

2 CATCHMENTS DESCRIPTION, CHARACTERISTICS AND PRESSURES

2.1 THREE RIVERS CATCHMENTS - GENERAL DESCRIPTION

The Three Rivers Project covers three significant rivers in Ireland and their catchment basins. These are: -

River Boyne; River no. 159 on the Ordnance Survey of Ireland map "Rivers and their Catchment Basins" draining a lowland catchment in the east of Ireland and discharging to the Irish Sea at Drogheda (Hydrometric Area 07). The catchment area covered by the project is 2693 km² from the source to the freshwater limit at St Mary's Bridge in Drogheda.

River Liffey; River No. 168 on the Ordnance Survey map, draining a smaller catchment to the south of the Boyne, discharging to Dublin Bay. The significance of the Liffey catchment, however, derives from the fact that the Dublin conurbation is substantially within the catchment and that the river provides drinking water to over 1 million people in addition to hydroelectric power generation (Hydrometric Area 09). The catchment area covered by the Project is 1185km² from source to the freshwater limit (FWL) at Islandbridge.

River Suir; River No. 182 on the Ordnance Survey map, draining a substantial catchment comprising lowland and upland areas in the south of Ireland and discharging to Waterford Harbour. The catchment area covered by the Project is 3548km² from the source to Cheek Point on the estuary.

2.1.1 Boyne Catchment

The Boyne catchment encompasses 66% of Co. Meath with small areas of Co. Cavan and Co. Louth to the north, Co. Westmeath to the west, Co. Offaly and Co. Kildare to the south. The total catchment area is estimated at 2,693km² with a main channel length of 113km. A characteristic of the catchment is the limited average gradient of 1.24m/km, representing only 140m fall from the headwaters of the main channel in north Kildare to the sea at Drogheda.

There are two main river systems in the Boyne catchment (**Figure. 2.1**), the Boyne itself that drains the southern part of the catchment, and the Kells Blackwater that drains the northern part of the catchment. Both rivers combine at Navan with the Boyne continuing eastwards to the sea at Drogheda via Slane.

The main Boyne River rises to the east of Edenderry and flows through the town before heading in a north-easterly direction to Trim and Navan. The main pressures in the headwaters area are the effluent from Edenderry Municipal Wastewater Treatment Plant (MWWTP) and the impact of peat harvesting in the upper catchment. On it's route to Navan the Boyne is joined by the following significant tributaries: -

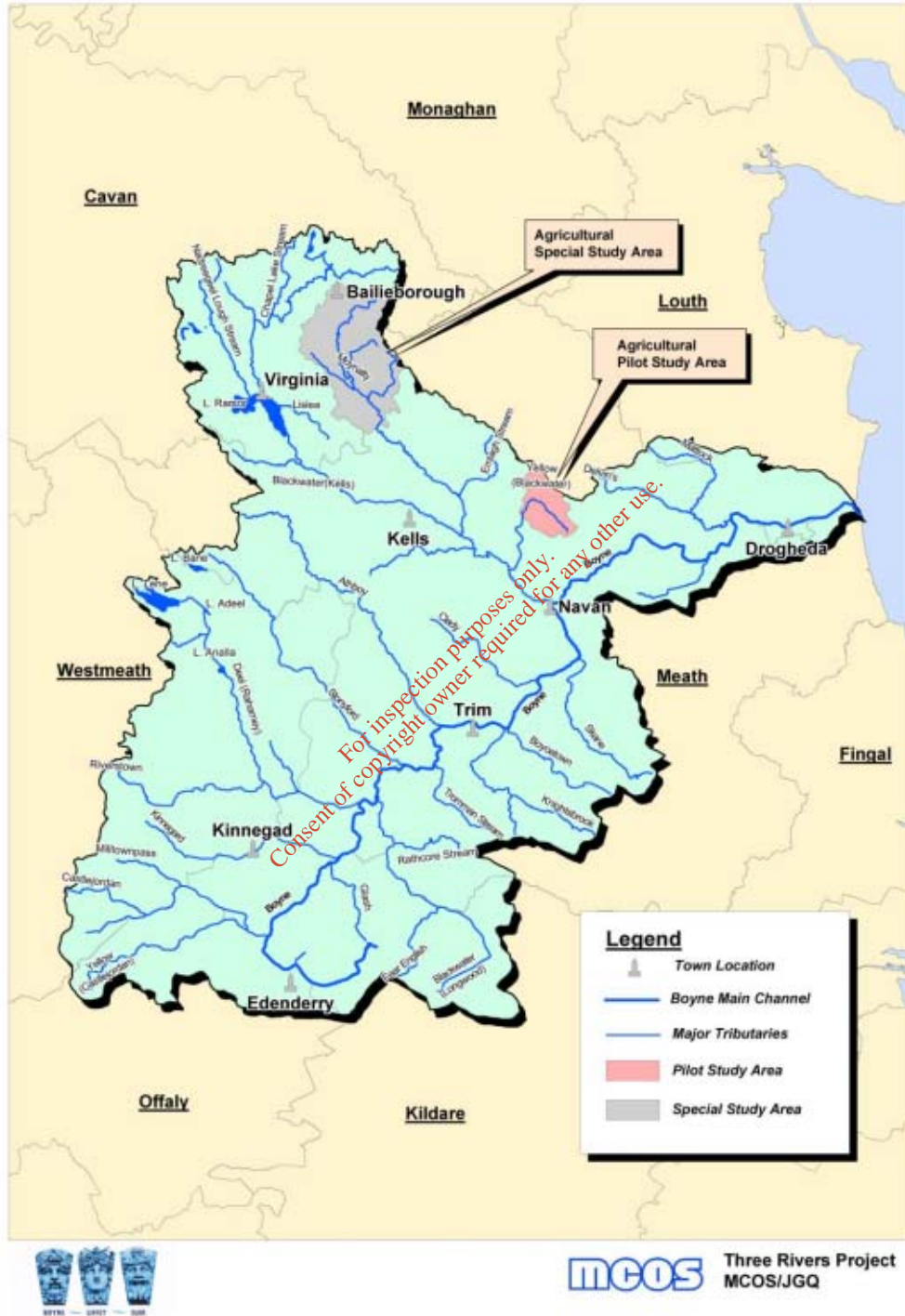
The Yellow (Castlejordan) River; drains a catchment in Co. Offaly to the west of Edenderry which includes Rhode (and ESB power station) and Castlejordan. There are significant peat workings in this catchment.

Kinnegad River; drains a catchment extending into Co. Westmeath and including the town of Kinnegad which traditionally has had a significant municipal wastewater effluent load.

The Longwood Blackwater; is a tributary rising north of Prosperous in Co. Kildare. The catchment includes the towns of Enfield and Longwood and this tributary joins the main Boyne channel near Donore Castle. There are significant areas of forestry in the upper Blackwater catchment in Co. Kildare.

2.1 Figure – Boyne Catchment Geography

Figure 2.1 Boyne Catchment



Deel/Riverstown; the River Deel system drains a substantial catchment in east Co. Westmeath and includes Lough Bane and Lough Lene. These lakes were historically classified as oligotrophic, but have been marginal mesotrophic over the past 10 years. However, a recovery was indicated at the start of the Project period. Lough Lene is a major source of water for abstraction for the Castlepollard Regional Water Supply Scheme and also has a designated bathing water area known as "The Cut".

Stonyford River; drains the Delvin area in east Westmeath and flows in a south-easterly direction to the north of Ballivor joining the River Boyne at Scarriff bridge upstream of Trim.

Knightsbrook and Boycetown; tributaries which drain a rural catchment north of Summerhill joining the Boyne at Trim.

Athboy/Tremblestown River; drains the Athboy area, the river flowing south-easterly to join the River Boyne just upstream of Trim.

River Skane; which rises west of Dunshaughlin and joins the Boyne upstream of Navan.

At Navan, the River Boyne is joined by the **Kells Blackwater** which rises north of Bailieborough in Co. Cavan and together with the Chapel Lake Stream and the Nadreegeel Lough Stream form the catchment of Lough Ramor, to the south of the town of Virginia. This headwater catchment in south-east Co. Cavan, comprises a network of small rivers and lakes with relatively poor water quality, epitomised by the condition of Lough Ramor itself, which is described as eutrophic or marginally hypertrophic. Lough Ramor is an important coarse fishery and is also exploited for industrial process water.

Key pressures in this catchment have been municipal and industrial effluents from Bailieborough and Virginia together with agricultural pollution. These municipal wastewater treatment plants (MWWTPs) have been upgraded prior to the commencement of the Three Rivers Project.

Downstream of Kells, the Blackwater is joined by the **Moynalty**, which rises to the south of Bailieborough and flows along the county boundary between Meath and Cavan flowing south to the Boyne. The Moynalty is an area characterised by intensive agriculture, including a number of pig rearing units. There are also 2 MWWTPs (Mullagh and Moynalty) discharging to the system.

The **Yellow (Blackwater) River** joins the Blackwater downstream of Donaghpatrick. Key pressures in this catchment are intensive agriculture, mainly tillage, and the tailings pond for Tara Mines, which is located near its confluence with the Blackwater.

The **Mattock River** and **Devlins** tributary drain a small sub-catchment mostly in Co. Louth including Collon and the Monasterboice area to join the River Boyne upstream of Drogheda. These sub-catchments are important fish nurseries.

The Boyne catchment is a lowland catchment covering the fertile plains of Co. Meath, a significant area of Co. Westmeath and parts of Kildare, Offaly, Cavan and Louth. The Boyne estuary is an important port and commercial salmon fishery, while the town of Drogheda is a major centre of population and industry. Upstream in the catchment, Navan is the largest inland town in the catchment, with Trim, Edenderry, Kells, Virginia and Bailieborough also important local towns. The eastern area of the catchment is experiencing significant development pressures with the towns of Navan and Dunshaughlin and to a lesser extent, Trim and Kells identified as growth centres.

The existing Boyne River network was developed in a comprehensive arterial drainage project in the 1970's and 1980's by the Office of Public Works (OPW), who maintain the system through a programme of maintenance dredging. In recent years, in collaboration with the Eastern and Central Fisheries Boards, a fisheries rehabilitation programme has been implemented, with the objective of increasing physical habitat diversity and other necessary features for good fish habitat.

2.1.2 Liffey Catchment

The River Liffey rises near the Sally Gap in Co. Wicklow and the upper catchment drains a high mountainous area in west Wicklow (**Fig. 2.2**). The catchment area included in this study extends as far as Islandbridge encompassing an area of approximately 1,185 km². The upper Liffey and Kings River catchments were impounded by a dam at Poulaphuca in the 1940's to form the major reservoir (the Blessington Lakes/Poulaphuca reservoir) which now services hydroelectric generation by the E.S.B. and major water abstraction by Dublin City Council for the Dublin region.

The upper catchment has an area of approximately 314 km², with an average rainfall of almost 1,400mm per annum in an area of granite geology and relatively little development. Forestry and moderate intensity agriculture are the main catchment activities in the uplands, with peat-covered uplands generally uncultivated. The main tributaries to the reservoir are the **Kings** and **Brittas** Rivers.

The dam at Poulaphuca is capable of passing up to 80m³/s when generating at full capacity. The Golden Falls reservoir is a smaller balancing reservoir downstream, which limits the maximum discharge (apart from overflow spills), to 30m³/s, with a continuous compensation flow of 1.5m³/s. No overflow spills have been recorded at the dam.

At present Poulaphuca reservoir supports daily abstractions of up to 236 million litres/day on behalf of Dublin City Council, and it has permission to abstract up to 318 million litres/day. The reservoirs are managed by the E.S.B. who are responsible for balancing abstraction, power generation, fishery and other interests. The reservoir also supports significant boating and other amenity activities.

The major town in the upper catchment is Blessington, which discharges treated effluent to the Golden Falls reservoir downstream of Poulaphuca.

Downstream of Golden Falls, the River Liffey flows in a westerly direction to Kilcullen and then north-westerly through the Curragh to Newbridge. After Newbridge it turns north-east past Naas to Celbridge and Leixlip. From Leixlip, the river flows in a generally easterly direction to Islandbridge from where it is tidal through Dublin, discharging to Dublin Bay.

The river is also impounded at Leixlip, though the storage volume is small. The E.S.B. manage a hydroelectric power station at this site also. Since the 1960s, this impoundment has been developed as a substantial source of water abstraction, notably for north Kildare, Fingal and the northern environs of Dublin City. At present, the abstraction rate at Leixlip is in the order of 140 million litres/day and a maximum figure of 175 million litres/day can be achieved.

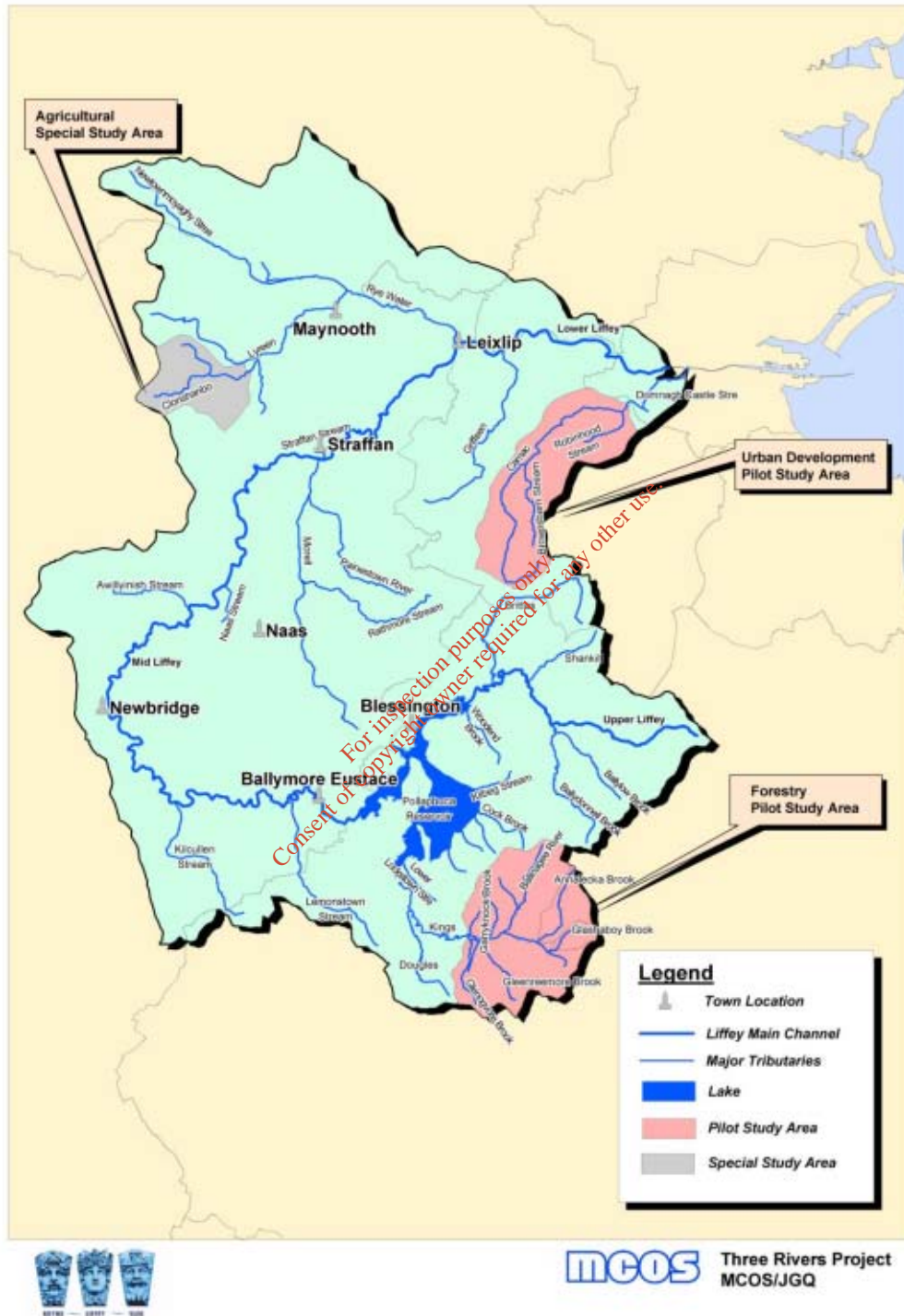
Between Golden Falls and Kilcullen, the natural channel flow is effectively regulated by the impoundment discharge, with base flows equivalent to the compensation release. In summertime, following fishery representations, the E.S.B. discharge freshets in order to improve water quality and fishery conditions. Notable tributaries in this section include the **Lemonstown** and **Kilcullen** streams that flow northward to join the main channel near Kilcullen. The Lemonstown and Kilcullen streams drain moderately intensive agricultural land composed mainly of pasture and silage.

The **Morrell/Painstown** tributary system originates in the foothills of the Dublin and Wicklow Mountains and flows westward to join the main Liffey channel east of Naas. This system flows through moderately intensive agricultural areas with significant urban centres.

At Leixlip, the Liffey is joined by the **Rye Water** a major tributary which drains Kilcock and Maynooth. The towns of Celbridge and Leixlip on the main Liffey channel, together with Kilcock and Maynooth, are all major growth centres, which have experienced continued expansion in recent years. They are also significant centres of industry, with the large Intel and Hewlett Packard electronics industries located in the catchment. The Rye Water is characterised by significant pollution pressures exacerbated by a very low dry weather base flow that is indicative of a high level of run-off response to rainfall. A river with these characteristics is also vulnerable to the impacts of catchment urbanisation on run-off and pollution load. The Rye Water has been regarded as an important fisheries nursery.

Figure 2.2 – Liffey Catchment Geography

Figure 2.2 Liffey Catchment



Downstream of Leixlip, the significant tributaries are the **Camac** and **Griffeen** rivers in South Dublin. These are fast becoming urban streams; with environmental pressures due to pollution in surface runoff and loss of base flow due to canalisation. These pressures are being considered in the development of drainage strategies in the Saggart/Newcastle, Clondalkin and Lucan catchments. The Saggart MWWTP was decommissioned in November 2001 (See Camac Report) while Newcastle MWWTP is due to cease operations shortly and this is expected to significantly improve water quality in the Camac and Griffeen respectively.

2.1.3 Suir Catchment

The Suir catchment is situated in the south east of the country and covers an area of approximately 3,484km², this represents about 4% of the area of Ireland. The Suir catchment covers a large part of Co. Tipperary with marginal areas of east Limerick and north Cork (**Figure 2.3**). The downstream catchment includes the northern part of Co. Waterford, in particular the Clodiagh (Waterford) sub-catchment and a significant area in south Kilkenny (Pollanassa/Blackwater catchment). The Suir River drains a substantial catchment comprising lowland and upland areas.

The Suir river rises in the Devils Bit mountain north of Templemore in North Tipperary before flowing in a southerly direction, passing through Thurles and Holycross, passing to the west of Cashel before continuing south to Caher and Ardfinnan. South of Ardfinnan, the main river meets the Knockmealdown mountain range forcing it to the north. At Knocklofty, the River Suir turns to the east, passing to the north of the Comeragh mountain range and flowing through Clonmel and Carrick-on-Suir before continuing to Waterford City and outfalling to Waterford Harbour. The river is tidal to a point above Carrick-on-Suir.

The Suir is normally referred to in the context of the "Three Sister" catchments (Barrow, Nore and Suir) which are contiguous and all three of which drain into Waterford Harbour.

Upstream of Thurles, the Suir is a relatively small river draining a mainly lowland catchment with two substantial towns, Templemore and Thurles, whose sewage effluents have traditionally had significant impact on water quality in the river. Both of these MWWTPs require upgrading.

To the north of Cashel, the Suir catchment is characterised by relatively lowland sub-catchments to the east of the river and a number of significant upland catchments to the west. The principal tributary rivers in this section of the catchment are:

River Clodiagh; (Tipperary) which drains an upland area comprising the eastern slopes of the Slieve Felim hills, including the town of Borrisoleigh. The main tributary rises close to Borrisoleigh and flows in a southerly direction to join the River Suir south of Holycross. The area comprises of agriculture, which varies in intensity as it extends up the catchment, with a significant development of afforestation over recent decades. The Borrisoleigh MWWTP (p.e. 1000) discharges to the Clodiagh. A major drainage scheme was implemented on the lower Clodiagh River in the 1950's.

Multeen Catchment; draining the southern slopes of the Slieve Felim mountain range including Cappawhite and Dundrum and joining the main river at Golden. While the upper catchment is mountainous, with significant forestry, the lowland area of the Multeen catchment is fertile agricultural land, mainly pasture. Some sections of the Multeen were drained in the 1950/60's.

Drish River; draining a relatively lowland catchment to the east of Thurles, includes a significant area of peat bog particularly in the Black and Clover sub-catchments. These bogs are commercially exploited in the area bordering on the N8 between Urlingford and Littleton, with a major commercial briquette factory at Littleton. There are two wastewater treatment plants in the Drish and water quality is relatively poor (Q3-4), with high colour and turbidity, reflecting the catchment type.

Between Cashel and Clonmel, the Suir catchment comprises a lowland fertile plain through which the main river flows, joined by significant tributaries from the west and south, which have their headwaters in the Galtee and Knockmealdown mountain ranges.

Figure 2.3 – Suir Catchment Geography

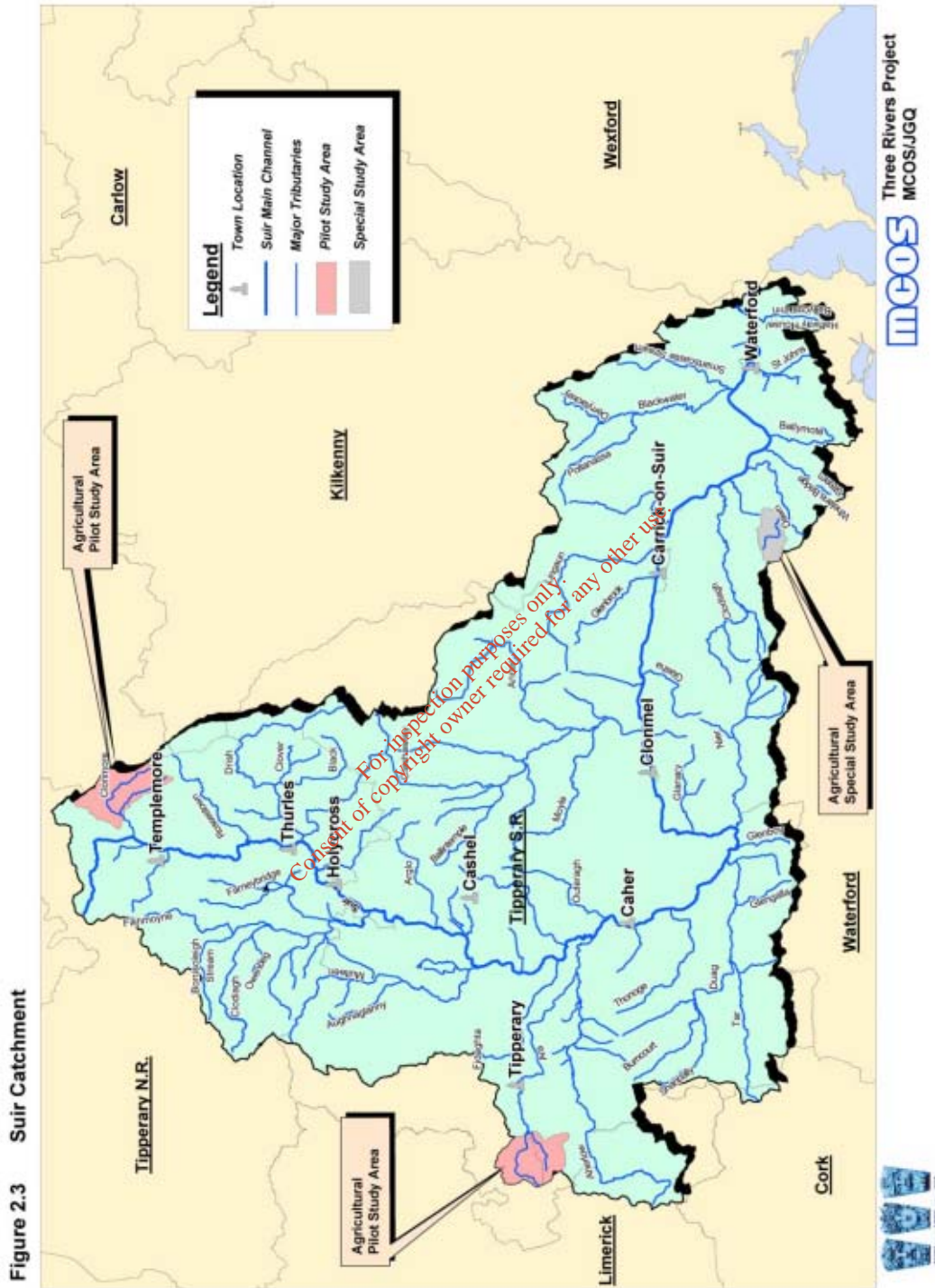


Figure 2.3 Suir Catchment

The **Fidaghta** is a small catchment just north of the Ara catchment. The catchment consists mainly of agricultural grazing land, with large areas of pig slurry spreadlands present.

Ara River; which drains a lowland catchment including the towns of Tipperary and Bansha before joining the Aherlow river upstream of its confluence with the Suir. Municipal wastewater discharge from both towns traditionally resulted in pollution pressures on the Ara River. Both of these plants are being up-graded.

Aherlow river; draining the “Glen of Aherlow” with its headwaters in the Galtee mountain range near Galbally, the river is initially a steep mountain stream which then flows through a fertile lower valley before being joined by the Ara and outfalling to the main river Suir north of Caher. The Aherlow River is designated as a Salmonid Fishery under the European Communities (Quality of Salmonid Waters) Regulations 1998, otherwise known as the “Salmonid Regulations”. The catchment is an area of outstanding natural beauty but is also the location of significant pig production enterprises and the associated landspreading of piggery slurries, which represents a potential risk to water quality.

Thonoge River; is a small tributary rising in the Galtee mountains and flowing through Ballylooby to join the River Suir north of Ardfinnan.

River Tar; is a major tributary system including the Burncourt, Shanbally, Duag, Glengalla and Glenboy tributaries. This river system drains the southern slopes of the Galtee Mountains and the northern slopes of the Knockmealdown Mountains with a fertile agricultural lowland catchment that includes the towns of Ballyporeen and Clogheen. The Tar system has relatively high base flows associated with significant groundwater re-charge and is a good quality fishery with relatively low pollution levels. There are a number of wastewater treatment plants in the catchment, which may exert pressure on the water quality.

River Nier; The river Nier drains a scenic valley of the Comeragh mountains rising high in that mountain range, with a number of “Cummeloughs” as its source and flowing westward down the Nier valley to Clogheen before joining the river Suir downstream of Newcastle. Because of its upland catchment and relatively high base flows, the Nier is a high quality relatively unpolluted river and an important fishery.

At Clonmel, the River Suir is a good quality river with relatively high base flows showing the influence of the Tar and Nier sub-catchment contributions. The river has been receiving untreated sewage from the Clonmel town and local industry for many years resulting in a significant deterioration in water quality downstream of the town. However, since early 1998, a new wastewater treatment plant has been commissioned in the town resulting in the removal of a substantial pollution load from the river.

The River Suir causes significant urban flooding at Clonmel periodically and OPW are currently undertaking a public consultation process prior to the implementation of a drainage scheme to alleviate this problem, which is due to start early in 2002. A further local flood relief scheme is under consideration at Carrick-on-Suir.

Downstream of Clonmel, the Suir receives a number of significant tributaries as follows: -

River Anner; including the Clashawley, Ballintemple and Moyle rivers, the Anner sub-catchment is a fertile lowland agricultural catchment with substantial pasture and arable cultivation. Significant towns include Killenaule and Fethard on the Clashawley River. The Anner River is a relatively good quality fishery, with somewhat impaired quality in the Clashawley and Moyle rivers, due to pollution pressures (domestic, agricultural and industrial) and very low summer base flows. In this karstified limestone area, surface streams can disappear underground, particularly at low flows and both the Moyle and Clashawley tributaries have been known to run practically dry.

Lingaun River; rises to the east of Slievenamon and forms the boundary between Counties Tipperary and Kilkenny over much of its length before joining the Suir downstream of Carrick-on-Suir. The Lingaun is a significant fishery river and has an appreciable extent of forestry in the catchment. There are two small wastewater treatment plants discharging to the Lingaun from Grangemockler and Faugheen.

Clodiagh (Waterford) River; rises in the eastern Comeragh mountains and flows eastwards through Clonea and Portlaw, outfalling to the Suir estuary. Connshingown, one of the finest Corrie lakes in Europe is located at the source of one tributary stream. The upland catchment includes substantial afforestation, while the lowland catchment is good quality agricultural land. Traditionally, the Clodiagh was vulnerable to pollution from a tannery at Portlaw that is no longer in operation. Other pressures include three small wastewater treatment plants at Portlaw, Clonea and Ballythomas. The river is an important source of water for the East Waterford Water Supply Scheme, which includes Waterford City and Tramore in its supply area.

River Blackwater (Kilmacow); drains an agricultural catchment in south Kilkenny including the Pollanassa and Smartcastle tributaries. The catchment comprises fertile agriculture, including both arable and pasture and also has significant forestry development. Pollanassa is reported to be experiencing poor water quality in recent years. The river discharges to the Suir estuary immediately upstream of Waterford City.

2.2 REVIEW OF KEY CATCHMENT CHARACTERISTICS

Available water quality data has demonstrated the continued presence of elevated concentrations of phosphorus in all three river systems. Environmental indicators include biological quality index for the various sites monitored, data on fish catches, fish counts and anecdotal evidence regarding fish numbers as well as visual indicators in the rivers.

In order to target the Management Strategies, it proved necessary to develop an understanding of catchment characteristics, particularly those likely to influence the phosphorus transfer mechanisms.

Among the factors considered in a risk study relating to phosphorus loads to river waters were:-

- The geological and soil characteristics of the catchment.
- Elevation and gradients of catchment areas and channels.
- Rainfall quantities and intensity.
- Groundwater resources and recharge characteristics.
- Catchment land covers including urban, arable, pasture, forest, bog and marsh.
- Population and population density with particular reference to wastewater effluents, both from sewerage systems and septic tanks.
- Agricultural practices and infrastructure on agricultural premises.
- Existing soil nutrient levels.

2.2.1 Geological Context

In general, the bedrock throughout Ireland is overlaid by a complex mixture of glacial deposits comprising clays, clay/sand/gravel mixtures, cleaner sand/gravels and including a covering of peat particularly in central areas of the country. These conditions give rise to highly variable and relatively unpredictable subsoil conditions, with varying groundwater flow characteristics.

The underlying bedrock is similarly complex and is illustrated in geological mapping provided by the Geological Survey of Ireland. Typical bedrock classification in the catchments is as follows:-

Boyne Catchment Geology

Two main geological units can be identified within the catchment:

The Lower Palaeozoic rocks of the Longford-Down Massif, in the northern third of the catchment. These rocks are greywackes, sandstones, siltstones, mudstones and interbedded volcanic rocks, generally fine grained and cleaved.

The Carboniferous lowlands occupy the remainder of the catchment, plus a small area north of Kells. The Dinantian limestones in the lower Boyne valley near Drogheda are karstified in places. The "Calp" Limestone is widespread but generally too shaly to be significantly karstified.

There are also some Lower Carboniferous clastic rocks (sandstones, siltstones, mudstones) particularly in the Navan area, and some other argillaceous limestones (e.g. Ballysteen Formation), and mudstones. Namurian (Upper Carboniferous) shales outcrop southwest of Navan and Trim.

Liffey Catchment Geology

Three main geological units can be distinguished:

The south-eastern region, in the Wicklow Mountains, is underlain by Wicklow Granite.

To the west of the granite lie Ordovician greywackes and slates.

The lower part of the catchment is underlain by Lower Carboniferous limestones, mainly the shaly limestones of the Calp Formation.

In the south and southwest of the catchment especially in the Curragh and in the Blessington area, extensive gravel deposits, often several tens of metres in thickness, overly the bedrock.

Suir Catchment Geology

The geology of the Suir catchment is quite complex. Three units can be recognised:

The uplands of the Slieve Felim, Gáree, Slievenamon, Knockmealdown and Comeragh mountains, which ring the catchment, are formed of Silurian and Devonian slates, greywackes and sandstones.

The Slieve Ardagh hills, which lie on the catchment divide with the Nore, are formed of Upper Carboniferous sandstones, shales and coal measures.

The remaining central areas, mostly lowlands, are almost entirely underlain by Lower Carboniferous limestones. The purer limestone formations are extensively karstified, particularly south of Cashel. Such karst areas are characterised by swallow holes, sinking streams, caves, and large karst springs.

These geological conditions impact on water characteristics to some extent. The upper Liffey waters are relatively soft and have low alkalinity, whereas in the lower Liffey at Leixlip, the water is characterised by high alkalinity and carbonate hardness. The River Suir water has similar characteristics, as does the Boyne to a lesser extent. Where a catchment is underlain by carboniferous limestone with karst properties, pollution is readily transferred between surface and groundwater. Furthermore, base flows can disappear in dry conditions when waters go underground entirely. Examples of this occur in the Moyle and Clashawley sub-catchments of the Suir.

Soil types

Boyne catchment; shows significant distinction between the Southern/Central and Northern areas of the catchment. The former are principally covered by grey brown podzolics and gleys with significant peat deposits whereas the soils in Cavan and Louth more typically are acid brown earths and gleys.

Liffey catchment; peat cover and rock outcrop in the upper catchment gives way to grey-brown podzolics and gleys.

Suir catchment; the central river plain of the Suir substantially comprises grey brown podzolics with a transition to acid brown earths downstream from Clonmel to Waterford Harbour. To the northwest and south of the catchment, the mountainous areas are indicated by peats and bare rock with brown podzolics changing to gleys at lower levels. In the northeastern area, significant peat cover is found.

2.2.2 Rainfall and Run-off

Run-off characteristics of a catchment are influenced by rainfall intensity and volume, catchment slope and channel slope. General rainfall trends can be summarised thus:-

Boyne catchment; typically 800mm annual average rainfall in the eastern part of the catchment increasing to 900mm and locally 1,000mm in the west and northwest. The average catchment rainfall is in the order of 900mm.

Liffey catchment; the upper catchment in the Wicklow Mountains has annual rainfall intensity up to 2,000mm reducing to approximately 1,300mm at Poulaphuca. In the bulk of the middle and lower catchment, average annual rainfalls are among the lowest in Ireland at approximately 750 - 800mm.

Suir catchment; typical average annual rainfall in the central area of the Suir catchment is approximately 1,000mm, increasing significantly in the Slieve Felim hills and the Galtees to the west where peak levels of 1,600mm are experienced and in the Knockmealdown/Comeragh mountain areas to the south where peak values up to 1,400mm would be expected. The catchment average annual rainfall is estimated at 1100mm.

Of particular significance are low summer flows when the ecological systems are most at risk from the combination of minimum dilution volumes available in river, significant potential organic loads (e.g. silage effluent, slurry spread, seasonal load) and nutrient enrichment, increased water temperature and sunlight conducive to excessive algal and plant productivity.

Low flows in the Liffey are effectively controlled by releases at Poulaphuca. Base flows in the River Boyne appear to be relatively low, probably influenced by the major arterial drainage scheme in the catchment (1970's and 80's). Base flows are significantly higher in the Suir system, apart from the upper section of the main river, and the upper Anner, probably as a result of recharge by ground waters.

2.2.3 Industry

Manufacturing and service industries have been successfully promoted in all three catchments in recent years with the support of state agencies and Local Authorities. Historically, industry was primarily associated with agriculture (food processing and the meat industries), which was the dominant form of economic activity, and activities such as abattoirs, rendering, sugar beet, flour milling and other processes flourished. This has changed considerably in the last 20 years with the closure of many of the smaller indigenous industries, integration into larger units and the emergence of new industries including the following important sectors:

Electronics, Mechanical Engineering, Pharmaceuticals, Tourism and leisure, Mining and metal extraction, and the Service sector.

2.2.4 Fisheries

The Three Rivers Systems are important freshwater fisheries and are generally regarded as high quality Salmonid rivers (trout and salmon). Apart from pollution, pressure on fisheries in the River Boyne has resulted from drainage works and on-going maintenance while in the case of the River Liffey, the management of flows and abstractions is a factor, particularly in the Middle Liffey between Golden falls dam and Leixlip.

The main channel of the River Boyne is a designated Salmonid water under the Salmonid Regulations, 1988 SI/293/88, which implements the European Directive on the quality of freshwaters needing protection in order to support fish life (78/659/EEC). These regulations specify a monitoring regime, the locations and number of monitoring stations to be determined by the competent (local) authority.

Fisheries in the River Liffey catchment are also mainly based on salmonid species, although the river is **not designated under the Salmonid Regulations**. Nevertheless, the Eastern Regional Fisheries Board has indicated that designation of the Liffey is a current objective. Salmon and trout are fished by anglers and commercial fishermen with brown trout angling in the reservoir and river, assisted by good stocking. Trout also exist in the Rivers Camac and Griffeen.

The Suir River is an important salmon and trout fishery. Natural populations of both occur throughout. The **Aherlow River** from its source to its confluence with the Suir main channel is **formally designated as a Salmonid fishery** under the Salmonid Regulations. The Southern Regional Fisheries Board has an objective that the entire Suir system should be formally designated in view of its ubiquitous distribution of salmonids.

A detailed fisheries survey of the River Suir and its tributaries was carried out in the period 1983 to 1985 by the Central Fisheries Board on behalf of the Southern Regional Fisheries Board, which aimed to establish baseline information regarding Salmonid populations in the Suir catchment. This survey found that at the time, the Suir was probably the most productive riverine trout fishery in the country and that the Suir was of national significance in terms salmon smolt production. A number of sub-catchments of the Suir were identified as very important Salmonid fisheries, some were regarded as of national importance including the lower Suir main channel, which was described as "probably the single largest and most valuable trout angling riverine fishery in Ireland. The Clodiagh was also identified as one of the best Salmonid spawning and nursery catchments in Ireland. Other important Salmonid catchments included the Multeen, Aherlow, Tar, Anner and the Lingaun catchment where trout and salmon stocks were described as "exceptionally large".

However, the quality of the Suir as a salmon fishery appears to have diminished in recent years, probably due both to the effects of eutrophication on the fishery habitat and the effect of over-fishing at sea on returning stocks.

2.2.5 Amenity Resources

The three rivers have significant amenity value to their respective communities. Practically all settlements in the catchments were founded on the rivers or their tributaries. Historically, many of these settlements turned their back on the rivers using them primarily for waste disposal. However, redevelopment in recent years has focused significantly on the development of the river as an amenity in urban areas with high quality development facing the rivers and a significant upgrading of the riverside areas. This is particularly evident in the larger riverside towns, e.g., Clonmel, Trim and Navan.

OTHER SIGNIFICANT AMENITIES INCLUDE;

Freshwater bathing; In the River Boyne catchment, an area of Lough Lene (The Cut) is designated and has been awarded a 'blue flag' in recent years.

Water based sports; including canoeing, rowing regattas, water skiing sailing and windsurfing are enjoyed on Poulaphuca Reservoir on the Liffey, and the rivers are used for many water contact or 'adventure' sports.

2.2.6 Lakes in the Catchments

According to the EPA, the second largest of the lakes in the three catchments, Lough Ramor was strongly eutrophic in 2000 despite reduced planktonic growth and reductions in chlorophyll values. It has however improved sufficiently in trophic status to meet the Phosphorus Regulations, as it was consistently hypertrophic for a number of years.

There has been a marked deterioration in Nadreegeel Lough (highly eutrophic) and it has declined from its baseline status of moderately eutrophic. Cavan Co. Co carries out monitoring on the Cavan lakes.

The status of Golden Falls has not improved since its baseline status in 1995-1997 (strongly eutrophic). Poulaphuca Reservoir (Blessington Lake) is monitored by Dublin City Council and has had no significant algal problems in 2000 and 2001. This lake is the principal source of potable water to the Dublin area. The lake is also an important mixed fishery and hosts a number of sailing and rowing clubs.

Ballyshonnock Lake in the Suir catchment was formed by the impoundment of the Dawn River and is used for the provision of potable water for Waterford City. It has been affected by algal blooms for a number of years, probably due to agricultural activities within its watershed.

Table 2.1 – Significant Lakes in the Boyne, Liffey and Suir Catchments and their Beneficial Uses

Lake	Status 2000	Area km ²	Location	Uses
Mullagh L.	Hypertrophic	0.28	Co. Cavan	Abstraction
Nadreegeel L	Highly Eutrophic	0.88	Co. Cavan	Abstraction
L. Ramor	Strongly Eutrophic	7.50	Co. Cavan	Abstraction, Game and Coarse Fishery
Golden Falls	Strongly Eutrophic	0.4	Co. Wicklow	Electricity Generation
Blessington Lake	Mesotrophic	19.5	Co. Wicklow	Abstraction/Amenity/Game and Coarse Fishery
Ballyshonnock	Moderately Eutrophic	0.2	Co. Waterford	Abstraction
Coumshingaun	Oligotrophic	0.17	Co. Waterford	Game Fishery

Source: Water Quality in Ireland, 1998-2000. Environmental Protection Agency

2.2.7 Designated Areas for Natural Heritage Protection

In each catchment, areas of importance for ecological or scientific reasons are identified for conservation under relevant Directives and associated National Regulations. The most relevant proposed National Heritage Areas (pNHA) associated with the Boyne, Liffey and Suir are included in **Appendix 2.a, 2.b, and 2.c**. In many cases the pNHA will be further classified as Special Areas of Conservation (SAC 's) and Special Protection Areas (SPA's) (**See Figures 2.4, 2.5, and 2.6**).

These areas have been selected having regard to the presence of species of flora or fauna requiring conservation and protection. Significant changes in the nutrient states of river and lake waters, low dissolved oxygen levels or the presence of toxic substances can have a significant influence on fish and bird communities in these areas. An example would be the reduction in otter numbers, which has been associated with widespread use of pesticides and other organic pollutants and the loss of riparian habitats. Changes in water levels as a result of drainage or flood alleviation schemes could also have significant impacts, particularly in wetlands and callows.

2.2.8 Other Designated Areas

Other areas considered by the Project as sensitive to changes in nutrient status include stretches of lakes/ivers adjacent to public water supply intakes, stretches of water designated as “sensitive” under the Urban Wastewater Directive and rivers designated under the Salmonid Regulations. River reaches identified as important salmonid spawning areas by local Fishery Officers but do not necessarily have a legislative designation were also considered.

The designated areas are shown in “sensitivity” maps shown in **Figures 2.4, 2.5, and 2.6.**

2.3 POINT SOURCE PRESSURES

The first step in developing management strategies for protecting and improving water quality is identifying and quantifying the pressures that have the potential to impact on that quality.

Pressures on a river system are defined as “any activity that will alter its physical, hydrological (water flow), biological and chemical elements, including discharges to or abstractions from the system”. Activities that result in discharges to river systems can generally be divided into those that result from point and diffuse discharges.

Regulated Point Discharges are typically those discharges that can be easily identified, monitored and quantified, e.g. discharges from municipal wastewater treatment plants or industries.

Urban areas can be significant sources of pollution, particularly when sewage infrastructure and/or treatment are inadequate. Major investment programmes are currently well underway in all 3 catchments supported by EU Cohesion Fund investment (**Appendix 2d**). Some of the major schemes underway in the 3 catchments are listed below:

- Extension and upgrade to Osberstown Regional Wastewater Treatment Plant
- Extension and upgrade to Leixlip Wastewater Treatment Plant
- Navan Sewerage Scheme
- Trim Sewerage Scheme
- Drogheda Main Drainage Scheme
- Tipperary Town Sewerage Scheme
- Carrick on Suir Sewerage Scheme

Water bodies designated as sensitive under the UWWT regulations in the three catchments include:

- River Boyne: 6.5km section downstream of sewage treatment plant outfall at Blackcastle, Navan.
- River Liffey: Downstream of Osberstown sewage treatment plant to Leixlip reservoir, Co. Kildare.
- Liffey Estuary: From Islandbridge Weir to Poolbeg Lighthouse.
- River Suir: downstream of Thurles sewage outfall, to Twoford Bridge.
- River Suir: downstream of Clonmel sewage outfall, to Coolnamuck Weir.
- Suir Estuary (Upper): from Coolnamuck Weir to Mount Congreve.

Effluents from industry are regulated by means of an effluent discharge licence from the Local Authority under the Water Pollution Act (Section 4 to watercourse/groundwater or Section 16 to municipal foul sewer), or in the case of scheduled industry through IPC licensing (Integrated Pollution Control) from the EPA. Licence enforcement is a key element in protecting the environment from damage due to industrial effluents. Satisfactory effluent standards can be achieved by individual treatment plants or by acceptance of the industrial effluent into the municipal system for treatment with municipal sewage. In the latter cases, the industry is required to contribute to the capital and operational cost of treatment in accordance with the “Polluter Pays” principle.

Historically, the greatest risk of pollution has generally related to older indigenous industry, where the provision of satisfactory effluent treatment may be impeded for reasons of economy, space or operational skill. While a flow measurement requirement may be incorporated on some discharge licences, flow data is not generally available, with concentration levels only for pollution parameters reported for compliance with license conditions. Flows, however, are necessary for calculations of loads and fluxes.

Figure 2.4 – Boyne Catchment – Sensitivity Map

Figure 2.4 Boyne Catchment - Sensitivity Map

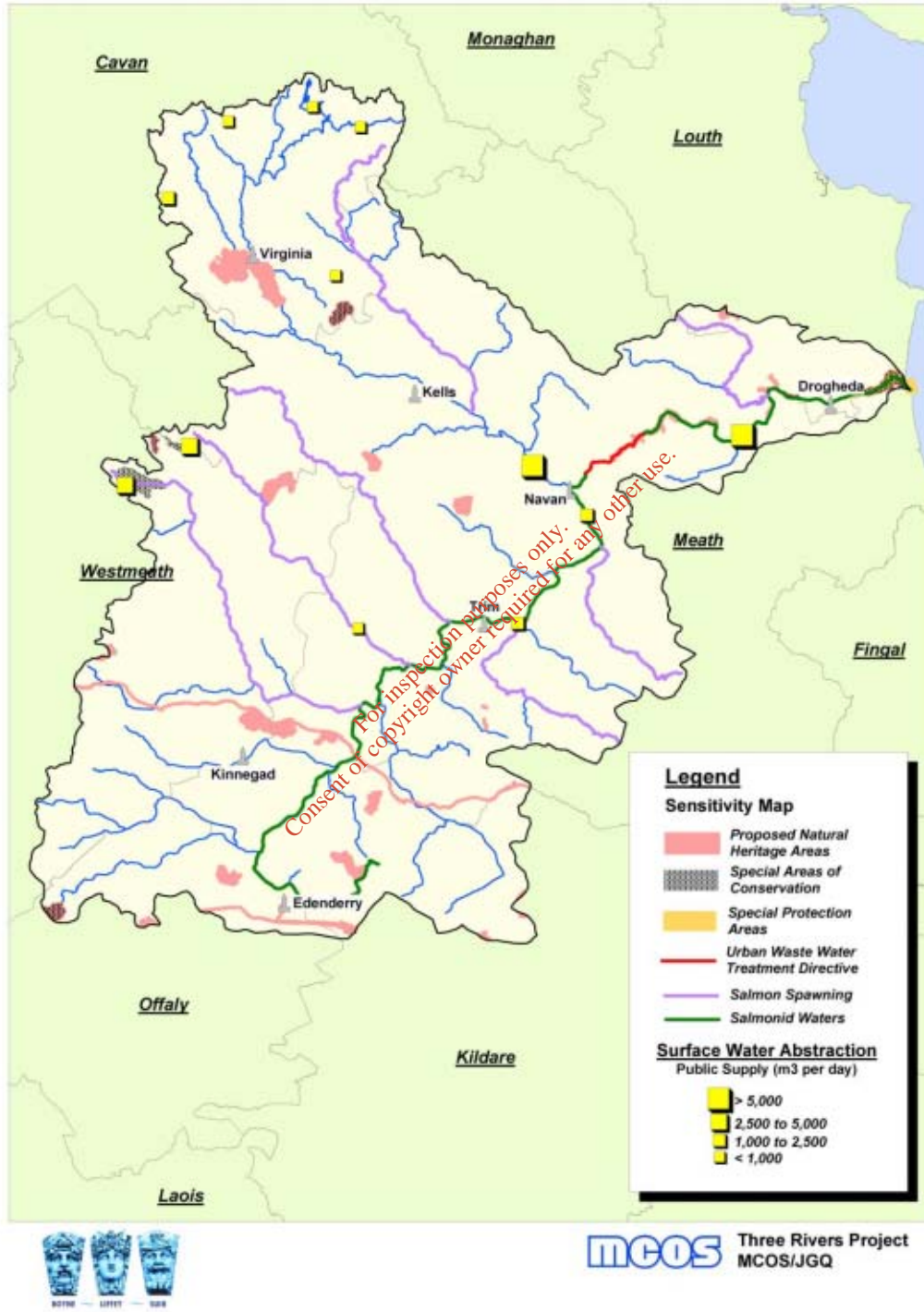


Figure 2.5 – Liffey Catchment – Sensitivity Map

Figure 2.5 Liffey Catchment - Sensitivity Map

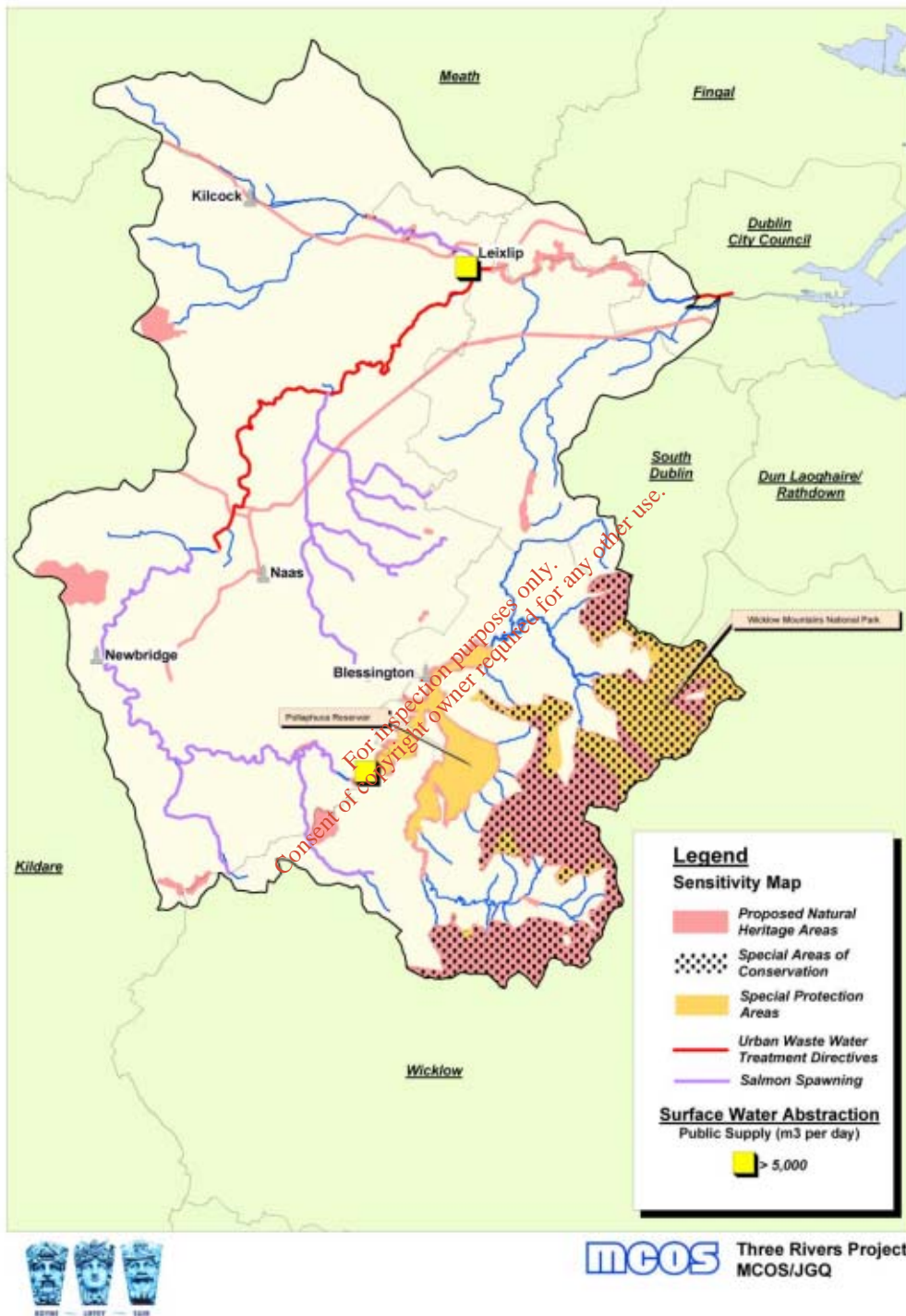
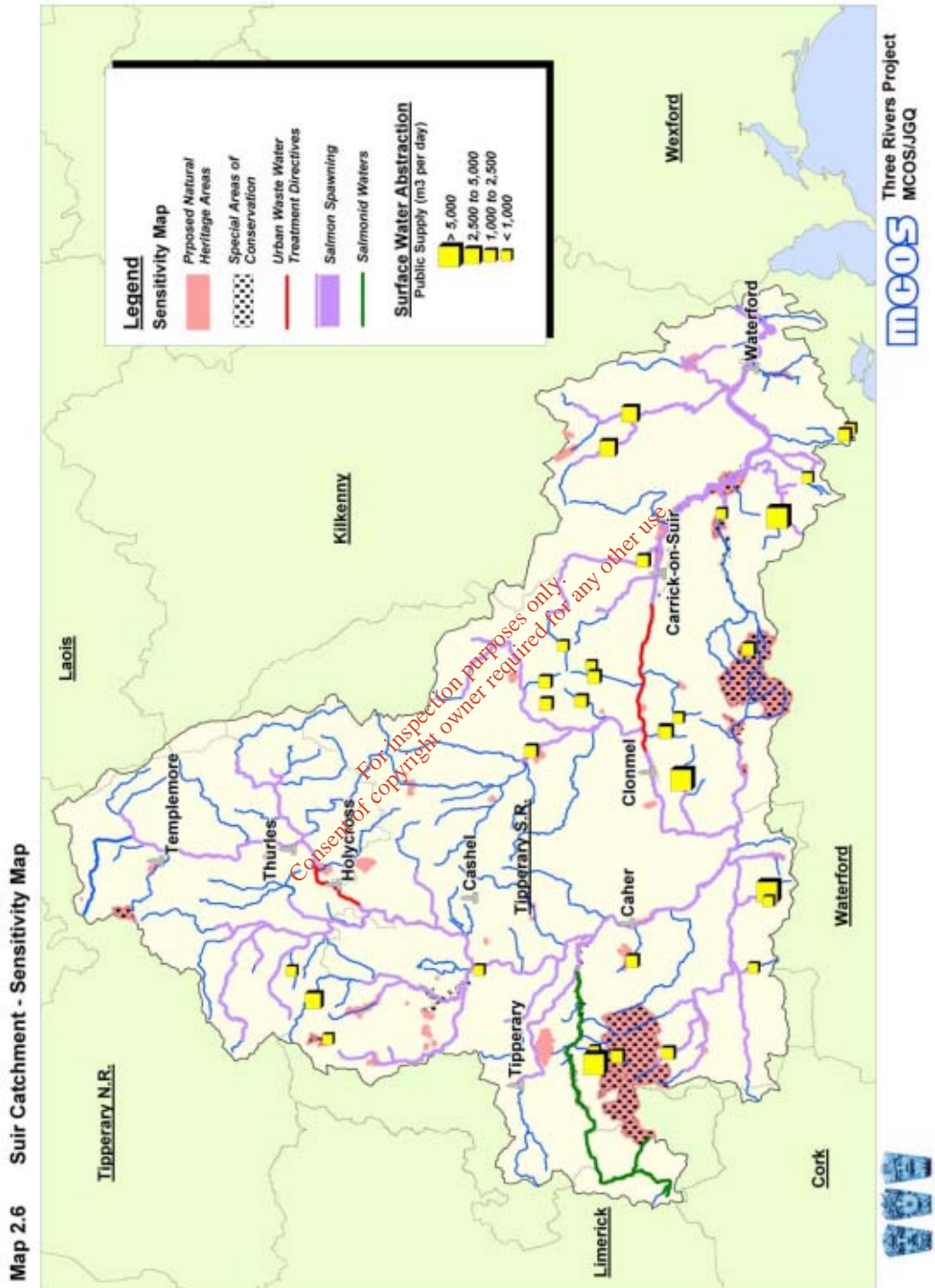


Figure 2.6 – Suir Catchment – Sensitivity Map



2.3.1 Point Source Pressures in the Boyne Catchment

Municipal Waste Discharges

There are a total of 36 MWWTPs discharging to the Boyne catchment (**Table 2.2**). Thirty (30) plants discharge to surface waters with the remaining 6 discharging to ground percolation. Point source discharges are shown in **Figure 2.7**.

Table 2.2 – MWWTPs in the Boyne Catchment

Name of Works	Receiving Water	Actual p.e. 2002	Type of Treatment	Local Authority
Bohermeen	Dry ditch	50	Secondary	Meath Co. Co.
Carlanstown	Moynalty from perc area	100	Secondary	Meath Co. Co.
Clonard	Kinnegad R. from perc area	100	Secondary	Meath Co. Co.
Longwood	Blackwater (Longwood)	1,200	Secondary	Meath Co. Co.
Slane	Boyne	2,200	Secondary	Meath Co. Co.
Ballivor	Stonyford R. from Ballivor R	800	Secondary	Meath Co. Co.
Summerhill	Knightsbrook	1,000	Secondary	Meath Co. Co.
Kilmessan	Skane	650	Secondary	Meath Co. Co.
Crossakeel	Athboy R. from Bellview	400	Secondary	Meath Co. Co.
Dunshaughlin	Skane	4,000	Secondary	Meath Co. Co.
Collon	Mattock	550	Secondary	Louth Co.Co.
Donore	Boyne	600	Secondary	Meath Co. Co.
Johnstown Bridge	Boyne	2,000	Secondary	Kildare Co. Co.
Killucan-Rathwire	Riverstown	400	Secondary	Westmeath Co. Co.
Athboy	Athboy	2,500	Secondary	Meath Co. Co.
Dunderry	Clady	250	Secondary	Meath Co. Co.
Navan	Boyne	25,000	Secondary + Nutrient reduction	Meath Co. Co.
Rochfortbridge	Rochfortbridge Stream	1,200	Secondary	Westmeath Co.Co.
Trim	Boyne	7,300	Secondary + Nutrient reduction	Trim UDC
Edenderry	Boyne	6,000	Secondary	Offaly Co.Co.
Delvin	Stonyford	650	Secondary	Westmeath Co.Co.
Raharney	perc area to Deel	140	Secondary	Westmeath Co.Co.
Bailieboro	Leer	2,000	Secondary + Nutrient reduction	Cavan Co.Co.
Mullagh	Moynalty (Mullagh Branch)	450	Secondary	Cavan Co.Co.
Virginia	Lough Ramor	1,000	Secondary + Nutrient reduction	Cavan Co.Co.
Kells	Blackwater	5,000	Secondary	Kells UDC
Ballinabrackey	Castlejordan	100	Secondary	Meath Co. Co.
IDA Plant, Kells	Blackwater	100	Secondary	Meath Co. Co.

Name of Works	Receiving Water	Actual p.e. 2002	Type of Treatment	Local Authority
Moynalty	Moynalty	100	Primary	Meath Co. Co.
Rhode	Yellow (Castlejordan)	500	Primary	Offaly Co.Co.
Clonmellon	Athboy River, trib of	350	Secondary	Westmeath Co.Co.
Kinnegad	Kinnegad	2,000	Secondary	Westmeath Co.Co.
Milltownpass	Milltownpass	80	Secondary	Westmeath Co.Co.
Clogherinko	Boyne, from stream	60	Primary	Kildare Co. Co.
Tullyallen	Boyne	631	Secondary	Louth Co.Co.
Drogheda	Boyne Estuary	58,200	Secondary	Louth Co.Co.

IPC and Section 4 Licensed Discharges

There are a total of 29 activities currently regulated under IPC legislation in the Boyne catchment. This number has increased from 23 activities in 1997. These include a number of industries previously covered by Section 4 licences. A total of 13 IPC activities in the catchment related to disposal of organic waste by land spreading from intensive agriculture operations, including pig units, slaughtering and rendering plants. There are 26 Section 4 discharges to the Boyne including 3 to the estuary. **Appendix 2.e** summarises the Section 4 licensed discharges to surface waters in the catchment, whilst **Appendix 2.f** gives a list of the current sites regulated by IPC Regulations.

2.3.2 Point Source Pressures in the Liffey Catchment

Point source discharges in the River Liffey catchment are indicated in **Figure 2.8** including MWWTPs (**Table 2.3**) and Section 4 License discharges. The two major MWWTPs in the catchment at Osberstown and Leixlip, have been recently upgraded with design capabilities of 80,000 p.e. and 90,000 p.e. respectively. Current loadings on each are in the order of 60,000 p.e.

Table 2.3 – MWWTPs in the Liffey Catchment

Name of Works	Receiving Water	Actual p.e. 2002	Type of Treatment	Local Authority
Knockiern	Unknown Stream	35	Secondary	Wicklow Co. Co.
Hollywood	Trib of Lemonstown	250	Secondary	Wicklow Co. Co.
Blessington	Golden Falls Lake	2200	Secondary	Wicklow Co. Co.
Leixlip	River Liffey	56666	Secondary +nutrient reduction	Kildare Co. Co.
Osberstown	River Liffey	60000	Secondary +nutrient reduction	Kildare Co. Co.
Straffan	River Liffey	200	Secondary	Kildare Co. Co.
Saggart/Rathcoole	River Camac	3650	Secondary (Decommissioned Nov 2001)	South Dublin Co. Co.
Newcastle	Trib of Griffeen	1300	Secondary	South Dublin Co. Co.
Ballymore Eustace	River Liffey	750	Primary	Kildare Co. Co.
Donore	River Liffey	85	Secondary	Kildare Co. Co.
Kilmeague	Groundwater	700	Primary	Kildare Co. Co.
Brannockstown	Groundwater	60	Primary	Kildare Co. Co.

IPC and Section 4 Licenced Discharges

In the Liffey catchment, a total of 15 Section 4 licences are in operation (**Appendix 2.g**), 5 of which licence effluent discharges to percolation areas.

A total of 51 IPC licence applications have been submitted to the EPA within the Liffey catchment, (**Appendix 2.h**). However, all process-related wastewater is diverted to foul sewers with the exception of P.D.M. Ltd, which discharge process-related wastewater to the Painestown River.

2.3.3 Point Source Pressures in the Suir Catchment

The locations of point source discharges in the Suir catchment are shown in **Fig 2.9**. MWWTP discharges are estimated at 67,700 p.e. to the freshwater catchment and approximately 142,400 p.e. discharging to the estuarine waters, the majority of which is without treatment at present.

Table 2.4 – List of MWWTPs in the Suir Catchment

Name of WWTP	Receiving Water	Actual p.e.	Treatment Type	Local Authority
Ballinakill	Suir Estuary	4,400	Primary	Waterford Corpo.
Freshfield	Suir Estuary	Unknown	Primary	Waterford Corpo.
Glenville	Suir Estuary	240	Primary	Waterford Corpo.
Glenville/Sycamore	Suir Estuary	168	Primary	Waterford Corpo.
Island View/Riverview	Suir Estuary	1,400	Primary	Waterford Corpo.
Kings Channel	Suir Estuary	800	Primary	Waterford Corpo.
Marian Terrace	Suir Estuary	48	Primary	Waterford Corpo.
Rocklands/Rockshire	Suir Estuary	Unknown	Primary	Waterford Corpo.
Volan	Suir Estuary	360	Primary	Waterford Corpo.
Holycross	River Suir	500	Secondary	Tipp N Riding Co. Co.
Templemore	River Suir	5,800	Primary	Tipp N Riding Co. Co.
Thurles	River Suir	8,000	Secondary	Tipp N Riding Co. Co.
Cahir	River Suir	3,000	Secondary	Tipp S Riding Co. Co.
Cashel	Black Stream	3,500	Secondary	Tipp S Riding Co. Co.
Mullinahone	River Anner	562	Secondary	Tipp S Riding Co. Co.
Tipperary	River Area	4,750	Secondary + Nutrient reduction	Tipp S Riding Co. Co.
Fiddown	River Suir	260	Secondary	Kilkenny Co. Co.
Mooncoin	River Suir	750	Primary	Kilkenny Co. Co.
Piltown	River Pil	900	Secondary	Kilkenny Co. Co.
Dangan	Blackwater	40	Primary	Kilkenny Co. Co.
Mullinavat	Blackwater	300	Secondary	Kilkenny Co. Co.
Ferrybank	Suir Estuary	1,000	Untreated	Kilkenny Co. Co.
Rathcuiheen/Abbey Park	Suir Estuary	400	Primary	Kilkenny Co. Co.
Slieverue	Suir Estuary	400	Primary	Kilkenny Co. Co.
Borrisoleigh	Cromoge River	1,000	Secondary	Tipp N Riding Co. Co.
Littleton	River Breagagh	706	Secondary	Tipp N Riding Co. Co.
Templetouhy	Rossetown	448	Secondary	Tipp N Riding Co. Co.
Twomileborris	Black River	325	Secondary	Tipp N Riding Co. Co.
Ardfinnan 1	River Suir	477.5	Primary	Tipp S Riding Co. Co.
Ardfinnan 2	River Suir	477.5	Primary	Tipp S Riding Co. Co.
Ballyclerihan	Stream to Anner	100	Secondary	Tipp S Riding Co. Co.

Name of WWTP	Receiving Water	Actual p.e.	Treatment Type	Local Authority
Ballynulty	Clashawley R.	121	Secondary	Tipp S Riding Co. Co.
Ballyporeen	Duag River	380	Primary	Tipp S Riding Co. Co.
Bansha	River Ara	417	Primary	Tipp S Riding Co. Co.
Boherlahan	Drain to Suir	116	Secondary	Tipp S Riding Co. Co.
Burncourt	Burncourt River	161	Primary	Tipp S Riding Co. Co.
Clogheen 1	River Tar	307	Primary	Tipp S Riding Co. Co.
Clogheen 2	Duag River	307	Primary	Tipp S Riding Co. Co.
Clonmel	River Suir	20,000	Secondary	Tipp S Riding Co. Co.
Drangan	River Anner	134	Secondary	Tipp S Riding Co. Co.
Dundrum	Multeen River	236	Secondary	Tipp S Riding Co. Co.
Faugheen(Newtown)	Trib of Lingaun	64	Secondary	Tipp S Riding Co. Co.
Fethard	Clashawley R.	1,920	Secondary	Tipp S Riding Co. Co.
Golden 1	River Suir	131.5	Primary	Tipp S Riding Co. Co.
Golden 2	River Suir	131.5	Primary	Tipp S Riding Co. Co.
Grangemockler	Lingaun	167	Primary	Tipp S Riding Co. Co.
Holycross	Suir River	600	Secondary	Tipp NR Co.Co. & Tipp SR
Killenaule	Clashawley R.	1,023	Secondary	Tipp S Riding Co. Co.
Kilsheelan 1	River Suir	500	Primary	Tipp S Riding Co. Co.
Kilsheelan 2	River Suir	500	Primary	Tipp S Riding Co. Co.
Lisronagh	River Moyle	12	Primary	Tipp S Riding Co. Co.
Marfield 1	River Suir	212	None	Tipp S Riding Co. Co.
Marfield 2	River Suir	212	None	Tipp S Riding Co. Co.
Newcastle 1	Glenboy River	161	Primary	Tipp S Riding Co. Co.
Newcastle 2	River Suir	161	Primary	Tipp S Riding Co. Co.
Newinn	Outeragh Stream	631	Secondary	Tipp S Riding Co. Co.
Redmonstown	River Anner	60	Primary	Tipp S Riding Co. Co.
Rosegreen	Stream to Anner	134	Secondary	Tipp S Riding Co. Co.
Ballythomas	River Clodiagh	40	Primary	Waterford Co. Co.
Bawnfune	Reisk Stream	150	N/a	Waterford Co. Co.
Cheekpoint	Suir Estuary	140	Primary	Waterford Co. Co.
Clonea	River Clodiagh	160	N/a	Waterford Co. Co.
Kilgainey	River Suir	40	N/a	Waterford Co. Co.
Portlaw	River Clodiagh	900	N/a	Waterford Co. Co.
Viewmount, Earls court, Collins	Suir Estuary	3,500	Primary	Waterford Co. Co.
Galbally	River Aherlow	290	Primary	Limerick Co. Co.

IPC and Section 4 Licensed Discharges – Suir Catchment

There are 30 Section 4 licences discharging to surface waters in the catchment, 5 of which discharge to the Suir estuary. There are a total of 26 integrated pollution control licences (IPC) in the catchment, with a further 2 applications pending. Ten IPC licensed industries discharge process water to surface water, the principal, being Merck Sharpe & Dohme, Louisiana Pacific Coillte (Ireland) Ltd., Medite of Europe, Munster Proteins Ltd, Minorco Lisheen Ltd, Clonmel Chilling Ltd, Quelly Pig Ltd and AIBP Ltd, Michell Ireland Ltd and Shamrock Aluminium Ltd. A list of the major licensed trade effluent discharges to the Suir and its tributaries, including Section 4 and IPC discharges are given in **Appendix 2i** and **Appendix 2j**.

Figure 2.7 – Boyne – Point Source Discharges

Figure 2.7 Boyne Catchment - Point Source Discharges



MCOS Three Rivers Project
MCOS/JGQ

Figure 2.8 – Liffey – Point Source Discharges

Figure 2.8 Liffey Catchment - Point Source Discharges

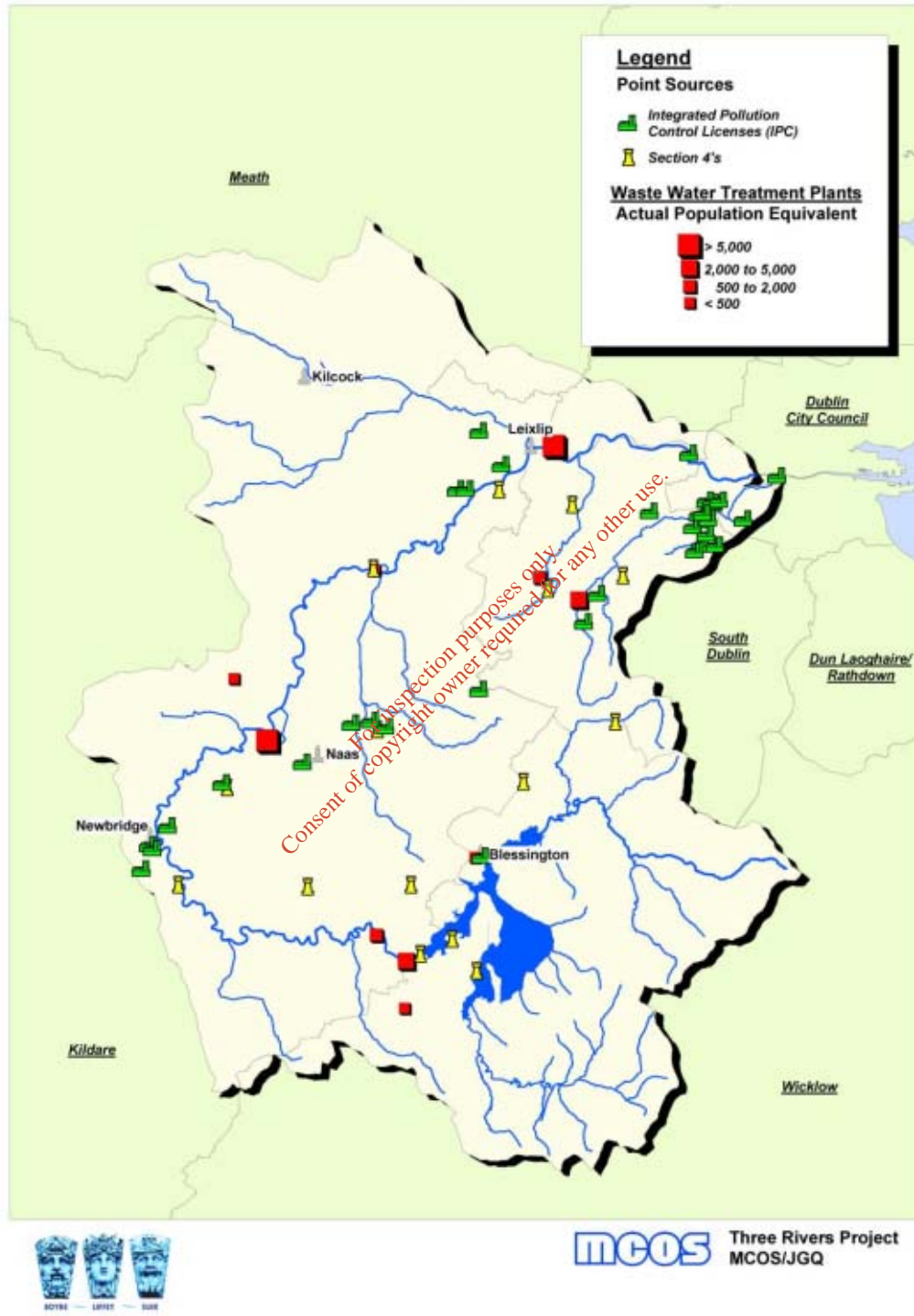
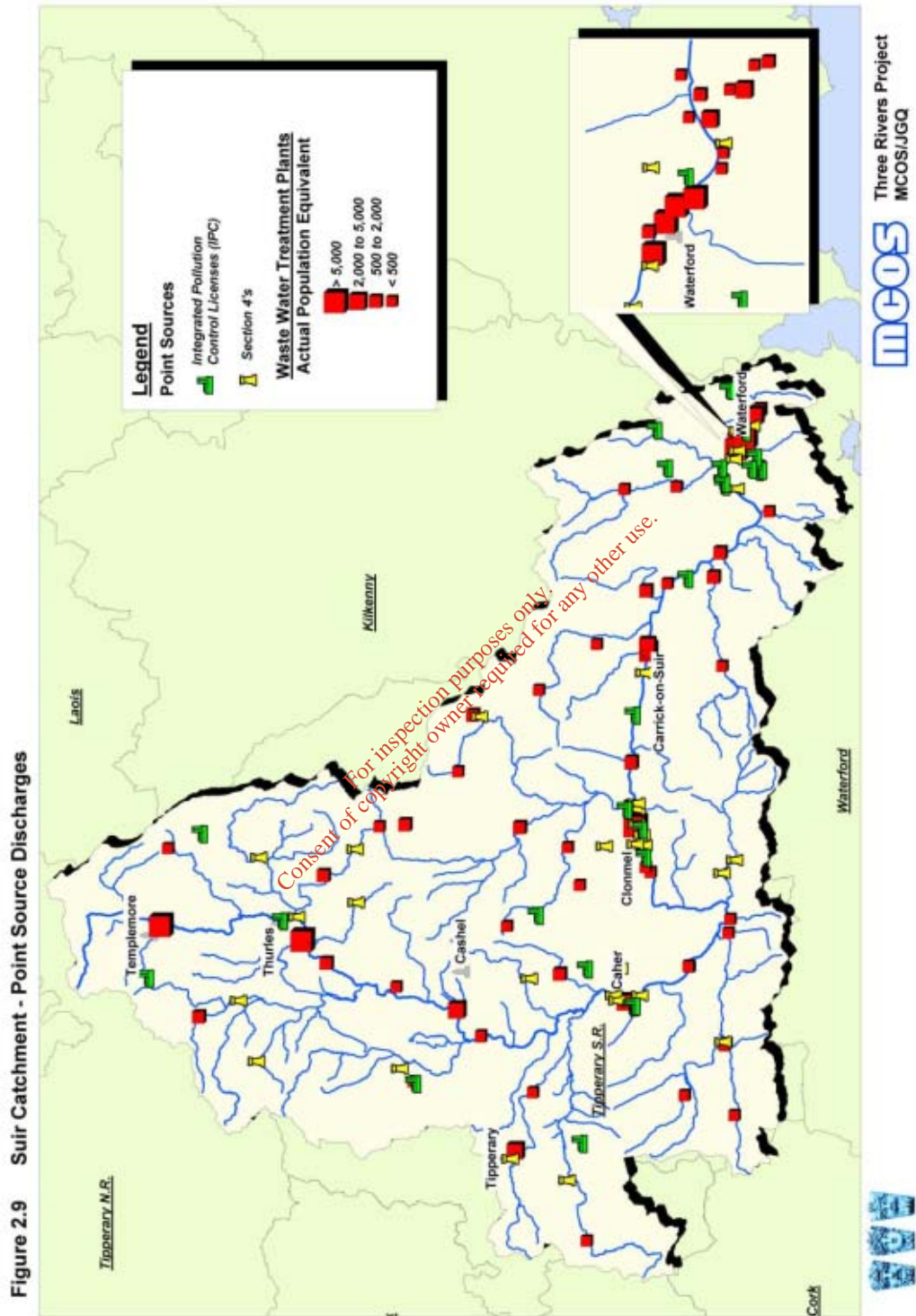


Figure 2.9 – Suir – Point Source Discharges



2.4 DIFFUSE SOURCE PRESSURES

Diffuse discharges are primarily associated with run-off from land as a result of landuse activities. Particular areas of a catchment may have a higher potential to generate diffuse discharges than other areas due to their physical characteristics (slope, soil characteristics, rainfall etc.) and the type and intensity of landuse. Therefore management measures should be focused on these higher risk areas to enable efficient use of resources.

2.4.1 Land Use

The various landuse types in the catchments have been identified from the CORINE Land Cover Dataset 1989, which is illustrated in **Figure. 2.10** for the Boyne, Liffey and Suir catchments respectively. A total of 31 land cover classes are identified in the CORINE Dataset which have been grouped for the purposes of this project into six main classes as follows:

Arable agriculture

Arable land used for crop cultivation accounts for 11% of total area in the Boyne catchment, 12% in the Liffey catchment and 10% in the Suir catchment. Arable agriculture has a significant potential for nutrient loss, in particular nitrogen, due to high fertiliser application rates at planting stage, the timing of application in winter/spring and soil erosion. It is also associated with higher use of pesticides for the treatment of crop disease presenting further risks in vulnerable areas.

Pasture

This is the dominant agricultural form in the catchments accounting for 80% of the Boyne catchment area, 63% of the Liffey area and 74% of the Suir catchment area. Pasture (mainly highly fertile) occupies the bulk of the lowland areas in each catchment. A higher proportion of dairy farming arises in the Suir catchment compared with the Boyne and Liffey catchments where beef production predominates. Intensive cattle rearing generates large quantities of slurry that requires safe disposal, usually by spreading to land to utilise the nutrient content of the slurry as organic fertiliser. The addition of both organic and inorganic fertiliser to pasture to boost productivity can, in some circumstances, lead to eutrophication to nearby waterbodies.

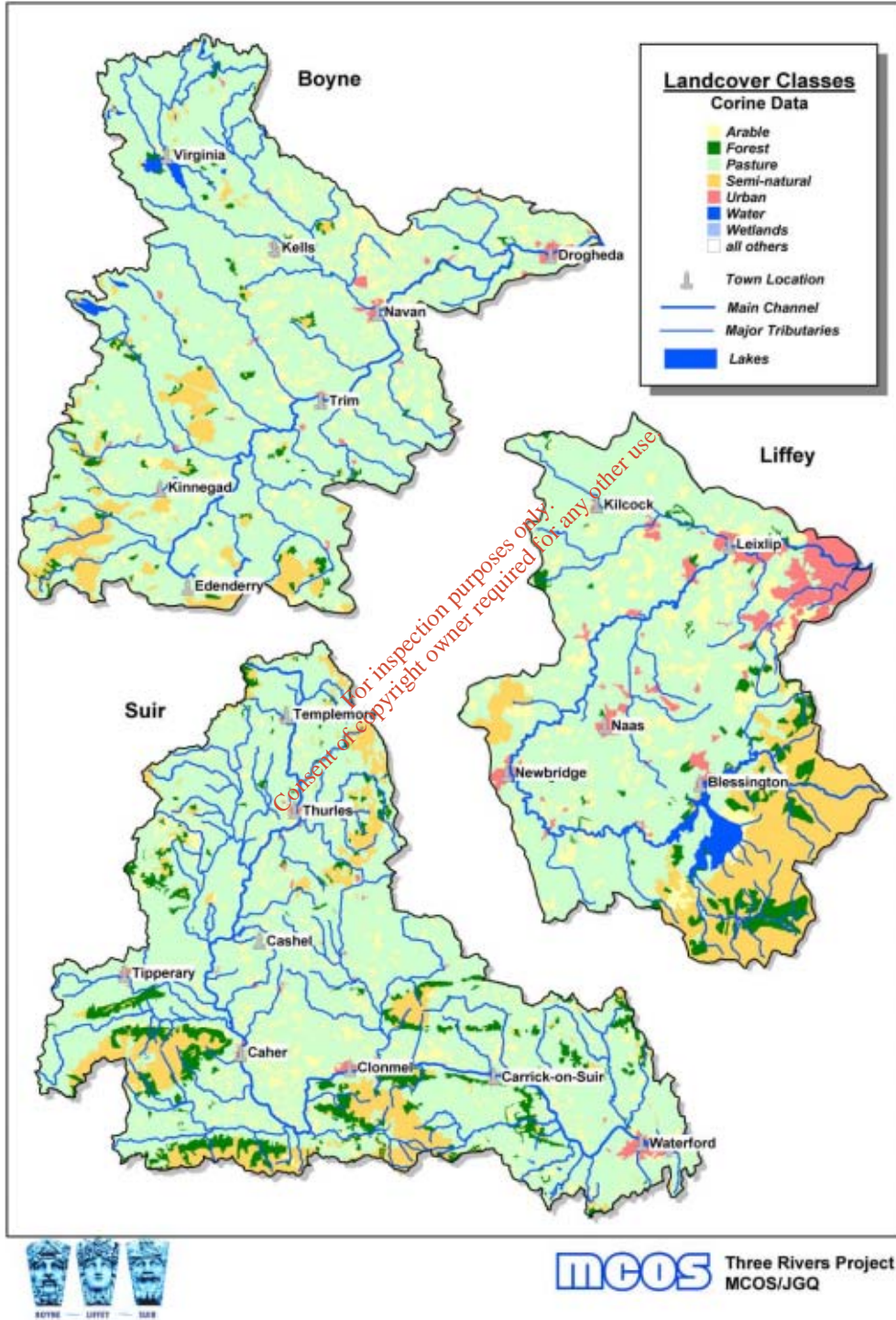
Forest including semi-natural areas

This classification includes forest and semi-natural areas with moors and heathland, and transitional woodland-scrub. This land cover accounts for 3% of the Boyne catchment, 9% of the Liffey catchment and 11% of the Suir catchment. According to Forestry Information and Planning System (FIPS, 1995), forested areas (excluding semi-natural areas) accounts for 2.7%, 6.7 % and 8.5% of Boyne, Liffey and Suir catchment respectively. Forestry tends to be located in the elevated areas, for example, in the Galtee, Knockmealdown, Comeragh and Slievenamon areas of the Suir catchment. Similarly in the case of the Liffey, forestry is principally located in the upper catchment draining to Poulaphuca however, afforestation is increasing in low productivity pasture areas. The bulk of afforestation comprises coniferous forest.

Water quality impacts due to afforestation would be expected to arise principally during ground preparation, planting, fertilisation and harvesting stages.

Fig 2.10 – Boyne, Liffey and Suir Catchments – Corine Landcover

Figure 2.10 Boyne, Liffey and Suir Catchment - Corine Landcover



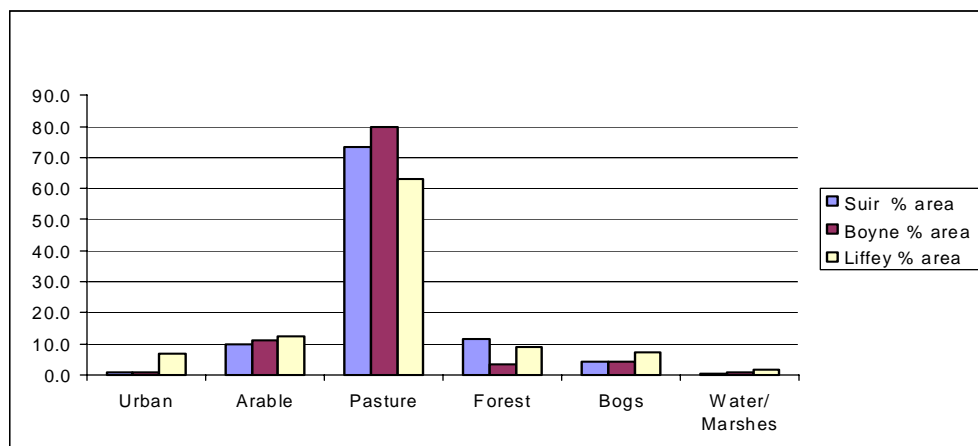


Figure 2.11 – Land Cover – Three Rivers Catchments (based on CORINE)

Bogs and Marshes

These are areas of low productivity and would be expected to be less critical from the point of view of nutrient losses. Water quality impact from bogs arises from siltation during peat harvesting. Bogs in the catchments account for 4% of the Boyne, 7% of the Liffey and 4% of the Suir. Bogs are actively worked in the southern area of the Boyne catchment (Co. Offaly) and in the north-eastern area of the Suir catchment (Drish catchment). There is also some exploration of peat in the upland areas of the Liffey.

Water Bodies

While rivers generally transport phosphorus in solution and particulate form, with some utilisation under favourable conditions, the behaviour of nutrients in lakes is more complex. Particulate matter is settled, while dissolved phosphorus has a prolonged residence time, which results in a higher potential utilisation in the production of algae and plant growth. As such, lakes are significantly more sensitive to phosphorus loading than river waters. They can also reduce the phosphorus loading on downstream rivers by settling out suspended solids on the lakebed. This is evident in the Boyne catchment where high nutrient loadings give rise to severe eutrophication problems in Lough Ramor and on the inflowing rivers, with significantly improved water quality conditions downstream on the Kells Blackwater.

In the Liffey catchment, protection of the Poulaphuca reservoir from nutrient enrichment is a paramount concern from the point of view of protecting the water quality for abstraction. Similar considerations apply to Lough Lene in Co. Westmeath (Boyne) and Ballyshonock (Suir).

The percentages of water by area in the Boyne, Liffey and Suir catchments are 1%, 2% and >1% (11 km²) respectively.

Urban Development

Including towns, cities and smaller settlements, road and rail infrastructure, large industrial areas such as airports, mining areas, construction sites and industrial complexes. Apart from foul and trade effluent discharges, such areas contribute to water pollution through contamination of surface water run-off that is extremely variable in terms of quality and can include significant pollution load in terms of organic sediments, hydrocarbons, heavy metals and nutrients. Such discharges are most critical in times of short duration heavy rainfall in the summer time following a dry period when river and stream flows are low. In some countries, (Scotland, Sweden and the USA), sustainable urban drainage systems (SUDS) are being developed taking into account water quantity, quality and amenity issues in order to protect receiving waters from urban storm water run-off.

Landuse associated with urban development is estimated at 1%, 7% & 1%, for the Boyne, Liffey and Suir catchments respectively.

Definition of these land use types and their characteristics in this report, therefore, is an important element in assessing the overall nutrient load and nutrient risk from diffuse sources. The development of future monitoring systems is largely driven by the need to achieve a greater understanding of the nutrient contributions from the different land use types and the impact of improved management practices on each. The relative percentages of each of the six main categories in each catchment are illustrated graphically in **Figure 2.11**.

2.4.2 Population Statistics

The population statistics in each catchment as estimated from the 1996 census statistics having regard to district electoral division (DED) boundaries are summarised in **Table 2.5**.

Table 2.5 – Urban/Rural Populations

Parameter	Boyne		Liffey		Suir	
	Urban Area	Pop.	Urban Area	Pop.	Urban Area	Pop.
Total CSO Pop. (1996)	124,824		279,172		159,756	
Urban Populations	Navan	12,810	Naas	17,900	Templemore	2,244
	Trim	4,405	Newbridge	15,000	Thurles	6,939
	Kells	3,542	Leixlip	13,451	Tipperary	4,854
	Virginia	811	Celbridge	12,600	Caher	937
	Drogheda	25,282	South Dublin	94,336	Cashel	2,687
	Slane	688	Dublin City	62,081	Clonmel	16,182
			Fingal	18,177	Carrick-on-Suir	5,217
					Waterford City	42,540
Sub-Total Urban	47,538		209,594		81,600	
Sub-Total Rural	77,286		69,578		78,156	
Catchment Area (km²)	2693		1185		3548	
Rural Population Density	Total Density/km ² = 29		Total Density/km ² = 57		Total Density/km ² = 22	

The table shows that the Liffey catchment is the most densely populated. Rural population densities vary somewhat between the catchments and reflect the land use. The extent of peat bogs, moors and heathland associated with mountain areas in the catchments influences the rural population density.

The urban communities are generally served by sewage collection systems and municipal wastewater treatment facilities. Overflows from the collection systems or at MWWTPs during storm conditions or system breakdowns, contribute to the polluting load to the river.

Such discharges are properly classified as part of the point load discharges associated with conurbations, though they are difficult to quantify other than by applying Time Series Rainfall (TSR) to detailed, calibrated models of the sewerage network.

Urban stormwater run-off discharging directly to water from drains can be a significant source of diffuse pollution due to suspended solids and organic matter associated with particulate loads, particularly in "first flush" discharges following a dry spell.

Rural population density would impact on water quality generally in terms of septic tank effluents which may enter surface waters via the groundwater system in the case of areas with permeable soils or through direct run-off by overland or drainage flows in areas with impermeable soils. Figures

generated by the Oslo/Paris Commission 1992 (OSPAR) give an estimated figure that some 30% of septic tank effluent load may reach surface waters.

2.5 SUMMARY

This Chapter has provided a review of water resources, and corresponding pressures on them, which are inter linked with and dependent on the Boyne, Liffey and Suir River Systems.

The River Boyne, which is a major trout and salmon river, is an important resource for water abstraction and supports substantial amenity and conservation areas that require protection.

The River Liffey provides drinking water resources for well in excess of 1 million people in the Greater Dublin area while supporting hydroelectric power standby generation, flood control, Salmonid fisheries, local and general amenities.

The River Suir is probably the most important Salmonid fishery in the country with proven fisheries resources, particularly in the highly productive limestone sub-catchments where water quality conditions remain relatively good. The river also supports substantial abstraction for drinking water and industry as well as general amenity.

In all cases, control of eutrophication through reduction in phosphorus load is identified as necessary to protect these resources. In the case of the Liffey, the integrated management of water resources is necessary to balance hydroelectric, water abstraction, fisheries and other environmental interests.

This section provides a brief overview of the characteristics of the three river catchments and the key issues, which are the focus of this project, having regard to the over-riding objective to reduce nutrient loading to the river systems, in order to conserve and improve water quality and their associated environmental systems.

2.6 SECTORAL LOADS – BOYNE, LIFFEY AND SUIR

An objective of this project was to estimate the nutrient inputs by sector to watercourses from point and diffuse sources. For point sources this requires information on flows and concentrations discharged by MWWTPs and by industrial facilities. The Urban Wastewater Treatment Regulations specify three parameters (BOD₅, COD, SS) to be monitored in the effluent from all treatment plants. In situations where the effluent discharges to a sensitive water body, monitoring of two additional parameters (P, N) is specified. In order to comply with the Regulations it is only necessary to meet the specified "concentration limits" for the relevant parameters. Flow measurement is not a specified requirement. Therefore, for the majority of MWWTPs information on flows and phosphorus concentrations in the effluent is not collected thus it is currently impossible to accurately quantify the phosphorus load discharged to the watercourse. The nutrient loads from MWWTPs have therefore been estimated in the majority of cases from the actual / estimated p.e. data from MWWTPs and using OSPAR figures to calculate annual Total Phosphorus (TP) loads.

Similarly for licenced discharges information on flow was not readily available therefore the estimated annual P loads from IPC licenced industry and Section 4 licences are based on their maximum licenced permitted discharge.

In order to estimate the load from diffuse sources, export coefficients for different land use types were determined and then assigned to each land use type identified in the CORINE (land use) dataset. The coefficient is the annual nutrient load coming from a hectare of land and arriving to the aquatic environment, and the total nutrient load is calculated by multiplying each coefficient by the land cover area.

Following extensive monitoring and investigation over the 3 years of the Project, export coefficients for different land use types, which were previously obtained from literature review, have been re-evaluated based on investigations in the Yellow (Blackwater), Clonmore and Camac pilot study areas using auto-sampled TP concentrations, flows and detailed land use data.

The suggested coefficients based on loss of TP from differing CORINE land use classifications are **2.27 kg/ha/yr** from arable, **0.32 kg/ha/yr** from grassland and **1.29 kg/ha/yr** from urban areas.

2.6.1 Loads from MWWTPs

The nutrient loads from MWWTPs have been estimated in the majority of cases from the actual p.e. data from MWWTPs and using OSPAR figures to calculate annual TP loads. Information was collected via Local Authority questionnaires. For a small number of plants where adequate flow and concentration data were available this was used to calculate an annual load.

In the Boyne the TP load from 30 MWWTPs account for 16% of the total river load. The most significant plants at Navan (25,000 p.e) and Trim (7,300 p.e.) were recently up-graded with nutrient reduction in place at Navan since February 2001 and at Trim since June 2001. However, the estimated load (to the FWL) from MWWTPs has increased by 30% to 32.6 tonnes from 1999 to 2001, due to an increase of 12,230 p.e. based on figures supplied by the L.A. On commissioning of the new secondary treatment works at Drogheda, operational since January 2001, the estimated TP load to the estuary has reduced from 1288 tonnes/yr to 27.9 tonnes/yr, where the discharge was untreated in the previous estimate in 1999.

It is estimated that MWWTPs contribute approximately 19% of the total load to the Liffey. A five-fold decrease in estimated TP loads from this source was seen from 1999 to 2001, due to the upgrading of Osberstown and Leixlip, which constitute 80% of the entire TP discharge from MWWTPs to the Liffey.

There are 60 MWWTPs in operation in the Suir catchment, making up an estimated 15% of the total catchment load. The most significant plants are Clonmel, Thurles, Templemore and Tipperary town. Waterford City is currently discharging either untreated or primary treated sewage to the Suir Estuary, however, a treatment plant for 188,000 p.e. is at the planning stage. During the lifetime of the Project, the most significant capital works include the upgrading of Tipperary town MWWTP and the redirection of urban storm water from Cashel through the MWWTP which should be reflected in reduced loads in the future.

2.6.2 Licensed Discharges

The estimated annual P loads from IPC licensed industry and Section 4 licences are based on their maximum licensed permitted discharge. Thus, it is probable that estimated nutrient loads from this source are higher than the actual loading.

In the Boyne catchment the load from licensed discharges is estimated at 9% of the total load, which when combined with the estimated load from MWWTPs, the point source load equates to 25% of the total load.

In the Liffey catchment, with the majority of industries discharging to the sewer network, licensed discharges to surface waters account for only 3% of the point source load. Point sources account for an estimated 22% of the TP load.

IPC licensed industry is estimated to discharge 27 tonnes TP/annum in the freshwater section of the Suir, thereby accounting for 14% of the total load. Point sources (licensed discharges and MWWTPs) are estimated to contribute of 56 tonnes TP/annum or 29% of the total load. The estimated TP load from point sources to the Suir estuary is 152 tonnes TP/annum with industry in the Waterford City area discharging to sewer accounting for a very high proportion of that load (97.4 t/a).

2.6.3 Diffuse Sources

Diffuse TP load estimates are based on export coefficients for different land use types, which have been re-evaluated following extensive monitoring and investigation in pilot study areas over the course of the Project. These revised coefficients have then been applied to the land use types identified in the CORINE (land use) dataset for each of the catchments to determine individual land use type loadings. As these loads have been generated from a completely different set of coefficients than used in the Baseline Report, there is little value in comparing the estimates.

In all three catchments, grassland (pasture), which is the largest landuse type by far, is the greatest contributor of phosphorus, however arable land contributes significantly more phosphorus per hectare, with an export coefficient of 2.27 kg/haTP, as compared with 0.32 kg/ha TP for grassland and 1.29 kg/ha TP for urban. Other diffuse sources include forestry and peatland. For this exercise, it has been assumed that all pollution emanating from agricultural activities is of a diffuse nature.

Agricultural land uses export over half of the TP load to each of the catchments with 63%, 58% and 57% from the Boyne, Liffey and Suir catchments respectively. Point discharges (MWWTPs and licensed discharges) contribute approximately one quarter of the total load. The Liffey catchment has the biggest percentage of urban cover (7%) of the three catchments, the Boyne the highest pasture cover (80% of the catchment) and Suir the highest forestry cover (11.5% of the catchment).

Unsewered populations, i.e. populations using septic tanks, generate a further load contributing an estimated 3% in the Liffey, 8% in the Boyne and 7% in the Suir. These estimates were based on the assumption that 30% of effluent produced by rural populations producing 175-litres/per person per day would reach watercourses. Loads from urbanised areas make up 1% in the Boyne and, <1% in the Suir, and as expected the contribution is higher in the Liffey at 10%. Forestry accounts for 5% of the TP load in the Liffey, 4% in the Suir and <2% in the lowland catchment of the Boyne. The loads from peatland areas are also low in the Boyne (1%), with 2% and 3% being the load contribution from the Liffey and Suir catchments respectively. **Figure 2.12 a) b) and c)** illustrates these estimates.

Agriculture is the major contributor to the freshwater section in each catchment; however in the estuarine section of the Suir MWWTPs account for 76% of the P load, as all discharges from Waterford City and Carrick on Suir discharge to the estuary untreated.

2.6.4 Estimated and Measured Nutrient Loads

Using export coefficients and estimated discharges from regulated point sources, nutrient budgets for each catchment were estimated (**Table 2.6**). Loads calculated from nutrient concentration and flow data, measured at the freshwater limits of each catchment suggest there is still a margin of error in the load estimates. Results indicate the methods used either over estimate the discharges or that all of the nutrients discharged do not reach the estuary but are utilised by aquatic flora or are adsorbed to sediment. Better resolution of point source discharges as recommended by the Project should resolve much of the difference between estimated and measured loads. It should be noted that the TP figures include "background" levels of P associated with natural processes such as soil chemistry and decomposition of vegetation, which would lead to a steady low-level input of P in any conditions.

Table 2.6 – Nutrient Loads (April 2000/April 2001)

	Final Report Estimated Loads (Tonnes P/ yr)		
	Boyne	Liffey	Suir
TP – Point	55	34	56
TP – Diffuse	155	77	139
Total Estimated Load	210	111 (3)	195
Load measured at the freshwater limit. (1)	161	86	189
EPA Measured Loads 1999 (2)	142	95	199
<p><i>Note</i> (1) calculated from weekly water quality and flow data, Estimated loads do not include discharges to the estuary (2) EPA loads for 2000/2001 were not available at time of report. EPA loads were calculated from monthly monitoring data measured at the FWL. (3) Load includes Camac catchment</p>			

The estimated load for the Suir catchment is, however, very close to the actual measured load with an error of only 2.5%. This indicates that the land use coefficients, which were derived from the Three Rivers Project pilot catchment areas, are good estimates of diffuse loss from this catchment.

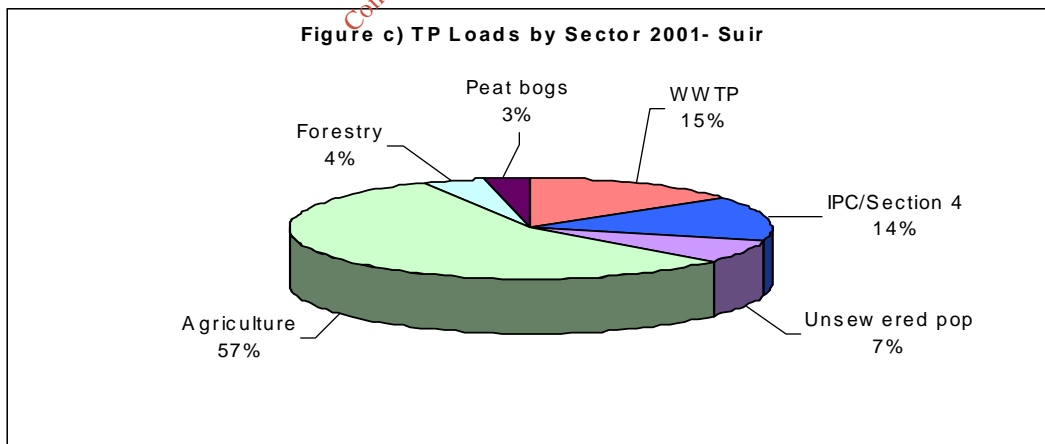
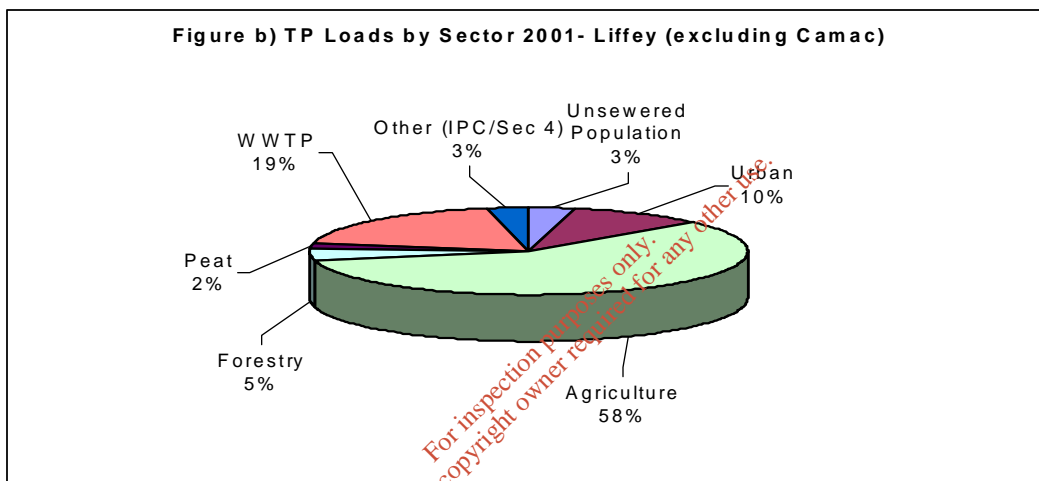
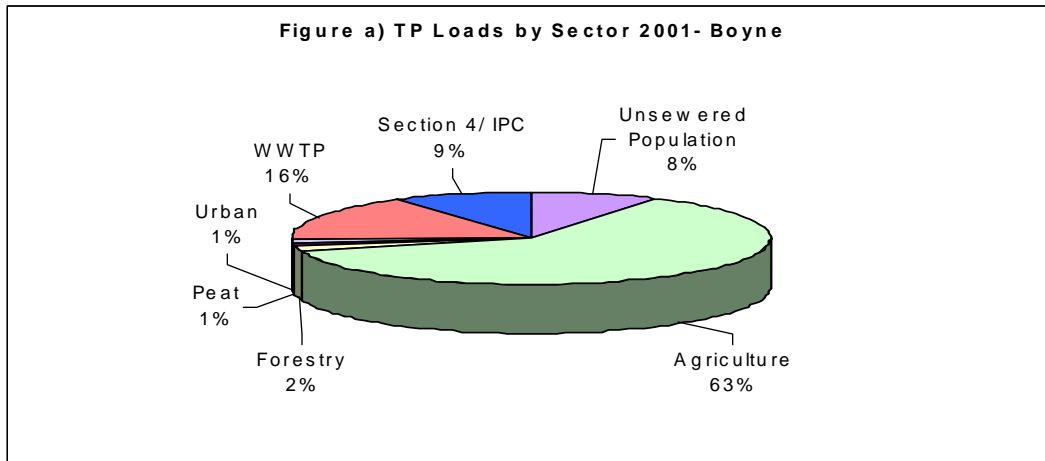


Figure 2.12 – TP Loads by Sector 2001, Boyne, Liffey and Suir Catchments

2.7 DISCUSSION

Intensive water quality/quantity monitoring by the Project has established more accurate nutrient export coefficients for agricultural (pasture and arable) and urban land uses. The close relationship found between measured loads and the loads using the revised export coefficients provides greater confidence in the validity of the new export coefficients and revised sectoral loads for each catchment. Using the revised coefficients, the diffuse TP load has decreased significantly from the Baseline estimate compared to the Final Report.

The contributions from the agricultural sector, with approximately two-thirds of the load, are similar for each catchment and the point source load is approximately one quarter of the total load in each catchment.

Local Authorities have generally failed to monitor flow and phosphorus concentrations in the effluent at the majority of WWTP's in each catchment and this has led to the necessity to estimate nutrient loads from these facilities. As stated previously, better monitoring of loads from treatment plants is required before accurate sectoral loads for all of the catchments can be established.

In terms of licenced discharges (IPC and Section 4 discharges) it is likely that loads calculated are overestimated. Calculations have been based on maximum licenced discharge limits, as there is also a general lack of flow monitoring data.

Although more monitoring data, and in particular flow monitoring, is required, the upgrading work carried out at the major MWWTPs, along with further work carried out on a number of smaller plants in the catchments are expected to have a beneficial effect on the nutrient loads to each catchment. The comparison of loads derived from the Project export coefficients with the monitoring data suggests that this method gives a good estimation of loads from diffuse sources.

2.8 CONCLUSIONS

- Agriculture accounts for 63%, 58% and 57% of the total load for the Boyne, Liffey and Suir catchments respectively.
- Diffuse sources account for 75%, 78% and 71% of the total load for the Boyne, Liffey and Suir catchments respectively, with the remainder from point sources.
- The TP loads for 2000/2001 as estimated by the Project, and the actual measured (using flows and weekly sampling) TP loads were:

Table 2.7 – Estimated and Measured TP Loads at the FWL

Catchment	Estimated TP Load (tonnes P/a)	Measured TP Load (tonnes P/a)
Boyne	210	161
Liffey	111*	86
Suir	195	189
* Including Camac catchment		
These figures were measured at the fresh water limit (FWL).		

- A significant decrease was seen in Liffey estimated TP loads from the Baseline to end of 2000 data. This was due to a combination of the upgrading of Osberstown and Leixlip MWWTPs, which account for 80% of TP discharged by MWWTPs in the Liffey catchment, and the use of more accurate export co-efficients for the estimation of the diffuse pollution inputs.

- In the Boyne the estimated TP load from MWWTPs has increased by 30% over the original Baseline estimate, due to increased loadings (p.e.) at a number of plants, based on data supplied by the L.A.
- Point source TP loading to the Suir catchment from MWWTPs' and industry are similar, with MWWTPs contributing 28.57t/a (15%) and industrial discharges contributing 26.97t/a (14%).
- In the Suir catchment, agriculture is the most important contributor of P (57%) to the freshwater section of the river. In the estuarine section, point source discharges with an estimated 76% of the load, are the most important source.

*For inspection purposes only.
Consent of copyright owner required for any other use.*