plan includes recommendations for actions to be implemented to achieve the stated objectives over a reasonable timetable.

2.0 Boyne Catchment - Water Resources

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2. *Boyne Catchment - Water Resources*

2.1 *River Boyne and It's Tributaries*

Chapter 1 briefly described the Boyne river system and it's relationship to the administrative boundaries as shown in **Fig. 1**. Approximately 54% of the catchment is in Co. Meath, 18% in Co. Westmeath, 12% in Co. Cavan, 8% in Co. Kildare, 5% in Co. Offaly and 3% in Co. Louth.

The catchment is relatively flat, containing no mountains with a watershed the summits of which are typically 250m O.D. to 340m O.D., the highest levels being in the north and north-east. The bulk of the catchment is under 75m O.D.

The two largest towns in the catchment are Drogheda on the Boyne estuary including the port and Navan, which is by far the largest inland town in the catchment and is the administrative capital of Co. Meath. **Table 2.1** is a list of the 15 largest urban centres in the catchment.

TABLE 2.1 - BOYNE CATCHMENT TOWNS

Town	County	Population		River/Tributary
		1991	1996	
Drogheda	Louth	24,656	25,250	Boyne Estuary
Navan	Meath	11,706		Boyne
Trim	Meath	4,185		Boyne
Edenderry	Offaly	3,742	3,596	Boyne
Kells	Meath	3,539		Kells, Blackwater
Bailieboro	Cavan	1,550		Kells, Blackwater
Dunshaughlin	Meath	1275	-----	Skane
Athboy	Meath	1,083		Athboy River
Virginia	Cavan	720		Lough Ramor
Rochfortbridge	Westmeath	721		Castlejordan
Slane	Meath	699		Boyne
Rhode	Offaly	500		Yellow River
Enfield	Meath	436		Blackwater (Longwood)
Kinnegad	Westmeath	415		Kinnegad
Kilucan	Westmeath	366		Riverstown
Collon	Louth	335		Mattock

The sub-catchments of the main tributaries of the River Boyne system are summarised in **Table 2.2.** The most significant tributary is the Kells Blackwater, which is equivalent to over one quarter of the total catchment including the area of Co. Cavan and a significant area of north Co. Meath. Other significant sub-catchments are the Deel draining the bulk of the catchment in Co. Westmeath, the Yellow River in Co. Offaly and the Longwood Blackwater draining part of Co. Kildare.

Associating the towns with the tributaries, the larger towns are on the main channel of theBoyne and on the Kells Blackwater (Kells, Bailieboro and Virginia).

TABLE 2.2 - BOYNE CATCHMENT TRIBUTARIES

River	Catchment Area km²	% of Total
1) Upstream from Navan		
Athboy	154.1	5.8
Blackwater (Longwood)	33.4	1.3
Boycetown	---------	---------
Castlejordan	95.8	3.6
Clady	51.8	2.0
Deel	286.5	10.8
Kinnegad	80.3	3.0
Knightsbrook	67.3	2.5
Riverstown	77.1	2.9
Slane	80.5	3.0
Stonyford	178.5	6.7
Trommon	29.2	1.1
Yellow	75.1	2.8
2) Lower Catchment from Navan		
Blackwater (Kells) - Moynalty	735 (180)	27.7
Mattock & Devlin	86	3.3
Total		67.5%

2.2 *Catchment Characteristics*

The catchment area of the River Boyne consists of peatland in the upper regions changing to highly productive agricultural land in the middle and lower reaches. The bedrock consists mainly of carboniferous limestone of varying ages with lower carboniferous limestones in the south and west of the catchment gradually varying to middle and upper carboniferous limestones in the north and east of the catchment. Areas of upper avonion shales and sandstones are located in the north-east of the catchment. while areas of silurian rocks are present in the north of the catchment. A small area of old red sandstone is present in the west of the catchment.

2.3 Water Resources - Hydrometric Data

The island of Ireland is divided into 40 hydrometric areas for the purposes of collecting hydrometric (River Flow) data. For this purpose, the River Boyne catchment is designated as hydrometric area 07.

River flow is recorded at locations throughout the catchment by the following agencies:-

- *Office of Public Works (OPW)*
- *Environmental Protection Agency (EPA)*
- *Electricity Supply Board (ESB)*
- *Local Authorities*

River flow data is essential for water resource management, flood flow management and pollution control. Historical flow data over a significant period of record can be used to estimate the following parameters of river flow:-

- *Flood flows of various return periods (likelihood of occurrence)*
- *Low flows expressed as minimum dry weather flow (DWF), usually defined as the flow below which the river would not be expected to fall more than once in 50 years. More usually, the 95 percentile flow is used when setting pollution standards and assessing compliance. This is defined as the flow at the location in the river which is exceeded 95% of the time*
- *Average daily flow provides a measure of the total run-off from the catchment which can be cross-referenced with rainfall and catchment characteristics in estimating total water resources*

The most accurate method of measuring channel flow is by constructing a specific control structure (weir, sluice, etc.). However, in practice, flow is estimated from measurement of water level (water depth) at a site which is converted to flow by reference to a suitable rating curve. The rating curve is determined from an appropriate number of actual measurements of river flow for a range of flow depths at the site. A good gauging station will have a consistent relationship between flow and water depth.

Hydrometric gauging station sites in the River Boyne catchment are indicated in **Map No.1** and comprise two types of station. Automatic recorder stations provide a continuous record of water level from which a continuous profile of river flow can be derived. Staff gauge stations, however, are manually read intermittently and are generally used for spot checks on low flows and flood flows.

River flows presented in this Report are based on OPW records and EPA records for the Local Authority sites. It would be a requirement for systematic water resource management that the number of sites be significantly increased with automatic recorder facilities, particularly where significant water abstractions or water discharges require to be assessed.

Tables 2.3 and 2.4 summarise the available hydrometric gauging records within the Boyne catchment. These records have significant limitations in terms of :-

- *The coverage of the catchment*
- *The period of record*
- *The extent of records which are processed and available for use*

A data management system is required by means of which the hydrometric data would be regularly updated from the source agencies. Ultimately, this should be in digital forn suitable for transfer between the agency and local authority and regular update of the available record. Procedures in the data management system for calculation of 95 percentile low flow and DWF automatically would update these key parameters as the dataset is extended.

The dry weather flow (DWF) is taken as the minimum flow which might be expected to occur once in 50 years. This critical parameter is necessary for consideration of the safe yield for water supply abstraction and also in considering threshold levels for toxic and dangerous substances. The 95 percentile flow is generally used in considering critical pollution thresholds and compliance with water quality standards. 95 percentile and DWF flows are presented in **Tables 2.3 and 2.4**, based on currently available data.

The Boyne arterial drainage scheme results in accelerated run-off from the catchment with reduced flood storage. Therefore, the current run-off regime is represented by post drainage data only.

TABLE 2.3 : HYDROMETRIC GAUGING STATIONS WITH AUTOMATIC RECORDERS

Station No.	Station Name	Area (km2)	River	Source	Grid Ref.	95% Flow (m^3/s)	D.W.F. (m^3/s)	Lowest Flow Date	Period of record available	Period for which records are processed
0701	Tremblestown	150	Athboy	OPW	N758 574	-	0.09	11/09/59	1939-1995	-
0702	Killyon	285	Deel	OPW	N683 491	0.8	0.37	10/09/59	1939-1995	1971-1992
0703	Castlerickard	179	Blackwater	OPW	N716 489	0.44	0.1	10/09/59	1953-1995	-
0704	Stramatt	256	Blackwater (Kells)	OPW	N630 833	0.02	0.009	03/09/75	1939-1995	1983-1993
0705	Trim	1282	Boyne	OPW	N801 569	3.02	1.05	11/09/59	1939-1995	1976-1993
0706	Fyanstown	179	Blackwater (Kells)	OPW	N790 757	0.19	0.09	29/08/75	1939-1995	-
0707	Boyne Aqueduct	432	Boyne	OPW	N692 452	-	0.41	10/09/59	1939-1995	-
0709	Navan Weir	1610	Boyne	OPW	N878 667	2.5	0.99	28/07/52	1939-1995	1977-1994
0710	Liscarton	717	Blackwater (Kells)	OPW	N846 689	1.23	0.33	9/75, 9/76	1939-1995	1952-1992
0711	O'Daly Bridge	294	Blackwater (Kells)	OPW	N652 805	0.4	0.03	29/08/75	1940-1995	1956-1980
0712	Slane Castle	2408	Boyne	OPW	N949 739	4.33	1.45	08/09/76	1940-1995	1975-1994
0714	Garr Bridge	44	Yellow	ESB	N533 369	0.13	0.10	03/07/62	1954-1995	1955-1977
0717	Rosehill Bridge	74	Moynalty	CAVAN	N720 852	0.09	0.053	08/08/77	1978-1995	1978-1981
0721	Drumree	3.9	Skane	MEATH	N943 517	0.01	-		1978-1995	1978-1987
0723	Athboy	98	Athboy	MEATH	N717 640	0.29	0.09	22/09/76	1977-1995	1978-1981
0724	Clonymeath	17.7	Clonymeath	MEATH	N856 490	0.01	-		1977-1995	1978-1983
0733	Virginia Hatchery	129	Blackwater (Kells)	OPW	N607 875	-	0.06	01/09/81	1980-1995	1980-1993
0737	Blackcastle	-	Boyne	OPW	N874 681	-	-			
0739	Johnstown Bridge	110	Blackwater	KILDARE	N762 400	0.24	0.06		1982-1995	-
0744	Ballivor	21.5	Ballivor	MEATH	N688 537	0.01	0.004		1989-1995	1990-1994
0761	Drogheda	-	Boyne Estuary	OPW	-	Tide	Tide	-	-	-
0762	Mornington	-	Boyne Estuary	OPW	O153 761	Tide	Tide	-	-	-
0771	Skeagh	4.8	Skeagh Lough	CAVAN	H655 003	-	0.0003	15/09/76	-	-
0772	Lough Bane	-	Deel	MEATH	N556 705	-	-		-	-
0773	Nadreegeel	13	Nadreegeel Lough	CAVAN	N554 928	-	0.0	16/09/76	-	-
0774	Lough Lene	-	Deel	WESTMEATH	N495 685	-	-		-	-
0781	Virginia	-	Ramor Lough	OPW	N599 872	-	-		-	-

TABLE 2.4 : HYDROMETRIC GAUGING STATIONS WITH STAFF GAUGES

Station No.	Station Name	Area (km^2)	River	Source	Grid Ref.	95% Flow (m^3/s)	D.W.F. (m^3/s)	Lowest Flow Date
0715	Delvin	-	Stonyford	WESTMEATH	N620 625	0.13	0.06	
0716	Dunsany	-	Skane	MEATH	N908 546	0.01	-	
0718	Athlumney	-	Boyne	OPW	-	-	-	
0719	Deerpark	13	Nadreegeel Lough	CAVAN	N589 882	-	0.02	01/09/81
0720	Kells	-	Blackwater (Kells)	MEATH	-	0.5	0.11	
0722	Kilmessan	-	Skane	MEATH	N888 573	0.029	-	
0725	Moynalty	-	Moynalty	MEATH	N733 826	0.13	0.08	08/08/77
0726	Boyne Bridge	-	Boyne	OFFALY	N633 340	-	0.00	20/07/76
0728	Derrygreenagh	-	Castlejordan	OFFALY	N477 390	-	-	
0729	Triermore	-	Athboy	WESTMEATH	N677 699	0.14	0.06	
0730	Raharney	-	Deel	WESTMEATH	N600 531	-	-	
0731	Rathwire	-	Riverstown	WESTMEATH	N581 509	0.15	0.092	09/09/97
0732	Kinnegad	54	Kinnegad	WESTMEATH	N602 452	0.11	0.10	
0708	Earls Bridge	134	Stonyford	MEATH	N620 625	0.34	0.16	1959
0734	Boyd's Bridge	-	Mattock	LOUTH	O017 808	0.006	0.004	
0735	Killinkere	-	Blackwater (Kells)	CAVAN	N612 936	-	0.05	01/09/81
0736	Rochfortbridge	-	Castlejordan	WESTMEATH	N480 408	0.03	0.015	08/09/76
0738	Trim Pumphouse	-	Knightsbrook	MEATH	N804 536	0.16	0.07	
0740	Clongall Bridge	-	Yellow	OFFALY	N592 374	-	-	
0741	Bellinter Bridge	-	Boyne	MEATH	N892 635	-	-	
0742	Longwood	-	Blackwater	MEATH	N722 452	0.36	0.09	22/09/76
0743	Drumbannon	-	Blackwater	CAVAN	N677 978	-	-	
0775	Lough Lene Outlet	-	Deel	WESTMEATH	N530 680	-	-	

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2.4 Rainfall

Daily rainfall data is available for various locations throughout the catchment. This information is published for 30 year periods and at 10 year intervals by the Meteorological Service. Records for the period 1951-1980 are tabulated in Appendix 1 and Isohyets of rainfall for the catchment are presented in **Map No.2**.

Rainfall in the Boyne catchment varies from approximately 830mm in the central area of the catchment (Trim, Navan and Drogheda) to approximately 1,100mm per annum in the Bailieboro area of Cavan.

In carrying out a water resource balance assessment, allowance must be made for uptake of rainfall in evaporation and transpiration. Estimates of evapotranspiration are also provided by the Meteorological Service and vary according to weather conditions including sunlight. Typical values of evapotranspiration loss for the catchment would be in the order of 400-450mm per annum.

Typical water resource balance calculations in the River Boyne catchment are summarised in **Table 2.5** based on data from the document "A Statistical Analysis of River Flows" produced by the Water Resources Section, Environmental Research Unit (now the EPA), for the Eastern Water Resource Region.

TABLE 2.5 - BOYNE CATCHMENT WATER RESOURCES (O.P.W. GAUGING SITES)

Flow Gauge Site		Catchment Area	Average Annual	Assumed Evapo-transpiration	Estimated Mean Flow	Measured Mean Flow	Yield
Ref.	**Location**	**km²**	**Rainfall (mm)**	**mm/yr**	**m³/s**	**m³/s**	**l/s per km²**
0705	Boyne at Trim	1282	913	420	20.04	20.07	15.7
0706	Moynalty at Fyanstown	179	980	475	2.70	2.95	16.5
0709	Boyne at Navan Weir	1610	898	420	24.4	25.24	15.6
0712	Boyne at Slane Castle	2408	920	420	38.2	38.79	16.1
0717	Moynalty at Rose Hill	74	1063	450	1.44	1.53	20.7
0721	Skane at Drumcree	3.9	900	400	0.06	0.09	23
0701	Tremblestown at Tremblestown	150	950	450	2.38	2.36	15.7

This table demonstrates a consistent net yield from the Boyne catchment in the order of 16l/s per km^2 as average daily flow. Higher figures are indicated for the smaller Moynalty and Skane catchments as would be expected, due to shorter times of concentration.

These figures give an overall estimate of the average water resources available in the catchment. However, from a water use and water quality point of view, the low flow data (95 percentile and DWF) are more significant.

2.5 *Lakes*

Lakes within a river system require particular attention in the context of water resources management. By virtue of the storage which they provide, they have greater potential to meet water abstraction requirements. At the same time, the long average residence time results in a complex eco-system which is sensitive to environmental pressures such as organic pollution and nutrient enrichment (phosphates and nitrates).

Table 2.6 is a list of lakes within the Boyne catchment. **Table 2.7** summarises the lakes for which detailed information is available on contributing catchment area, lake surface area, stored volume, mean and maximum depth and water residence time. These parameters provide a basis for assessing the lakes from the point of view of potential abstraction yield and likely impact of organic or nutrient loadings.

The table indicates the more significant lakes as follows:-

- *Lough Ramor in Co. Cavan*
- *Lough Lene in Co. Westmeath*
- *Lough Bane in Co. Westmeath (34%) and Co. Meath (67%).*
- *Nadreegeel Loughs in Co. Cavan*
- *Skeagh Lough in Co. Cavan*
- *Castle Lake in Co. Cavan*
- *Drumkeery Lake in Co. Cavan*
- *Lisgrea Lake in Co. Cavan*

The lakes provide a valuable angling resource, particularly for Co. Cavan with significant economic gain in the local areas. The majority of the lakes provide good course angling, with the foregoing lakes being the more notable. Significant lakes from a water abstraction point of view are Lough Lene, Skeagh Lough, Nadreegeel Lough, Lough Acurry, Drumkeery Lough and Cuilcagh Lough.

Water quality data in lakes shows that, while generally satisfactory, the majority show evidence of nutrient enrichment, leading to varying degrees of eutrophication. This involves excessive growth of plants and planktonic algae. It causes fluctuation in dissolved oxygen (D.O.), pH and turbidity (water clarity) and can render the water less suitable for abstraction, fish life and other beneficial uses.

TABLE 2.6 - BOYNE CATCHMENT LAKES

Name	Sub-Catchment	County
Lough Bane	River Deel	Westmeath/Meath
Lough Lene	River Deel	Westmeath
Ben Lough Upper	River Deel	Westmeath
Ben Lough Middle	River Deel	Westmeath
Ben Lough Lower	River Deel	Westmeath
Lough Glass North	River Deel	Meath
Lough Glass	River Deel	Westmeath
Lough Adeel	River Deel	Westmeath
Lough Analla	River Deel	Westmeath
Dysart Lakes	River Deel	Westmeath
Lough Hoo	River Deel	Meath
Drumcree Lakes	River Deel	Meath
Lough Shesk	Stonyford River	Meath
Newtown Lough	Athboy River	Westmeath
Bookers Lough	Stonyford River	Meath
Crowinstown Lough	Stonyford River	Meath
Archerstown House Lake	Stonyford River	Meath
Ballinlough Castle Lake	Stonyford River	Meath
White Lough	Athboy River	Meath
Black Lough	Athboy River	Meath
Killnacastle Lake	Athboy River	Meath
Skeagh	Blackwater (Kells) River	Cavan
Drumkeery	Blackwater (Kells) River	Cavan
Castle	Blackwater (Kells) River	Cavan
Galbalie	Blackwater (Kells) River	Cavan
Parkeus	Blackwater (Kells) River	Cavan
Acurry	Blackwater (Kells) River	Cavan
Galloncurra	Blackwater (Kells) River	Cavan
Gallon	Blackwater (Kells) River	Cavan
Corratimner	Blackwater (Kells) River	Cavan
Lisgrea	Blackwater (Kells) River	Cavan
Nadreegeel	Blackwater (Kells) River	Cavan
Ramor	Blackwater (Kells) River	Cavan
Cuilcagh	Blackwater (Kells) River	Cavan
Kilmere	Blackwater (Kells) River	Cavan
Mullagh	Monalty River	Cavan
Bailieboro	Monalty River	Cavan
Lenanaurragh	Monalty River	Cavan

TABLE 2.7 - BOYNE CATCHMENT - LAKES AND THEIR WATER RESOURCES

Name	River	County Location	Catchment Area *km2*	Surface Area *km2*	Volume x 10^6 m^3	Depth		Water Residence Time Years
						Mean *(m)*	Max. *(m)*	
Acurry	Blackwater (Kells)	Cavan	1.0	0.19	0.6	3.1	6	0.81
Bailieborough	Moynalty	Cavan	1.8	0.10	0.25	2.5	6.4	0.12
Castle Lake	Blackwater (Kells)	Cavan	38.4	0.25	0.56	2.25	6.9	0.02
Cuilcagh Lough	Blackwater (Kells)	Cavan	0.9	0.09	0.14	1.56	4.6	0.26
Drumkeery	Blackwater (Kells)	Cavan	8.27	0.14	0.5	3.7	9.0	0.09
Mullagh Lough	Moynalty	Cavan	1.26	0.34	0.4	1.17	6.0	0.47
Nadreegeel Lough	Blackwater (Kells)	Cavan	5.6	0.45	1.1	2.56	11.1	0.32
Nadreegeel Lough East	Blackwater (Kells)	Cavan	17.2	0.50	1.1	2.18	7.2	0.11
Lough Ramor	Blackwater (Kells)	Cavan	248	7.4	26	3.57	15.0	0.17
Skeagh Lake (Upper)	Blackwater (Kells)	Cavan	3.92	0.68	1.5	2.19	10.4	0.5
Lough Lene	River Deel	Westmeath	-----	4.225	4.2/m depth	-----	-----	----
Lough Bane	River Deel	Westmeath/ Meath	-----	0.886	0.885/m depth	-----	-----	----

3.0 River Boyne Catchment - Landuse

4.5 General Amenity

The Boyne River and it's tributaries are of major amenity value to the people resident in the catchment and to visitors. Maintenance of this amenity requires a clean river with satisfactory water quality and a general absence of litter and other debris.

Compliance with the required standards for the key beneficial uses of the Boyne River System outlined above will ensure a satisfactory water quality generally. Compliance with the requirements for water abstraction for potable use, bathing and recreation and development of salmonid fisheries will require effective control of discharges from wastewater treatment plants, industry and agriculture.

In addition, consideration may be required to the following:-

- ***Storm Sewer Overflows*** *; overflows from combined sewer systems will require to meet minimum standards based on guidelines provided by the Department of the Environment, in the context of the Urban Wastewater Treatment Directive (91/271/EEC). In particular, such overflows should have discreetly located outfalls with effective control of detritus to prevent an aesthetic nuisance at the site*

- ***Phosphate Levels*** *; phosphate levels in rivers and more particularly in lakes give rise to enrichment which causes excessive plant and algal growth. This process is known as eutrophication*

4.6 Waste Discharges

All liquid waste from domestic and industrial development must ultimately be disposed of to receiving waters. This section of the plan reviews the major discharges to the Boyne River System, the nature and general design parameters of existing treatment facilities and probable pollution loads at the discharge point.

The impact of these discharges is considered later in the plan having regard to:-

- *Low flows in the river*
- *Background water quality*
- *Water quality objectives*

The bulk of waste discharges in the River Boyne catchment are organic biodegradable substances. Biochemical oxygen demand (BOD) is used as a measure of the strength of organic wastes. It is defined as "the mass of dissolved oxygen required by a specific volume of liquid for the process of biochemical oxidation under prescribed conditions over 5 days at 20^{o}C". It is the normal parameter used to measure pollution strength (as mg/l) and pollution load (kg/day).

The term population equivalent (P.E.) is used to express the wastewater load at a works in terms of equivalent persons. The combined organic load from domestic and trade discharges is expressed as population equivalent on the basis of 60 grammes BOD_5 per equivalent persons.

The impact of waste discharge on river water quality is a function of the waste volume and characteristics and the flow in the river (dilution). A further factor is the recovery rate of the river associated with the nature of the flow, extent of re-aeration, etc.

The minimum standards for compliance with current regulations appropriate to rivers supporting abstraction for potable water use, bathing and water contact recreational activity and designated as a salmonid fishery are identified in this section. These standards have obvious implications for the amount of organic waste which can be accommodated in a river at any section, sometimes referred to as the assimilative capacity. Notwithstanding the over-riding requirement to minimise waste discharges, the approach does permit an objective evaluation of whether a particular effluent can be accommodated or whether a higher standard of treatment is essential. In this regard, the following approach can be adopted:-

- ***Biochemical Oxygen Demand (BOD $_5$)*** *; given the requirement for a maximum level of 5mg/l as O_2 at 95% low flow, there must be reasonable assurance that this limit will not be breached. The EEC Directive on salmonid waters (78/659/EEC) sets a guideline value of the 3mg/l as O_2. Therefore, this value might be regarded as an objective value in a salmonid river where possible*

- ***Phosphates mg/l P*** *; the Salmonid Directive does not specify limits for phosphates. In the case of lakes, it provides a relationship for determination of likely critical loading expressed as mg P per m^2 of lake surface per year depending on the mean depth of the lake and the theoretical retention time, expressed in years. In other cases, it states that the limit value of 0.2mg/l expressed as PO_4 may be regarded as indicative in order to reduce eutrophication. A figure of double this value is suggested for cyprinid waters. For salmonid waters, the equivalent value expressed as mg/l, as P is approximately 0.07 mg/l*

4.7 Existing Municipal Discharges

Table 4.9 is a schedule of existing municipal wastewater treatment plants in the catchment, indicating the existing treatment process type, capacity, existing loading and typical effluent load characteristics in terms of BOD_5 (kg/d) and orthophosphate as mg/l P.

Effluent quality data is listed in Appendix 5 and it also includes key operating parameters of some plants, including MLSS (aeration tank suspended solids) and SVI (sludge volume index). It is apparent that upgrading of existing plants is required in the major towns of Navan and Trim together with smaller plants at Rhode, Moynalty and at Collon, where the results of effluent sampling appear to be unsatisfactory. In general, a minimum standard of 20mg/l of BOD_5 and 30mg/l ofS.S. is taken as standard for municipal discharges to inland waters.

The effluent data for municipal wastewater treatment plants in Appendix 5 shows the following:-

- ***Athboy S.T.W.;*** *this plant discharging to the Athboy River, is within capacity and occasional poor effluent results appear to be associated with excessive sludge accumulation indicated by high MLSS and elevated SVI values*

- ***Ballivor S.T.W.*** *; discharging to Stonyford River, plant nominally within capacity with occasional unsatisfactory results evidenced by high suspended solids in the effluent, elevated BOD and high S.V.I. indicating reduced settleability*

- ***Crossakiel S.T.W.;*** *discharging to Athboy River, plant within capacity and with satisfactory effluent apart from high occasional suspended solids*

- ***Donore S.T.W.;*** *discharging to the River Boyne, plant within capacity, with high quality effluent*

- ***Dunderry S.T.W.;*** *discharging to Clady River, works nominally within capacity but results show inconsistent effluent, corresponding with excessive MLSS. Occasional high effluent BOD and suspended solids levels occur*

- ***Dunshaughlin S.T.W.;*** *discharging to Skane River. Existing plant proposed for upgrading*

- ***Kells S.T.W.*** *; high quality effluent discharging to Blackwater River, indicated for plant operating satisfactorily, well within capacity*

- ***Kilmessan S.T.W.;*** *discharging to Skane River, shows generally satisfactory effluent with occasional exceedence of 20 : 30 standard for BOD and suspended solids respectively*

- ***Lloyd S.T.W.;*** *to Kells Blackwater, has satisfactory effluent from available data*

- ***Longwood S.T.W.;*** *to Longwood Blackwater, operates well within capacity, is reasonably satisfactory, with occasionally high suspended solids*

- ***Navan S.T.W.*** *; to River Boyne, is overloaded and has unsatisfactory effluent, particularly as regard suspended solids*

- ***Slane S.T.W.;*** *to River Boyne, is within capacity, with a high quality effluent generally*

- ***Summerhill S.T.W.;*** *to Knightsbrook River, is within capacity with satisfactory effluent apart from occasional failures*

- ***Trim S.T.W.;*** *to River Boyne, overloaded with reasonable effluent generally but occasional failure of BOD, suspended solids standards and high ammonia discharge*

- ***Bailieboro S.T.W.;*** *shows a high quality effluent in terms of BOD, suspended solids, ammonia and phosphates*

- ***Mullagh S.T.W.;*** *shows a reasonable effluent to the Moynalty River, generally to a satisfactory standard*

- ***Virginia S.T.W.;*** *for the old septic tank works, this effluent received negligible treatment, and a new sewage treatment plant is under construction*

It is accepted that water quality in the vicinity of an outfall may not comply with the general standard for the river stretch (mixing zone). However, outfalls should be located with care to ensure that acute toxicity will not arise and that the mixing zones will not act as barriers to prevent the passage of migratory fish. In addition, the following criteria should apply at outfalls:-

- *Effective screening and detritus control must be in place to ensure the absence of visual or aesthetic nuisance from sewage derived debris.*

- *The discharge should be free of scum, oil and floating debris*

- *The discharge should be free of substances which produce odour, colour, taste or turbidity*

- *The discharge should not give rise to objectionable growth of nuisance plants, sewage fungus or animal species associated with sewage*

More detailed operational data on the existing wastewater treatment plants, their current status and available effluent sampling data are contained in Appendix 5. In general, the smaller activated sludge plants perform moderately satisfactorily with occasional solids carryover due to the difficulty of controlling a stable sludge level. This can result from occasional hydraulic overload, flushing out sludge solids, or irregular desludging.

TABLE 4.9 - MUNICIPAL WASTE WATER EFFLUENTS DISCHARGES (Ref. To Map No.6)

Map Ref	Name	Receiving Water	Capacity	Current Load	Average Load to River		Comment
			P.E.	P.E.	B.O.D. $_5$ kg/d	Ortho- phosphate mg/l P.	
1	Athboy S.T.W. (extended aeration)	Athboy River	2500	1450	12	6.8	Plant within capacity for B.O.D.
2	Crossakiel S.T.W. (extended aeration)	Athboy River	400	150	1	6.6	Plant within capacity
3	Clonmellon S.T.W. (extended aeration)	Athboy Tributary	600	300	2.5	3.5	Plant within capacity
4	Johnstown Bridge (extended aeration)	Blackwater (Longwood)	1000	518	4	n/s	Plant within capacity
5	Longwood S.T.W. (extended aeration)	Blackwater (Longwood)	700	100	1	1.6	Plant within capacity
16	Trim S.T.W. (extended aeration)	River Boyne	4000	5400	49	5.6	Plant overloaded

TABLE 4.9 - MUNICIPAL WASTE WATER EFFLUENTS DISCHARGES (Ref. To Map No.6)

17	Edenderry S.T.W. (E.A. and grass plot tertiary treatment)	River Boyne	5000	4000	32-40	6.0-6.8*	Irish Country Meats additional load added *Total-P
6	Dunderry S.T.W. (package extended aeration)	Clady River	250	180	1.5	15	Works adequate
7	Kinnegad S.T.W. (new works)	Kinnegad River	-----	2000	9	-----	New works satisfactory
8	Summerhill (extended aeration)	Knightsbrook River	260	750	2	3.3	Well within capacity
9	Dunshaughlin S.T.W. (extended aeration)	Skane River	1500	2500	10	-----	River flows inadequate for this effluent
10	Kilmessan S.T.W. (extended aeration)	Skane River	600	206	200-300	13.3	Some abattoir load (max 5kgs B.O.D_5 /d). Plant Satisfactory
11	Delvin S.T.W. (Septic Tank)	Stoneyford River	-----	400	20	7.5	New treatment plant nearing completion
12	Ballivor S.T.W. (extended aeration)	Stoneyford River	600	500	4	1.8	N.E.C. effluent also discharges 2.25kgs/d B.O.D_5

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TABLE 4.9 - MUNICIPAL WASTE WATER EFFLUENTS DISCHARGES (Ref. To Map No.6)

14	Rochfort Bridge S.T.W.	Castlejordan Tributary	New Plant 1500	500	8	10	New E.A. plant for 1500 P.E.
15	Kilucan-Rathmire S.T.W. (extended aeration)	Riverstown River	600	300	2.5	4	Satisfactory Capacity
18	Rhode S.T.W. (Imhoff Tank)	Yellow River	400	500	16	n/a	Doubtful capacity/performance Substantial E.S.B. discharge also
24	Bailieboro S.T.W. (extended aeration)	Lear River	2500	1500	4	n/a	New plant has adequate capacity
36	Collon S.T.W. (extended aeration)	Mattock River	500	350	3	n/a	Sampling results less than satisfactory
39	Donore S.T.W. (extended aeration)	River Boyne	600	320	2.6	3	Plant is satisfactory for present loads
33	Kells S.T.W. (extended aeration)	Kells Blackwater	5000	3000	24.3	5.1	Plant capacity is adequate
	Lloyd S.T.W. (extended aeration)	Kells Blackwater	350	100	1	n/a	Surplus plant capacity
31	Moynalty S.T.W. (Septic Tank)	Moynalty River	-----	200	6	n/a	Poor effluent quality

TABLE 4.9 - MUNICIPAL WASTE WATER EFFLUENTS DISCHARGES (Ref. To Map No.6)

28	Mullagh S.T.W. (extended aeration)	Moynalty River	-----	435	3.5	3.2	Adequate Capacity
34	Navan S.T.W. (extended aeration)	River Boyne	10000	23800	400-450	n/a	Major plant upgrading planned to 60,000 p.e.
35	Slane S.T.W. (extended aeration)	River Boyne	1500	700	6	3.2	Adequate capacity
37	Tullyallen S.T.W. (extended aeration)	River Boyne	500	200	1.6	5.2	Adequate capacity
26	Virginia S.T.W. (Septic Tank)	Louth Ramor	-----	1100	35	8-10	Proposed new works for 2000 P.E. with "P" Removal

4.8 Industrial Discharges

There are a significant number of industrial discharges to the Boyne River system, many of them relatively small trade wastes or institutional discharges.

The larger industrial discharges licensed in the catchment are summarised in Table 4.10. These Licences are subject to periodic review and the Licence conditions include requirements for monitoring of compliance.

In the case of Irish Cement and Tara Mines, the main issues relate to inorganic parameters such as suspended solids and in the case of the mines discharge, heavy metals.

The Bailieboro Co-op discharge to the Lear River follows tertiary treatment on grass plots designed to achieve a very high standard of effluent including a limit of 1mg/l P. This is necessary to protect the downstream lakes from eutrophication.

The ESB Power Station at Rhode has a significant discharge to the Yellow River which has low base flows. This discharge requires review.

TABLE 4.10 - MAJOR INDUSTRIAL WASTE EFFLUENTS - BOYNE CATCHMENT

Licencee	Receiving Water	Licence or Estimated			Other
		Flow	BOD 5 mg/l	S.S. mg/l	
Irish Cement Donore	River Boyne	8600 m^3/d	20	30	Quarry effluent
Tara Mines Ltd Navan	River Boyne	max $45m^3/min$	-----	-----	100 : 1 dilutions required in Boyne to effluent metals limits stated
Virginia Milk Products	Lough Ramor	38m3/hr	20	30	9mg/l P, Ph6-9. Sampling results show compliance
Ditto-Cooling Water	Lough Ramor	$360m^3/hr$	-----	-----	Uncontaminated
Wellman International	Moynalty	-----	20	20	Fibre Plant - BOD limit 13.6 kgs/d, other parameter limits
Bailieboro Co-op	Lear River	$820m^3/d$	20*	30*	Effluent land-spread 1mg/l P *reduced by grass plot treatment to 1.03 kgs BOD/d.
Bailieboro Co-op	Lear River	$1450m^3/d$	-----	-----	Cooling water only
E.S.B., Rhode	Yellow River	$1136m^3/d$	32 measured	84 measured	Requires detailed assessment

Appendix 6 contains results of sampling and analysis of effluent at Bailieboro Foods, Virginia Milk Products and Wellman International, all in Co. Cavan. Recent results show:-

- ***Bailieboro Foods** ; results are generally reasonable, with some failures and one notable very poor effluent (11/4/95). The cooling waste effluent quality is generally low in organic and nutrient load.*

- ***Virginia Milk Products** ; effluent analysis indicates a very high quality discharge with low organic load*

- ***Wellman International** ; the data shows a reasonable effluent, with some inconsistency and occasional elevated BOD and suspended solids concentrations*

4.9 Storm Sewer Overflows and Other Issues

Apart from treatment plant effluents, consideration is required to be given to storm sewer overflows from combined systems. Most urban developments in excess of **25 years** old are drained on a combined system with both storm and foul discharges collected in a common sewer network. In such systems, it has been the practice to provide overflows to relieve the hydraulic loading in times of rainfall. This practice can give rise to significant pollution in a number of respects:-

- *Organic pollution measured in terms of BOD*

- *Bacteriological impact, related to the volume of discharge*

- *Ammonia discharges which can give rise to concentrations which result in toxic conditions for fish life*

- *Hydrogen Sulphide concentrations can be discharged at the outset of a storm, when settled organic matter is re-suspended in sewers. This is extremely toxic in receiving waters and is difficult to detect, being oxidised very quickly*

- *Nutrient loads are carried over in the discharge spill in both soluble and particulate form which may contribute to enrichment of bed sediments*

- *Sediment deposits containing high organic loading can be discharged at overflows resulting in detrimental environmental and aesthetic impact*

- *Where industrial wastes are present in the sewer, metals and other toxins can be discharged*

Criteria for combined sewer overflows have been evolved by the Department of the Environment which are regarded as complying with the Urban Wastewater Treatment Directive. These criteria include the following:-

- *A minimum overflow setting below which overflows will not occur. This is normally expressed as a multiple of the dry weather flow (DWF) and is typically in the order of 6-7. Where high strength industrial effluents are discharged to the sewer system, the settings would require to be adjusted accordingly*

- *The type of storm overflow structure should be such as to ensure efficient hydraulic control and solids separation. Guidelines for such structures are contained in the WRC Guidelines (UK), ref. ER 304 E*

- *The locations of overflow discharge points should be discreetly located and should have effective control of floating debris to avoid aesthetic nuisance*

- *A dilution standard should be applied which will ensure a maximum BOD limit in the river of 20mg/l and ideally 10mg/l. The use of storage and recycling can be used to control spill frequency and this is particularly appropriate for bathing or recreational use waters (4, 8 or 16 times per year)*

- *Consideration should be given to preventing overflow spills during "first flush" conditions. This is usually achieved by ensuring that overflows will not occur within the time of concentration of the sewer network. During the early period of the storm, sewage strengths can increase considerably as sediment and slime is re-suspended into the flow. Afterwards, the concentrations tend to fall considerably*

- *Significant overflows in the catchment should be monitored using automatic recording equipment to measure spill frequency and duration and with provision for automatic sampling*

The foregoing criteria are applied to overflows from combined or partially combined sewer systems and to similar overflows from pumping stations and at the inlet to treatment plants. Separate storm drainage systems can also be contaminated to a significant extent due to organic material washed into the sewers and mis-connections, particularly from dishwasher and washing machine discharges. These issues require policing to ensure that they are satisfactory.

Storm drainage systems for petrol stations and other areas where oil spillages are likely, should always be fitted with oil traps. In sensitive receiving waters, provision of oil and grit traps might also be considered on the outlets from road drainage systems, etc.

4.10 Legislation and Regulations

4.10.1 Legislation

The control of water pollution is principally governed by the Local Government (Water Pollution) Act 1977 and the Local Government (Water Pollution) (Amendment) Act 1990 together with the associated Local Government (Water Pollution) Regulations 1978 to 1996. In essence, it is a statutory offence under the Water Pollution Act to "cause or permit any pollutant matter to enter waters". One of the main provisions of the Act is to provide for a licensing system to control the discharge of trade or sewage effluent to a watercourse or sewer.

The Act requires that any undertaking which is going to discharge trade effluent or sewage to a watercourse must apply for a licence. Such licences are issued subject to conditions laid down by the Local Authority. Effluent monitoring to be carried out by the licencee is normally a licence requirement and the results must be made available for inspection at any time by the Local Authority Failure to comply with the terms of a licence is a statutory offence, and while in theory any person may prosecute the culprit, in practice due to the difficulties in obtaining proof, only the Local Authority or the Fishery Boards have taken prosecutions.

The Local Authority is given a general power to take any action it deems necessary to prevent pollution or remove polluting matter from waters and the polluter is liable to repay the full cost of these measures to the Local Authority. The Act also enables the Local Authority to serve notice requiring specific action to be taken to prevent polluting matter from entering waters and for the recovery of the costs of such action.

The Amendment Act of 1990 essentially strengthens the provisions of the 1977 Act and the water pollution control provisions of the Fisheries (Consolidation) Act, 1959. The fines have been substantially increased under the 1990 Act whereby the maximum fine on summary conviction has increased from £250 to £1,000 and on conviction on indictment from £5,000 to £25,000. These increases apply to offences under both the Water Pollution and the Fisheries Acts. The Principal (1977) Act provides in Section 17 for review of licences for discharge to sewer at intervals of not less than three years.

In addition to the provisions in Irish Law, there are a number of directives and regulations emanating from the European Union concerning water quality. Regulations are binding in their entirety and immediately applicable in all members states. Directives on the other hand leave the form and methods of achievement to the discretion of the national authorities and are binding on the member states to which they are addressed.

The directives relevant to the Boyne are listed below:-

- *The Directive concerning the Quality Required of Surface Water Intended for the Abstraction of Drinking Water in member states (75/440/EEC) and Irish Government Regulations (S.I. No.294 of 1989)*

- *The Directive concerning the Methods of Measurement and Frequency of Sampling and Analysis of Surface Water Intended for the Abstraction of Drinking Water in member states (79/869/EEC), Regulations also included in (S.I. No.294 of 1989)*

- *The Directive on the Quality of Freshwaters Needing Protection in order to Support Fish Life (78/659/EEC) and associated Regulations (S.I. No. 293 of 1988)*

- *The Directive concerning Urban Waste Water Treatment (91/271/EEC) and the Environmental Protection Agency Act, 1992 (Urban Waste Water Treatment) Regulations (S.I. No. 419 of 1994)*

- *The Directive on the Protection of Waters Against Pollution Caused by Nitrates from Agricultural Sources (91/676/EEC)*

4.10.2 Integrated Pollution Control

A recent development in pollution control in Ireland is the introduction of a new licence called the Integrated Pollution Control or IPC Licence. This licence is administered by the Environmental Protection Agency which was established by the Environmental Protection Agency Act of 1992. The licensing function of the Agency commenced on the 16th May, 1994 and is being expanded on a phased basis to cover scheduled industry categories.

The concept of an IPC Licence has been gaining importance in recent years. Its main environmental objective is to prevent or solve problems rather than transferring them from one environment to another. Consequently, only one licence is issued to cover all aspects of air, water, waste and noise. The licence will involve a more holistic approach to pollution control with all aspects of the environment including air, water, noise etc., provided for under the one licence. The IPC licence, when issued, will replace the existing Local Authority Licence.

A comprehensive monitoring programme will be required as part of the IPC procedure, with sampling and analyses of the following parameters demanded by a typical licence.

- *Emissions to Atmosphere*
- *Atmospheric Emissions - Abatement/Treatment Control*
- *Monitoring of Atmospheric Conditions*
- *Effluent Treatment Control*
- *Monitoring of Emissions to Waters*
- *Toxic and Dangerous Waste Disposal - off-site*
- *Other Wastes*
- *Analysis of wastes for disposal off-site by landfill*
- *Noise*
- *Surface water monitoring on-site*
- *Groundwater monitoring on-site*
- *Reporting*

It will also be a condition of the licence that incidents are reported by phone or fax to the Agency's Headquarters in Wexford as soon as practicable after the occurrence. Action must be taken to minimise the effect on the environment and minimise any waste generated.

4.11 Summary

This section has examined beneficial uses of the River Boyne system which require certain minimum standards of water quality for their existence. At the same time, it has considered the pressures on the river system, primarily wastewater discharges, which tend to cause water quality deterioration. In the management of the river system, minimum standards must be applied which can reliably ensure that all of the beneficial uses can be sustained at present and into the future.

A legislative framework exists to support environmental management by setting minimum standards for compliance and the use of licensing to control emissions. The standards relate to the nature and beneficial uses of waters but also include uniform emission standards for waste discharges.

TABLE 4.11 BOYNE WATER QUALITY - NATIONAL AND E.U. STANDARDS

Parameter	Units	Salmonid Water EU 78/659/EEC & S.I. 293,1988		Raw Water Quality (A2) EU 75/440 & S.I. 294,1988		Bathing Water Standard EU 76/160 & S.I. 84,1988		Comment
		G. Values	I. Values	G. Values	I. Values	G. Values	I. Values	
Ammonia								
- Un-ionised	mg/l NH4	.005	0.025	<1.0 (N)	<1.5 (N)			
- Total	mg/l NH4	.04	1.0					
Bacteria								
- Total Coliforms	/100ml			5,000	25,000	500	5,000	
- Faecal Coliforms	/100ml			2,000	5,000	100	1,000	
- F. Streptococci	/100ml			1,000	2,000	100	300	
- Salmonella	/500ml			None	None/100ml	-	-	
BOD_5	mg/lO_2	3.0	5.0	<5.0	5.0			
Dissolved Oxygen	mg/lO_2 % Sat	50% >9 100%>7	50% >9		>50%	80%-120%		Salmonid Waters - Special Provisions if <6mg/l O_2
Nutrients								
- Nitrates	mg/l N				50 as No_3			1.0mg/l in D.O.E. Guidelines
- Nitrites	mg/l N		0.05					
- Phosphates	mg/l P		0.07	0.36				0.7 as P_2O_5 - Raw Water (G)
Metals								* Hardness 250 - 350 may Permit Values >0.3
- Zinc	mg/l Zn		0.3*					

5.0 Current Water Quality

5. *Current Water Quality*

5.1 *Introduction*

Water quality in the River Boyne catchment has been assessed as follows:-

- ***Biological monitoring;*** *biological assessment expressed as a biotic index which combines diversity on the basis of certain taxonomic groups, with the pollution indication of individual species or groups, into a single index or score. The water resources branch of the EPA (formerly ERU) has developed a biotic index suitable for the procedures used in the evaluation of Irish Water Bodies. The basis of the index is summarised in **Table 5.1**. It provides a relationship between water quality and typical riffle fauna ranging from Q_1 (bad) to Q_5 (good). These ratings can be further interpreted to four basic classifications of "unpolluted", "slight pollution" "moderate pollution" and "serious pollution" at times.*

- ***Physico-chemical assessment ;*** *physical and chemical parameters which can determine the characteristics of the water column based on laboratory analysis. These parameters can be referenced to specified standards such as those previously summarised in E.U. Directives and associated National Regulations (dissolved oxygen, BOD, suspended solids, phosphates, nitrates, ammonia, etc.)*

- ***Microbiological assessment ;*** *generally used to assess the public health issues associated with water quality. Typical microbiological parameters are total coliforms, faecal coliforms, faecal streptococci, salmonella and entero-viruses. These parameters are particularly significant in the context of the bathing water and drinking water standards (see 4.9)*

- ***Trophic status ;*** *based on assessment of plant and algal production associated with nutrient loads. This is an important parameter in the context of lakes and slow moving rivers where nutrient enrichment can result in very serious water quality impacts such as severe algal blooms with associated severe changes in oxygen concentration, water quality and taste problems due to subsequent algal decay*

5.2 *Biological Quality Assessment*

The EPA carry out regular biological assessment of Irish rivers which provide a basis for determining current water quality status and trends over time. Biological assessment has important advantages over chemical data in the following respects:-

- *Biological organisms integrate pollution effects over time, whereas chemical data represents a once off representation of conditions in the water column at a test location*

- *Biological communities integrate the effects of multiple stresses and demonstrate cumulative impacts*

- *Biological communities can serve as early warning by detecting intermittent pollution and subtle changes, missed by occasional chemical surveys (e.g. the impact of storm sewer overflows)*

Well documented changes occur in the biota of rivers and streams in response to pollution. The use of indicator species, i.e., those which by their presence and abundance are indicative of the prevailing environmental conditions, is well established. Macro-invertebrates (visible with the naked eye) tend to be the most commonly used taxa, classified as sensitive, less sensitive, relatively tolerant, tolerant or most tolerant forms.

TABLE 5.1 THE BIOTIC INDEX WATER QUALITY SCHEME OF THE ENVIRONMENTAL RESEARCH UNIT (after Mc Garrigle et Al, 1992).

The Faunal Groupings

Group A - Sensitive Forms	Group C - Relatively Tolerant Forms	Group D - Tolerant Forms
Plecoptera (excl. Leuctra sp. Nemouridae), Heptageniidae, Siphlonuridae Cased Trichoptera	Tricladida, Ancylidae, Neritidae, Astacidae, *Gammarus sp.*, *Baetis rhodani*, Caenidae, Limnephilidae, Glossosmatidae, Uncased Trichoptera, Coleoptera, Coenagriidae, Sialidae, Tipulidae, Simuliidae, Hemiptera (excl. *Aphelocheirus sp.*) Hydracarina	Hirudinea, Mullusca (excl. Ancylidae, Neritidae) *Asellus sp.* Chironomidae (excl. *Chironomus sp.*, *Rheotanytarsus sp.)*

Group B - Less Sensitive Forms	Group E - Most Tolerant Forms
Leuctra sp.. Nemouridae, Baetidae (excl. *Baetis rhodani*), Leptophlebiidae, Ephemerellidae, Ephemeridae, Cased Trichoptera (excl. Limnephilidae, Hydroptilidae, Glossosmatidae), Odonata (excl. Coenagriidae) *Aphelocheirus sp.*, *Rheotanytarsus sp.*	*Chironomus sp.*, Tubificidae

RELATIONSHIP BETWEEN WATER QUALITY AND THE TYPICAL RIFFLE FAUNA

Quantity	Q_V	A	B	C	D	E
Eroding Sites						
Good	Q_5	++++	+++	++	+/-	+/-
Fair	A_4	++	++++	+++	++	+/-
Doubtful	Q_3	-	+/-	++++	+++	++
Poor	Q_2	-	-	+/-	++++	+++
Bad	Q_1	-	-	-	+/-	++++
Depositing Sites						
Good	Q_5	+/-	++++	+++	++	+/-
Fair	Q_4	-	++	++++	++	+/-
Doubtful	Q_3	-	+/-	++	+++	+++
Poor	Q_2	-	-	+/-	+++	+++
Bad	Q_1	-	-	-	-	++++

++++ Abundant, +++ Common, ++ Present, +/- Sparse or Absent, - Absent

Biotic Index or Q-Value	Community Diversity	Water Quality	Condition
Q5	High	Good	Satisfactory
Q4	Slightly Reduced	Fair	Satisfactory
Q3	Significantly Reduced	Doubtful	Unsatisfactory
Q2	Low	Poor	Unsatisfactory
Q1	Very Low	Bad	Unsatisfactory

This is further classified in 4 general pollution classes as follows:-

Biotic Index	Quality Status	Classification
Q5,Q4-5,Q4	Unpolluted Water	Class A
Q3-4	Slightly Polluted Water	Class B
Q3,Q2-3	Moderately Polluted Water	Class C
Q2, Q1-2,Q1	Seriously Polluted Water	Class D

Biotic indices, therefore, are used to determine water quality status as regards organic pollution. They are not designed to detect toxic pollution and should therefore be combined with physico-chemical assessment of the water column and bed sediments. Since most of the pollution occurring in Irish rivers is organic, the use of a biotic index provides a useful method of interpreting the significance of the invertebrate communities in terms of water quality.

The EPA survey method involves complete assessment of the site in the field, including ascribing a Q-Value. Preference is given to riffled sites with turbulent flow conditions and hand-net sampling is carried out according to ISO standard 7828-1985 (McGarrigle et.al. 1991). This involves kick sampling for 2-5 minutes with a similar period spent picking animals from stones to ensure that those with sufficient holdfast mechanisms are included in the sample.

The sample is transferred to a tray and a field inventory of the invertebrates is made on site. The general conditions such as botton substratum, velocity, clarity, presence or absence of sewage fungus, macrophytes or algae are also recorded. The data is then condensed into a 5 point biotic index of Q-value, which is interpreted as follows:-

Class A waters are considered unpolluted and can be regarded as satisfactory. Water classified as B and C are likely to have an adverse effect on beneficial uses to a lesser or greater extent. Class D waters are seriously polluted and may be incapable of sustaining aquatic life.

5.2.1 Biological Assessment of Boyne River System

The site locations where biological monitoring of the River Boyne is carried out in the catchment are shown in **Map No.9** and the data is summarised in **Table 5.2a** for stations on the main river channel. **Fig. 5A and 5B** are extracted from the ERU Reports (1991 and 1995) entitled "Ireland - River Quality". In this map, blue signifies unpolluted (Class A), green signifies slightly polluted (Class B), brown signifies moderately polluted (Class C) and red signifies seriously polluted (Class D). **Table 5.2** gives historical data for the Boyne River and more recent 1994 data.

An overview of the Boyne catchment for 1994 data **(Tables 5.2)** indicates the following:-

- *The main River Boyne channel is relatively unpolluted from Slane to Drogheda and upstream of the Stonestown River tributary. The Kells Blackwater is of similar quality in its lower reaches, as is the Stonyford River and Lough Lene*

- *Rivers indicated as slightly polluted include the Boyne channel upstream of Slane to upstream of Trim, the Moynalty River, the Athboy and Deel Rivers, the Yellow River and the downstream section of the River Blackwater (Longwood)*

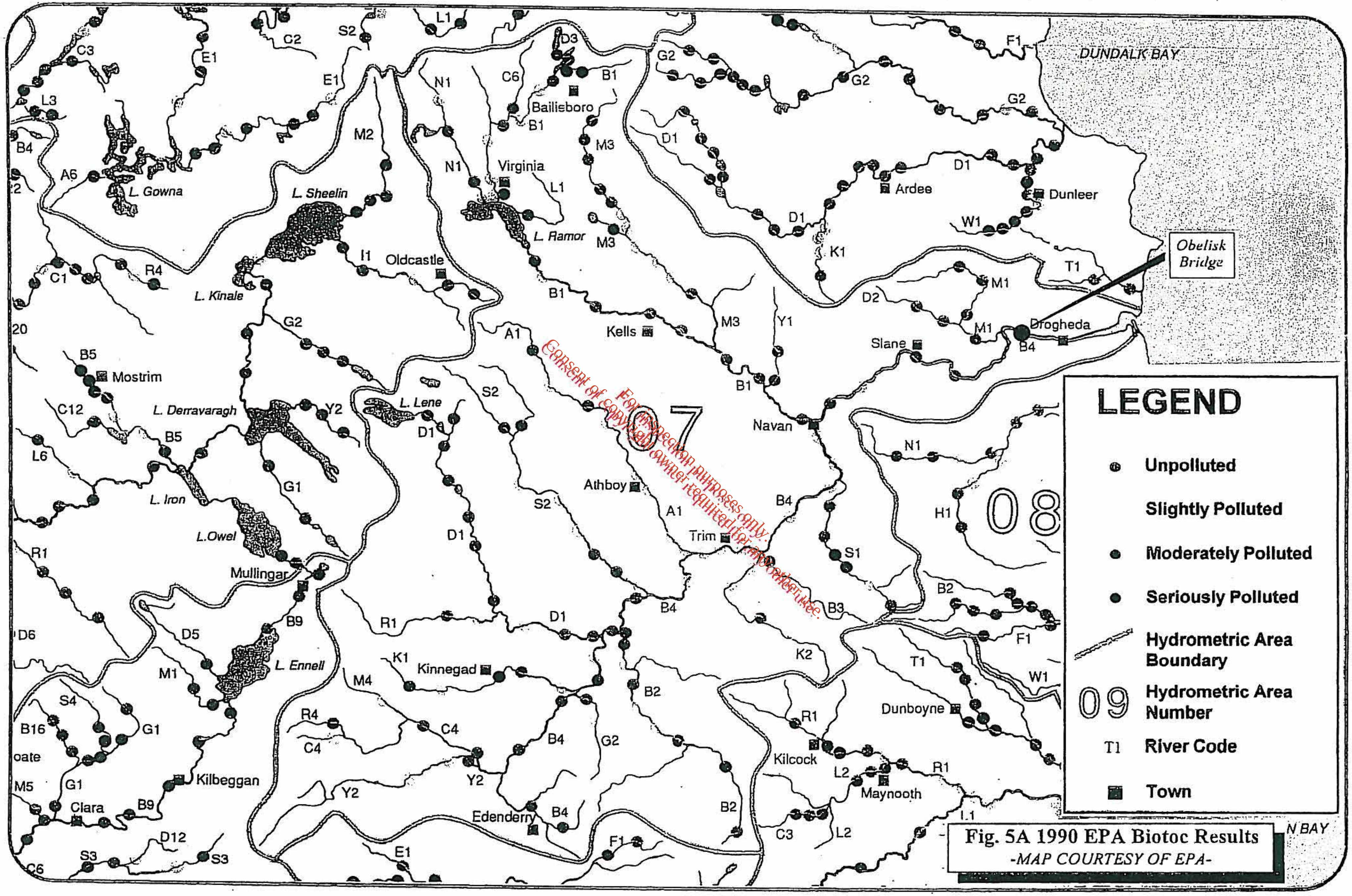

Fig. 5A 1990 EPA Biotoc Results

-MAP COURTESY OF EPA-

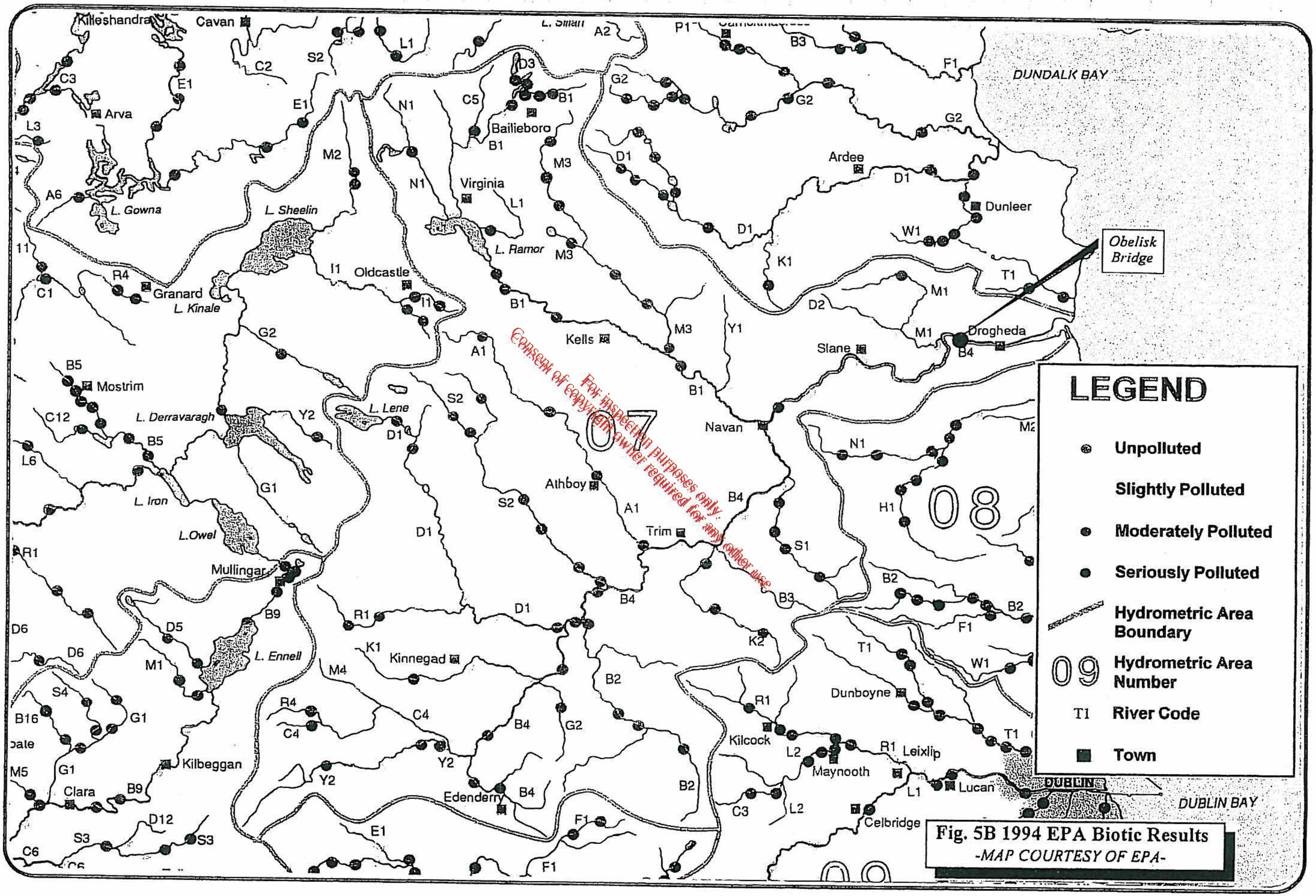

Fig. 5B 1994 EPA Biotic Results

-MAP COURTESY OF EPA-

- *Moderately polluted sections of the Boyne system include the upper sections of the Moynalty and Kells Blackwater upstream of Lough Ramor and at the lake outlet, the Skane River, the upper sections of the Longwood Blackwater, and on the Riverstown River upstream of Kinnegad and in the vicinity of Edenderry*

- *Seriously polluted classifications apply to a short stretch of the Kells (Blackwater) upstream of Castle Lake, Bailieborough*

This data indicates extensive sections of slightly polluted river with local sections moderately polluted and with occasional black spots. The least satisfactory sections are the upper reaches of the Kells Blackwater and Moynalty Rivers in Co. Cavan and the smaller tributary rivers in the south-east of the catchment.

Reference to the Q ratings for the River Boyne, in **Table 5.2**, indicates that there has been a slight general decline in water quality in recent years (1971-1994). This decline reflects increased nutrient enrichment, primarily phosphates arising from municipal sewage and agricultural run-off.

Table 5.2 refers to the main River Boyne channel only. Similar Tables of biological rating are presented in Appendix 2 for the various tributary rivers. A general overview of the biological data in the Appendix indicates as follows:-

- ***River Boyne - main channel** ; showed deterioration during the 1970's particularly in the upper channel but has significantly improved and is now classified generally as slightly polluted. Some deterioration between 1986 and 1994 may reflect increased eutrophication*

- ***River Athboy** ; the Athboy River data indicates slightly polluted tending towards moderately polluted. This appears to be associated with sewage discharge at Athboy and general pollution*

- ***Longwood Blackwater** ; this river also qualifies as slightly polluted. There has been a reduction in the extent of serious pollution in the upper reaches in recent years.*

- ***Castlejordan River** ; Data indicates moderately polluted river showing disimprovement compared with previous samplings. A new STW at Rochfortbridge recently commissioned should improve water quality*

- ***Clady River** ; this small river shows seriously to moderately polluted water quality consistently through the 1980's associated with sewage discharge*

- ***River Deel** ; water quality in the River Deel is slightly polluted with little change over time*

- ***Kinnegad River** ; the Kinnegad River is shown as slightly polluted, though significantly improved between the 1970's and 1990's. Improvement in sewage treatment at Kinnegad is reflected in recent improvement.*

- ***Knightsbrook River*** *; the Knightsbrook River is indicated as moderately polluted to unpolluted downstream near the River Boyne confluence. This is associated with both municipal and agricultural run-off. The river shows significant improvement from earlier samplings*

- ***River Skane*** *; the River Skane is indicated as moderately polluted. This is associated with sewage discharges but has shown a striking reduction in pollution recently.*

- ***Stonyford River*** *; the Stonyford River is indicated as relatively unpolluted with little change in biological improvement over time*

- ***Tromman Stream*** *; a single set of data on the Tromman Stream in 1985 showed it to be moderately polluted to unpolluted*

- ***Yellow River*** *; available data on the Yellow River to 1985 indicated unpolluted with marginal improvement over time*

TABLE 5.2 : EPA BIOLOGICAL QUALITY RATINGS - RIVER BOYNE

Station Ref.	Location	Quality (Q) Ratings								
		1971	1973	1975	1977	1979	1981	1986	1990	1994
0100	River Bridge	4-5	ND	ND	ND	ND	3-4	4	4	ND
0160	Kishawanny Bridge	ND	ND	ND	ND	ND	ND	ND	ND	3-4
0200	Boyne Bridge	2-3	3-4	3-4	3	4	4	4	3	4
0300	Kinnafad Bridge	2-3	2-3	2	1-2	2-3	4	4	ND	3
0400	Ballyboggan Bridge	4-5	3	ND	4-5	4	4	4	4	4
0500	Leinster Bridge	ND	ND	ND	ND	ND	4	ND	4	ND
0600	Ashfield Bridge	4-5	ND	4	4	4	4	4-5	4	4
0700	Stonyford Bridge	ND	ND	ND	ND	ND	3-4	4	3-4	ND
0800	Inchamore Bridge	4-5	ND	3	4	4	4-5	4-5	4	4
0900	Scarriff Bridge	5	ND	3-4	4	4-5	5	5	4	4
1000	Derrinydaly Bridge	5	ND	ND	4	4	5	5	3-4	3-4
1100	d/s Athboy R. Confluence	5	ND	4-5	4-5	3-4	4	4	3-4	ND
1200	Trim West Bridge	ND	ND	ND	ND	ND	4	4-5	3-4	3-4
1300	Newtown Trim Bridge	4-5	ND	4	4	3-4	4	4	3-4	ND
1400	500m d/s Knightsbrook R.	ND	ND	ND	3	3-4	3-4	4	3-4	3-4
1500	Bective Bridge	5	ND	4-5	3-4	4-5	5	5	3-4	3-4
1600	Ballinter Bridge	ND	ND	ND	ND	ND	4	4-5	3-4	3-4
1700	Kilcarn Old Bridge	5	ND	4	4	3-4	4	4-5	3-4	ND
1800	Navan Railway Bridge	ND	ND	ND	4	4	4	4-5	3-4	3-4
1900	2km d/s Navan	4	4	4	3-4	3	3-4	4	2-3	3
2000	Broadboyne Bridge	ND	ND	ND	ND	ND	ND	4	ND	ND
2010	500m d/s Broadboyne Bridge	ND	ND	ND	ND	ND	ND	ND	3-4	3-4
2100	Slane Bridge	4-5	4-5	4	4	4	4-5	4	4	3-4
2150	Ford S. of Broc House	ND	ND	ND	ND	ND	ND	ND	4-5	4
2200	Oldbridge	5	4-5	3	ND	ND	4	4	ND	3-4
2300	Drogheda West Bridge	ND	ND	ND	ND	ND	ND	ND	ND	ND
2400	Drogeda Railway Viaduct	ND	ND	ND	ND	ND	ND	ND	ND	ND

*ND = No Data

3/jg/cb/boyne/reports/6959a

- ***River Blackwater (Kells)*** *; this river is shown as grossly polluted in it's upper reaches, improving to slightly polluted/moderately polluted in the middle reaches and relatively unpolluted in it's lower reaches. Overall, the middle and lower reaches of the river have slightly disimproved over time up to 1994*

- ***River Devlin*** *; data on this river shows it to be slightly polluted and somewhat disimproved from the mid-1980's*

- ***Drumkeery Lough Stream*** *; this is indicated as moderately polluted, improved since 1990*

- ***Lislea River*** *; indicated as unpolluted with no change recently*

- ***Mattock River*** *; the Mattock River is indicated as slightly polluted to un-polluted over it's length, which is an improvement over the years*

- ***Moynalty River*** *; this river is generally slightly polluted with a local black spot on the Chapel Lake branch*

This biological data on the River Boyne system provides an overview of the water quality environment. It indicates a reasonably satisfactory situation overall in the catchment, with a number of remaining black spots and with indications of an increase in the extent of slightly to moderately polluted river. This is almost certainly associated with eutrophication arising from nutrient enrichment.

Biological rating is an essential part of water quality assessment, providing a reliable indicator of general quality and change over time. It is particularly useful in assessing the cumulative impact of general pollution or occasional discharges which may not be identified in periodic water sampling. A programme of annual biological sampling should be implemented as part of water quality management of the River Boyne System.

5.3 Physico-chemical Assessment

Regular sampling is carried out in the Boyne River System for a range of physico-chemical parameters by the local authorities in association with EPA. Appendix 3 of the Technical Data contains summary Tables of water quality data for catchment rivers. The sampling locations on each river are tabulated, together with the EPA reference number, where relevant.
This sampling programme provides a water quality database from which the following can be established:

- *The parameter values in the water column which can be used to monitor pollution levels based on guideline values, for example, the limits in the relevant E.U. directives and associated National Regulations.*
- *Trends can be evaluated over time and by river reach.*
- *Physico-chemical data is particularly useful to trace pollution incidents to outfalls and primary sources.*
- *The effects of discharge loads can be assessed, relative to baseline values and guideline limits, by sampling upstream and downstream of discharges.*

This ongoing monitoring programme requires the implementation of an environmental database management system which would allow for data update, analysis, trending and reporting. The development of a Water Services G.I.S., currently underway by the Local Government Computer Services Board, will provide for management of environmental data, allowing spatial reference and visual displays including thematic mapping.

The following parameters are monitored on a routine basis:-

- *Biochemical Oxygen Demand (BOD)*
- *Dissolved Oxygen*
- *Nitrate*
- *Phosphate*
- *Suspended Solids*
- *pH*
- *Temperature*
- *Conductivity*
- *Colour*

- *Turbidity*
- *Faecal Coliforms*
- *Chloride*
- *Chemical Oxygen Demand (COD)*

Biochemical Oxygen Demand

BOD is a measure of the biological activity of the water. When organic matter is discharged to a river, it serves as a food source for the bacteria present and is broken down to simple compounds such as carbon dioxide and water. The amount of oxygen required in this breakdown is known as the oxygen demand. The five day BOD test, (BOD_5) which is the standard analytical procedure, is the amount of dissolved oxygen taken up by bacteria in degrading oxidisable matter in the sample, measured after five days incubation in the dark at 20 deg.C. The resulting drop in dissolved oxygen is the BOD of the sample. BOD is expressed in mg/l of O_2 and the standard for Salmonid waters is less than or equal to **5mg/l O_2**. There is no health significance to BOD but it is a very important parameter as it gives an indication of the amount of organic matter in the waterbody.

Dissolved Oxygen

An unpolluted water will be saturated with oxygen and a concentration of 9.2mg/l represents 100% saturation at 20 deg.C. Oxygen solubility has an inverse relationship with temperature and therefore concentrations will be higher in Winter. High algal growth can cause severe oxygen variations due to alternate photosynthesis and respiration. The levels of dissolved oxygen are particularly critical to fish, with salmonid fish species adversely affected if levels fall to around 50% saturation. Normal values are in the range of 80% to 120% of saturation. In salmonid waters, at least 50% of samples should have dissolved oxygen concentration of 9.0mg/l or more, with 100% greater than 7 mg/l O_2.

Nitrate

Nitrate (NO_3) is an important parameter in terms of eutrophication or nutrient enrichment and gives a good indication of run-off from agricultural activities. It is also an indication of sewage contamination and its presence in freshwaters is indicative of human activity. The units of measurement are mg/l, usually expressed as mg/l N. It's significance from a health perspective is that high nitrate levels in drinking water are very hazardous to infants and may induce methaemoglobinaemia or blue baby syndrome. There is no standard for salmonid waters. Due to its relative abundance, it is rarely the controlling nutrient for algal and plant growth in fresh waters. For surface waters for abstraction, the limit is 50 mg/l as NO_3 (S.I. 294).

Nitrite

Nitrite (NO_2) normally exists in relatively low concentration, even in sewage, because Nitrogen will tend to exist in a more reduced form (Ammonia - NH_3) or more oxidised state (Nitrate - NO_3). Values greater than about 0.01mg/l N in freshwaters can be indicative of sewage discharge. The salmonid water regulations specify a limit of 0.05mg/l NO_2.

Phosphate

Phosphates, expressed as mg/l P, are particularly important in terms of eutrophication. Excessive levels cause serious eutrophication, particularly in lakes, though rivers with poor flow regime are also affected. This is associated with algal blooms and diurnal variation in oxygen levels due to photosynthesis in daytime and respiration at night. Phosphates are abundant in organic wastes from wastewater and agricultural run-off.

A value in the order of **0.2 mg/l** as PO_4, equivalent to 0.0652 mg/l as P., is indicated in the Salmonid Directive as a general guide to prevent eutrophication. However, its impact is dependent on a range of factors, specific to each waterbody. All waterbodies have a threshold limit having regard to water turnover and values above the threshold can lead to high algal growth and plant crop, particularly in favourable weather conditions. The surface water standard for abstractions has a limit of 0.7 mg/l as P_2O_5, equivalent to 0.3mg/l as P (S.I. 294).

Suspended Solids

Suspended solids measured as mg/l, are solids suspended in the water column which may settle slowly or remain in suspension. These solids may consist of algae, sewage solids or other particulate materials, either inert or organic. The presence of suspended solids interferes with aquatic plant life due to reduced light penetration, damaging fish life and causing a build up of material on the beds. The standard for salmonid waters is less than or equal to **25mg/l** solids.

Conductivity

The conductivity of a waterbody is a measure of its ability to carry electric current and varies with the number and type of ions contained in the waterbody. It is of no health significance, but provides a useful indication of the magnitude of dissolved solids present and also a useful indication of hardness and alkalinity. It is usually determined in the field with a portable meter and units of measurement are µs/cm at 25° or 20° as there is some variation on the temperature used. There is no standard for Salmonid waters.

pH

The pH of a solution indicates whether it is acidic or basic and by definition is the negative logarithm of the hydrogen ion concentration. It is expressed on a scale from 0-14 with 7 being neutral, above 7 alkaline and below 7 acidic. The normal range for freshwaters is 6.5-8.0. The standard for Salmonid waters is between 6 and 9. It can be measured conveniently in the field using a portable meter. There is no direct health significance but it is very important environmental parameter as it affects the behaviour of other substances. Extremes of pH can cause fish morality and corrosion of metal fixtures, pipes etc. Short-term fluctuations in pH are usually associated with severe eutrophication.

Temperature

Temperature is a very important parameter principally due to its relationship with other constituents, most notably dissolved oxygen. The normal temperature ranges in Irish freshwaters are from freezing point in winter to occasional summer maxima in the order of 25°C. Elevated temperatures may have adverse effects on aquatic life and the standards for Salmonid waters are outlined in **Table 5.1**. The unit of measurement is deg.C and measurement is usually carried out on site.

Ammonia

Ammonia is produced in natural waters due to the breakdown of urea and other nitrogen containing compounds. It may be present in different forms depending on the pH and free or un-ionised ammonia is NH_3 while ionised ammonia is NH_4^+. High ammonia concentrations indicate sewage or industrial contamination. High ammonia loads may arise from sewage overflows in storm conditions. The ammonia tolerances for fishery waters are narrow with mandatory limits in the Salmonid Regulations of 1mg/l total ammonia (NH_4) and 0.02mg/l un-ionised ammonia (NH_3). The ratio of both is pH dependent and can therefore be altered by algal activity, for example.

Colour

Natural colour results from organic debris such as peat, leaves, needles and branches in various stages of decomposition. Waters can appear highly coloured due to suspended matter and this is known as apparent colour to distinguish it from true colour due to vegetable or organic extracts. These materials will give the water a yellow-brown appearance which is primarily a problem for waters extracted for drinking. The units of measurement are (mg/l Hazen) and there is no standard for salmonid waters.

Turbidity

Turbidity is caused by a wide variety of suspended materials, for example clay particles, sewage solids, silt and sand washings. Turbidity in waters interferes with the natural passage of light and the visual depth is restricted. The units of measurement vary depending on the method of analysis used and this causes difficulty in setting standards. There are no salmonid standards.

C.O.D.

Chemical oxygen demand or COD is the oxygen required for complete oxidation of organic matter to carbon dioxide and water regardless of the biological assimilability of the substances. Consequently, COD values may be significantly higher than BOD values particularly if large amounts of resistant organic matter is present. It can be determined in a relatively short time compared to the BOD which takes 5 days and an approximate BOD:COD ratio can often be established. Typically for certain wastes, the COD/BOD ratio is about 1.54:1 and therefore can be indicative of the BOD of a sample. There is no standard for salmonid waters, as the test is not sensitive enough for waters of low oxygen demand. It is a more useful parameter in terms of the polluting strength of a waste.

Faecal Coliforms

Escherichia coli is a coliform bacteria found in the intestine of both humans and animals. Its presence indicates waste of faecal origin and the possibility that pathogenic or disease causing bacteria may be present. There are health risks associated with their presence in waterbodies and consequently strict standards are in force regarding drinking waters and waters used for water contact sports such as swimming. They are a useful indication of sewage contamination and their presence in high numbers would infer recent sewage contamination. Coliform organisms die off over time and the rate of die-off is much greater in saltwater than in freshwaters. There is no standard for salmonid waters. Standards for designated bathing waters and for surface waters used for abstraction are given in Table 4.11. Coliforms are usually measured as faecal coliforms or total coliforms. Faecal coliforms are of faecal origin, whereas total coliforms are all coliform bacteria present, including those from soil and other sources.

Chloride

Chlorides occur naturally in all waters and the concentrations vary widely depending on the proximity to seawater. In freshwaters, natural sources include soil and rock formations. Sewage contains large amounts of chlorine and high chlorine levels may indicate sewage contamination. Natural levels for freshwaters are in the order of 15-35 mg/l Cl. There are no standards for salmonid waters and standards for drinking water are concerned with taste rather than toxicity. Standards for total residual chlorine in fish waters, however, are tight, equivalent to 0.003mg/l Cl.

Hydrogen Sulphides

Hydrogen Sulphide is developed in sewage in anaerobic conditions, for example in pipe bed sediments or pipe wall slimes in foul/combined sewers. It can be flushed out at storm overflows at the onset of storm conditions and is highly toxic to aquatic life. However, it is difficult to detect, being very quickly oxidised.

Physico-Chemical Parameter Range

Tables 5.3 summarise the recent water quality history of the River Boyne main channel, and its' tributaries giving maximum, minimum and mean values. These summary tables illustrate the water quality ranges in the Boyne River system.

5.3.1 River Boyne System - Dissolved Oxygen

Dissolved oxygen (D.O.) has been identified as a key parameter, particularly in the context of fish life. Specifically, the Salmonid regulations require 50% of values to be in excess of 9mg/l O_2. The E.U. directive for salmonid waters sets guideline values of 100% of samples greater then 7mg/l O_2. Minimum D.O. levels in the presence of heavy algal or plant growth will tend to occur in early mornings.

The general pattern of D.O. levels and range of values is generally as follows:-

- ***River Boyne upstream of Yellow River;*** *this section of the main Boyne channel has sluggish flow and heavy plant growth, including duckweed mats (Lama minor). Dissolved oxygen surveys since 1990 at low flows showed extremely low night time D.O. levels, well below the salmonid directive limits. Levels of less than 20% saturation were recorded in August, 1990. These levels could result in fish kills. Recent data since 1994 shows a range from 6.4 - 14.2mg/l at Ballyboggan. Data upstream in Co. Kildare (Clonkeen Bridge and Edenderry Bridge)slow similar tendencies to low D.O. levels on occasions*

TABLE 5.3A : BOYNE MAIN CHANNEL - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO *mg/l*	BOD *mg/l*	PH	NO_2 *mg/l*	NO_3 *mg/l*	NH_4 *mg/l*	PO_4 *mg/l*
Clonkeen Bridge	5.89 *(0.7-7.8)*	3.179 *(1.7-6.0)*	7.79 *(7.6-8.2)*	- -	9.08 *(7.5-12.8)*	0.093 *(0.03-0.14)*	0.167 *(0.105-0.384)*
Edenderry Bridge	5.89 *(4.0-7.0)*	2.93 *(2.4-3.5)*	7.76 *(7.6-8.0)*	- -	6.71 *(3.5-9.4)*	0.118 *(0.03-0.18)*	0.218 *(0.125-0.41)*
Ballyboggan	9.634 *(6.4-14.8)*	2.216 *(0.6-5.3)*	7.863 *(7.0-8.5)*	0.077 *(0.016-0.198)*	9.608 *(0.44-25.7)*	0.175 *(0.01-0.57)*	0.214 *(0.0045-0.6)*
Stonyford	10.101 *(2.6-14.9)*	3.425 *(0.4-1.01)*	7.899 *(7.1-8.45)*	0.085 *(0.009-0.33)*	10.721 *(0.3-25)*	0.147 *(0.009-0.51)*	0.329 *(0.004-6.54)*
Inchahore	9.970 *(1.9-14.8)*	1.982 *(0.6-4.6)*	7.986 *(7.1-9.3)*	0.069 *(0.009-0.363)*	10.372 *(0.88-22.5)*	0.120 *(0.003-0.37)*	0.283 *(0.015-3.389)*
Derrinadaly	10.432 *(5.3-15.1)*	1.963 *(0.3-4.3)*	8.001 *(7.1-8.6)*	0.063 *(0.009-0.33)*	10.314 *(0.88-23.4)*	0.119 *(0.004-0.83)*	0.347 *(0.006-6.27)*
Newtown	10.868 *(5.3-16)*	2.072 *(0.3-5.2)*	8.049 *(7.1-8.6)*	0.060 *(0.006-0.2)*	10.233 *(0.44-22.9)*	0.114 *(0.007-0.68)*	0.298 *(0.002-5.05)*
Bective	10.951 *(6.1-16.1)*	2.169 *(0.2-4.8)*	8.083 *(7.1-8.6)*	0.055 *(0.003-0.13)*	10.459 *(0.88-23.7)*	0.105 *(0.01-0.709)*	0.282 *(0.005-2.42)*
Bellinter	10.760 *(6.8-15.2)*	2.129 *(0.2-5.6)*	7.986 *(7.05-8.5)*	0.065 *(0.00[illegible]-0.3)*	10.544 *(0.38-24.1)*	0.103 *(0.002-0.4)*	0.298 *(0.005-2.8)*
Kilcarne	10.879 *(7.1-15.3)*	2.043 *(0.3-6.0)*	8.039 *(7-8.6)*	0.063 *(0.003-0.27)*	10.792 *(0.83-25)*	0.103 *0.005-0.4)*	0.251 *(0.01-1.77)*
New Bridge	11.160 *(7.2-15.9)*	2.196 *(0.2-5.7)*	8.075 *(6.9-8.7)*	0.069 *(0-0.36)*	10.667 *(0.66-24.3)*	0.115 *(0.01-0.41)*	0.181 *(0.006-0.6)*
Broad Boyne	11.316 *(7.1-15.4)*	2.426 *(0.1-6.3)*	8.091 *(6.7-8.5)*	0.073 *(0.001-0.3)*	11.012 *(0.69-24.3)*	0.108 *(0.019-0.4)*	0.230 *(0.005-1.17)*
Slane	11.536 *(7.9-15.9)*	2.322 *(0.3-5.6)*	8.139 *(6.8-8.6)*	0.069 *(0.003-0.28)*	11.189 *(0.3-24.4)*	0.094 *(0.001-0.27)*	0.270 *(0.005-2.2)*
Old Bridge	11.462 *(8-15.6)*	2.325 *(0.2-5.8)*	8.149 *(6.8-8.66)*	0.065 *(0.006-0.36)*	11.489 *(0.44-25.2)*	0.086 *(0.004-0.38)*	0.257 *(0.007-1.85)*

TABLE 5.3B : RIVER BLACKWATER (KELLS) - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Bloomsbury Bridge	10.850 *(7.1-15.6)*	2.817 *(0.5-9.0)*	7.954 *(7.3-8.4)*	0.070 *(0.01-0.36)*	8.867 *(2.6-20.09)*	0.109 *(0.003-0.3)*	0.360 *(0.01-1.5)*
Carnaross	11.354 *(6.4-16.2)*	3.403 *(1.1-12.5)*	7.834 *(7.0-8.55)*	0.045 *(0.01-0.20)*	6.267 *(0.88-21.24)*	0.102 *(0.01-0.37)*	0.230 *(0.01-0.55)*
Donaghpatrick Bridge	11.076 *(6.4-15.5)*	2.989 *(0.8-9.4)*	7.967 *(7.4-8.4)*	0.079 *(0.01-0.5)*	8.9882 *(1.76-20.85)*	0.116 *(0.001-0.64)*	0.340 *(0.05-1.03)*
Liscarton	11.226 *(7.1-17.2)*	2.851 *(0.4-10.0)*	7.974 *(7.5-8.4)*	0.053 *(0.009-0.16)*	9.164 *(2.21-22.1)*	0.107 *(0.003-0.34)*	0.339 *(0.05-1.4)*
Mabes Bridge	11.853 *(7.7-16.3)*	3.195 *(0.7-12.1)*	8.048 *(7.1-8.7)*	0.041 *(0.004-0.29)*	7.208 *(1.77-18.4)*	0.095 *(0.004-0.5)*	0.268 *(0.005-1.7)*
O' Daly's Bridge	10.867 *(5.7-16.0)*	3.583 *(0.5-10.5)*	7.848 *(6.8-8.5)*	0.044 *(0.009-0.2)*	5.145 *(0.442-20.94)*	0.092 *(0.002-0.26)*	0.388 *(0.03-2.9)*
Polboy Bridge	11.442 *(7.8-15.9)*	3.011 *(0.8-9.6)*	8.025 *(7.3-8.9)*	0.071 *(0.016-0.36)*	9.402 *(1.76-21.67)*	0.101 *(0.005-0.3)*	0.339 *(0.01-2.4)*
Sedenrath	10.774 *(6.1-15.8)*	3.008 *(0.8-9.8)*	7.949 *(7.2-8.47)*	0.050 *(0.01-0.132)*	8.026 *(1.77-27.25)*	0.103 *(0.009-0.3)*	0.335 *(0.01-0.98)*

TABLE 5.3C : ATHBOY RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO *mg/l*	BOD *mg/l*	PH	NO2 *mg/l*	NO3 *mg/l*	NH4 *mg/l*	PO4 *mg/l*
Athboy	10.200 *(7.1-14.0)*	1.683 *(0.8-2.7)*	7.935 *(7.4-8.7)*	0.054 *(0.02-0.15)*	7.647 *(0.88-16.1)*	0.088 *(0.013-0.19)*	0.182 *(0.02-0.95)*
Mitchelstown	10.071 *(3.9-14.2)*	1.800 *(0.9-3.6)*	7.929 *(7.4-8.3)*	0.089 *(0.03-0.23)*	8.209 *(1.32-16.70)*	0.097 *(0.02-0.24)*	0.286 *(0.08-1.7)*
Clonlesson	10.514 *(7.1-14.3)*	1.794 *(0.4-3.3)*	7.947 *(7.5-8.3)*	0.057 *(0.02-0.15)*	8.4648 *(1.3-7.6)*	0.077 *(0.03-0.19)*	0.369 *(0.05-2.88)*
Kilnagros	9.362 *(4.1-13.9)*	2.078 *(0.6-4.8)*	7.967 *(7.5-8.5)*	0.264 *(0.02-2.6)*	7.945 *(0.88-17.45)*	0.112 *(0.03-0.30)*	0.478 *(0.12-2.36)*
Martinstown	11.038 *(8.1-14.9)*	2.122 *(0.4-6.8)*	8.022 *(7.0-8.5)*	0.061 *(0.02-0.17)*	8.730 *(0.44-18.01)*	0.099 *(0.01-0.3)*	0.667 *(0.08-4.9)*
Milltown	10.662 *(7.6-14.5)*	1.683 *(0.3-4.0)*	8.025 *(7.5-8.5)*	0.067 *(0.02-0.17)*	9.861 *(0.88-19.3)*	0.085 *(0.02-0.22)*	0.522 *(0.07-3.57)*
Tremblestown	9.486 *(3.8-13.5)*	2.329 *(0.8-5.1)*	7.937 *(7.4-8.5)*	0.182 *(0.02-2.4).*	8.389 *(1.32-19.55)*	0.143 *(0.02-0.51)*	0.339 *(0.1-1.7)*

TABLE 5.3D : RIVER BLACKWATER (KELLS) - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Bloomsbury Bridge	10.850 *(7.1-15.6)*	2.817 *(0.5-9.0)*	7.954 *(7.3-8.4)*	0.072 *(0.01-0.36)*	8.867 *(2.6-20.09)*	0.109 *(0.003-0.3)*	0.360 *(0.01-1.5)*
Carnaross	11.354 *(6.4-16.2)*	3.403 *(1.1-12.5)*	7.834 *(7.0-8.55)*	0.045 *(0.01-0.20)*	6.267 *(0.88-21.24)*	0.102 *(0.01-0.37)*	0.230 *(0.01-0.55)*
Donaghpatrick Bridge	11.076 *(6.4-15.5)*	2.989 *(0.8-9.4)*	7.967 *(7.4-8.4)*	0.079 *(0.01-0.5)*	8.9882 *(1.76-20.85)*	0.116 *(0.001-0.64)*	0.340 *(0.05-1.03)*
Liscarton	11.226 *(7.1-17.2)*	2.851 *(0.4-10.0)*	7.974 *(7.5-8.4)*	0.053 *(0.009-0.16)*	9.164 *(2.21-22.1)*	0.107 *(0.003-0.34)*	0.339 *(0.05-1.4)*
Mabes Bridge	11.853 *(7.7-16.3)*	3.195 *(0.7-12.1)*	8.048 *(7.1-8.7)*	0.041 *(0.004-0.29)*	7.208 *(1.77-18.4)*	0.095 *(0.004-0.5)*	0.268 *(0.005-1.7)*
O' Daly's Bridge	10.867 *(5.7-16.0)*	3.583 *(0.5-10.5)*	7.848 *(6.8-8.85)*	0.044 *(0.009-0.2)*	5.145 *(0.442-20.94)*	0.092 *(0.002-0.26)*	0.388 *(0.03-2.9)*
Polboy Bridge	11.442 *(7.8-15.9)*	3.011 *(0.8-9.6)*	8.025 *(7.3-8.9)*	0.071 *(0.016-0.36)*	9.402 *(1.76-21.67)*	0.101 *(0.005-0.3)*	0.339 *(0.01-2.4)*
Sedenrath	10.774 *(6.1-15.8)*	3.008 *(0.8-9.8)*	7.949 *(7.2-8.47)*	0.050 *(0.01-0.132)*	8.026 *(1.77-27.25)*	0.103 *(0.009-0.3)*	0.335 *(0.01-0.98)*

TABLE 5.3E : BLACKWATER SOUTH - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Blackwater	9.469 *(6.9-13.7)*	1.938 *(1.0-3.0)*	7.848 *(7.4-8.2)*	0.081 *(0.01-0.15)*	10.620 *(1.76-26.5)*	0.111 *(0.01-0.36)*	0.208 *(0.05-0.58)*
Trim	10.342 *(7.2-13.6)*	2.046 *(1.0-4.0)*	7.950 *(7.5-8.8)*	0.074 *(0.01-0.12)*	10.6329 *(2.2-27.0)*	0.103 *(0.01-0.36)*	0.159 *(0.05-0.57)*
Castlerickard	10.292 *(7.7-13.5)*	1.992 *(1.0-4.0)*	7.926 *(7.5-8.3)*	0.068 *(0.01-0.12)*	11.319 *(2.65-27.2)*	0.083 *(0.01-0.26)*	0.204 *(0.03-0.78)*
Johnstown	9.885 *(6.4-13.5)*	1.892 *(1.0-4.0)*	7.892 *(7.4-8.3)*	0.076 *(0.01-0.12)*	10.786 *(0.44-25.9)*	0.132 *(0.03-0.36)*	0.243 *(0.02-0.88)*
Racketstown	10.885 *(7.9-13.5)*	2.223 *(1.0-5.0)*	7.900 *(7.4-8.3)*	0.066 *(0.01-0.12)*	11.095 *(2.21-26.4)*	0.085 *(0.01-0.26)*	0.156 *(0.03-0.5)*

TABLE 5.3F : BOYCETOWN RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Boycetown	10.333 *(7.9-12.4)*	2.347 *(1.0-5.0)*	7.886 *(7.5-8.1)*	0.076 *(0.01-0.15)*	10.938 *(2.0-27.85)*	0.172 *(0.01-0.83)*	0.236 *(0.036-1.01)*
Derrypatrick	10.520 *(8.4-12.5)*	2.293 *(0.7-6.3)*	7.779 *(7.0-8.1)*	0.067 *(0.02-0.16)*	10.033 *(1.0-24.12)*	0.135 *(0.01-0.61)*	0.229 *(0.04-1.09)*
Milltown	11.340 *(9.1-12.8)*	2.180 *(0.9-4.4)*	7.935 *(7.5-8.2)*	0.080 *(0.02-0.20)*	10.7091 *(2.0-27.21)*	0.172 *(0.01-0.91)*	0.171 *(0.01-1.03)*
Scurlogstown	11.587 *(8.0-13.1)*	2.320 *(0.5-3.9)*	7.943 *(7.2-8.2)*	0.064 *(0.02-0.18)*	11.248 *(1.0-26.95)*	0.122 *(0.01-0.31)*	0.123 *(0.016-0.43)*

TABLE 5.3 : BOYNE MAIN CHANNEL - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO	BOD	PH	NO_2	NO_3	NH_4	PO_4
	mg/l	*mg/l*		*mg/l*	*mg/l*	*mg/l*	*mg/l*
Ballyboggan	9.634 *(6.4-14.8)*	2.216 *(0.6-5.3)*	7.863 *(7.0-8.5)*	0.077 *(0.016-0.198)*	9.608 *(0.44-25.7)*	0.175 *(0.01-0.57)*	0.214 *(0.0045-0.6)*
Stonyford	10.101 *(2.6-14.9)*	3.425 *(0.4-101)*	7.899 *(7.1-8.45)*	0.085 *(0.009-0.33)*	10.721 *(0.3-25)*	0.147 *(0.009-0.51)*	0.329 *(0.004-6.54)*
Inchahore	9.970 *(1.9-14.8)*	1.982 *(0.6-4.6)*	7.986 *(7.1-9.3)*	0.069 *(0.009-0.363)*	10.372 *(0.88-22.5)*	0.120 *(0.003-0.37)*	0.283 *(0.015-3.389)*
Derrinadaly	10.432 *(5.3-15.1)*	1.963 *(0.3-4.3)*	8.001 *(7.1-8.6)*	0.063 *(0.009-0.33)*	10.314 *(0.88-23.4)*	0.119 *(0.004-0.83)*	0.347 *(0.006-6.27)*
Newtown	10.868 *(5.3-16)*	2.072 *(0.3-5.2)*	8.049 *(7.1-8.6)*	0.060 *(0.006-0.2)*	10.233 *(0.44-22.9)*	0.114 *(0.007-0.68)*	0.298 *(0.002-5.05)*
Bective	10.951 *(6.1-16.1)*	2.169 *(0.2-4.8)*	8.083 *(7.1-8.6)*	0.055 *(0.003-0.13)*	10.459 *(0.88-23.7)*	0.105 *(0.01-0.709)*	0.282 *(0.005-2.42)*
Bellinter	10.760 *(6.8-15.2)*	2.129 *(0.2-5.6)*	7.986 *(7.05-8.5)*	0.065 *(0.001-0.3)*	10.544 *(0.38-24.1)*	0.103 *(0.002-0.4)*	0.298 *(0.005-2.8)*
Kilcarne	10.879 *(7.1-15.3)*	2.043 *(0.3-6.0)*	8.039 *(7-8.6)*	0.063 *(0.003-0.27)*	10.792 *(0.83-25)*	0.103 *0.005-0.4)*	0.251 *(0.01-1.77)*
New Bridge	11.160 *(7.2-15.9)*	2.196 *(0.2-5.7)*	8.075 *(6.9-8.7)*	0.069 *(0-0.36)*	10.667 *(0.66-24.3)*	0.115 *(0.01-0.41)*	0.181 *(0.006-0.6)*
Broad Boyne	11.316 *(7.1-15.4)*	2.426 *(0.1-6.3)*	8.091 *(6.7-8.5)*	0.073 *(0.001-0.3)*	11.012 *(0.69-24.3)*	0.108 *(0.019-0.4)*	0.230 *(0.005-1.17)*
Slane	11.536 *(7.9-15.9)*	2.322 *(0.3-5.6)*	8.139 *(6.8-8.6)*	0.069 *(0.003-0.28)*	11.189 *(0.3-24.4)*	0.094 *(0.001-0.27)*	0.270 *(0.005-2.2)*
Old Bridge	11.462 *(8-15.6)*	2.325 *(0.2-5.8)*	8.149 *(6.8-8.66)*	0.065 *(0.006-0.36)*	11.489 *(0.44-25.2)*	0.086 *(0.004-0.38)*	0.257 *(0.007-1.85)*

TABLE 5.3G : CASTLEJORDAN RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Baltinoran	9.417 *(7.0-12.4)*	2.714 *(1.4-6.0)*	7.948 *(7.5-8.5)*	0.148 *(0.07-0.42)*	8.222 *(2.6-16.4)*	0.435 *(0.072-1.9)*	0.136 *(0.04-0.5)*
Castlejordan	10.754 *(7.9-13.9)*	2.459 *(1.2-4.2)*	8.053 *(7.6-8.6)*	0.113 *(0.04-0.41)*	8.565 *(1.76-18.4)*	0.292 *(0.01-1.94)*	0.097 *(0.04-0.34)*
Kildangan	10.229 *(7.8-12.7)*	2.559 *(1.5-4.3)*	8.001 *(7.6-8.6)*	0.122 *(0.013-0.39)*	8.0330 *(1.76-19.1)*	0.344 *(0.019-1.87)*	0.106 *(0.07-0.26)*

TABLE 5.3H : CLADY RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Balbrigh	10.246 *(4.1-14.5)*	3.154 *(0.6-9.0)*	7.903 *(7.4-8.2)*	0.089 *(0.02-0.21)*	12.335 *(2.54-29.7)*	0.463 *(0.01-2.7)*	0.612 *(0.11-2.1)*
Spollens	11.980 *(7.0-15.4)*	2.800 *(0.9-3.9)*	7.876 *(7.2-8.3)*	0.104 *(0.01-0.33)*	13.876 *(2.62-29.8)*	0.242 *(0.03-0.94)*	0.509 *(0.14-0.9)*
Cookes	9.975 *(7.4-13.2)*	3.438 *(1.1-10.0)*	7.813 *(7.5-8.1)*	0.100 *(0.037-0.18)*	8.8500 *(1.0-13.4)*	0.320 *(0.01-1.5)*	0.462 *(0.15-0.83)*
Dunderry	9.275 *(3.5-13.8)*	2.692 *(0.5-4.2)*	7.765 *(7.2-8.3)*	0.100 *(0.02-0.22)*	12.212 *(3.0-27.3)*	0.353 *(0.05-2.1)*	0.478 *(0.2-1.25)*
Tullaghanstown	9.308 *(2.3-14.3)*	6.415 *(0.5-46.0)*	7.943 *(7.0-9.8)*	0.110 *(0.04-0.29)*	13.012 *(5.2-28.1)*	0.457 *(0.03-3.1)*	0.765 *(0.02-3.2)*

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TABLE 5.3I : RIVER DEEL - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO *mg/l*	BOD *mg/l*	PH	NO2 *mg/l*	NO3 *mg/l*	NH4 *mg/l*	PO4 *mg/l*
Trim	10.200 *(8.3-12.2)*	1.888 *(0.4-3.5)*	7.996 *(7.5-8.2)*	0.068 *(0.01-0.27)*	7.071 *(1.32-16.3)*	0.101 *(0.01-0.28)*	0.778 *(0.02-5.07)*
Clondalee	9.800 *(7.5-13.3)*	1.918 *(0.6-3.4)*	7.922 *(7.3-8.2)*	0.072 *(0.01-0.28)*	6.979 *(1.76-15.43)*	0.236 *(0.03-1.88)*	0.782 *(0.08-5.76)*
Inan	9.676 *(7.2-13.0)*	1.865 *(0.6-4.0)*	7.934 *(7.1-8.2)*	0.065 *(0.02-0.28)*	7.2953 *(1.7-16.9)*	0.138 *(0.05-0.34)*	0.989 *(0.07-7.26)*

TABLE 5.3J : DEVLIN'S RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO *mg/l*	BOD *mg/l*	PH	NO2 *mg/l*	NO3 *mg/l*	NH4 *mg/l*	PO4 *mg/l*
Sallygardens	10.729 *(7.6-14.2)*	2.780 *(1.7-5.0)*	7.767 *(7.0-8.3)*	0.157 *(0.02-0.47)*	14.115 *(2.4-31.09)*	0.242 *(0.05-0.67)*	1.032 *(0.49-1.78)*
Grange	10.638 *(8.0-14.1)*	6.800 *(1.4-6.8)*	7.845 *(7.0-8.2)*	0.212 *(0.03-0.58)*	14.811 *(0.43-30.01)*	0.167 *(0.05-0.31)*	0.769 *(0.36-1.56)*
Devlins	10.563 *(6.9-14.2)*	2.386 *(0.2-4.3)*	7.804 *(6.9-8.2)*	0.112 *(0.03-0.27)*	10.9988 *(0.17-26.95)*	0.116 *(0.03-0.38)*	0.658 *(0.44-0.98)*
Monk-Newtown	12.000 *(10.1-14.2)*	2.875 *(1.4-6.3)*	7.811 *(6.9-8.5)*	0.101 *(0.01-0.28)*	9.528 *(0.22-26.87)*	0.109 *(0.03-0.39)*	0.722 *(0.33-1.6)*

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TABLE 5.3K : KINNEGAD RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Ballivor	9.895 *(6.7-14.2)*	2.125 *(0.6-4.2)*	7.918 *(7.3-8.5)*	0.089 *(0.01-0.2)*	7.503 *(0.44-16.4)*	0.211 *(0.03-0.75)*	0.467 *(0.02-4.9)*
Clonard	10.281 *(6.9-13.4)*	2.465 *(0.8-6.3)*	7.966 *(7.6-8.6)*	0.076 *(0.01-0.23)*	7.919 *(0.88-17.20)*	0.129 *(0.01-0.68)*	0.135 *(0.04-0.36)*
Kilwarden	9.495 *(3.9-14.4)*	2.375 *(1.0-6.7)*	7.915 *(7.6-8.6)*	0.136 *(0.01-1.3)*	7.2585 *(0.44-17.6)*	0.174 *(0.02-0.75)*	0.366 *(0.07-2.5)*

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TABLE 5.3L : KNIGHTSBROOK - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Ballinrig	10.917 *(8.1-13.5)*	2.109 *(0.8-3.7)*	8.138 *(7.8-8.5)*	0.078 *(0.01-0.24)*	9.584 *(3.09-25.4)*	0.098 *(0.03-0.25)*	0.640 *(0.03-2.1)*
Laracor	10.596 *(7.6-12.4)*	1.970 *(0.6-5.0)*	8.117 *(7.7-8.8)*	0.055 *(0.01-0.12)*	10.106 *(3.09-21.29)*	0.078 *(0.03-0.16)*	0.536 *(0.11-1.67)*
Summerstown	11.063 *(7.3-13.8)*	1.970 *(0.4-3.7)*	8.117 *(7.8-8.5)*	0.055 *(0.01-0.11)*	9.8300 *(2.6-21.02)*	0.073 *(0.01-0.19)*	0.523 *(0.05-1.8)*
Cloneymeath	10.452 *(5.7-13.5)*	1.914 *(0.2-3.9)*	8.157 *(7.8-8.4)*	0.066 *(0.01-0.25)*	7.716 *(1.0-17.5)*	0.087 *(0.03-0.28)*	0.709 *(0.02-2.13)*
Curleys	10.240 *(6.1-12.1)*	2.264 *(0.6-5.8)*	8.065 *(7.7-8.3)*	0.056 *(0.01-0.12)*	8.447 *(1.7-16.7)*	0.139 *(0.06-0.31)*	0.471 *(0.18-1.6)*
Dangan	10.529 *(6.3-13.0)*	2.351 *(0.6-7.7)*	8.119 *(7.8-8.5)*	0.105 *(0.01-0.55)*	8.656 *(1.3-21.02)*	0.198 *(0.03-1.3)*	0.605 *(0.01-1.9)*
Trim	11.096 *(8.4-13.4)*	2.022 *(0.8-4.4)*	8.123 *(7.5-8.5)*	0.047 *(0.01-0.09)*	10.124 *(2.6-22.05)*	0.065 *(0.02-0.18)*	0.460 *(0.09-1.8)*
Moynalvey	10.100 *(5.2-12.9)*	2.089 *(0.2-5.0)*	8.131 *(7.7-8.5)*	0.086 *(0.01-0.21)*	7.155 *(1.76-17.4)*	0.134 *(0.04-0.45)*	0.491 *(0.03-1.8)*

TABLE 5.3M : MATTOCK RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO *mg/l*	BOD *mg/l*	PH	NO2 *mg/l*	NO3 *mg/l*	NH4 *mg/l*	PO4 *mg/l*
Boyds	11.246 *(7.5-14.5)*	2.517 *(0.7-6.7)*	7.673 *(7.2-8.4)*	0.107 *(0.03-0.4)*	9.662 *(0.34-28.03)*	0.212 *(0.04-1.02)*	0.713 *(0.17-1.6)*
Kellystown	11.683 *(8.7-14.6)*	2.171 *(0.8-4.0)*	7.673 *(7.0-8.6)*	0.066 *(0.02-0.2)*	12.123 *(0.39-32.03)*	0.102 *(0.02-0.33)*	0.533 *(0.1-1.3)*
Mattock	12.546 *(10.8-15.3)*	2.450 *(0.2-6.0)*	7.758 *(2.7-8.7)*	0.089 *(0.02-0.19)*	13.7803 *(0.38-30.83)*	0.101 *(0.01-0.19)*	0.477 *(0.06-1.15)*
New Bridge	11.270 *(8.7-14.8)*	2.208 *(0.3-5.7)*	7.638 *(2.3-8.5)*	0.090 *(0.03-0.29)*	16.259 *(0.3-32.12)*	0.136 *(0.02-0.5)*	0.459 *(0.04-1.26)*

TABLE 5.3N : MOYNALTY RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO *mg/l*	BOD *mg/l*	PH	NO2 *mg/l*	NO3 *mg/l*	NH4 *mg/l*	PO4 *mg/l*
Bloomsbury	10.033 *(6.3-14.0)*	2.392 *(0.8-5.9)*	7.788 *(7.0-8.2)*	0.087 *(0.02-0.18)*	11.729 *(2.2-25.24)*	0.094 *(0.01-0.2)*	0.284 *(0.1-0.6)*
Carlanstown	11.168 *(6.4-15.0)*	2.392 *(1.0-6.5)*	7.832 *(6.6-8.6)*	0.091 *(0.01-0.46)*	11.437 *(3.54-24.15)*	0.076 *(0.002-0.2)*	0.283 *(0.1-1.2)*
Sharcoman	11.346 *(5.4-15.1)*	2.776 *(1.0-5.5)*	7.710 *(6.6-8.3)*	0.069 *(0.02-0.23)*	9.9654 *(2.6-23.77)*	0.091 *(0.01-0.28)*	0.418 *(0.03-1.2)*
Mahonstown	9.950 *(4.4-15.3)*	2.350 *(1.0-4.1)*	7.666 *(6.6-8.4)*	0.080 *(0.01-0.33)*	11.197 *(3.54-23.95)*	0.081 *(0.01-0.24)*	0.378 *(0.05-1.5)*
Fyanstown	10.036 *(5.2-14.2)*	2.228 *(1.0-4.5)*	7.810 *(6.7-8.3)*	0.090 *(0.01-0.28)*	11.818 *(2.65-24.03)*	0.116 *(0.002-0.51)*	0.271 *(0.08-0.54)*
Moynalty	10.727 *(4.9-15.4)*	2.416 *(1.0-4.7)*	7.649 *(6.55-8.4)*	0.076 *(0.02-0.28)*	10.813 *(3.1-23.99)*	0.108 *(0.02-0.3)*	0.365 *(0.01-0.9)*
Rathboumes	8.696 *(1.0-14.8)*	1.808 *(0.6-4.3)*	7.343 *(6.7-8.1)*	0.064 *(0.01-0.2)*	23.900 *(0.44-23.9)*	0.106 *(0.03-0.31)*	0.306 *(0.04-0.55)*
Rosehill	9.874 *(5.8-15.0)*	2.382 *(0.3-6.1)*	7.480 *(6.6-8.3)*	0.092 *(0.02-0.83)*	10.303 *(2.2-29.0)*	0.134 *(0.004-0.36)*	0.353 *(0.02-0.81)*

TABLE 5.3O : SKANE RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Ambrose	12.559 *(8.9-16.2)*	3.247 *(0.6-8.8)*	8.249 *(7.8-8.6)*	0.094 *(0.03-0.21)*	12.761 *(0.04-43.7)*	0.094 *(0.01-0.42)*	0.638 *(0.05-1.8)*
Blacklodge	9.441 *(3.6-13.0)*	3.253 *(0.6-8.3)*	7.958 *(6.9-8.4)*	0.156 *(0.04-0.47)*	11.365 *(1.25-22.7)*	0.288 *(0.04-0.82)*	1.474 *(0.3-4.0)*
Dowdstown	12.065 *(9.4-14.2)*	3.353 *(0.4-8.7)*	8.205 *(7.7-8.6)*	0.091 *(0.02-0.18)*	12.3888 *(3.5-26.23)*	0.104 *(0.01-0.36)*	0.505 *(0.06-1.1)*
Drumree	8.435 *(4.7-12.6)*	4.212 *(2.0-9.8)*	7.946 *(7.6-8.3)*	0.237 *(0.05-0.64)*	11.354 *(3.87-23.77)*	1.049 *(0.06-5.48)*	3.949 *(0.5-18.2)*
Dunshaughlin	9.365 *(6.4-13.9)*	10.100 *(1.4-10.1)*	7.740 *(7.3-8.2)*	0.079 *(0.01-0.2)*	5.950 *(0.8-11.3)*	0.479 *(0.01-3.9)*	1.017 *(0.14-5.7)*
Kilmessan	11.306 *(9.2-13.3)*	2.788 *(0.3-6.8)*	8.131 *(7.8-8.5)*	0.089 *(0.03-0.2)*	11.075 *(5.2-23.69)*	0.094 *(0.01-0.32)*	0.708 *(0.05-1.3)*
Riverstown	11.576 *(9.3-14.2)*	3.741 *(0.9-12.2)*	8.216 *(7.8-8.6)*	0.105 *(0.02-0.23)*	10.323 *(0.04-24.29)*	0.105 *(0.02-0.32)*	0.785 *(0.24-1.6)*

TABLE 5.3P : STONYFORD RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Cloghabrock	9.581 *(2.3-12.7)*	2.195 *(0.7-5.7)*	7.966 *(7.6-8.4)*	0.069 *(0.01-0.29)*	6.119 *(0.44-13.45)*	0.151 *(0.03-0.61)*	1.014 *(0.01-7.69)*
Earls Bridge	10.171 *(4.2-12.7)*	2.514 *(0.4-6.3)*	7.973 *(7.6-8.4)*	0.064 *(0.02-0.28)*	6.468 *(0.88-14.44)*	0.168 *(0.01-0.68)*	0.846 *(0.05-4.17)*
Rathkenna	9.567 *(1.5-12.8)*	2.024 *(0.5-3.5)*	7.997 *(7.7-8.3)*	0.066 *(0.01-0.29)*	6.2829 *(0.88-13.8)*	0.123 *(0.02-0.34)*	1.039 *(0.03-7.57)*
Shonco	9.867 *(2.6-12.7)*	2.195 *(0.9-3.7)*	7.959 *(7.6-8.3)*	0.069 *(0.02-0.3)*	6.370 *(0.88-15.52)*	0.159 *(0.01-0.46)*	0.972 *(0.06-8.38)*
Stonyford	9.152 *(2.4-13.4)*	2.262 *(0.6-3.8)*	7.865 *(7.3-8.2)*	0.072 *(0.01-0.29)*	6.244 *(0.44-15.25)*	0.132 *(0.04-0.27)*	1.016 *(0.06-9.46)*

TABLE 5.3Q : TROMMAN RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Boards Mill	10.575 *(8.5-13.5)*	1.950 *(1.0-4.0)*	8.048 *(7.4-8.4)*	0.072 *(0.01-0.15)*	9.230 *(2.2-17.4)*	0.059 *(0.01-0.18)*	0.185 *(0.03-0.93)*
Killballyporter	10.633 *(8.3-14.3)*	2.017 *(1.0-4.0)*	7.986 *(7.5-8.5)*	0.058 *(0-0.11)*	8.974 *(2.0-15.5)*	0.166 *(0.02-0.52)*	0.207 *(0.02-0.96)*
Castletown	10.117 *(7.8-12.7)*	2.058 *(1.0-4.0)*	7.959 *(7.3-8.3)*	0.076 *(0.01-0.15)*	8.9951 *(2.0-18.9)*	0.118 *(0.02-0.52)*	0.230 *(0.04-0.94)*
Tromman	10.600 *(8.3-13.4)*	2.267 *(1.0-4.0)*	7.994 *(7.2-8.5)*	0.073 *(0.01-0.15)*	9.184 *(1.0-18.0)*	0.138 *(0.03-0.61)*	0.242 *(0.03-0.93)*

TABLE 5.3R : YELLOW RIVER SOUTH - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Clongall	11.114 *(7.9-14.1)*	2.615 *(1.2-4.2)*	8.062 *(7.7-8.6)*	0.123 *(0.02-0.52)*	8.816 *(1.32-18.5)*	0.282 *(0.01-1.37)*	0.118 *(0.02-0.28)*
Sheep	10.871 *(6.4-13.5)*	2.862 *(1.1-7.4)*	8.078 *(7.7-8.7)*	0.144 *(0.02-0.84)*	8.601 *(1.32-18.5)*	0.205 *(0.02-0.59)*	0.132 *(0.05-0.36)*

TABLE 5.3S : YELLOW RIVER - PHYSICO - CHEMICAL DATA (MEAN AND RANGE)

Station	DO mg/l	BOD mg/l	PH	NO2 mg/l	NO3 mg/l	NH4 mg/l	PO4 mg/l
Milestown	11.242 *(9.4-13.0)*	2.325 *(0.6-4.9)*	7.963 *(7.7-8.3)*	0.640 *(0.03-6.3)*	17.896 *(0.52-35.9)*	0.082 *(0.01-0.18)*	0.251 *(0.01-0.57)*
Kells Blackwater	12.550 *(10.2-14.1)*	2.558 *(0.7-4.6)*	8.073 *(7.7-8.3)*	0.605 *(0.03-5.9)*	17.570 *(0.33-36.4)*	0.069 *(0.02-0.21)*	0.169 *(0.03-0.58)*
Moortown	10.917 *(9.2-12.8)*	2.225 *(0.8-3.6)*	7.912 *(7.7-8.3)*	0.659 *(0.02-6.6)*	18.3508 *(0.52-36.37)*	0.067 *(0.01-0.26)*	0.197 *(0.01-0.68)*
Yellow River	10.033 *(6.3-12.1)*	2.483 *(1.0-4.1)*	7.899 *(7.6-8.2)*	0.300 *(0.02-2.6)*	13.644 *(0.44-30.0)*	0.109 *(0.01-0.24)*	0.347 *(0.05-1.05)*

- ***Boyne channel from Yellow River to Trim;*** *downstream of the Yellow River, D.O. levels in the Boyne channel appear to be relatively satisfactory*

- ***River Boyne between Trim and Navan;*** *this section of river was surveyed in the summer of 1989 at low flow. Variations from 65% - 144% saturation D.O. were recorded at Newtownbridge; 48% - 158% saturation upstream of the confluence with the Knightsbrook River and 62% - 144% saturation at Bective bridge. More recently in November, 1993, a value of 16.1 mg/l showed significant supersaturation at Bective. Macrophyte and algal growth is extensive in these areas, particularly between the outfall from Trim wastewater treatment works and Bective bridge. Under critical low flow conditions in summer time, this section of river was shown to be marginal for compliance, with a risk of unsatisfactory conditions. This requires limitation of nutrient input and organic load to this section. In the downstream section approaching Navan, dissolved oxygen levels were satisfactory, exceeding 60% saturation at all stages. Any nutrient load arising in the river Skane does not appear to be influencing conditions in the River Boyne*

- ***River Boyne downstream of Navan;*** *D.O. levels measured downstream of Navan showed values of 44% saturation at Broadboyne bridge on the 22nd July, 1989 and 54% saturation on the 18th July, at the same site, both recorded in the early morning. Therefore, this area was shown to be marginal for compliance under critical conditions. Extensive surveys showed that dissolved oxygen levels less than 6mg/l O_2, were present in the stretch of river between Navan town and Broadboyne Bridge (approximately 6.4km) for a significant period of time. More recent data indicates a more moderate range from 7.1-15.8 mg/l O_2. The effect of Navan weir would tend to bring D.O. levels downstream of the weir towards saturation level, providing safe D.O. levels for fish in this area. Downstream to Drogheda, D.O. levels in the river appear to be generally satisfactory*

- ***Blackwater (Longwood) River;*** *spot surveys in May, 1989 recorded a D.O. of 5.4mg/l O_2 in the vicinity of Blackwater Bridge and Johnstown Bridge under early morning conditions. This shows this river to be marginal for compliance with salmonid standards. Recent data shows a generally satisfactory range of values*

- ***Kinnegad River;*** *a minimum D.O. value of 4.1mg/l O_2 was recorded in this river downstream of Kinnegad in 1989. Associated growths of macrophytes and algae were noted in the area consistent with this low result. Recent critical values recorded were 4.4 mg/l in August, 1990, 5.4 mg/l in August, 1991 and 3.9 mg/l in May 1995*

- ***Athboy River,*** *similar results were recorded on the Athboy River in the region of Athboy with a minimum value of 4.0mg/l O_2 in an area of extensive macrophyte and algal growth. Recent data showed a range from 7 - 14 mg/l.*

- ***Skane River;*** *a minimum value of 4.5mg/l O_2 was recorded in the afternoon of 29th May, 1990 on this river, indicating depressed dissolved oxygen values, associated with organic loading. Recent data shows occasional low values at Drumree (6.0, 5.9, 4.7, 4.2, 5.1 mg/l). These levels are unsatisfactory*

- ***Clady River;*** *a D.O. concentration of 3mg/l O_2 was recorded in the early morning of 22nd July, 1989 upstream of the Clady confluence with the River Boyne. This is a very unsatisfactory level. Recent data shows ongoing critical values, 3.5 mg/l O_2 in July, 1995 and 4.6 mg/l in September, 1994*

- ***River Devlin;*** *median dissolved oxygen levels measured in this river exceed the minimum requirements at all stations. However, low individual values have been recorded with a range of 31% to 145% saturation*

- ***Stonyford River;*** *Minimum D.O. values on the Stonyford River are 2.3 mg/l (Nov.1993) at Clogherbrook, 4.2 mg/l at Earls Bridge, 1.5 mg/l at Rathkenna, 2.6 mg/l at Shanco Bridge and 2.4 mg/l at Stonyford Bridge all on the same date, with general evidence of organic pollution. Otherwise, the D.O. data is reasonably satisfactory*

- ***Mattock River;*** *dissolved oxygen levels at monitoring sites on this river exceeded 6mg/l O_2. However, a supersaturation value of 154% saturation was recorded in July, 1991, indicating the effects of substantial photosynthesis. Recent data has been generally satisfactory*

- ***Moynalty River;*** *values in the Moynalty River for early morning conditions in July, 1990 showed a range of 39% to 68% saturation. Spot values of approximately 10% saturation have been recorded locally in this river system. Recent data in Appendix 3 show minimum values of 6.3 mg/l at Bloomsbury Bridge, 4.4 mg/l at Mahonstown, 5.4 mg/l at Sharcoman House and very low values (1,2.9,3.2,3.8 mg/l) at Rathbournes Bridge. These results show occasional severe deficiency compared with the minimum standards*

- ***Nadreegeel Stream (Park River);*** *surveys have indicated a range of values from 40% to 190% saturation on this river, indicative of occasional severe problems*

- ***River Blackwater (Kells);*** *Survey results on this river in 1990 and 1991 generally showed a range from 60% to 95% saturation, which is satisfactory. However, values less than 6mg/l O_2 have been recorded at a number of stations, particularly upstream in the catchment. Recent data shows the majority of results to be satisfactory for the downstream section but the range of data includes occasional extreme values from less than 6 to 16 mg/l O_2. Upstream, in Co. Cavan, water quality is poor with severe organic pollution indicated by high BOD, ammonia and phosphate levels and low D.O. levels*

The foregoing dissolved oxygen profile in the River Boyne system shows general compliance, with some critically low readings in sections of the river system for critical conditions (low river flows, high summer temperatures and growth conditions). Data for the Yellow, Castlejordan, Deel and Knightsbrook rivers, shows satisfactory D.O. levels with rare values below 7 mg/l. The critical areas listed above are consistent with those river sections with inferior biological status, as outlined in section 5.2. The key issues adversely affecting D.O. levels are;

- *Limiting organic loading*
- *Control of nutrients to limit plant and algal growth, particularly in slow flowing rivers.*

5.3.2 Biochemical Oxygen Demand (BOD_5)

Biochemical oxygen demand (BOD_5) is the accepted measure of biodegradable organic matter present in the water, with a limiting value of 5mg/l O_2 required in the Salmonid Waters Regulations (SI 293, 1988). Any values over 4 mg/l O_2 are borderline and indicate significant waste loads in the river.

In the upper Boyne catchment, values in excess of this limit have been noted as follows:

- ***River Boyne Upstream;*** *Channel near Edenderry indicates occasional high values (4-5 mg/l)*
- ***Upper Boyne Tributaries;*** *Locally on the rivers Clady, Deel, Kinnegad, Knightsbrook, Skane and Yellow.*
- ***River Boyne Downstream;*** *Occasional high values are recorded at Bective, approaching 5 mg/l O_2. Values of 5.6 mg/l are recorded at Bellinter on successive days in January, 1995. Occasional high values are recorded downstream at Broadboyne and Slane, presumably related to the Navan Wastewater discharge (> 5 mg/l O_2)*
- ***River Blackwater (Kells);*** *the limit values have been found to be exceeded in the region upstream of Lough Ramor, with a number of exceedences downstream of the lake outlet. Occasionally exceedence of the limit value (5 mg/l O_2) is indicated in Appendix 3 at Bloomsbury Bridge, Carnaross, Donagh Patrick Bridge, Liscarton and Mabes Bridge*
- ***River Devlin;*** *the limit value of 5mg/l was exceeded in the upper region of Sally gardens and at Grange Crossroads (June 1995); otherwise the values in this river appear reasonable*
- ***River Clady ;*** *a number of high values have been recorded at Tullaghanstown (1993/1994)*
- ***River Mattock;*** *reasonable values have been recorded apart from one exceedence at Boyd's bridge (May 1991) and New Bridge (May 1994)*
- ***Moynalty River;*** *Significant exceedence of the limit values have been identified on this river, indicating excessive organic pollution in the upper reaches where values are high with occasional breaches of the limit*

- ***Nadreegeel Stream;*** *median values in this river were 1.5 - 3.0mg/l, with exceedences of the limit value at Billis bridge (Station 0200) and south west of Lisgrea crossroads (0400).*

- ***Skane River;*** *very high values of BOD have been recorded at most stations, with occasional significant exceedence of the limit*

- ***Yellow River;*** *the median values in the Yellow River are in the range of 2.0-3.0, with all values recorded below the limit, though occasionally reaching 4 mg/l.*

BOD levels indicate the need for improved wastewater treatment practices at Navan, Edenderry and in the upper reaches of the Kells, Blackwater and Moynalty rivers. Local problems are also identified at specific sites on a number of tributary rivers.

5.3.3 Nitrate and Ammonia

Nitrate levels measured in the river Boyne system have all been well below the limit value for surface waters for abstraction of 50mg/l NO_3. Nevertheless, nitrates are generally abundant to support plant and algal growth when combined with elevated levels of phosphates.

The salmonid regulations specify a standard limit value of 0.05 mg/l NO_2 for nitrite for 90% of samples over a 12 month period. Survey data for the river Boyne system shows values generally in excess of this limit value. The typical range is 0.05-0.15 mg/l NO_2 for the main Boyne channel and tributaries. The E.R.U. document 'Parameters of Water Quality - Interpretation and Standards' by P.J. Flanagan (October, 1992) suggests that values greater than 0.01mg/l - N may indicate sewage pollution. In any event, excessive levels can be taken as indicative of organic pollution, either from agriculture or sewage discharge.

The ammonia limit value of 1mg/l NH_4 has in the past been exceeded in the upper reaches of the River Boyne near Edenderry, on the Kinnegad River and the river Skane in the upper catchment. In the lower catchment the values have been exceeded occasionally in the river Blackwater (Kells) upstream of Castlelake, on the Mullagh branch of the Moynalty River and at Billis bridge on the Nadreegeel stream. Median values exceed the limit value at station 0170, north ofBailieboro. These excessive values can be taken as indicative of organic pollution from sewage or slurry. Recent data in Appendix 3 shows very few exceedences of the limit value. Depending on pH, levels of non-ionised Ammonia associated with these exceedences can be toxic to fish. The limit value for this form of Ammonia is 0.02 mg/l NH_3 and this value is not exceeded in the data in Appendix 3.

5.4 Trophic Status and Associated Phosphate Standards in Boyne River System

Phosphates (PO_4), generally expressed as mg/l P, occur widely in nature and are significant constituents of detergents, particularly those for domestic use, as well as being widely used as an agricultural fertiliser. Run-off and sewage discharges are therefore important contributors of phosphates to surface waters.

The significance of phosphorous is principally in regard to eutrophication (over-enrichment) of lakes and, to a lesser extent, rivers. In combination with nitrate, phosphate in such water bodies promotes the growth of algae and other plants leading to blooms, littoral slimes, etc. Daytime photosynthesis and night-time respiration give rise to excessive dissolved oxygen levels in daytime (supersaturation) and depleted levels at night-time, together with other changes such as increased pH.

Phosphates can be present in solution, in colloidal suspension or adsorbed onto particulate matter. The element exists in bound and unbound forms which are difficult to separate totally. The term orthophosphate is a widely used measure of bioavailability of this important nutrient.

In lake waters, concentrations above 0.01 mg/l P are considered likely to promote excessive algal growth. Extensive research is available on the determination of appropriate limits for particular lake conditions. For surface water abstractions, for Class A2 waters, a limit of 0.3 mg/l P is adopted. There are no limits in the Salmonid Regulations, but a figure of 0.2 mg/l, expressed as PO_4, equivalent to 0.0652 mg/l as P, is stated as indicative in order to reduce eutrophication. A figure of 0.1mg/l P has been suggested by the U.S. EPA (EPA 1976) for total phosphorous in rivers and streams.

Phosphorous occurs in both 'available' and 'unavailable' forms. The 'available' form of phosphorous, as dissolved inorganic phosphate (orthophosphate), is predominantly taken up by plants and algae for growth. Phosphates from sewage effluent and farmyard waste are generally in the available form.

Background catchment phosphate load varies considerably, depending on the catchment soil classification, as indicated on the following Table.

Classification of Soils by Phosphate Levels

Soil Type	Characteristic	Total Phosphorus Export mg P/m²-yr
Oligotrophic Soils	Low Nutrient Losses	<20
Mesotrophic Soils	Medium Nutrient Losses	20 - 50
Polytrophic Soils	Large Nutrient Losses	>50

The catchment to Navan Weir (1610km^2) was analysed to assess the phosphate export load from the Boyne catchment. Available data indicated the median total phosphate concentration as 0.065mg/l P. The median concentration of ortho-P was calculated as 0.040 mg/l P, representing 62% of the total - P load. This data results in the following phosphate balance at Navan weir.

Phosphate Balance at Navan Weir

Table 5.4

Long term average river flow	- 25.24 m^3/s
Median total - P concentration	- 0.065 mg/l
Estimated export load - P	- 51,738 kg/year
Catchment area to Navan Weir	- 1,610 km^2
Export load of catchment - total P	- 32 mg/m^2 year
Median ratio ortho - P/total - P	- 62%
Median ortho - P concentration	- 40 mg/l
Ortho - Phosphate at 62% of total P	- 32,078 kg/year

The Total Phosphate export load from the Boyne at 32mg/m^2 - year falls into the category of Mesotrophic soil. The most obvious source of phosphate, in a readily available form, is from the various sewage treatment plants in the catchment. Typically, the phosphate load is estimated at 2 grams-P per capita per day. The secondary treatment will result in some reduction in this load, particulate phosphates in particulate form removed as sludge. Nevertheless, treated effluent, without specific chemical or biological treatment for phosphate removal, is likely to have concentrations in the order of 6-10mg/l P.

An estimate of the phosphate load from wastewater treatment to the Boyne Catchment upstream of Navan Weir is contained in **Table 5.4**, expressed as orthophosphate. If this load is reflected fully at Navan Weir, it would be approximately 30% of the orthophosphate load from the catchment as a whole, leaving 70% being contributed through general run-off.

TABLE 5.5 BOYNE TO NAVAN WEIR - PHOSPHATE LOAD FROM SEWAGE TREATMENT PLANTS

Works	Estimated Orthophosphate kgs P/year	
	Private	Local Authority
Warrenstown College	172	
Dalgan Park	172	
Lisdoran Conference Centre	23	
Athboy		795
Crossakiel		81
Clonmellon		172
Johnstown Br		298
Longwood		57
Dunderry		103
Kinnegad		1,525
Summerhill		147
Dunshauglin		588
Kilmessan		210
Delvin		229
Ballivor		53
Rochfortbridge		426
Killucan		93
Trim		1,837
Edenderry		2,296
Clonard		57
Rhode		275
Total	**367**	**9,242**

This approach neglects the uptake of phosphate in vigorous plant and algal growth on sections of river channel, downstream of wastewater in-flows. This pattern had already been identified when considering the biotic status, dissolved oxygen levels and the BOD levels in the river system. Examples include the River Boyne downstream of Edenderry and downstream of Trim, the Kinnegad river downstream of Kinnegad, etc.

The phosphate levels recorded in the river system (Appendix 3) show wide variations at each site. High concentrations at low flow conditions in summer weather are most likely to result in excessive algal and plant growth. Small sluggish rivers are particularly vulnerable. Rivers showing very high average values are the Clady, Deel, Delvin, Kinnegad, Knightsbrook, Mattock, Moynalty, Athboy and locally on the Kells/Blackwater and main Boyne channel itself.

A survey of plant and algal growth was carried out in the stretch of river from Navan Weir (Station 1700) to Broadboyne Bridge (2000), approximately 5km downstream, during the summer of 1989. During this period, river flows were low, estimated at less than 95%ile flow. Water temperature, low river flow and sunlight penetration provided optimum growth conditions.

The results of the field survey are depicted in **Fig. 2.** Algal growth varied from approximately 0% to 80% and macrophyte growth varied from approximately 3% to 87%.

Plant life is poor immediately downstream of Navan due to limited light penetration arising from water depth and relatively high turbidity. This is associated with the River Blackwater (Kells) in-flow, containing significant phytoplankton and the high turbidity effluent from the wastewater treatment works.

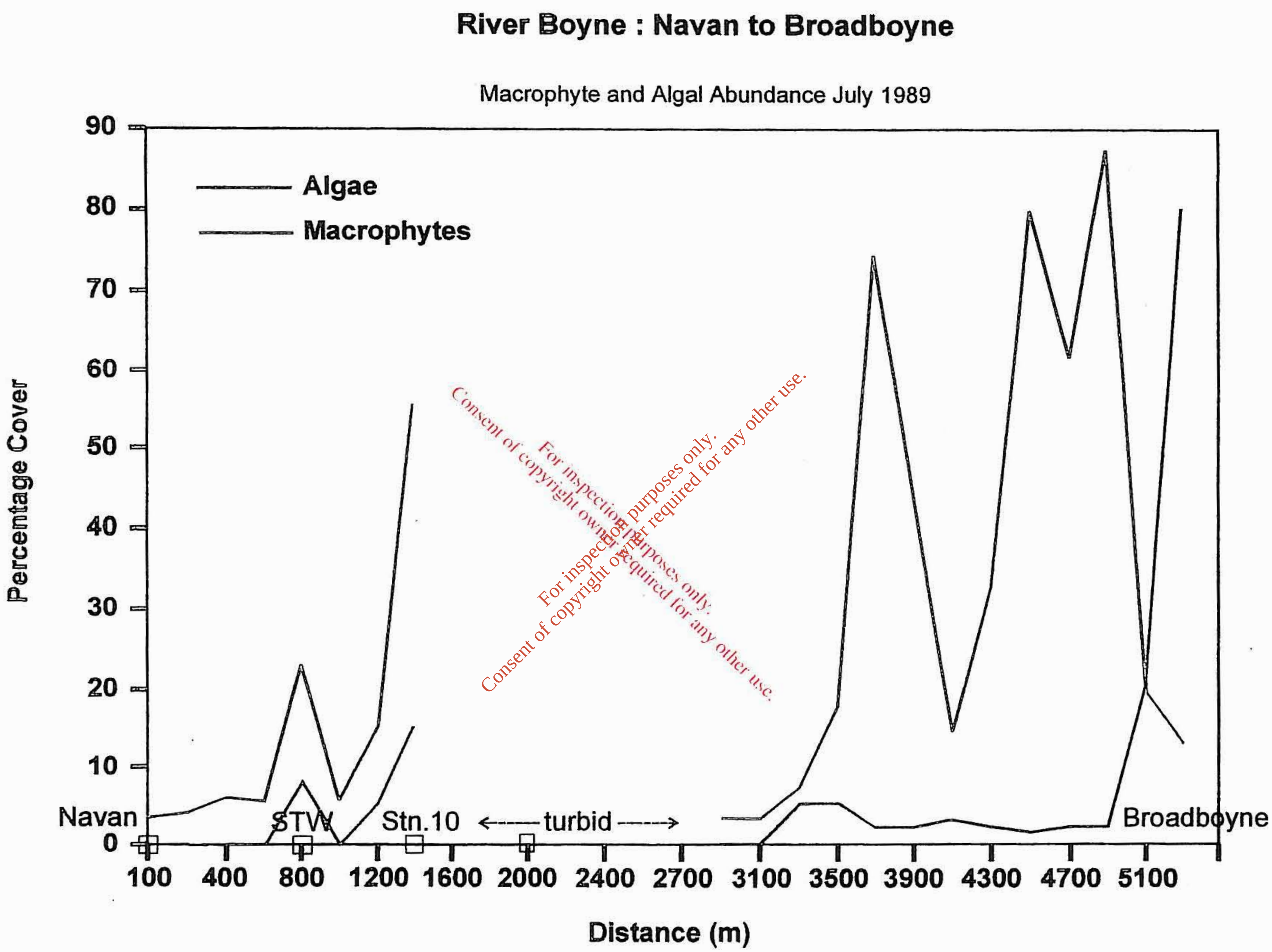

Fig. 2 Algal and Macrophyte Abundance from Navan to Broadboyne (July '89)

Compared with the upstream section of the Boyne between Navan and Trim, the macrophyte and algal densities differ substantially. The density downstream of Navan is lower and species composition is also different. The main types identified as important in this stretch are *Schaenaplectus* and *Patonageton* species with moss, algae, *Sperganium Erectun* and *Nupher* also being of minor importance.

The differences over sections of the river illustrate the significance of water depth, colour and velocity in addition to nutrient levels as critical factors in determining the ecological characteristics from site to site.

Moss is present over the bottom of the river in the section considered. These aquatic mosses, such as Fontinalis, require free CO_2 for photosynthesis rather than bicarbonate ions. They are therefore normally confined to reasonably turbulent fast-flowing water with plentiful CO_2 present. In this section of the Boyne, the flow is relatively slow and lacking in turbulence. However, the weirs along this stretch of river clearly provide sufficient atmospheric interchange to cater for the CO_2 requirement.

5.5 River Water Quality Data

The foregoing sections describe in general terms the characteristics of the Boyne river system based on available water quality data. This data is contained in tabular form in Appendix 3.

These tables summarise the range and mean for all of the physico-chemical parameters defined in the foregoing section. In addition, graphs have been developed in the Appendix to indicate variations and trends over time. The data can be used to identify possible sources of pollution and its nature by considering the different parameters together. These can sometimes be grouped to develop a Water Quality Index (WQI).

5.6 Lake Water Quality in the Boyne Catchment

The lakes in the catchment are extremely important elements of the river system of the Boyne because:

- *They support significant beneficial uses, most notably water supply abstraction, boating and bathing.*
- *The larger lakes are important fisheries*
- *They are more sensitive eco systems than rivers due to their longer retention time and potential accumulation of pollution inputs*
- *They provide major natural amenity*
- *They can function to improve water quality downstream and can also be used to regulate downstream flow*

The lakes in the catchment are listed in **Table 2.6** and are discussed generally in Chapter 2. The physical parameters of the significant lakes are summarised in **Table 2.7**.

Additional water quality information is contained in Appendix 4 based on water quality sampling of some lakes and the "Water Quality Management Plan for Co. Cavan". Briefly, the results are discussed as follows:

- ***Lough Acurry;*** *this is a relatively small lake used for abstraction with a soft acidic water which is moderately coloured. In general, water quality is satisfactory throughout the lake. On the feeder streams, intermittent organic pollution is indicated with associated elevated levels of phosphate*

- ***Bailieboro Lake;*** *this is a small soft water lake of moderate alkalinity. This has the characteristics of a eutrophic lake with moderately high phosphate levels and significant algal biomass. Its principal use is as a fishery*

- ***Castle Lake;*** *this relatively small lake is moderately soft with moderate alkalinity. Water quality is unsatisfactory with elevated orthophosphate, total phosphate and ammonia concentrations, indicative of significant enrichment of the lake. In surveys, surface D.O. levels were low and biomass production was exceptionally high with blue-green algae being the most prominent. The main feeder stream is the River Blackwater which has moderate levels of organic pollution and high nutrient concentrations (average 0.433mg/l of total -P). The outlet River Blackwater shows a moderate level of organic pollution and high nutrient enrichment. Historical data indicates extreme variation in dissolved oxygen and BOD on occasion*

- ***Cuilcagh Lough;*** *this is a small soft water lake which is used for abstraction. Data shows relatively low oxidised nitrogen, orthophosphate, ammonia and silica concentrations, though with elevated total phosphorous levels. However, the lake has given rise to substantial algal populations on a number of occasions, when elevated ammonia and phosphorus concentrations were noted in the deeper layers*

- ***Drumkeery Lake;*** *this is also a relatively small lake with moderately soft water which is markedly coloured with poor transparency. Concentrations of total phosphorus and ammonia have been noted as high with DO levels at the surface less than saturation and markedly reduced into deeper layers. Dense algal development, consistent with that of a eutropic lake has been noted. The lake is fed from a feeder stream outflowing from Skeagh Lake which is markedly influenced by the eutropic conditions of the latter lake. High total phosphorus concentrations and elevated chlorophyll concentrations are evident*

- ***Mullagh Lough;*** *this is a relatively small soft water lake showing a significant pH variation. Consistently high total phosphorus concentrations were noted, though orthophosphate, oxidised nitrogen and ammonia levels were low. Very dense algal populations have been measured in summertime, with super-saturated DO conditions and elevated pH values in the surface layers. The lake, which is used for abstraction, is classified as hypereutrophic*

- ***Nadreegeel Lough West (Lackan);*** *this is a relatively small soft water lake with low colour and moderate water transparency. Measured nutrient concentrations were moderate though sizeable algal populations indicate a degree of enrichment. The lake is classified as slightly eutropic*

- ***Nadreegeel Lough East;*** *this is a small soft water lake with moderate colour and poor transparency. The lake shows distinct signs of artificial enrichment in the north-west corner, in particular. Phosphorus and chlorophyll concentrations are markedly higher in this area, than at other locations in the lake, with DO super-saturation observed. The lake is classified as eutropic and this is associated with the feeder streams, one of which in particular has consistently high phosphorus and ammonia concentrations. The biological quality rating of the stream is occasionally as low as 1-2, indicative of heavily polluted waters*

- ***Lough Ramor;*** *this is a large and important lake with surface area of 7.4km*^{2} *and estimated lake volume of 26Mm*^{3}*. It supports significant industrial abstraction. It is a moderately soft lake, with high colour and low water transparency. Variation in the pH value indicates photosynthetic activity due to algae. Total phosphorus concentrations in the lake are high, though recorded values for other nutrients are moderate. Surface DO levels were found to be super-saturated, with significant decline through the deeper layers accompanied by elevated levels of phosphorus, ammonia and silica. Very large phytoplankton populations have been measured in the lake which is characterised as hypereutropic. Examination indicates significant organic pollution in a number of incoming streams which also exhibit poor biological quality. Data in Appendix 4 shows high BOD and chlorophyll "a" levels during 1991. In general, water quality of the feeder streams was found to have deteriorated since the mid-1970's*

- ***Skeagh Lough (Upper);*** *this is a relatively small, moderately soft water lake, with significant colour and low water transparency. DO levels varied from near saturation at the surface to significantly depleted in the lower layers. BOD data in Appendix 4 show values of 5.4 and 6.6 mg/l* O_2 *with ortho-phosphate levels in the range 0.01-0.07 mg/l. Algal populations are consistent with a eutrophic lake. Data in Appendix 4 shows occasional high ortho-phosphate, BOD, ammonia and chlorophyll "a" levels. Sampling of the feeder stream shows evidence of occasional organic pollution and nutrient enrichment. The outflow through Drumkeery Lake is consistent with the foregoing showing high total phosphorus and chlorophyll levels*

The foregoing brief summary of lake water quality, primarily within the Boyne Catchment of County Cavan shows generally that these lakes are enriched, with water quality problems typical of nutrient enriched waters and resulting eutrophication. These problems include de-oxygenation at lower levels, fluctuations in pH and high turbidity (lack of transparency).

These conditions are attributable to both direct and diffuse inflows. For example, waste inflows to Lough Ramor, the major lake in the catchment, are associated with Virginia Wastewater Treatment Works, Virginia Milk Products and diffuse inflows attributed to run-off and leaching from the landspreading of organic wastes.

In recent years, improvements have been carried out at Virginia Wastewater Treatment Works and the Virginia Milk Products, with the addition of an upgraded treatment plant to reduce the phosphorus input. Recent sampling indicates improved water quality as a result.

6.0 Boyne Catchment - Water Quality Management Plan

6. *Boyne Catchment - Water Quality Management Plan*

6.1 Introduction and Objectives

The overall objectives of a Water Quality Management Plan for the Boyne catchment can be stated as follows:-

- *To protect water quality for abstraction as a primary beneficial use*
- *To protect and conserve water quality in the Boyne river system to protect fish life*
- *To conserve the natural habitats within the river system as far as possible and to conserve visual amenity*
- *To maintain and develop the amenity potential of the River Boyne and it's tributaries for recreation including water-based recreational use*
- *To provide for the disposal of effluents from existing and future development within the required water quality parameters*

The management strategy applies to the main channel of the River Boyne and it's tributary rivers and lakes as identified in **Fig. 1.** This is the network of freshwater channels and lakes covered by the EPA Water Quality Monitoring Programme, upstream of the Boyne estuary (Obelisk Bridge)

All existing and future waste discharges within the catchment are deemed to come within the scope of the plan. This plan recognises the strategy document "Managing Ireland's Rivers and Lakes - A Catchment - Based Strategy Against Eutrophication", published by the Minister for the Environment on 22nd May, 1997.

6.2 Water Quality Management Policies

In order to satisfy the foregoing objectives, the following primary management policies are proposed to be adopted:-

1. An integrated approach to be adopted by the six Local Authorities responsible for the River Boyne catchment (Meath County Council, Kildare County Council, Offaly County Council, Westmeath County Council, Cavan County Council and Louth County Council) with a Steering Group established to implement the catchment management policies in the plan
2. The minimum river water quality objectives shall be as defined in **Table 6.1,** defining target quality (Q) ratings
3. The minimum lake water quality objectives shall be as defined in **Tables 6.2 and 6.3** as appropriate. All lakes, other than those in the Kells Blackwater catchment are designated as clear water lakes
4. Wastewater treatment to be a minimum of secondary treatment for all significant waste discharges with site specific consideration of the need for higher standards of effluent, nutrient control or the impact of combined sewer overflows to be evaluated, having regard to

the nature of the effluent load, low river flow (95 percentile), background water quality and compliance with the stated water quality objectives

5. In view of the tendency to eutrophication in many of the lakes and certain river reaches on the Boyne system, specific nutrient budgets to be established, particularly in terms of phosphates, based on individual studies, having regard to residence time, critical phosphorus concentrations, mean water depth and current trophic status. Interim standards for phosphates for phosphates in rivers and lakes to be in accordance with **Tables 6.1 and 6.3**. Policies to be developed to limit overall nutrient load from all sources (agriculture, domestic and industrial effluent discharges and natural background loads)

6. Policies to limit adverse impact of peat silt on river water quality to be implemented in connection with existing and new peat extractions

7. An integrated monitoring programme to be implemented for the catchment, directed by the Steering Committee, to include flow monitoring, biological, physico-chemical and trophic status determination at satisfactory frequencies having regard to beneficial uses and pressures

8. A G.I.S. based data management system to be implemented for handling, updating and reporting on water quality and catchment data relevant to the plan area. It should have facilities for interpretation and trending of data to assist catchment management.

6.3 Water Quality Standards

Environmental quality standards to be adopted in the plan are based on water quality criteria necessary to protect the beneficial uses. These are expressed in terms of allowable concentrations of specific chemicals in water which protect aquatic life or human health. The criteria are based on current available information on the effects of pollutants.

The standards will require to be reviewed at 5 year intervals to account for any new information and new Directives and Standards. A proposed E.U. Directive on the ecological quality of water is anticipated in the next few years to replace the existing legislation. It will concern the adoption of measures in each member state for the control of pollution of surface waters from point sources, sources of diffuse pollution and other factors affecting surface water quality. It is anticipated that this Directive will cover the following:-

- *All surface waters, not just those designated in respect of particular activities*
- *A wide range of toxic or harmful chemical substances will be covered instead of selective indicative substances*
- *Water quality will be monitored and classified in terms of biological as well as physico-chemical parameters*
- *Standardised monitoring and classification would be introduced for comparability across the community*
- *Inventories of discharges and of diffuse sources of pollution will be required*

Measures contained in programmes for protection of the ecological quality of water will have regard to best environmental practices and best available technology not entailing excessive cost (BATNEEC), implemented according to the "pollutor pays" principal. This approach differs from the historical method of determining an assimilative capacity which involved estimation of the maximum amount of waste which could be discharged to a river system before the particular water quality standard would be exceeded.

Nevertheless, the approach to be adopted in the plan is to set appropriate standards in terms of a range of relevant parameters defined in the various Directives and Regulations. The minimum standards required for effluent discharges can then be determined on the basis of existing background levels of a pollutant and the available dilutions (based on 95 percentile low flow and the appropriate standard).

Specific standards are specified hereunder in respect of five key water quality parameters for waters which are to comply with salmonid standards:-

- *Dissolved Oxygen (D.O.)*
- *5 day Biochemical Oxygen Demand (BOD_5)*
- *Ammonia*
- *Oxidised Nitrogen*
- *Ortho Phosphate/Total Phosphate*

The five parameters give a measure of the effects of organic biodegradable waste which are the predominant type of waste generated and discharged in the catchment. Standards for other parameters shall be those set out in E.U. Directives and National Regulations summarised in Chapter 4 and **Table 4.11**, as updated from time to time.

The standards for the five key parameters are specified in percentile limits as follows:-

Dissolved Oxygen (D.O.)

- *99.9 percentile limit : equal to or greater than 4 mg/l O2*
- *95 percentile limit : equal to or greater than 6 mg/l O2*
- *50 percentile limit : equal to or greater than 9 mg/l O2*
- *Where dissolved oxygen levels fall below 6 mg/l O2 investigations will be instituted to determine the cause*

Five day Biochemical Oxygen Demand (BOD_5)

- *95 percentile limit : equal to or less than 5 mg/l*
- *50 percentile limit : equal to or less than 3 mg/l*

Ammonia

- *95 percentile limit : equal to or less than 1.0 mg/l N (Total)*
- *95 percentile limit : equal to or less than 0.02 mg/l N (un-ionised)*
- *50 percentile limit : equal to or less than 0.2 mg/l N (Total)*

Total Oxidised Nitrogen (Nitrate + Nitrite)

- *99.9 percentile limit : equal to or less than 11 mg/l N*
- *95 percentile limit : equal. to or less than 5 mg/l N*
- *50 percentile limit : equal to or less than 3 mg/l N*

Orthophosphate/Total Phosphorus

The phosphate standards are set out in **Tables 6.1 to 6.3.**

It should be noted that the Urban Wastewater Treatment Directive (91/271) makes specific provision for nutrient removal from wastes discharged to waters which are eutrophic or are liable to become eutrophic. Accordingly, phosphate removal should be provided for significant effluent discharges (at least those from WWT plants with design capacity $\geq$ 2000 PE).

Mixing Zones

The standards specified above are applicable outside the mixing zone, i.e., the area adjacent to a discharge where initial dilution occurs and where receiving waters may not meet in full the quality criteria applicable to the receiving water as a whole. In the mixing zone, where organic wastes are concerned, the main objective will be to prevent nuisance and to ensure the passage of fish. The permitted extent of the mixing zone will depend on site specific characteristics, such as the strength of the mixing forces (such as river flow), the exchange rate and the size of receiving water body and whether other mixing zones are involved.

For all discharges, the following criteria should apply to the mixing zone area:-

- *There should be no accumulation of objectionable deposits*
- *The waters should be free of scum, oil and other floating debris*
- *Discharges should not produce objectionable odour, colour, taste or excessive turbidity*
- *The conditions at the outfall should not produce objectionable growth of nuisance plants such as sewage fungus*

Critical Flows and Discharges

In general, the specified water quality standards will be taken to apply only at flows equal to or greater than the 95 percentile flow. In the case of dissolved oxygen (D.O.), the 99.9 percentile limit of 4 mg/l O_2 for salmonid waters will apply at all flows including the dry weather flow. Similar flow conditions will apply to the 99.9 percentile limit for oxidised nitrogen of 11 mg/l N. Standards for toxic substances such as heavy metals apply for all flows including the dry weather flow.

In calculating the impact of a waste discharge, the objective should be not to exceed a BOD limit of 4 mg/l, in order to allow a margin for carry-over from other discharges. An effluent discharge should not result in a BOD increment of more than 2 mg/l O_2 in the receiving water.

6.4 Other Sources of Waste Discharge

The plan must have regard to the existing and potential pollution from waste discharges other than domestic or industrial effluent. Such discharges can derive from :-

- ***Agriculture*** *; including animal manures and silage liquor and fertiliser run-off*
- ***Domestic Septic Tanks*** *; organic and nutrient discharges can arise from unsatisfactory septic tanks and small package systems associated with inadequate design, poor maintenance, unsatisfactory percolation areas and bypassing direct to watercourses*
- ***Peat Siltation*** *; there is evidence of peat siltation in the upper section of the main channel and it's important tributaries. This can give rise to increased colour and possibly eutrophication arising from the humic complexes associated with peat silt*
- ***Forestry*** *; areas zoned for afforestation should have monitoring of water quality parameters to assess the possible effects on water quality, particularly where lakes and rivers are used for abstraction*
- ***Landfill Sites*** *; future public and private landfill sites will be required to conform with strict siting and leachate control criteria to prevent migration of pollution to the watercourses. Monitoring of existing sites is required to assess possible groundwater and surface water impacts and to determine whether control measures are necessary*
- ***Petrol and Diesel Storage*** *; overground tanks containing diesel fuel, heating oil or other similar products, other than domestic installations, should be bunded to contain the liquids in case of spillage. All discharges from filling stations should be fitted with petrol interceptors to prevent contamination of water courses.*

Surveys should be carried out to identify and map sources of waste from agriculture. Field surveys have indicated unsatisfactory effluent storage facilities and lack of control of soiled water from open yard systems. Comprehensive farm surveys are required to establish catchment farm records to be integrated to the G.I.S. system, together with records of monitoring and pollution incidents. This system should provide the basis for undertaking measures, where necessary, to protect water quality

Similarly, records of septic tank systems should be developed, together with details of their function (domestic house, public house, commercial premises). By incorporating these records into the G.I.S. Data Management System, statistics could be maintained on monitoring results and pollution incidents associated with such systems.

Pollution incidents can also arise from road accidents which result in spillages to water courses. Records of these events should also be maintained. Accident black spots might be identified with particular reference to water supply abstractions which would be vulnerable to such incidents.

Additional studies are recommended to quantify the effects of non-point sources of pollution from the following sources:-

- *Roadway run-off*
- *Baseline survey of persistent organic matter in aquatic organisms*
- *Sheep dipping and discharge of spent sheep dip*
- *Discharges from combined sewer overflows*

6.5 Monitoring Programmes

A standardised monitoring programme should be adopted for the catchment to include the following:-

- ***Permanent river flow monitoring*** *; the arrangements for river flow monitoring should be reviewed and additional stations installed where required, particularly in the vicinity of significant water supply abstractions or waste discharges, to be automatic recording stations*
- ***Physico-chemical Parameters*** *; locations of sampling sites to be reviewed and appropriate frequency of sampling determined for the key physico-chemical parameters should be carried out to include BOD, dissolved oxygen, pH, temperature, suspended solids, phosphate, nitrates, ammonia, nitrite and faecal coliforms*
- ***Biological (invertebrate)*** *; monitoring should be carried out at all EPA reference sites at least once per year*

A Data Management System should be established to store all of the catchment data with facilities for editing and reporting. This should be a G.I.S. system capable of spatial reference. This can be implemented based on the National Water Services G.I.S., currently being developed by the Local Government Computer Services Board. The system should provide for digital data exchange between the six authorities involved in the catchment and with the EPA National Database, and be compatible with the National and E.U. Environmental Information Systems.

In this regard, it should be noted that the plan is based on the currently available information, some of it relying on a limited dataset. The acquisition of additional data from a comprehensive programme of monitoring would reduce the element of uncertainty in decision making.

Issues which require to be resolved in relation to the Data Management System include :-

- *A nominated G.I.S. Manager to co-ordinate and manage the Boyne Catchment Database*
- *Arrangements for routine collection of data from the 6 different Authorities and return of the data in G.I.S. format to each user authority*
- *The development of appropriate report formats to summarise water quality data, trends and pollution events*
- *Maintenance of key catchment information including records of licensed industry, municipal wastewater discharges, abstractions, landuse changes and other catchment information*

6.6 Implementation

Having been adopted by the relevant Local Authorities, specific measures are required for it's implementation. This will involve a commitment of resources in respect of the following:-

- *Establishment of the Data Management System with a nominated G.I.S. Manager and procedures for data capture and reporting*
- *Provision of the necessary resources to implement the Water Quality Monitoring Programme required by the Plan*
- *Specific technical resources to carry out the specialist surveys (farmyards, septic tanks, background organics, etc.)*

The plan requires a commitment to minimum effluent standards from wastewater treatment plants throughout the catchment. This will require improved operational practices to ensure compliance with the standards. It may also require upgrading of treatment facilities as part of the sanitary services, capital programme.

Establishment of a Data Management System will involve an initial set-up cost on the part of the individual authorities in terms of computer equipment, software and development of the database. This would utilise the National Water Services G.I.S. currently being developed by the Local Government Computer Services Board.

TABLE 6.1 - INTERIM STATUTORY STANDARDS FOR RIVERS

Existing Biological Quality Rating (Q)		MRP annual median (mgP/l) 2007	Corresponding Min. Target Q Rating
5)		0.015	5
)			
4-5)	unpolluted	0.020	4-5
)			
4)		0.030	4
3-4	slightly polluted	0.030	4
3)		0.050	3-4
)	moderately polluted		
2-3)		0.070	3
< 2	seriously polluted	0.070	3

TABLE 6.2 - INTERIM STATUTORY STANDARDS FOR CLEAR WATER LAKES

Existing Trophic Status		Target Trophic Status 2007	Total P annual average (ug P/l) 2007
Ultra-Oligotrophic	)	Ultra-Oligotrophic	<5
Oligotrophic	) satisfactory	Oligotrophic	5-10
Mesotrophic	)	Mesotrophic[or	10-20
		Oligotrophic*]	[5-10]
Eutrophic	)	Mesotrophic	10-20
	) unsatisfactory		
Hypertrophic	)	Eutrophic	20-50

TABLE 6.3 - INTERIM STATUTORY STANDARDS FOR OTHER LAKES

Existing Trophic Status		Target Trophic Status 2007	Total P annual average (ug P/l) 2007
Oligotrophic	)	Oligotrophic	<=10
Mesotrophic	) satisfactory	Mesotrophic[or	10-20
		Oligotrophic*]	[<=10]
Eutrophic	)	Mesotrophic	10-35
	) unsatisfactory		
Hypertrophic	)	Eutrophic	35-100

** in the case of lakes which were originally of that quality*

Client :

MEATH COUNTY COUNCIL
COMMUNITY & ENVIRONMENT SECTION
Mr. O. Perkins, B.E., C.Eng., F.I.E.I.
County Engineer

Job :

WATER QUALITY MANAGEMENT PLAN
RIVER BOYNE CATCHMENT

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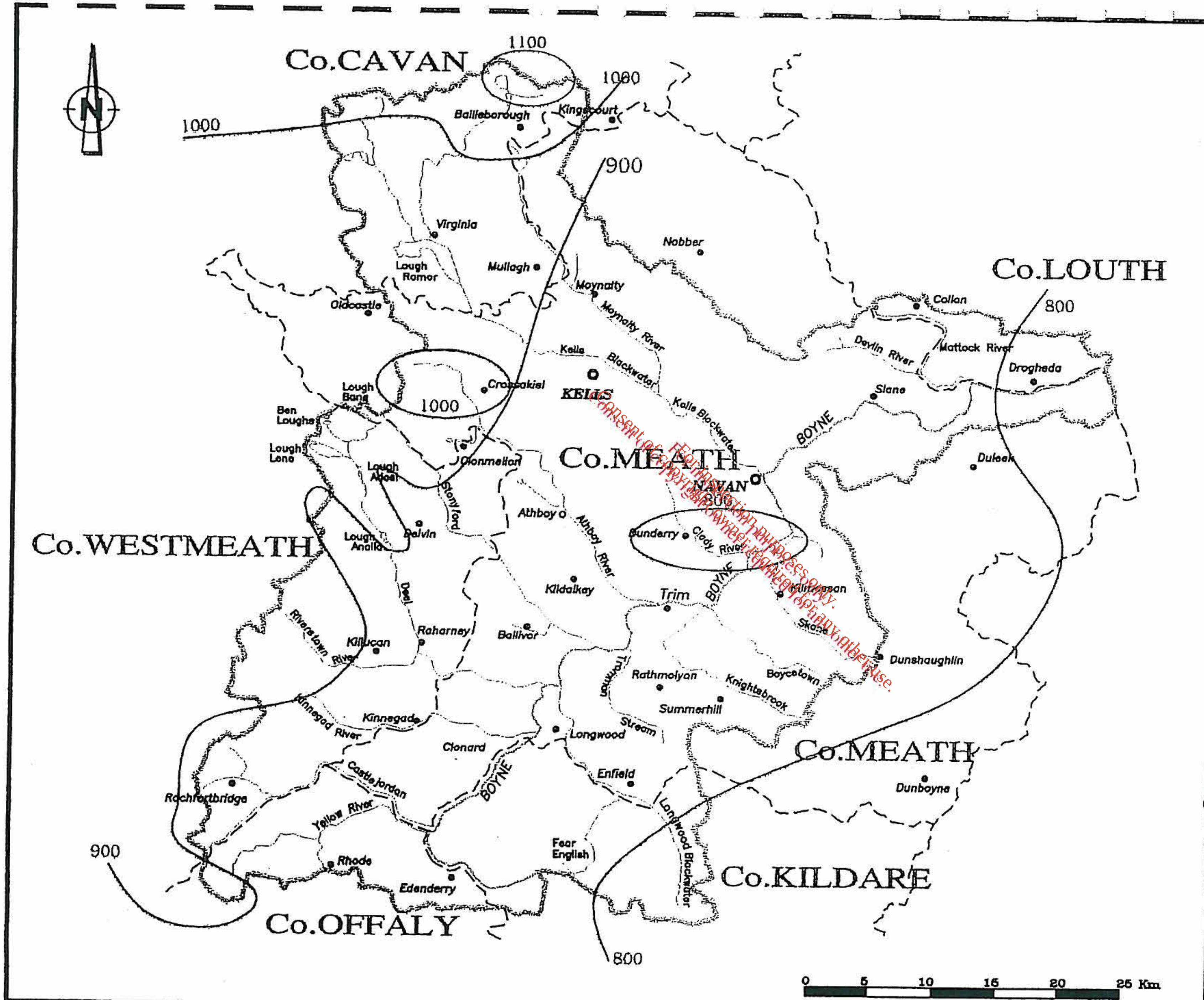
Phone 021-870200
Fax No. 021-873742

Title:

HYDROMETRIC GAUGING STATIONS

Map No.: 1 | File No.: WQM-B



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MEATH COUNTY COUNCIL COMMUNITY & ENVIRONMENT SECTION
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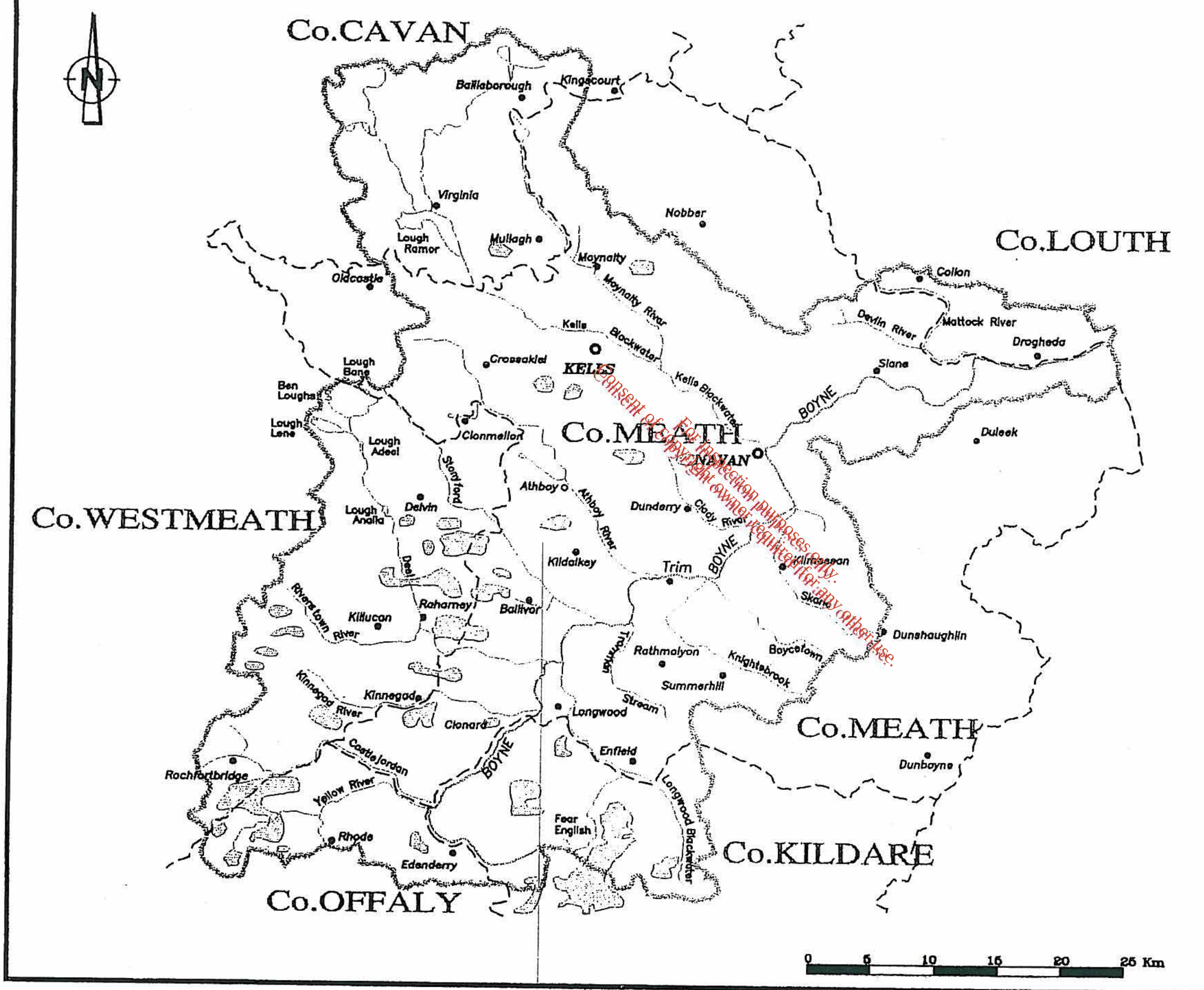
Fax No. 021-873742

Title:
ISOHYETS OF RAINFALL

Map No. 2 | File No.: WQM-C



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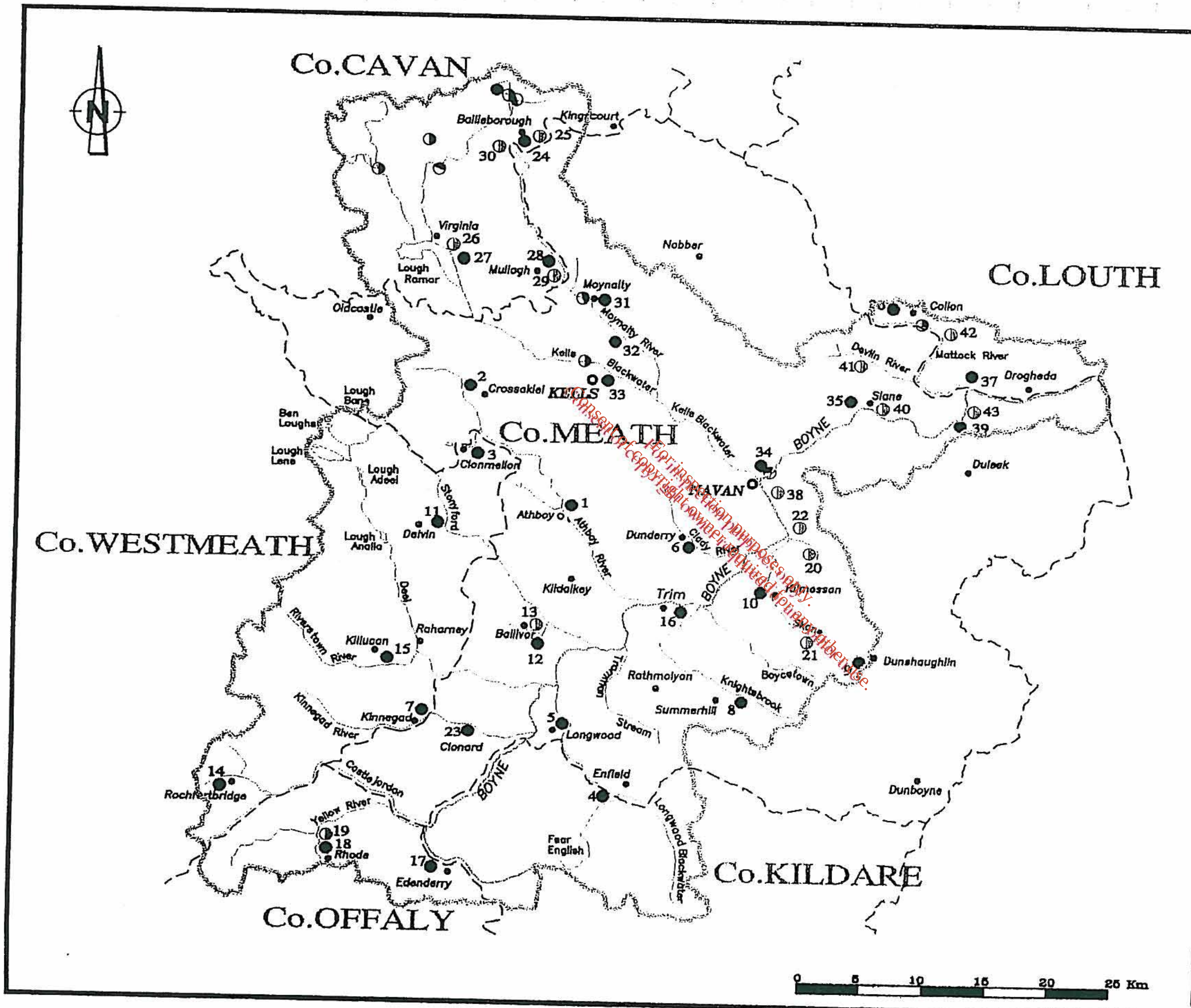
Fax No. 021-873742

Title:
PEATLANDS

Map No. 4 | File No.: WQM-C



LEGEND:

BOYNE CATCHMENT

COUNTY BOUNDARY

BOYNE MAIN CHANNEL

TRIBUTARIES

TOWNS

MUNICIPAL WASTEWATER DISCHARGES

INDUSTRIAL WASTEWATER DISCHARGES

Client :

MEATH COUNTY COUNCIL
COMMUNITY & ENVIRONMENT SECTION

Mr. O. Perkins, B.E., C.Eng., F.I.E.I.
County Engineer

Job :

WATER QUALITY MANAGEMENT PLAN

RIVER BOYNE CATCHMENT

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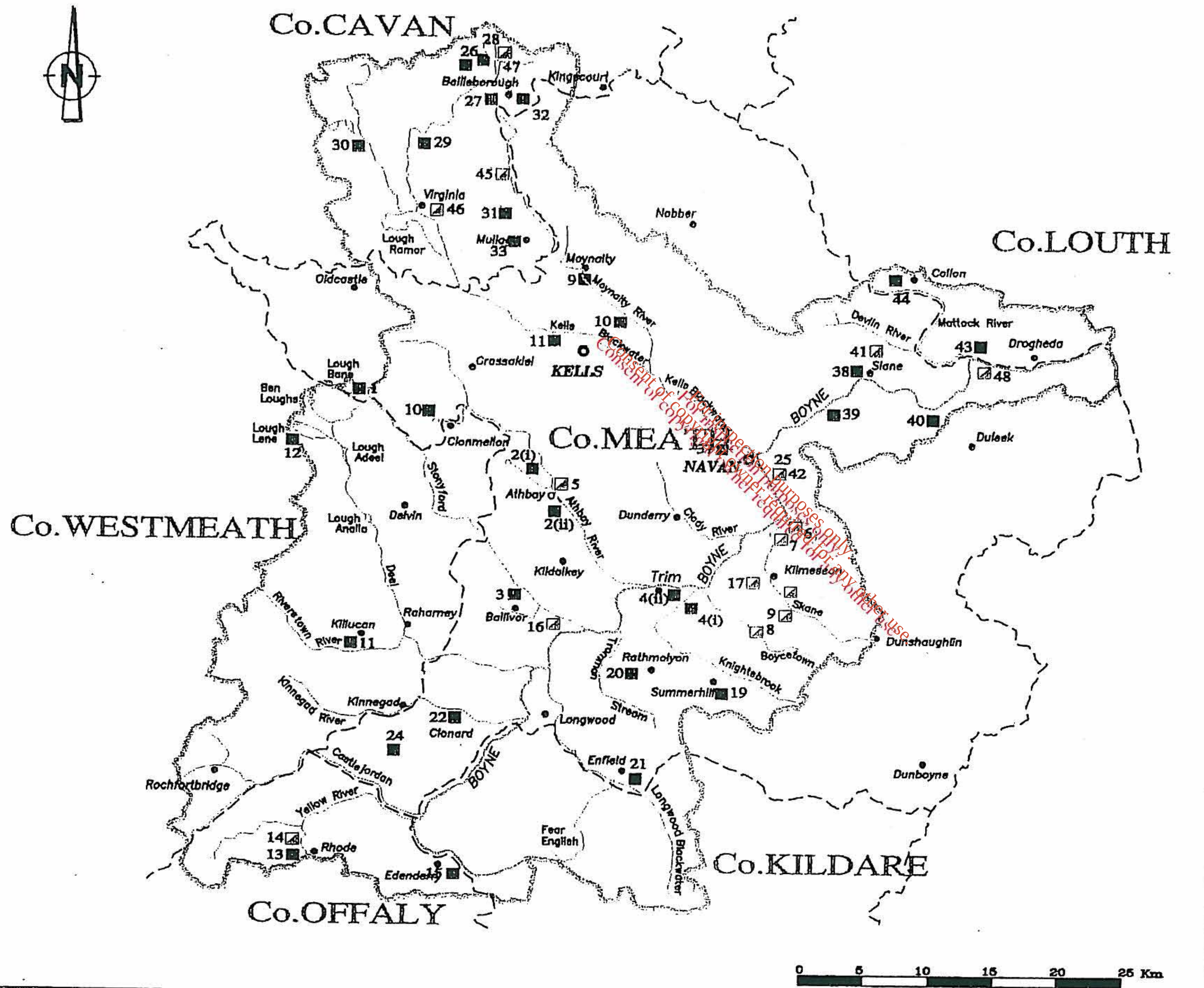
Title:

DISCHARGES

Map No. 6 | File No.: WQM-A



LEGEND:

- BOYNE CATCHMENT
- COUNTY BOUNDARY
- BOYNE MAIN CHANNEL
- TRIBUTARIES
- TOWNS
- LOCAL AUTHORITY ABSTRACTIONS
- OTHER ABSTRACTIONS

Client :

MEATH COUNTY COUNCIL
COMMUNITY & ENVIRONMENT SECTION

Mr. O. Perkins, B.E., C.Eng., F.I.E.I.
County Engineer

Job :

WATER QUALITY MANAGEMENT PLAN

RIVER BOYNE CATCHMENT

MCOS
M.C.O'SULLIVAN
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Ashurst, Mount Merrion Avenue, Blackrock, Co. Dublin
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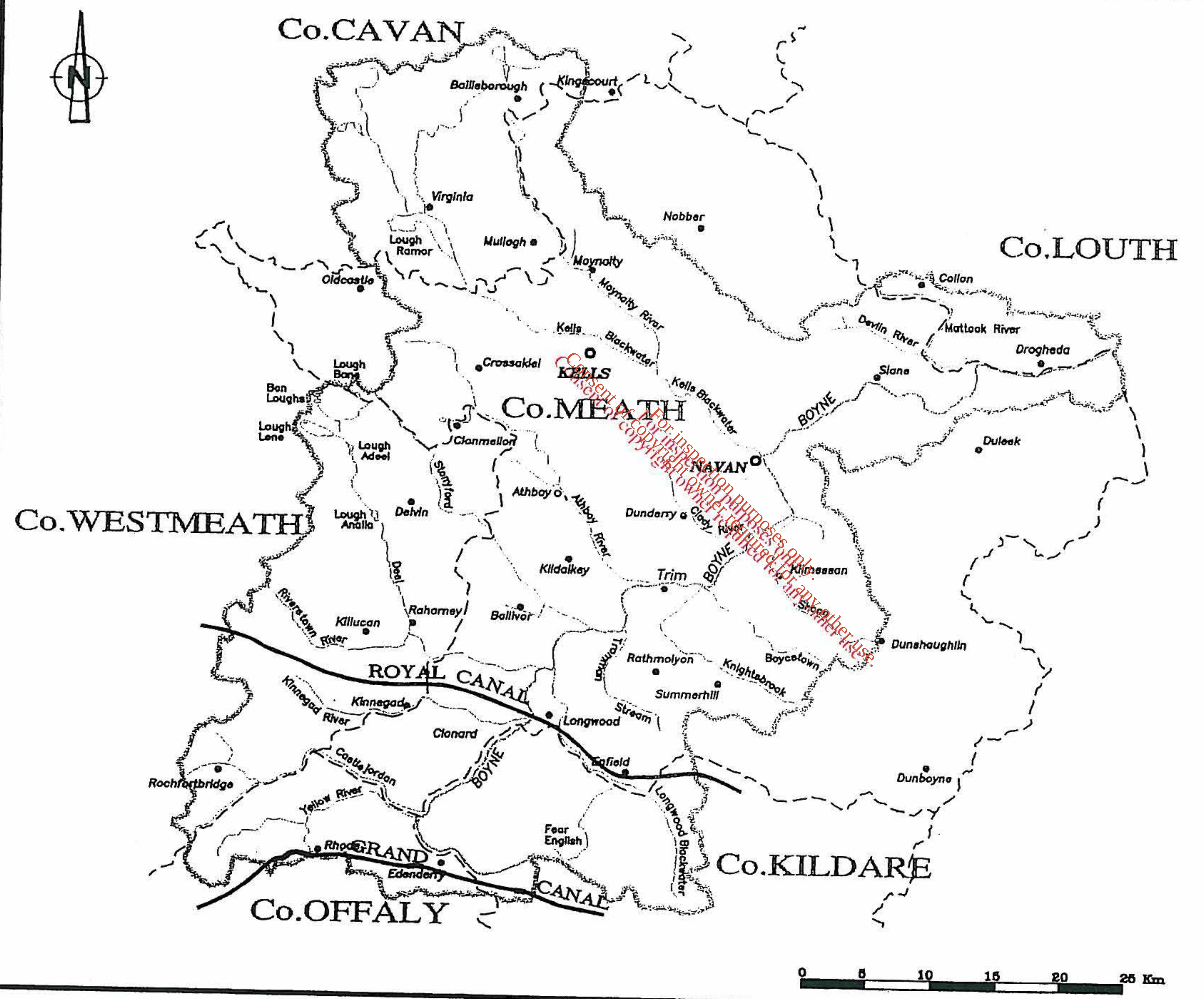
Fax No. 021-873742

Title:

ABSTRACTIONS

Map No. 7 | File No.: WQM-A



LEGEND:

BOYNE CATCHMENT
COUNTY BOUNDARY
BOYNE MAIN CHANNEL
TRIBUTARIES
TOWNS
CANALS — ROYAL CANAL

Client :
MEATH COUNTY COUNCIL
COMMUNITY & ENVIRONMENT SECTION
Mr. O. Perkins, B.E., C.Eng., F.I.E.I.
County Engineer

Job :
WATER QUALITY MANAGEMENT PLAN
RIVER BOYNE CATCHMENT

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Title:
CANALS

Map No. 8 | File No.: WQM-A

Client :
MEATH COUNTY COUNCIL
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WATER QUALITY MANAGEMENT PLAN
RIVER BOYNE CATCHMENT

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Title:
SAMPLING STATIONS

Map No. 9 | File No.: WQM-C