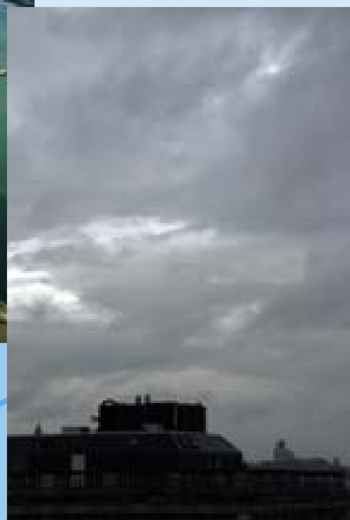
CDM

eastern river basin district

Dublin City Council

Eastern River Basin District Project

Urban Pressures - National POM/Standards Study
The Assessment of Urban Pressures in River and Transitional Waterbodies in Ireland



March 2009

Final Report

Document Control Sheet

Client	Dublin City Council			
Project	Eastern River Basin District – National POM/Standards Study			
Report	The Assessment of Urban Pressures in River and Transitional Surface Waterbodies in Ireland – Final Report			
Date	March 09			
Project No: 39325		**Document Reference:** 39325/UP40/DG 48 - S		
Version	**Author**	**Reviewed**	**Checked**	**Date**
Draft 01	A G Kerr	B Kolb	A Hooper	May 08
Draft 02	A G Kerr	B Kolb	A Hooper	June 08
Draft 02 – Rev 1	A G Kerr	-	-	October 08
Final - Rev 1	A G Kerr	A Hooper	L Casserly	December 08
Final - Rev 2	AG Kerr	A Hooper	L Casserly	March 09

Distribution	Copy No.		Distribution	Copy No.
Master	01		KCC – Alan Dunney	14
DCC – Tom Leahy	02		CCC – Edith Roberts	15
DCC – Don Mc Entee	03		MCC – Tim O' Leary	16
DCC – Ray Earle	04		SWRBD – Seán Ó Breasail	17
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WCC – Michael Geaney	11		NIEA – Kevin McGrady	24
KCC – Oliver Ring	12		Website: www.erbd.ie	25
KCC – Michael O' Leary	13			

Acknowledgements

The Eastern River Basin District (ERBD) Project Consultants Camp Dresser Mc Kee (CDM) and The Co ordinating Authority Dublin City Council (DCC) for the surface waters aspect of the urban pressures study would like to thank all those who have provided data, information and advice for this study.

Particular thanks must go to the Urban Pressures Assessment Steering Group and Advisors from the Department of Environment, Heritage and Local Government (DEHLG), the Environmental Protection Agency (EPA) and Local Authority personnel.

The Urban Pressures steering group consisted of Don Mc Entee DCC (Chairman), Ray Earle Project Co-ordinator ERBD, Gerard O'Connell DCC, Gerry O' Donoghue (DEHLG), PJ Shaw Department of Communications Marine and Natural Resources (DCMNR), David Harrington Wicklow County Council, Michael Geaney Wicklow County Council, Michael O Leary Kildare County Council, Tim O'Leary Meath County Council, Oliver Ring Kerry County Council, Edith Roberts Cork City Council, Matthew Craig EPA, David Smith EPA, Bruce Misstear Trinity College Dublin (TCD), Kevin McGrady Northern Ireland Environment Agency (NIEA), Dominic Casey South Western River Basin District (SWRBD), Seán Ó Breasail Project Co-ordinator SWRBD, Jane Healy (SWRBD), Trevor Champ Central Fisheries Board (CFB), Noel Ferris (NIEA), and Natalya Hunter Williams Geological Survey of Ireland (GSI).

The following organisations have provided their data for use in this project: Department of Environment, Heritage and Local Government, Environmental Protection Agency, Carlow County Council, Clare County Council, Cork County Council, Donegal County Council, Dublin City Council, Dun Laoghaire-Rathdown County Council, Fingal County Council, Galway County Council, Kerry County Council, Kildare County Council, Kilkenny County Council, Laois County Council, Limerick County Council, Louth County Council, Mayo County Council, Meath County Council, Offaly County Council, Roscommon County Council, Sligo County Council, South Dublin County Council, Tipperary County Council – South Riding, Waterford County Council, Westmeath County Council, Wexford County Council, Wicklow County Council, Met Eireann.

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List of Acronyms:

CFB – Central Fisheries Board

CDM – Camp Dresser McKee

CSO – Combined Sewer Overflow

DCC – Dublin City Council

DEHLG – Department of the Environment, Heretage, and Local Government

DCMNR – Department of Communications Marine and Natural Resources

EDEN – Environmental Data Exchange Network

EMC – Event Mean Concentration

EMEP – European Monitoring and Evaluation Monitoring Programme

EPA – Environmental Protection Agency

EQS – Environmental Quality Standards (For Water)

ERBD – Eastern River Basin District

GDSDS – Greater Dublin Strategic Drainage Study

GIS – Geographical Information System

GSI – Geological Survey of Ireland

IPPC – Intergrated Pollution Prevention Control

LADP –Local Area Development Plan

LIDAR - Light Detection and Ranging

LIMS – Laboratory Information Management System

MIR – Minucipal and Industrial Regulation

NIEA – Northern Ireland Environment Agency

NUWWS – National Urban Waste Water Study

OSPAR – Oslo Paris Convention 1992

PE – Population Equivalent

POM – Programme of Measures

PR – Preliminary Report

PSG – Project Steering Group

PSO – Pump Station Overflow

RBD – River Basin District

RBMP – River Basin Management Plan

SEPA – Scottish Environmental Protection Agency

SWRBD – South Western River Basin District

TCD – Trinity College Dublin

TSR – Time Series Rainfall

TUCSON - The Unified Climatoligical and Synoptic Observing Network

UKWIR – United Kingdom Water Industry Research

WB – Water Body

WFD – Water Framework Directive

WWTP – Wastewater Treatment Plant

List of Key Legislation

Basic Measures

Irish Legislation	Corresponding EU Directive
SI 722 European Communities (Water Policy) Regulations 2003	Water Framework Directive (2000/60/EC)
11 Basic Directives	
S.I. 79 of 2008 Bathing Water Quality Regulations, 2008	The Bathing Water Directive (2006/7/EC) (76/160/EEC repealed)
S.I. 291 of 1985 EC (Conservation of Wild Birds) and amendments	The Birds Directive (79/409/EEC)
S.I. 278 of 2007 EC (Drinking water Regulations) (No 2)	The Drinking Water Directive (98/83/EC) (80/778/EEC repealed 25/12/2003)
S.I. 74 of 2006 EC (Control of Major Accident Hazards Involving Dangerous Substances) Regulations, 2006	The Major Accidents (Seveso) Directive (96/82/EC) extended by Directive 2003/105/EC
S.I. 349 of 1989 EC (Environmental Impact Assessment Regulations) 1989 and amendments	The Environmental Impact Assessment Directive (85/337/EEC) as amended by Directive 97/11/EC
S.I. 148 of 1998 Waste Management (Use of Sewage Sludge in Agriculture) Regulations, 1998 - 2001	The Sewage Sludge Directive (86/278/EEC)
S.I. 254 of 2001 Urban Waste Water Treatment Regulations, 2001 and 2004	The Urban Waste-water Treatment Directive (91/271/EEC)
S.I. 624 of 2001 EC (Classification Packaging and Labelling of Plant Protection Products and Biocide Products) Regulations, 2001. S.I. 83 of 2003 EC (Authorisation, Placing on the market, use and control of Plant Protection Products) Regulations, 2003 and amendments. S.I. 320 of 1981 EC (Prohibition of certain active substances in plant protection products).	The Plant Protection Products Directive (91/414/EEC)
S.I. 378 of 2006 EC Good Agricultural Practice for Protection of Waters Regulations, 2006 - 2007	The Nitrates Directive (91/676/EEC)
S.I. 94 of 1997 EC (Natural Habitats) Regulations, 1997 - 2005	The Habitats Directive (92/43/EEC)
S.I. 85 of 1994 EPA (Licensing) Regulations, 1994 & 2004	The Integrated Pollution Prevention Control Directive (96/61/EC)
Other Relevant Directives	
S.I. 684 of 2007 Waste Water Discharge (Authorisation) Regulations, 2007. S.I. 41 of 1999 Protection of Groundwater Regulations, 1999 (to be revoked 22/12/2013)	The Ground-Water Directive (80/68/EEC) (To be revoked 22/12/2013)
S.I. 684 of 2007 Waste Water Discharge (Authorisation) Regulations, 2007. Water Services Act 2007. S.I. 12 of 2001 Water Quality Dangerous Substances Regulations, 2001. Local Government (Water Pollution) Act, 1977 and amendments (Section 4 and 16)	The Dangerous Substances Directive (2006/11/EC) (76/464/EEC Repealed) and Daughter Directives
S.I. 294 of 1989 Quality of Surface Water intended for the Abstraction of Drinking Water	Surface Water Abstraction Directive (75/440/EEC)
S.I. 268 of 2006 The Quality of Shellfish Waters Regulation Regulations, 1998	The Shellfish Water Directive (79/923/EEC)
Planning and Development Regulations 2001 - 2007 (S.I. 436 of 2004)	Strategic Environmental Assessment Directive (2001/42/EC)
S.I. 117 of 2003 EC (Port Reception Facilities for Ship Generated Waste and Cargo Residues) Regulations, 2003	EU Directive on port reception facilities for ship-generated waste and cargo residues (2000/59/EC)
EU Regulations Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH) (1907/2006/EC)	Dangerous Substances
Other Basic Measures	
Measures to apply the principle of recovery of costs of water use	National Water Pricing Policy Framework (1998)
To promote efficient and sustainable water use	National Water Pricing Policy Framework (1998)
To safeguard water quality in order to reduce the purification treatment required for drinking water.	
Controls over the abstraction and impoundment of fresh surface water.	Planning and Development Acts 2000-2006. Water Supplies Act 1942
Control, including a requirement for prior authorisation of artificial recharge or augmentation of groundwater bodies	
Control of point source discharges	SI 254 of 2001 Urban Waste Water Treatment. EPA Regulations 1992 - 2003 and associated licensing regulations. Water Pollution Act. SI 684 of 2007 Waste Water Discharge (Authorisation) Regulations, 2007.
Control of diffuse source of pollution	Water Services Act 2007. SI 378 of 2006 Good Agricultural Practice for Protection of Water Regulations, 2006.
Control on other activities with an impact on the status of water	
Including hydromorphological condition of the water bodies	Planning and development processes and marine licensing systems provide general control at approval stage.
Authorisation of direct pollution discharge into groundwater	SI 684 of 2007 Waste Water Discharge (Authorisation) Regulations,

Irish Legislation	Corresponding EU Directive
	2007. SI 41 of 1999 Protection of groundwater regulation.
Elimination of surface water pollution by priority substance and to progressively reduce pollution by other substances.	Various pollution reduction plans and programmes
Regulations to prevent and reduce the impacts of accidentals pollution incident	SI 74 of 2006 Control of Major Accident Hazards Involving Dangerous Substances. Framework for Major Emergency Management, Office of Emergency Planning, 2006.

Supplementary Measures

Supplementary Measure	Pressure benefitted
Riparian Buffers	Diffuse nutrients from forestry and agriculture
Inspections and Upgrades	Agricultural diffuse and farmyard
Treatment Plant Tie-ins	Septic tank discharges
Tertiary Treatment	Wastewater Treatment Plants
Introduce Soft Edges to Inferior Habitats	Morphological changes
Treatment of Mine Discharge	Mine discharges
Enforce Regulations on Septic Systems	Septic tank discharges
Further Investigate cause of failure	All
Proper Disposals of Harbour Dredgings	Port operations
Assess the effects of coastal defences	Morphological changes
Monitor Shipping Activities	Pollution from shipping
Mitigate impact of quarry activities	Quarry discharges and abstractions
Maintain good hydrological status	Abstractions
Implementation of S.U.D.S	Diffuse urban pollution
GDSDS Compliance - CSOs	Point source pollution in urban areas
Facilitate Fish Migration	Morphological changes
Review Dredging Practice	Morphological changes
Upgrade WWTW <2000 PE	WWTW
Upgrade WWTW and Collecting Systems <2000 PE	WWTW
Evaluate Bog Impact	Diffuse rural pollution
Investigate and eliminate misconnections	Urban diffuse pollution
Investigate Fats, Oils and Grease Issues	Urban point source pollution
Restrict Cattle Access to rivers - Create Cattle Drinking points	Agricultural diffuse pollution
CSO - Upgrades and Rehabilitation	Urban point source pollution
CSO - Implement FOGG Regulations	Urban point source pollution
CSO - Network Management & Operations Programme	Urban point source pollution
Gullies Management	Diffuse urban pollution
Street Cleaning Programme	Diffuse urban pollution
Storm Sewers (Screening & Treatment)	Diffuse urban pollution
River Polishing - Reed Beds	Point Sources
Survey Banks/Coast	Morphological changes
Implement Upstream Programmes of Measures	Upstream pressures
Preservation and/or restoration of the bank	Morphological changes
Septic system management programme	Septic tank discharges
Assess effect of causeway	Morphological changes
Further Investigate cause of failure	Establish cause of problems
Address diffuse silt pollution from green field site development	Development

Executive Summary

E1: Overview

Under The Water Framework Directive (WFD) a River Basin Management Plan (RBMP) must be prepared for each European river basin and delivered to Europe by the end of 2009. Each RBMP is required to be accompanied by a comprehensive Programme of Measures for waterbodies which will be required to ensure that the WFD key objectives are achieved by 2015. A detailed understanding of the risks associated with all pollution sources in waterbodies is fundamental for the development of a Programme of Measures to remedy such pollution sources.

However following an initial submission of an "Article V Initial Characterisation" report to Europe in 2005 a number of issues were identified where it was believed there was insufficient understanding of the issues to enable a more thorough appreciation of the risks posed to waterbodies both in terms of scale and impact. One of these issues related to the pollution threat posed by urban areas on receiving surface waters. It was known that urban areas pose a risk of pollution to waterbodies, but assessing the risk is complex because of the myriad of potential urban pollution sources found there such as surface water road runoff etc.

In order to acquire a more detailed understanding of the risks posed by the pollution pressures from urban areas CDM were appointed in December 2005 to undertake an urban pressures study project titled "The Assessment of Urban Pressures in Rivers, Transitional Waters and Ground Waters in Ireland".

The scope of the urban pressures study, ***which is fundamentally a desktop study***, entailed assessing urban pressure risks for the 33 largest urban areas nationally as detailed on Figure E.1. Urban areas were selected where the population exceeded 10,000 as per the 2002 Census figures.

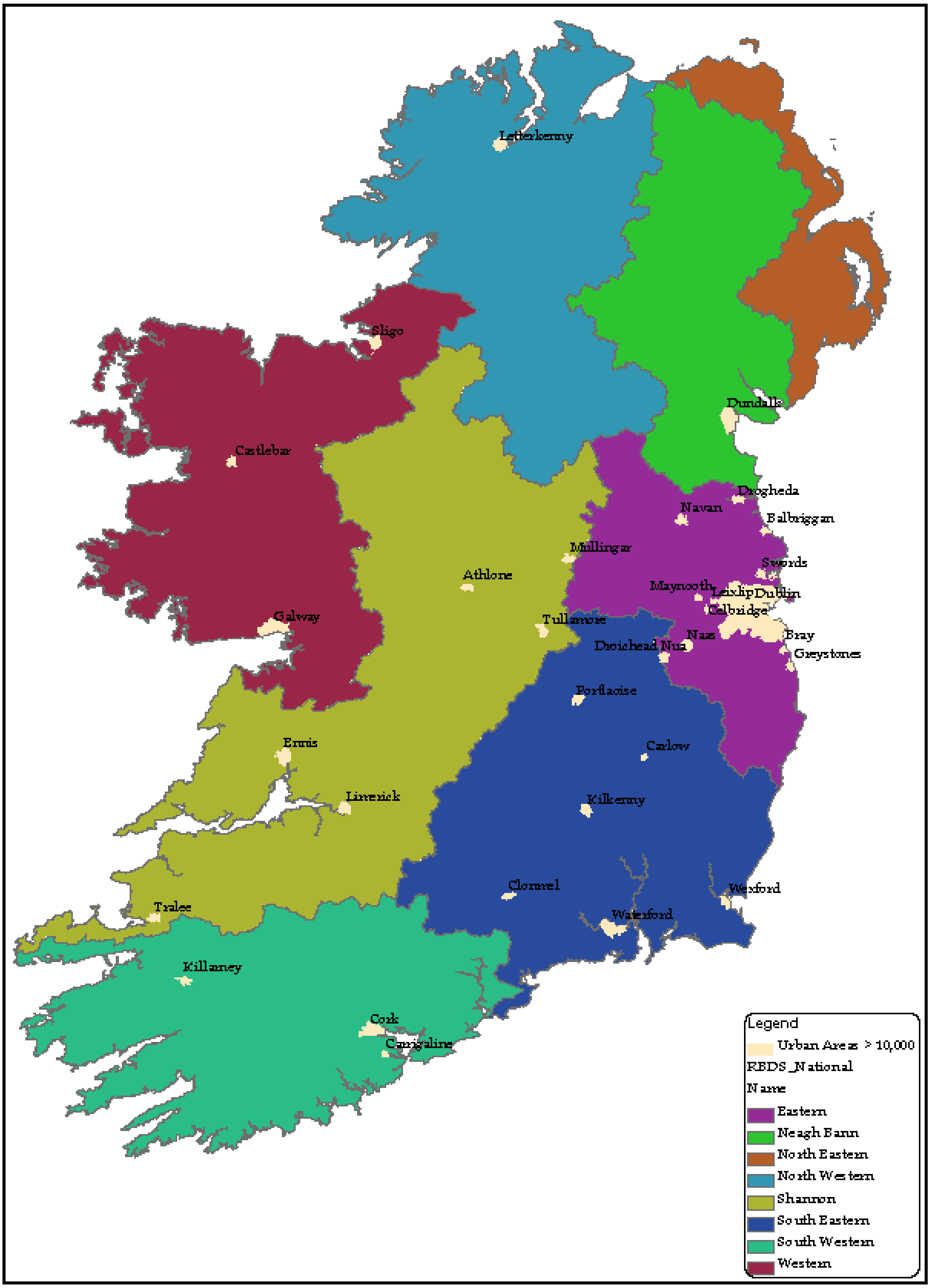
There were two distinct parts to the urban pressures study;

- an assessment of impacts on surface waters - including rivers and transitional waters
- an assessment of impacts on ground waters

The requirements for each part of the study were significantly different as were the study programmes. For example, whilst the ground water aspect of the study included for substantial field work including the provision of new groundwater monitoring wells, there was minimal provision for fieldwork or sampling under the surface waters aspect of the study. Partly to accommodate these differences the urban pressures study was implemented in two parallel stages – surface waters and ground waters. This report ***deals specifically with the findings from the surface waters study*** aspect of the project.

In essence the scope of the surface waters study involved undertaking a macro overview of water quality status in river and transitional surface waters within specified urban areas using a consistent cumulative assessment estimation methodology which did not involve an extensive period of study for each surface water.

Figure E.1: Study Areas



Whilst there were many facets to this wide ranging study of urban surface waters the main original overriding objectives for the surface waters aspect of the study were to:

- Undertake annual average flow impact assessment (through compliance with supplied chemical water quality standards) of urban pressures in Irish urban waters for a range of up to 14 parameters including nutrients and selected metals
- Gather missing data and improve data layers in the National EPA Geographical Information System (GIS) developed to support the study
- Conduct additional analyses to characterise Combined Sewer Overflows (CSOs) in urban areas in Ireland
- Estimate the type and scale of individual urban pressures in urban surface waters
- Develop an assessment methodology that considers assimilative capacity of the urban surface waters in Ireland based upon the combined cumulative annual loadings from all urban pressures
- Develop rankings for urban pressures

Additionally the average annual flow assimilative capacity impact assessment was intended to highlight:

- Whether (and for what parameters) urban pressures impair ecological status, as measured through compliance with supplied EPA chemical water quality standards
- Provide an initial understanding of the magnitude of impairment in each of the 33 study urban areas
- Provide a comparative assessment for urban pressures between the 33 study urban areas

Equipped with this information it should then be possible to assist at a later stage with the identification and prioritisation of Programmes of Measures and future capital expenditure that will be needed in some urban areas to meet the Water Framework Directive requirements of good ecological status.

As has been stated previously there was minimal provision within the urban pressures surface waters budget to undertake water quality sampling and monitoring. Therefore f**undamentally this surface waters study was scoped as a macro level desktop study** drawing primarily upon outputs from both existing national datasets and reports.

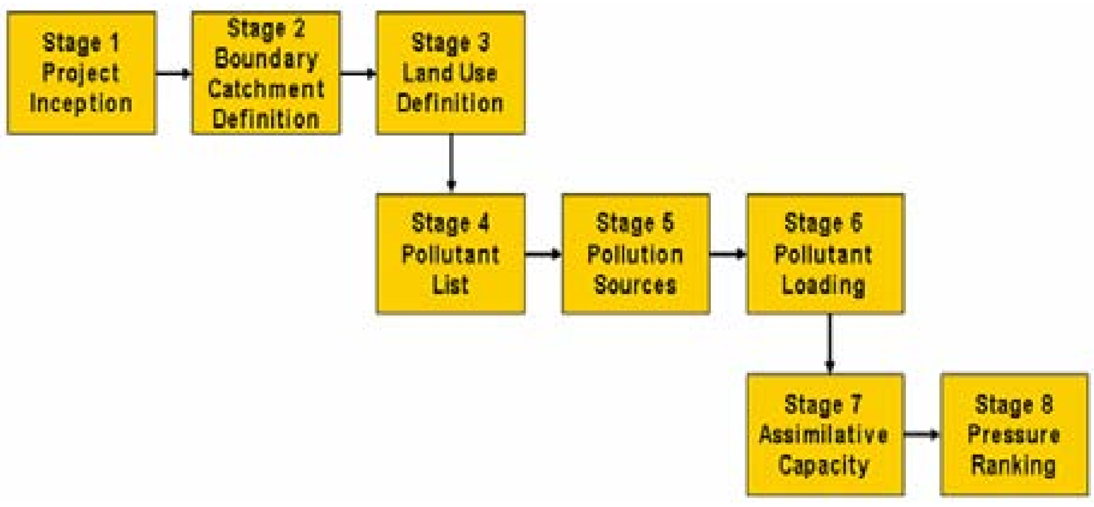
In addition there was a provision to include data from at least one major external combined sewer overflow (CSO) study which was planned to be implemented in parallel (though externally) to the overall urban pressures study. However, due to lack of funding the CSO study was not commissioned and consequently an alternative methodology for assessing CSO hydraulic spill performance was adopted utilising the partly completed suite of hydraulic sewer network models which had been prepared nationally over previous years.

Furthermore because of significant data gaps/limitations with the national datasets alternative approaches based upon the use of surrogate data were adopted (using both UK and European data) as the study progressed for estimating a number of the urban pressure cumulative annual water quality loadings.

The study was implemented under the guidance of a Project Steering Group (PSG). It should be acknowledged that the PSG members remained fully engaged in the process throughout and provided significant guidance, help and support throughout the project.

There were eight key stages to the project as depicted in Figure E.2.

Figure E.2: Project Stages



This report details how the urban pressures surface water study was implemented and the main study findings. The report concludes with a series of recommendations, which if implemented in full, will ensure that any proposed future Programmes of Measures can be properly targeted and cost effectively implemented.

E2: Study Outputs

The staged approach to the project is outlined in Figure E.2. Because of the scale and complexity of the project a phased approach was adopted for the preparation and sign off for each project stage. As each project stage was completed a technical document was prepared detailing the methodology/approach that was adopted by the PSG to implement and complete the project stage. The technical documents were either internal working documents or externally distributed documents. All externally distributed documents were issued to the PSG for ratification and project signoff.

Following project signoff the externally distributed documents were:

- Uploaded to the Eastern River Basin District (ERBD) website – **www.erbd.ie**
- Emailed to the Dublin City Council as Co ordinating Authority
- Emailed to the PSG

The extensive list of signed off supporting technical documents is detailed in Appendix A. This final report draws frequently upon key extracts from all of the previously signed off documents in Appendix A. The reader is therefore referred to the individual documents in Appendix A should more detail or clarity be required on any of the matters raised within this report.

E3: Main Study Findings

One of the main study outputs involved an assimilative capacity assessment of the annual cumulative impact of urban pressures on the surface waterbodies located within 33 urban area catchments nationally. These 33 urban area catchments contain 26 urban rivers and the 13 urban transitional surface waterbodies.

Many difficulties/issues were encountered during the implementation of the study (see Section 5). In the majority of cases these difficulties/issues related to a combination of either data gaps or sparse data for existing Irish datasets for specific urban surface waterbody study purposes including;

- Lack of CSO spill performance water quality data
- Lack of CSO spill performance quantitative data
- Hydrology data for rivers
- Tidal inflow data for transitional waters
- Air quality monitoring data
- Waste water treatment effluent quality and flow data
- River water quality data
- Transitional water quality data
- Chemical water quality standards
- Point source discharge quality and flow data
- Urban surface water runoff water quality data

In consultation with the PSG the study team introduced a number of alternative approaches to improve the data gap and sparse data issues and to facilitate the assessment procedures including the;

- Re running of hydraulic sewer network models to obtain CSO annual spill performance data
- Re running of hydraulic sewer network models to obtain urban landuse rainfall runoff coefficients
- Adoption of surrogate chemical water quality standards from sources outside of Ireland

- Adoption of surrogate water quality concentration runoff data for urban catchment landuses from sources outside of Ireland
- Adoption of surrogate waste water treatment effluent water quality concentration data from sources outside of Ireland
- Adoption of surrogate CSO spill water quality concentration data from sources outside of Ireland
- Introduction of tidal prediction software for predicting tide levels

Initially seven individual urban pressures were identified for assessment as per Figure 3.5. However, it was not possible to compile cumulative annual urban pollution loading estimates for either of the groundwater or point source urban pressures. Therefore only five of the seven identified urban pressures were assessed. In each case these five individual urban pressures were assessed for the 14 study (chemical) parameters detailed in Table 3.5.

The five urban pressures which were assessed are as follows;

- Incoming loadings from upstream catchment
- Diffuse urban catchment surface water runoff
- Wastewater Treatment Plant (WWTP) discharges
- CSO discharges
- Atmospheric deposition (direct to surface waters)

By adopting the alternative approaches referred to previously the study team was able to prepare estimates of cumulative annual urban pollution loadings (kg/yr) entering the urban surface waters from each of the five individual urban pressures for most of the 14 study parameters. In a small number of cases however it was not possible to produce cumulative annual urban pollution loading estimates for one of the 14 study parameters corresponding to an individual urban pressure because of data limitations.

The alternative approaches referred to previously also enabled the project team to undertake water quality assimilative capacity impact assessments for most of the 26 urban rivers and the 13 urban transitional waters located within the 33 study urban areas. In each case and for each urban surface waterbody a separate assimilative capacity impact assessment was implemented for each of the 14 study parameters.

The assimilative capacity impact assessments are detailed in full in Section 3.9.4, Figures 3.10 – 3.23. The key outputs/findings from the assimilative capacity impact assessment Figures 3.10 – 3.23 are reproduced below as Figures E.3 – E.30.

In essence Figures E.3 – E.30 show the predicted mean annual average concentration levels (blue horizontal bars) for the existing catchment urbanisation scenario in both the urban river and transitional waterbodies. In each case the plotted vertical red coloured lines on the Figures represent the indicative study chemical water quality standards as indicated on Table 3.43. A solid vertical line indicates an indicative study chemical water quality standard provided by the EPA whereas a dotted solid vertical line indicates an indicative study chemical water quality standard based upon the adoption of a surrogate standard from outside of Ireland.

Whilst most of the Figures E.3 – E.30 are based upon the cumulative annual loadings from all five urban pressures for each of the 14 study parameters - in a small number of cases there was no cumulative annual loading data available for an individual urban pressure for a small number of the 14 study parameters. The reader is referred to Figures 4.1 to 4.28 in Section 4 of the report to obtain a more detailed understanding of the urban pressure data gaps by individual parameter and the supporting/surrogate data which was used to construct Figures E.3 – E.30.

Figures E3 – E30 indicate much variability depending upon whether river or transitional waterbodies are being considered. The Figures consistently show ***apparent*** exceedances of the ***'indicative' study Water Quality Standards*** for many of the study parameters for a small number of both urban rivers and transitional waters. These ***apparent*** exceedances for the urban surface waterbodies occur where the blue horizontal bars on the Figures cross to the right of a vertical red line. In each case the vertical red line represents the ***'indicative' study Water Quality Standard*** for the parameter of interest.

The ***apparent*** exceedances fluctuate by both study parameter type and surface waterbody type i.e. river or transitional surface waterbodies. The number of urban surface river waterbodies showing ***apparent*** exceedances include;

- Santry and Camac rivers (Dublin)
- Dodder and Tolka rivers (Dulin)
- Brosna river (Mullingar)
- Triogue (Barrow) river (Portlaoise)

Whilst the urban transitional water bodies showing ***apparent*** exceedances include the:

- Dublin Liffey Estuary Upper transitional water (Dublin)
- Swilly Estuary transitional water (Letterkenny)
- The Boyne Estuary transitional water (Drogheda)
- Limerick Dock transitional water (Limerick)

Co incidentially in each case those urban river waterbodies exhibiting the ***apparent*** exceedances correspond to highly urbanised catchments whereby the urban rivers are small urbansied streams with low annual cumulative river flows. ***Therefore in reality these particular urban river waterbodies will be the first to show any likely significant effects from urban pressures on their ecological status.***

Whilst it is acknowledged that there is likely to be significant overestimation of annual pollutant loads within this study for all assessed urban surface waterbodies – primarily because of both the use of surrogate and detection limit analysis data as reported

throughout this report - it is not currently possible to determine the scale of such overestimation for the above group of urban surface waters without further detailed/comprehensive water quality sampling/monitoring programmes and further detailed study of the surface waterbodies.

The issue of overestimation of pollution loads has been discussed at length at both Project Steering Group and Local Authority Level. For example the Local Authorities currently undertake river monitoring programmes under a wide range of Regulations including;

- S.I. No. 293 of 1988 – European Communities (Quality of Salmonid Waters) Regulations, 1988.
- S.I. No. 257 of 1998 – Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorous) Regulations, 1998.
- S.I. No. 12 of 2001 – Water Quality (Dangerous Substances) Regulations, 2001.
- S.I. No. 722 of 2003 – European Communities (Water Policy) Regulations, 2003.

In all cases the Local Authority river monitoring is undertaken using accredited testing facilities. The monitoring results from these programmes are reported to the Environmental Protection Agency at the frequencies required and form part of the National datasets returned to the European Environment Agency.

Having consulted with Dublin City Council (DCC) during this study for example, to validate/calibrate the pollutant loadings estimated from this macro level study, we are aware that their river monitoring results would suggest that the estimating procedures used for this study to derive the macro cumulative annual loadings for a number of the 14 parameters appear to be overestimating the cumulative annual loadings on a number of highly urbanised rivers including the Liffey, Dodder, Tolka, Camac and Santry.

Whilst it is acknowledged that the implementation of the DCC river monitoring sampling programmes may not be specifically aligned to enable the estimation of cumulative annual pollutant loadings in river waterbodies nevertheless we would strongly advocate that the scale of any likely overestimation of cumulative annual pollutant loads from this study should be investigated further and clearly understood before any of the Basic or Supplementary measures involving the installation of hard infrastructure (Capital Construction Costs) are considered further.

Overall however by adopting both the project methodology as outlined throughout this report in conjunction with the various alternative approaches - including the use of surrogate data etc - it has been possible to undertake for the first time across Irish urban catchments a comprehensive assessment to:

- Characterise CSO spill performance – spill frequency and water quality
- Identify, classify and quantify individual urban pressures
- Assess assimilative capacities (cumulative annual average flow conditions) in urban surface waters from the cumulative impact of urban pressures as measured against indicative chemical water quality standards

- Compare the scale of urban pressures relative to each other and also across urban catchments and receiving surface waterbodies

- Present an initial and inter-comparative understanding of the magnitude of impairment between surface waterbodies and across urban catchments

With regard to CSOs the study has also highlighted a number of interesting facts including;

- For the majority of the re-modelled sewer networks in the urban catchments the ***predicted cumulative annual CSO spill to surface waters is as low as the order of 5 – 10 % of the overall cumulative annual foul/surface water runoff flow carried by the sewer network. The remaining 90 - 95% of the cumulative annual sewer network flow discharges directly to the downstream WWTP.***

- In all cases the sewer network re-modelling shows that for the future catchment scenario when main drainage upgrade recommendations have been implemented ***there is a significant reduction in the cumulative annual CSO spill volumes*** to the receiving water bodies.

Both of these facts are significant as they demonstrate firstly that the cumulative annual CSO spill volumes are not significant when compared to the influent flows to the downstream WWTP, and secondly that the continued roll out of ***the main drainage programme is providing secondary water quality benefits particularly towards compliance with chemical water quality standards.***

The cumulative annual loading assessments in Figures 4.29 – 4.56 of Section 4 of the main body of the report show that for most river waterbodies and many of the transitional waterbodies the diffuse urban pressure is the dominant pressure generated from within the actual urban catchment in particular for the study metal parameters. In contrast for many of the river waterbodies and most of the transitional waterbodies the WWTP urban pressure is the dominant pressure generated from within the actual urban catchment for the majority of the nutrient parameters. In a very small number of river waterbodies and transitional waterbodies the CSO urban pressure is significant particularly for a number of the nutrients. This is symptomatic of the fact that those particular waterbodies are small urban streams in very highly urbanized settings with relatively low annual stream flows and high concentrations of CSOs.

Therefore, whilst the scope of the study has been delivered and all of the study objectives have been met, ***it must be recognised this has been achieved in a number of cases by the use of surrogate data from outside of Ireland and the adoption of alternative approaches. For this reason further supporting work will be required to validate the findings of this study. This supporting work will involve improvements to both the detail and accuracy of existing national datasets plus the gathering of more targeted water quality and matched flow sampling/monitoring data.***

Figure E.3: Nitrates for River Waters

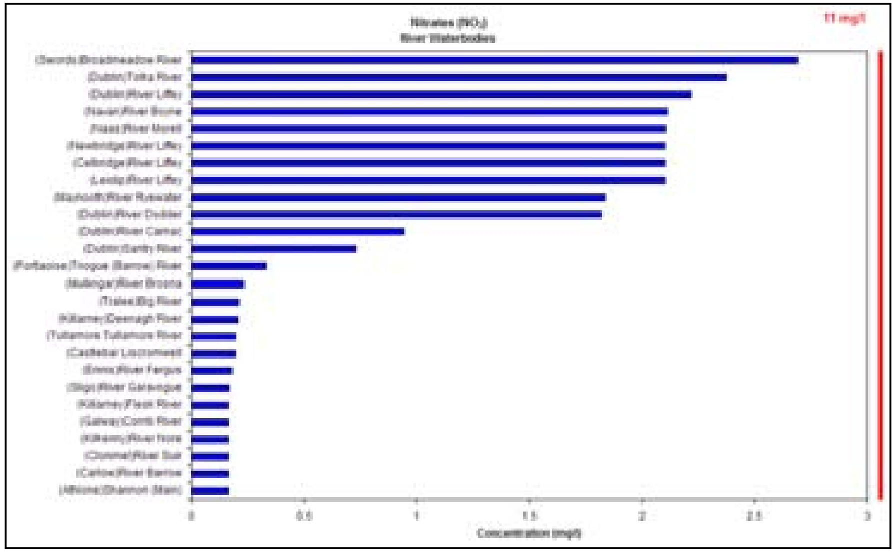


Figure E.4: Nitrates for Transitional Waters

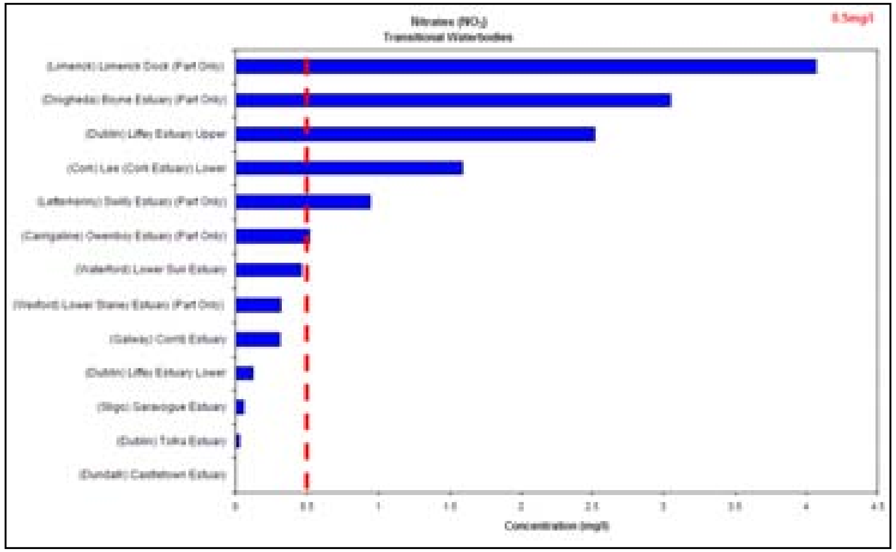


Figure E.5: Nitrites for River Waters

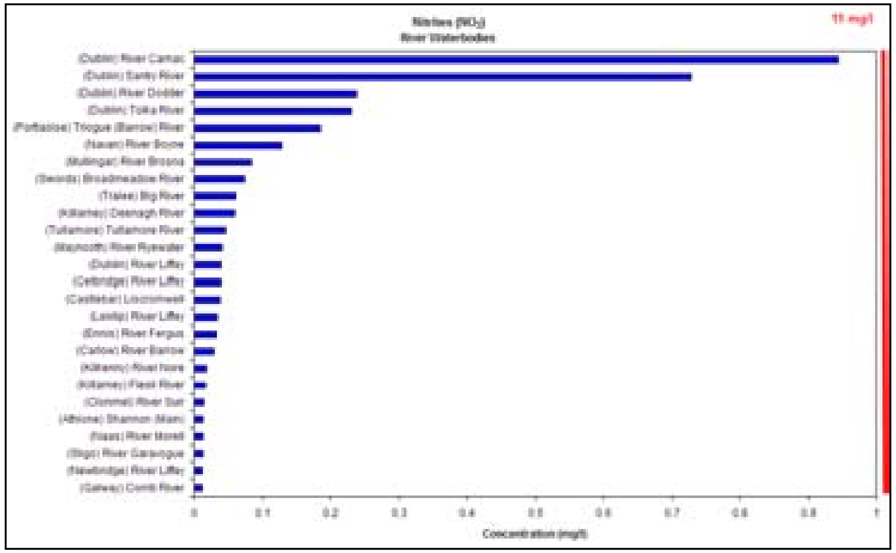
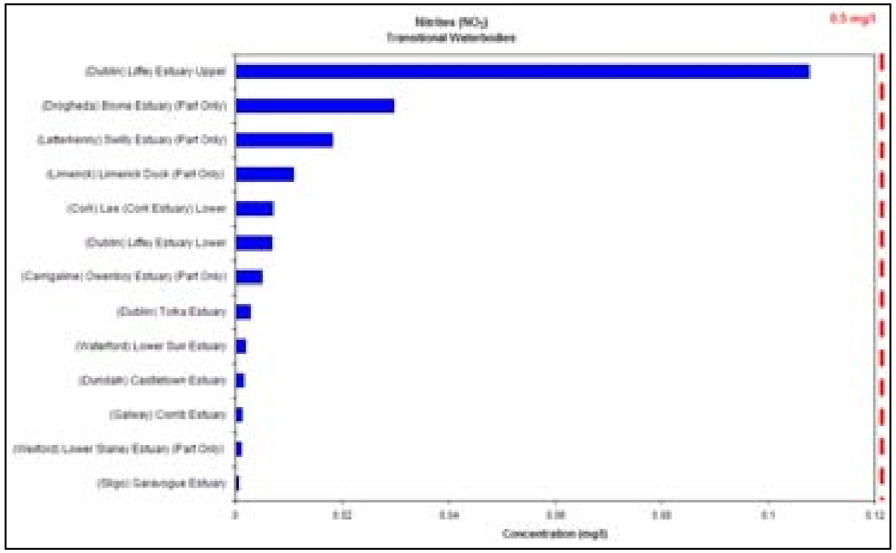


Figure E.6: Nitrites for Transitional Waters



Supplied Indicative Irish Water Quality Standards (Annual Average Concentrations)

Assumed Study Specifc Surrogate Water Quality Standards (Annual Average Concentrations)

1 Predicted Mean Annual Average Concentration Levels for Existing Catchment Urbanisation Conditions - Based upon Mean Annual Average Cumulative Flow Assessment.

2 Plots based upon cumulative predicted annual loadings across 5 urban pressures – Combined Sewer Overflows, Diffuse Urban Runoff, Waste Water Treatment Plants, Atmospheric Deposition and Incoming Loadings from Upstream.

Figure E.7: Total Nitrogen for River Waters

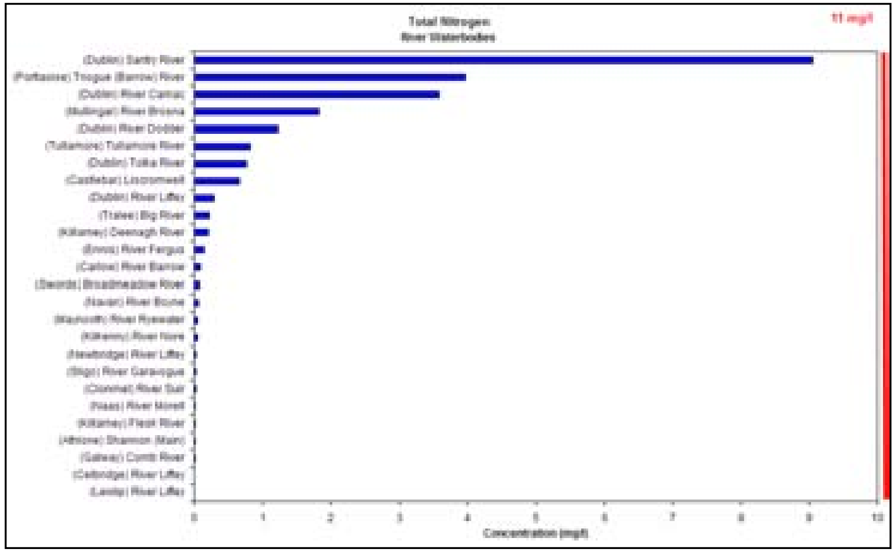


Figure E.8: Total Nitrogen for Transitional Waters

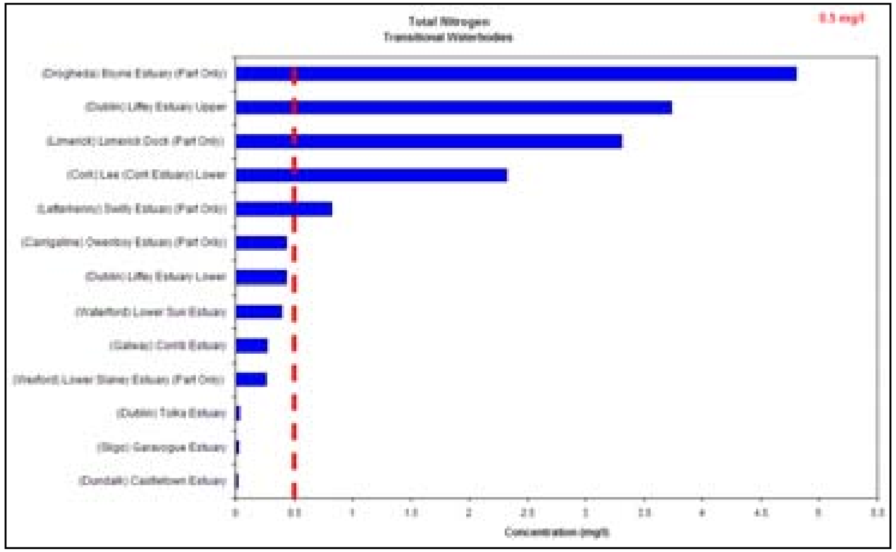


Figure E.9: Total Kjeldahl Nitrogen for River Waters

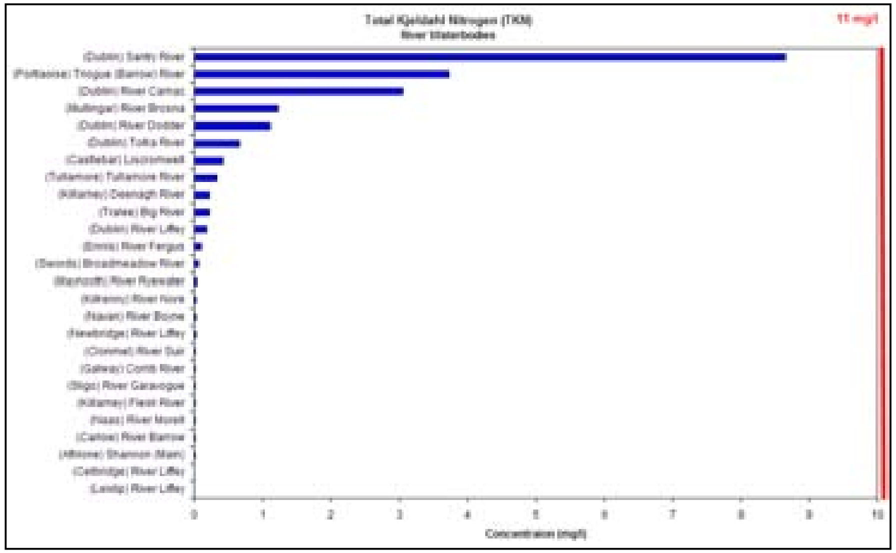


Figure E.10: Total Kjeldahl Nitrogen for Transitional Waters

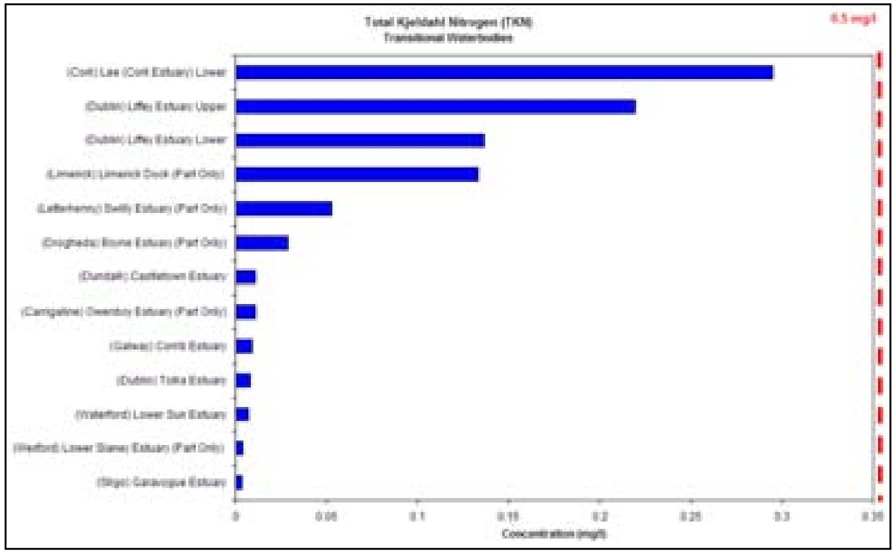


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Figure E.11: Total Phosphorous for River Waters

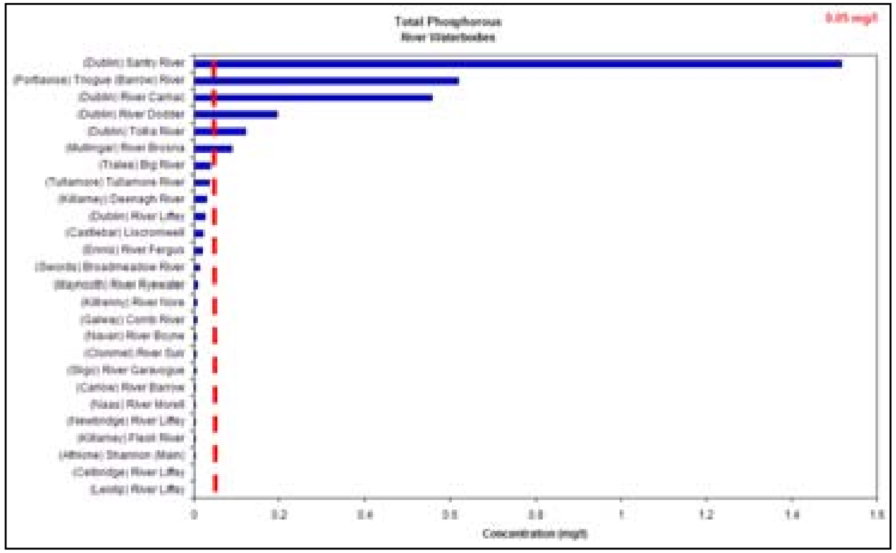

Figure E.12: Total Phosphorous for Transitional Waters

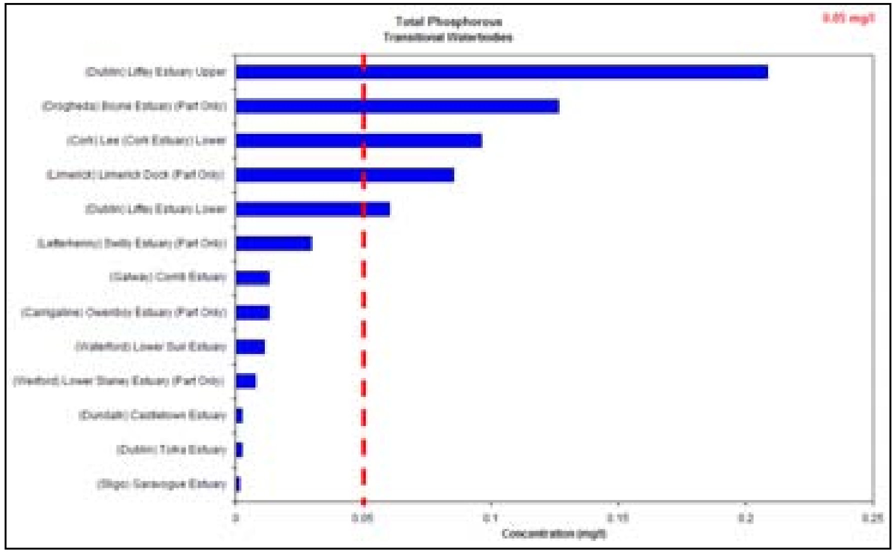

Figure E.13: Ortho-phosphate for River Waters

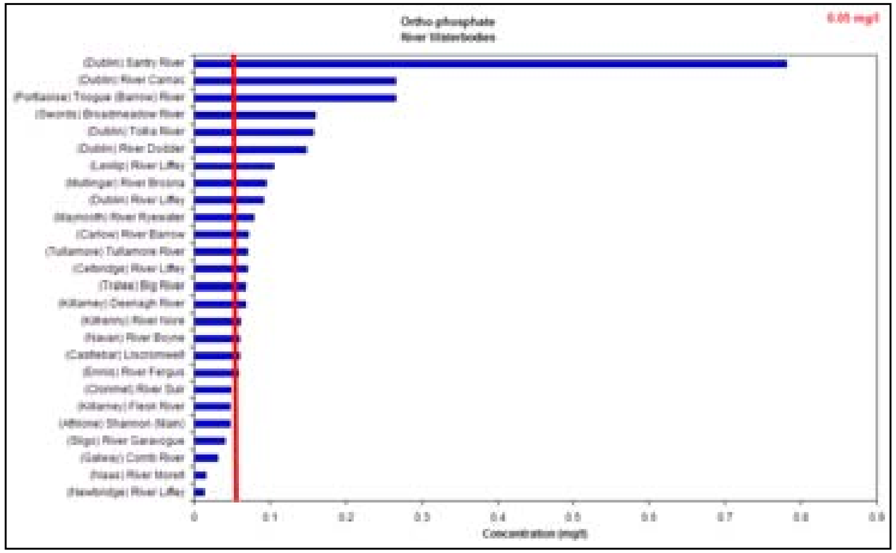

Figure E.14: Ortho-phosphate for Transitional Waters

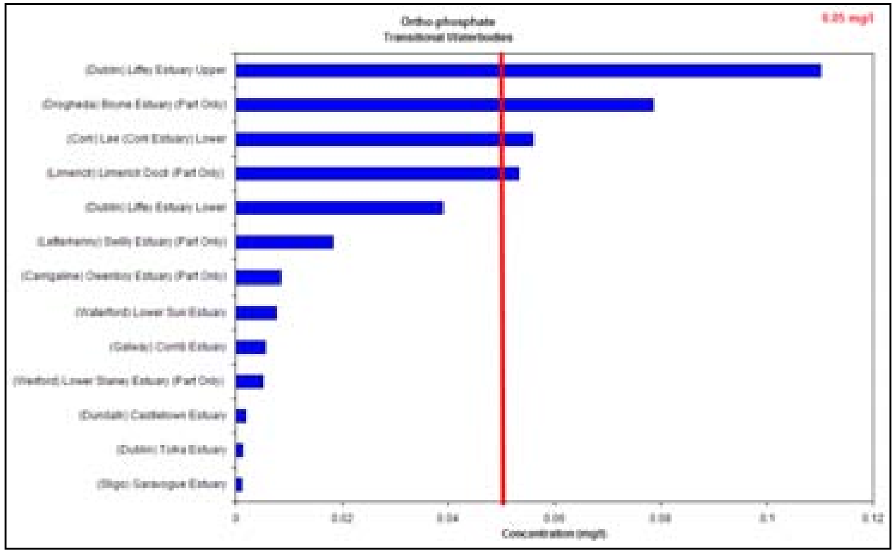

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Figure E.15: Cadmium for River Waters

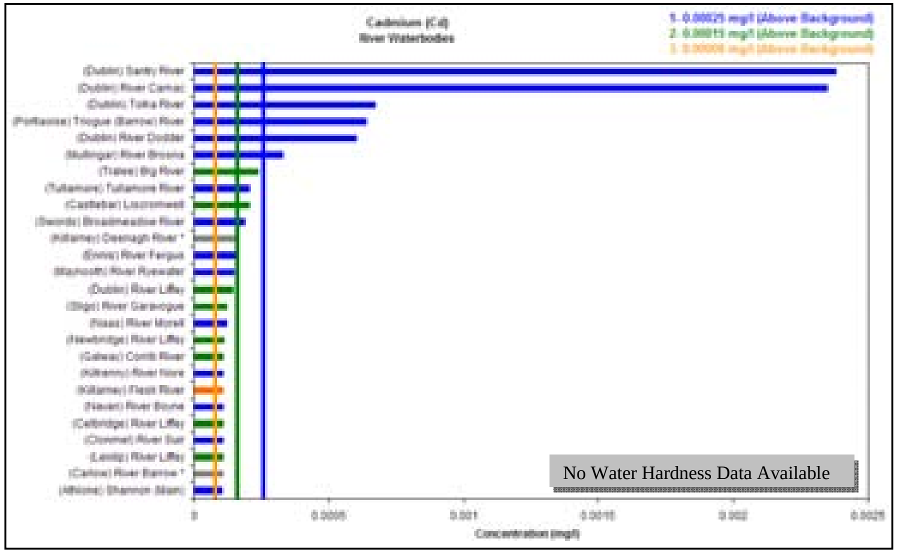

Figure E.16: Cadmium for Transitional Waters

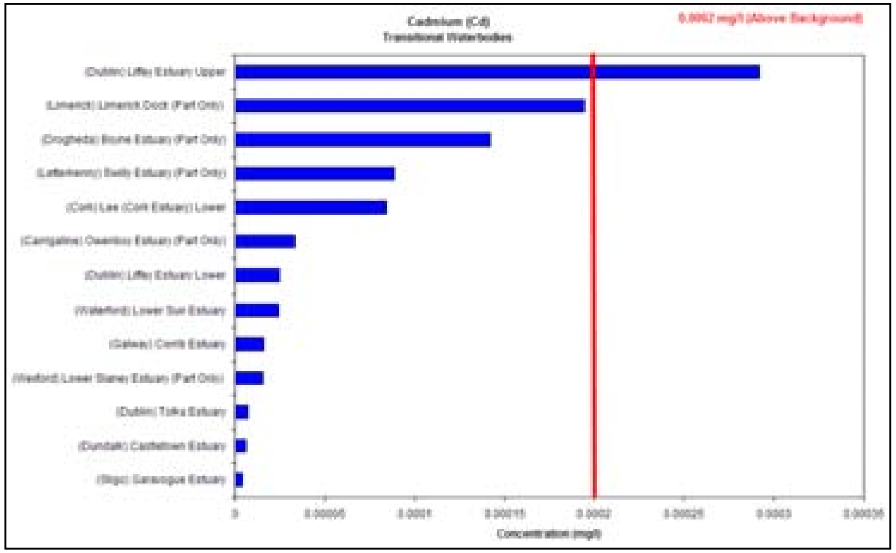

Figure E.17: Chromium for River Waters

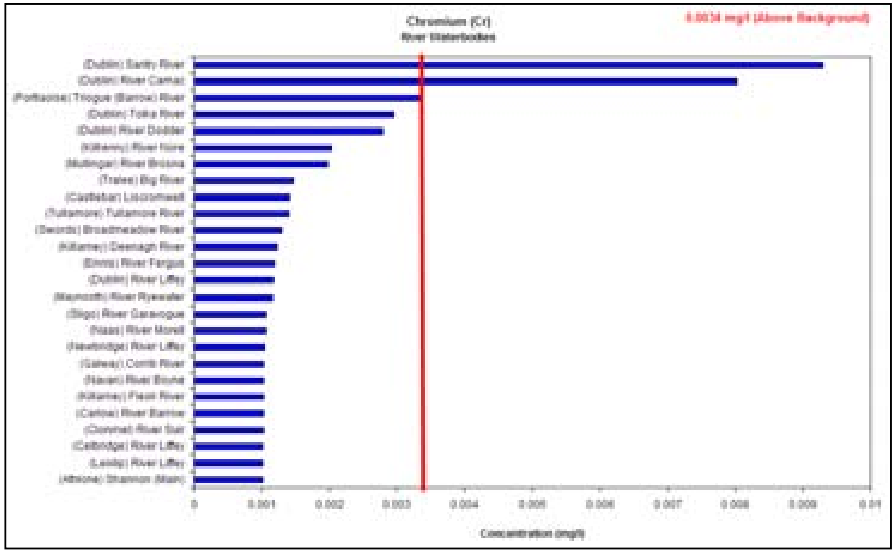

Figure E.18: Chromium for Transitional Waters

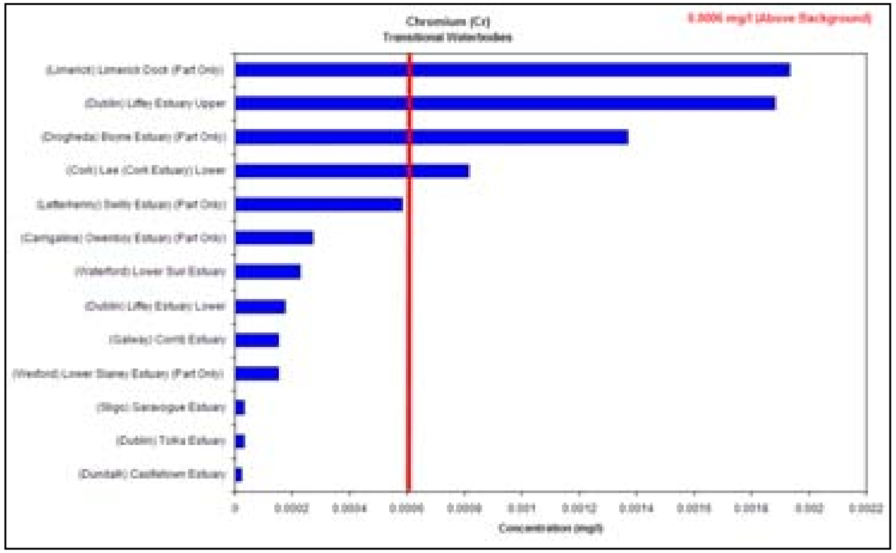

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Figure E.19: Copper for River Waters

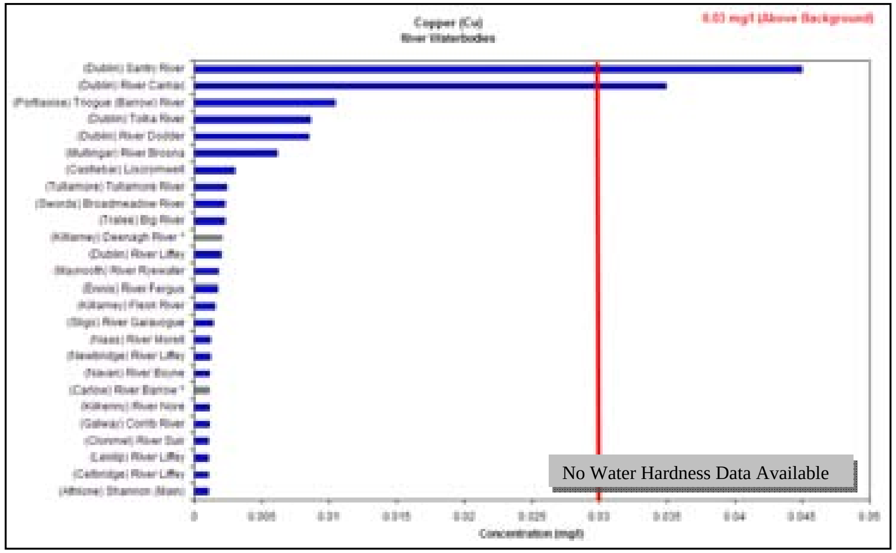

Figure E.20: Copper for Transitional Waters

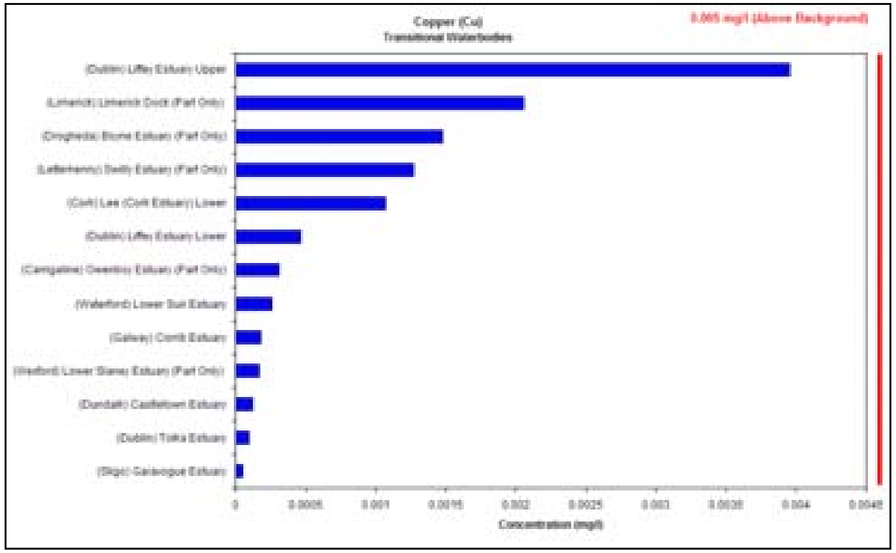

Figure E.21: Iron for River Waters

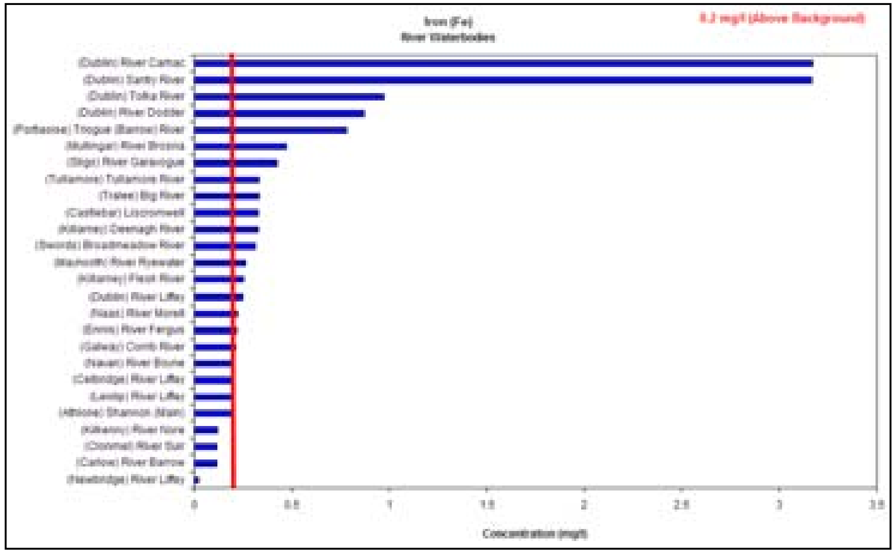

Figure E.22: Iron for Transitional Waters

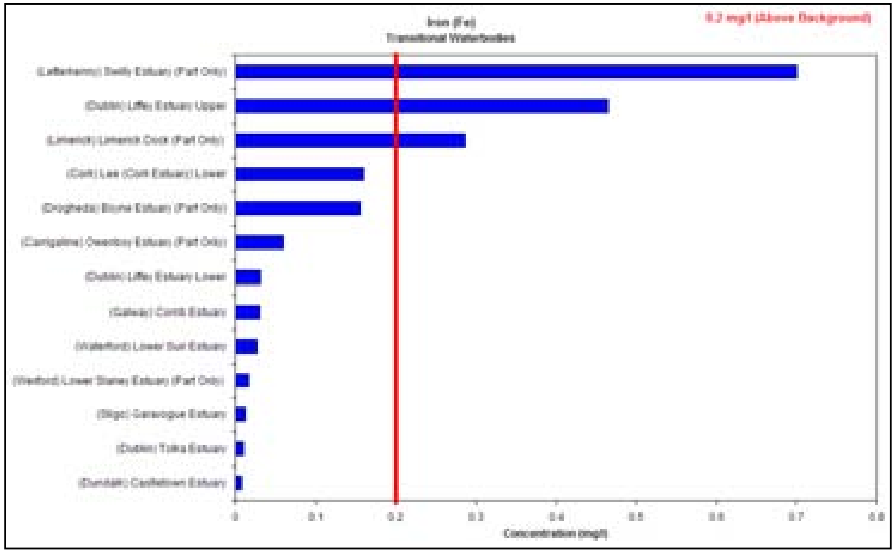

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Figure E.23: Lead for River Waters

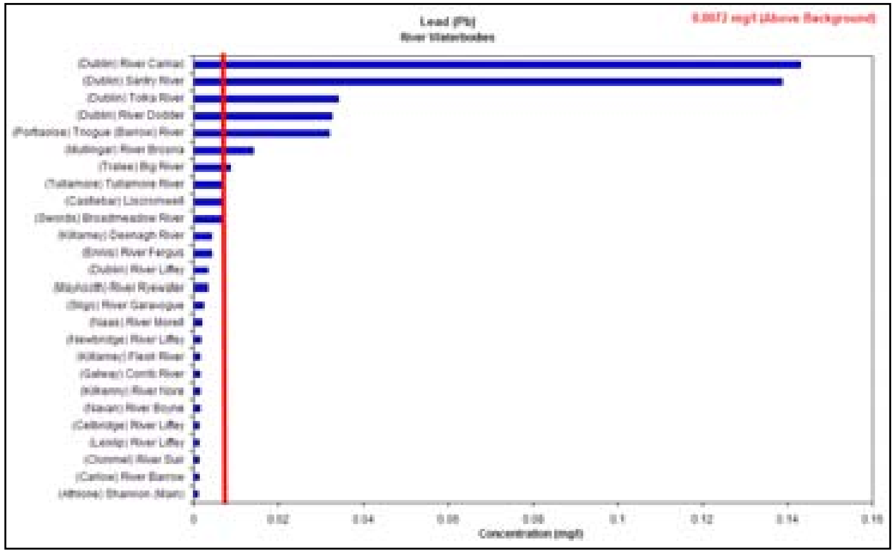

Figure E.24: Lead for Transitional Waters

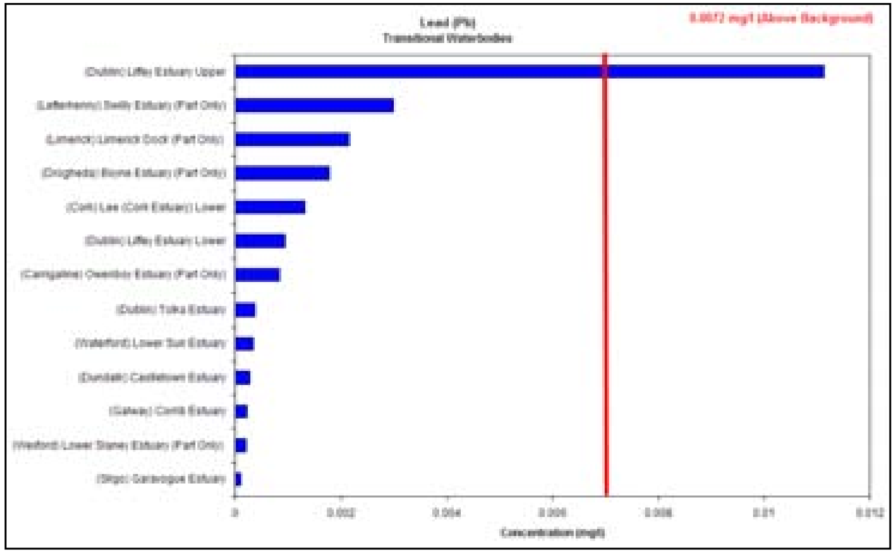

Figure E.25: Mercury for River Waters

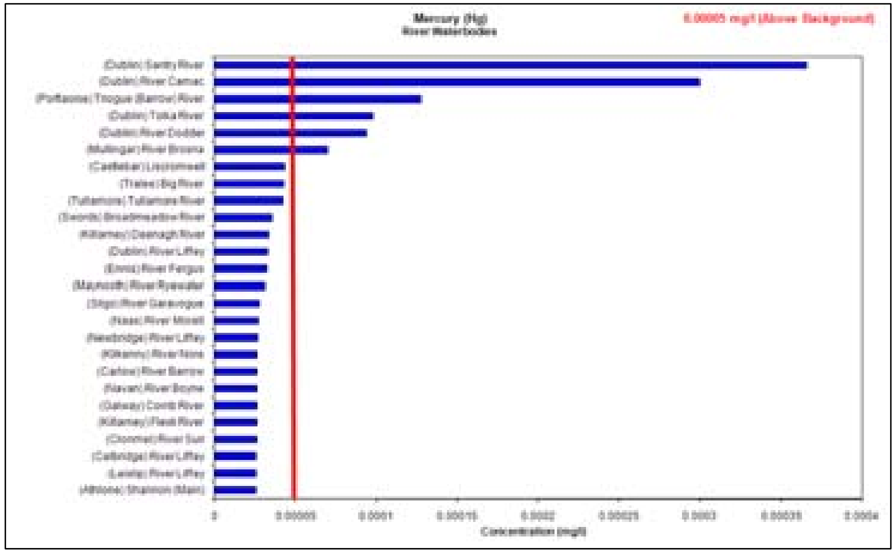

Figure E.26: Mercury for Transitional Waters

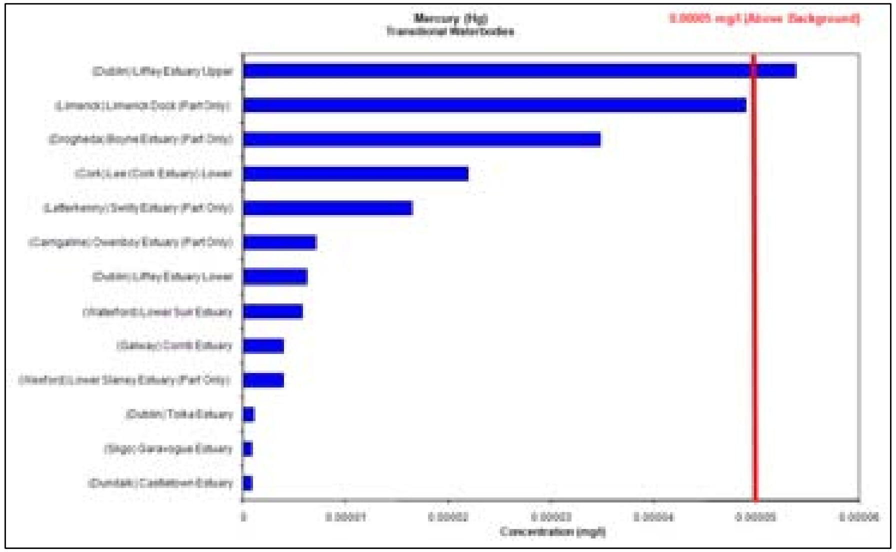

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Figure E.27: Nickel for River Waters

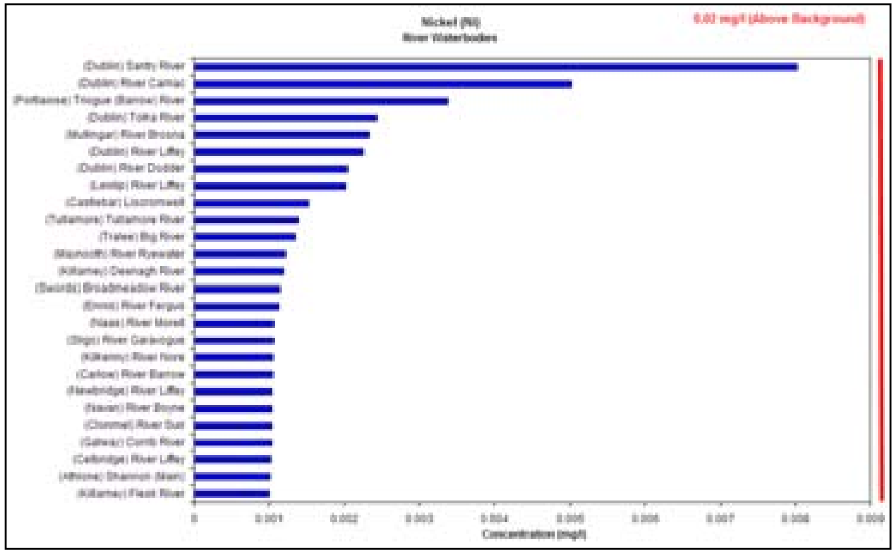


Figure E.28: Nickel for Transitional Waters

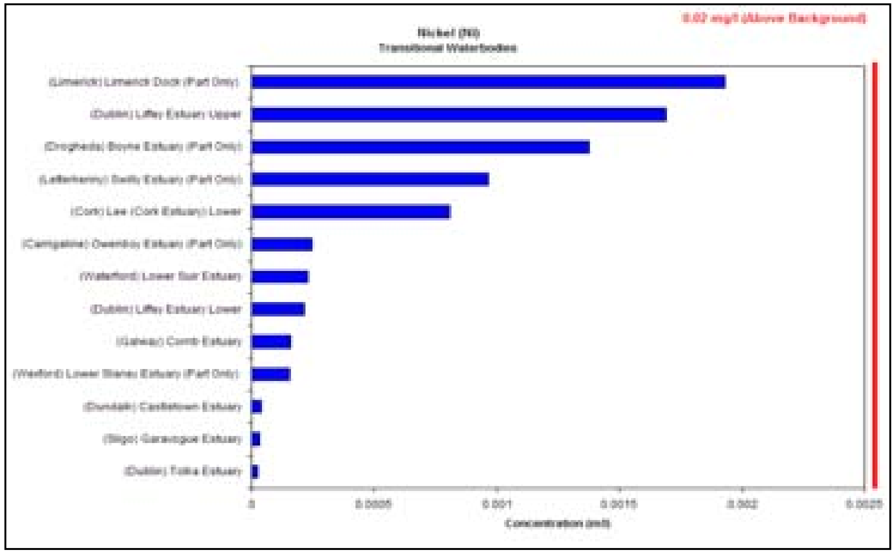


Figure E.29: Zinc for River Waters

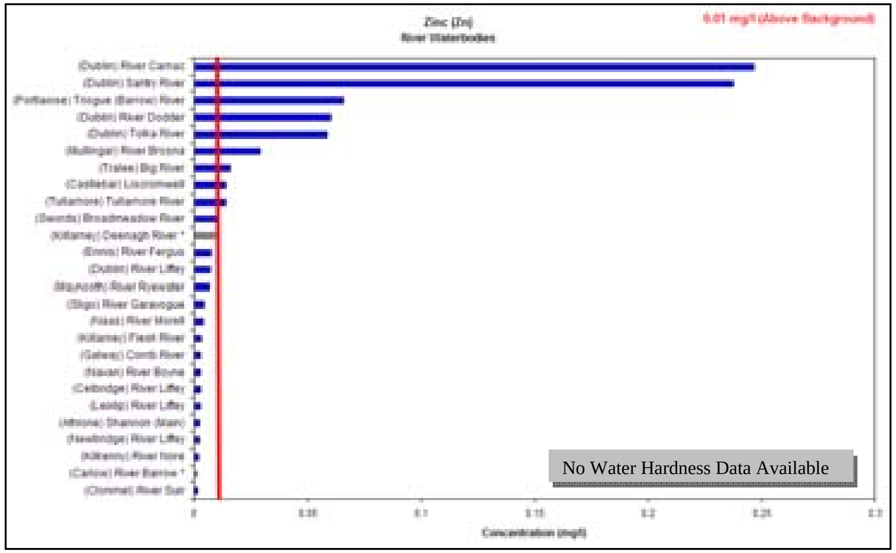
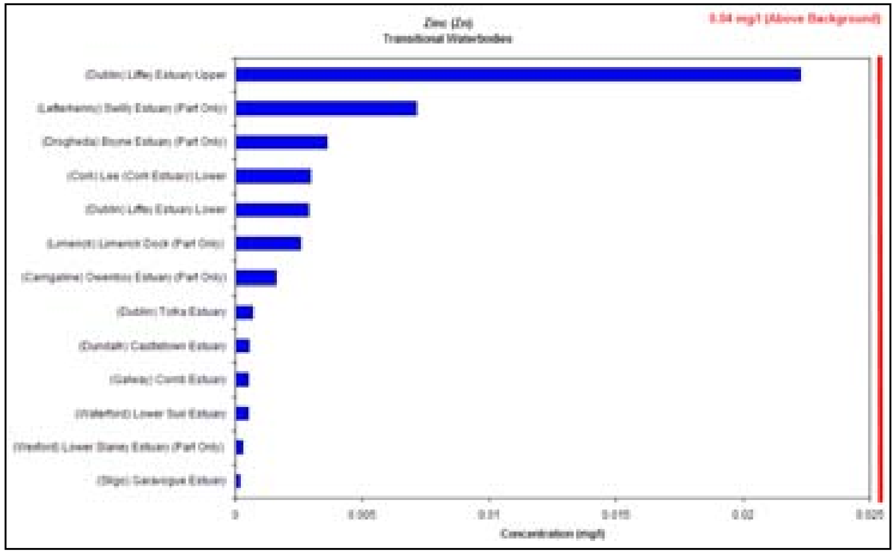


Figure E.30: Zinc for Transitional Waters



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E4: Main Recommendations

The urban pressures surface waters study of rivers and transitional waters in Ireland has generated an extensive list of issues that will require resolution. Given the extensive nature of this study such an outcome was to be expected. Many of the problems/issues highlighted by this study will be addressed in part (or are currently being addressed) as the implementation of the WFD progresses. For example;

- The significant lack of urban surface water quality data that was encountered on this study will be addressed in part as the EPA continue to roll out and implement in full their water quality Surveillance Monitoring Programme.
- The lack of bathymetric data for the urban transitional waters may be fully overcome as a result of the coastal Light Detection and Ranging (LIDAR) project currently being undertaken.
- The EPA planned network of national tidal gauges for transitional waterbodies.
- The full implementation of current EU Directives via the Urban Waste Water Treatment Regulations and the Dangerous Substances Regulations etc.
- The EPA programme to improve and enhance the national hydrometric network for flow recording in rivers.
- The introduction of the national LIMS database and EDEN projects.
- The implementation of the Waste Water Discharge (Authorisation) Regulations 2007.

However, even with these implementation advances there will still remain many additional issues (see Table 5.1 in Section 5) which will need addressing if there is to be a greater and more detailed understanding of urban pressure impacts on surface waters in Ireland.

Therefore at this stage the main recommendations of this report are as follows;

Need for further studies – water quality and flow studies.

- Consider the need to increase the number of atmospheric monitoring stations nationally and to widen the suite of parameters tested at these stations.
- Consider the need to undertake pilot studies to convert atmospheric monitoring concentrations into atmospheric deposition loadings to land.
- Consider the need for the development of a CSO parameter based discharge effluent water quality characteristics table for Irish CSOs.
- Consider the need for the development of an Event Mean Concentration (EMC) database for water quality concentration surface water runoff values from Irish landuse types.
- Consider the need to develop water quality concentration data for influents into Irish WWTPs.

- Consider the need to develop water quality concentration data for effluents from Irish WWTPs.

- Initiate a special study to quantify the migration of parameters of interest from rivers into adjacent groundwaters and vice versa.

- Establish background water quality levels in urban waters for the parameters of interest to this study

- Embark on a series of detailed pilot studies for a number of urban waters, specifically those most likely to be impacting ecological status including the Santry, Camac, Dodder, Tolka, Brosna, and Triogue urban rivers and the Dublin Liffey Estuary Upper and the Letterkenny – Swilly transitional urban waters.

Rationalisation/standardisation of technical guidance procedures.

- Standardise the procedures/technical guidance for undertaking sewer network modelling – model build, verification/calibration and optioneering/solutions development.

- Introduce the need for annual time series modelling analysis for all sewer network modelling studies.

- Complete the main drainage programme (including sewer network modelling) nationally for the remainder of the 33 study urban areas where no models currently exist.

- Standardise the procedures for the development and reporting of development plans and introduce standardised landuse/zoning classifications.

Rationalisation/standardisation of the guidance documents for reporting.

- Standardise the final reporting for sewer network modelling studies.

Comprehensive implementation of existing Policies and Regulations.

- Finalise the chemical water quality standards for the parameters of interest to this study

- Continue with the rollout of the main drainage upgrade programme.

- Review the implementation of IPPC Licencing in accordance with the findings of this report – flow and quality – so that annual cumulative discharge loadings can be calculated by licencee.

Greater use of information management and information management systems integration.

- Gather specific data from pilot catchments to assist in the process of calibrating and sensitivity testing the surrogate data adopted for this study.

Integrated knowledge sharing between Government bodies.

- Consider the need to retrofit controls for the collection/treatment of urban surface water diffuse discharges prior to discharge into highly urbanized streams – for example improved drainage systems such as Sustainable Drainage Systems (SuDS) solutions etc.
- Consider the gradual introduction of Sustainable Drainage Systems (SuDS) solutions on new build developments.

Generation of comprehensive datasets – mapping, river/flows etc.

- Implement detailed effluent monitoring – flow and quality – for all IPPCs so as to be able to calculate cumulative annual discharge loadings to the environment.
- Wherever feasible consider adopting lower detection limits for analysis of metals so that the concentrations in surface waters can be more accurately quantified.
- Consider the need to extend WFD water quality sampling monitoring programmes to include sites specific to the urban surface waters, particularly at the upstream boundary of the urban area catchment so as to facilitate more detailed estimation of incoming loads from upstream.

Additional monitoring –flow/quality

- Consider the installation of hydrometric flow sites specific to the urban surface waters, particularly at the upstream boundary of the urban area catchment so as to facilitate more detailed estimation of incoming loads from upstream and to facilitate the assimilative capacity impact assessments for the urban river waterbodies.
- Introduction of protocols between Government/Statutory bodies regarding the standardisation of electronic datasets and the subsequent sharing/exchange of such datsets between Departments.
- Consider re-running the methodologies presented in this report at key future intervals when updated datsets become available.

To ensure compliance with the reporting requirements of the WFD River Basin Plan each of the above recommendations will have to be classified at some stage in the future as Measures – Basic Measures or Supplementary Measures - in accordance with the current understanding of the Key Legislation requirements specific to Ireland as detailed in the Key Legislation Table located in advance of this Executive Summary.

We recommend that the extensive list of recommendations detailed in this report (which may ultimately form part of the Programmes of Measures to be defined for the River Basin Districts) should be implemented in phased stages. The completion of each stage or group of stages should be followed by a post project appraisal. This staged approach will enable the cumulative benefits of the implemented recommendations to be assessed at key intervals thereby allowing for a future change in Programme of Measures implementation strategy should this be necessary.

1 Introduction

The Water Framework Directive (WFD) (2000/60/EC) was published by the European Union on 22nd Dec 2000 and transposed into Irish Law by SI No 722 OF 2003. The key objective of the Water Framework Directive (WFD) is to establish good ecological status in all surface waters and good chemical status and sustainable quantitative status in all groundwaters throughout the European Union. Furthermore the WFD stipulates that a river basin management plan must be prepared for each river basin. The first such plans must be finalized and delivered to Europe by the end of 2009. Each river basin management plan is required to be accompanied by a comprehensive Programme of Measures which will be required to ensure that the WFD key objectives are achieved by 2015.

During 2002 – 2004 the DEHLG appointed consultants to undertake river basin projects across Ireland. Since then the DEHLG and the consultants have been working towards the preparation of the river basin management plans. As part of the overall WFD each country was obliged to undertake an initial characterisation for each river basin and report the findings in a submission to Europe by 2005. The purpose was primarily to report on the conditions of the waters and the likelihood of achieving the objectives of the Water Framework Directive. The initial submission also outlined the gaps in data and knowledge that would have to be addressed. The initial submission was called "The initial characterisation" as requested under Article 5.

The Republic of Ireland made their Initial Characterisation submission to Europe in March 2005. As part of the initial characterisation submission a significant number of waterbodies across the country were individually defined, and characterised into types according to their physical and other attributes. In addition, the likely dominant pressures and impacts on all of these individual waterbodies were identified as part of the same submission.

The ''Initial Characterisation of Risk WFD Article V Report'' included several risk assessment tests that either wholly or largely describe risk to surface waters from a wide range of activities in urban areas.

- For rivers, the risk tests essentially considered pollutants as individual point sources, without considering their composite effect or without factoring in the potentially widespread impacts posed by urbanisation. The exception was a "general diffuse" test, which includes a threshold for percent of urban area in a watershed, but does not allow for differentiation of actual or site-specific pressures on the basis of human activities, or the extent and state of local infrastructure.

- In transitional waters, the diffuse tests require impact data, and thus integrate the effects of multiple pollution sources. However, only limited impact data were available to make evaluations - for instance in the Eastern River Basin District's transitional waters, no impact data was available for hazardous substances, and only 4 of the 13 waters had eutrophication related data. The point source assessments in transitional waters are the same as those in rivers and therefore also do not consider composite effects of pollution.

Even with these limitations, the data that were compiled to complete the risk assessments formed a reasonable foundation on which an understanding of integrated urban pressures to surface waters could begin to be built. Although data gaps did exist, particularly for CSOs,

it was acknowledged that additional work was needed to understand the urban pollution sources/pressures so as to build an integrated urban pollution assessment.

Whilst it was known that urban areas pose a risk of pollution to surface waters, the actual assessment of the risk is complex because of the myriad of potential pollution sources. In an urban setting, it can often be complicated to develop an understanding of the cumulative risk that these many sources pose to a water body, while at the same time determining the contribution to the cumulative risk assessment that is attributable to individual (or types of) pollution sources.

A detailed understanding of the risks associated with individual pollution sources is fundamental for the development of a programme of measures to remedy such pollution sources. Equally, the assimilative capacity of the receiving water body also needs to be determined to ensure that a rational and cost effective programme of measures can be derived. In response to the identified need for additional work, to assess both the urban pressures and an integrated assessment of urban pollution CDM were approached in the summer of 2005 to undertake an urban pressures study. The urban pressures study was commissioned by the DEHLG following a detailed submission from CDM (our Ref 39325\ERBD\10\DG06) in December 2005. Following approval the project commenced in February 2006 with a projected 18 - month schedule.

The scope of the urban pressures study entailed assessing risks for the 33 largest urban areas nationally (see Figure E.1). Urban areas were selected where the population exceeded 10,000 as per the 2002 Census figures.

There were two distinct parts to the urban pressures study; namely an assessment of impacts on surface waters including both rivers and transitional waters, plus a further assessment for ground waters. The requirements for each part of the study were significantly different as was the study programme for both. To overcome these differences the urban pressures study was implemented in two parallel stages – surface waters and groundwaters. This report deals specifically with the surface waters part of the project.

2 Scope and Objectives

2.1 Scope

The original scope for the project was detailed in the CDM December 2005 proposal document (our Ref 39325\ERBD\10\DG06). The original scope was discussed during the first and second Project Steering Group (PSG) meetings in early/mid 2006. Based upon the early findings of the study, including non availability of the reports/data that had been proposed for use within the original scope, an updated version of the scope was prepared under the guidance of the PSG. The updated version of the scope, detailed in the document titled – ''Urban Pressures Pos Paper'', Ref 39325\UP40\DG01, was presented to and subsequently signed off by the PSG at the 3rd PSG meeting of 4th Oct 2006. This report is based fully upon the requirements of the updated version of the scope (hereinafter referred to as - The Scope).

In essence The Scope of the study involves obtaining a macro overview of current (and possibly future) water quality status in river and transitional surface waters within urban areas using a consistent cumulative assessment methodology which does not involve an extensive period of study for each surface water. This cumulative assessment highlights:

- The type, nature and scale of the individual urban pressures affecting the urban surface waters.
- Whether (and for what parameters) urban pressures impair ecological status, as measured through compliance with supplied chemical water quality standards.
- An initial and inter-comparative understanding of the magnitude of impairment.

Equipped with this information it will then be possible to assist in prioritising urban areas and measures within each urban area for Programmes of Measures and future capital expenditures that will be needed in some urban areas to meet the Water Framework Directive requirements of good ecological status.

To address the question of ecological health in the waterbodies, the parameters that need to be considered are those that reduce dissolved oxygen, drive eutrophication, are toxic, or bio accumulate. There are many sources of these parameters in urban areas, and thus, the only way effective (and cost effective) decisions can be made about a Programme of Measures to remedy pollution is to:

- Understand which of the sources are significant generators of problematic parameters
- Consider if the cumulative loadings from these parameters results in an unacceptable impact

The Scope included assessing nutrient parameters plus up to 10 dangerous substances. The final list for assessment was to be developed in conjunction with the PSG during the early stages of the project.

The urban areas to be assessed as part of the study were selected on the basis of legally defined boundary/ development limits. Those urban areas with a population in excess of 10,000 were selected for study. The populations were based upon the Census returns for the year 2002. The 33 study urban areas and associated 2002 census population values are listed below in Table 2.1. The locations of the 33 study urban areas in relation to the River Basin District catchments are shown on Figure 2.1.

Fundamentally, the urban pressures surface waters part of the study was scoped as a desktop study drawing upon outputs from both existing national datasets and reports. In addition there was a provision to include data from at least one major external combined sewer overflow (CSO) study which was planned to be implemented in parallel (though externally) to the urban pressures study. There was little provision within the urban pressures surface waters budget to undertake any substantial water quality sampling/monitoring or fieldwork.

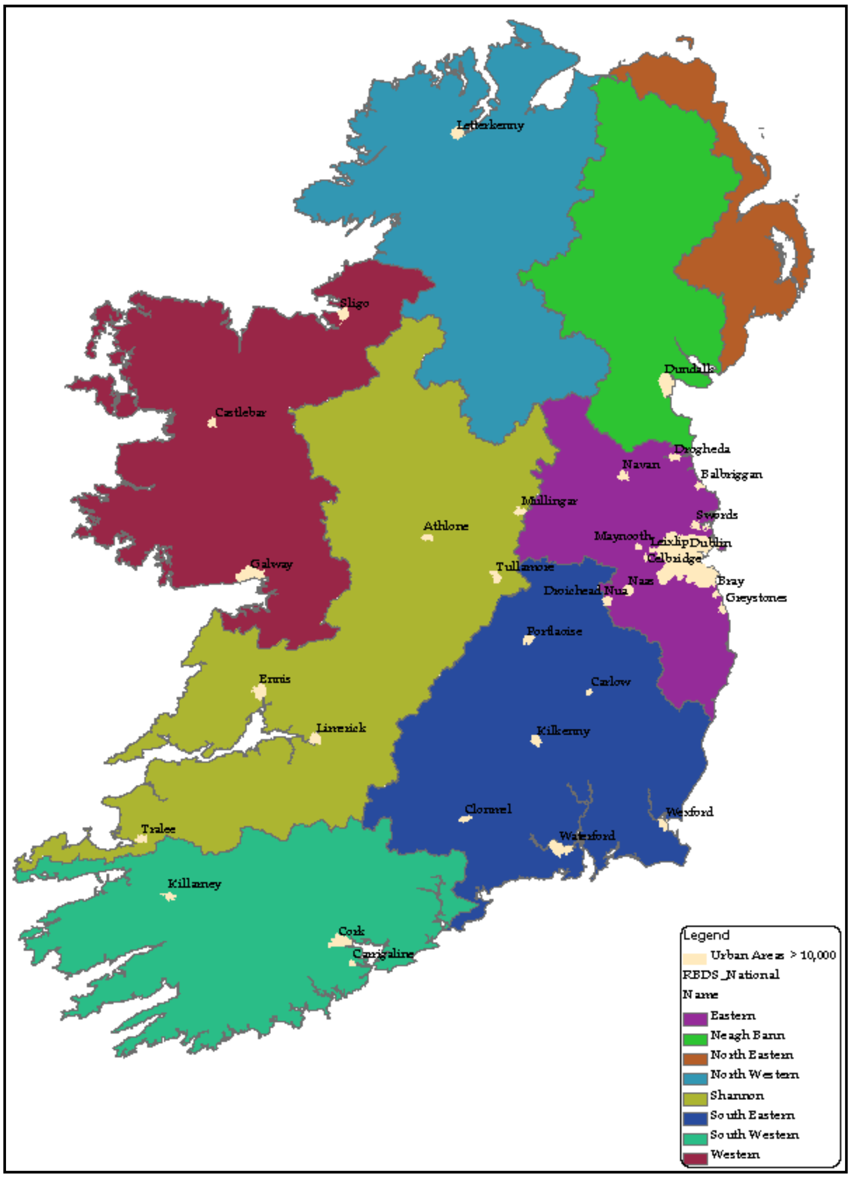
Table 2.1: Study Urban Areas

Urban Area/Town	Population 2002, Census
Greater Dublin Area	1,004,614
Cork City, Cork	186,239
Limerick City, Limerick	86,998
Galway City, Galway	66,163
Waterford City, Waterford	46,736
Dundalk Town, Louth	32,505
Drogheda Borough, Louth	31,020
Bray Town, Wicklow	30,951
Swords, Fingal	27,175
Ennis Town, Clare	22,051
Tralee Town, Kerry	21,987
Kilkenny Environs, Kilkenny	20,735
Sligo Borough, Sligo	19,735
Navan Environs, Meath (An Uaimh)	19,417
Carlow Town, Carlow	18,487
Naas Town, Kildare	18,288
Wexford Town, Wexford	17,235
Clonmel Town, Tipperary	16,910
Droichead Nua (formerly Newbridge), Kildare	16,739
Celbridge, Kildare	16,016
Athlone, Westmeath	15,936
Mullingar, Westmeath	15,621
Letterkinney, Donegal	15,231
Leixlip, Kildare	15,061
Malahide, Fingal	13,826
Killarney Town, Kerry	13,137
Portlaoighise	12,127
Greystones, Wicklow	11,913
Castlebar Town, Mayo	11,371
Carrigaline, Cork	11,191
Tullamore Town, Offaly	11,098
Balbriggan, Co. Dublin	10,294
Maynooth, Kildare	10,151

After the project started, an alternative and more robost methodology for assessing CSO hydraulic spill performance was proposed and adopted utilising the partly completed suite of hydraulic sewer models which had been prepared nationally over previous years. This alternative allowed for much better representation of CSO spills than would have been developed from the originally envisioned small scale fieldwork exercise.

Equally because of the limited quantity of sampled/monitored data in either the national datasets or the existing reports, for individual urban pressure types covering a number of parameters of interest to this study, cumulative annual loadings could not be estimated. To overcome this, an alternative methodology was adopted based upon the adoption of surrogate data from both the UK and Europe to represent a number of the urban pressure cumulative annual loadings.

Figure 2.1: Study Urban Area Catchment Locations Relative to RBD Catchments.



2.2 Objectives

Numerous objectives were defined within The Scope relating to surface waters;

- Gather missing data and improve data layers in the national GIS;
- Conduct additional analyses to characterise CSOs in Ireland;
- Develop an assessment methodology that considers ***assimilative*** capacity of the surface waters for the combined pollutant loads from urban areas including upstream catchment contributions.
- Reduce the uncertainty in the initial characterisation by addressing gaps that exist in the current understanding of urban pollution sources and pressures/impacts, including discharges from CSOs.
- Develop a better understanding of the causes and processes which contribute to the urban pressures.
- Obtain additional information about CSO operation in Irish urban areas and to develop criteria that address, in a macro level, the potential for these overflows to impact the ecological status of the receiving water as measured against chemical water quality standards.
- Develop a predictive urban assessment tool which can be used to nationally characterise urban surface waters, both river and transitional/estuarine, as either having sufficient or insufficient assimilative capacity for the pollutant loads from the urban area itself.
- Develop a ranking system that will be applied nationally to rank the individual urban pressure impacts in terms of severity thereby ensuring that the various River Basin Districts (RBDs) will be sufficiently informed so as to enable them to develop and prioritise suitable and appropriate Programmes of Measures (POMs).
- In GIS, improve existing pressure layers in as much detail as possible by including future plans for urban growth (e.g., roads, sewer systems) – e.g., through county development plans.
- In GIS, either document existing data or develop average daily tidal volume for WFD specified transitional waters (using associated defined boundaries) with CSOs
- GIS – Updated data layers and attribute tables on CSOs
- Estimates of CSO spill frequencies for urban areas
- Estimate likely impact potential from CSO spills

3 Project Methodology

3.1 Project Steering Group (PSG)

It was recognised at an early stage that the successful delivery of this project would depend upon significant engagement and interaction with key stakeholders, most of whom would be from the State Sector Agencies. This stakeholder engagement/interaction was required for many reasons such as:

- They are the custodians of many of the national datasets and reports that would be required to undertake the study.
- They are the repository for many other sources of data which may benefit the study.
- They have access to resources which could be harnessed to assist the study.
- They will be significantly affected by the implementation of the WFD.

Furthermore, it was also recognised that because of the complex technical issues surrounding this project, that additional technical support could be provided wherever possible to the project team via the appropriate State Sector Agencies.

For these two main reasons a PSG was set up from the outset of the project. The PSG provided technical guidance and advice, assisted in developing the overall approach and direction for the project, and ensured that any difficulties regarding the sourcing of national datasets and reports were resolved quickly. The original Steering Group was comprised of representatives from the following:

- Dublin City Council (Contracting Authority)
- Department of Environment Heritage and Local Government
- Kildare CoCo
- Kerry CoCo
- South West River Basin District Consultants
- Meath CoCo
- Kerry CoCo
- Wicklow CoCo
- Eastern River Basin District Project Manager
- Environmental Protection Agency
- Environment and Heritage Service (NI)
- Geological Survey of Ireland

- Trinity College Dublin
- Department of the Marine, Natural Resources and Communications

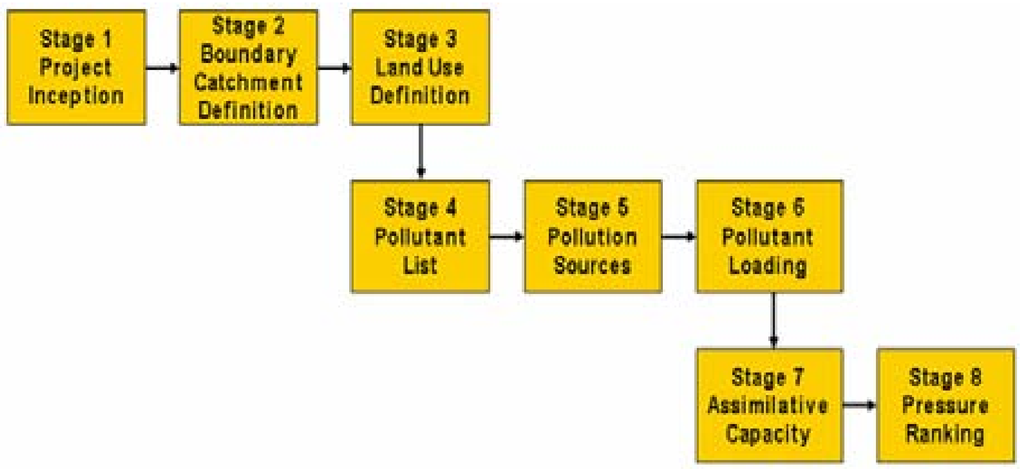
As the project progressed the attendance at the PSG meetings reduced. Overall however the PSG meetings were well attended and it should be acknowledged that the PSG members remained fully engaged in the process throughout and provided significant guidance, help and support throughout the project.

The final full PSG meeting for the project was held on Friday 12th December 2008.

3.2 Project Stages

From the outset a staged approach was adopted by the PSG for the implementation of the project. There were eight project stages in total as detailed in Figure 3.1.

Figure 3.1: Project Stages



Most stages of the project involved a period of detailed study and assessment followed by preparation of a technical report detailing the findings. Many technical reports were developed and presented to the PSG as the project progressed. It was agreed at the outset of the project that the technical reports would be presented and signed off by the PSG as the project progressed. The full list of issued technical reports is detailed in Appendix A.

It should be noted that this report makes many references to, and contains many extracts from, these previous technical reports. The reader should refer to these previous reports in the event that further clarification on technical aspects of this report or additional technical detail relating to the project methodology etc is required.

3.3 Stage 1 – Project Inception

The first stage of the study was implemented during the period March 06 to June 06. During this stage the PSG convened several times to discuss and agree the overall approach for the project. The PSG Terms of Reference were discussed at these early meetings as were the protocols and procedures for the management of project and any follow on project scope enhancements.

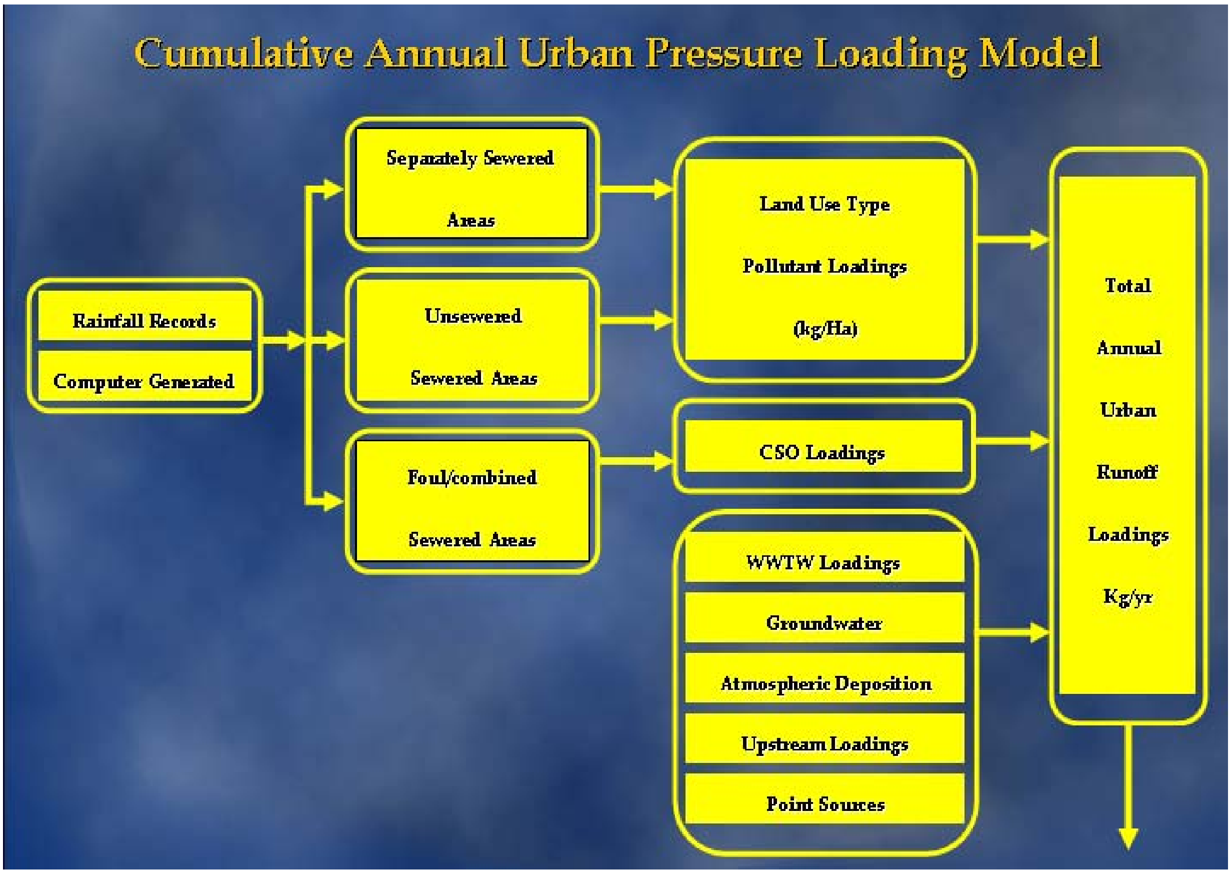
Details of the original project scope and objectives were revisited and updated during this period. The updated project scope and objectives remained largely unchanged from those contained in the November 2005 project proposal. However, due to issues including an acknowledged lack of progress in commissioning an external parallel project (to assess CSO performance) – the results of which were intended to be used as inputs to this study - revised methodologies and approaches had to be agreed to enable this project to proceed. The main revisions included:

- An agreement to have the existing hydraulic sewer network models for a large number of the urban areas rerun with an annual time series rainfall to obtain both CSO spill performance and catchment runoff data.
- Utilisation of County/Local Area Development Plans due to non availability of national aerial photography data coverage and unsuitability of Corine urban land cover data.
- ***An agreement to utilise surrogate data from the UK or Europe as appropriate in those instances where Irish based water quality data had gaps or did not exist or was not provided.***

A revised document titled - "Position Paper for Urban Pressures in Surface Waters and Ground Waters", Ref 39325/UP40/DG01 – S, June 06 was prepared to reflect the revised approach and subsequently signed off by the PSG at the PSG meeting of 4th October 2006.

The overall runoff/loading model that was adopted for the project is detailed in Figure 3.2. The various project stages which were necessary to support the full implementation of the project runoff/loading model are detailed in the remaining sections of this Chapter.

Figure 3.2: Urban Pressures Runoff / Loading Model

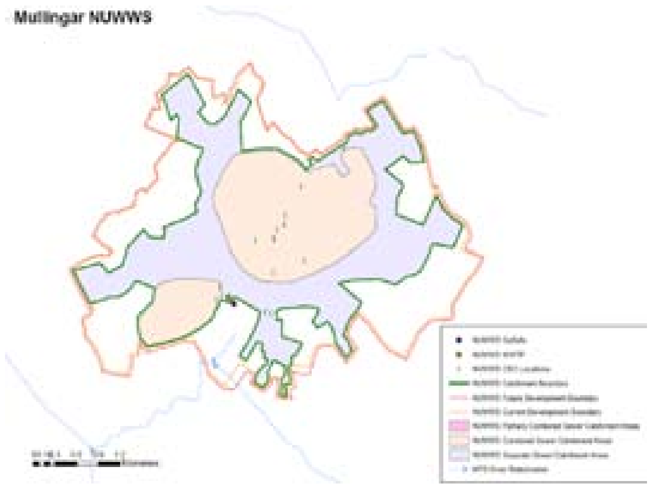


3.4 Stage 2 – Urban Area Boundary Catchment Definition

This stage of the project involved defining the catchment boundaries for the 33 study urban areas identified in Table 2.1. There were many potential data sources available with which to undertake this task including data from:

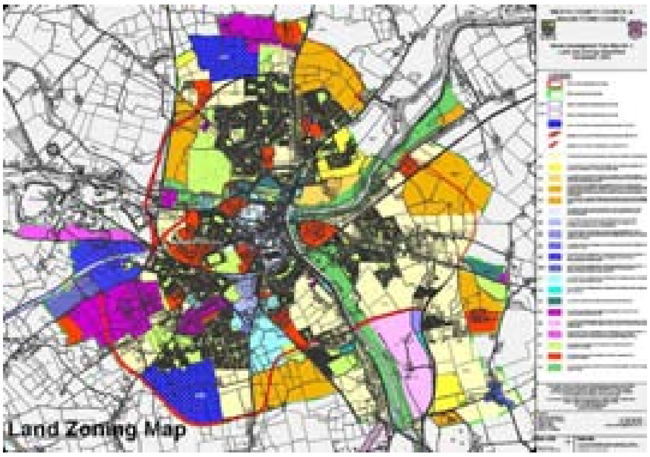
Aerial Photography

National Urban Waste Water Study

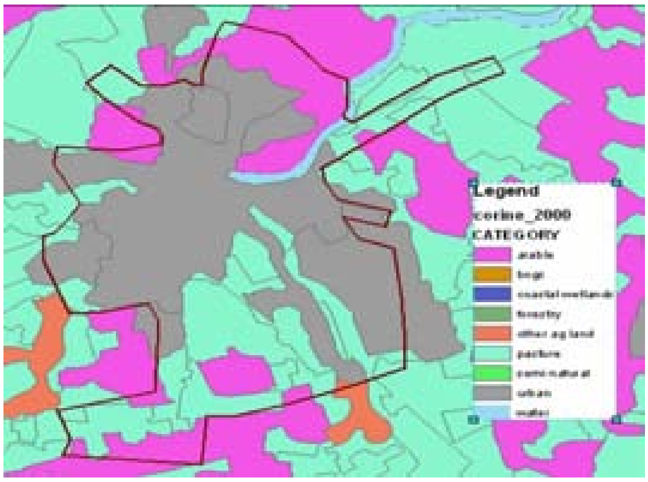


Greater Dublin Strategic Drainage Study

County / Local Development Plans (LADP)



CORINE Land use data



All of the datasets were assessed for use on the project. Many of the datasets were limited in their spatial coverage. For example aerial photography was not available outside of the ERBD catchment area whereas the Greater Dublin Strategic Drainage Study (GDSDS) data only applied to the Greater Dublin Area whilst the National Urban Wastewater Study (NUWWS) data did not cover the Dublin area.

Following discussions with the PSG, relating to the limitations of the various datasets, the decision was made to use the County/Local Area Development Plans for defining the urban study area catchment boundaries. The general consensus was that even though the County/Local Area Development Plans were not all presented to the same development horizon, this shortcoming would be more than offset by the fact that the County/Local Area Development Plans are:

- Prepared to a similar high level of detail/accuracy.
- Available for all 33 urban areas.
- Prepared to a reasonably common and consistently standardised format.

Details of the County/Local Area Development Plans that were collected and collated as part of this stage of the project are listed in Table 3.1.

Table 3.1: County / Local Area Development Plans

Urban Area	River Basin District	2002 Census Population	Current County / Local Area Development Plans	Total Area within Local Area Plan (Km²)
Greater Dublin Area	ERBD	1,004,614	Dublin City Development Plan 2005-2011	118.545
Cork City, Cork	SWRBD	186,239	Cork City Development Plan 2004	39.374
Limerick City, Limerick	SHANNON	86,998	Limerick City Development Plan 2004	20.257
Galway City, Galway	WRBD	66,163	Galway City Development Plan 2005-2011	50.544
Waterford City, Waterford	SERBD	46,736	Waterford City 2002 - 2008	?
Dundalk Town, Louth	NBRBD	32,505	Dundalk Development Plan 2003-2008	42.224
Drogheda Borough, Louth	ERBD	31,020	Drogheda Town Development Plan 2005-2011	13.366
Bray Town, Wicklow	ERBD	30,951	Bray Development Plan 2005-2011	?
Swords, Fingal	ERBD	27,175	Fingal Development Plan 2005-2011	11.848
Ennis Town, Clare	SHANNON	22,051	Ennis and Environs Development Plan 2003	30.029
Tralee Town, Kerry	SWRBD	21,987	Tralee Town Development Plan 2003	13.408
Kilkenny Environs, Kilkenny	SERBD	20,735	Kilkenny City and Environs Development Plan 2002	18.236
Sligo Borough, Sligo	WRBD	19,735	Sligo and Environs Development 2004-2010	21.474
Navan Environs, Meath	ERBD	19,417	Navan Development Plan 2003	15.137
Carlow Town, Carlow	SERBD	18,487	Carlow Town Local Development Plan 2003	?
Naas Town, Kildare	ERBD	18,288	Naas Town Council Development Plan 2005-2011	18.509
Wexford Town, Wexford	SERBD	17,235	Wexford Town and Environs Development Plan 2002	14.662
Clonmel Town, Tipperary	SERBD	16,910	South Tipperary County Development Plan 2003	?
Newbridge, Kildare	ERBD	16,739	Newbridge Local Area Plan 2002	14.059
Celbridge, Kildare	ERBD	16,016	Celbridge Development Plan 2002	?
Athlone, Westmeath	SHANNON	15,936	Athlone Development Development Plan 2002	14.454
Mullingar, Westmeath	ERBD	15,621	Westmeath County Development Plan 2002	13.792
Letterkenny, Donegal	NWRBD	15,231	Letterkenny Development Plan 2003 – 2009	?
Leixlip, Kildare	ERBD	15,061	Leixlip Local Area Plan 2002	7.253
Malahide, Fingal	ERBD	13,826	Fingal Development Plan 2005-2011	4.67
Killarney Town, Kerry	SWRBD	13,137	Kerry County Council Development Plan (Draft) 2003-2009	14.734
Portlaoise, Laois	ERBD	12,127	Portlaoise Local Area Plan 2006	?
Greystones, Wicklow	ERBD	11,913	Greystones Local Area Plan 2006-2011	9.718
Castlebar Town, Mayo	WRBD	11,371	Castlebar Development Plan 2004	12
Carrigaline, Cork	SWRBD	11,191	Cork County Development Plan 2003	5.594
Tullamore Town, Offaly	SHANNON	11,098	Tullamore and Environs Development Plan 2004-2010	15.89
Balbriggan, Co. Dublin	ERBD	10,294	Fingal Development Plan 2005-2011	8.95
Maynooth, Kildare	ERBD	10,151	Maynooth Development Plan 2002	6.979

The work undertaken as part of this stage of the study is detailed and reported in the document titled - "Urban Area Catchment Boundary Definition – Current and Future'', Ref 39325/UP40/DG18 – S, Nov 2006.

3.5 Stage 3 – Land Use Definition

This stage of the project involved the definition of the various land use types within the defined urban study catchments. The same data sources were used for this stage of the project as were used for Stage 2 referred to previously.

Following discussions with the PSG, relating to the limitations of the various datasets for defining land uses a decision was made to use the land use planning map from each of the County/Local Authority Development Plans to define the urban area land uses and types for this study. The general consensus was that although there was some variation in the defined land uses between the detailed land use classification/type maps contained within the various County/Local Authority Development Plans, this shortcoming would be more than offset for the same reasons as outlined in Section 3.4.

From a review of the land use plans which were supplied with the County/Local Authority Development Plans it was apparent that there was a wide variation in the classification/description of similar land uses between plans. A decision was made to develop a generic suite of land use descriptions which could be applied equally to represent the land uses for all urban areas.

Eventually ten generic land use classifications were proposed as detailed in Table 3.2. The selection of these ten generic land uses was partly influenced by:

- The definitions of land use which are commonly adopted for hydraulic sewer network and urban surface water runoff modelling
- The definitions of land use that are commonly used to undertake urban diffuse water quality loading runoff modelling using Event Mean Concentrations (EMCs).

Table 3.2: Standardised Generic Land Use Types

Standardised Generic Landuses
Residential
Open Space - Managed
Open space – Unmanaged
Town Centre
Commercial
Light Industrial
Heavy Industrial
Settlement/Whitelands
Mixed Use
Highways

An EMC describes the loading to a receiving water from stormwater runoff - The total mass load of a chemical yielded from a storm, divided by the total storm discharge.

EMCs can be used for most pollutants for different land uses and coupled with runoff volumes to generate a pollutant unit area runoff load in kg/ha/yr.

Each of the 33 urban study area land use maps was revisited and each of the specified land use types contained within was reclassified in turn as one of the ten standardised generic land use types. On completion of this exercise it was then possible to compare the urban areas using common land use definitions for both current and future proposed development horizons.

Following completion of this stage of the project a digital data layer was prepared for each of the 33 urban study areas containing the reclassified standardised generic land use types.

The work undertaken and the technical approach adopted for this stage of the project is detailed and reported in the document titled - "Land Use Reclassification Methodology", Ref 39325/UP40/DG19 – S, March 2007.

The results of this exercise are shown in tabular form on Table 3.3 for river surface waters and Table 3.4 for transitional surface waters. In addition, and to provide more clarity, the same data is presented in bar chart format in Figures 3.3 and 3.4.

3.6 Stage 4 – Derivation of Pollutant List

The 14 parameters to be assessed under the urban pressures study were defined during stage 4 of the project which is reported separately in the document titled - ''Pollutant List Methodology'', Ref. 39325/UP40/DG17, Final Rev 2, September 2006. These parameters are listed below in Table 3.5.

This urban pressures study considered the loadings of the parameters listed in Table 3.5 on the assimilative capacity of urban surface waters classed either as river or transitional surface waters.

This report sets out the methodology adopted to estimate the annual urban pollution loadings for each of the 14 parameters from each of the urban pressure source types discharging to the various selected surface waters within the 33 urban areas.

Table 3.5: Study Parameters

Study Parameters
Nitrates (NO3)
Nitrites (NO2)
Total N
Nitrogen (TKN)
Total Phosphorous
Ortho-phosphate
Cadmium, Cd
Chromium, Cr
Copper, Cu
Iron, Fe
Lead, Pb
Mercury, Hg
Nickel, Ni
Zinc, Zn

Table 3.3: Existing Catchment Land Use Areas (River surface waters)

EXISTING LAND USE AREA (HA)															
Urban Area	**Residential**	**Open space – Managed**	**Open space – Unmanaged**	**Town Centre**	**Commercial**	**Light Industrial**	**Heavy Industrial**	**Settlement / Whitelands**	**Mixed use**	**Highways**		**Rivers**	**Urban Roads**		**TOTAL**
(Athlone) Shannon (Main)	316.880	226.000		14.497	18.139	138.060			75.492				119.977		909.045
(Carlow) River Barrow	216.597	52.863		53.414		68.215			66.490				67.610		525.188
(Castlebar) Liscromwell	337.818	124.819		41.597	4.210	27.967			54.001				77.641		668.054
(Celbridge) River Liffey	215.019	252.465			9.546	9.884			26.735			7.240	24.233		545.123
(Clonmel) River Suir	376.342	235.647			47.940	0.004	30.177		93.160				75.135		858.405
(Ennis) River Fergus	891.351	480.676		69.241	54.402	38.477			62.280				190.719		1787.147
(Kilkenny) River Nore	457.423	593.562			47.915	88.772			88.564				130.467		1406.703
(Leixlip) River Liffey	160.433	290.848		9.097		53.160			31.594				34.089		579.221
(Maynooth) River Ryewater	152.754	305.687		32.251		2.490			75.983				35.657		604.823
(Mullingar) River Brosna	318.297	39.245	138.005	31.960	23.998	33.212			82.403				110.449		777.570
(Naas) River Morell	369.757	849.079		35.763	8.887	61.268			43.247	18.883		7.958	40.989		1435.830
(Navan) River Boyne	406.700	116.211	71.657	49.772		7.474	28.163		82.581				152.643		915.201
(Newbridge) River Liffey	264.775	424.432		43.455		41.008			24.044				57.172		854.885
(Portlaoise) Triogue (Barrow) River	458.138	128.690		51.159	16.464	120.400			76.728				68.082		919.661
(Swords) Broadmeadow River	332.729	99.861	1.744	53.513		223.057			91.827				153.587		956.317
(Tralee) Big River	514.187	224.490			8.428	99.755			107.728				69.926		1024.515
(Tullamore) Tullamore River	321.265	25.034	26.085		50.197	4.304	67.771		59.419				76.074		630.148
(Dublin) River Dodder	3222.714	1610.981	1204.075			176.291	0.092		415.322				1075.609		7705.084
(Dublin) River Camac	1485.652	2114.467	1528.512	61.876		1041.095	7.527		276.046				869.816		7384.991
(Dublin) River Liffey	1244.830	1212.862	1583.151	58.113		94.291			146.522				676.232		5016.001
(Dublin) Tolka River	1351.999	1697.769	294.010	47.265		1332.509			462.276				680.792		5866.620
(Dublin) Santry River	636.851	494.662	2.022			481.252	39.901		356.171				468.671		2479.530
(Galway) Corrib River	986.343	1607.977		33.154	132.942	226.447			279.450				284.891		3551.204
(Killarney) Deenagh River	136.404	17.073	448.148	1.991					29.849				6.996		640.461
(Killarney) Flesk River	277.738	12.217	233.859	3.575	6.889	16.993			2.341				1.922		555.534
(Sligo) River Garavogue	327.79	273.1166		36.723	12.821	5.179			97.677				154.021		907.328

Table 3.4: Existing Catchment Land Use Areas (Transitional surface waters)

EXISTING LAND USE AREA (HA)															
Urban Area	**Residential**	**Open space – Managed**	**Open space – Unmanaged**	**Town Centre**	**Commercial**	**Light Industrial**	**Heavy Industrial**	**Settlement / Whitelands**	**Mixed use**	**Highways**		**Rivers**	**Urban Roads**		**TOTAL**
(Carrigaline) Owenboy Estuary (Part Only)	311.355	22.758		6.812		21.684			13.203				40.984		416.796
(Cork) Lee (Cork Estuary) Lower	2068.052	622.418	101.239	0.884	112.098	114.131	59.448		183.487				327.783		3589.541
(Drogheda) Boyne Estuary (Part Only)	485.528	139.632	0.000	36.679		249.213			130.212				132.614		1173.878
(Dundalk) Castletown Estuary	834.034	684.210	126.903	52.901	5.291	85.733	6.108		818.635				365.767		2979.581
(Letterkenny) Swilly Estuary (Part Only)	627.688	137.495	236.178	37.730	34.943	281.685			180.338				84.355		1620.413
(Limerick) Limerick Dock (Part Only)	955.168	421.931			44.694	11.017			135.213				212.087		1780.110
(Waterford) Suir Estuary	685.166	1363.628	335.71	29.757		343.156			214.285			313.347	286.594		3571.643
(Wexford) Lower Slaney Estuary (Part Only)	351.230	350.925		66.081		55.068			78.860				55.111		957.275
(Dublin) Liffey Estuary Upper	3005.922	3563.775	3125.278	198.983		1141.276	20.690		582.168				1701.060		13339.152
(Dublin) Liffey Estuary Lower	6455.785	5278.496	4376.173	323.838		1390.157	282.0857		1210.499				3126.405		22443.439
(Dublin) Tolka Estuary	1987.981	2150.660	296.703	47.265		1341.312			596.662				947.377		7367.960
(Galway) Corrib Estuary	1181.640	1869.785		33.154	134.936	226.447			298.388				315.891		4060.241
(Sligo) Garavogue Estuary	541.286	392.647		53.000	65.484	143.304	23.834		235.552				259.206		1714.313

Figure 3.3: Existing Catchment Land Use Areas (River Waters)

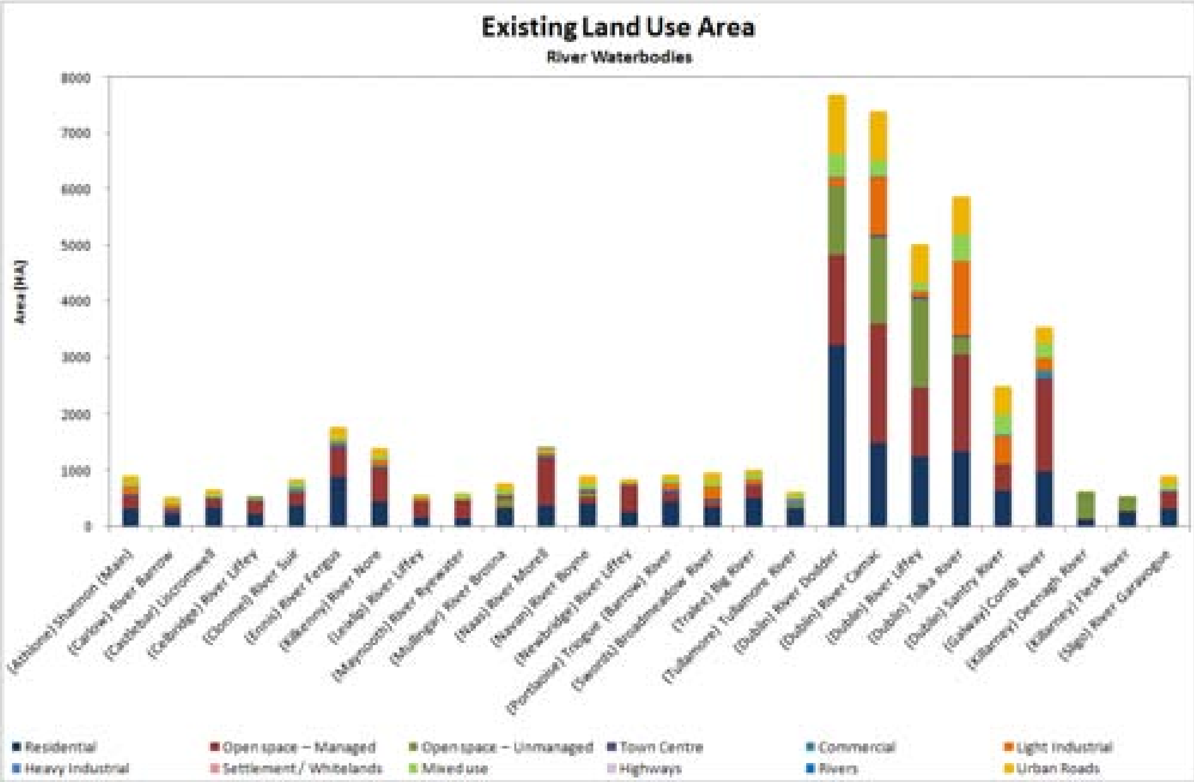
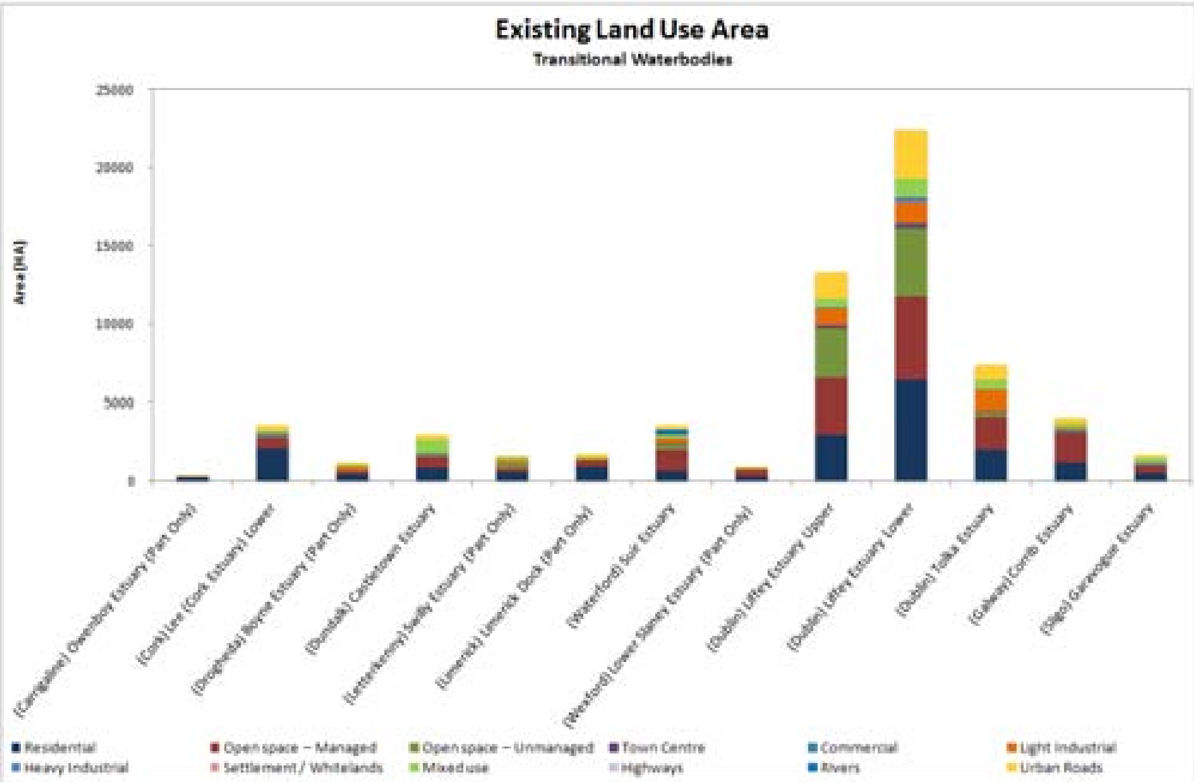


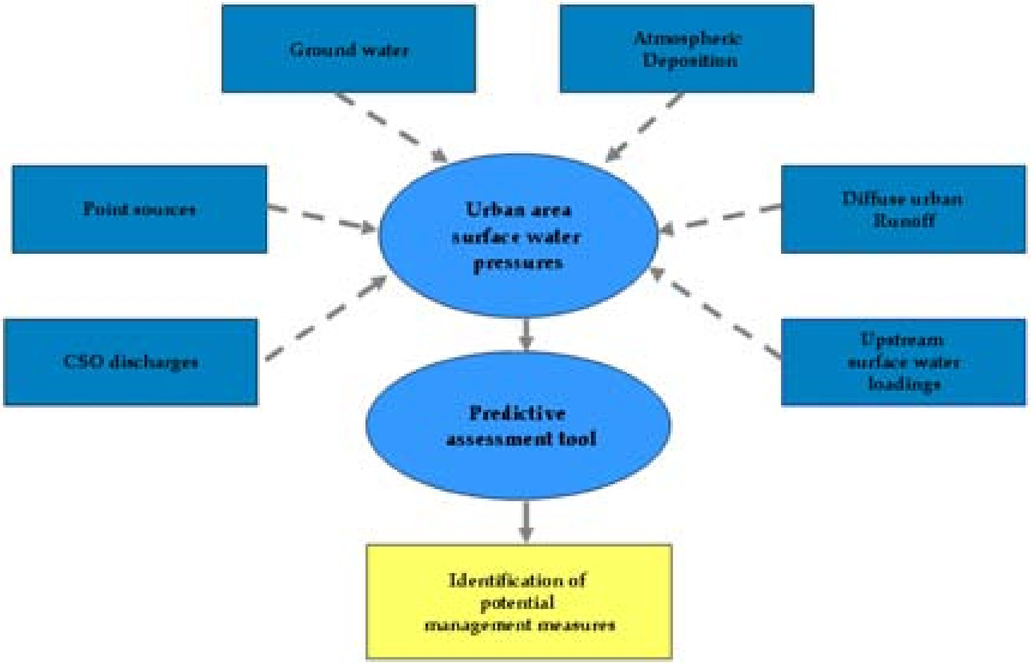
Figure 3.4: Existing Catchment Land Use Areas (Transitional Waters)



3.7 Stage 5 – Selection of Urban Pressures

Under stage 5 of the project the individual urban pressures to be assessed were identified. In discussion with the PSG it was established that an initial attempt should be made to assess the seven most potentially significant urban pressure types. It was recognised by the PSG at that time that existing data limitations could lead to a reduction in the number of urban pressure types ultimately assessed. The seven defined urban pressure types are outlined in Figure 3.5.

Figure 3.5: Potentially Significant Urban Pressure Types



3.8 Stage 6 – Estimation of Urban Pressure Loadings

Seven distinct urban pressure types were identified at the outset of the project. This stage of the study involved collating and assessing available national datasets and wherever possible converting this data into a number of loading matrices, one loading matrix for each of the seven urban pressure types. Each loading matrix represents the annual cumulative loading (kg/yr) entering each of the study urban surface waters corresponding to each of the 14 study parameters.

The procedures adopted to derive the various loading matrices are detailed in the following sub sections. It should be noted however that due to the variability of national datasets combined with a number of fundamental gaps in the data it was not possible to produce a loading matrix for each of the seven urban pressure types. In particular it was not possible to produce loading matrices for either the Point Source or the Ground water urban pressure types. This issue will be discussed further in the following sections.

3.8.1 CSO Discharge Pressures

The WFD Article V characterisation of combined sewer and (foul sewer) pump station overflows was based solely on frequency of overflow. However the frequency of overflow information utilised for that exercise was typically based upon assumed or anecdotal information relating to CSO spill performance. In fact, the application of the risk assessment on a national level indicated that 70% of the river segments with CSOs had an unknown spill frequency.

The assumed or anectdotal CSO information was used for risk classification of rivers. The ***outcome of that exercise was that less than 1% of the river segments nationwide*** were classified as being ***"at risk" from CSO discharges***. Therefore it was recognised that ***additional study was necessary because of both this uncertainty combined with the very high cost typically associated with the likely Programme of Measures for CSO upgrade programmes.***

Without this further information it is possible that CSO upgrade measures would be over-prescribed if the CSO overflows, though more frequent, did not impact the ecological status of the receiving water.

Whilst it is recognised that nationwide consideration of CSOs requires developing some basic data, including location of all of the overflows and a frequency of spill for each one, it was acknowledged that more comprehensive analysis requiring a good understanding of the individual network layouts and data on spill quantity (if not also quality) of spills for each individual CSO would not be possible. To undertake such an exercise nationally would involve significant financial costs. We believe however that with time the comprehensive implementation of the Waste Water Discharge (Authorisation) Regulations – 2007 will address this data shortfall in the future.

Therefore, the objectives of the work for CSOs were to develop methods to obtain additional information about CSO operation, and to develop criteria that address, in a simple way, the potential for these overflows to impact the ecological status of the receiving water without undertaking detailed studies/assessments of CSOs at this stage.

The proposed approach was to build on work previously commissioned by DEHLG (the Tolka study, the GDSDS, data from the recent Cork and Limerick drainage schemes) and the planned Dublin City Council CSO Lower Liffey study.

During the early part of this stage of the project it was quickly established that major data gaps existed with the national datasets and that the WFD Article V CSO risk assessments contained data gaps both in terms of CSO hydraulic and quality discharges. Furthermore it was established that a number of the studies which were to inform this part of the project were of no significant value to the project. In addition the CSO Lower Liffey study was postponed and would not therefore provide CSO overflow spill quality data or hydraulic spill frequency data for the CSOs in the Lower Liffey.

With regard to both identifying CSO locations and establishing hydraulic discharge spill performance it was also determined during this period that there was in existence an extensive suite of calibrated hydraulic sewer models available for many of the urban areas of interest to this study. However no parallel models or datasets were available to estimate CSO discharge quality.

3.8.1.1 CSO Hydraulic Performance

Given this new information and following a recommendation from CDM a decision was made by the Project Steering Group to have all available calibrated sewer network models re-run for a one year time series rainfall. The output from these model re-runs would provide both comprehensive detail relating to known (and modelled) CSO locations plus continuous and discrete event rainfall overflow spill performance for a common year's rainfall record thus permitting comparison among urban areas. The models were re run for two scenarios;

- The existing current CSO spill scenario before any recommended main drainage upgrades are implemented
- The future CSO spill scenario following the implementation of the recommended main drainage upgrade proposals

The model re-run exercise was successfully completed for 18 of the 33 study urban areas for each of the two modelled scenarios. The annual number of spills, plus the cumulative annual spill volumes and the numbers of CSOs in each of the modelled study urban areas are detailed in Table 3.6. The remodelling showed two points of particular interest;

- For the majority of the re-modelled urban catchments the predicted cumulative annual CSO spill is only of the order of 5 – 10 % of the overall cumulative annual flow in the sewer network. The remaining 90 - 95% of the cumulative annual sewer network flow discharges to the downstream Wastewater Treatment Plant (WWTP).
- In all cases the re-modelling shows that for the future catchment post implementation of the main drainage recommendations there is a significant reduction in the cumulative annual CSO spill volumes to the receiving waters.

For those 15 urban study areas where no hydraulic sewer remodelling was available an interpolation exercise was undertaken to derive estimates for CSO numbers, annual cumulative spill volumes and annual number of overflow spill events. The details of this interpolation exercise are detailed in Table 3.7.

A pilot task was undertaken to reconcile the detailed CSO location data obtained from the hydraulic sewer network modelling exercise with the CSO location data contained in the WFD Article V report for the Greater Dublin area. A number of inconsistencies were found to exist between the two data sources. Given these difficulties, the task of comprehensively reconciling the CSO location data is considered to be an additional task which may have to be undertaken in the future. We are also aware that such a detailed CSO identification programme has already commenced separately for a number of the larger study urban areas as part of the obligations under the 2007 Waste Water Discharge (Authorisation) Regulations - (S.I. No. 684 of 2007).

Although the CSO locations have not been reconciled a consistency check was undertaken to confirm that the number of interpolated CSOs for the unmodelled urban study areas detailed in Table 3.7 is consistent with the number of CSOs quoted elsewhere. This consistency check, which is detailed in Table 3.8 below, was done by comparing the interpolated CSO numbers against the CSO numbers quoted in both the WFD Article V Characterisation Report (March 2005) and the National Urban Waste Water Study (April 2004). The results of the consistency check show a reasonable level of correlation between the majority of the interpolations and the figures quoted in the two reports. For this reason the study proceeded on the basis of the CSO numbers, annual spill volumes and annual number of spills per CSO as quoted in Table 3.7.

Table 3.6: CSO Spill Performance – Remodelled Areas

Urban Area Number	City/Town	Sewer Remodelling Values and Assumed Values					
		Existing Urban Area			Future Urban Area		
		Number of Overflows	Number of Annual Spills	Total Volume of Annual Spills (m^3)	Number of Overflows	Number of Annual Spills	Total Volume of Annual Spills (m^3)
1	Athlone	10	1626	148144	4	25	31695
2	Balbriggan	6	171	11203	0	0	0
3	Bray	no model	no model	no model	no model	no model	no model
4	Carlow	no model	no model	no model	no model	no model	no model
5	Carrigaline	3	122	17417	3	105	7196
6	Castlebar	no model	no model	no model	no model	no model	no model
7	Celbridge	6	27	1362	6	3	0.17
8	Clonmel***	12	32962	75004	12	32554	10843
9	Cork	no model	no model	no model	no model	no model	no model
10	Drogheda	no model	no model	no model	no model	no model	no model
11	Dublin	251	11982	6886894	222	6564	4222369
12	Dundalk	no model	no model	no model	no model	no model	no model
13	Ennis	2	204	118160	1	1	13
14	Galway	no model	no model	no model	no model	no model	no model
15	Greystones	no model	no model	no model	no model	no model	no model
16	Kilkenny	no model	no model	no model	no model	no model	no model
17	Killarney	no model	no model	no model	no model	no model	no model
18	Leixlip	4	6	622	4	0	0
19	Letterkenny	10	775	128692	0	0	0
20	Limerick *	47	47	10232200	1	7	50000
21	Malahide	8	1123	94310	6	26	5277
22	Maynooth	4	57	12131	4	1	3.85
23	Mullingar	13	100	167580	1	0	0
24	Naas	1	12	3300	0	0	0
25	Navan	no model	no model	no model	no model	no model	no model
26	Newbridge	3	145	78491	0	0	0
27	Portlaoise **	7	472	795438	6	0	0
28	Sligo	6	686	93295	no model	no model	no model
29	Swords	4	452	4787	5	7	8
30	Tralee	no model	no model	no model	no model	no model	no model
31	Tullamore	no model	no model	no model	no model	no model	no model
32	Waterford	no model	no model	no model	no model	no model	no model
33	Wexford	no model	no model	no model	no model	no model	no model

* In the case of Limerick the 47 overflows quoted for the existing urban area condition represent the situation prior to the construction of the Limerick Main Drainage / WWTP project which was completed several years ago. Prior to the Main Drainage / WWTP project all sewage from Limerick discharged directly to the Shannon River through these 47 outfalls. Construction and commissioning of the Limerick Main Drainage / WWTP project facilitated the removal of these 47 outfalls. Technically therefore the 47 Limerick outfalls are classed as effluent outfalls rather than CSOs.

** Model results for Portlaoise should be treated with caution as quoted urban area total spill volume is considered to be too high.

*** Suspect – Spill frequencies very high

Table 3.7: CSO Numbers and Spill Performances – Remodelling and Interpolation

Urban Area Number	City/Town	Data Source Type	Sewer Remodelling Values and Assumed Values					
			Existing Urban Areas			Future Urban Areas		
			Number of Overflows	Number of Yearly Spills	Total volume of Yearly Spills (m³)	Number of Overflows	Number of Yearly Spills	Total Volume of Yearly Spills (m³)
1	Athlone	Remodelled	10	1626	148144	4	25	31695
2	Balbriggan	Remodelled	6	171	11203	0	0	0
3	Bray	Interpolated	18	513	33609	0	0	0
4	Carlow	Interpolated	11	30215	68754	11	29841	9939
5	Carrigaline	Remodelled	3	122	17417	3	105	7196
6	Castlebar	Interpolated	10	27468	62503	18	2472	5625
7	Celbridge	Remodelled	6	27	1362	6	3	0
8	Clonmel	Remodelled	12	32962	75004	12	32554	10843
9	Cork	Interpolated	57	57	12409264	1	8	50000
10	Drogheda	Interpolated	10	1130	11968	12	17	19
11	Dublin	Remodelled	251	11982	6886894	222	6564	4222369
12	Dundalk	Interpolated	4	452	4787	5	7	8
13	Ennis	Remodelled	2	204	118160	1	1	13
14	Galway	Interpolated	4	4	870826	0	0	0
15	Greystones	Interpolated	7	197	12883	0	0	0
16	Kilkenny	Interpolated	15	41203	93755	15	127	13554
17	Killarney	Interpolated	9	1382	125922	3	21	26941
18	Letterkenny	Remodelled	10	775	128692	0	0	0
19	Leixlip	Remodelled	4	6	622	4	0	0
20	Limerick *	Remodelled	47	47	10232200	1	7	50000
21	Malahide	Remodelled	8	1123	94310	6	26	5277
22	Maynooth	Remodelled	4	57	12131	4	1	4
23	Mullingar	Remodelled	13	100	167580	1	0	0
24	Naas	Remodelled	1	12	3300	0	0	0
25	Navan	Interpolated	12	32962	75004	12	32554	10843
26	Newbridge	Remodelled	3	145	78491	0	0	0
27	Portlaoise **	Remodelled	7	472	795438	6	0	0
28	Sligo	Remodelled	6	686	93295	0	0	0
29	Swords	Remodelled	4	452	4787	5	7	8
30	Tralee	Interpolated	15	1163	193038	0	0	0
31	Tullamore	Interpolated	5	813	74072	2	13	15848
32	Waterford	Interpolated	23	2599	27525	29	40	46
33	Wexford	Interpolated	8	910	9634	10	14	16

Interpolated spill performances

* In the case of Limerick the 47 overflows quoted for the existing urban area condition represent the situation prior to the construction of the Limerick Main Drainage / WWTP project which was completed several years ago. Prior to the Main Drainage / WWTP project all sewage from Limerick discharged directly to the Shannon River through these 47 outfalls. Construction and commissioning of the Limerick Main Drainage / WWTP project facilitated the removal of these 47 outfalls. Technically therefore the 47 Limerick outfalls are classed as effluent outfalls rather than CSOs.

** Model results for Portlaoise should be treated with caution as quoted urban area total spill volume is considered to be too high.

Table 3.8: Consistency Check – CSO Numbers and Spill Performance – Remodelling and Previous Studies

Urban Area Number	City/Town	Data Source/Type	WFD Article V CSO's			NUWWS			Sewer Remodelling Values and Assumed Values – Existing Urban Areas			Sewer Remodelling Values and Assumed Values – Future Urban Areas		
			Number of CSOs	Number of Yearly Spills	Total Volume of Yearly Spills (m^3)	Number of CSOs	Number of Yearly Spills	Total Volume of Yearly Spills (m^3)	Number of Overflows	Number of Yearly Spills	Total Volume of Yearly Spills (m^3)	Number of Overflows	Number of Yearly Spills	Total Volume of Yearly Spills (m^3)
1	Athlone	NUWWS/Sewer Model	0	0	0	11	0	0	10	1626	148144	4	25	31695
2	Balbriggan	GDSDS	6	Unclear, Suggested >30	Unknown	n/a	n/a	n/a	6	171	11203	0	0	0
3	Bray	NUWWS	0	0	0	0	0	0	no model	no model	no model	no model	no model	no model
4	Carlow	NUWWS	11	Not Quoted	Unknown	11	0	0	no model	no model	no model	no model	no model	no model
5	Carrigaline	Sewer Model	0	0	0	No Data	No Data	No Data	3	122	17417	3	105	7196
6	Castlebar	NUWWS	6	Not Quoted	Unknown	6	0	0	no model	no model	no model	no model	no model	no model
7	Celbridge	GDSDS	7	42	Unclear, Suggested min 14+	n/a	n/a	n/a	6	27	1362	6	3	0.17
8	Clonmel	NUWWS/Sewer Model	11	Not Quoted	Unknown	11	0	0	12	32962	75004	12	32554	10843
9	Cork	NUWWS	57	Not Quoted	Unknown	57	0	0	no model	no model	no model	no model	no model	no model
10	Drogheda	NUWWS	10	>60	Unclear, Suggested Min 7+	10	No Data		no model	no model	no model	no model	no model	no model
11	Dublin	GDSDS	204	Unclear, Suggested >1122	Unclear, Suggested Min 7+	n/a	n/a	n/a	251	11982	6886894	222	6564	4222369
12	Dundalk	NUWWS	0	0	0	0	0	0	no model	no model	no model	no model	no model	no model
13	Ennis	NUWWS/Sewer Model	0	0	0	0	0	0	2	204	118160	1	1	13
14	Galway	NUWWS	4	Not Quoted	Unknown	4	0	0	no model	no model	no model	no model	no model	no model
15	Greystones	NUWWS	0	0	0	No Data	No Data	No Data	no model	no model	no model	no model	no model	no model
16	Kilkenny	NUWWS	15	Not Quoted	Unknown	15	0	0	no model	no model	no model	no model	no model	no model
17	Killarney	NUWWS	1	Not Quoted	Unknown	1	0	0	no model	no model	no model	no model	no model	no model
18	Leixlip	GDSDS	2	Not Quoted	Unknown	n/a	n/a	n/a	4	6	622	4	0	0
19	Letterkenny	NUWWS/Sewer Model	6	Not Quoted	Unknown	9	0	0	10	775	128692	0	0	0
20	Limerick *	NUWWS/Sewer Model	1	>6	Unclear, Suggested min 7+	0	0	0	47	47	10232200	1	7	50000
21	Malahide	GDSDS	7	42	Unclear, suggested min 21+	n/a	n/a	n/a	8	1123	94310	6	26	5277
22	Maynooth	GDSDS	5	Unclear, Suggested >12	Unclear, Suggested Min 7+	n/a	n/a	n/a	4	57	12131	4	1	3.85
23	Mullingar	Sewer Model	15	Unclear, Suggested >78	Unclear, suggested min 77+	14	No Data	No Data	13	100	167580	1	0	0
24	Naas	GDSDS	1	>6	Unclear, Suggested <6	n/a	n/a	n/a	1	12	3300	0	0	0
25	Navan	NUWWS	0	0	0	0	No Data	No Data	no model	no model	no model	no model	no model	no model
26	Newbridge	GDSDS	2	12	Unclear, Suggested Min 7+	n/a	n/a	n/a	3	145	78491	0	0	0
27	Portlaoise **	Sewer Model	10	Not Quoted	Unknown	10	0	0	7	472	795438	6	0	0
28	Sligo	NUWWS/Sewer Model	1	Not Quoted	Unknown	1	0	0	6	686	93295	no model	no model	no model
29	Swords	GDSDS	3	18	Unclear Suggested min 7+	n/a	n/a	n/a	4	452	4787	5	7	8
30	Tralee	NUWWS	0	0	0	15	0	0	no model	no model	no model	no model	no model	no model
31	Tullamore	NUWWS	2	12	12	5	0	0	no model	no model	no model	no model	no model	no model
32	Waterford	NUWWS	23	Not Quoted	Unknown	23	0	0	no model	no model	no model	no model	no model	no model
33	Wexford	NUWWS	0	Not Quoted	0	0	0	0	no model	no model	no model	no model	no model	no model

* In the case of Limerick the 47 overflows quoted for the existing urban area condition represent the situation prior to the construction of the Limerick Main Drainage / WWTP project which was completed several years ago. Prior to the Main Drainage / WWTP project all sewage from Limerick discharged directly to the Shannon River through these 47 outfalls. Construction and commissioning of the Limerick Main Drainage / WWTP project facilitated the removal of these 47 outfalls. Technically therefore the 47 Limerick outfalls are classed as effluent outfalls rather than CSOs.

** Model results for Portlaoise should be treated with caution as quoted urban area total spill volume is considered to be too high.

3.8.1.2 CSO Discharge Quality Performance

The sourcing of existing CSO discharge spill quality data for Irish CSOs was not possible. At the time the original project was scoped it was assumed that such data existed and it was also expected that further data would be provided from the imminent Lower Liffey CSO study. No suitable data was provided from either source.

Given that such data is a fundamental building block for the type of project being undertaken the decision was taken by the Project Steering Group, following advice from CDM, that surrogate CSO quality data from the UK should be adopted for the study. Following this decision surrogate CSO discharge spill water quality data was obtained from the UK Water Industry Research (UKWIR) Report – "Priority Hazardous Substances Trace Organics and Diffuse Pollution (Water Framework Directive) – Surface water drains and intermittent discharges from sewer networks" – Ref 04/WW/17/4. The UKWIR surrogate data covered 7 of the eight metal parameters listed in Table 3.5. It should be noted however that the data presented in the UKWIR Report is based upon a small and limited data set. There are also many limitations with the data. For example the UK environment is more heavily industrialised than that in Ireland. <u>Therefore the adopted surrogate concentration values should be treated with some caution, as they are likely to be higher than equivalent Irish values.</u>

For reference purposes it is noted that Table 2.2 of the 1997 EPA Waste Water Treatment Manuals – Primary, Secondary and Tertiary Treatment, quotes influent concentrations for Irish WWTWs for seven of the metals listed in Table 3.5 of the order of < 1mg/l.

Nevertheless it was considered suitable to develop macro water quality discharge estimates for the CSOs in the 33 urban study areas for the parameters of interest.

The UKWIR surrogate data did not include nitrogen or phosphorous parameters which were being assessed in this study. For this reason ***and to be conservative the water quality concentrations for untreated raw sewage were assumed for these parameters***. These later water quality concentration values were extracted from the work reported in the document titled - ''Urban Pressures: Surface Waters – WWTP effluent discharge loadings'', Ref 39325/UP40/DG25 – S, Final 02, Dec 2007. The proposed finalised CSO discharge concentration values are detailed in Table 3.9 below. It should be noted that CSO discharge concentration values could be prepared for only 11 of the 14 study parameters listed from Table 3.5.

By amalgamating and applying the yearly annual CSO spill data from Table 3.7 for the existing urban areas with the concentration data from Table 3.9 the cumulative annual loading estimates for the CSOs were estimated for the existing development horizon and presented in Table 3.10. The data presented in Table 3.10 is based on the assumptions that for Bray, Carrigaline, Sligo and Waterford the data used is based on proposed future works for the towns as recommended in the associated Preliminary Reports (PR).

For a more detailed understanding of how the CSO assessment aspect of the project was implemented the reader is referred to the document titled - ''Urban Pressures: Surface Waters – CSO Source Loadings'', Ref 39325/UP40/DG43 – S, Final 01, Dec 2007.

Table 3.9: Proposed CSO Discharge Water Quality Concentration Matrix Values

Urban Area Number	City/Town	Receiving Water	Nitrates (mg/l)	Nitrites (mg/l)	Total Nitrogen (mg/l)	Nitrogen (TKN) (mg/l)	Total Phosphorous (mg/l)	Ortho-phosphate (mg/l)	Cadmium (mg/l)	Chromium (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Mercury (mg/l)	Nickel (mg/l)	Zinc (mg/l)
1	Athlone	Shannon (River)	nd	nd	31.78	48.60	6.48	4.30	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
2	Balbriggan	NONE PROPOSED	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
3	Bray	NONE PROPOSED	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
4	Carlow	River Barrow (River)	nd	nd	0.60	44.40	9.10	8.40	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
5	Carrigaline	Owenboy Estuary (Part Only) (Transitional)	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
6	Castlebar	Liscromwell (River)	nd	nd	16.00	44.49	2.70	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
7	Celbridge	River Liffey (River)	nd	nd	38.10	44.49	8.61	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
8	Clonmel	River Suir (River)	nd	nd	34.47	44.49	13.23	13.96	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
9	Cork	Lee (Cork Estuary) Lower (Transitional)	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
10	Drogheda	Boyne Estuary (Part Only) (Transitional)	nd	nd	10.57	44.49	1.86	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
11	Dublin	River Dodder (River)	nd	nd	31.78	31.80	5.48	2.85	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
11	Dublin	River Camac (River)	nd	nd	31.78	31.80	5.48	2.85	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
11	Dublin	River Liffey (River)	nd	nd	31.78	31.80	5.48	2.85	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
11	Dublin	Tolka River (River)	nd	nd	31.78	31.80	5.48	2.85	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
11	Dublin	Santry River (River)	nd	nd	31.78	31.80	5.48	2.85	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
11	Dublin	Liffey Estuary Upper (Transitional)	nd	nd	31.78	31.80	5.48	2.85	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
11	Dublin	Liffey Estuary Lower (Transitional)	nd	nd	31.78	31.80	5.48	2.85	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
11	Dublin	Tolka Estuary (Transitional)	nd	nd	31.78	31.80	5.48	2.85	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
12	Dundalk	Castletown Estuary (Transitional)	nd	nd	31.78	44.49	7.01	4.65	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
13	Ennis	River Fergus (River)	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
14	Galway	Corrib Estuary (Transitional)	nd	nd	24.74	44.49	18.61	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
14	Galway	Corrib River (River)	nd	nd	24.74	44.49	18.61	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
15	Greystones	NONE PROPOSED	nd	nd	31.78	44.49	7.80	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
16	Kilkenny	River Nore (River)	nd	nd	31.78	44.49	7.01	3.18	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
17	Killarney	Deenagh River (River)	nd	nd	31.78	44.49	4.33	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
17	Killarney	Flesk River (River)	nd	nd	31.78	44.49	4.33	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
18	Letterkenny	Swilly Estuary (Part Only) Transitional	nd	nd	38.10	44.49	8.61	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
19	Leixlip	River Liffey (River)	nd	nd	31.78	44.49	4.01	2.08	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
20	Limerick	Limerick Dock (Part Only) Transitional)	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
21	Malahide	NONE PROPOSED	nd	nd	31.78	44.49	7.01	4.87	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
22	Maynooth	River Ryewater (River)	nd	nd	38.10	44.49	8.61	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
23	Mullingar	River Brosna (River)	nd	nd	31.78	44.49	5.58	3.67	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
24	Naas	River Morell (River)	nd	nd	42.70	44.49	3.50	2.79	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
25	Navan	River Boyne (River)	nd	nd	48.00	44.49	6.78	4.58	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
26	Newbridge	River Liffey (River)	nd	nd	42.70	44.49	3.50	2.79	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
27	Portlaoise	Triogue (Barrow) River (River)	nd	nd	31.78	44.49	7.01	1.90	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
28	Sligo	Garavogue Estuary (Transitional)	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
28	Sligo	River Garavogue (River)	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
29	Swords	Broadmeadow River (River)	nd	nd	31.78	53.18	7.01	5.82	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
30	Tralee	Big River (River)	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
31	Tullamore	Tullamore River (River)	nd	nd	43.60	44.49	7.49	5.72	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
32	Waterford	Lower Suir Estuary (Transitional)	nd	nd	31.78	44.49	7.01	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200
33	Wexford	Lower Slaney Estuary (Part Only) (Transitional)	nd	nd	29.16	44.49	5.43	4.77	0.000178	0.006890	0.037900	nd	0.008130	0.000357	0.007840	0.078200

No data

Raw Sewage from the document titled – '' WWTP Loadings Methodology'', Ref: 39.325/UP40/DG25 - S

UKWIR Report - Ref: 04/WW/17/4

Table 3.10: CSO Discharge Annual Loading Matrix – Existing Development Horizon

LOADING MATRIX

Surface Water Type	Urban Area	Surface Water Name	Nitrates (kg/yr)	Nitrites (kg/yr)	Total N (kg/yr)	Nitrogen (TKN) (kg/yr)	Total Phosphorous (kg/yr)	Ortho-phosphate (kg/yr)	Cadmium (kg/yr)	Chromium (kg/yr)	Copper (kg/yr)	Iron (kg/yr)	Lead (kg/yr)	Mercury (kg/yr)	Nickel (kg/yr)	Zinc (kg/yr)
r	Athlone	Shannon (Main) (River)	nd	nd	4708	7200	960	637	0.026	1.021	5.615	nd	1.204	0.053	1.161	12
r	Carlow	River Barrow (River)	nd	nd	41	3053	626	578	0.012	0.474	2.606	nd	0.559	0.025	0.539	5.377
t	Carrigaline	Owenboy Estuary (Part Only) (Transitional)	nd	nd	554	775	122	83	0.003	0.120	0.660	nd	0.142	0.006	0.137	1.362
r	Castlebar	Liscromwell (River)	nd	nd	1000	2781	169	298	0.011	0.431	2.369	nd	0.508	0.022	0.490	4.888
r	Celbridge	River Liffey (River)	nd	nd	52	61	12	6.497	0.0002	0.009	0.052	nd	0.011	0.0005	0.011	0.107
r	Clonmel	River Suir (River)	nd	nd	2585	3337	992	1047	0.013	0.517	2.843	nd	0.610	0.027	0.588	5.865
t	Cork	Lee (Cork Estuary) Lower (Transitional)	nd	nd	394366	552088	86989	59192	2.209	85	470	nd	101	4.430	97	970
t	Drogheda	Boyne Estuary (Part Only) (Transitional)	nd	nd	126	532	22	57	0.002	0.082	0.454	nd	0.097	0.004	0.094	0.936
t	Dundalk	Castletown Estuary (Transitional)	nd	nd	152	213	34	22	0.001	0.033	0.181	nd	0.039	0.002	0.038	0.374
r	Ennis	River Fergus (River)	nd	nd	3755	5257	828	564	0.021	0.814	4.478	nd	0.961	0.042	0.926	9.240
r	Kilkenny	River Nore (River)	nd	nd	2980	4171	657	298	0.017	0.646	3.553	nd	0.762	0.033	0.735	7.332
t	Letterkenny	Swilly Estuary (Part Only) (Transitional)	nd	nd	4903	5726	1108	614	0.023	0.887	4.877	nd	1.046	0.046	1.009	10
r	Lexlip	River Liffey (River)	nd	nd	20	28	2.494	1.294	0.0001	0.004	0.024	nd	0.005	0.0002	0.005	0.049
t	Limerick	Limerick Dock (Part Only) (Transitional)	nd	nd	325179	455231	71728	48808	1.821	70	388	nd	83	3.653	80	800
r	Maynooth	River Ryewater (River)	nd	nd	462	540	104	58	0.002	0.084	0.460	nd	0.099	0.004	0.095	0.949
r	Mullingar	River Brosna (River)	nd	nd	5326	7456	935	615	0.030	1.155	6.351	nd	1.362	0.060	1.314	13
r	Naas	River Morell (River)	nd	nd	141	147	12	9.207	0.001	0.023	0.125	nd	0.027	0.001	0.026	0.258
r	Navan	River Boyne (River)	nd	nd	3600	3337	509	344	0.013	0.517	2.843	nd	0.610	0.027	0.588	5.865
r	Newbridge	River Liffey (River)	nd	nd	3352	3492	275	219	0.014	0.541	2.975	nd	0.638	0.028	0.615	6.138
r	Portlaoise	Triogue (Barrow) River (River)	nd	nd	25279	35389	5576	1511	0.142	5.481	30	nd	6.467	0.284	6.236	62
r	Swords	Broadmeadow River (River)	nd	nd	152	255	34	28	0.001	0.033	0.181	nd	0.039	0.002	0.038	0.374
r	Tralee	Big River (River)	nd	nd	6135	8588	1353	921	0.034	1.330	7.316	nd	1.569	0.069	1.513	15
r	Tullamore	Tullamore River (River)	nd	nd	3230	3295	555	424	0.013	0.510	2.807	nd	0.602	0.026	0.581	5.792
t	Waterford	Suir Estuary (Transitional)	nd	nd	875	1225	193	131	0.005	0.190	1.043	nd	0.224	0.010	0.216	2.152
t	Wexford	Lower Slaney Estuary (Part Only) (Transitional)	nd	nd	281	429	52	46	0.002	0.066	0.365	nd	0.078	0.003	0.076	0.753
r	Dublin	River Dodder (River)	nd	nd	56992	57028	9827	5111	0.319	12	68	nd	15	0.640	14	140
r	Dublin	River Camac (River)	nd	nd	16618	16628	2866	1490	0.093	3.603	20	nd	4.251	0.187	4.100	41
r	Dublin	River Liffey (River)	nd	nd	3427	3429	591	307	0.019	0.743	4	nd	0.877	0.039	0.846	8.433
r	Dublin	Tolka River (River)	nd	nd	14284	14293	2463	1281	0.080	3.097	17	nd	3.654	0.160	3.524	35
r	Dublin	Santry River (River)	nd	nd	53271	53305	9186	4777	0.298	12	64	nd	14	0.598	13	131
t	Dublin	Liffey Estuary Upper (Transitional)	nd	nd	33533	33554	5782	3007	0.188	7.270	40	nd	8.578	0.377	8	83
t	Dublin	Liffey Estuary Lower (Transitional)	nd	nd	121945	122022	21028	10936	0.683	26	145	nd	31	1.370	30	300
t	Dublin	Tolka Estuary (Transitional)	nd	nd	20302	20315	3501	1821	0.114	4.402	24	nd	5.194	0.228	5.008	50
t	Galway	Corrib Estuary (Transitional)	nd	nd	21544	38743	16206	4154	0.155	6.000	33	nd	7.080	0.311	6.827	68
r	Galway	Corrib River (River)	nd	nd	21544	38743	16206	4154	0.155	6.000	33	nd	7.080	0.311	6.827	68
r	Killarney	Deenagh River (River)	nd	nd	2223	3112	303	334	0.012	0.482	2.651	nd	0.569	0.025	0.548	5.471
r	Killarney	Flesk River (River)	nd	nd	1779	2490	242	267	0.010	0.386	2.121	nd	0.455	0.020	0.439	4.376
t	Sligo	Garavogue Estuary (Transitional)	nd	nd	2965	4151	654	445	0.017	0.643	3.536	nd	0.758	0.033	0.731	7.296
r	Sligo	River Garavogue (River)	nd	nd	353	494	78	53	0.002	0.076	0.421	nd	0.090	0.004	0.087	0.868
?	Balbriggan	NONE PROPOSED	nd	nd	356	498	79	53	0.002	0.077	0.425	nd	0.091	0.004	0.088	0.876
?	Bray	NONE PROPOSED	nd	nd	1068	1495	236	160	0.006	0.232	1.274	nd	0.273	0.012	0.263	2.628
?	Greystones	NONE PROPOSED	nd	nd	409	573	100	61	0.002	0.089	0.488	nd	0.105	0.005	0.101	1.007
?	Malahide	NONE PROPSED	nd	nd	2997	4196	661	459	0.017	0.650	3.574	nd	0.767	0.034	0.739	7.375

nd - no data

3.8.2 Point Source Pressures

Estimating point source loads requires site-specific information and can be based upon monitoring data, license data, or appropriate estimates given the nature of the point source. For the purposes of this project the point sources were initially classified into four main categories:

- Section 4 Discharges
- Section 16 Discharges
- WWTP Discharges
- IPPC – Discharges – surface water/sewer/atmosphere

However since the WWTP discharges were reclassified and calculated as a separate urban pressure for project purposes (Section 3.8.4 below) there were in effect only three main point source categories considered under this stage of the project.

3.8.2.1 Section 4 Licences

An updated EPA Section 4 licence dataset was provided in excel by the SWRBD Municipal and Industrial Regulation (MIR) project group (our ref 39325/UP50/DI 64 – S). Following a comprehensive review of this data it was established that 39 Section 4 licences are located within 16 of the study urban area catchments. The monitored data covers the period 1981 - 2005.

The intention was to use a combination of the monitored effluent flow and concentration data to estimate the annual cumulative discharge loadings to the urban area surface waters for the parameters of interest. Unfortunately, in the majority of cases the supplied dataset was found to be largely incomplete with most licences missing either the concentration data or the flow data. Therefore for the majority of the licences it was not possible to estimate annual cumulative yearly discharge loadings for the parameters of interest to the study. For this reason urban pressure loadings from Section 4 Licences have not been estimated.

3.8.2.2 Section 16 Discharges

Section 16 licences are issued by the relevant local authority under Section 16 of the Local Government (Water Pollution) Act 1977 as amended in 1990 for discharge of trade effluents or other matter (other than domestic sewage or storm water) to a sewer.

No information regarding Section 16s was made available during the project. Therefore we have not made separate provision for this type of point source discharge as part of the study. It was therefore assumed that any concentration loadings which are derived for the WWTP influents (Section 3.8.4 below) include an allowance for the Section 16 discharges.

3.8.2.3 IPPC – Discharges

IPPC licences are issued under the Environmental Protection Agency Act, 1992 and were subsequently amended by the Protection of the Environment Act, 2003 which is based on the Integrated Pollution Prevention Control (IPPC) Directive. The IPPC licence deals with all emissions to land, sewer and air. The aim of the licence is to minimise the emissions to land, sewer and air.

The EPA provided the definitive list of active IPPC licences as per October 2006. From a review of this list it was established that 139 IPPC licences are located within the 33 study urban area catchment boundaries.

Following a further detailed and extensive screening exercise it was established that a significant number of the 139 licences do not provide adequate effluent concentration data for the parameters of interest to this study. Of the 139 supplied licences, data for only 59 can be utilised as part of this study in relation to 28 of the 33 study urban area catchment. Each of the 59 IPPC Licences can apply to either surface water, sewer or atmospheric discharges separately or in combination.

IPPC – Surface Water Discharge

Only nine of the 59 IPPC licences include discharges to surface water within the study urban catchment areas. However as there are ***no monitored results available for volumetric flows*** leaving the industries/installations it was not possible to estimate the annual cumulative loadings discharging into the surface waters from the industries/installations for any of the parameters of interest.

IPPC – Foul Sewer Discharge

There are a total of 43 IPPC licences discharging to sewer within the study urban catchment areas. These IPPC to sewer licences monitor at least one of the parameters which are of interest to the urban pressures study. However as there are ***no monitored results available*** for volumetric flows leaving the industries/installations it was not possible to estimate the annual cumulative loadings discharging into the sewers from the industries/installations for the parameter of interest.

3.8.2.4 IPPC – Atmospheric Stack Discharge

Eighteen of the 59 IPPC licences discharge to atmosphere within the study urban catchment areas. Unfortunately as ***there are no monitored results available for stack emissions*** from the industries/installations it was not possible to estimate the annual cumulative loadings discharging from the industries/installations.

Overall therefore it has not been possible to estimate any meaningful cumulative annual discharge loadings for point sources.

As an aside the issue of atmospheric deposition loadings is addressed in the separate document titled - ''Surface Waters - Atmospheric Deposition Loadings Methodology'', Ref 39325/UP40/DG30 - S. That document presents indicative annual cumulative loading estimates for atmospheric deposition for the entire country which could be applied across the 33 urban study catchment areas.

For a more detailed understanding of how the point source assessment aspect of the project was implemented the reader is referred to the document titled - ''Urban Pressures: Surface Waters – Point Source Input Estimation'', Ref 39325/UP40/DG43 – S, Final 01, Dec 2007.

3.8.3 Groundwater Pressures

Urban groundwaters were identified for further study whereby the urban pressures affecting the urban groundwaters have to be identified and assessed. The urban groundwaters assessment is being undertaken as a separate parallel project to the assessment of the surface waters which is covered in this report.

Initially it was believed that it may be possible to study the groundwater – surface water interface and produce annual cumulative loadings for the study parameters entering the urban surface waters from the urban groundwaters. As the two projects, groundwaters and surface waters, progressed it became apparent that it would not be possible to estimate the annual cumulative loadings discharging into the surface waters from the groundwaters – primarily because the groundwaters project was not scoped to undertake that type of quantitative analysis.

For this reason urban pressure loadings from groundwaters to surface waters have not been estimated as part of this study.

3.8.4 Wastewater Pressures

Wastewater discharge loadings require site-specific information and can be based upon monitoring data, design data, estimating procedures or in extreme cases on the use of surrogate data.

WWTP data was supplied to CDM by the SWRBD based upon the 2003 WWTP returns from Local Authorities to the EPA. This data set was screened to select WWTP data and untreated outfall collection system data matching the 33 urban areas included in this project.

Because the supplied data was only partially complete, other methods were adopted to fill the data gaps. These methods were as follows:

- Direct contact with Local Authorities
- Contact with the Office of Environmental Enforcement, EPA.
- Review of the EPA Register of Protected Areas for receiving water standards and locations of Nutrient Sensitive Waters
- Review of EPA waste water treatment manuals
- Review of National Urban Waste Water Study Final Report, April 2004 – DEHLG
- Review of the Greater Dublin Strategic Drainage Study (GDSDS)
- Collection of data for proposed future waste water treatment plants in areas with no current WWTP– Local Authorities.

The additional data was gathered in the following four categories.

3.8.4.1 Current and Future Treatment Facilities

Details of the current treatment facilities for each of the 33 study urban area catchments were extensively reviewed and collated. The results of the review and collation exercise have been presented in Table 3.11 overleaf.

It is noted that whilst no WWTP currently exists for the four urban catchment areas of Bray, Carrigaline, Sligo and Waterford, there are completed Preliminary Reports for these areas and construction contracts are currently pending to build the necessary WWTPs.

3.8.4.2 Nutrient Sensitive Waters

The designation of a surface water as 'Sensitive' is a requirement of WFD Article V of the EU Council Directive (91/271/EEC) and was developed for Ireland in the 2001 Urban Wastewater Regulations. Those waters which are classified as sensitive are identified on Table 3.11.

The requirements for nutrient sensitive waters for a range of parameters are shown in Table 3.12 below.

Nutrient sensitive waters are classified into three groups for surface waters:

- Freshwaters, estuaries and coastal waters which are eutrophic or which may become eutrophic if protective action is not taken.
- Surface waters intended for the abstraction of drinking water which contain more than 50 mg/l of nitrates.
- Areas where further treatment is required, to comply with other European Council Directives.

Table 3.12: WWTP Discharge Limits to Nutrient Sensitive Waters

Parameter	Concentration Limit	Minimum % Reduction
Total Phosphorus	2 mg/l (10,000-100,000 pe)	80
	1 mg/l (> 100,000 pe)	
Total Nitrogen	15 mg/l (10,000-100,000 pe)	70-80
	10 mg/l (> 100,000 pe)	

3.8.4.3 Flow and Composition

Flow data for a number of the WWTPs was provided by the SWRBD MIR project whilst details of the influent and effluent quality data was extracted from the 2003 EPA WWTP returns provided by the MIR group. In all cases, the supplied datasets were incomplete. Missing data was sought from both EPA and a number of the Local Authorities. The information received from all parties has been collated and is presented within Table 3.13.

Table 3.11: Key WWTP Details

Urban Area Number	Urban Area	WWTP Name	Population Census 2002 Census	Existing WWTP	Preliminary Report Pending	Type		Receiving Waters		Sensitive Waters UWWT Regs 2001
						Works	Treatment	Type	Name	
1	Athlone	Athlone	15936	Y		Secondary treatment	Extended Aeration	Freshwater (River)	Shannon	Yes
2	Balbriggan	Balbriggan/Skerries	10294	Y		Secondary treatment		Coastal	Irish Sea	No
3	Bray	Bray	30951	N	Y	Preliminary treatment		Coastal	Irish Sea (1 mile out*)	No
4	Carlow	Mortarstown	18487	Y		Secondary treatment	Extended Aeration	Freshwater (River)	Barrow	Yes
5	Carrigaline	Ringskiddy Outfall	11191	N	Y	Outfall	None	Transitional	Cork Harbour	No
6	Castlebar	Castlebar	11371	Y		Secondary treatment	Extended Aeration	Freshwater (River)	Castlebar River	Yes
7	Celbridge	Leixlip	16016	Y		Secondary treatment	Conventional Aeration	Freshwater (River)	River Liffey	Yes
8	Clonmel	Clonmel	16910	Y		Secondary treatment	Extended Aeration	Freshwater (River)	Suir	Yes
		Marlfield		N		Primary treatment	Septic/Imhoff Tank	Freshwater (River)	Suir	No
		Redmonstown		N		Primary treatment	Septic/Imhoff Tank	Freshwater (River)	Anner	No
		Kilmacomma		N		Primary treatment on	Septic/Imhoff Tank	Freshwater (River)	Suir River	No
9	Cork	Carrigrennan	186239	Y		Secondary Treatment	Secondary	Transitional	Cork Harbour	Yes
10	Drogheda	Drogheda	31020	Y		Secondary		Transitional	Boyne Estuary	No
11	Dublin	Ringsend	1004614	Y		Secondary Treatment	Sequential Batch Reactor	Transitional	Liffey Estuary	Yes
		Balgriffin		Y		Secondary Treatment	Secondary	Freshwater (River)		No
		Leixlip		Y		Secondary treatment	Conventional Aeration	Freshwater (River)	River Liffey	Yes
		Coliemore Outfall		N		Outfall	None	Coastal	Irish Sea	No
12	Dundalk	Dundalk	32505	Y		Secondary		Transitional	Dundalk Bay	Yes
13	Ennis	Clonroadmore	22051	Y		Secondary treatment	Extended Aeration	Freshwater (River)	Fergus River	No
		Clareabbey		Y		Secondary treatment	Extended Aeration	Freshwater (River)	Fergus River	No
		Clarecastle		N		Primary Treatment	Septic Tank	Transitional	Shannon Estuary	No
14	Galway	Mutton Island	66163	Y		Nutrient Reduction		Transitional	Corrib Estuary	No
15	Greystones	Greystones	11913	Y		Primary and Secondary	Conventional Aeration	Coastal	Irish Sea	No
16	Kilkenny	Purcellsinch	20735	Y		Secondary treatment	Extended Aeration	Freshwater (River)	Nore	Yes
17	Killarney	Killarney	13137	Y		Secondary treatment	Extended Aeration	Freshwater (Lake)	Lough Leane	Yes
18	Leixlip	Leixlip	15061	Y		Secondary treatment	Conventional Aeration	Freshwater (River)	River Liffey	Yes
19	Letterkenny	Letterkenny	15231	Y		Secondary treatment	Conventional Aeration	Transitional	Swilly	No
20	Limerick	Limerick	86998	Y		Nutrient reduction	Conventional Aeration	Transitional	Shannon Estuary	No
21	Malahide	Malahide	13826	Y		Secondary treatment	Conventional Aeration	Transitional	Broadmeadow	Yes
22	Maynooth	Leixlip	10151	Y		Secondary treatment	Conventional Aeration	Freshwater (River)	River Liffey	Yes
23	Mullingar	Mullingar	15621	Y		Secondary treatment	Extended Aeration	Freshwater (River)	Brosna	Yes
24	Naas	Osberstown	18288	Y		Secondary treatment	Conventional Aeration	Freshwater (River)	River Liffey	Yes
25	Navan	Navan	19417	Y		Primary and secondary	Extended Aeration	Freshwater	Boyne River	Yes
26	Newbridge	Osberstown	16739	Y		Secondary treatment	Conventional Aeration	Freshwater (River)	River Liffey	Yes
27	Portlaoise	Portlaoise	12127	Y		Secondary treatment	Extended Aeration	Freshwater (River)	Triogue	Yes
28	Sligo	Sligo	19735	N	Y	No Treatment	None	Transitional	Garavogure River Estuary	No
29	Swords	Swords	27175	Y		Nutrient Reduction	Conventional Aeration	Transitional	Broadmeadow	Yes
30	Tralee	Tralee	21987	Y		Secondary treatment	Conventional Aeration	Transitional	Tralee Bay	Yes
31	Tullamore	Tullamore	11098	Y		Secondary treatment	Conventional Aeration	Freshwater (River)	Tullamore	Yes
32	Waterford	Water Park PS	46736	N	Y	Pumping Station	Preliminary	Transitional	River Suir	No
		Ballynakill		N		Primary treatment	Septic/Imhoff Tank	Transitional	River Suir	No
		Island View		N		Primary treatment	Septic/Imhoff Tank	Transitional	River Suir	No
		Abbey Park		N		Primary treatment	Septic/Imhoff Tank	Transitional	Suir	No
		Giles Quay		N		Primary treatment	Septic Tank	Transitional	Suir	No
33	Wexford	Wexford	17235	Y		Nutrient reductions	SBR	Transitional	Wexford Habour	Yes

MIR Base Data — Preliminary Report — Local Authorities — EPA WWTP Returns — EPA Register of Protected Areas

Table 3.13: Collection System and Waste Water Treatment Plant Flow and Strength Data

Urban Area Number	Urban Area	County	RBD	Pop. CSO Census 2002	WWTP Name	Inflow (m3/d)	Outflow (m3/d)	PE		Year of data	Influent Monitoring Results									Effluent Monitoring Results								
								Operational	Design		BOD mg/l	COD mg/l	TSS mg/l	Total P mg/l	Ortho P mg/l	Total N mg/l	NH3-N mg/l	TON mg/l	TKN mg/l	BOD mg/l	COD mg/l	TSS mg/l	Total P mg/l	Ortho P mg/l	Total N mg/l	NH3-N mg/l	TON mg/l	TKN mg/l
1	Athlone	Westmeath	SHIRBD	15936	Athlone	5932		21000	12200	2003	184	407	168	6	4	-	34	-	49	10	37	6	1	0	-	3	9	7
2	Balbriggan	Fingal	ERBD	10294	Balbriggan/Skerries	6900			30000	-	Recently commissioned - no data available									Recently commissioned - no data available								
3	Bray	Wicklow	ERBD	30951	Bray	11000		40000		-	No Data									No Data								
4	Carlow	Carlow	SERBD	18487	Mortarstown	8500		35000	26700	2003	282	557	202	9	8	1	35	0	44	8	30	6	1	1	27	2	6	2
5	Carrigaline	Cork	SWRBD	11191	Ringskiddy Outfall	6105		32650		-	No Data									No Data								
6	Castlebar	Mayo	WRBD	11371	Castlebar	7500	8000	23000		2003	110	294	8	2.7	-	16	-	0.4	-	2.3	25	8	0.14	0.12	-	0.23	9	-
7	Celbridge	Kildare	ERBD	16016	Leixlip	23376		80000		2003	169	464	302	9	-	38	-	-	-	4	23	9	1	-	14	-	-	-
8	Clonmel	Tipperary	SERBD	16910	Clonmel	6362	6362	37111	80000	2003	323	524	277	13	14	34	14	-	-	10	35	22	1	-	9	2	-	-
					Marlfield	Not measured		367	212	-	No Data									No Data								
					Redmonstown	Not measured		60	60	-	No Data									No Data								
					Kilmacomma	Not measured		150	240	-	No Data									No Data								
9	Cork	Cork	SWRBD	186239	Carrigrennan		93561	250000	413000	2005	160	388	176	-	-	-	-	-	-	9	73	14	-	-	-	-	-	-
10	Drogheda	Louth	ERBD	31020	Drogheda		8996	67700	101000*	2005	330	840	507	2	-	11	-	-	-	4	70	9	2	3	8	-	-	-
11	Dublin	Dublin	ERBD	1004614	Ringsend	394136	389480	1900000		2003	298	575	280	5	3	-	24	0	32	26	102	57	3	2	-	6	6	8
					Balgriffin	No Data		100	0		No Data									No Data								
					Leixlip	23376		80000		2003	169	464	302	9	-	38	-	-	-	4	23	9	1	-	14	-	-	-
					Coliemore Outfall	No Data		812	0		No Data									No Data								
12	Dundalk	Louth	NBRBD	32505	Dundalk	20,000	12000	179535	0	2003	220	494	223	-	5	-	1	-	-	9	47	12	-	2	-	-	-	-
13	Ennis	Clare	SHIRBD	22051	Clonroadmore	6000		17000		2003	166	300	108	-	-	-	-	-	-	8	31	11	-	-	-	-	-	-
					Clareabbey	1500		6000		2003	193	450	315	-	-	-	-	-	-	13	51	17	-	-	-	-	-	-
					Clarecastle	No Data		9000	0		No Data									No Data								
14	Galway	Galway	WRBD	66163	Mutton Island		46855	63700	91600	2005	187	429	269	19	-	25	-	-	-	11	43	16	7	-	13	-	-	-
15	Greystones	Wicklow	ERBD	11913	Greystones	5400		27000		2005	279	626	309	8	-	-	54	-	-	13	52	16	2	-	18	28	-	-
16	Kilkenny	Kilkenny	SERBD	20735	Purcellsinch	8500	8500	107650	107650	2003	614	986	416	-	3	-	24	-	-	27	61	48	-	1	-	7	-	-
17	Killarney	Kerry	SWRBD	13137	Killarney	7072	7072	51000		2003	217	420	195	4	-	-	-	-	-	6	26	3	0	-	-	-	-	-
18	Leixlip	Kildare	ERBD	15061	Leixlip	23376		80000		2003	169	464	302	9	-	38	-	-	-	4	23	9	1	-	14	-	-	-
19	Letterkenny	Donegal	NWRBD	15231	Letterkenny	5300	4500	22000		2003	175	636	107	4	2	-	15	0	-	188	564	94	3	2	-	12	0	-
20	Limerick	Limerick	SHIRBD	86998	Limerick	43108	44000	130000	130000		No Data									10	20	4	0.98	-	11.9	11.1	-	11.3
21	Malahide	Fingal	ERBD	13826	Malahide	3,500	3,500	21000		2003	236	477	213	-	5	-	35	1	-	8	53	35	-	4	-	1	24	-
22	Maynooth	Kildare	ERBD	10151	Leixlip	23376		80000		2003	169	464	302	9	-	38	-	-	-	4	23	9	1	-	14	-	-	-
23	Mullingar	Westmeath	SHIRBD	15621	Mullingar	7500		24000	12400	2003	205	534	240	6	4	-	25	-	-	6	24	5	0	0	-	1	2	-
24	Naas	Kildare	ERBD	18288	Osberstown	19294		80000		2003	153	500	236	4	3	43	24	1	-	4	35	11	1	0	14	1	6	-
25	Navan	Meath	ERBD	19417	Navan	8300	7500	40000		2003	127	432	213	7	5	48	24	-	-	3	22	4	1	1	20	0	-	-
26	Newbridge	Kildare	ERBD	16739	Osberstown	19294		80000		2003	153	500	236	4	3	43	24	1	-	4	35	11	1	0	14	1	6	-
27	Portlaoise	Laois	SERBD	12127	Portlaoise	5200		20000	18000	2003	135	373	320	-	2	-	25	-	-	13	82	25	-	1	-	14	-	-
28	Sligo	Sligo	WRBD	19735	Sligo	17142		20000			No Data									No Data								
29	Swords	Fingal	ERBD	27175	Swords	8,500	8,500	60000		2003	302	719	426	-	6	-	39	0	53	6	42	22	-	1	-	6	7	15
30	Tralee	Kerry	SHIRBD	21987	Tralee	10,714	10,714	42000		2003	83	193	82	-	-	-	-	-	-	8	40	17	-	-	-	-	-	-
31	Tullamore	Offaly	SHIRBD	11098	Tullamore	4514	4164	20000*	15833	2003	284	540	238	7	6	44	33	1	-	11	31	12	1	0	28	18	2	-
32	Waterford	Waterford	SERBD	46736	Water Park PS	11000	11000	135000			No Data									No Data								
					Ballynakill	Not measured		3500			No Data									No Data								
					Island View	Not measured		2400			No Data									No Data								
					Abbey Park	130	130	924	924		No Data									No Data								
					Giles Quay	Not measured		400	560		No Data									No Data								
33	Wexford	Wexford	SERBD	17235	Wexford	9531		13000		2005	231	474	259	5	-	29	24	-	-	9	35	14	2	-	6	3	-	-

MIR Base Dataset

Local Authorities

EPA Data (2005 EPA returns from David Smith, 2003 EPA returns from MIR project)

3.8.4.4 WWTP Discharge Limits

The discharge limits for the WWTPs were found by consulting EPA's Urban Waste Water Discharges in Ireland Report 2002/2003 which explains the 2001 Urban Waste Water Regulations. Discharge limits are based on both Population Equivalents (pe) and the nutrient sensitivity designation of the receiving waters. The discharge limits for a range of parameters are shown below in Table 3.14.

The relevant discharge limit information for each WWTP is shown in Table 3.14.

3.8.4.5 Data Interpolation and Assumptions

Significant data gaps remained following the review and assessment of the supplied data referred to in the previous tables. The main data gaps are demonstrated on Table 3.13 and are of two main types:

- lack of continuous influent/effluent flow records
- lack of complete influent/effluent load/composition water quality records

With regard to the influent/effluent flow record issue, the data on Table 3.13 shows that all 33 WWTWs have either an influent or an effluent flow quoted. In some cases the WWTPs have both influent and effluent flows quoted. In the majority of cases where the WWTP has both an influent and effluent flow quoted the effluent flow is either equal to or less than the quoted influent flow. The reduction in flow through the works is considered to be related to spill to storm tanks at the head of the WWTPs during high flow conditions.

Therefore the study proceeded on the working assumption that WWTP influent and effluent flows are equal. This is a reasonable assumption to make when assessed against the macro level context and objectives of this study.

In the case of the influent/effluent load/composition water quality monitoring data results detailed in Table 3.13 it should be noted that the data covers few of the study parameters detailed previously in Table 3.5. In general the WWTPs are monitored for up to nine parameters: BOD, COD, TSS, Total N, Ammonical Nitrogen, TON and Total Kjeldahl Nitrogen. There are no measurements at the WWTPs for any of the 8 metals.

However, in addition to the data in Table 3.13 a comprehensive record of daily influent and effluent strength data for the year 2005 was provided by Dublin City Council (our ref 39325/UP50/CI_282) for the Ringsend WWTP. In addition to the above reference was also made to the EPA Waste Water Treatment Manual to determine the strength of WWTP influents for Ireland. The combination of the data from the three data sources is collated in Table 3.15 for waste water treatment plant effluents.

Table 3.14: WWTP Discharge Limits and Sensitivity Classifications of Receiving Waters

Urban Area Number	Urban Area	County	RBD	Pop. CSO Census 2002	WWTP Name	Sensitivity UWWT Regs 2001	Discharge Limits (2001 Urban WW Regs/ Urban Waste Water Treatment Directive (91/271/EEC))					Min % Removal (2001 Urban WW Regs)				
							BOD	COD	TSS	Total P	Total N	BOD	COD	TSS	Total P	Total N
1	Athlone	Westmeath	SHIRBD	15936	Athlone	Yes	25	125	35	2	15	70-90	75	90	80	70-80
2	Balbriggan	Fingal	ERBD	10294	Balbriggan/ Skerries	No	25	125	35	-	-	70-90	75	90	-	-
3	Bray	Wicklow	ERBD	30951	Bray	No	25	125	35	-	-	70-90	75	90	-	-
4	Carlow	Carlow	SERBD	18487	Mortarstown	Yes	25	125	35	2	15	70-90	75	90	80	70-80
5	Carrigaline	Cork	SWRBD	11191	Ringskiddy Outfall	No	25	125	35	-	-	70-90	75	90	-	-
6	Castlebar	Mayo	WRBD	11371	Castlebar	Yes	25	125	35	2	15	70-90	75	90	80	70-80
7	Celbridge	Kildare	ERBD	16016	Leixlip	Yes	25	125	35	2	15	70-90	75	90	80	70-80
8	Clonmel	Tipperary	SERBD	16910	Clonmel	Yes	25	125	35	2	15	70-90	75	90	80	70-80
					Marlfield	No	< 2000 pe - Appropriate Treatment by 31 Dec 2005					< 2000 pe - Appropriate Treatment by 31 Dec 2005				
					Redmonstown	No	< 2000 pe - Appropriate Treatment by 31 Dec 2005					< 2000 pe - Appropriate Treatment by 31 Dec 2005				
					Kilmacomma	No	< 2000 pe - Appropriate Treatment by 31 Dec 2005					< 2000 pe - Appropriate Treatment by 31 Dec 2005				
9	Cork	Cork	SWRBD	186239	Carrigrennan	Yes	25	125	35	1	10	70-90	75	90	80	70-80
10	Drogheda	Louth	ERBD	31020	Drogheda	No	25	125	35	-	-	70-90	75	90	-	-
11	Dublin	Dublin	ERBD	1004614	Ringsend	Yes	25	125	35	1	10	70-90	75	90	80	70-80
					Balgriffin	No	< 2000 pe - Appropriate Treatment by 31 Dec 2005					< 2000 pe - Appropriate Treatment by 31 Dec 2005				
					Leixlip	Yes	25	125	35	2	15	70-90	75	90	80	70-80
					Coliemore Outfall	No	< 2000 pe - Appropriate Treatment by 31 Dec 2005					< 2000 pe - Appropriate Treatment by 31 Dec 2005				
12	Dundalk	Louth	NBRBD	32505	Dundalk	Yes	25	125	35	1	10	70-90	75	90	80	70-80
13	Ennis	Clare	SHIRBD	22051	Clonroadmore	No	25	125	35	-	-	70-90	75	90	-	-
					Clareabbey	No	25	125	35	-	-	70-90	75	90	-	-
					Clarecastle	No	25	125	35	-	-	25	125	35	-	-
14	Galway	Galway	WRBD	66163	Mutton Island	No	25	125	35	-	-	70-90	75	90	-	-
15	Greystones	Wicklow	ERBD	11913	Greystones	No	25	125	35	-	-	70-90	75	90	-	-
16	Kilkenny	Kilkenny	SERBD	20735	Purcellsinch	Yes	25	125	35	1	10	70-90	75	90	80	70-80
17	Killarney	Kerry	SWRBD	13137	Killarney	Yes	25	125	35	2	15	70-90	75	90	80	70-80
18	Leixlip	Kildare	ERBD	15061	Leixlip	Yes	25	125	35	2	15	70-90	75	90	80	70-80
19	Letterkenny	Donegal	NWRBD	15231	Letterkenny	No	25	125	35	-	-	70-90	75	90	-	-
20	Limerick	Limerick	SHIRBD	86998	Limerick	No	25	125	35	-	-	70-90	75	90	80	-
21	Malahide	Fingal	ERBD	13826	Malahide	Yes	25	125	35	2	15	70-90	75	90	80	70-80
22	Maynooth	Kildare	ERBD	10151	Leixlip	Yes	25	125	35	2	15	70-90	75	90	80	70-80
23	Mullingar	Westmeath	SHIRBD	15621	Mullingar	Yes	25	125	35	2	15	70-90	75	90	80	70-80
24	Naas	Kildare	ERBD	18288	Osberstown	Yes	25	125	35	2	15	70-90	75	90	80	70-80
25	Navan	Meath	ERBD	19417	Navan	Yes	25	125	35	2	15	70-90	75	90	80	70-80
26	Newbridge	Kildare	ERBD	16739	Osberstown	Yes	25	125	35	2	15	70-90	75	90	80	70-80
27	Portlaoise	Laois	SERBD	12127	Portlaoise	Yes	25	125	35	2	15	70-90	75	90	80	70-80
28	Sligo	Sligo	WRBD	19735	Sligo	No	25	125	35	-	-	70-90	75	90	-	-
29	Swords	Fingal	ERBD	27175	Swords	Yes	25	125	35	2	15	70-90	75	90	80	70-80
30	Tralee	Kerry	SHIRBD	21987	Tralee	Yes	25	125	35	2	15	70-90	75	90	80	70-80
31	Tullamore	Offaly	SHIRBD	11098	Tullamore	Yes	25	125	35	2	15	70-90	75	90	80	70-80
32	Waterford	Waterford	SERBD	46736	Water Park PS	No	25	125	35	-	-	70-90	75	90	-	-
					Ballynakill	No	25	125	35	-	-	70-90	75	90	-	-
					Island View	No	< 2000 pe - Appropriate Treatment by 31 Dec 2005					< 2000 pe - Appropriate Treatment by 31 Dec 2005				
					Abbey Park	No	< 2000 pe - Appropriate Treatment by 31 Dec 2005					< 2000 pe - Appropriate Treatment by 31 Dec 2005				
					Giles Quay	No	< 2000 pe - Appropriate Treatment by 31 Dec 2005					< 2000 pe - Appropriate Treatment by 31 Dec 2005				
33	Wexford	Wexford	SERBD	17235	Wexford	Yes	25	125	35	2	15	70-90	75	90	80	70-80

MIR Base Data; Local Authorities; EPA WWTW Returns; EPA Register of Protected Areas; Preliminary Report

*Regulations demand improved treatment of wastewater however the regulations only apply to existing secondary treatment works.

Table 3.15: Estimated Characteristics of Untreated (Influent) Urban Waste Water

Parameter	Average Monitoring Concentrations from Table 3.13 (mg/l)	EPA Typical Characteristics of Urban Waste Water (Wastewater Treatment Manual) (mg/l)	Ringsend WWTP monitored concentrations (mg/l)
BOD	218	100 – 300	295.14
COD	501	250 – 800	611.49
Suspended Solids	249	100 – 350	291.82
Total Phosphorus * (as P)	7	1 – 10 (inorganic & organic)	6.5
Orthophosphates * (as P)	5		3.52
Total Nitrogen * (as N)	32	20 – 85	43.25
Ammonia * (NH_3 as N)	27	10 - 30	26.92
Total Oxidised Nitrogen * (as N)	1		0.45
Total Kjeldahl Nitrogen * (as N)	44		42.3
Heavy Metals* (Cd, Cr, Cu, Pb, Hg, Ni. Ag, Zn)	Not monitored	< 1mg/l	

Parameters of interest to this study.

It should be noted that TKN should not be higher than Total N. Hence figures contained in Table 3.1 are deemed to be incomplete..

From a review of the data in Table 3.15 it is apparent that the values determined for the parameters using both the averaging approach (based upon the supplied data in Table 3.13) and the 2005 influent values for the Ringsend WWTP are broadly within the range of values quoted in the EPA Wastewater Treatment Manual. Therefore the study proceeded on the basis of the averaged figures for the parameters in red from Table 3.15 above (with the exception of the metals) for those WWTPs where there are no quoted influent concentration values in Table 3.13.

As stated previously none of the eight metals listed on Table 3.5 are monitored in the influent to any of the WWTPs, with the exception of Ringsend WWTP where a very small number of values were provided for the year 2005. The EPA Waste Water Treatment Manual indicates that the likely influent concentration for most of the study metals is < 1 mg/l. A value is not quoted for iron.

To try and supplement WWTP influent concentration data for the metals the SWRBD MIR project team were approached to provide influent/effluent concentration characterization data from their Further Characterisation project looking into Muncipal and Industrial issues. As part of that study the SWRBD MIR group were intending to undertake some water quality monitoring at the inlet and outlet from a small number of WWTPs in the SWRBD region. Unfortunately the timeframe for that project was such that no relevant data could be provided to this project.

In the absence of more detailed influent quality data specific to Ireland (with the exception of Ringsend WWTP) ***a decision was made to utilise surrogate data based upon the results from the work done outside of Ireland by UKWIR*** under their project Priority Hazardous Substances Trace Organics and Diffuse Pollution (Water Framework Directive) - Screening Study and Literature review of quantities in sewage, sludge and effluent, ref 02/WW/17/2, 2003.

The UKWIR project characterized WWTP influents and effluents at 30 WWTPs across the UK for the presence of a wide range of substances including all but one of the metals (Fe) included in Table 3.5. The 30 WWTPs covered different types of catchment including, rural, urban, industrial - both large and small and works receiving sewage from separate and combined sewerage systems. The UKWIR report is however non specific and omits typical relevant information relating to catchment types, level of urbanization/industrialisation and sizes etc.

Therefore the adopted WWTP influent surrogate concentration data based upon the UKWIR report values must be used with caution as urbanization/industrialization patterns in the UK may differ from those in Ireland. However, the existence of the Ringsend WWTP influent data provides an opportunity to compare recorded metals concentrations from at least one source in Ireland against the UKWIR data.

Table 4.1 of the UKWIR study contains a set of WWTP influent concentration estimates for a range of metal parameters. These values are presented below in Table 3.16 in conjunction with the average concentrations of the Ringsend WWTP (2005).

Table 3.16: Estimated Influent Strength Concentrations of Untreated Urban Waste Water

Parameter	WWTP Influent Characteristic Values*		Ringsend WWTP (2005)
	Max (ug/l)	Mean (µg/l)	Mean (µg/l)
Cd	6.12	0.76	< 4
Hg	4.58	0.54	?
Pb	165	25.3	< 20
Ni	97.9	14.2	< 12
Cu	556	77.8	60.57
Cr	111	12.4	8.29
Zn	770	155.4	164.8
Fe	?	?	885

*Based upon results quoted in Table 4.1 of UKWIR Report ref 02/WW/17/2, 2003.

The influent concentration data in Table 3.16 shows broad similarities between the two data sets, with the mean values in the Ringsend set being slightly lower than those measured in the UKWIR Study. In comparing them however it has to be remembered that the UKWIR data is based upon a national UK screening programme involving 30 WWTPs whilst the Ringsend WWTP data only applies to a single WWTP and is comprised of only six matching influent/effluent samples for the year 2005.

In the case of Cadmium it is likely that the influent concentrations for Ringsend are much less than 4 ug/l but as the limit of detection of the test for the influent analysis was 4 ug/l it was not possible to determine the lower concentration levels. It is proposed therefore to adopt the UKWIR value of 0.76 ug/l for this parameter for the study WWTPs. In the case of chromium it is proposed to adopt the lower value of 8.29 ug/l from Ringsend to represent all WWTPs. Therefore following a review of the data in Table 3.16 the overall influent strength concentrations proposed for use on the study are as detailed in Table 3.17.

Table 3.17: Proposed Influent Strength Concentrations of Untreated Urban Waste Water

Parameter	Assumed WWTP Influent Concentrations (ug/l)	
	Ringsend WWTP	All Other WWTPs
Cd	0.76	0.76
Hg	0.54	0.54
Pb	20	25.3
Ni	12	14.2
Cu	60.57	60.57
Cr	8.29	8.29
Zn	164.8	155.4
Fe	885	885

Table 3.13 shows that there is little effluent concentration data for Irish WWTPs for most of the parameters of interest to this study. The one exception is in the case of the Ringsend WWTP whereby a small amount of effluent concentration data was provided for the year 2005.

Therefore to progress the study an approach was adopted whereby effluent concentrations were estimated based upon the WWTP process parameter removal rates (i.e. the concentration of the parameter remaining in the effluent was estimated by applying a removal rate to the influent concentration). The working assumption was that the removed/retained parameter fraction will be retained within the WWTP sludge.

However it was established that there is a ***significant absence of WWTP process parameter removal rate information for Irish WWTPs***. In particular for the 8 metals of interest to the urban pressures study none are routinely monitored in the outgoing effluents at any Irish WWTPs – therefore parameter removal rates cannot be established. The one exception is in the case of Ringsend WWTP where a small amount of influent and effluent concentration data was provided for most parameters of interest for the year 2005. The availability of matching influent and effluent concentration data enabled parameter removal rates to be established for the Ringsend WWTP.

Because of these difficulties the use of surrogate WWTP process removal rate data from elsewhere was investigated including:

- Removal rate data quoted in UKWIR report titled ''Identification of the Source of Priority Substances in Sewage Catchments'', Ref 02/WW/14/1, 2002.
- Removal rate data from an American study undertaken by CDM in the late 80s.

Appendix 4 of the UKWIR report provides values for % retention of metals in both WWTP sludges and final treated effluents. These retention percentages are quoted in Table 3.18 below for 7 of the 8 metals being assessed under this study. The retention percentages apply to secondary biological treatment works.

The % retention values obtained from the American CDM study and the monitored Ringsend WWTP results are also detailed in Table 3.18.

Whilst the retention percentages correlate well between the UKWIR and the CDM study data for metals such as Cd, Pb, and Ni – they are not as comparable for other metals. Equally when the UKWIR and Ringsend data are compared they show a reasonable level of broad correlation for two of the three metals for those parameters common to both.

Given that the CDM data comes from a much older study than either of the UKWIR study or the Ringsend WWTP ***it was decided to proceed using a combination of the UKWIR and Ringsend WWTP data***.

For Ringsend WWTP the actual monitored data was used for parameters Cu, Cr, Zn, & Fe whilst the UKWIR data was used as surrogate data for parameters Cd, Hg, Pb, & Ni. The UKWIR data for all metals excluding iron was used as surrogate data for all other study WWTPs. For iron, Fe, Ringsend WWTP data was used for all study WWTPs.

Table 3.18: Metal Retention Percentages in WWTPs

Parameter	WWTP Parameter/Substance Retention Rates % Secondary Treatment Process	CDM Study (late 80's) Secondary Treatment Process	Ringsend WWTP Monitored Values (2005)
Cd	54% in Effluent 46% in Sludge	50% in Effluent 50% in Sludge	?
Hg	38% in Effluent 62% in Sludge	25% in Effluent 75% in Sludge	?
Pb	37% in Effluent 63% in Sludge	43% in Effluent 57% in Sludge	?
Ni	69% in Effluent 31% in Sludge	68% in Effluent 32% in Sludge	?
Cu	35% in Effluent 65% in Sludge	18% in Effluent 82% in Sludge	22% in Effluent 78% in Sludge
Cr	40% in Effluent 60% in Sludge	24% in Effluent 76% in Sludge	53% in Effluent 47% in Sludge
Zn	45% in Effluent 55% in Sludge	24% in Effluent 76% in Sludge	52% in Effluent 48% in Sludge
Fe	?	?	24% in Effluent 76% in Sludge

The retention percentages were applied to the proposed incoming WWTP influent concentrations quoted on Table 3.17 to produce a set of WWTP final effluent concentrations for the study parameters.

The effluent concentrations for the nitrogen and phosphorus parameters (excluding nitrites/nitrates) have been determined on the basis of the following:

- For those WWTPs where effluent monitored results are available the monitored results were used to represent the effluent concentrations.

- For those WWTPs with no effluent monitoring results and which discharge to sensitive waters it was assumed that their effluent is compliant with the 2001 UWWT Regulation discharge limits.

- For those WWTPs with no effluent monitoring results and which discharge to non-sensitive waters and have nutrient reduction treatment facilities in operation, it was assumed that they comply with the 2001 UWWT Regulation discharge limits.

- For those small number of WWTPs with no nutrient reduction treatment facilities and no effluent monitoring results which discharge to non-sensitive waters, representative effluent concentrations have been estimated based upon the overall average concentration value estimated from the monitored WWTPs listed in Table 3.13.

Using the data from the various tables quoted above, a WWTP effluent discharge concentration loading matrix was prepared for use in the study representing the existing catchment development horizon. The details of the loading matrix are presented in Table 3.19. Table 3.19 contains suggested WWTP effluent discharge concentrations for 12 (nitrates and nitrites are excluded) of the 14 parameter suite being assessed under this study.

By amalgamating and applying the flow data from Table 3.13 with the concentration data from Table 3.19 the Cumulative Annual Loading Estimates for WWTP Effluent Discharges were estimated for the existing development horizon and presented in Table 3.20.

The data presented in Table 3.20 is based on the following assumptions:

- For Bray, Carrigaline, Sligo and Waterford the data used is based on proposed future works for the towns as recommended in the associated Preliminary Reports.

- The proposed WWTP influent metal concentration values from Table 3.17 have been used in the analysis.

- The nine smaller works with pe values ranging from 60 to 9,000 have not been included in the loading estimates as their population equivalents fall below the 10,000 threshold values used for this study.

In addition Table 3.20 also lists for each WWTP discharge (or planned discharge) for the 33 urban catchment areas the following;

- Point of Discharge for the effluent (three categories - In catchment ; Within 1km d/s ; or Further downstream)

- Name of receiving water and type - Transitional Water / River / Coastal

The data presented in Table 3.20 is based upon individual WWTP loadings. The urban pressures surface waters study is however considering impacts on receiving waters within urban areas. Whilst most urban areas are served by a single WWTP discharging to a single point in a surface water, a number of the urban areas have more than one surface water. Therefore in some cases there are individual surface waters within urban areas which receive no direct WWTP discharges.

To address this issue Table 3.21, The WWTP Effluent Discharge Annual Loading Matrix has been prepared for the existing development horizon. Table 3.21 was prepared to allocate WWTP effluent loadings by receiving study urban surface water as opposed to study urban area. The data in Table 3.21 is used as part of the overall project stage 7 assimilative capacity assessments which are discussed later under Section 3.9 of this report.

For a more detailed understanding of how the WWTP assessment aspect of the project was implemented the reader is referred to the document titled – ''Surface Waters – WWTP effluent discharge loadings'', Ref 39325/UP40/DG25 – S, Final 02, Feb 2008.

Table 3.19: WWTP Effluent Concentration Loading Matrix – Existing Development Horizon

					Effluent Loading Matrix Values A						Effluent Loading Matrix Values B							
Urban Area number	Urban Areas	Pop. CSO Census 2002	RBD	WWTP Name	Nitrates (mg/l)	Nitrites (mg/l)	Total Nitrogen (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Phosphorous (mg/l)	Ortho-phosphate (mg/l)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Fe (µg/l)	Pb (µg/l)	Hg (µg/l)	Ni (µg/l)	Zn (µg/l)
1	Athlone	15936	SHIRBD	Athlone	nd	nd	15.00	6.67	0.86	0.49	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
2	Balbriggan	10294	ERBD	Balriggan/Skerries	nd	nd	14.97	8.47	2.00	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
3	Bray	30951	ERBD	Shanganagh	nd	nd	14.97	8.47	1.51	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
4	Carlow	18487	SERBD	Mortarstown	nd	nd	27.00	1.80	0.52	0.97	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
5	Carrigaline	11191	SWRBD	Lower Harbour Scheme	nd	nd	14.97	8.47	1.51	1.00	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
6	Castlebar	11371	WRBD	Castlebar	nd	nd	15.00	8.47	0.14	0.12	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
7	Celbridge	16016	ERBD	Leixlip	nd	nd	13.89	8.47	1.05	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
8	Clonmel	16910	SERBD	Clonmel	nd	nd	9.21	8.47	1.45	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
9	Cork	186239	SWRBD	Carrigrennan	nd	nd	15.00	8.47	2.00	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
10	Drogheda	31020	ERBD	Drogheda	nd	nd	7.60	8.47	1.80	2.82	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
11	Dublin	1004614	ERBD	Ringsend	nd	nd	15.00	7.59	3.26	2.20	0.410	4.394	13.325	212.400	7.400	0.205	8.280	85.696
12	Dundalk	32505	NBRBD	Dundalk	nd	nd	15.00	8.47	2.00	1.72	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
13	Ennis	22051	SHIRBD	Clonroadmore	nd	nd	14.97	8.47	1.51	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
				Clareabbey	nd	nd	14.97	8.47	1.51	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
14	Galway	66163	WRBD	Mutton Island	nd	nd	12.97	8.47	7.26	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
15	Greystones	11913	ERBD	Greystones	nd	nd	18.01	8.47	1.54	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
16	Kilkenny	20735	SERBD	Purcellsinch	nd	nd	15.00	8.47	2.00	0.60	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
17	Killarney	13137	SWRBD	Killarney	nd	nd	15.00	8.47	0.26	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
18	Leixlip	15061	ERBD	Leixlip	nd	nd	13.89	8.47	1.05	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
19	Letterkenny	15231	NWRBD	Letterkenny	nd	nd	14.97	8.47	3.32	2.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
20	Limerick	86998	SHIRBD	Limerick	nd	nd	11.90	11.30	0.98	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
21	Malahide	13826	ERBD	Malahide	nd	nd	15.00	8.47	2.00	3.97	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
22	Maynooth	10151	ERBD	Leixlip	nd	nd	13.89	8.47	1.05	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
23	Mullingar	15621	SHIRBD	Mullingar	nd	nd	15.00	8.47	0.29	0.14	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
24	Naas	18288	ERBD	Osberstown	nd	nd	13.73	8.47	0.72	0.46	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
25	Navan	19417	ERBD	Navan	nd	nd	19.95	8.47	1.46	1.31	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
26	Newbridge	16739	ERBD	Osberstown	nd	nd	13.73	8.47	0.72	0.46	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
27	Portlaoise	12127	SERBD	Portlaoise	nd	nd	15.00	8.47	1.51	0.70	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
28	Sligo	19735	WRBD	Sligo	nd	nd	14.97	8.47	1.51	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
29	Swords	27175	ERBD	Swords	nd	nd	15.00	15.00	2.00	0.72	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
30	Tralee	21987	SHIRBD	Tralee	nd	nd	15.00	8.47	2.00	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
31	Tullamore	11098	SHIRBD	Tullamore	nd	nd	27.75	8.47	0.50	0.41	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
32	Waterford	46736	SERBD	Waterford	nd	nd	14.97	8.47	1.51	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930
33	Wexford	17235	SERBD	Wexford	nd	nd	6.11	8.47	1.95	1.21	0.410	3.316	21.200	212.400	9.361	0.205	9.798	69.930

Monitored - Table 3.13

Assumed : Based upon calculated average of monitored effluent results

Based upon assumed compliance with Sensitive Water discharge limits - See Table 3.12

Preliminary Report

Based upon Tables 3.17 & 3.18

No data

Table 3.20: Cumulative Annual Loading Estimates for WWTP Effluent Discharges – Existing Development Horizon

Urban Area Number	Urban Area	Pop Census 2002	RBD	WWTP Name	PE Operational	Receiving Waters		Point of Discharge (Relative to Urban Catchment Boundary)	Inflow (m3/d)	Outflow (m3/d)	Inflow (m3/yr)	Outflow (m3/yr)	Yearly Effluent Loadings kg/yr													
						Type	Name						Nitrates (kg/yr)	Nitrites (kg/yr)	Total Nitrogen (kg/yr)	Total Kjeldahl Nitrogen (kg/yr)	Total Phosphorous (kg/yr)	Ortho-phosphate (kg/yr)	Cd (kg/yr)	Cr (kg/yr)	Cu (kg/yr)	Fe (kg/yr)	Pb (kg/yr)	Hg (kg/yr)	Ni (kg/yr)	Zn (kg/yr)
1	Athlone	15936	SHIRBD	Athlone	21000	River	Shannon	Inside Catchment	5932	5932	2165180	2165180	nd	nd	32478	14435	1869	1051	0.889	7.18	46	460	20	0.444	21	151
2	Balbriggan	10294	ERBD	Balriggan /Skerries	30000	Coastal	Irish Sea	Far Downstream	6900	6900	2518500	2518500	nd	nd	37702	21332	5037	3036	1.034	8.35	53	535	24	0.517	25	176
3	Bray	30951	ERBD	Shanganash	130800	Coastal	Irish Sea		29430	29430	10741950	10741950	nd	nd	160807	90984	16220	12951	4.408	35.62	228	2282	101	2.204	105	751
4	Carlow	18487	SERBD	Mortarstown	35000	River	Barrow	Within 1km downstream	8500	8500	3102500	3102500	nd	nd	83768	5585	1618	3003	1.273	10.29	66	659	29	0.637	30	217
5	Carrigaline	11191	SWRBD	Lower Harbour Scheme	60383	Coastal	Irish Sea	Pumped downstream to Ringaskiddy	11533	11533	4209545	4209545	nd	nd	63017	35655	6356	4210	1.728	13.96	89	894	39	0.864	41	294
6	Castlebar	11371	WRBD	Castlebar	23000	River	Liscromwell River	Inside Catchment	7500	8000	2737500	2920000	nd	nd	43800	24732	409	350	1.198	9.68	62	620	27	0.599	29	204
7	Celbridge	16016	ERBD	Leixlip	80000	River	River Liffey	Pumped to Leixlip WWTP	23376	23376	8532240	8532240	nd	nd	118474	72268	8977	10287	3.502	28.29	181	1812	80	1.751	84	597
8	Clonmel	16910	SERBD	Clonmel	37111	River	Suir	Inside Catchment	6362	6362	2322130	2322130	nd	nd	21393	19668	3377	2800	0.953	7.70	49	493	22	0.477	23	162
9	Cork	186239	SWRBD	Carrigrennan	250000	Transitional	Lough Mahon	Far Downstream	93561	93561	34149765	34149765	nd	nd	512246	289249	68300	41173	14.015	113.24	724	7253	320	7.008	335	2388
10	Drogheda	31020	ERBD	Drogheda	67700	Transitional	Boyne Estuary	Inside Catchment	8996	8996	3283540	3283540	nd	nd	24966	27812	5906	9260	1.348	10.89	70	697	31	0.674	32	230
11	Dublin	1004614	ERBD	Ringsend	1900000	Transitional	Liffey Estuary Lower	Inside Catchment	394136	389480	143859640	142160200	nd	nd	2132403	1079674	463481	312833	58.343	624.61	1894	30195	1052	29.171	1177	12183
12	Dundalk	32505	NBRBD	Dundalk	179535	Transitional	Castletown Estuary	Inside Catchment	20,000	12000	7300000	4380000	nd	nd	65700	37099	8760	7547	1.798	14.52	93	930	41	0.899	43	306
13	Ennis	22051	SHIRBD	Clonroadmore	17000	River	Fergus River	Inside Catchment	6000	6000	2190000	2190000	nd	nd	32784	18549	3307	2640	0.899	7.26	46	465	21	0.449	21	153
				Clareabbey	6000	River	Fergus River	Inside Catchment	1500	1500	547500	547500	nd	nd	8196	4637	827	660	0.225	1.82	12	116	5	0.112	5	38
14	Galway	66163	WRBD	Mutton Island	63700	Transitional	Corrib Estuary	Far Downstream	46855	46855	17102075	17102075	nd	nd	221861	144855	124223	20619	7.019	56.71	363	3632	160	3.509	168	1196
15	Greystones	11913	ERBD	Greystones	27000	Coastal	Irish Sea	Within 1km downstream	5400	5400	1971000	1971000	nd	nd	35496	16694	3032	2376	0.809	6.54	42	419	18	0.404	19	138
16	Kilkenny	20735	SERBD	Purcellsinch	107650	River	Nore	Within 1km downstream	8500	8500	3102500	3102500	nd	nd	46538	26278	6205	1862	1.273	10.29	66	659	29	0.637	30	217
17	Killarney	13137	SWRBD	Killarney	51000	Lake	Lough Leane	Inside Catchment	7072	7072	2581280	2581280	nd	nd	38719	21863	676	3112	1.059	8.56	55	548	24	0.530	25	181
18	Leixlip	15061	ERBD	Leixlip	80000	River	River Liffey	Downstream into Dublin Urban Area	23376	23376	8532240	8532240	nd	nd	118474	72268	8977	10287	3.502	28.29	181	1812	80	1.751	84	597
19	Letterkenny	15231	NWRBD	Letterkenny	22000	Transitional	Swilly	Within 1km downstream	5300	4500	1934500	1642500	nd	nd	24588	13912	5458	3625	0.674	5.45	35	349	15	0.337	16	115
20	Limerick	86998	SHIRBD	Limerick	130000	Transitional	Limerick Dock	Within 1km downstream	43108	44000	15734420	16060000	nd	nd	191114	181478	15739	19363	6.591	53.25	340	3411	150	3.296	157	1123
21	Malahide	13826	ERBD	Malahide	21000	Coastal	Irish Sea	Inside Catchment	3,500	3,500	1277500	1277500	nd	nd	19163	10820	2555	5069	0.524	4.24	27	271	12	0.262	13	89
22	Maynooth	10151	ERBD	Leixlip	80000	River	River Liffey	Pumped to Leixlip WWTP	23376	23376	8532240	8532240	nd	nd	118474	72268	8977	10287	3.502	28.29	181	1812	80	1.751	84	597
23	Mullingar	15621	SHIRBD	Mullingar	24000	River	Brosna	Inside Catchment	7500	7500	2737500	2737500	nd	nd	41063	23187	786	378	1.123	9.08	58	581	26	0.562	27	191
24	Naas	18288	ERBD	Osberstown	80000	River	River Liffey	Within 1km downstream	19294	19294	7042310	7042310	nd	nd	96714	59648	5079	3222	2.890	23.35	149	1496	66	1.445	69	492
25	Navan	19417	ERBD	Navan	40000	River	Boyne River	Inside Catchment	8300	7500	3029500	2737500	nd	nd	54613	23187	3987	3574	1.123	9.08	58	581	26	0.562	27	191
26	Newbridge	16739	ERBD	Osberstown	80000	River	River Liffey	Pumped to Naas WWTP	19294	19294	7042310	7042310	nd	nd	96714	59648	5079	3222	2.890	23.35	149	1496	66	1.445	69	492
27	Portlaoise	12127	SERBD	Portlaoise	20000	River	Triogue	Inside Catchment	5200	5200	1898000	1898000	nd	nd	28470	16076	2866	1338	0.779	6.29	40	403	18	0.389	19	133
28	Sligo	19735	WRBD	Sligo	50000	Transitional	Garavogure River Estuary	Inside Catchment	12500	12500	4562500	4562500	nd	nd	68301	38644	6889	5501	1.872	15.13	97	969	43	0.936	45	319
29	Swords	27175	ERBD	Swords	60000	Transitional	Broadmeadow	Inside Catchment	8500	8500	3102500	3102500	nd	nd	46538	46538	6205	2239	1.273	10.29	66	659	29	0.637	30	217
30	Tralee	21987	SHIRBD	Tralee	42000	Transitional	Lee K Estuary	Far Downstream	10714	10714	3910610	3910610	nd	nd	58659	33123	7821	4715	1.605	12.97	83	831	37	0.802	38	273
31	Tullamore	11098	SHIRBD	Tullamore	20000*	River	Tullamore	Inside Catchment	4514	4164	1647610	1519860	nd	nd	42176	12873	763	629	0.624	5.04	32	323	14	0.312	15	106
32	Waterford	46736	SERBD	Waterford		Transitional	Lower Suir Estuary	Inside Catchment	16992	16992	6202080	6202080	nd	nd	92845	52532	9365	7478	2.545	20.57	131	1317	58	1.273	61	434
33	Wexford	17235	SERBD	Wexford	13000	River	Piercetown Coolballow	Inside Catchment	9531	9531	3478815	3478815	nd	nd	21250	29466	6787	4194	1.428	11.54	74	739	33	0.714	34	243

MIR Base Dataset — Local Authorities — EPA Data (David Smith, 2003 EPA Returns, EPA Regulations) — Preliminary Reports

1 *Balbriggan, Bray, Carrigaline, Sligo and Waterford WWTW data based on future works from preliminary works.*
2 *Where the outflow volume is not provided it is presumed to be equal to the inflow.*
3 *Effluent total kjeldahl nitrogen, and ortho-phosphate are based on monitored effluent data as shown in Table 3.13. Where this is not available, the average of monitored urban wastewater effluents for the parameter concerned from Table 3.13 has been used.*
4 *Effluent total phosphorous and total nitrogen assumptions:*
  1 *Those WWTP discharging to sensitive waters discharge nitrogen and phosphorous in compliance with 2001 WWTW Discharge Limits (Table 3.12) .*
  2 *Those WWTP with nutrient reduction facilities discharging to non-sensitive waters discharge nitrogen and phosphorus in compliance with 2001 WWTW Discharge Limits (Table 3.12).*
  3 *For those WWTP for which the above assumptions do not apply, monitored data was used where available. Where monitored information was not available the average monitored value was used (Table 3.13).*
5 *Effluent metal volumes based upon effluent concentrations in Table 3.19. Table 3.19 is based on both monitored Ringsend WWTP influents and mean UKWIR influent strength wastewater concentrations (Table 3.16/3.17), adjusted by process separation factors (Table 3.18).*

Table 3.21: WWTP Effluent Discharge Annual Loading Matrix – Existing Development Horizon

LOADING MATRIX

Surface Water Type	Urban Area Name	Surface Water Name	Nitrates (kg/yr)	Nitrites (kg/yr)	Total N (kg/yr)	Nitrogen (TKN) (kg/yr)	Total Phosphorous (kg/yr)	Ortho-phosphate (kg/yr)	Cadmium (kg/yr)	Chromium (kg/yr)	Copper (kg/yr)	Iron (kg/yr)	Lead (kg/yr)	Mercury (kg/yr)	Nickel (kg/yr)	Zinc (kg/yr)
r	Athlone	Shannon (Main) (River)			32478	14435	1869	1051	0.889	7	46	460	20	0.444	21	151
r	Carlow	River Barrow (River)			83768	5585	1618	3003	1.273	10	66	659	29	0.637	30	217
t	Carrigaline	Owenboy Estuary (Part Only) (Transitional)														
r	Castlebar	Liscromwell (River)			43800	24732	409	350	1.198	10	62	620	27	0.599	29	204
r	Celbridge	River Liffey (River)							**Celbridge pumps to Leixlip**							
r	Clonmel	River Suir (River)			21393	19668	3377	2800	0.953	7.700	49	493	22	0.477	23	162
t	Cork	Lee (Cork Estuary) Lower (Transitional)														
t	Drogheda	Boyne Estuary (Part Only) (Transitional)			24966	27812	5906	9260	1.348	11	70	697	31	0.674	32	230
t	Dundalk	Castletown Estuary (Transitional)			65700	37099	8760	7547	1.798	15	93	930	41	0.899	43	306
r	Ennis	River Fergus (River)			32784	18549	3307	2640	0.899	7.262	46	465	21	0.449	21	153
r	Kilkenny	River Nore (River)			46538	26278	6205	1862	1.273	10	66	659	29	0.637	30	217
t	Letterkenny	Swilly Estuary (Part Only) (Transitional)														
r	Lexlip	River Liffey (River)														
t	Limerick	Limerick Dock (Part Only) (Transitional)														
r	Maynooth	River Ryewater (River)							**Maynooth pumps to Leixlip**							
r	Mullingar	River Brosna (River)			41063	23187	786	378	1.123	9.078	58	581	26	0.562	27	191
r	Naas	River Morell (River)							**Naas pumps to Osberstown**							
r	Navan	River Boyne (River)			54613	23187	3987	3574	1.123	9.078	58	581	26	0.562	27	191
r	Newbridge	River Liffey (River)							**Newbridge pumps to Osberstown**							
r	Portlaoise	Triogue (Barrow) River (River)			28470	16076	2866	1338	0.779	6.294	40	403	18	0.389	19	133
r	Swords	Broadmeadow River (River)														
r	Tralee	Big River (River)														
r	Tullamore	Tullamore River (River)			42176	12873	763	629	0.624	5	32	323	14	0.312	15	106
t	Waterford	Suir Estuary (Transitional)			92845	52532	9365	7478	2.545	21	131	1317	58	1.273	61	434
t	Wexford	Lower Slaney Estuary (Part Only) (Transitional)			21250	29466	6787	4194	1.428	12	74	739	33	0.714	34	243
r	Dublin	River Dodder (River)														
r	Dublin	River Camac (River)														
r	Dublin	River Liffey (River)			118474	72268	8977	10287	3.502	28	181	1812	80	1.751	84	597
r	Dublin	Tolka River (River)														
r	Dublin	Santry River (River)														
t	Dublin	Liffey Estuary Upper (Transitional)														
t	Dublin	Liffey Estuary Lower (Transitional)			2132403	1079674	463481	312833	58	625	1894	30195	1052	29	1177	12183
t	Dublin	Tolka Estuary (Transitional)														
t	Galway	Corrib Estuary (Transitional)			221861	144855	124223	20619	7.019	57	363	3632	160	3.509	168	1196
r	Galway	Corrib River (River)														
r	Killarney	Deenagh River (River)														
r	Killarney	Flesk River (River)														
t	Sligo	Garavogue Estuary (Transitional)			68301	38644	6889	5501	1.872	15	97	969	43	0.936	45	319
r	Sligo	River Garavogue (River)														
?	Balbriggan	NONE PROPOSED														
?	Bray	NONE PROPOSED														
?	Greystones	NONE PROPOSED														
?	Malahide	NONE PROPSED														

3.8.5 Atmospheric Deposition Pressures

The project brief stipulated that consideration would be given to the need to include an atmospheric deposition load as an urban pressure. Atmospheric deposition is the process by which chemical constituents move from the atmosphere to the Earth's surface. Deposition occurs in two ways:

- Wet Deposition – Gaseous, aerosol or particulate matter in rain or cloud droplets.
- Dry Deposition – Deposits directly onto the surface of the Earth.

Atmospheric deposition can be local or long-range. Pollutants can have varying residency times in air, travel great distances (transboundary pollutants) and undergo chemical changes before being deposited to the ground (Scottish EPA).

Wet deposition can be estimated by multiplying chemical concentration in rainwater by the precipitation rate. Concentration maps may be prepared by simple interpolation of the annual average concentration data from wet-only samplers over the relevant area (Aherne et al., 2000).

Dry deposition can be estimated by multiplying pollutant concentration in air by a dry deposition rate. Alternatively dry deposition can be estimated by utilising a vegetation specific filter factor to determine the percentage of wet deposition taken up in the actual vegetation. The difference between the estimated vegetation percentage and 100 % is the defacto dry deposition percentage (Aherne et al., 2000).

In total eleven data sources were extensively reviewed as part of this project. The eleven data sources fell into three categories incorporating:

- Air Quality Monitoring (5 No)
- Modelling (3 No)
- Emissions Monitoring (3 No)

The details of the extensive review process are presented in the document titled – ''Surface Waters – Atmospheric Deposition Loadings Methodology'', Ref 39325/UP40/DG30 – S, Final 02, Jan 2008. In essence the review process highlighted that whilst there are many atmospheric monitoring, assessment and modelling programmes ongoing many of them focus on parameters other than those of interest to this study. Table 3.22 shows the data coverage from a number of various data sources which potentially relates to the study parameters.

Table 3.22 demonstrates that whilst there is ***considerable air monitoring information available for nitrogen compounds there is a significant absence of any meaningful data for other parameters of interest including either phosphorus or the metals.***

Table 3.22: Background Atmospheric Monitoring Data Availability

Urban Area Number	Closest Urban Area	Air Monitoring Station	Station Control	N	P	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Zn
1	Athlone												
2	Balbriggan												
3	Bray												
4	Carlow	Carlow	EPA 2005	NO_2						Y			
		Oak Park	EPA Trans., Teagasc	NO_x, NH_4									
5	Carrigaline	`											
6	Castlebar												
7	Celbridge												
8	Clonmel												
9	Cork	Old Station Rd	EPA 2005	NO_2						Y			
		Glashaboy	EPA 2005	NO_2, NO_x									
10	Drogheda												
11	Dublin	Branch Road	EPA 2005							Y			
		Coleraine Street	EPA 2005	NO_2						Y			
		Kilbarrack	EPA 2005							Y			
		Rathmines	EPA 2005	NO_2						Y			
		Winetavern Street	EPA 2005	NO_2						Y			
12	Dundalk	Kilkitt, Co. Monaghan	EPA 2005	NO_2, NOx									
13	Ennis												
14	Galway	Mace Head	EPA Trans.										
		Burren*	ESB	NOx, NH_4									
15	Greystones	Turlough Hill*	ESB	NOx, NH_4		Y	Y	Y		Y	Y	Y	Y
16	Kilkenny	Kilkenny	EPA 2005	NO_2						Y			
17	Killarney	Valentia	Met Eireann	NOx, NH_4			Y	Y		Y	Y	Y	Y
18	Leixlip												
19	Letterkenny	Malin Head	EPA Trans.	NOx, NH_4									
		Glenn Veagh	EPA Trans.	NOx, NH_4									
20	Limerick												
21	Malahide												
22	Maynooth												
23	Mullingar												
24	Naas												
25	Navan												
26	Newbridge												
27	Portlaoise	Mountrath, Co Laois	EPA 2005	NO_2, NOx						Y			
		RidgeCapard*	ESB	NOx									
28	Sligo	Lough Navar	U.K DOE	NO_3, NH_4									
29	Swords												
30	Tralee												
31	Tullamore												
32	Waterford												
33	Wexford	Wexford	EPA 2005	NO_2						Y			
		Wexford	EPA Trans.	NOx, NH_4									
		Carnsore Point	EPA trans.	NOx, NH_4									

* Red denotes monitoring stations which closed in 2003.

Following a completion of the review Table 3.23 was prepared which details the national estimated atmospheric deposition loading rates that are recommended for use for this study to cover a number of the study parameters across the 33 urban study areas. It should be noted that the data in Table 3.23 is based upon a combination of data from five data sources including:

- EPA Critical Loads Document (Aherne, J., et al.)– Research document entitled Critical Loads and Levels. The annual deposition loading rates for each of the urban areas was found by superimposing the outline of the urban areas on the total nutrient nitrogen deposition map compiled within the EPA study. (Total Nitrogen)

- Eutrophication Document (Jennings, E. et al, 2003) - Eutrophication from agricultural sources. There were two values given for Ireland. One for the east and the second for the west. (Phosphorous)

- EMEP Models – The loadings for each of the urban areas was found by superimposing the outline of the urban areas on the national EMEP model atmospheric deposition maps. (Cadmium, Lead, Mercury)

- Valentia Background Monitoring – The total deposition concentration of heavy metals in rainfall was transformed to loadings by multiplying the concentration of heavy metal in rainfall by the yearly rainfall depth specific to the urban area for the year 2005. The rainfall data was sourced from the Met Eireann Tucson (The Unified Climate and Synoptic Observation Network) raingauge network rainfall records (the document titled - ''Surface Waters – Urban Catchment Diffuse Runoff Methodology'', Ref 39325/UP 40/DG 44). This approach presumes that the total concentration of metals found in rainfall samples in Valentia, Kerry is representative of the remainder of the country. This is a reasonable assumption to make when assessed against the macro level context and objectives of this study particularly in view of the fact that the atmospheric deposition loadings will be applied only directly to surface water surfaces because the atmospheric deposition loadings to urban lands are accounted for within the EMCs used for the diffuse runoff estimations (Section 3.8.6 below for details. Cadmium, Chromium, Copper, Lead, Mercury, Nickel & Zinc)

- EPA Oak Park – When compiling this data three recent average concentrations of nitrates were available: Glenveagh, Co. Donegal (April – Dec 2005), Oak Park (2005), Co. Carlow and Valentia, Co. Kerry (2004). At 0.26mg/l, Oak Park had the highest value and therefore was used for this assessment to be conservative. The total deposition concentration of nitrates in rainfall in mg/l was transformed to loadings by multiplying the concentrations of nitrates by the average rainfall (the document titled - ''Surface Waters – Urban Catchment Diffuse Runoff Methodology'', Ref 39325/UP 40/DG 44) around the country. (Nitrates).

Table 3.23 shows that atmospheric deposition loading estimates have been derived for ten of the fourteen parameters listed in Table 3.5. There are four parameters for which no loading estimates could be prepared: nitrites, total kjeldahl nitrogen (TKN), ortho-phosphate and iron.

Table 3.23: Estimated Atmospheric Deposition Loadings (kg/ha/year)

Urban Area Number	Urban Area	Tucson Rainfall Details (mm)	EPA Oak Park		EPA Critical Loads Document		EPA Eutrophication Document			Valentia Background Monitoring (1997 -2006) using National Rainfall Data (1971 -2000)						
			NO3-N	NO2-N	Total N	TKN	Total P	PO_4^{3-}	Fe	Cd	Cr	Cu	Pb	Hg	Ni	Zn
1	Athlone	868	2.257	n/a	15	n/a	0.040	n/a	n/a	0.002	0.013	0.047	0.020	0.001	0.061	0.259
2	Balbriggan	676	1.758	n/a	10	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
3	Bray	676	1.758	n/a	10	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
4	Carlow	731	1.901	n/a	15	n/a	0.110	n/a	n/a	0.001	0.011	0.039	0.017	0.001	0.051	0.218
5	Carrigaline	755	1.963	n/a	20	n/a	0.040	n/a	n/a	0.002	0.011	0.040	0.018	0.001	0.053	0.225
6	Castlebar	1011	2.629	n/a	5	n/a	0.040	n/a	n/a	0.002	0.015	0.054	0.024	0.001	0.071	0.302
7	Celbridge	676	1.758	n/a	15	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
8	Clonmel	988	2.569	n/a	20	n/a	0.110	n/a	n/a	0.002	0.015	0.053	0.023	0.001	0.069	0.295
9	Cork	755	1.963	n/a	10	n/a	0.040	n/a	n/a	0.002	0.011	0.040	0.018	0.001	0.053	0.225
10	Drogheda	676	1.758	n/a	15	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
11	Dublin	676	1.758	n/a	10	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
12	Dundalk	910	2.366	n/a	10	n/a	0.110	n/a	n/a	0.002	0.014	0.049	0.021	0.001	0.064	0.272
13	Ennis	1011	2.629	n/a	15	n/a	0.040	n/a	n/a	0.002	0.015	0.054	0.024	0.001	0.071	0.302
14	Galway	1011	2.629	n/a	10	n/a	0.040	n/a	n/a	0.002	0.015	0.054	0.024	0.001	0.071	0.302
15	Greystones	676	1.758	n/a	10	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
16	Kilkenny	731	1.901	n/a	15	n/a	0.110	n/a	n/a	0.001	0.011	0.039	0.017	0.001	0.051	0.218
17	Killarney	984	2.558	n/a	15	n/a	0.040	n/a	n/a	0.002	0.015	0.053	0.023	0.001	0.069	0.294
18	Leixlip	676	1.758	n/a	15	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
19	Letterkenny	1011	2.629	n/a	10	n/a	0.040	n/a	n/a	0.002	0.015	0.054	0.024	0.001	0.071	0.302
20	Limerick	1011	2.629	n/a	10	n/a	0.110	n/a	n/a	0.002	0.015	0.054	0.024	0.001	0.071	0.302
21	Malahide	676	1.758	n/a	10	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
22	Maynooth	676	1.758	n/a	10	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
23	Mullingar	868	2.257	n/a	15	n/a	0.110	n/a	n/a	0.002	0.013	0.047	0.020	0.001	0.061	0.259
24	Naas	676	1.758	n/a	15	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
25	Navan	676	1.758	n/a	15	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
26	Newbridge	676	1.758	n/a	15	n/a	0.110	n/a	n/a	0.001	0.010	0.036	0.016	0.001	0.047	0.202
27	Portlaoise	731	1.901	n/a	15	n/a	0.110	n/a	n/a	0.001	0.011	0.039	0.017	0.001	0.051	0.218
28	Sligo	1011	2.629	n/a	10	n/a	0.040	n/a	n/a	0.015	0.054	0.024	0.001	0.071	0.302	0.302
29	Swords	676	1.758	n/a	10	n/a	0.110	n/a	n/a	0.010	0.036	0.016	0.001	0.047	0.202	0.202
30	Tralee	984	2.558	n/a	15	n/a	0.040	n/a	n/a	0.015	0.053	0.023	0.001	0.069	0.294	0.294
31	Tullamore	868	2.257	n/a	15	n/a	0.110	n/a	n/a	0.013	0.047	0.020	0.001	0.061	0.259	0.259
32	Waterford	945	2.457	n/a	15	n/a	0.110	n/a	n/a	0.014	0.051	0.022	0.001	0.066	0.282	0.282
33	Wexford	945	2.457	n/a	15	n/a	0.110	n/a	n/a	0.014	0.051	0.022	0.001	0.066	0.282	0.282

n/a = Not Available

However by definition values for three of these parameters (nitrites, TKN and ortho-phosphates are included within the presented total nitrogen and total phosphorous loadings on the above table. Atmospheric deposition values for iron have not been developed due to a general lack of information.

The atmospheric deposition loading estimates for the metals are generally less than 10 kg/km2/yr except for zinc where the highest value is 30 kg/km2/yr. Total phosphorous atmospheric deposition was also quite low with an upper value of 10.65 kg/km2/yr. The total nitrogen atmospheric deposition loadings were significantly higher at between 500 and 1500 kg/km2/yr with up to 270 kg/km2/yr contributed to by nitrates.

It should also be noted from Table 3.23 that the loadings for cadmium, lead and mercury from the EMEP data source are on average approximately 80% less than the loadings found using Valentia monitoring data.

In order to prepare the atmospheric deposition annual loading matrix the atmospheric deposition loading values in Table 3.23 were applied only to the surface area of the surface waters within the study urban areas. Atmospheric deposition loading values have not been prepared for the land surfaces within the study urban area catchments because runoff loadings for these areas were based upon the EMC approach referred to in Section 3.8.6. The surface areas for each of the surface waters in the study urban area catchments were estimated using GIS and are detailed in Table 3.24.

By amalgamating and applying the surface water surface area data from Table 3.24 with the cumulative annual loading data from Table 3.23 the cumulative annual loading estimates for atmospheric deposition directly onto the surface waters were estimated for the existing development horizon. The prepared estimates are presented in Table 3.25.

For a more detailed understanding of how the atmospheric deposition loading assessment aspect of the project was implemented the reader is referred to the document titled - ''Surface Waters – Atmospheric Deposition Loadings Methodology'', Ref 39325/UP40/DG44 – S, Final 02, Jan 2008.

3.8.6 Diffuse Urban Runoff Pressures

For the purposes of this study diffuse urban runoff is defined as surface water rainfall runoff from within the study urban catchment areas which discharges to surface waters through any pathway with the exception of those discharges which emanate from foul/combined sewer networks (Combined Sewer Overflows or untreated effluent outfalls) or WWTP outfalls.

For most urban catchments the diffuse urban runoff will be comprised of two components:

- Runoff from permeable or impermeable areas connected to separate storm sewer systems which discharge directly to surface waters.
- Overland flow/runoff from permeable or impermeable areas draining directly to surface waters.

Table 3.24: Surfacewater Surface Areas within Study Urban Areas

Urban Area Name	Surface Water Name	Tucson Rainfall Details (mm)	Area of Surfacewater (km²)
Athlone	Shannon (Main) (River)	868	0.29
Carlow	River Barrow (River)	731	0.08
Carrigaline	Owenboy Estuary (Part Only) (Transitional)	755	0.18
Castlebar	Liscromwell (River)	1011	0.03
Celbridge	River Liffey (River)	676	0.07
Clonmel	River Suir (River)	988	0.18
Cork	Lee (Cork Estuary) Lower (Transitional)	755	0.89
Drogheda	Boyne Estuary (Part Only) (Transitional)	676	0.52
Dundalk	Castletown Estuary (Transitional)	910	1.88
Ennis	River Fergus (River)	1011	0.48
Kilkenny	River Nore (River)	731	0.19
Letterkenny	Swilly Estuary (Part Only) (Transitional)	1011	0.19
Lexlip	River Liffey (River)	676	0.05
Limerick	Limerick Dock (Part Only) (Transitional)	1011	1.43
Maynooth	River Ryewater (River)	676	0.11
Mullingar	River Brosna (River)	868	0.02
Naas	River Morell (River)	676	0.01
Navan	River Boyne (River)	676	0.21
Newbridge	River Liffey (River)	676	0.18
Portlaoise	Triogue (Barrow) River (River)	731	0.05
Swords	Broadmeadow River (River)	676	0.03
Tralee	Big River (River)	984	0.04
Tullamore	Tullamore River (River)	868	0.10
Waterford	Lower Suir Estuary (Transitional)	945	4.32
Wexford	Lower Slaney Estuary (Part Only) (Transitional)	945	10.90
Dublin	River Dodder (River)	676	0.15
Dublin	River Camac (River)	676	0.16
Dublin	River Liffey (River)	676	3.29
Dublin	Tolka River (River)	676	0.18
Dublin	Sanrty River (River)	676	0.04
Dublin	Liffey Estuary Upper (Transitional)	676	0.20
Dublin	Liffey Estuary Lower (Transitional)	676	4.81
Dublin	Tolka Estuary (Transitional)	676	3.58
Galway	Corrib Estuary (Transitional)	1011	9.66
Galway	Corrib River (River)	1011	0.71
Killarney	Deenagh River (River)	984	0.13
Killarney	Flesk River (River)	984	0.17
Sligo	Garavogue Estuary (Transitional)	1011	8.83
Sligo	River Garavogue (River)	1011	0.10
Balbriggan	NONE PROPOSED	676	
Bray	NONE PROPOSED	676	
Greystones	NONE PROPOSED	676	
Malahide	NONE PROPSED	676	

CDM

Table 3.25: Atmospheric Deposition Annual Loading Matrix – Existing Development Horizon

LOADING MATRIX

Surfacewater Type	Urban Area Name	Surface Water Name	Nitrates (kg/yr)	Nitrites (kg/yr)	Total N (kg/yr)	Nitrogen (TKN) (kg/yr)	Total Phosphorous (kg/yr)	Ortho-phosphate (kg/yr)	Cadmium (kg/yr)	Chromium (kg/yr)	Copper (kg/yr)	Iron (kg/yr)	Lead (kg/yr)	Mercury (kg/yr)	Nickel (kg/yr)	Zinc (kg/yr)
r	Athlone	Shannon (Main) (River)	0.649	nd	4.312	nd	0.011	nd	0.001	0.004	0.014	nd	0.006	0.0003	0.018	0.074
r	Carlow	River Barrow (River)	0.151	nd	1.189	nd	0.009	nd	0.0001	0.001	0.003	nd	0.001	0.0001	0.004	0.017
t	Carrigaline	Owenboy Estuary (Part Only) (Transitional)	0.347	nd	3.540	nd	0.007	nd	0.0004	0.002	0.007	nd	0.003	0.0002	0.009	0.040
r	Castlebar	Liscromwell (River)	0.071	nd	0.136	nd	0.001	nd	0.0001	0.000	0.001	nd	0.001	0.00003	0.002	0.008
r	Celbridge	River Liffey (River)	0.127	nd	1.086	nd	0.008	nd	0.0001	0.001	0.003	nd	0.001	0.0001	0.003	0.015
r	Clonmel	River Suir (River)	0.459	nd	3.571	nd	0.020	nd	0.0004	0.003	0.009	nd	0.004	0.0002	0.012	0.053
t	Cork	Lee (Cork Estuary) Lower (Transitional)	1.739	nd	8.860	nd	0.035	nd	0.002	0.010	0.035	nd	0.016	0.001	0.047	0.199
t	Drogheda	Boyne Estuary (Part Only) (Transitional)	0.912	nd	7.785	nd	0.057	nd	0.001	0.005	0.019	nd	0.008	0.001	0.024	0.105
t	Dundalk	Castletown Estuary (Transitional)	4.439	nd	19	nd	0.206	nd	0.004	0.026	0.092	nd	0.039	0.002	0.120	0.510
r	Ennis	River Fergus (River)	1.273	nd	7.265	nd	0.019	nd	0.001	0.007	0.026	nd	0.012	0.0005	0.034	0.146
r	Kilkenny	River Nore (River)	0.368	nd	2.902	nd	0.021	nd	0.0002	0.002	0.008	nd	0.003	0.0002	0.010	0.042
t	Letterkenny	Swilly Estuary (Part Only) (Transitional)	0.511	nd	1.943	nd	0.008	nd	0.0004	0.003	0.010	nd	0.005	0.0002	0.014	0.059
r	Lexlip	River Liffey (River)	0.091	nd	0.780	nd	0.006	nd	0.0001	0.001	0.002	nd	0.001	0.0001	0.002	0.011
t	Limerick	Limerick Dock (Part Only) (Transitional)	3.765	nd	14	nd	0.158	nd	0.003	0.021	0.077	nd	0.034	0.001	0.102	0.432
r	Maynooth	River Ryewater (River)	0.191	nd	1.087	nd	0.012	nd	0.0001	0.001	0.004	nd	0.002	0.0001	0.005	0.022
r	Mullingar	River Brosna (River)	0.047	nd	0.310	nd	0.002	nd	0.00004	0.0003	0.001	nd	0.0004	0.00002	0.001	0.005
r	Naas	River Morell (River)	0.020	nd	0.174	nd	0.001	nd	0.00001	0.0001	0.0004	nd	0.0002	0.00001	0.001	0.002
r	Navan	River Boyne (River)	0.374	nd	3.187	nd	0.023	nd	0.0002	0.002	0.008	nd	0.003	0.0002	0.010	0.043
r	Newbridge	River Liffey (River)	0.308	nd	2.626	nd	0.019	nd	0.0002	0.002	0.006	nd	0.003	0.0002	0.008	0.035
r	Portlaoise	Triogue (Barrow) River (River)	0.086	nd	0.677	nd	0.005	nd	0.00005	0.0005	0.002	nd	0.001	0.00005	0.002	0.010
r	Swords	Broadmeadow River (River)	0.045	nd	0.258	nd	0.003	nd	0.0003	0.001	0.0004	nd	0.00003	0.001	0.005	0.005
r	Tralee	Big River (River)	0.095	nd	0.555	nd	0.001	nd	0.001	0.002	0.001	nd	0.00004	0.003	0.011	0.011
r	Tullamore	Tullamore River (River)	0.228	nd	1.513	nd	0.011	nd	0.001	0.005	0.002	nd	0.0001	0.006	0.026	0.026
t	Waterford	Suir Estuary (Transitional)	11	nd	65	nd	0.476	nd	0.061	0.220	0.095	nd	0.004	0.285	1.219	1.219
t	Wexford	Lower Slaney Estuary (Part Only) (Transitional)	27	nd	164	nd	1.199	nd	0.153	0.556	0.240	nd	0.011	0.719	3.074	3.074
r	Dublin	River Dodder (River)	0.267	nd	1.517	nd	0.017	nd	0.0002	0.002	0.005	nd	0.002	0.0002	0.007	0.031
r	Dublin	River Camac (River)	0.281	nd	1.600	nd	0.018	nd	0.0002	0.002	0.006	nd	0.003	0.0002	0.008	0.032
r	Dublin	River Liffey (River)	5.782	nd	33	nd	0.362	nd	0.003	0.033	0.118	nd	0.053	0.003	0.155	0.664
r	Dublin	Tolka River (River)	0.311	nd	1.769	nd	0.019	nd	0.0002	0.002	0.006	nd	0.003	0.0002	0.008	0.036
r	Dublin	Santry River (River)	0.074	nd	0.423	nd	0.005	nd	0.00004	0.0004	0.002	nd	0.001	0.00004	0.002	0.009
t	Dublin	Liffey Estuary Upper (Transitional)	0.343	nd	1.950	nd	0.021	nd	0.0002	0.002	0.007	nd	0.003	0.0002	0.009	0.039
t	Dublin	Liffey Estuary Lower (Transitional)	8.447	nd	48	nd	0.529	nd	0.005	0.048	0.173	nd	0.077	0.005	0.226	0.971
t	Dublin	Tolka Estuary (Transitional)	6.290	nd	36	nd	0.394	nd	0.004	0.036	0.129	nd	0.057	0.004	0.168	0.723
t	Galway	Corrib Estuary (Transitional)	25	nd	97	nd	0.386	nd	0.019	0.145	0.522	nd	0.232	0.010	0.686	2.917
r	Galway	Corrib River (River)	1.878	nd	7.142	nd	0.029	nd	0.001	0.011	0.039	nd	0.017	0.001	0.051	0.216
r	Killarney	Deenagh River (River)	0.338	nd	1.984	nd	0.005	nd	0.0003	0.002	0.007	nd	0.003	0.0001	0.009	0.039
r	Killarney	Flesk River (River)	0.430	nd	2.523	nd	0.007	nd	0.0003	0.003	0.009	nd	0.004	0.0002	0.012	0.049
t	Sligo	Garavogue Estuary (Transitional)	23	nd	88	nd	0.353	nd	0.132	0.477	0.212	nd	0.009	0.627	2.665	2.665
r	Sligo	River Garavogue (River)	0.272	nd	1.036	nd	0.004	nd	0.002	0.006	0.002	nd	0.0001	0.007	0.031	0.031
?	Balbriggan	NONE PROPOSED														
?	Bray	NONE PROPOSED														
?	Greystones	NONE PROPOSED														
?	Malahide	NONE PROPSED														

nd = No data

In general the largest flow contribution to the storm sewer systems in an urban catchment emanates from the connected hardstanding impermeable areas as opposed to the connected softer permeable areas which contribute significantly less flow to the storm sewers.

There were four stages to the methodology for calculating the diffuse urban runoff from the urban study catchments as follows:

- The development of suitable catchment surface water runoff factors
- The development of suitable diffuse urban runoff parameter loading matrices
- The selection of annual rainfall data
- Calculation of the cumulative annual runoff loadings

3.8.6.1 Development of Surface Water Runoff Factors

The catchment surface water rainfall runoff factors are required to calculate the annual runoff volumes/loadings. These were identified from a combination of the following sources:

- Sewer network and surface water runoff modelling studies
- Urban Area Runoff Factors – From technical literature

As part of the project, existing and future Infoworks/Hydroworks hydraulic sewer network models for foul/combined urban areas were re-run for 9 towns/cities outside of the Greater Dublin Strategic Sewer Study (GDSDS) area and for 15 foul/combined sewer network models within the GDSDS area.

The 15 foul/combined sewer network models covering the GDSDS area included models for 9 of the towns/cities which were assessed as part of this study including Dublin City.

A further 23 storm sewer surface water models from within the GDSDS study area were also re-run. One of the objectives for re-running the models was to establish overall urban catchment runoff performance.

Following a review of the modelling results from the 24 foul/combined sewer network models it was established that the modelled catchment contributing area types could be classified into the four discreet landuse categories of paved, pitched, permeable, and other.

Unfortunately, within the Infoworks/Hydroworks hydraulic sewer network models there was no further sub- division of these four landuse categories. Therefore, it was not possible to make a direct linkage between the modelled catchment landuse categories with the more detailed customary planning landuse designations such as mixed use, commercial etc which had been defined previously as part of the detailed landuse/zoning reclassification exercise which was done using the County and Local Area Development Plans (Table 3.2). Details of the previous landuse/zoning reclassification exercise are contained in the document titled – ''Land Use Reclassification Methodology'', Ref 39325/UP40/DG19 – S, March 2007.

For this reason the Infoworks/Hydroworks sewer network model results cannot be used to provide runoff factors for the modelled urban areas specific to individual land use classifications. Each sewer network model, does however, provide a single catchment specific runoff factor for the overall modelled urban catchment.

The catchment specific runoff factors vary across the modelled urban catchments, and are generally related to the extent of the impermeable area within the urban catchment as detailed in Figures 3.6 and 3.7 for GDSDS foul/combined and non GDSDS foul/combined models respectively. The results show that the runoff percentage increases in parallel with the level of impermeable area/urbanisation within the modelled urban catchment.

It is worth noting however that although the remodelling exercise was undertaken by up to 8 different consultants using a standardised brief – the base models used by the consultants had been originally built using either Hydroworks or Infoworks plus a number of runoff models such as the Wallingford Runoff model and The New UK Runoff model. This difference in approach has resulted in a number of modelling styles which can be used in part to explain the small number of unusual looking variations in Figures 3.7 and 3.8.

For example for the Letterkenny modelling (See Figure 3.7) the 10 metre strip modelling approach was used which would explain the high 70% catchment runoff value. We believe a similar approach was also used for the Portlaoise model. It is unclear which model technique was used for the Mullingar, Athlone, Ennis and Limerick, all of which have similar runoff percentages. However, the same consultants were involved in the development of all four models. In the case of model F004 as detailed in Figure 3.6 the modelling consultant has raised serious concerns re the efficacy of the model.

Figure 3.6: GDSDS Foul/Combined Model Results

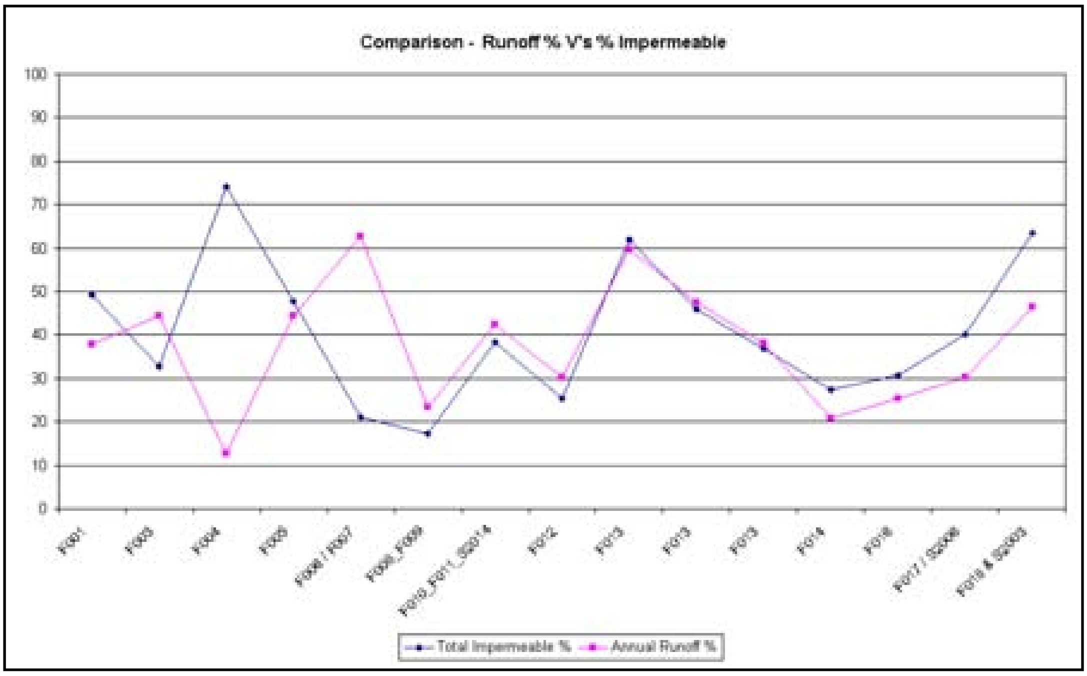
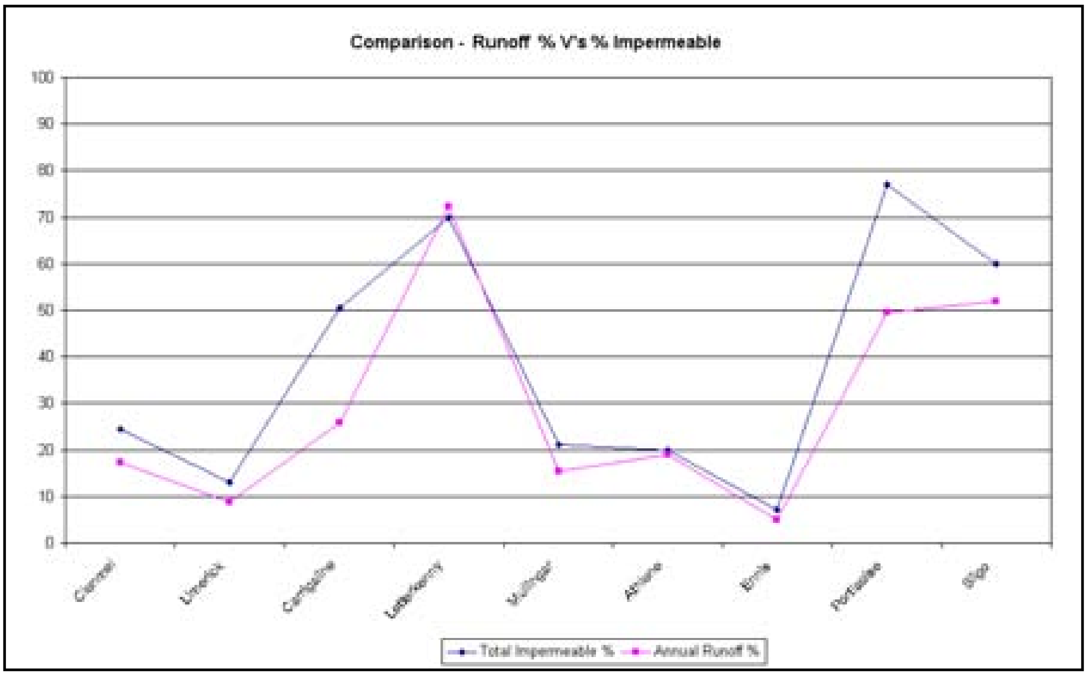


Figure 3.7: Non GDSDS Foul/Combined Model Results

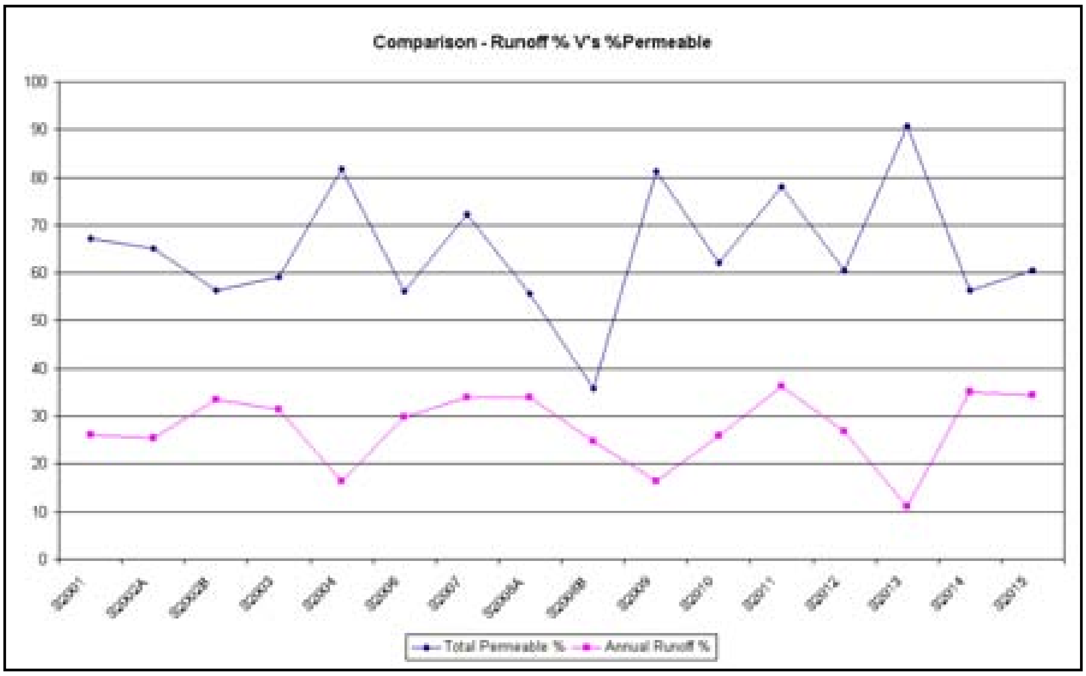


Highly urbanised catchments with a significant percentage of impermeable area connected to the foul/combined sewer system can have runoff factors of the order of 70% – 80%. In the main however these types of catchments are unusual.

With the exception of the small number of model anomalies referred to previously the remaining models indicate that the majority of catchments have an urbanised/impermeable percentage in the 40% - 50% range with a corresponding percentage runoff.

For the 17 storm sewer type 2 models from the GDSDS the remodelling results shown on Figure 3.8 indicate that the rainfall runoff factor decreases as the catchments become less urbanised, i.e., as the impermeable area percentages decrease. In cases where there is minimum (20-30%) urbanisation/impermeability, the modelling shows that the runoff factor varies between 15 and 35% i.e. 15 – 35% of annual yearly rainfall storm water runoff from these urban catchment types will discharge to surface waters via either storm drains or overland flow.

Figure 3.8: GDSDS Storm Type 2 Models



3.8.6.2 *Urban Area Runoff Factors*

Much work and research has been done over many years to determine rainfall runoff factors within urban catchment areas. A review of many of the published rainfall runoff factors indicates that they are broadly similar to those determined from the results of the Infoworks/Hydroworks sewer network remodelling exercise referred to above.

The Wallingford Procedure was developed in the mid eighties to study urban catchment runoff. The Wallingford Procedure has been built into the Hydroworks/Infoworks sewer network modelling software. This software in turn has been used to undertake thousands of urban catchment surface water runoff studies across Ireland, the UK, Europe, USA and Australia. The Wallingford software contains a set of default rainfall runoff factors (for the UK scenario) for single storm events for various land use types as detailed in Table 3.26.

Table 3.26: Wallingford Procedure Landuse Runoff Factors

Surface Type	Land Use Description	Runoff Factor
1	High quality paved roads with gullies < 100m apart	1
2	High quality paved roads with gullies > 100m apart	0.9
3	Medium quality paved roads	0.85
4	Poor quality paved roads	0.8
11	High density housing	0.55
12	Medium density housing	0.45
13	Low density housing or industrial areas	0.35
14	Open areas	0.25

These default rainfall runoff factors have to be used with caution as they do not take account of antecedent wetness conditions. In the case of permeable areas, for example, the rainfall runoff factor of 25% does not make any allowance for the increasing wetness of the catchment as a storm progresses or from multiple storms in close succession. In effect therefore on occasion the value of 25% may be an under representation for longer duration storms.

There are many other sources for urban runoff data including the Caltrans data, which originates from the California Department of Transportation. Sample Caltrans data are detailed in Table 3.27.

Table 3.27: Caltrans Landuse Runoff Factors

Land Use Description	Runoff Factor
Business:	
Downtown areas	0.70 – 0.95
Neighbourhood areas	0.50 – 0.70
Residential:	
Single family areas	0.30 – 0.50
Multi units, detached	0.40 – 0.60
Multi units, attached	0.60 – 0.75
Suburban	0.25 – 0.40
Apartment Dwelling Areas	0.50 – 0.70
Industrial:	
Light areas	0.50 – 0.80
Heavy areas	0.60 – 0.90
Parks, cemeteries:	0.10 – 0.25
Playgrounds:	0.20 – 0.40
Railroad yard areas:	0.20 – 0.40
Unimproved areas:	0.10 – 0.30
Lawns:	
Sandy soil, flat, 2%	0.05 - 0.10
Sandy soil, average, 2-7%	0.10 - 0.15
Sandy soil, steep, 7%	0.15 – 0.20
Heavy soil, flat, 2%	0.13 – 0.17
Heacy soil, average, 2-7%	0.18 – 0.25
Heavy soil, steep, 7%	0.25 – 0.35
Streets:	
Asphaltic	0.70 – 0.95
Concrete	0.80 – 0.95
Brick	0.70 – 0.85
Drives and walks	0.75 – 0.85
Roofs:	0.75 – 0.95

In order to calculate runoff volumes it is necessary to develop surface water rainfall runoff factors by land use type. The data presented in Tables 3.26 and 3.27 was used to make these linkages. There are a number of benefits from using the data presented in these two tables for calculating the rainfall runoff factors for the surface water runoff such as:

- The Tables are based upon runoff factors which have been refined across extensive use of modelling nationally and internationally.

- The Tables offer a comprehensive set of rainfall runoff factors for all main urban catchment land use types;
- The Tables include rainfall runoff factor values which correlate broadly with similar values for both highly urbanised/impermeable and highly permeable catchments as demonstrated when they are compared to the results from both the GDSDS remodelling work and the national sewer remodelling work refered to previously.

The 33 study urban catchments were previously assessed and the associated land uses were reclassified into 10 standardised/generic land use classes as per Table 3.29. The details of the reclassification are reported in the document titled – ''Land Use Reclassification Methodology'', Ref 39325/UP40/DG19 – S, March 2007.

By comparing both the Caltrans and Wallingford Procedure surface water rainfall runoff factors as per Table 3.28 in conjunction with many years extensive experience in the hydraulic sewer modelling (based upon The Wallingford Procedure) of sewer networks across Ireland a recommended set of land use surface water runoff factors has been prepared to represent each of the 10 standardised/generic land use types detailed in Table 3.29. This recommended set of surface water runoff factors is contained in Table 3.28.

Table 3.28: Recommended Catchment Runoff Factors

Surface Type	Wallingford Descriptions & Runoff Coefficients	Caltrans Descriptions & Runoff Coefficients	Recommended Runoff Coefficients
Residential	Medium Density Housing - 0.45	Multi units attached – 0.67	0.55
Open Space Managed	Open Areas – 0.25	Playgrounds – 0.30	0.2
Open Space Un managed	Open Areas – 0.25	Parks, cemeteries – 0.18	0.2
Town Centre	High Quality paved roads gullies<100m apart - 1.00	Downtown areas – 0.82	0.85
Commercial	Medium quality paved roads – 0.85	Downtown areas – 0.82	0.8
Light Industrial	High Density Housing – 0.55	Light areas – 0.65	0.55
Heavy Industrial	Medium Quality paved roads – 0.85	Heavy areas – 0.75	0.8
Settlement/Whitelands	Open Areas – 0.25	Unimproved areas – 0.2	0.2
Mixed Use	Medium density Housing – 0.45	Neighbourhood areas 0.6	0.6
Highways	High Quality paved roads gullies<100m apart – 1.00	Asphaltic – 0.82	0.85

Table 3.29: Standardised / Generic Land Use Types and Descriptions

Land Use Type	Land Use Type Description
Residential	This category includes areas intended primarily for either the protection of existing housing or the development of new housing in the town. Although both current and future housing areas are shown on the land use plan these were categorised separately during the reclassification exercise. Whilst most development plans differentiate between current and future housing areas a number did not. In these cases the background Ordnance Survey mapping behind the land use zoning map was used to distinguish between the existing and potential future residential development.
Open space – Managed:	Initially open space referred to those zones intended as both public or private open space. This included green areas in residential zones, parks, sports grounds, and high visual amenity areas. In some cases green belt zones were also included within the open space category. However at the request of the Urban Pressures Steering Group open space has been divided into managed and unmanaged.
	This division was requested because managed open spaces are likely to be subject to pesticide use. This issue will relate more specifically to the groundwater aspect of the project.
	In this respect managed open spaces are deemed to include all maintained parklands, greens, sports fields, nature parks etc.
Open space – Unmanaged:	As stated for Open – Managed above this division was requested by the Urban Pressures Steering Group.
	Unmanaged open spaces are deemed to include all open space areas which fall outside of the managed spaces such as maintained parklands, greens, sports fields, nature parks etc.
Town Centre -	The town centre land use zone can be referred to as a concentrated heavily urbanized area in a town which provides a broad range of facilities and services for the public and the general community of that town. Often it will include services of a retailing, professional, financial, and social nature. Town Centre can also be divided into current and future land use where there is a differentiation between existing and proposed in the zoning categories. If general all town centre uses were considered as current land uses. Often town centres can exclude neighbourhood centres and small parades of shops of purely local significance.
Commercial	The commercial category includes zones that permit development of facilities for services, commodities, and businesses. Most of the town development plans had zones proposed for commercial uses. If commercial land use was mixed with another land use, it was reclassified as mixed use. Most commercial land uses were considered as existing, unless the urban development plan stated otherwise.
Light Industrial	The light industrial category consists of light business and technology industries, and associated services. Some town plans have zones proposed as light industrial already. However, if an industrial zoning is not specified as light industrial, it will not be included in this category. Zones intended for business and technology development were included as light industrial.
Heavy Industrial	This category can include large manufacturing and processing operations which have the capacity to generate high levels of noise, smoke, and pollution, discharges. For this reason, heavy industries are usually situated outside urban areas, and it is unusual for this type of land to be zoned within the immediate urban area.
Settlement/ Whitelands	This category includes those areas that are zoned for future development but at the time of the development plan it was still unclear as to what actual type of land use is proposed. In all cases these areas have been classified as future development areas.
Mixed Use	Mixed use refers to a zone where multiple uses are permitted in the same parcel of land. Such uses may be permitted, for example, in neighbourhood commercial districts, where apartments may be developed over retail space etc. Therefore this category of land may consist of a combination of 2 or more usage types as specified within the original LA development plan. In other cases some development plans have separate land use categories for institutional and educational establishments whilst other development plans combine both of these into the one landuse type/category. For this study we have classified institutional and educational lands into the single landuse type/category of mixed use.
Highways	This category was added to allow for defined existing or proposed motorways. Proposed new (or extensions to) National Roads are also included within this category. Existing National roads have not been included within this category as inevitably these are combined into the fabric of mixed use, residential, town centre land uses etc and are therefore already accounted for. This category is only used where the road infrastructure is located within the urban catchment boundary. Major road infrastructure bypasses outside of the urban catchment boundary are not included within this category.

3.8.6.3 Development of diffuse urban runoff parameter loading matrix

A number of studies were reviewed in an attempt to determine Irish runoff concentrations for the 14 parameters listed in Table 3.5. These included the 2000 "Impact Assessment of Highway Drainage on Surface Water Quality", report and the 2002 Final Report: "Three Rivers Project – Water Quality Monitoring and Management".

The conclusion of the review of these studies was ***that there was insufficient data relative to the study parameters of interest for Ireland. Therefore, a wider more extensive review was initiated which considered and identified runoff concentrations from outside of Ireland including*** the USA and Europe, and a compilation of runoff concentrations by Dr. Mitchell, a UK researcher.

The Mitchell set of runoff concentrations - or Event Mean Concentrations (EMC) as they are more commonly known – were compiled for use in the UK and Northern European Countries. The EMC dataset contains surface water runoff concentration values for a range of land use types in an urban environment for most of the parameters of interest to this study. The detail of the EMC review process and work is outlined in the document titled – ''Surface Waters – Pollutant List Derivation Methodology'', Ref 39325/UP40/DG17 – S. For reference purposes the proposed EMC values proposed in that document are replicated below in Table 3.30.

Table 3.30: Proposed Diffuse Urban Runoff EMC values

Parameter	Unit	Mitchell						
		Urban Open	Developed Urban	Multi-Lane Highway	Main Highway	Industrial and Commercial	Residential	All
Nitrates(NO3) Nitrites(NO2)	mg/l	0.84	-	0.81	0.81	0.60	0.98	-
Total N	mg/l	1.68	-	-	2.37	1.52	2.85	-
Nitrogen(TKN)	mg/l	1.21	-	2.37	1.60	1.54	2.40	-
Total Phosphorous	mg/l	0.22	-	0.28	0.34	0.30	0.41	-
Ortho-phosphate	mg/l	0.06	-	0.18	0.18	0.16	0.20	-
Cadmium	µg/l	-	-	-	-	-	-	2.20
Chromium	µg/l	-	-	-	-	-	-	7.30
Copper	µg/l	27.90	51.10	80.30	80.30	-	-	-
Iron	mg/l	-	-	-	-	-	-	2.98
Lead	µg/l	60.60	-	330.10	201.00	132.60	140.50	-
Mercury	µg/l	-	-	-	-	-	-	0.27
Nickel	µg/l	14.80	30.40	-	-	-	-	-
Zinc	µg/l	203.00	-	417.30	253.10	188.60	296.90	

3.8.6.4 Selection of Annual Rainfall Data

For the national and GDSDS hydraulic sewer network remodelling exercise which was undertaken the models were rerun using an annual continuous rainfall dataset (Time Series Rainfall, TSR). The use of an annual continuous rainfall dataset in the remodelling process enabled both continuous yearly surface water runoff volumes to be predicted and CSO spill performance to be determined (Section 3.8.1). Met Eireann provided the annual continuous rainfall dataset for Ireland for the year 2005 from their national Irish TUCSON (The Unified Climatoligical and Synoptic Observing Network) automatic weather station raingauge network which comprises 14 permanent rainfall monitoring stations across Ireland. The national annual continuous rainfall dataset was used at the request of the urban pressures study PSG so as to reflect the regional rainfall variations across the country.

The 2005 annual continuous rainfall dataset adopted for each of the 33 study urban catchment areas was allocated based upon proximity of the nearest TUCSON raingauge. Accordingly, the 2005 annual cumulative rainfall depths allocated to each of the study urban catchment areas as per the relevant TUCSON raingauge are listed in Table 3.31.

Table 3.31: Recommended Rainfall Depths for 2005

Urban Area Number	Urban Area	Population 2002	Tucson Rainfall Depth(mm) 2005
1	Athlone	15936	868
2	Balbriggan*	10294	598
3	Bray*	30951	598
4	Carlow	18487	731
5	Carrigaline	11191	755
6	Castlebar	11371	1011
7	Celbridge*	16016	598
8	Clonmel	16910	988
9	Cork	186239	755
10	Drogheda	31020	676
11	Dublin*	1004614	598
12	Dundalk	32505	910
13	Ennis	22051	1011
14	Galway	66163	1011
15	Greystones	11913	676
16	Kilkenny	20735	731
17	Killarney	13137	984
18	Leixlip*	15061	598
19	Letterkenny	15231	1011
20	Limerick	86998	1011
21	Malahide*	13826	598
22	Maynooth*	10151	598
23	Mullingar	15621	868
24	Naas*	18288	598
25	Navan	19417	676
26	Newbridge*	16739	598
27	Portlaoise	12127	731
28	Sligo	19735	1011
29	Swords*	27175	598
30	Tralee	21987	984
31	Tullamore	11098	868
32	Waterford	46736	945
33	Wexford	17235	945

*GDSDS hydraulic sewer models

It should be noted that TUCSON rainfall data was not used for the remodelling of any of the GDSDS hydraulic sewer network models as this remodelling work had already been done prior to the receipt of the TUCSON rainfall datafiles.

CDM

The reruns of the GDSDS hydraulic sewer network models used the annual Time Series Rainfall (TSR) that was used to undertake the original GDSDS modelling . The GDSDS TSR was originally generated using an annual rainfall dataset for Dublin for the year 1993.

Although the 1993 annual rainfall depth of 598mm from the GDSDS TSR is 13% less than the 2005 recorded annual rainfall depth of 676mm from the TUCSON raingauge in Phoenix Park no adjustments have been made to the surface water runoff results generated from the rerunning of the GDSDS models for the study urban areas. Given the study constraints, combined with the macro level nature of this study, the 13% margin is considered to be acceptable and does not justify rerunning the GDSDS study urban area catchment hydraulic sewer network models with the 2005 TUCSON rainfall.

3.8.6.5 Calculation of Cumulative Annual Runoff Loadings

The cumulative annual runoff loadings were estimated for each study urban catchment area using the following equation:

Cumulative annual runoff loading for individual land use (per parameter) =

Land Use Area

x Annual Rainfall

x Runoff Factor

x Land Use Area Event Mean Concentration

The details relating to the identification, classification, and quantification of landuses are referred to previously in this report under Section 3.5. The annual rainfall and runoff factor issues have also been referred to previously in this section.

The philosophy behind and the derivation of the EMCs is detailed in the documents titled – ''Surface Waters – Pollutant List Derivation Methodology'', Ref 39325/UP40/DG17 – S, and ''Surface Waters – Urban Catchment Diffuse Runoff Methodology'', Ref 39325/UP40/DG44 – S".

The EMC data presented in Table 3.30 is based upon the concept of an average concentration (for the specified pollution parameter) for the surface water runoff volume from a single rainfall event.

Before the cumulative annual runoff loading calculations could be completed however, there was a need to align the data in Tables 3.27 and 3.28 to produce a single unified table representing the 10 standardised/generic land uses to match those detailed in Table 3.29.

The results of the alignment process are detailed in Table 3.32 which provides both runoff factors and EMCs for each of the 10 standardised/generic land use types. The alignment process is detailed in the document titled – ''Surface Waters – Urban Catchment Diffuse Runoff Methodology'', Ref 39325/UP40/DG44 – S.

By applying the calculation outlined above using Table 3.32 the cumulative annual runoff loadings for each of the 14 parameters to each receiving surface water within the 33 study urban catchment areas were estimated.

The cumulative annual runoff loadings, which exclude the surface water component discharging directly to the foul/combined sewerage system, are detailed in Table 3.33.

Table 3.32: Realignment of Landuse types, EMC values and Runoff Factors

Land Use Types Table 3.29	EMC Land use Types Table 3.30	UCDR Parameter Loading Matrix Realignment														Recommended Runoff Factor
		Nitrates (mg/l)	Nitrites (mg/l)	Total N (mg/l)	Nitrogen (TKN) (mg/l)	Total Phosphorous (mg/l)	Ortho-phosphate (mg/l)	Cadmium (mg/l)	Chromium (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Mercury (mg/l)	Nickel (mg/l)	Zinc (mg/l)	
Residential	Residential	0.98	0.98	2.85	2.4	0.41	0.198	0.0022	0.0073	0	2.98	0.1405	0.00027	0	0.2969	0.55
Open Space Managed	Urban Open	0.84	0.84	1.68	1.21	0.22	0.056	0.0022	0.0073	0.0279	2.98	0.0606	0.00027	0.0148	0.203	0.2
Open Space Un managed	Urban Open	0.84	0.84	1.68	1.21	0.22	0.056	0.0*	0.0*	0.0*	0.0*	0.0*	0.0*	0.0*	0.0*	0.2
Town Centre	Main Highway	0.81	0.81	2.37	1.6	0.34	0.178	0.0022	0.0073	0.0803	2.98	0.201	0.00027	0	0.2531	0.85
Commercial	Industrial & Commercial	0.6	0.6	1.52	1.54	0.3	0.156	0.0022	0.0073	0	2.98	0.1326	0.00027	0	0.1886	0.8
Light Industrial	Industrial & Commercial	0.6	0.6	1.52	1.54	0.3	0.156	0.0022	0.0073	0	2.98	0.1326	0.00027	0	0.1886	0.55
Heavy Industrial	Industrial & Commercial	0.6	0.6	1.52	1.54	0.3	0.156	0.0022	0.0073	0	2.98	0.1326	0.00027	0	0.1886	0.8
Settlement/Whitelands	Urban Open	0.84	0.84	1.68	1.21	0.22	0.056	0.0*	0.0*	0.0*	0.0*	0.0*	0.0*	0.0*	0.0*	0.2
Mixed Use	Developed Urban	0.0	0.0	0.0	0.0	0.0	0.0	0.0022	0.0073	0.0511	2.98	0	0.00027	0.0304	0	0.6
Highways	Main Highway	0.81	0.81	2.37	1.6	0.34	0.178	0.0022	0.0073	0.0803	2.98	0.201	0.00027	0	0.2531	0.85

0.0* Metals concentrations for these land use types have been reduced to zero to reflect lack of development/management/urbanisation in these areas

Table 3.33: Diffuse Urban Runoff Annual Loading Matrix – Existing Development Horizon

LOADING MATRIX

Surface Water Type	Urban Area Name	Surface Water Name	Nitrates (kg/yr)	Nitrites (kg/yr)	Total N (kg/yr)	Nitrogen (TKN) (kg/yr)	Total Phosphorous (kg/yr)	Ortho-phosphate (kg/yr)	Cadmium (kg/yr)	Chromium (kg/yr)	Copper (kg/yr)	Iron (kg/yr)	Lead (kg/yr)	Mercury (kg/yr)	Nickel (kg/yr)	Zinc (kg/yr)
r	Athlone	Shannon (Main) (River)	2566	2566	7035	5668	1054	508	7.442	25	96	10080	446	0.913	15	768
r	Carlow	River Barrow (River)	1415	1415	4016	3164	593	294	4.166	14	67	5643	264	0.511	8.416	431
t	Carrigaline	Owenboy Estuary (Part Only) (Transitional)	1370	1370	3944	3225	573	279	3.369	11	26	4563	221	0.413	2.069	416
r	Castlebar	Liscromwell (River)	2612	2612	7381	5841	1069	518	7.052	23	95	9552	445	0.865	12	787
r	Celbridge	River Liffey (River)	1019	1019	2689	2166	385	171	2.686	9	23	3638	139	0.330	7.619	293
r	Clonmel	River Suir (River)	2975	2975	8177	6707	1212	576	8.617	29	85	11672	475	1.057	22	886
t	Cork	Lee (Cork Estuary) Lower (Transitional)	6369	6369	17514	14209	2565	1212	16	55	157	22319	995	2.022	27	1859
t	Drogheda	Boyne Estuary (Part Only) (Transitional)	2884	2884	8077	6620	1222	602	8.571	28	100	11610	515	1.052	17	876
t	Dundalk	Castletown Estuary (Transitional)	7869	7869	21694	16863	3125	1483	28	94	499	38558	1312	3.494	146	2288
r	Ennis	River Fergus (River)	7637	7637	21356	17087	3101	1486	20	65	221	26582	1251	2.408	25	2285
r	Kilkenny	River Nore (River)	3279	3279	8755	7047	1287	595	9.176	30	102	12429	509	1.126	23	958
t	Letterkenny	Swilly Estuary (Part Only) (Transitional)	5764	5764	15805	13211	2400	1155	16	54	143	22098	920	2.002	36	1630
r	Lexlip	River Liffey (River)	1036	1036	2681	2133	389	173	2.877	10	33	3897	150	0.353	8.863	296
t	Limerick	Limerick Dock (Part Only) (Transitional)	5087	5087	14097	11241	2032	961	14	45	158	18412	806	1.668	28	1510
r	Maynooth	River Ryewater (River)	1049	1049	2738	2092	385	170	3.152	10	51	4270	154	0.387	14	299
r	Mullingar	River Brosna (River)	2057	2057	5707	4478	833	401	5.356	18	83	7255	343	0.657	10	567
r	Naas	River Morell (River)	2570	2570	6556	5154	936	403	6.822	23	78	9241	351	0.837	21	725
r	Navan	River Boyne (River)	2526	2526	7129	5565	1033	503	6.762	22	107	9159	441	0.830	12	742
r	Newbridge	River Liffey (River)	1289	1289	3300	2529	468	203	3.391	11	49	4593	186	0.416	10	364
r	Portlaoise	Triogue (Barrow) River (River)	2662	2662	7500	6149	1118	546	7.419	25	75	10050	454	0.911	12	806
r	Swords	Broadmeadow River (River)	2721	2721	7644	6156	1161	579	8.076	27	116	10939	518	0.991	13	831
r	Tralee	Big River (River)	3630	3630	10103	8343	1488	710	10	34	86	13889	566	1.258	24	1085
r	Tullamore	Tullamore River (River)	2123	2123	5949	4986	913	451	6.062	20	54	8212	372	0.744	8.391	638
t	Waterford	Suir Estuary (Transitional)	8459	8459	21841	17220	3194	1430	23	77	311	31289	1249	2.835	70	2297
t	Wexford	Lower Slaney Estuary (Part Only) (Transitional)	2788	2788	7564	5959	1091	508	7.776	26	105	10533	442	0.954	21	819
r	Dublin	River Dodder (River)	17484	17484	47901	37546	6847	3196	42	141	569	57529	2667	5.212	75	4816
r	Dublin	River Camac (River)	13756	13756	35640	27986	5260	2389	34	113	489	46198	2077	4.186	69	3550
r	Dublin	River Liffey (River)	8493	8493	21815	16422	3070	1338	18	59	314	24008	1135	2.175	36	1969
r	Dublin	Tolka River (River)	11185	11185	29670	24016	4515	2136	33	109	424	44577	1896	4.039	79	3222
r	Dublin	Santry River (River)	5516	5516	15181	12131	2306	1132	18	59	277	23976	1036	2.172	48	1666
t	Dublin	Liffey Estuary Upper (Transitional)	25314	25314	66108	51037	9574	4333	61	202	967	82271	3767	7.454	127	6439
t	Dublin	Liffey Estuary Lower (Transitional)	46648	46648	124737	96991	18084	8374	116	384	1777	156664	7253	14.194	226	12428
t	Dublin	Tolka Estuary (Transitional)	15273	15273	41044	32951	6161	2924	44	147	590	60024	2587	5.438	105	4442
t	Galway	Corrib Estuary (Transitional)	11372	11372	29798	23798	4357	1970	32	108	384	43981	1710	3.985	100	3283
r	Galway	Corrib River (River)	9994	9994	26189	20952	3850	1749	29	96	349	39241	1527	3.555	89	2891
r	Killarney	Deenagh River (River)	1043	1043	2515	1959	347	134	1.368	4.540	10	1853	73	0.168	3.634	148
r	Killarney	Flesk River (River)	1892	1892	5103	4216	735	333	3.549	12	4.852	4808	224	0.436	0.748	456
t	Sligo	Garavogue Estuary (Transitional)	6273	6273	17356	13816	2592	1263	19	64	293	26288	1133	2.382	52	1889
r	Sligo	River Garavogue (River)	3416	3416	9507	7313	1364	654	10	32	167	13184	594	1.195	25	1019
?	Balbriggan	NONE PROPOSED	1441	1441	3756	2920	553	253	3.880	13	59	5256	238	0.476	7.644	417
?	Bray	NONE PROPOSED	998	998	2749	2207	395	185	2.522	8.368	27	3416	146	0.309	5.791	273
?	Greystones	NONE PROPOSED	2232	2232	6170	4906	887	418	4.940	16	54	6692	334	0.606	3.324	602
?	Malahide	NONE PROPSED	1318	1318	3793	3026	544	265	3.141	10	34	4255	218	0.386	1.174	398

Although the EMC data presented in Table 3.30 is based upon the concept of an average concentration (for the specified pollution parameter) for the surface water runoff volume from a single rainfall event, this study is applying EMCs to the annual cumulative rainfall surface water runoff volume from multiple rainfall events, many of which will be small and will not generate much actual runoff.

Therefore it is likely that the EMC approach adopted in this study overestimates annual pollution runoff loadings. Unfortunately it is not possible to estimate the degree of any such overestimation. For this reason the estimated cumulative annual runoff loadings contained within this report, and as detailed in Table 3.33 must be treated with caution and should only be used within the overall context of this urban pressures study.

For a more detailed understanding of how the diffuse urban runoff assessment aspect of the project was implemented the reader is referred to in both the documents titled – ''Urban Pressures: Surface Waters – Pollutant List Derivation Methodology'', Ref 39325/UP40/DG17 – S, September 2006 and the document titled – ''Urban Pressures: Surface Waters – Urban Catchment Diffuse Runoff Methodology'', Ref 39325/UP40/DG44 – S, Final 01, Dec 2007.

3.8.7 Upstream Surface Water Loading Pressures

For the purposes of this study upstream surface water loadings are defined as either:

- the loadings being carried by rivers flowing into the study urban river waters from upstream of the study urban area catchment
- the loadings being carried by the study urban river waters into the downstream study urban transitional waters

As part of the process to determine the upstream surface water loadings many of the water quality monitoring programmes, which are currently being undertaken to assess water quality in Irish waters, were investigated

Many of these water quality sampling monitoring programmes are mandatory as they are driven by the requirements of National Legislation and EU Directives including:

- Surface Water Regulations 1998
- Bathing Water Regulations 1989-1998
- Drinking Water Directive 98/83/EC
- Dangerous Substances Directive 76/464/EEC
- Freshwater Fish Directive 78/659/EEC
- Salmonid Waters Regulations
- Ground Water Directive 80/86/EEC
- Shellfish Directive 79/923/EEC

- OSPAR Convention (1992). The Convention for the Protection of the Marine Environment of the North-East Atlantic

- The estuarine and coastal waters monitoring programme

In addition to the mandatory water quality sampling programmes two other sampling/monitoring programmes were ongoing in parallel to this urban pressures study as follows:

- An investigatory water quality monitoring programme was commissioned during the years 2005 and 2006 as part of a Water Framework Directive Further Characterisation POMS project. The purpose of the investigatory water quality monitoring programme was to assess the presence and scale of dangerous substances in Irish surface waters.

- The WFD Surveillance Monitoring Programme which commenced in July 2007. The WFD Surveillance Monitoring Programme dataset currently includes monitored results for 66 sites for the 8 metals of interest to this urban pressures study for the period Jul 07 – Dec 07.

Following a review of the various water quality sampling monitoring programmes it was established that a number of them could contribute to the calculation of the upstream surface water loadings.

All of the relevant information from the datasets referred to previously was uploaded onto GIS and analysed. This process enabled the water quality sampling/monitoring points to be classified as to where they were located relative to the individual study urban area waters i.e. upstream, downstream or within the main body of the study urban area surface water. Details of the various sampling/monitoring programmes and their associated monitored locations and parameters are listed in the tables in Appendix B.

A detailed review and assessment of all of the sampling/monitoring datasets established that there were significant gaps in the data for both river and transitional waters for many of the parameters of interest to this study. The data gaps reflect the fact that most of the sampling/monitoring programmes were set up to assess/monitor parameters other than those of relevance to this study. The review also showed that none of the supplied data sets comprehensively covered all of the 14 study parameters listed in Table 3.5. The review highlighted the fact that the sampling/monitoring datasets generally apply to one or other of the two types of parameter of interest to this study – nutrients or metals. Consequently the supplied datasets were screened into two categories:

- Datasets relevant to nutrients - Nitrogen and Phosphorous based parameters.

- Datasets relevant to metals – Cd, Cr, Cu, Fe, Pb, Hg, Ni, and Zn.

Data from the following sampling/monitoring programmes was considered to be the most appropriate for assessing the nutrients for the purposes of this study;

- OSPAR data

- EPA monitoring data

- EPA national monitoring data (LIMS)
- Water Framework Directive Further Characterisation POMS project data

The analysis associated with the use of this data for the nutrients is detailed in the next section.

For the metals both the Local Authority Dangerous Substance Implementation Reports (Table B.2) and the WFD Surveillance Monitoring Programme dataset (Table B.3) were reviewed. However, the data from the WFD Further Characterisation POMS project was excluded as most of the associated data monitoring sites did not match the study urban areas. Following the review a decision was made to use only the WFD Surveillance Monitoring Programme dataset for the assessment of the metals. The rationale and analysis associated with the use of this data for the metals is detailed in the Section 3.8.7.2.

The final stage of the process involved extracting values for the 14 study parameters listed in Table 3.5 with the ultimate aim of compiling a surface water cumulative annual loading matrix. Because of the split in the datasets as referred to previously the surface water cumulative annual loading matrix was compiled in two stages as follows:

- Development of an annual cumulative loading matrix for nutrients
- Development of an annual cumulative loading matrix for metals

3.8.7.1 Development of annual cumulative loading matrix for nutrients

Table B.1 shows that none of the sampling/monitoring programmes covers all of the nutrient parameters listed in Table 3.5. Furthermore when the sampling/monitoring locations are assessed it is apparent that in ***many cases there are no sampling results at either the upstream or downstream of the river or transitional surface waters*** as they enter or leave the study urban area catchments.

A review of Table B.1 shows that for the river surface waters the sampling/monitoring programmes which provide the most data coverage for the study nutrients are the EPA (LIMS) national monitoring programme and the EPA data. In contrast, for the transitional surface waters, the sampling/monitoring programmes of most significance (in the context of upstream locations of the study urban area catchments) are the EPA (LIMS) national monitoring programme, EPA data and OSPAR data. However, even with these data sources significant data gaps still remain regarding an understanding of nutrient concentrations entering the study urban area catchment surface waters from upstream flows.

Table 3.34 provides an overview of the total number of relevant sampling/monitoring locations from each of the sampling/monitoring programmes which are considered useful for assessing the background loading concentrations for nutrients entering the study urban area catchments from upstream. The Table also shows the number of sampling points located either within the body of or downstream of the study urban area surface waters.

Table 3.34: Number of useful Sampling / Monitoring Points and Locations Associated with Study Urban Area Surface Waters

Sampling/Monitoring Data Sets	Transitional Surface Waters			River Surface Waters		
	U/S	Int	D/S	U/S	Int	D/S
EPA - (LIMS)	6	-	2	6	4	6
EPA (ERBD)	6	1	-	9	3	13
OSPAR	5	-	-	-	4	2
WFD – POM – Dangerous Substances Monitoring Programme	1	2	3	-	1	1

A closer inspection of the data for the sites listed in Table 3.34 shows that the monitored data for the listed sampling/monitoring sites does not cover the full suite of the nutrient study parameters listed in Table 3.5. To demonstrate this point the actual nutrient data coverage for each of the Table 3.34 upstream location sampling/monitoring sites is highlighted in Table 3.35.

Table 3.35: Nutrient Parameters Sampled for Each Programme – Upstream Locations Only

	EPA - LIMS	EPA (ERBD)	OSPAR	WFD – POM Dangerous Substances Monitoring
Nitrates	✓*	✓*	X	X
Nitrites	✓*	✓	X	X
Total N	✓*	X	✓	X
Nitrogen (TKN)	X	X	X	✓
Total Phosphorous	✓*	X	✓	✓
Ortho-phosphate	✓*	✓	✓	X

✓ Complete set of results
✓* Incomplete set of results
X No Results

To overcome these data gaps, estimated/interpolated values were developed for surface water nutrient concentrations based upon the supplied data.

The estimated/interpolated data was developed using an averaging approach based largely upon the annual sampled/monitored parameter concentration results for both the river and transitional surface waters. The averaging approach was implemented as follows:

1. If sampled/monitored concentration data exists for a location upstream of the study urban area - use the data.

Where there is no monitoring data for a location upstream of the study urban area the following method was adopted:

1. For the Eastern River Basin District (ERBD) - use an average of all available sampled/monitored data from the ERBD sites.

2. For study urban catchment areas outside the ERBD - use an average of all available sampled/monitored data for the remaining River Basin Districts outside of the ERBD.

3. For study urban catchment areas outside the ERBD – if no data exists for the River Basin Districts outside of the ERBD - use an average of the sampled/monitored data from the ERBD sites.

For reference purposes the River Basin Districts within Ireland are shown previously on Figure 2.1.

Table 3.36 lists the proposed concentration levels for the nutrient parameters based upon the preceding methodology and for those cases where no monitored results exist.

Table 3.36: Proposed nutrient concentrations (mg/l)

Surface Water Type	River Basin District	Nitrates	Nitrites	Total Nitrogen (N)	Total Kjeldahl Nitrogen (TKN)	Total Phosphorous	Ortho Phosphate
Rivers	ERBD	2.100	0.037	?	?	?	0.070
Rivers	All Other RBDs	0.162	0.013	?	?	?	0.046
Transitional	ERBD	2.140	0.034	2.920	?	0.114	0.063
Transitional	All Other RBDs	2.140	0.005	1.770	?	0.047	0.031

By combining the data from Table 3.36 with the relevant monitored data, Table 3.37 the nutrient concentration matrix was prepared It should be noted from Table 3.37 that there are no monitoring results available for Nitrogen (TKN) in the upstream vicinity for any of the study urban area catchment surface waters - river or transitional. In addition there is no data available for either Total Phosphorous or Total N in the upstream vicinity for river surface waters.

3.8.7.2 Development of annual cumulative loading matrix for metals

As discussed previously the bulk of the available sampling/monitoring concentration data for metals was gathered under both the Local Authority Dangerous Substances and the EPA WFD Surveillance Monitoring Programmes (See Tables B.2 and B.3 in Appendix B).

The available data from both of these programmes was reviewed in detail to establish both the site location coverage for the sampling/monitoring programmes and the results of the sampling analysis for the site locations.

Table 3.37: Nutrient Concentration Matrix

Urban Area Name	Surface Water Name	RBD	Nitrates (mg/)	Nitrites (mg/l)	Total N (mg/l)	Nitrogen TKN (mg/l)	Total Phosphorous (mg/l)	Ortho-Phosphate (mg/l)
Athlone	Shannon (Main) (River)	IE-Shannon	0.162	0.013	nd	nd	nd	0.046
Carlow	River Barrow (River)	IE-South Eastern	0.162	0.028	nd	nd	nd	0.067
Carrigaline	Owenboy Estuary (Part Only) (Transitional)	IE-South Western	2.144	0.005	1.770	nd	0.047	0.031
Castlebar	Liscromwell (River)	IE-Western	0.162	0.005	nd	nd	nd	0.045
Celbridge	River Liffey (River)	IE-Eastern	2.099	0.037	nd	nd	nd	0.070
Clonmel	River Suir (River)	IE-South Eastern	0.162	0.013	nd	nd	nd	0.046
Cork	Lee (Cork Estuary) Lower (Transitional)	IE-South Western	2.144	0.005	2.840	nd	0.067	0.033
Drogheda	Boyne Estuary (Part Only) (Transitional)	IE-Eastern	2.280	0.020	3.570	nd	0.090	0.053
Dundalk	Castletown Estuary (Transitional)	IE-Neagh Bann	2.144	0.005	1.770	nd	0.047	0.043
Ennis	River Fergus (River)	IE-Shannon	0.162	0.013	nd	nd	nd	0.046
Kilkenny	River Nore (River)	IE-South Eastern	0.162	0.016	nd	nd	nd	0.059
Letterkenny	Swilly Estuary (Part Only) (Transitional)	IE-North Western	2.144	0.005	1.770	nd	0.047	0.031
Lexlip	River Liffey (River)	IE-Eastern	2.099	0.032	nd	nd	nd	0.105
Limerick	Limerick Dock (Part Only) (Transitional)	IE-Shannon	2.144	0.005	1.690	nd	0.034	0.021
Maynooth	River Ryewater (River)	IE-Eastern	1.820	0.025	nd	nd	nd	0.075
Mullingar	River Brosna (River)	IE-Shannon	0.162	0.013	nd	nd	nd	0.046
Naas	River Morell (River)	IE-Eastern	2.099	0.006	nd	nd	nd	0.014
Navan	River Boyne (River)	IE-Eastern	2.113	0.126	nd	nd	nd	0.056
Newbridge	River Liffey (River)	IE-Eastern	2.099	0.008	nd	nd	nd	0.012
Portlaoise	Triogue (Barrow) River (River)	IE-South Eastern	0.162	0.013	nd	nd	nd	0.046
Swords	Broadmeadow River (River)	IE-Eastern	2.663	0.045	nd	nd	nd	0.153
Tralee	Big River (River)	IE-Shannon	0.162	0.013	nd	nd	nd	0.046
Tullamore	Tullamore River (River)	IE-Shannon	0.162	0.013	nd	nd	nd	0.046
Waterford	Suir Estuary (Transitional)	IE-South Eastern	2.144	0.005	1.770	nd	0.047	0.031
Wexford	Lower Slaney Estuary (Part Only) (Transitional)	IE-South Eastern	2.144	0.005	1.770	nd	0.047	0.031
Dublin	River Dodder (River)	IE-Eastern	1.615	0.033	nd	nd	nd	0.050
Dublin	River Camac (River)*	IE-Eastern	⋆	⋆	⋆	⋆	⋆	⋆
Dublin	River Liffey (River)	IE-Eastern	2.200	0.022	nd	nd	nd	0.067
Dublin	Tolka River (River)	IE-Eastern	2.180	0.036	nd	nd	nd	0.098
Dublin	Santry River (River)*	IE-Eastern	⋆	⋆	⋆	⋆	⋆	⋆
Dublin	Liffey Estuary Upper (Transitional)	IE-Eastern	1.828	0.031	2.594	nd	0.126	0.068
Dublin	Liffey Estuary Lower (Transitional)	IE-Eastern	1.829	0.030	2.919	nd	0.114	0.063
Dublin	Tolka Estuary (Transitional)	IE-Eastern	2.640	0.068	2.919	nd	0.114	0.087
Galway	Corrib Estuary (Transitional)	IE-Western	2.144	0.005	1.770	nd	0.047	0.031
Galway	Corrib River (River)	IE-Western	0.162	0.009	nd	nd	nd	0.029
Killarney	Deenagh River (River)	IE-South Western	0.162	0.013	nd	nd	nd	0.046
Killarney	Flesk River (River)	IE-South Western	0.162	0.013	nd	nd	nd	0.046
Sligo	Garavogue Estuary (Transitional)	IE-Western	2.144	0.005	0.781	nd	0.033	0.026
Sligo	River Garavogue (River)	IE-Eastern	0.162	0.005	nd	nd	nd	0.039
Balbriggan	NONE PROPOSED	IE-Eastern						
Bray	NONE PROPOSED	IE-Eastern						
Greystones	NONE PROPOSED	IE-Eastern						
Malahide	NONE PROPSED	IE-Eastern						

ERBD Only Estimates — Other RBD Estimates — Actual Monitored Value

⋆ No upstream loading contribution as the river rises within the study urban area catchment.

nd = No data

The review of the Local Authorities Dangerous Substance Implementation Reports established for the study metals that:

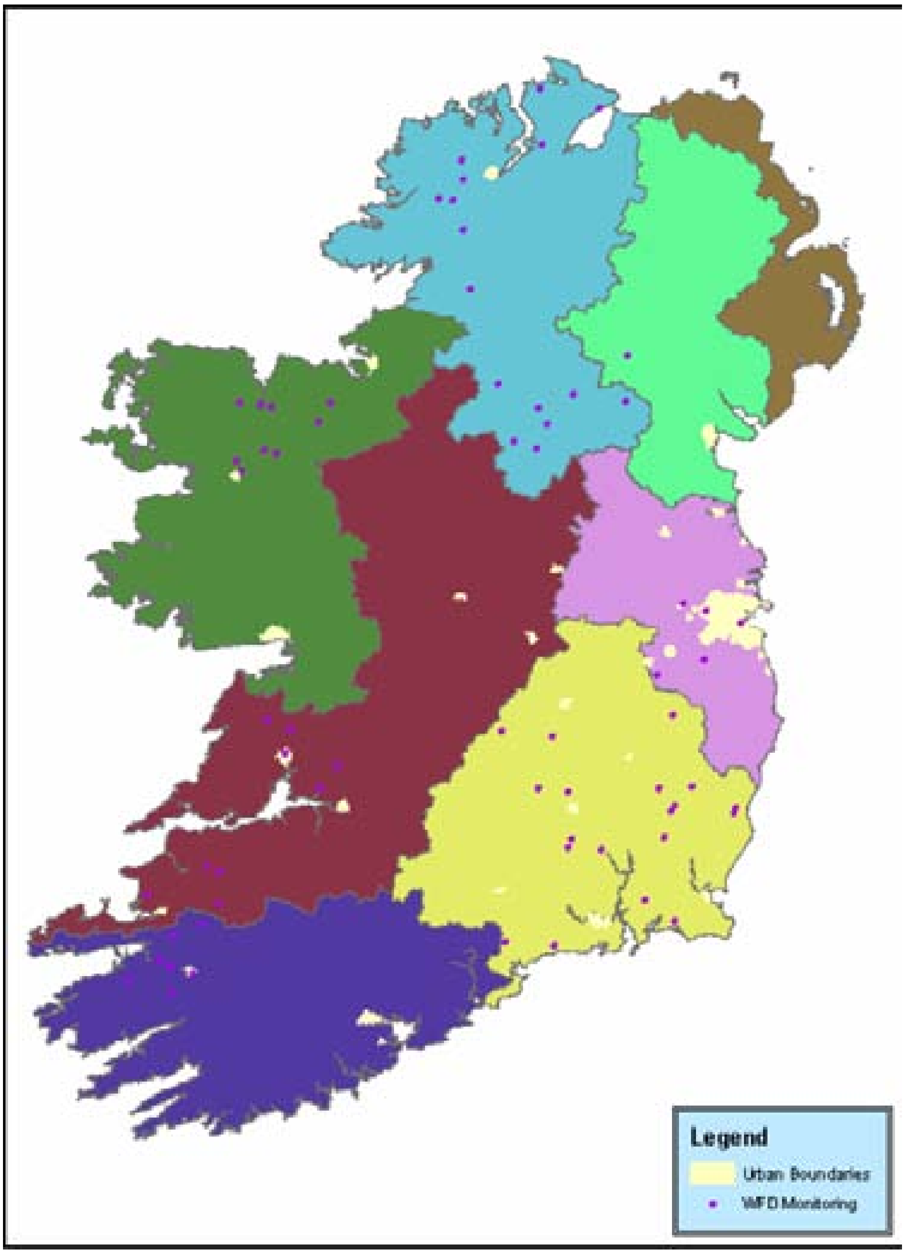
- There are not many monitoring locations upstream of the study urban area catchments.
- Most monitored locations only have 1 or 2 sample results for any given study metal parameter.
- The sample results date back to 2004.
- ***Each Local Authority used different laboratories and analysis methods for their sample analysis - which resulted in variations of the adopted detection limits for metals across Local Authorities.***
- ***Many of the sample results are quoted as being less than a specified detection limit. The specified detection limits are directly related to the sensitivity of the laboratory test equipment used for undertaking the sample analysis. Therefore in many cases actual concentrations were not established in the samples.***

The WFD surveillance monitoring programme comprises 180 sites of which the first 66 have been monitored since July 2007. The monitored results for the 66 sites were provided for the period Jul 07 – Dec 07 (internal document reference 39325/UP40/DI_197). The monitored results comprise of up to 5 samples for most of the 66 monitored sites. Various parameters were analysed including the 8 metals of interest to this study. See Figure 3.9 below for the locations of the 66 monitoring sites.

In the case of the WFD Surveillance Monitoring Programme the review established for metals that:

- The dataset is the most comprehensive and consistent (Jul 2007 – Dec 2007 sampling record) available.
- The data forms a recent dataset.
- There are a number of sampled/monitored locations in each RBD
    - South Eastern RBD – 19 locations
    - Shannon IRBD – 9 locations
    - Western RBD – 9 locations
    - Eastern RBD – 5 locations
    - South Western RBD – 7 locations
    - North Western IRBD – 16 locations
    - Neagh Bann IRBD – 1 locations
    - North Eastern RBD – 0 locations

Figure 3.9: WFD Surveillance Monitoring Programme



- Analysis for all samples was undertaken in laboratories using an identical analytical method and the same limits of detection.
- Each monitored location has up to 5 sample results
- In many cases the analytical testing techniques employed have lower detection limits than those that were used for the Dangerous Substances monitoring programme.

For these reasons a decision was made to proceed with this stage of the study assessment using only the EPA WFD Surveillance Monitoring Programme results data. The WFD Surveillance Monitoring Programme data was subsequently reviewed to estimate the background water quality concentration values for the 8 study metals at each of the 66 sampled/monitored sites. The details of this review procedure are recorded in internal document reference 39325/UP40/DG_78.

As part of the review procedure Figures C.1 – C.8 in Appendix C were prepared. These 8 Figures show the estimated median concentration values for the sample results at each of the 66 sampled/monitored sites for each of the 8 study metals.

However, it should be noted that because of laboratory analytical testing limitations for a number of the study metals such as cadmium, chromium, copper, lead, mercury, nickel and zinc the reported concentration values for many of the samples for these study metals are quoted at a specified value corresponding to the test detection limit (i.e. not detected) – as shown on Figures C.1 – C.8. This is because in many samples the actual concentration value in the sample was below the test detection limit therefore it could not be detected by the test. In such cases the test detection limit is quoted for the sample concentration by the laboratories.

Following discussions with the EPA regarding this issue, and in line with their recommendation to overcome this reporting difficulty, the laboratory test detection limit concentration values have been used for a number of study metals including chromium, copper, lead, zinc, nickel, cadmium and iron as a surrogate concentration value for cumulative annual loading assessment purposes. For each of these study metals it is accepted that the adopted surrogate concentration value is higher than the actual concentration value in the surface water.

For mercury it was agreed that an adopted surrogate value, representing half of the "indicative" water quality standard of 0.05 ug/l from Table 3.42, would be used for cumulative annual loading assessment purposes.

Using the data from Figures C.1 – C.8, in conjunction with the approach agreed by the EPA on detection limit reporting, the metals concentration matrix Table 3.38 was prepared for the study metals.

It should be remembered that in most cases the concentrations quoted in the concentration matrix Table 3.38 represent overestimates.

Table 3.39 represents the combined concentration matrix for both the nutrients and the parameters.

By multiplying the concentrations in Table 3.39 with the estimated annual cumulative inflow (rivers (A) , transitionals (B)), as per Table 3.44, for each of the study urban area surface waters estimates for the cumulative annual loadings entering the urban surface waters from upstream were developed. The estimated cumulative annual loads are detailed Table 3.40 – The upstream surface water loading matrix.

The adopted methodology/procedures for calculating the annual cumulative flow data for both the urban river and transitional surface waters are outlined in Section 3.9.3.

3.9 Stage 7 – Assimilative Capacity Assessment

The original project scope envisaged an assimilative capacity assessment for two urban surface water types – rivers and transitional (estuarine) surface waters. The assimilative capacity assessment was to be undertaken for two flow conditions in the urban river surface waters – the mean annual average flow condition and the low flow Q95 flow condition.

However because of ***the lack of comprehensive Q95 river flow*** data for most of the study urban river surface waters the ***assimilative capacity assessments were restricted to a single flow condition - the mean annual flow condition***.

Finally the assimilative capacity assessment was to be undertaken based upon the combined cumulative annual loadings from all urban pressures on the urban surface waters. Although seven urban pressures were identified from the outset of the study ultimately it was only ***possible to estimate loadings for five of the seven urban pressures*** as explained previously in Section 3.8. Therefore the assimilative capacity assessments presented in this section are based upon the cumulative impacts of five urban pressures.

Table 3.38: Water Framework Directive Surveillance Monitoring Programme – Metals Concentration Matrix

Urban Area Name	Surface Water Name	RBD	Cadmium (mg/l)	Chromium (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Mercury (mg/l)	Nickel (mg/l)	Zinc (mg/l)
Athlone	Shannon (Main) (River)	IE-Shannon	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Carlow	River Barrow (River)	IE-South Eastern	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Carrigaline	Owenboy Estuary (Part Only) (Transitional)	IE-South Western	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Castlebar	Liscromwell (River)	IE-Western	0.0001	0.001	0.001	0.203	0.001	0.000025	0.001	0.002
Celbridge	River Liffey (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Clonmel	River Suir (River)	IE-South Eastern	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Cork	Lee (Cork Estuary) Lower (Transitional)	IE-South Western	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Drogheda	Boyne Estuary (Part Only) (Transitional)	IE-Eastern	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.002
Dundalk	Castletown Estuary (Transitional)	IE-Neagh Bann	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Ennis	River Fergus (River)	IE-Shannon	0.0001	0.001	0.001	0.148	0.001	0.000025	0.001	0.001
Kilkenny	River Nore (River)	IE-South Eastern	0.0001	0.002	0.001	0.109	0.001	0.000025	0.001	0.001
Letterkenny	Swilly Estuary (Part Only) (Transitional)	IE-North Western	0.0001	0.001	0.002	1.480	0.001	0.000025	0.002	0.006
Lexlip	River Liffey (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.002	0.002
Limerick	Limerick Dock (Part Only) (Transitional)	IE-Shannon	0.0001	0.001	0.001	0.148	0.001	0.000025	0.001	0.001
Maynooth	River Ryewater (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Mullingar	River Brosna (River)	IE-Shannon	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Naas	River Morell (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Navan	River Boyne (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Newbridge	River Liffey (River)	IE-Eastern	0.0001	0.001	0.001	0.008	0.001	0.000025	0.001	0.001
Portlaoise	Triogue (Barrow) River (River)	IE-South Eastern	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Swords	Broadmeadow River (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Tralee	Big River (River)	IE-Shannon	0.0001	0.001	0.001	0.148	0.001	0.000025	0.001	0.001
Tullamore	Tullamore River (River)	IE-Shannon	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Waterford	Suir Estuary (Transitional)	IE-South Eastern	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Wexford	Lower Slaney Estuary (Part Only) (Transitional)	IE-South Eastern	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Dublin	River Dodder (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Dublin	River Camac (River)*	IE-Eastern	*	*	*	*	*	*	*	*
Dublin	River Liffey (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.002	0.002
Dublin	Tolka River (River)	IE-Eastern	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Dublin	Santry River (River)*	IE-Eastern	*	*	*	*	*	*	*	*
Dublin	Liffey Estuary Upper (Transitional)	IE-Eastern	0.0001	0.001	0.001	0.188	0.001	0.000025	0.001	0.004
Dublin	Liffey Estuary Lower (Transitional)	IE-Eastern	0.0001	0.001	0.001	0.188	0.001	0.000025	0.001	0.004
Dublin	Tolka Estuary (Transitional)	IE-Eastern	0.0001	0.001	0.001	0.188	0.001	0.000025	0.001	0.004
Galway	Corrib Estuary (Transitional)	IE-Western	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Galway	Corrib River (River)	IE-Western	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Killarney	Deenagh River (River)	IE-South Western	0.0001	0.001	0.002	0.245	0.001	0.000025	0.001	0.002
Killarney	Flesk River (River)	IE-South Western	0.0001	0.001	0.002	0.245	0.001	0.000025	0.001	0.002
Sligo	Garavogue Estuary (Transitional)	IE-Western	0.0001	0.001	0.001	0.398	0.001	0.000025	0.001	0.002
Sligo	River Garavogue (River)	IE-Eastern	0.0001	0.001	0.001	0.398	0.001	0.000025	0.001	0.002
Balbriggan	NONE PROPOSED	IE-Eastern								
Bray	NONE PROPOSED	IE-Eastern								
Greystones	NONE PROPOSED	IE-Eastern								
Malahide	NONE PROPSED	IE-Eastern								

* No upstream loading contribution as the river rises within the study urban area catchment.

Table 3.39: Upstream Surface Waters: Combined Concentration Matrix

Urban Area Name	Surface Water Name	Nitrates (mg/)	Nitrites (mg/l)	Total N (mg/l)	Nitrogen TKN (mg/l)	Total Phosphorous (mg/l)	Ortho-Phosphate (mg/l)	Cadmium (mg/l)	Chromium (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Mercury (mg/l)	Nickel (mg/l)	Zinc (mg/l)
Athlone	Shannon (Main) (River)	0.162	0.013	nd	nd	nd	0.046	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Carlow	River Barrow (River)	0.162	0.028	nd	nd	nd	0.067	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Carrigaline	Owenboy Estuary (Part Only) (Transitional)	2.144	0.005	1.770	nd	0.047	0.031	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Castlebar	Liscromwell (River)	0.162	0.005	nd	nd	nd	0.045	0.0001	0.001	0.001	0.203	0.001	0.000025	0.001	0.002
Celbridge	River Liffey (River)	2.099	0.037	nd	nd	nd	0.070	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Clonmel	River Suir (River)	0.162	0.013	nd	nd	nd	0.046	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Cork	Lee (Cork Estuary) Lower (Transitional)	2.144	0.005	2.840	nd	0.067	0.033	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Drogheda	Boyne Estuary (Part Only) (Transitional)	2.280	0.020	3.570	nd	0.090	0.053	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.002
Dundalk	Castletown Estuary (Transitional)	2.144	0.005	1.770	nd	0.047	0.043	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Ennis	River Fergus (River)	0.162	0.013	nd	nd	n/d	0.046	0.0001	0.001	0.001	0.148	0.001	0.000025	0.001	0.001
Kilkenny	River Nore (River)	0.162	0.016	nd	nd	nd	0.059	0.0001	0.002	0.001	0.109	0.001	0.000025	0.001	0.001
Letterkenny	Swilly Estuary (Part Only) (Transitional)	2.144	0.005	1.770	nd	0.047	0.031	0.0001	0.001	0.002	1.480	0.001	0.000025	0.002	0.006
Lexlip	River Liffey (River)	2.099	0.032	nd	nd	nd	0.105	0.0001	0.001	0.001	0.197	0.001	0.000025	0.002	0.002
Limerick	Limerick Dock (Part Only) (Transitional)	2.144	0.005	1.690	nd	0.034	0.021	0.0001	0.001	0.001	0.148	0.001	0.000025	0.001	0.001
Maynooth	River Ryewater (River)	1.820	0.025	nd	nd	nd	0.075	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Mullingar	River Brosna (River)	0.162	0.013	nd	nd	nd	0.046	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Naas	River Morell (River)	2.099	0.006	nd	nd	nd	0.014	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Navan	River Boyne (River)	2.113	0.126	nd	nd	nd	0.056	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Newbridge	River Liffey (River)	2.099	0.008	nd	nd	nd	0.012	0.0001	0.001	0.001	0.008	0.001	0.000025	0.001	0.001
Portlaoise	Triogue (Barrow) River (River)	0.162	0.013	nd	nd	nd	0.046	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Swords	Broadmeadow River (River)	2.663	0.045	nd	nd	nd	0.153	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Tralee	Big River (River)	0.162	0.013	nd	nd	nd	0.046	0.0001	0.001	0.001	0.148	0.001	0.000025	0.001	0.001
Tullamore	Tullamore River (River)	0.162	0.013	nd	nd	nd	0.046	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Waterford	Suir Estuary (Transitional)	2.144	0.005	1.770	nd	0.047	0.031	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Wexford	Lower Slaney Estuary (Part Only) (Transitional)	2.144	0.005	1.770	nd	0.047	0.031	0.0001	0.001	0.001	0.109	0.001	0.000025	0.001	0.001
Dublin	River Dodder (River)	1.615	0.033	nd	nd	nd	0.050	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Dublin	River Camac (River)*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Dublin	River Liffey (River)	2.200	0.022	nd	nd	nd	0.067	0.0001	0.001	0.001	0.197	0.001	0.000025	0.002	0.002
Dublin	Tolka River (River)	2.180	0.036	nd	nd	nd	0.098	0.0001	0.001	0.001	0.197	0.001	0.000025	0.001	0.002
Dublin	Santry River (River)*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Dublin	Liffey Estuary Upper (Transitional)	1.828	0.031	2.594	nd	0.126	0.068	0.0001	0.001	0.001	0.188	0.001	0.000025	0.001	0.004
Dublin	Liffey Estuary Lower (Transitional)	1.829	0.030	2.919	nd	0.114	0.063	0.0001	0.001	0.001	0.188	0.001	0.000025	0.001	0.004
Dublin	Tolka Estuary (Transitional)	2.640	0.068	2.919	nd	0.114	0.087	0.0001	0.001	0.001	0.188	0.001	0.000025	0.001	0.004
Galway	Corrib Estuary (Transitional)	2.144	0.005	1.770	nd	0.047	0.031	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Galway	Corrib River (River)	0.162	0.009	nd	nd	nd	0.029	0.0001	0.001	0.001	0.200	0.001	0.000025	0.001	0.002
Killarney	Deenagh River (River)	0.162	0.013	nd	nd	nd	0.046	0.0001	0.001	0.002	0.245	0.001	0.000025	0.001	0.002
Killarney	Flesk River (River)	0.162	0.013	nd	nd	nd	0.046	0.0001	0.001	0.002	0.245	0.001	0.000025	0.001	0.002
Sligo	Garavogue Estuary (Transitional)	2.144	0.005	0.781	nd	0.033	0.026	0.0001	0.001	0.001	0.398	0.001	0.000025	0.001	0.002
Sligo	River Garavogue (River)	0.162	0.005	nd	nd	nd	0.039	0.0001	0.001	0.001	0.398	0.001	0.000025	0.001	0.002
Balbriggan	NONE PROPOSED														
Bray	NONE PROPOSED														
Greystones	NONE PROPOSED														
Malahide	NONE PROPSED														

Outside ERBD   ERBD Data

* No upstream loading contribution as the river rises within the study urban area catchment.   nd No Data

Table 3.40: Upstream Surface Water Loading Matrix – Existing Development Horizon

LOADING MATRIX

Surface Water Type	Urban Area Name	Surface Water Name	Nitrates (kg/yr)	Nitrites (kg/yr)	Total N (kg/yr)	Nitrogen (TKN) (kg/yr)	Total Phosphorous (kg/yr)	Ortho-Phosphate (kg/yr)	Cadmium (kg/yr)	Chromium (kg/yr)	Copper (kg/yr)	Iron (kg/yr)	Lead (kg/yr)	Mercury (kg/yr)	Nickel (kg/yr)	Zinc (kg/yr)
r	Athlone	Shannon (Main) (River)	449066	34817	nd	nd	nd	128746	277	2772	2772	554403	2772	69	2772	5544
r	Carlow	River Barrow (River)	146879	25205	nd	nd	nd	61018	91	907	907	98826	907	23	907	907
t	Carrigaline	Owenboy Estuary (Part Only) (Transitional)	192636	449	159044	nd	4201	2799	9	90	90	17968	90	2	90	180
r	Castlebar	Liscromwell (River)	12823	396	nd	nd	nd	3562	7.916	79	79	16029	79	2	79	119
r	Celbridge	River Liffey (River)	882686	15470	nd	nd	nd	29388	42	421	421	82864	421	11	421	841
r	Clonmel	River Suir (River)	247605	19197	nd	nd	nd	70988	153	1528	1528	166598	1528	38	1528	1528
t	Cork	Lee (Cork Estuary) Lower (Transitional)	3055604	7125	4047063	nd	95676	47339	143	1425	1425	285004	1425	36	1425	2850
t	Drogheda	Boyne Estuary (Part Only) (Transitional)	3713023	33222	5813813	nd	146925	85819	163	1629	1629	177509	1629	41	1629	3257
t	Dundalk	Castletown Estuary (Transitional)	**No flow data**													
r	Ennis	River Fergus (River)	61817	4793	nd	nd	nd	17723	38	382	382	56475	382	10	382	382
r	Kilkenny	River Nore (River)	198223	19578	nd	nd	nd	72192	122	2447	1224	133372	1224	31	1224	1224
t	Letterkenny	Swilly Estuary (Part Only) (Transitional)	333980	779	275741	nd	7283	4854	16	156	312	230519	156	4	312	935
r	Lexlip	River Liffey (River)	963291	14689	nd	nd	nd	48199	46	459	459	90430	459	11	918	918
t	Limerick	Limerick Dock (Part Only) (Transitional)	14274807	33286	11250752	nd	225348	137006	666	6657	6657	985273	6657	166	6657	6657
r	Maynooth	River Ryewater (River)	117087	1576	nd	nd	nd	4806	6.433	64	64	12674	64	2	64	129
r	Mullingar	River Brosna (River)	4623	358	nd	nd	nd	1326	2.854	29	29	5708	29	1	29	57
r	Naas	River Morell (River)	735836	2069	nd	nd	nd	4909	35	351	351	69078	351	9	351	701
r	Navan	River Boyne (River)	2318251	138239	nd	nd	nd	61440	110	1097	1097	216136	1097	27	1097	2194
r	Newbridge	River Liffey (River)	588987	2189	nd	nd	nd	3256	28	281	281	2105	281	7	281	281
r	Portlaoise	Triogue (Barrow) River (River)	2503	194	nd	nd	nd	718	1.545	15	15	1684	15	0	15	15
r	Swords	Broadmeadow River (River)	243543	4070	nd	nd	nd	13993	9.145	91	91	18017	91	2	91	183
r	Tralee	Big River (River)	12047	934	nd	nd	nd	3454	7.437	74	74	11006	74	2	74	74
r	Tullamore	Tullamore River (River)	10218	792	nd	nd	nd	2929	6.307	63	63	12614	63	2	63	126
t	Waterford	Suir Estuary (Transitional)	4686140	10927	3868966	nd	102191	68102	219	2185	2185	238213	2185	55	2185	2185
t	Wexford	Lower Slaney Estuary (Part Only) (Transitional)	2746092	6403	2267225	nd	59884	39908	128	1281	1281	139594	1281	32	1281	1281
r	Dublin	River Dodder (River)	137513	2767	nd	nd	nd	4257	8.515	85	85	16774	85	2	85	170
r	Dublin	River Camac (River)	**No upstream loading contribution as the river rises within the study urban area catchment.**													
r	Dublin	River Liffey (River)	1071215	10712	nd	nd	nd	32477	49	487	487	95922	487	12	974	974
r	Dublin	Tolka River (River)	125466	2060	nd	nd	nd	5629	5.755	58	58	11338	58	1	58	115
r	Dublin	Santry River (River)	**No upstream loading contribution as the river rises within the study urban area catchment.**													
t	Dublin	Liffey Estuary Upper (Transitional)	943983	16163	1339289	nd	64976	35127	52	516	516	97084	516	13	516	2066
t	Dublin	Liffey Estuary Lower (Transitional)	1100233	18167	1755922	nd	68551	37704	60	602	602	113091	602	15	602	2406
t	Dublin	Tolka Estuary (Transitional)	151940	3896	167998	nd	6559	5001	6	58	58	10820	58	1	58	230
t	Galway	Corrib Estuary (Transitional)	6989990	16299	5771068	nd	152432	101582	326	3260	3260	651975	3260	81	3260	6520
r	Galway	Corrib River (River)	528100	29339	nd	nd	nd	95091	326	3260	3260	651975	3260	81	3260	6520
r	Killarney	Deenagh River (River)	3576	277	nd	nd	nd	1025	2.208	22	33	5408	22	1	22	44
r	Killarney	Flesk River (River)	69582	5395	nd	nd	nd	19949	43	430	644	105232	430	11	430	859
t	Sligo	Garavogue Estuary (Transitional)	935876	2182	340874	nd	14331	11396	44	436	436	173710	436	11	436	873
r	Sligo	River Garavogue (River)	70706	2182	nd	nd	nd	17066	44	436	436	173710	436	11	436	873
?	Balbriggan	NONE PROPOSED														
?	Bray	NONE PROPOSED														
?	Greystones	NONE PROPOSED														
?	Malahide	NONE PROPSED														

For each study urban surface water the assimilative capacity assessments were undertaken for the 14 individual parameters (Table 3.5) using a combination of:

- cumulative annual urban pressure loading (kg/yr) of parameter into the urban surface water
- proposed indicative water quality standard (per parameter) for the urban surface water
- cumulative annual flow (m3/s) in the urban surface water

In total, assimilative capacity assessments were completed for 26 urban river surface waters and 13 urban transitional surface waters for a total of 14 parameters under a single annual flow condition. In the remainder of this section we have detailed the datasets that were used at each stage of the assimilative capacity assessments and also outlined the source of these datasets.

At the end of this section we also present the results of the assimilative capacity assessments in graphical form. The graphs also provide an indication of those surface waters that are the most likely to be at risk of failure of the "indicative"water quality standards.

3.9.1 Cumulative Annual Urban Pressure Loading

The procedures used to estimate the cumulative annual loadings for the various urban pressures are detailed throughout Section 3 of this report. Cumulative annual loadings were estimated in total for five discrete urban pressures as follows:

- Combined sewer overflow (CSO) discharges – Table 3.10
- WWTP discharges - Table 3.21
- Atmospheric deposition (direct to surface waters) - Table 3.25
- Diffuse urban catchment surface water runoff – Table 3.33
- Incoming loadings from upstream catchment – Table 3.40

The cumulative annual loadings from each of these five urban pressures have been combined into table Table 3.41 overleaf. Table 3.41 represents the combined cumulative annual loading estimates (kg/yr) for all five urban pressures discharging into the urban surface waters.

Table 3.41: Cumulative Urban Pressures Loading Matrix

LOADING MATRIX

Surface Water Type	Urban Area Name	Surface Water Name	Nitrates (kg/yr)	Nitrites (kg/yr)	Total N (kg/yr)	Nitrogen (TKN) (kg/yr)	Total Phosphorous (kg/yr)	Ortho-Phosphate (kg/yr)	Cadmium (kg/yr)	Chromium (kg/yr)	Copper (kg/yr)	Iron (kg/yr)	Lead (kg/yr)	Mercury (kg/yr)	Nickel (kg/yr)	Zinc (kg/yr)
r	Athlone	Shannon (Main) (River)	451633	37383	44225	27302	3883	130942	286	2805	2919	564943	3240	71	2810	6475
r	Carlow	River Barrow (River)	148294	26620	87826	11801	2838	64893	96	931	1042	105128	1201	24	946	1560
t	Carrigaline	Owenboy Estuary (Part Only) (Transitional)	194006	1819	163545	3999	4895	3162	12	101	116	22531	311	3	92	597
r	Castlebar	Liscromwell (River)	15435	3008	52181	33354	1646	4728	16	113	239	26201	552	3	121	1114
r	Celbridge	River Liffey (River)	883705	16489	2742	2227	397	29566	45	430	444	86502	560	11	428	1134
r	Clonmel	River Suir (River)	250580	22172	32159	29712	5581	75411	162	1565	1666	178763	2025	40	1574	2582
t	Cork	Lee (Cork Estuary) Lower (Transitional)	3061974	13494	4458952	566297	185230	107744	161	1565	2052	307323	2520	42	1549	5679
t	Drogheda	Boyne Estuary (Part Only) (Transitional)	3715909	36106	5846990	34964	154075	95737	173	1668	1799	189816	2174	42	1678	4364
t	Dundalk	Castletown Estuary (Transitional)	7873	7869	87565	54175	11919	9052	30	109	592	39489	1353	4	189	2595
r	Ennis	River Fergus (River)	69455	12429	57903	40894	7236	22413	59	455	653	83522	1654	12	429	2829
r	Kilkenny	River Nore (River)	201502	22856	58275	37497	8149	74946	133	2489	1395	146460	1762	32	1278	2406
t	Letterkenny	Swilly Estuary (Part Only) (Transitional)	339745	6543	296451	18937	10791	6622	32	211	459	252617	1077	6	348	2575
r	Lexlip	River Liffey (River)	964327	15725	2701	2161	392	48373	49	469	492	94327	609	12	927	1214
t	Limerick	Limerick Dock (Part Only) (Transitional)	14279899	38374	11590042	466471	299108	186774	681	6773	7203	1003685	7547	172	6766	8968
r	Maynooth	River Ryewater (River)	118136	2625	3202	2631	490	5034	10	75	115	16944	219	2	78	429
r	Mullingar	River Brosna (River)	6681	2416	52095	35120	2554	2719	9	57	176	13545	398	2	67	828
r	Naas	River Morell (River)	738407	4639	6697	5301	948	5322	42	373	429	78319	702	10	372	1426
r	Navan	River Boyne (River)	2320777	140765	65346	32088	5528	65860	118	1129	1265	225877	1564	29	1136	3134
r	Newbridge	River Liffey (River)	590276	3478	6654	6021	742	3678	31	292	333	6698	467	7	291	651
r	Portlaoise	Triogue (Barrow) River (River)	5166	2856	61250	57614	9560	4113	10	52	161	12137	493	2	52	1017
r	Swords	Broadmeadow River (River)	246264	6791	7796	6411	1195	14599	17	118	208	28955	610	3	105	1015
r	Tralee	Big River (River)	15677	4564	16238	16932	2842	5085	18	110	168	24895	642	3	100	1174
r	Tullamore	Tullamore River (River)	12341	2915	51356	21155	2230	4433	13	89	152	21149	450	3	87	876
t	Waterford	Suir Estuary (Transitional)	4694610	19387	3984592	70977	114944	77140	244	2283	2629	270820	3492	59	2318	4919
t	Wexford	Lower Slaney Estuary (Part Only) (Transitional)	2748906	9192	2296483	35854	67816	44656	137	1319	1460	150866	1755	34	1339	2346
r	Dublin	River Dodder (River)	154997	20251	104895	94573	16674	12565	51	238	722	74303	2766	8	174	5127
r	Dublin	River Camac (River)	13757	13756	52259	44614	8125	3879	34	117	509	46198	2082	4	73	3591
r	Dublin	River Liffey (River)	1079714	19206	143749	92120	12638	44410	70	575	986	121743	1703	16	1094	3549
r	Dublin	Tolka River (River)	136651	13245	43956	38308	6978	9046	39	170	499	55915	1957	6	140	3373
r	Dublin	Santry River (River)	5516	5516	68453	65435	11492	5910	18	70	340	23976	1049	3	61	1798
t	Dublin	Liffey Estuary Upper (Transitional)	969297	41477	1438931	84591	80333	42467	113	725	1523	179355	4292	21	652	8587
t	Dublin	Liffey Estuary Lower (Transitional)	1146890	64815	4135056	1298687	571143	369846	235	1636	4419	299950	8938	60	2035	27318
t	Dublin	Tolka Estuary (Transitional)	167220	19169	229380	53266	16221	9746	50	209	672	70844	2650	7	167	4723
t	Galway	Corrib Estuary (Transitional)	7001387	27671	6044367	207396	297218	128326	366	3430	4040	699589	5137	89	3535	11070
r	Galway	Corrib River (River)	538096	39333	47740	59695	20056	100994	355	3362	3642	691216	4793	85	3356	9479
r	Killarney	Deenagh River (River)	4619	1320	4740	5071	650	1493	4	27	46	7262	96	1	26	198
r	Killarney	Flesk River (River)	71475	7287	6884	6706	977	20549	47	442	651	110040	654	11	431	1320
t	Sligo	Garavogue Estuary (Transitional)	942172	8455	429584	56611	24467	18604	65	517	830	200967	1613	15	536	3091
r	Sligo	River Garavogue (River)	74122	5598	9860	7807	1442	17772	53	469	604	186894	1030	12	461	1893
?	Balbriggan	NONE PROPOSED	1441	1441	4112	3418	632	307	4	13	59	5256	238	0	8	418
?	Bray	NONE PROPOSED	998	998	3817	3703	631	345	3	9	28	3416	146	0	6	276
?	Greystones	NONE PROPOSED	2232	2232	6579	5480	988	479	5	16	54	6692	334	1	3	603
?	Malahide	NONE PROPSED	1318	1318	6790	7222	1205	724	3	11	37	4255	219	0	2	405

3.9.2 Water Quality Standards

A set of draft indicative chemical water quality standards (EQS) for use in the assimilative capacity assessments were provided by the EPA. The draft indicative EQS are listed in Table 3.42.

Table 3.42: Draft Indicative Water Quality Standards for Selected Parameters

Parameter	Unit	Concentration (ug/l) Rivers	Concentration (ug/l) Transitionals
Nitrates (NO3)	mg/l	No EQS proposed	No EQS proposed
Nitrites (NO2)	mg/l	No EQS proposed	No EQS proposed
Total N	mg/l	No EQS proposed	No EQS proposed
Nitrogen (TKN)	mg/l	No EQS proposed	No EQS proposed
Ammonium	mg/l	High/Good Boundary <0.035 mg/l N, Good/Moderate <0.060 mg/l N	No EQS proposed
Total Phosphorous	mg/l	No EQS proposed	No EQS proposed
Ortho-phosphate	ug/l	50 (Median)	0-17 psu (Winter Median) EQS 60µg P/l 35psu (Winter Median) EQS 40µg P/l

Parameter	Unit	Annual Average Concentration (ug/l)		Maximum Allowed Concentration (ug/l)	
		Rivers	Transitional	Rivers	Transitional
		AA	AA	MAC	MAC
Cadmium*	ug/l	≤0.08 (Class1)	0.2	≤0.45 (Class1)	≤0.45 (Class1)
		0.08 (Class 2)		0.45 (Class2)	0.45 (Class 2)
		0.09 (Class 3)		0.6 (Class3)	0.6 (Class 3)
		0.15 (Class 4)		0.9 (Class 4)	0.9 (Class 4)
		0.25 (Class 5)		1.5 (Class 5)	1.5 (Class 5)
Chromium (VI)	ug/l	3.4	0.6	-	32
Chromium (III)	ug/l	4.7	-	32	-
Copper	ug/l	5 µg l^{-1} (where hardness ≤ 100 mg CaCO3 l^{-1}) or 30 µg l^{-1} (where hardness > 100 mg CaCO3 l^{-1})	5 µg l^{-1}	-	-
Iron	ug/l	200**	200**	200**	200**
Lead	ug/l	7.2	7.2	-	-
Mercury	ug/l	0.05**	0.05**	0.07**	0.07**
Nickel	ug/l	20	20	-	-
Zinc	ug/l	8 µg l^{-1} (where hardness ≤ 10 mg CaCO3 l^{-1})	40	-	-
		50 µg l^{-1} (where hardness > 10 - ≤100 mg CaCO3 l^{-1})			
		100 µg l^{-1} (where hardness > 100 mg CaCO3 l^{-1})		-	-

*For Cadmium and its compounds the EQS values vary dependent upon the hardness of the water as specified in five class categories (Class 1: <40 mg CaCO3/l, Class 2: 40 to <50 mg CaCO3/l, Class 3: 50 to <100 mg CaCO3/l, Class 4: 100 to <200 mg CaCO3/l and Class 5: ≥200 mg CaCO3/l).
** Internal consideration ongoing within the EPA
It should also be noted that the values quoted for the metals are concentrations above background levels. Background levels have not been established.

The draft indicative EQS apply mainly to the metals of interest to this study. With the exception of ortho phosphate and ammonia (which is not being considered under this study)

no draft EQS were provided by the EPA for any of the nutrients of interest to this study. The orthophosphate EQS likely addresses eutrophication concerns in rivers, whilst the ammonia EQS is probably related to ammonia's potential to be toxic.

The remaining nutrients of interest to this study – nitrate, nitrite, ammonia (transitional), total nitrogen and total phosphorus affect the ecological status of a water body by enhancing the trophic pressure when they are found in excess amounts. To proceed with the water quality assessment work, surrogates for EQSs need to be developed to permit comparison of the loads of these parameters in their receiving waters. These surrogates were developed based on water quality assessment work being done by CDM on the Avoca River in Wicklow, and typical threshold values used in temperate waters in the US.

In typical freshwaters, phosphorus is the nutrient of interest, as it (rather than nitrogen) limits algal growth (a key eutrophication parameter). Therefore we propose to establish the total phosphorus EQS at the same level as the orthophosphate EQS, a conservative assumption as orthophosphate is one component of total phosphorus. ***In marine waters, the reverse is true and nitrogen is most often the nutrient that limits algal growth.*** The limiting nutrient in transitional waters is more difficult to define as this is where there freshwater mixes with ocean water. Often, however, nitrogen is found to be the limiting nutrient, except at the head of riverine estuaries.

An extensive study (www.smast.umassd.edu/Coastal/research/estuaries/estuaries.html) of Massachusetts coastal ponds, embayments and estuaries has established allowable nitrogen concentrations to support good ecological status (evaluated based on meeting minimum dissolved oxygen levels, restore or maintain eelgrass, and have a healthy macroinvertebrate population). The Massachusetts study has found that nitrogen concentration targets are typically between 0.3 and 0.6 mg/l total nitrogen. For this urban pressures study we have selected 0.5 mg/l as the indicative surrogate EQS value for total nitrogen and all of its separate components in transitional waters. ***It should be noted however that this indicative surrogate value of 0.5 mg/l has been selected for this study for indicative purposes only. This indicative surrogate value should never be used as a representative EQS for any Irish Transitional/Coastal waters.***

The nitrogen level in rivers does not typically affect ecological status. Therefore for those rivers discharging to transitional waters a surrogate EQS could be based upon a modified value of the EQS selected for the downstream transitional waters. In these cases the river EQS could be set by using the transitional water EQS and a dilution factor. A reasonable dilution factor (assuming the incoming tidal water had much less nitrogen than the river water) would be determined by multiplying the transitional water EQS by the ratio of the river flow to the tidal prism volume. If the river does not immediately discharge into a transitional water, then an indicative surrogate EQS of 11 mg/l can be set, which is a public health standard for nitrate levels in drinking water in Ireland. ***Because the study of the river/ transitional water mixing zone interface is location specific each individual location would require significant detailed study to determine site specific EQS. This level of study was outside the scope of this project brief and for this reason this study progressed on the basis of an assumed singular indicative surrogate WQS value for all rivers irrespective of location.***

Therefore based upon water quality assessment work being done by CDM on the Avoca River in Wicklow, and further extensive water quality assessment work which CDM is undertaking across the USA, a high level review was undertaken to derive 'consensus' standards which could be used as surrogate data for the nutrients being assessed as part of this study. A set of 'consensus' surrogate EQS were subsequently developed and these were used for this study for the water quality assimilative capacity assessments.

Table 3.43 lists both the 'consensus' surrogate EQS which were derived by CDM for the majority of the nutrients plus the "Indicative" EQS specified by the EPA for the metals in Table 3.42.

Table 3.43: Proposed Study Water Quality Standards

Parameter	Unit	Rivers	Transitionals
Nitrates (NO3)	mg/l	11	0.5
Nitrites (NO2)	mg/l	11	0.5
Total N	mg/l	11	0.5
Nitrogen (TKN)	mg/l	11	0.5
Total Phosphorous	ug/l	50	50
Ortho-phosphate	ug/l	50	50

Parameter	Unit	Annual Average Concentration (ug/l)		Maximum Allowed Concentration (ug/l)	
		Rivers	Transitionals	Rivers	Transitionals
		AA	AA	MAC	MAC
Cadmium	ug/l	<=0.08 (Class 1: < 40 mg Ca CO3/l)	0.2	<=0.45 (Class 1)	<=0.45 (Class 1)
	ug/l	0.08 (Class 2: 40 to < 50mg Ca CO3/l)	0.2	0.45 (Class 2)	0.45 (Class 2)
	ug/l	0.09 (Class 3: 50 to < 100 mg Ca CO3/l)	0.2	0.6 (Class 3)	0.6 (Class 3)
	ug/l	0.15 (Class 4: 100 to < 200 mg Ca CO3/l)	0.2	0.9 (Class 4)	0.9 (Class 4)
	ug/l	0.25 (Class 5: > = 200 mg Ca CO3/l)	0.2	1.5 (Class 5)	1..5 (Class 5)
Chromium (VI)	ug/l	3.4	0.6	-	32
Chromium (III)	ug/l	4.7	-	32	-
Copper	ug/l	5 where hardness <= 100mg CaCO3/l	5	-	-
	ug/l	30 where hardness > 100mg CaCO3/l	5	-	-
Iron	ug/l	200	200	200	200
Lead	ug/l	7.2	7.2	-	-
Mercury	ug/l	0.05	0.05	0.07	0.07
Nickel	ug/l	20	20	-	-
Zinc	ug/l	8 where hardness <= 10 mg CaCO3/l	40	-	-
	ug/l	50 where hardness > 10 mg and <= 100 mg CaCO3/l	40	-	-
	ug/l	100 where hardness > 100 mg CaCO3/l	40	-	-

It should also be noted that the values quoted for the metals are concentrations above background levels. Background levels have not been established.

It should be noted that the surrogate ***EQS have been derived by CDM specifically to enable this study to proceed***. Furthermore it should be noted that the proposed EQS for this study as presented in Table 3.43 ***have not been approved/endorsed by the EPA*** as their work in finalising EQS is still ongoing at the time of writing. ***Therefore the EQS quoted in Table 3.43 should only be used for indicative purposes and restricted specifically for use on this urban pressures surface water assimilative capacity assessment study.***

It should also be noted that the EPA have advised that the supplied preliminary indicative water quality standards quoted for metals in Table 3.42 are above background levels. Background levels have still to be determined.

For a more detailed understanding of how the EQS presented in Table 3.43 were initially developed the reader is referred to the document titled – ''Urban Pressures: Surface Waters – Confirmation of indicative water quality standards'', Ref 39325/UP40/DG51 – S, April 2008. However, subsequent to publishing document 39325/UP40/DG51 - S, the initial surrogate EQS values were refined/modified further as described above.

3.9.3 Cumulative Annual Flows

The study involves a widespread assessment of assimilative capacities for 26 urban river surface waters and 13 urban transitional surface waters across 33 study urban areas.

The annual average river flows for the 26 urban surface river waters were provided by the EPA. These river flows are listed in column A of Table 3.44 below.

For the 13 urban transitional surface waters the tidal prism method was to be used to calculate the cumulative annual tidal inflow to the transitional surface water. Some difficulty was encountered with this methodology however because it was not possible to determine the low water tide mark contour lines from the existing national Irish mapping. This in turn made it difficult to define the corresponding low water polygon which is needed for the tidal prism method to estimate tidal volumes. A similar problem existed for the high water tide mark line. To overcome this problem the study proceeded by using the single transitional water polygon that was prepared for each transitional water as part of the original WFD Article V submission. This single transitional surface water polygon was used to represent both the high and low tide polygons for the tidal prism calculations.

In addition to the low and high water polygons the corresponding tidal range was required for each of the transitional surface waters. Unfortunately a national network of tidal gauge information relating to the transitional waters was not available. Consequently the actual tidal range values (high and low tide) adopted for the 13 transitional surface waters were extracted from the The Proudman Oceanographic Laboratory Poltips 3, Version 3.24, coastal tidal prediction software (For Liffey Estuary Upper and Lower the Dublin/North wall was used whilst the Dublin Bay was used for the Tolka Estuary).

Using the Poltips 3 software all high and low tide predictions for the closest gauge to each of the transitional surface waters was extracted for the full period 1/1/2005 – 31/12/2006.

Both the high tide values and the low tide values were averaged for the entire two year period. These average high and low tide values were used to calculate the tidal range for each of the 13 study transitional surface waters. The estimated cumulative annual tidal inflows for the 13 transitional surface waters are detailed in column C of Table 3.44 below. It should be noted that by adopting the WFD Article V transitional water polygons to represent both the high and low tide polygons the tidal prism methodology will produce a slight over estimation of the cumulative annual tidal inflow volume into the transitional surface waters.

Table 3.44: Flow for River and Transitional Waters

Urban Area Name	Urban Water Name	Cumulative Annual Riverflow - Downstream end (m³/yr) (A)	Cumulative Annual River Flow into Transitional Waters (m3/yr) (B)	Cumulative Annual Tidal Inflow entering Transitional water (m³/yr) (C)
Athlone	Shannon (Main)	2,772,014,400		
Carlow	River Barrow	906,660,000		
Carrigaline	Owenboy Estuary (Part Only)		89,838,495	374,494,160
Castlebar	Liscromwell	79,155,360		
Celbridge	River Liffey	420,627,168		
Clonmel	River Suir	1,528,423,776		
Cork	Lee (Cork Estuary) Lower		1,425,022,080	1,921,798,284
Drogheda	Boyne Estuary (Part Only)		1,628,519,040	1,218,077,644
Dundalk	Castletown Estuary		0	4,960,105,453
Ennis	River Fergus	381,585,600		
Kilkenny	River Nore	1,223,596,800		
Letterkenny	Swilly Estuary (Part Only)		155,756,304	360,646,314
Leixlip	River Liffey	459,038,016		
Limerick	Limerick Dock (Part Only)		6,657,249,600	3,507,138,815
Maynooth	River Ryewater	64,333,440		
Mullingar	River Brosna	28,540,080		
Naas	River Morell	350,648,784		
Navan	River Boyne	1,097,137,440		
Newbridge	River Liffey	280,670,400		
Portlaoise	Triogue (Barrow) River	15,452,640		
Swords	Broadmeadow River	91,454,400		
Tralee	Big River	74,366,793		
Tullamore	Tullamore River	63,072,000		
Waterford	Lower Suir Estuary		2,185,444,800	10,106,937,285
Wexford	Lower Slaney Estuary (Part Only)		1,280,676,960	8,729,383,688
Dublin	River Dodder	85,147,200		
Dublin	River Camac	14,569,632		
Dublin	River Liffey	486,915,840		
Dublin	Tolka River	57,553,200		
Dublin	Santry River	7,568,640		
Dublin	Liffey Estuary Upper		516,402,000	385,561,999
Dublin	Liffey Estuary Lower		601,549,200	9,500,643,097
Dublin	Tolka Estuary		57,553,200	6,913,665,453
Galway	Corrib Estuary		3,259,876,320	22,591,786,834
Galway	Corrib River	3,259,876,320		
Killarney	Deenagh River	22,075,200		
Killarney	Flesk River	429,520,320		
Sligo	Garavogue Estuary		436,458,240	16,363,453,785
Sligo	River Garavogue	436,458,240		
Balbriggan	NONE PROPOSED			
Bray	NONE PROPOSED			
Greystones	NONE PROPOSED			
Malahide	NONE PROPSED			

CDM

However in the absence of more accurate information relating to the high and low water tide mark contours this was considered to be the best way to proceed.

It is worth noting however that a comprehensive national programme of LIDAR mapping is currently ongoing to define and map the low and high tide water mark lines around the Irish coast line. The completion of the LIDAR study will enable the tidal prism cumulative annual flow calculations presented in this Report to be revisited and refined in the future.

The procedures adopted for deriving the river surface water cumulative annual flows are outlined in an internal supporting project document (our Ref 39325/UP40/DG63).

Similarly for transitional surface waters the estimated cumulative annual flow data was estimated as per the procedures outlined in internal supporting project document reference 39325/UP40/DG39.

3.9.4 Assimilative Capacity Analysis

As explained previously the assimilative capacities were assessed for 26 river surface waters and 13 transitional surface waters for one flow condition – the annual average flow. Furthermore the cumulative impacts from five of the seven potential urban pressures were assessed as part of the assimilative capacity assessment. The results of these assimilative capacity assessments are presented in each of 14 figures (Figures 3.10 to 3.23; one per study parameter). The assimilative capacity assessments for the urban river surface waters are shown on the left hand side of each figure whilst the assimilative capacity assessments for the urban transitional surface waters are shown on the right hand side of each figure.

Each figure is split vertically into three boxes. The lower green box on each figure presents the cumulative annual loading (kg/yr) of the study parameter into the individual urban surface waters. For reference purposes the total urban catchment area sizes in hectares discharging to each urban surface water are shown as a navy line superimposed on the lower green box.

The middle blue box on each figure presents the cumulative annual flow into the urban surface water.

The upper yellow box presents the results of the actual assimilative capacity assessment. The bars in yellow represent the average annual concentration (mg/l) per urban surface water compared against the draft "indicative" water quality standards which are depicted by a red line. Yellow bars falling below the red line indicate that the urban surface water does not breach the draft "indicative" EQS for the mean annual flow condition in the receiving water whereas yellow bars extending above the red line indicate a breach of the draft "indicative" water quality standard.

For ease of understanding the EQS compliance results from all of the Figures 3.10 to 3.23 have been summarized into a single Table 3.45 – Pass/Fail.

3.9.5 Assimilative Capacity Results

For probably the first time in Ireland these results provide a common basis with which to compare water quality compliance across urban surface waters within Ireland for the larger urban areas (>10,000 population). ***It should be noted however that the results presented in Figures 3.10 to 3.23 are based upon many assumptions as detailed earlier throughout this***

report. Accordingly the results must be viewed in the context of the data limitations and constraints. Furthermore these results should only be viewed/used within the context of this macro level study.

Nevertheless the results bring together a significant volume of data relevant to the Irish context and they provide a baseline from which further refinement/investigation can be properly targeted and planned so as to improve the current understanding of cumulative urban pressures in Irish urban surface waters.

The analyses suggest that for orthophosphate a number of urban river and transitional surface waters are outside EQS limits including up to 19 rivers including the Camac, Tolka, Dodder and Santry in Dublin plus the Brosna in Mullingar and the Triogue in Portlaoise etc. Five transitional waters are also outside the EQS limits.

The analyses show a number of suggested EQS limit failures for metals including cadmium, chromium, copper, iron, lead, mercury and zinc. There are no suggested EQS limit failures for nickel. The suggested EQS limit failures vary across the metals. For example:

- a small number of river waters and one transitional water are outside the EQS limit for cadmium.
- a number of transitional waters and two rivers are outside the EQS limit for chromium
- as few as two rivers are outside the EQS limit for copper
- many rivers and transitional waters are outside the EQS limit for iron
- a small number of rivers and one transitional water are outside the EQS limit for lead
- a small number of rivers and one transitional water are outside the EQS limit for mercury
- a number of rivers and one transitional water are outside the EQS limit for zinc

It has to be stressed that all of the above assimilative capacity assessment results have to be treated with a significant degree of caution primarily because of the many constraints and limitations referred to previously.

In all cases the results show a worst case scenario because of the degree of overestimation of the cumulative annual loads as discussed throughout Section 3. In particular the use of detection limits for metals analysis will lead to significant overestimation of the annual metals loads.

There are however a small number of urban river and transitional waters for which several of the many parameters consistently exceed the indicative water quality standards. These urban waters include the:

- Santry and Camac rivers
- Dodder and Tolka rivers which exhibit consistent but less pronounced spiking

- Brosna river in Mullingar and Triogue (Barrow) river which exhibit consistent but less pronounced spiking
- Dublin Liffey Estuary Upper/Limerick Dock/Boyne Estuary transitional waters which all exhibit very pronounced spiking
- Letterkenny – Swilly River Estuary – transitional water which exhibits pronounced spiking

In all cases the urban river waters with suggested significant "exceedance" of water quality standards correspond to highly urbanised catchments with low annual stream flows. Therefore in reality these particular urban waters will be the first to show any likely significant effects from urban pressures on their ecological status.

Whilst ***we cannot determine the scale of the load overestimation*** on this small group of urban river waters the scale of the potential water quality compliance issues for each of these urban river waters leads us to conclude that a ***more detailed/comprehensive water quality sampling monitoring programme should be instigated for these urban river waters to establish EQS compliance or failure.***

Figure 3.10: Surface Waters Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Nitrites)

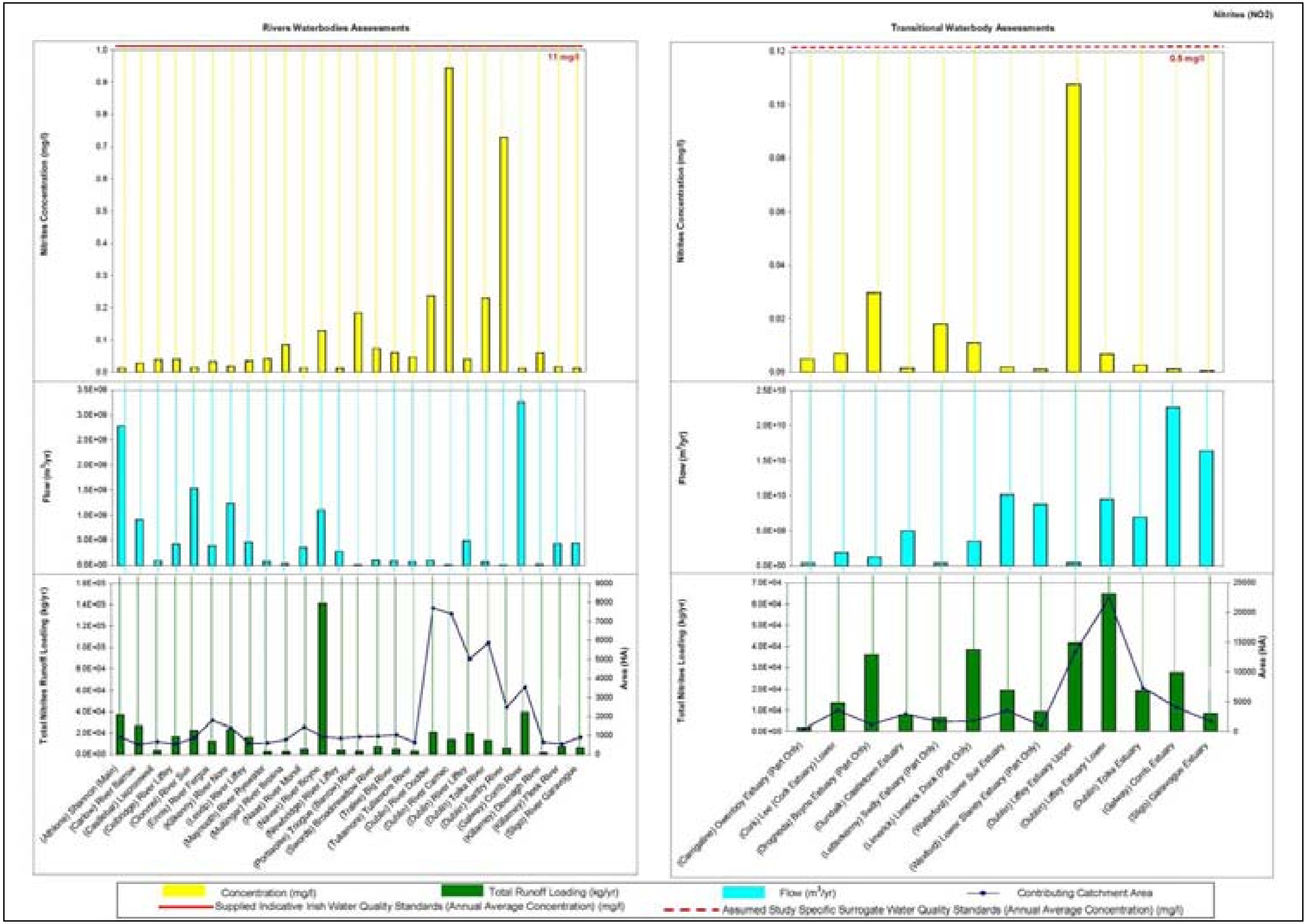


Figure 3.11: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters Nitrates)

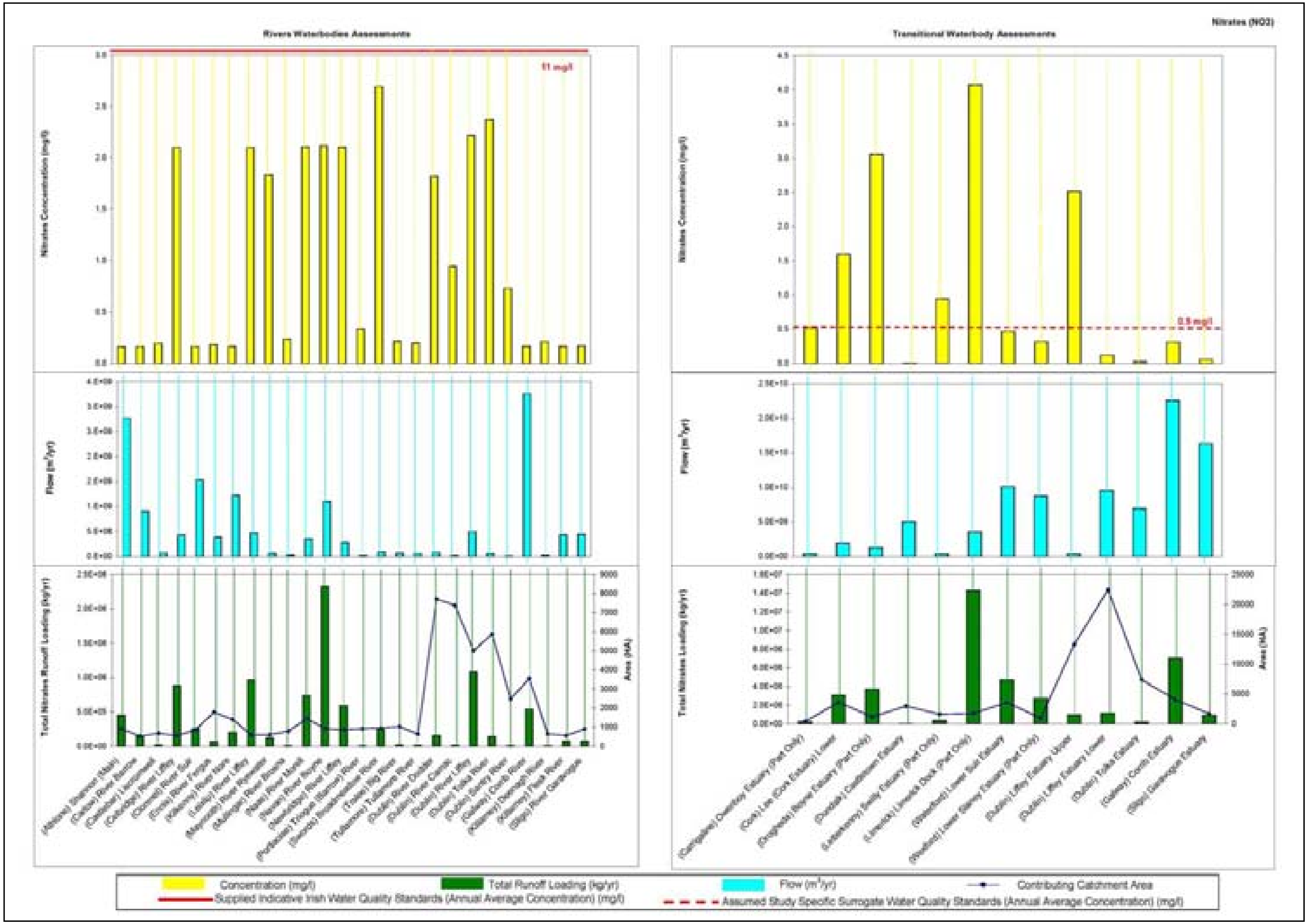


Figure 3.12: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Total Nitrogen)

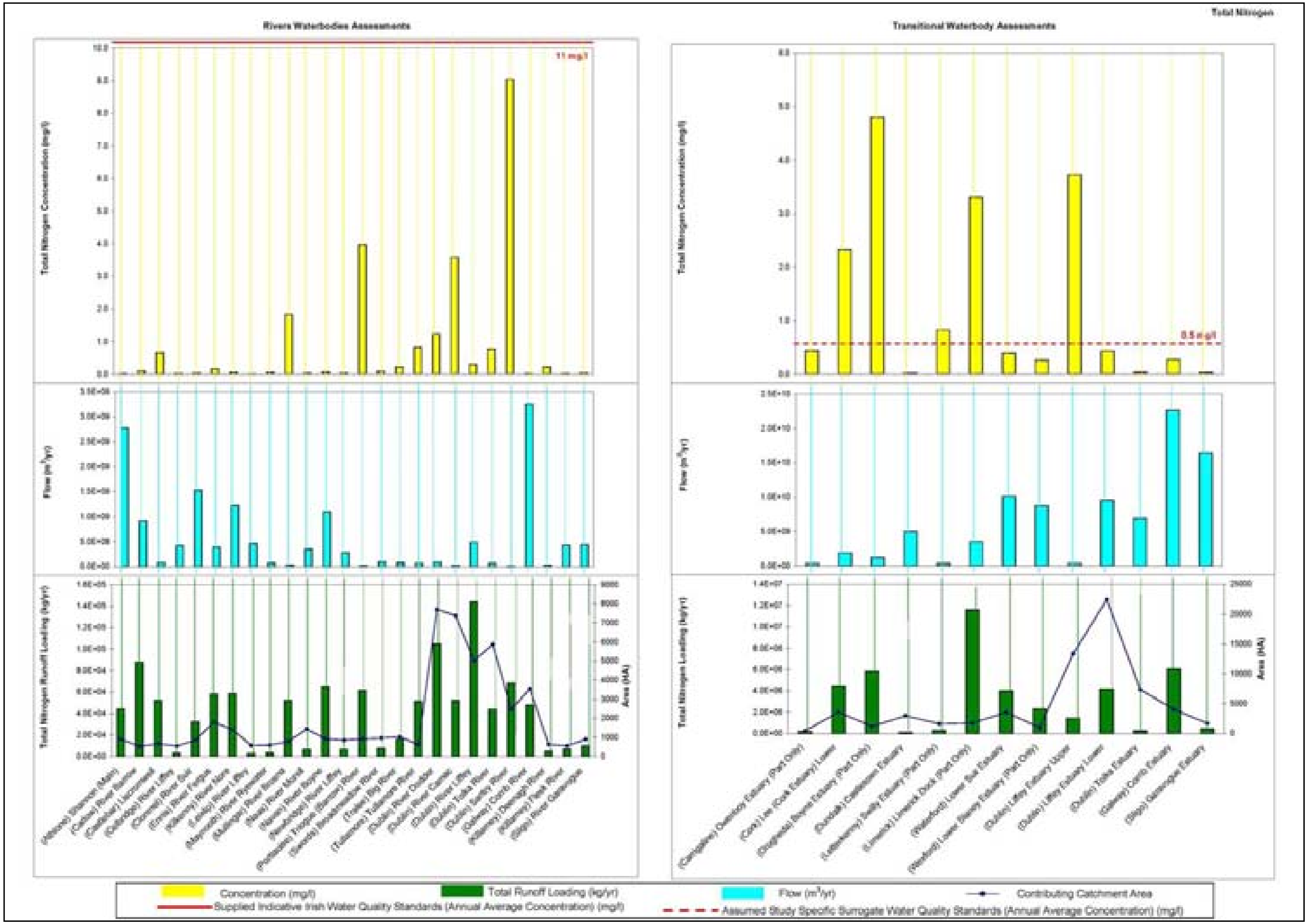


Figure 3.13: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Total Kjeldahl Nitrogen - TKN)

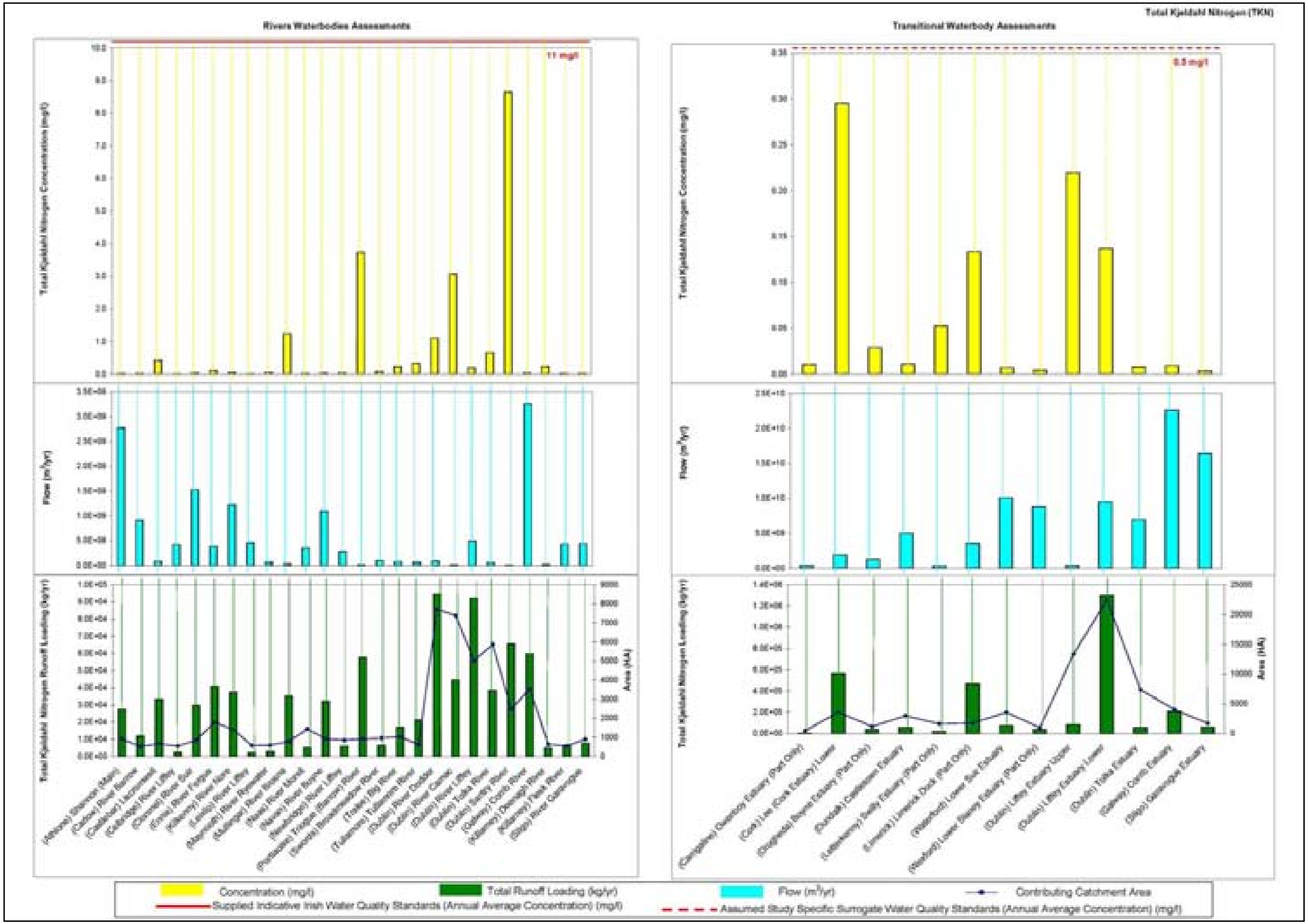


Figure 3.14: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Total Phosphorous)

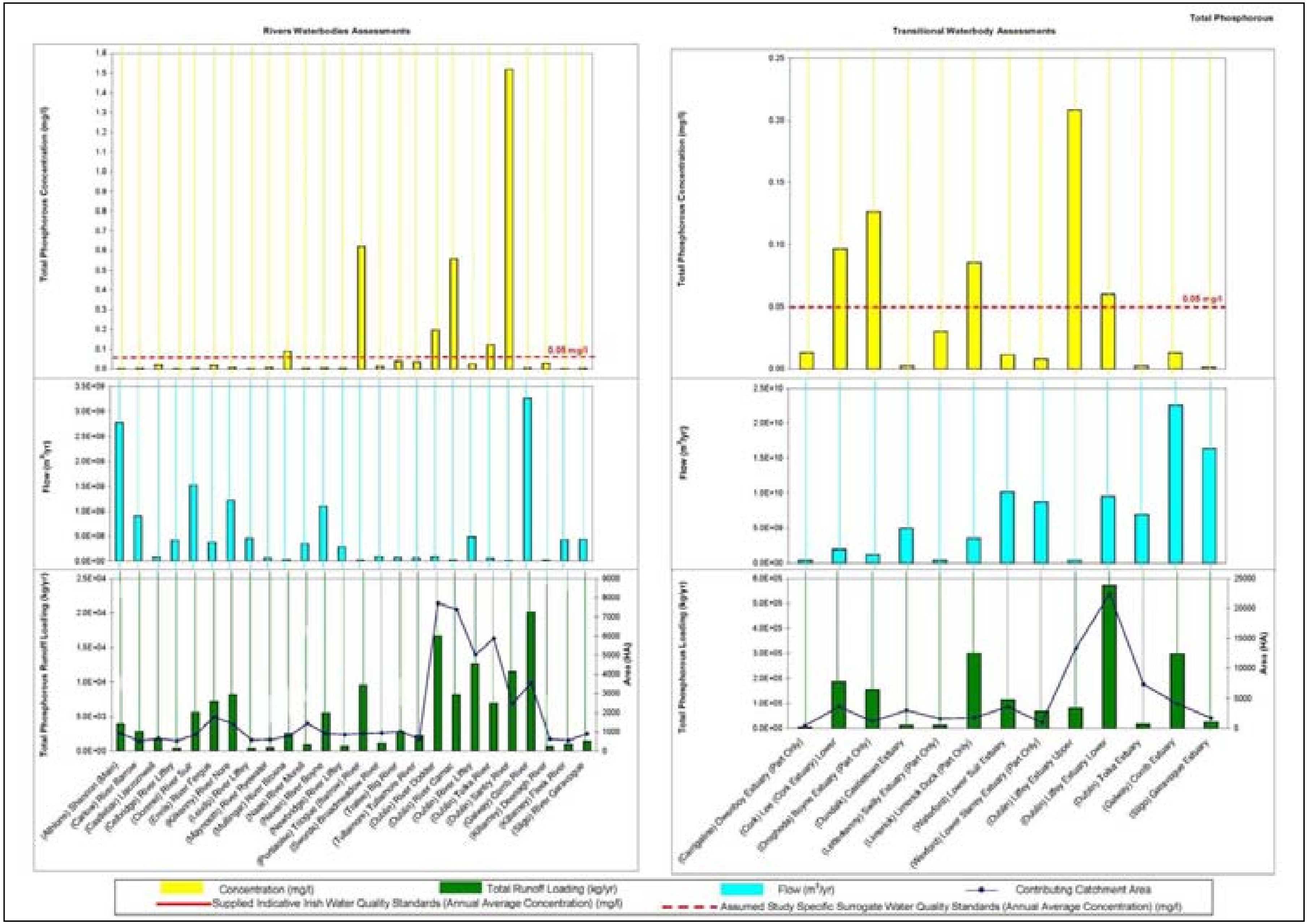


Figure 3.15: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Ortho-phosphorate)

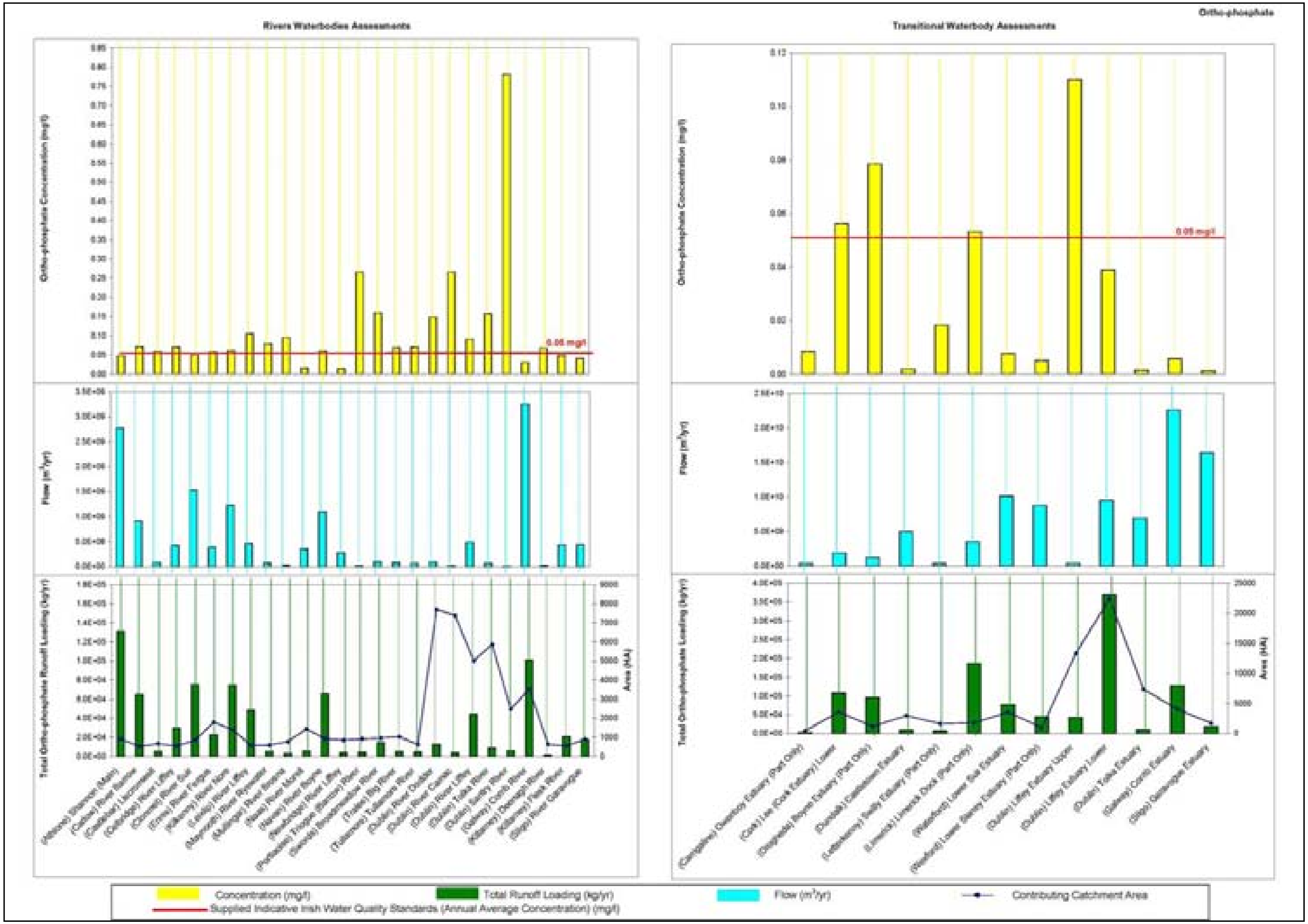


Figure 3.16: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Cadmium)

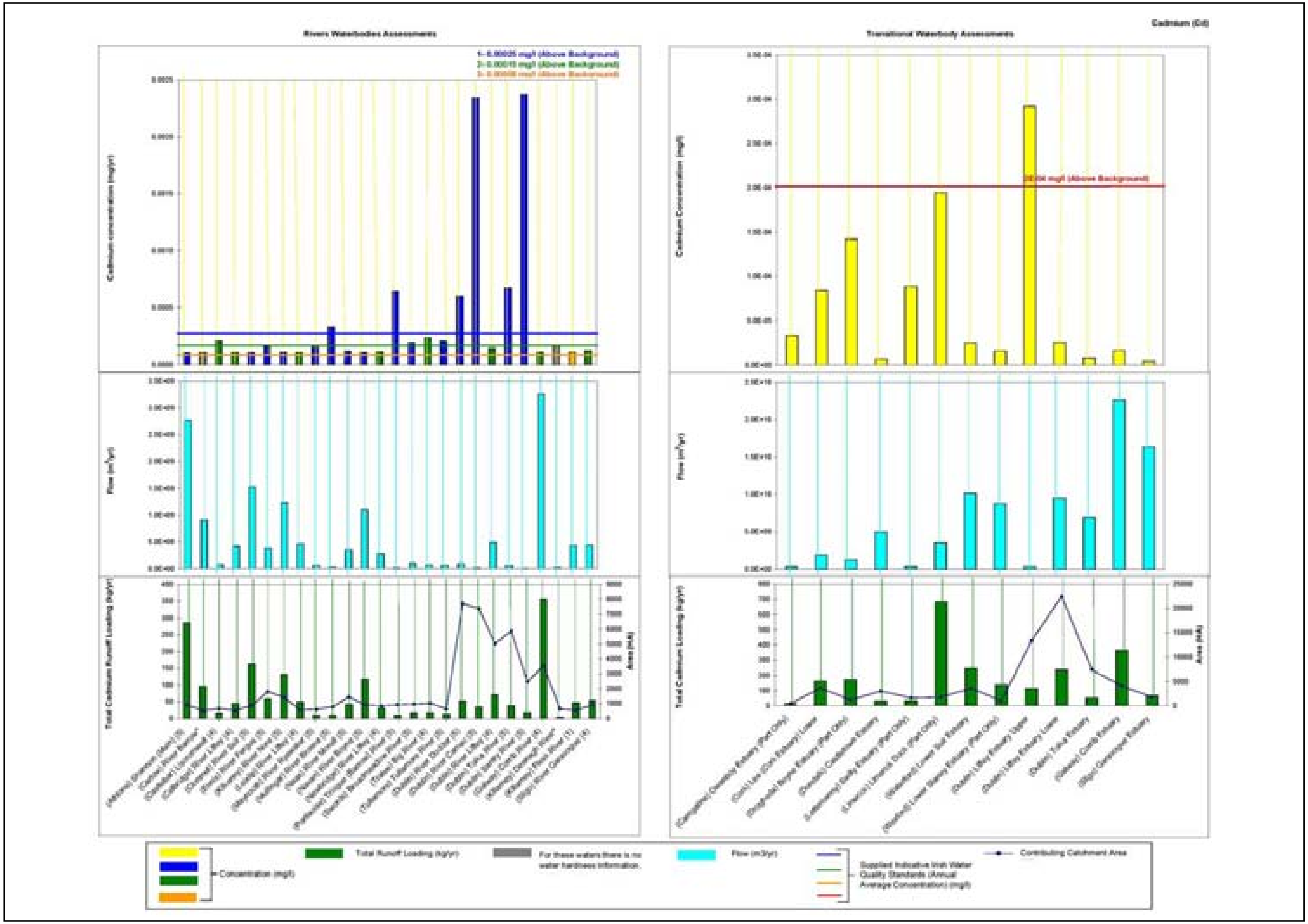


Figure 3.17: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Chromium)

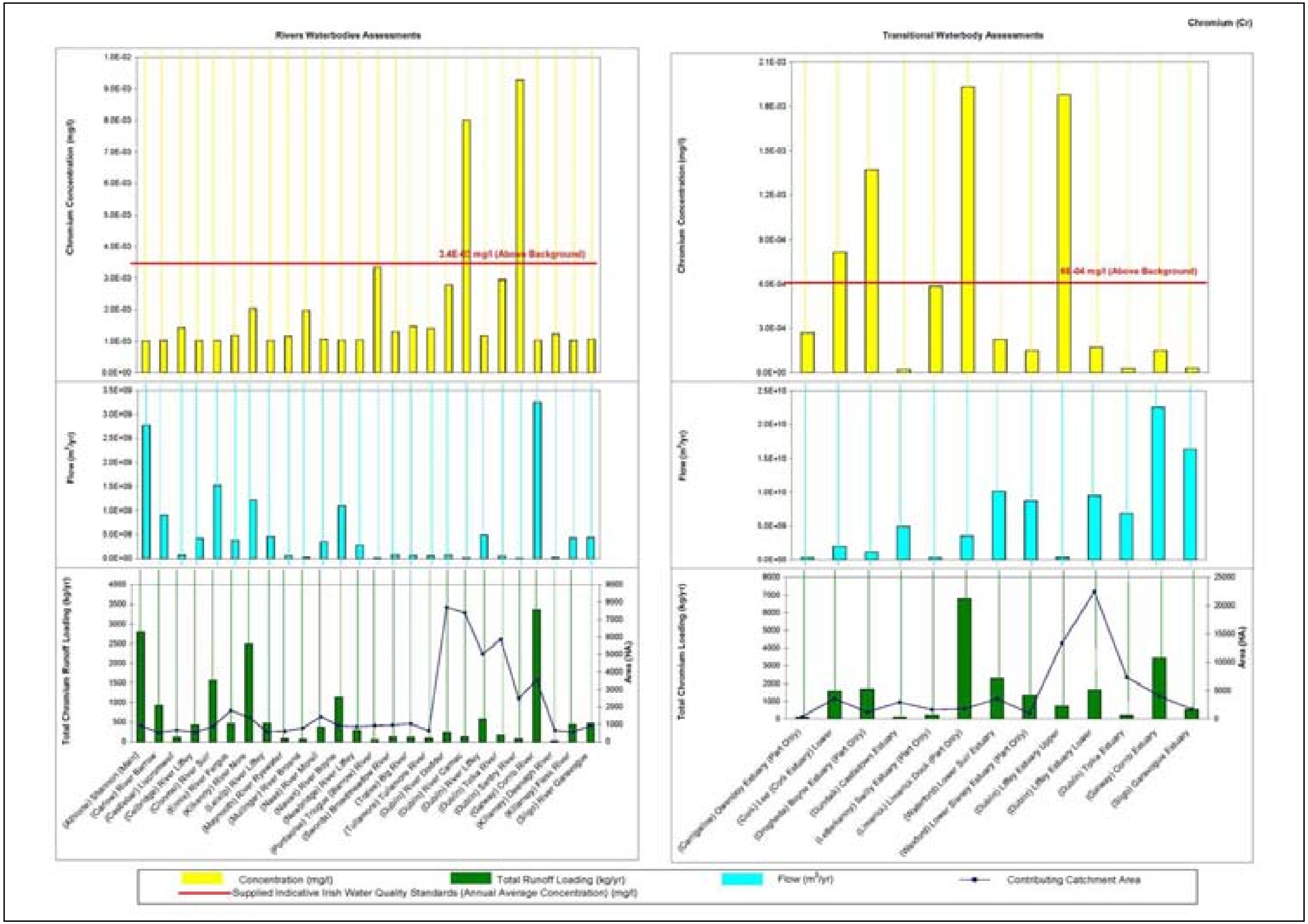


Figure 3.18: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Copper)

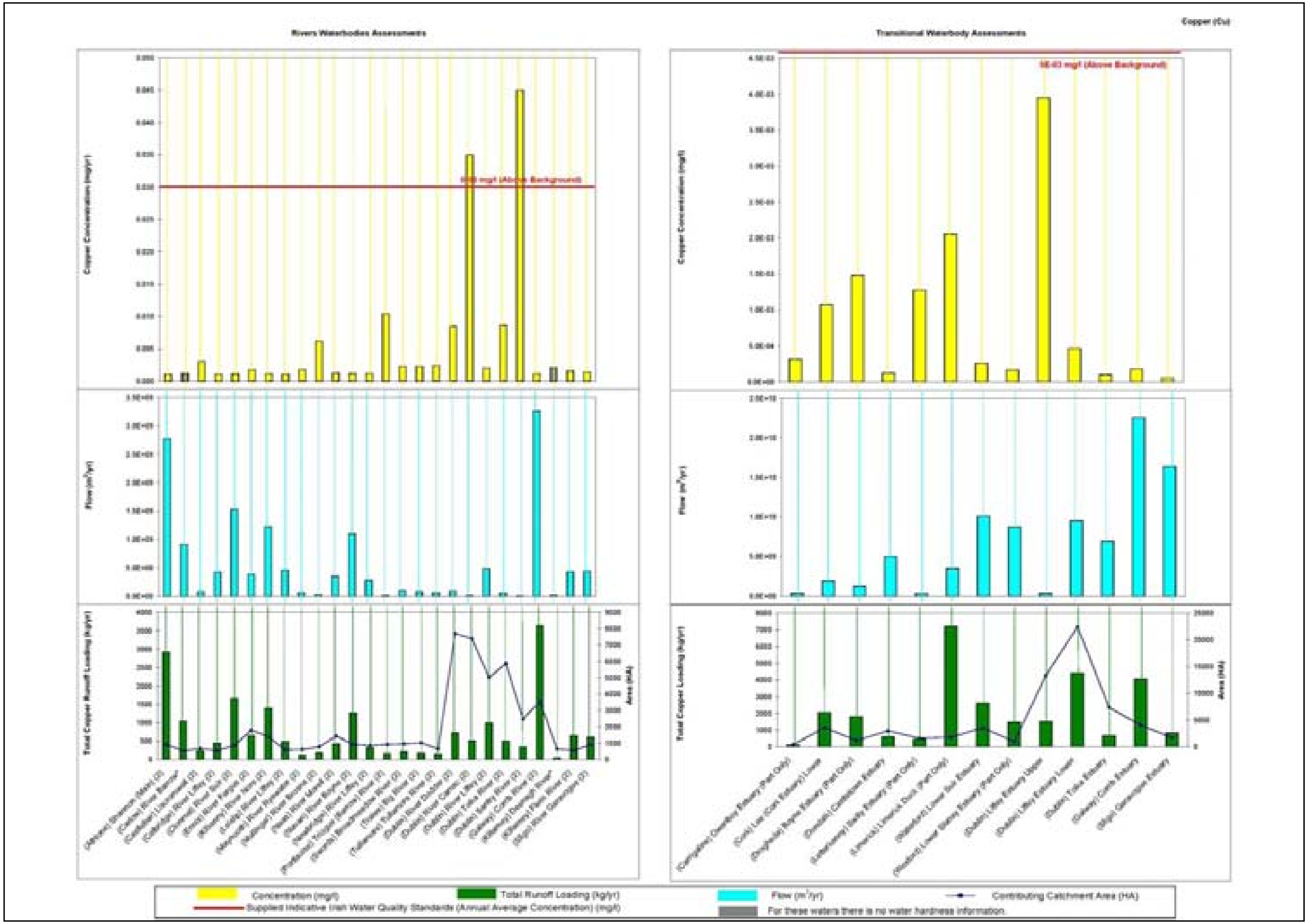


Figure 3.19: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Iron)

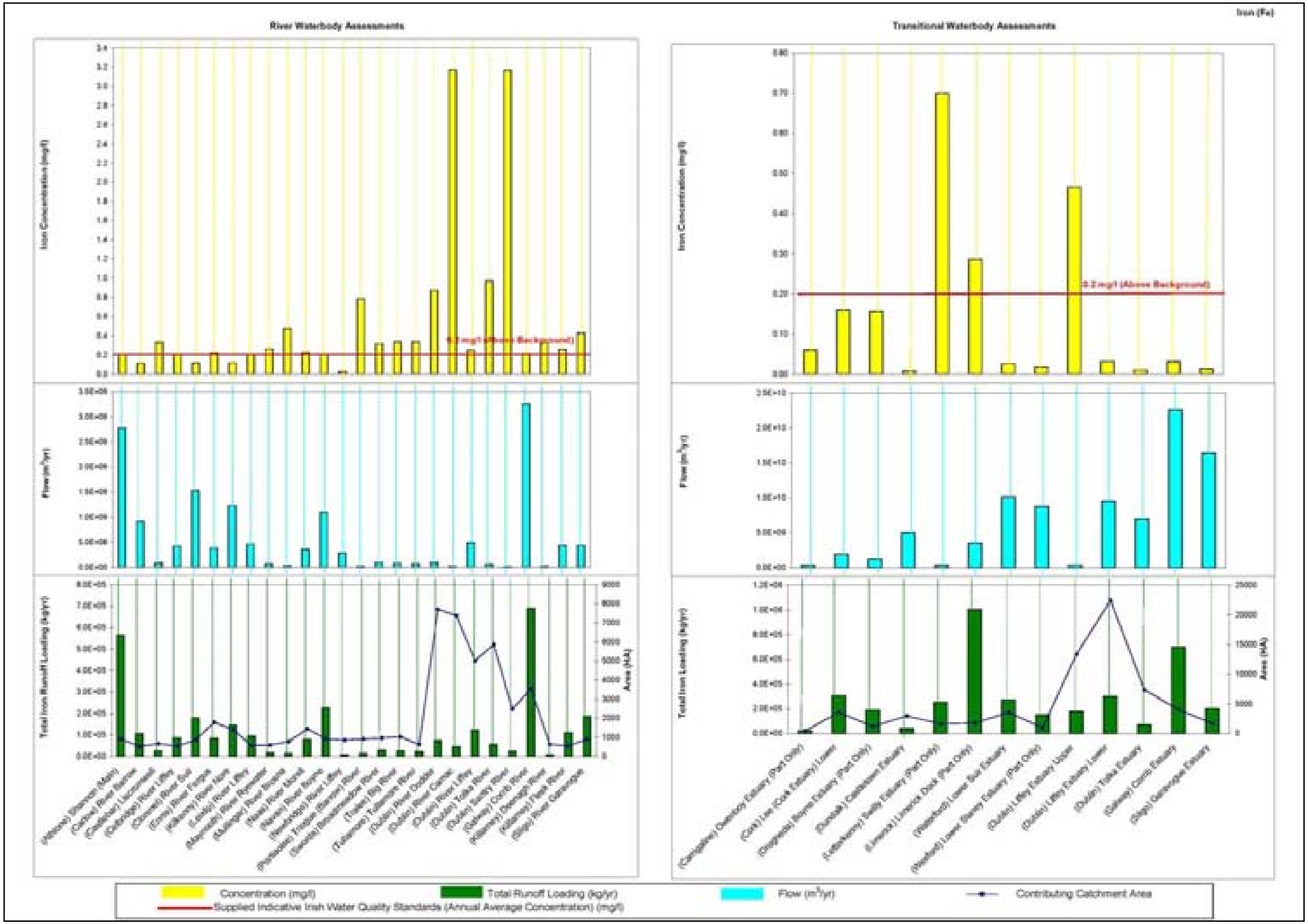


Figure 3.20: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Lead)

Figure 3.21: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Mercury)

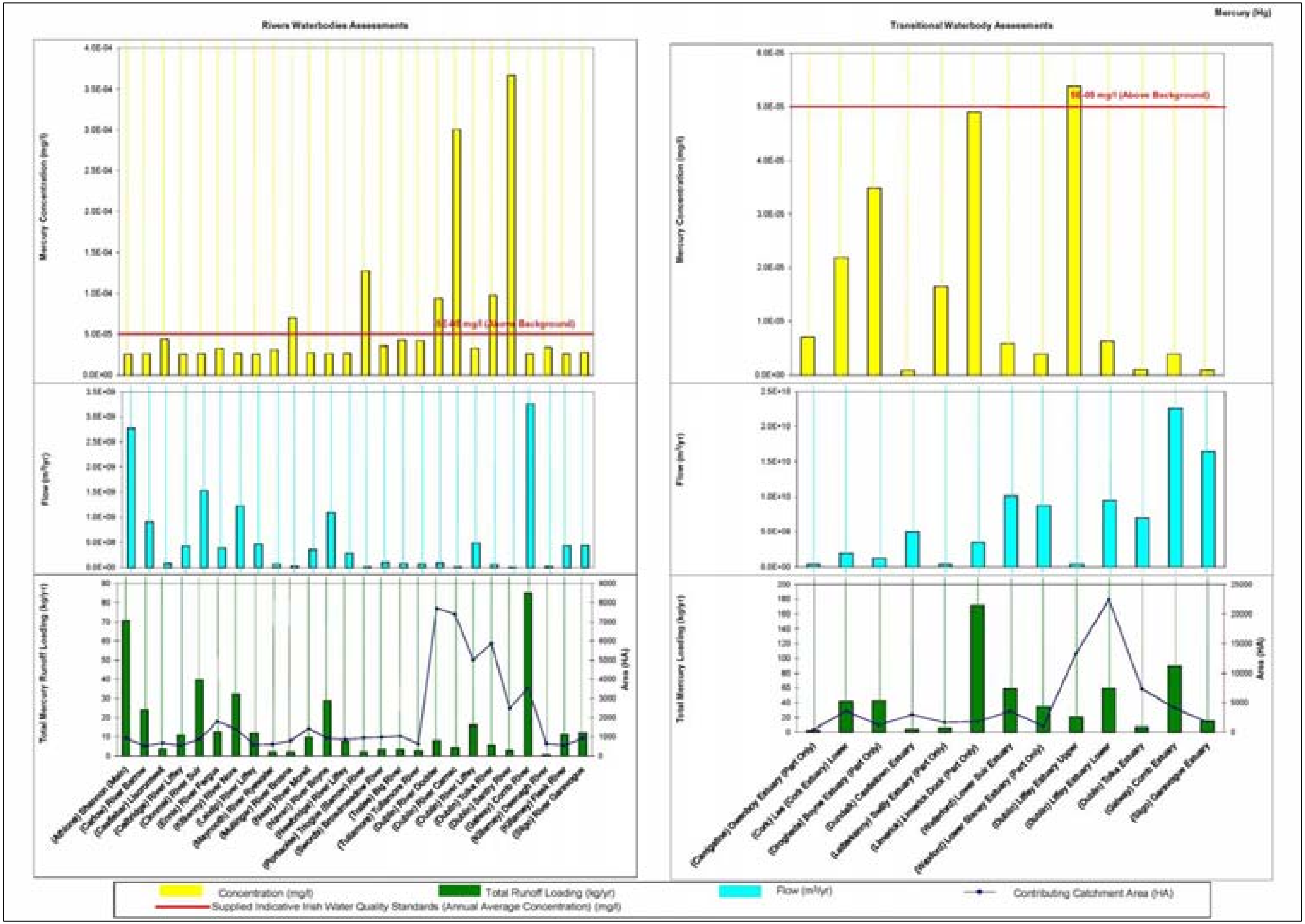


Figure 3.22: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Nickel)

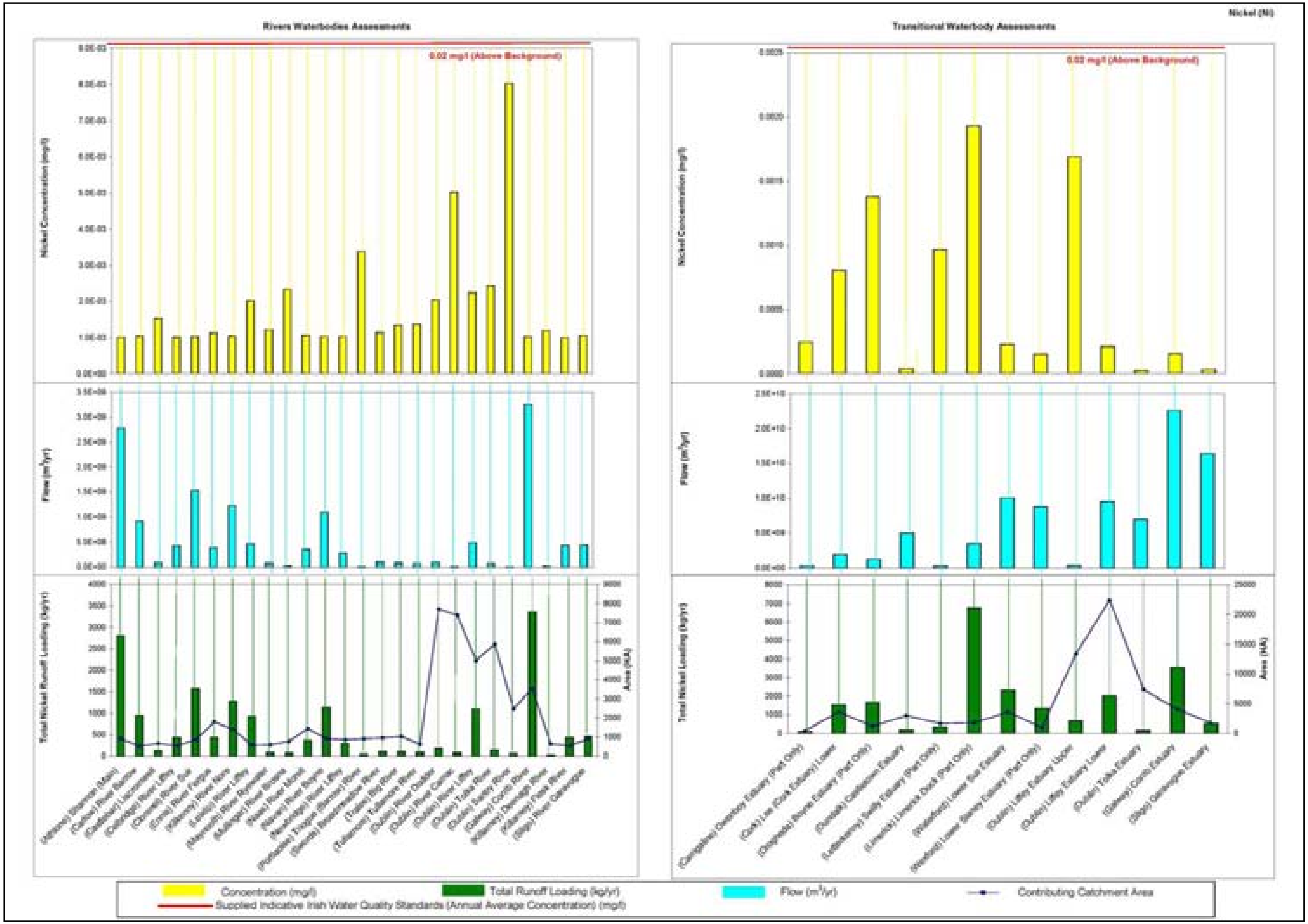


Figure 3.23: Surface Water Assimilative Capacity: Annual Cumulative Loadings to Existing Urban Surface Waters (Zinc)

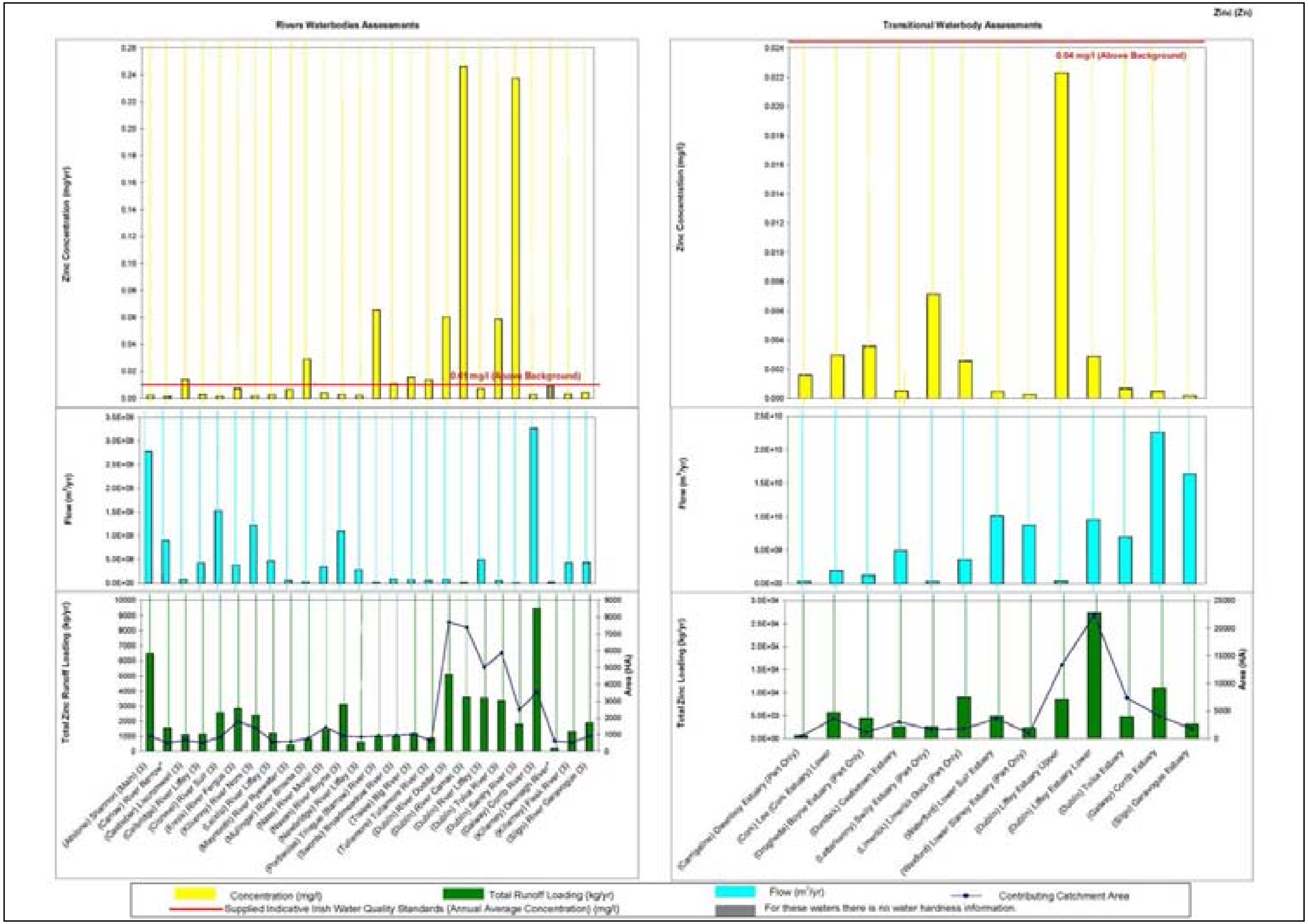


Table 3.45: Indicative Pass / Fail

Waterbody Name	Nitrates (mg/l)	Nitrites (mg/l)	Total N (mg/l)	Nitrogen (TKN) (mg/l)	Total Phosphorous (mg/l)	Ortho-Phosphate (mg/l)	Cadmium (mg/l)	Chromium (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Mercury (mg/l)	Nickel (mg/l)	Zinc (mg/l)
RIVERS														
(Athlone) Shannon (Main)	0.163	0.013	0.016	0.010	0.001	0.047	0.0001	0.0010	0.001	**0.204**	0.001	0.00003	0.001	0.002
(Carlow) River Barrow	0.164	0.029	0.097	0.013	0.003	**0.072**	0.0001	0.0010	0.001	0.116	0.001	0.00003	0.001	0.002
(Castlebar) Liscromwell	0.195	0.038	0.659	0.421	0.021	**0.060**	**0.0002**	0.0014	0.003	**0.331**	0.007	0.00004	0.002	**0.014**
(Celbridge) River Liffey	2.101	0.039	0.007	0.005	0.001	**0.070**	0.0001	0.0010	0.001	**0.206**	0.001	0.00003	0.001	0.003
(Clonmel) River Suir	0.164	0.015	0.021	0.019	0.004	0.049	0.0001	0.0010	0.001	0.117	0.001	0.00003	0.001	0.002
(Ennis) River Fergus	0.182	0.033	0.152	0.107	0.019	**0.059**	0.0002	0.0012	0.002	**0.219**	0.004	0.00003	0.001	0.007
(Kilkenny) River Nore	0.165	0.019	0.048	0.031	0.007	**0.061**	0.0001	0.0020	0.001	0.120	0.001	0.00003	0.001	0.002
(Leixlip) River Liffey	2.101	0.034	0.006	0.005	0.001	**0.105**	0.0001	0.0010	0.001	**0.205**	0.001	0.00003	0.002	0.003
(Maynooth) River Ryewater	1.836	0.041	0.050	0.041	0.008	**0.078**	0.0001	0.0012	0.002	**0.263**	0.003	0.00003	0.001	0.007
(Mullingar) River Brosna	0.234	0.085	1.825	1.231	**0.089**	**0.095**	**0.0003**	0.0020	0.006	**0.475**	**0.014**	**0.00007**	0.002	**0.029**
(Naas) River Morell	2.106	0.013	0.019	0.015	0.003	0.015	0.0001	0.0011	0.001	**0.223**	0.002	0.00003	0.001	0.004
(Navan) River Boyne	2.115	0.128	0.060	0.029	0.005	**0.060**	0.0001	0.0010	0.001	**0.206**	0.001	0.00003	0.001	0.003
(Newbridge) River Liffey	2.103	0.012	0.024	0.021	0.003	0.013	0.0001	0.0010	0.001	0.024	0.002	0.00003	0.001	0.002
(Portlaoise) Triogue (Barrow) River	0.334	0.185	3.964	3.728	**0.619**	**0.266**	**0.0006**	0.0034	0.010	**0.785**	**0.032**	**0.00013**	0.003	**0.066**
(Swords) Broadmeadow River	2.693	0.074	0.085	0.070	0.013	**0.160**	0.0002	0.0013	0.002	**0.317**	0.007	0.00004	0.001	**0.011**
(Tralee) Big River	0.211	0.061	0.218	0.228	0.038	**0.068**	**0.0002**	0.0015	0.002	**0.335**	**0.009**	0.00004	0.001	**0.016**
(Tullamore) Tullamore River	0.196	0.046	0.814	0.335	0.035	**0.070**	0.0002	0.0014	0.002	**0.335**	0.007	0.00004	0.001	**0.014**
(Dublin) River Dodder	1.820	0.238	1.232	1.111	**0.196**	**0.148**	**0.0006**	0.0028	0.008	**0.873**	**0.032**	**0.00009**	0.002	**0.060**
(Dublin) River Camac	0.944	0.944	3.587	3.062	**0.558**	**0.266**	**0.0023**	**0.0080**	**0.035**	**3.171**	**0.143**	**0.00030**	0.005	**0.246**
(Dublin) River Liffey	2.217	0.039	0.295	0.189	0.026	**0.091**	0.0001	0.0012	0.002	**0.250**	0.003	0.00003	0.002	0.007
(Dublin) Tolka River	2.374	0.230	0.764	0.666	**0.121**	**0.157**	**0.0007**	0.0030	0.009	**0.972**	**0.034**	**0.00010**	0.002	**0.059**
(Dublin) Santry River	0.729	0.729	9.044	8.646	**1.518**	**0.781**	**0.0024**	**0.0093**	**0.045**	**3.168**	**0.139**	**0.00037**	0.008	**0.237**
(Galway) Corrib River	0.165	0.012	0.015	0.018	0.006	0.031	0.0001	0.0010	0.001	**0.212**	0.001	0.00003	0.001	0.003
(Killarney) Deenagh River	0.209	0.060	0.215	0.230	0.029	**0.068**	0.0002	0.0012	0.002	**0.329**	0.004	0.00003	0.001	0.009
(Killarney) Flesk River	0.166	0.017	0.016	0.016	0.002	0.048	**0.0001**	0.0010	0.002	**0.256**	0.002	0.00003	0.001	0.003
(Sligo) River Garavogue	0.170	0.013	0.023	0.018	0.003	0.041	0.0001	0.0011	0.001	**0.428**	0.002	0.00003	0.001	0.004
TRANSITIONAL														
(Carrigaline) Owenboy Estuary (Part Only)	**0.518**	0.005	0.437	0.011	0.013	0.008	0.00003	0.0003	0.0003	0.060	0.001	0.00001	0.0002	0.002
(Cork) Lee (Cork Estuary) Lower	**1.593**	0.007	**2.320**	0.295	**0.096**	**0.056**	0.0001	**0.0008**	0.001	0.160	0.001	0.00002	0.001	0.003
(Drogheda) Boyne Estuary (Part Only)	**3.051**	0.030	**4.800**	0.029	**0.126**	**0.079**	0.0001	**0.0014**	0.001	0.156	0.002	0.00003	0.001	0.004
(Dundalk) Castletown Estuary	0.002	0.002	0.018	0.011	0.002	0.002	0.00001	0.0000	0.0001	0.008	0.0003	0.000001	0.00004	0.001
(Letterkenny) Swilly Estuary (Part Only)	**0.942**	0.018	**0.822**	0.053	0.030	0.018	0.0001	0.0006	0.001	**0.700**	0.003	0.00002	0.001	0.007
(Limerick) Limerick Dock (Part Only)	**4.072**	0.011	**3.305**	0.133	**0.085**	**0.053**	0.0002	**0.0019**	0.002	**0.286**	0.002	0.00005	0.002	0.003
(Waterford) Lower Suir Estuary	0.464	0.002	0.394	0.007	0.011	0.008	0.00002	0.0002	0.0003	0.027	0.0003	0.00001	0.0002	0.0005
(Wexford) Lower Slaney Estuary (Part Only)	0.315	0.001	0.263	0.004	0.008	0.005	0.00002	0.0002	0.0002	0.017	0.0002	0.000004	0.0002	0.0003
(Dublin) Liffey Estuary Upper	**2.514**	0.108	**3.732**	0.219	**0.208**	**0.110**	**0.0003**	**0.0019**	0.004	**0.465**	**0.011**	**0.00005**	0.002	0.022
(Dublin) Liffey Estuary Lower	0.121	0.007	0.435	0.137	**0.060**	0.039	0.00002	0.0002	0.0005	0.032	0.001	0.00001	0.0002	0.003
(Dublin) Tolka Estuary	0.024	0.003	0.033	0.008	0.002	0.001	0.00001	0.0000	0.0001	0.010	0.0004	0.000001	0.00002	0.001
(Galway) Corrib Estuary	0.310	0.001	0.268	0.009	0.013	0.006	0.00002	0.0002	0.0002	0.031	0.0002	0.000004	0.0002	0.0005
(Sligo) Garavogue Estuary	0.058	0.001	0.026	0.003	0.001	0.001	0.000004	0.00003	0.0001	0.012	0.0001	0.000001	0.00003	0.0002
OMITTED TOWNS														
Balbriggan														
Bray														
Greystones														
Malahide														

Red denotes fail for the draft consensus environmental water quality standards.

4 Stage 8 – Urban Pressure Rankings

One of the objectives of the study was to prepare a ranking for the urban pressures in urban surface waters. ***However in a number of instances the methodologies/approach adopted for undertaking this overall study required the use of datasets which are currently not available in Ireland***. In these instances the study proceeded on the basis of either surrogate data from outside of Ireland and/or simplified assumptions/interpolations based upon existing Irish data.

Furthermore, although the seven main individual urban pressures (see Figure 3.5) considered to affect urban surface waters were initially assessed, ultimately it was only feasible to estimate cumulative annual loadings for five of the seven urban pressures as explained in Sections 3.7 and 3.8.

In addition it should be noted that cumulative annual loading data was not available for all of the 14 study parameters for each of the study river and transitional waterbodies. In those cases where loads could not be estimated the figures presented later in this section have been marked with an asterix to highlight the missing data.

Therefore the rankings presented and discussed in this section should be both viewed and understood in the context of the constraints/restrictions posed by current data availability and the assumptions/interpolations used to fill as many gaps as possible.

Nevertheless the significant body of work which was undertaken as part of this study was prepared in a robust and consistent fashion and equally was based upon many comprehensive national datasets including the results from many calibrated hydraulic sewer network models and County and Local Development plans etc. In all cases best available data was used.

For these reasons we believe that it is reasonable to develop rankings for urban pressures relating to urban surface waters. Furthermore we believe that even with the existing data limitations the urban pressures on urban surface waters can be ranked in a meaningful and constructive manner using a combination of both urban pressure type and urban surface waters.

This ranking is however influenced by both the substantial overestimation of the upstream cumulative annual loadings which in turn have been generated from sampling/monitoring data based mainly on test detection limit values for many of the metals parameters (detailed in Section 3.8.7.2) and the use of surrogate data for a number of the urban pressures.

For this reason we believe it is prudent to present two ranking scenarios as follows;

- Scenario 1 - Urban Pressure Ranking - based upon 5 urban pressure types.
- Scenario 2 - Urban Pressure Ranking - based upon 4 urban pressure types – Upstream Loadings excluded.

The first urban pressure ranking scenario provides a detailed understanding as to how the various urban pressures vary both in scale between each other and also across urban surface waters. Under this scenario the data representing the upstream pollution loading component has been included within the overall analysis. This scenario therefore provides an opportunity to compare the scale of the pressures on urban surface waters - from urban pressure types generated within the urban catchment - against the pressures on the urban surface waters caused by incoming flows from upstream of the urban catchment.

The second urban pressure ranking scenario discounts entirely upstream loadings and therefore provides a comparative understanding as to how the various urban pressure types that are generated specifically within the urban catchment footprints vary both in scale between each other and also across urban surface waters.

4.1 Scenario 1 – Urban Pressure Ranking

For this scenario the cumulative annual loadings for five urban pressure types were estimated and assessed namely:

- Combined sewer overflow (CSO) discharges
- Atmospheric deposition (direct to surface waters)
- WWTP discharges
- Incoming loadings from upstream catchment
- Diffuse urban catchment surface water runoff

Figures 4.1 - 4.28 have been compiled for each of the 14 study parameters using the estimated cumulative annual loading data from the various urban pressure loading matrices detailed throughout Section 3 of this report for each of the five urban pressures.

From a review of Figures 4.1 – 4.28 it is apparent that ***for virtually all of the surface waters (river and transitional) the bulk of the nitrates and nitrites appear to be emanating from the upstream catchment pressure*** - with the exception of the nitrite discharge from the diffuse urban catchment surface water runoff which discharges to the Liffey Estuary Lower transitional waters.

In contrast for many of the metals, although the upstream catchment flow pressure contributes significant annual pollution loadings to the overall annual contribution the contribution from a number of the other urban pressures – particularly the diffuse urban and WWTP pressures - rises significantly as a portion of the overall cumulative annual loading.

It should be remembered however for the reasons outlined previously in Section 3.8.7.2 that the estimated ***cumulative annual upstream pressure loadings for the metals are overestimates caused by the use of detection limit analysis results***. Therefore the actual cumulative annual ***upstream pressure loadings for the metals will invariably be less than those shown in Figures 4.1 – 4.28.*** At this stage however the extent of any overestimation for the cumulative annual loadings for the metals cannot be determined.

The urban pressure posed by CSOs for all of the 14 study parameters is generally less than that posed by any of the upstream, diffuse or WWTP urban pressures. The CSO load has been determined using flow from the hydraulic sewer network modelling work referred to in Section 3.8.1 which showed that on average across ***sewer networks in Ireland CSOs***

discharge approximately 5% (by volume) of the annual foul/combined flow into surface waters. The remaining 95% approx of flow (by volume) is retained within the sewer networks and ultimately discharges to the downstream WWTPs.

Overall the pressure associated with atmospheric deposition direct to urban surface waters would appear to be minimal compared to the other 4 urban pressures.

We believe that the impacts from the remaining two urban pressures – point sources and groundwater inflows - which could not be estimated because of lack of data – are likely to be insignificant (on a mean annual average flow basis) when ranked against the three larger urban pressures – Upstream, Diffuse and WWTPs.

In summary therefore Figures 4.1 – 4.28 show that in general for most of the nutrients and metals parameters the five urban pressures can be ranked (in decreasing order) in terms of overall cumulative annual loading contribution as follows:

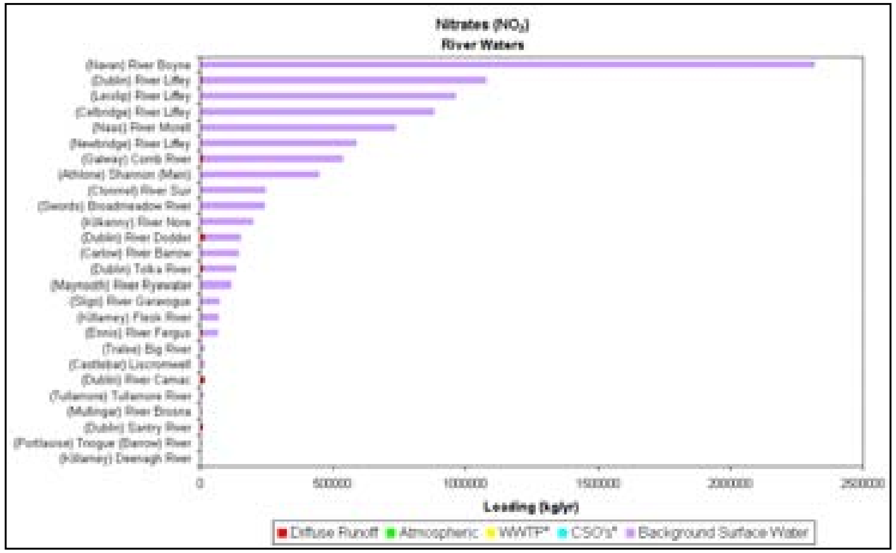
- Incoming loadings to urban surface waters from upstream catchments (largest)
- Diffuse urban catchment surface water runoff
- WWTP discharges
- Combined sewer overflow (CSO) discharges
- Atmospheric deposition (direct to surface waters) - (Smallest)

Furthermore, and in the case of the metals parameters, if the effects of loading overestimates were removed (from the upstream catchment pressure) it is likely that the overall urban pressure rankings would be as follows:

- Diffuse urban catchment surface water runoff (Largest)
- WWTP discharges
- Incoming loadings from upstream catchment
- Combined sewer overflow (CSO) discharges
- Atmospheric deposition (direct to surface waters) - (Smallest)

There are many individual exceptions to the above summary. To understand the complexity of the individual urban pressures for individual study parameters across both urban river and transitional surface water types it is necessary for the reader to study each urban pressure / parameter / urban surface water individually.

Figure 4.1: Nitrates for River Waters

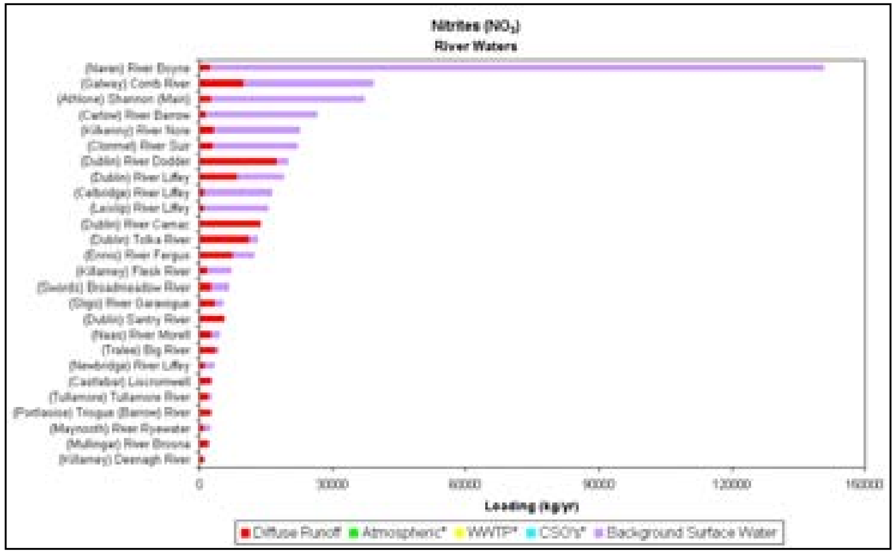


* No cumulative annual loading was estimated for these urban pressures.

Figure 4.2: Nitrates for Transitional Waters

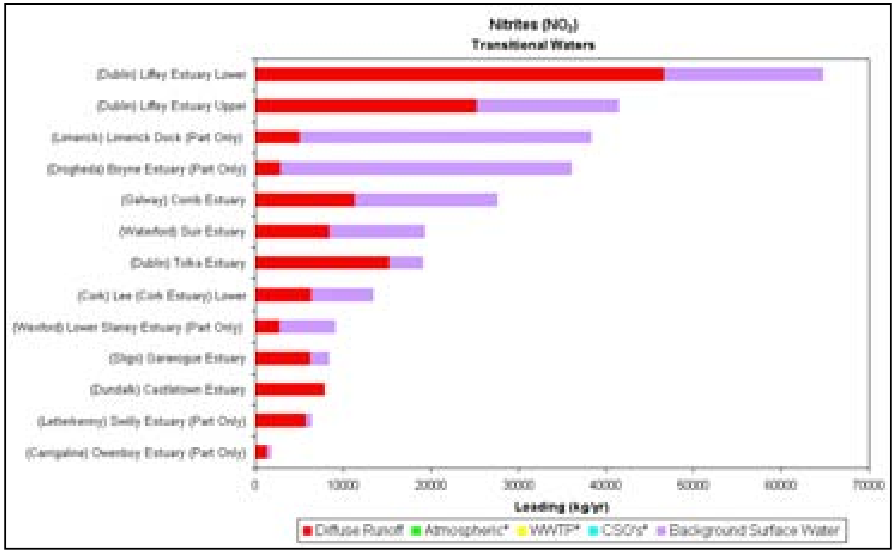
* No cumulative annual loading was estimated for these urban pressures.

Figure 4.3: Nitrites for River Waters



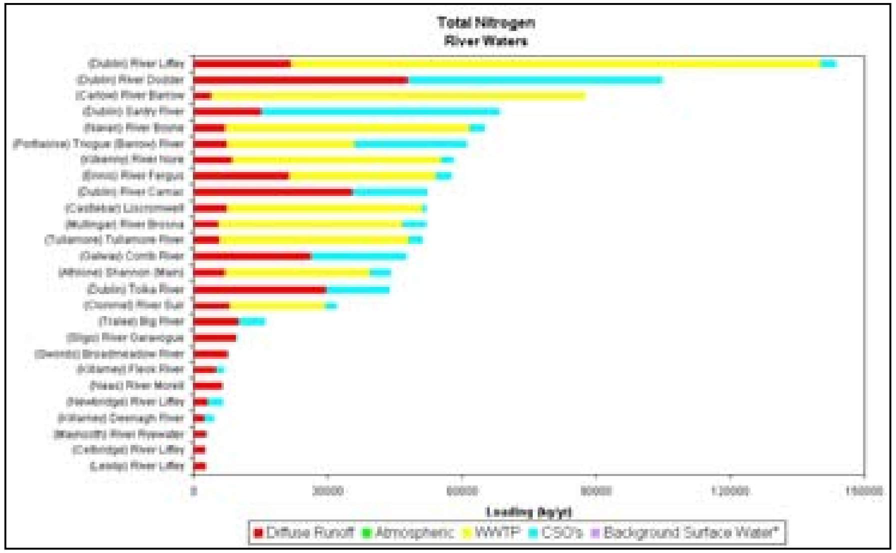
* No cumulative annual loading was estimated for these urban pressures.

Figure 4.4: Nitrites for Transitional Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.5: Total Nitrogen for River Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.6: Total Nitrogen for Transitional Waters

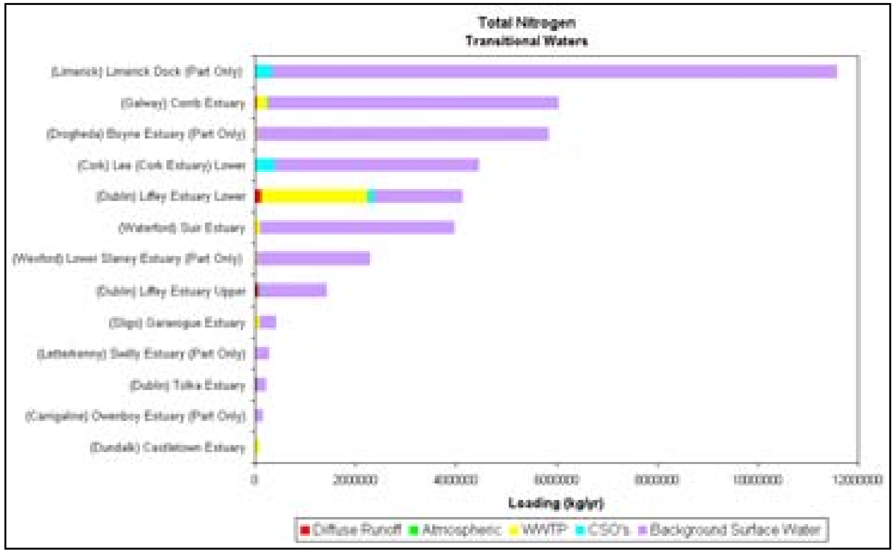
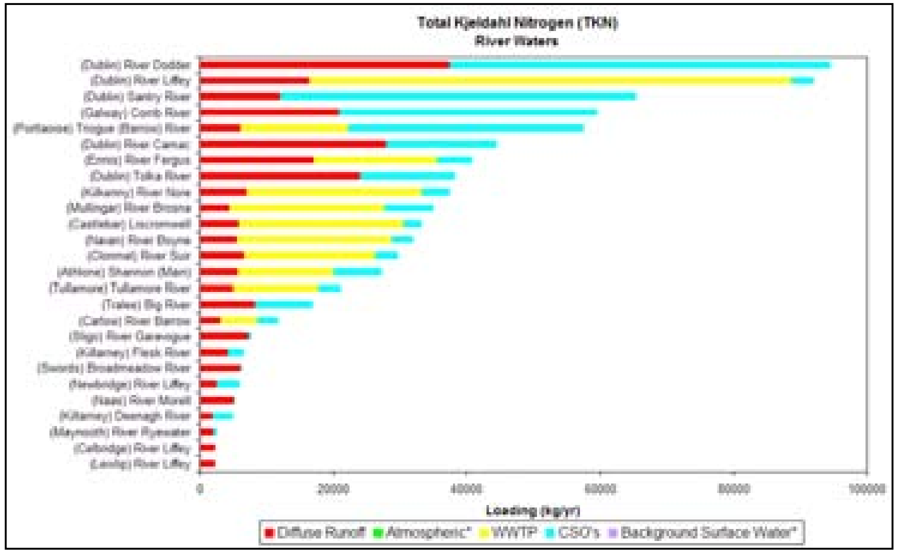
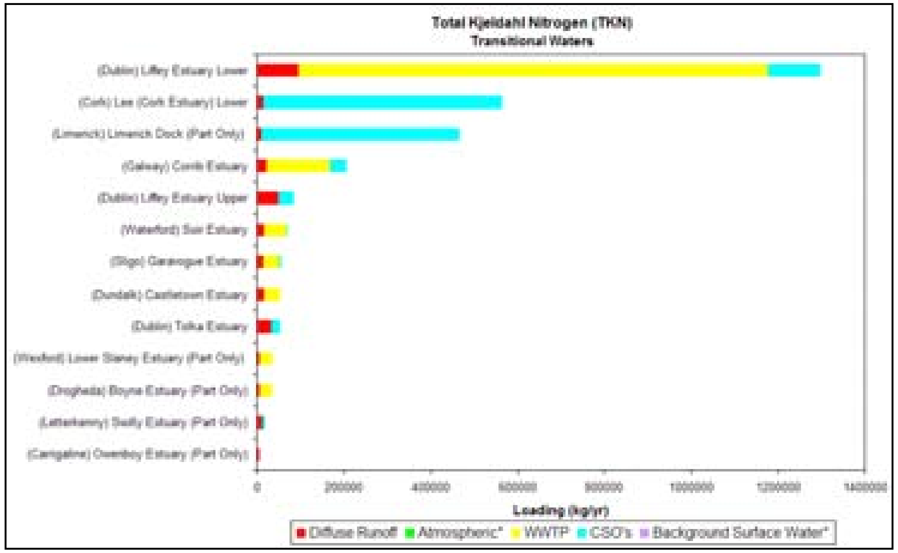


Figure 4.7: Total Kjeldahl Nitrogen for River Waters



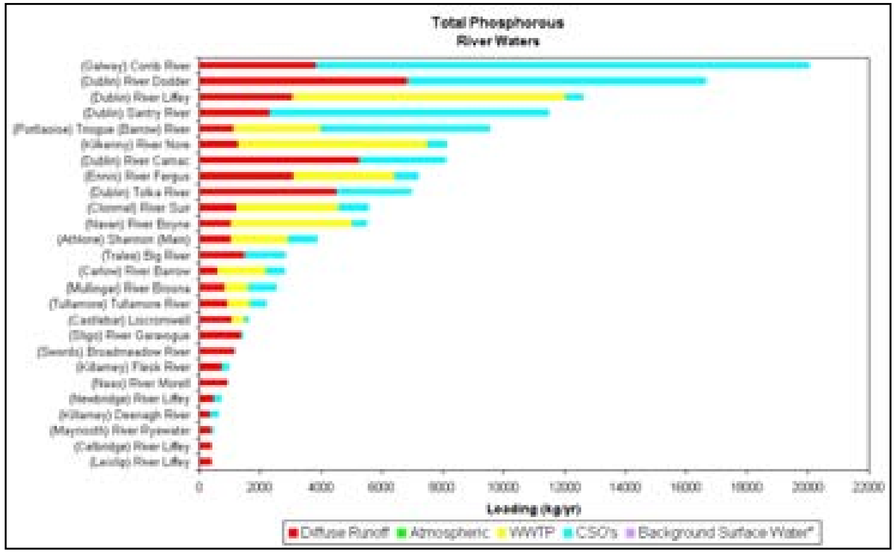
* No cumulative annual loading was estimated for these urban pressures.

Figure 4.8: Total Kjeldahl Nitrogen for Transitional Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.9: Total Phosphorous for River Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.10: Total Phosphorous for Transitional Waters

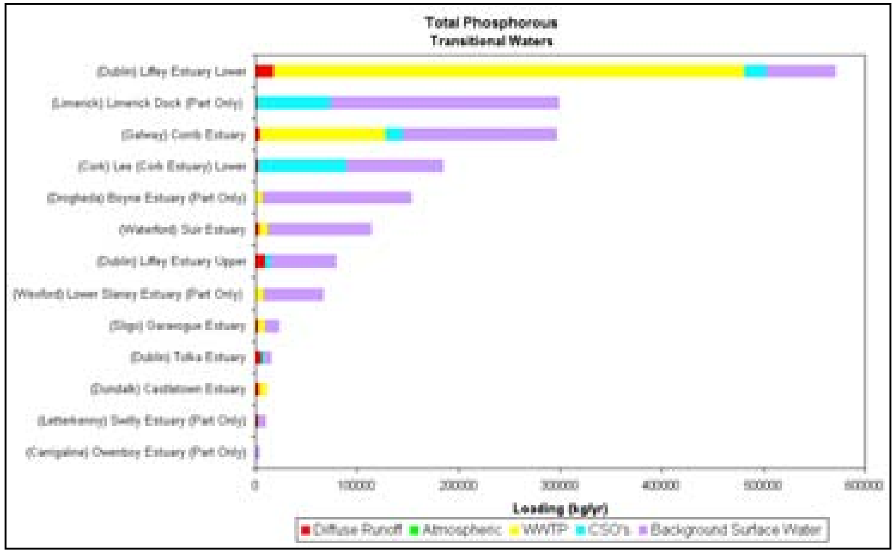
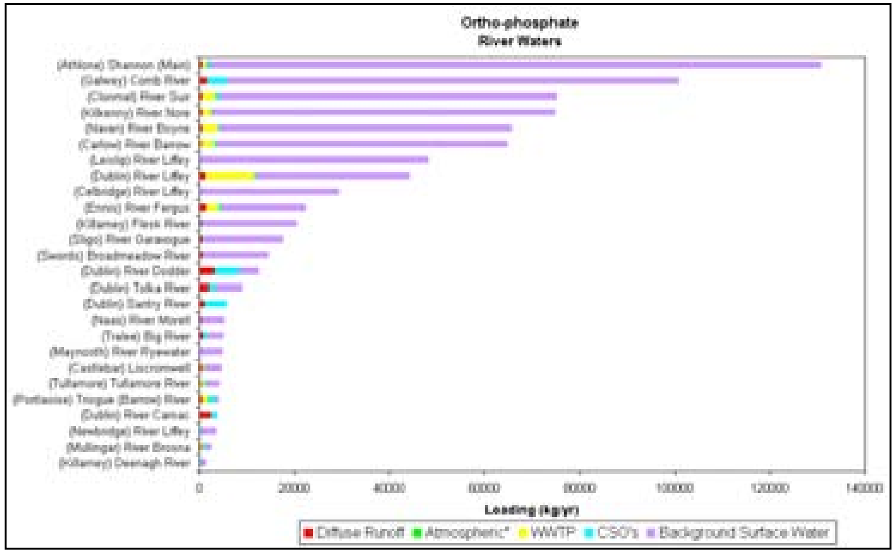
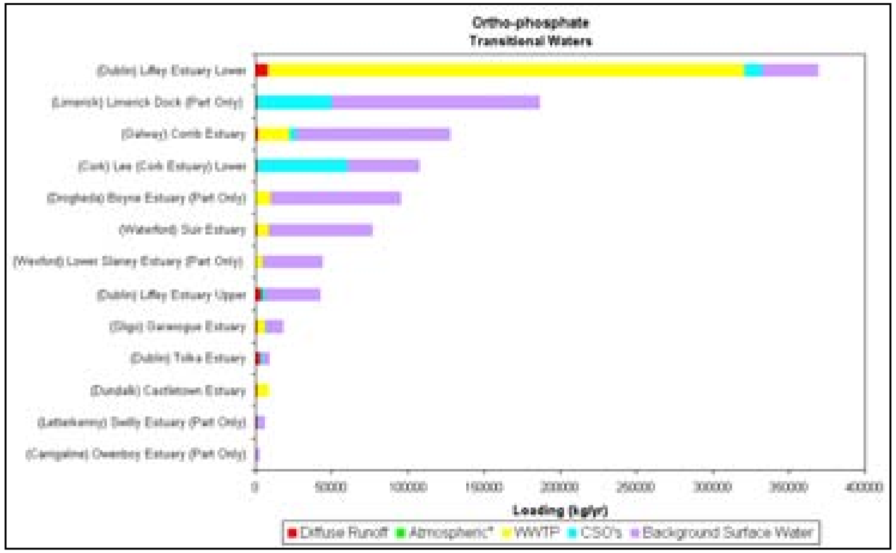


Figure 4.11: Ortho-phosphate for River Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.12: Ortho-phosphate for Transitional Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.13: Cadmium for River Waters

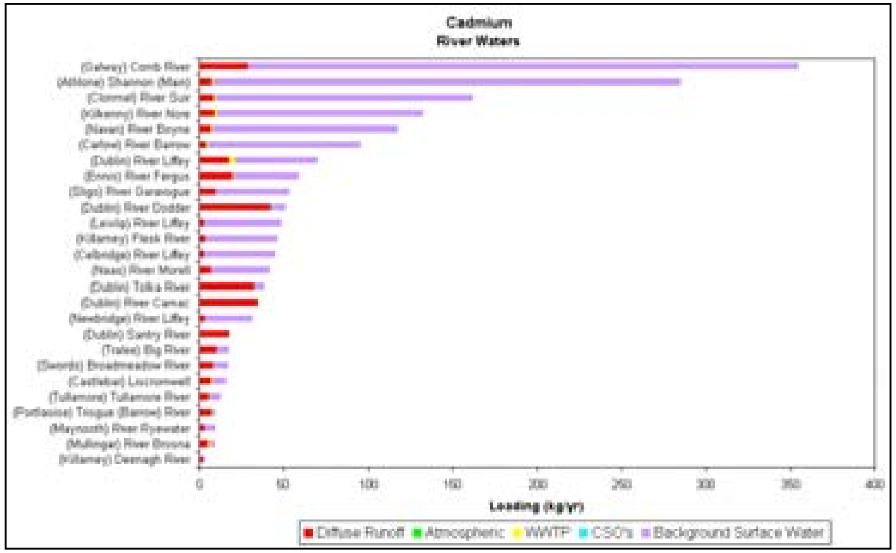


Figure 4.14: Cadmium for Transitional Waters

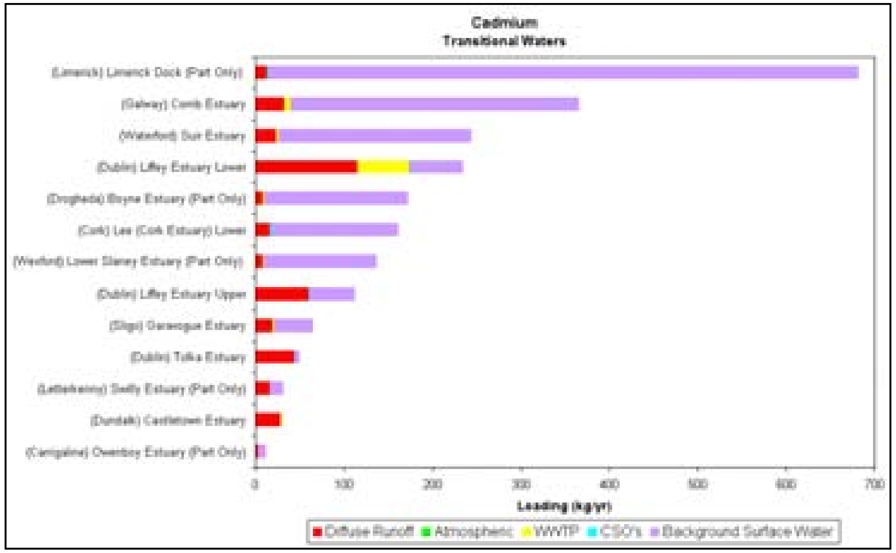


Figure 4.15: Chromium for River Waters

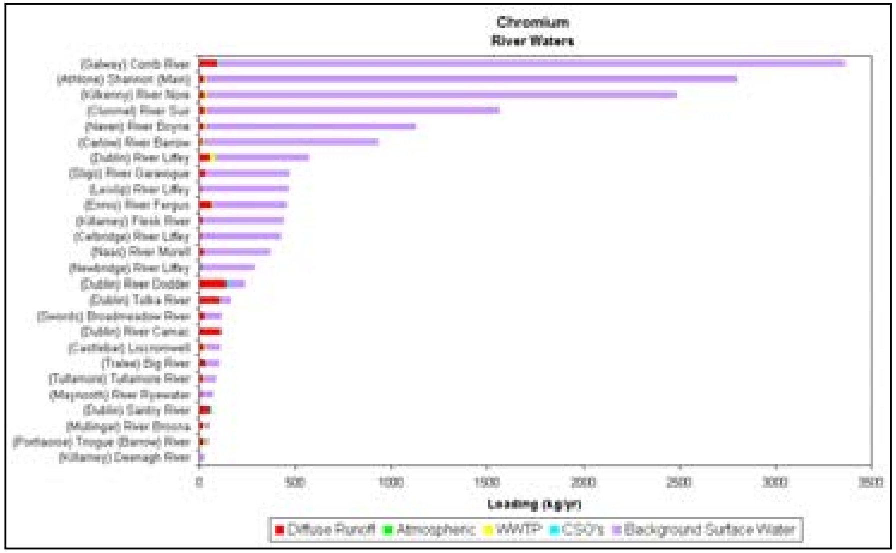


Figure 4.16: Chromium for Transitional Waters

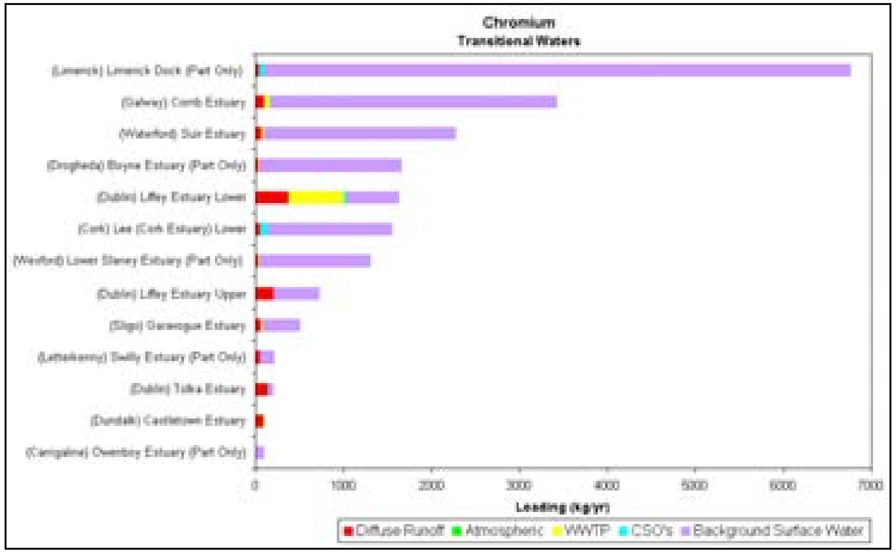


Figure 4.17: Copper for River Waters

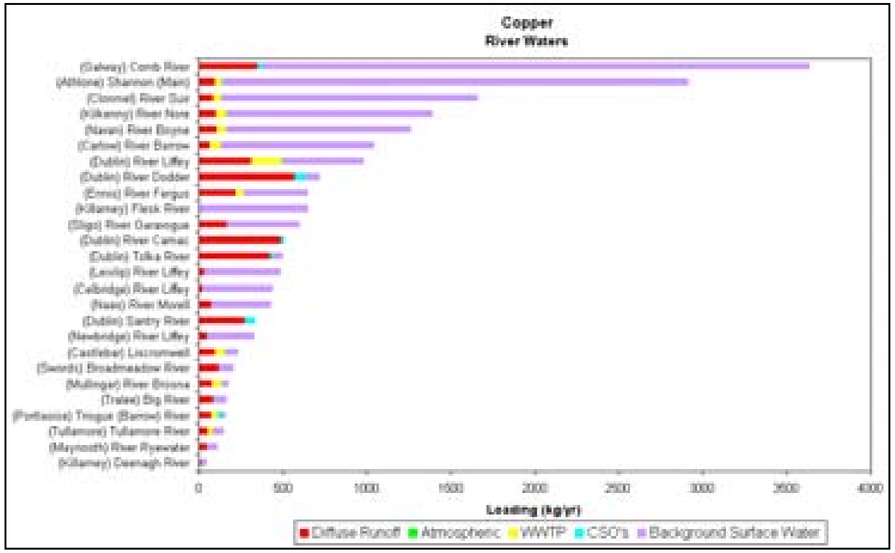


Figure 4.18: Copper for Transitional Waters

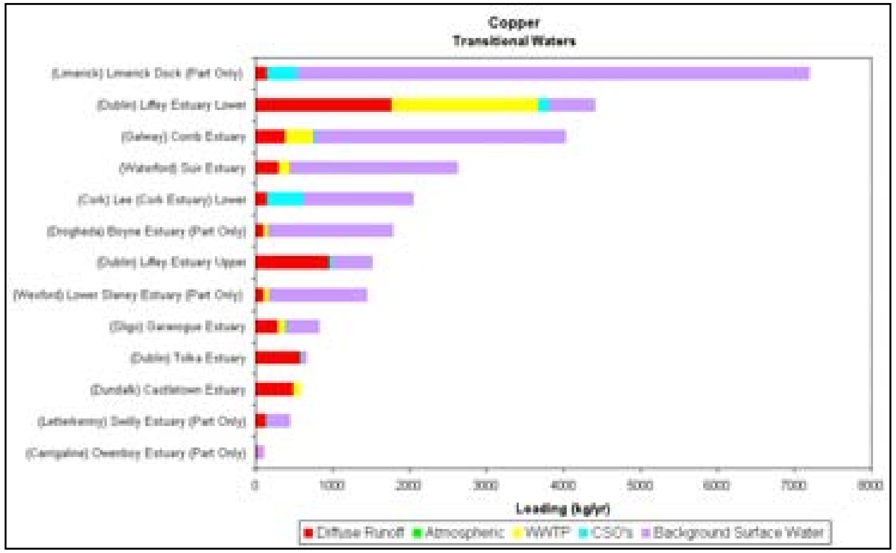
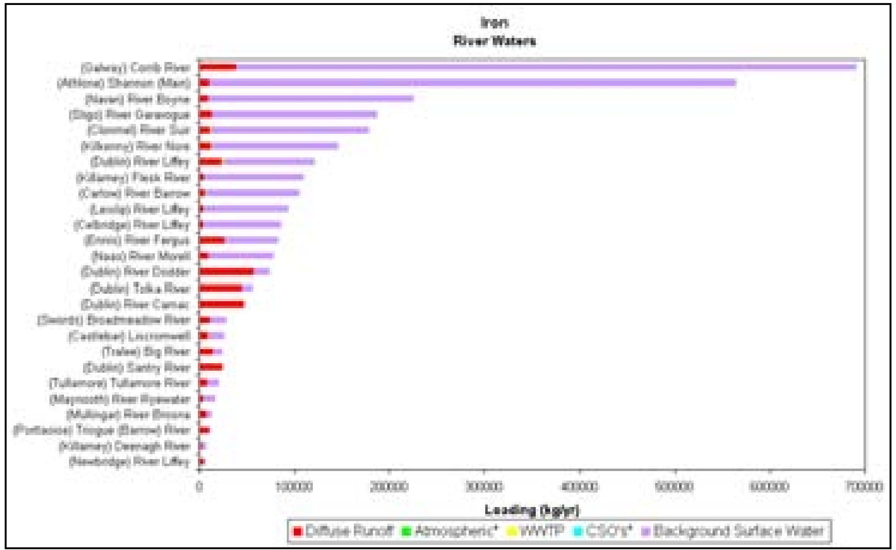
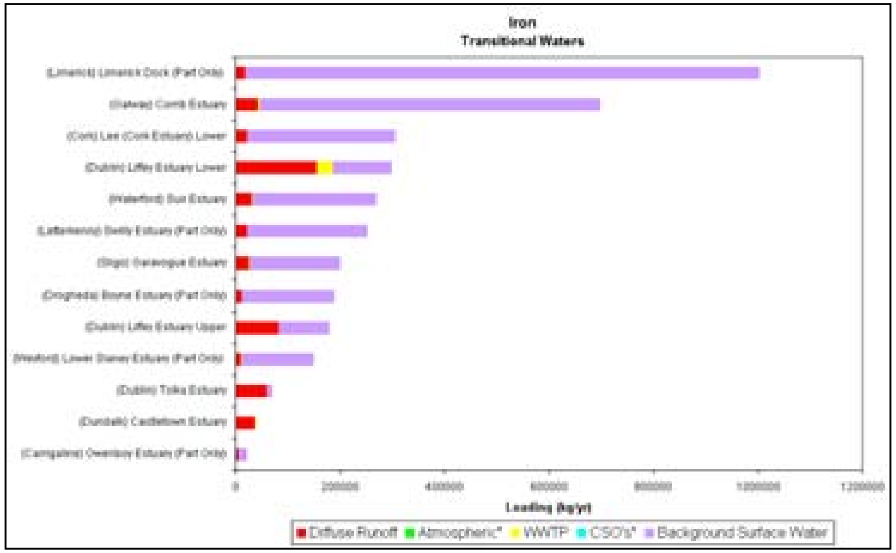


Figure 4.19: Iron for River Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.20: Iron for Transitional Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.21: Lead for River Waters

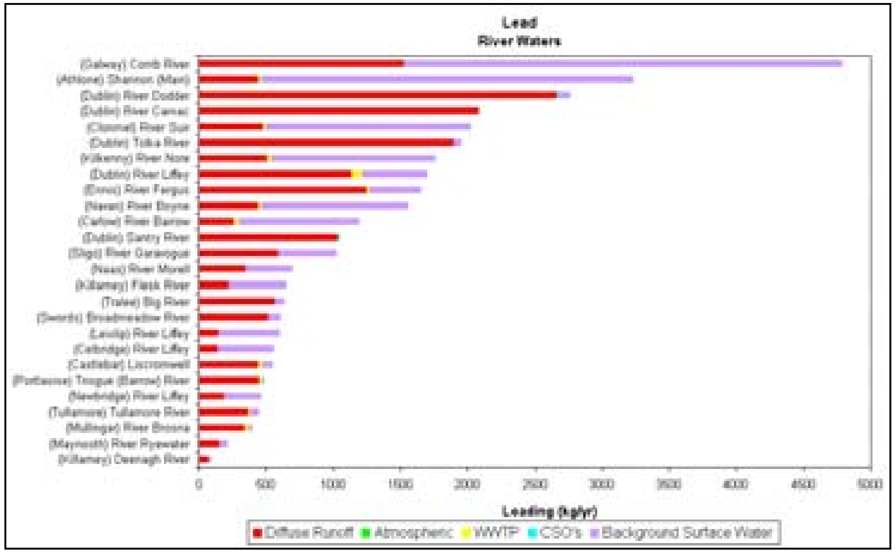


Figure 4.22: Lead for Transitional Waters

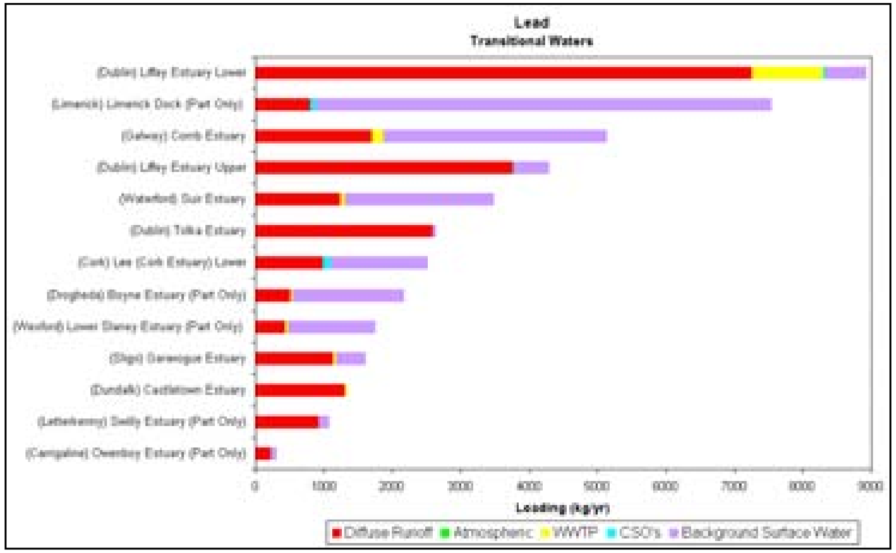


Figure 4.23: Mercury for River Waters

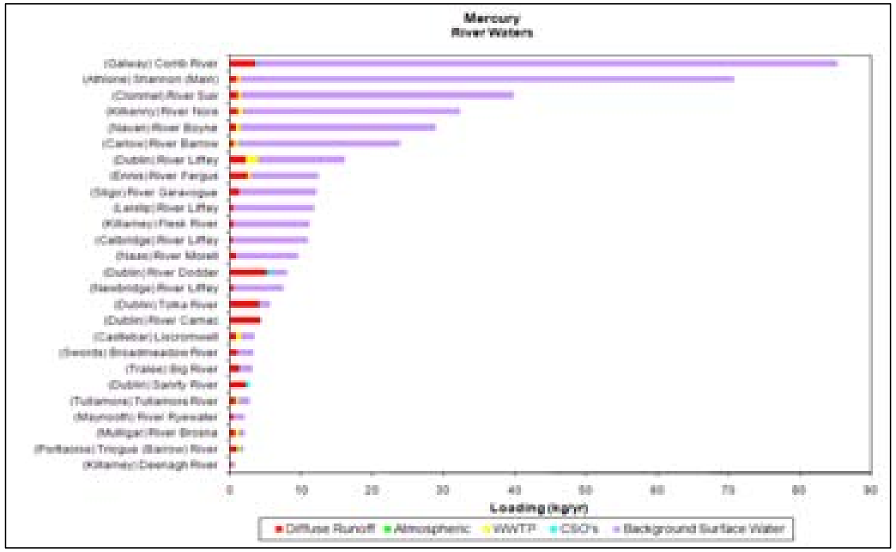


Figure 4.24: Mercury for Transitional Waters

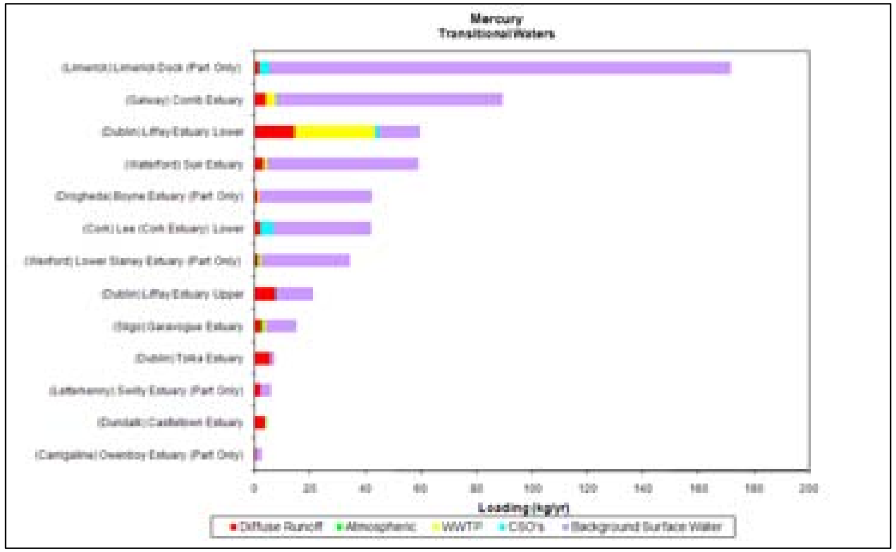


Figure 4.25: Nickel for River Waters

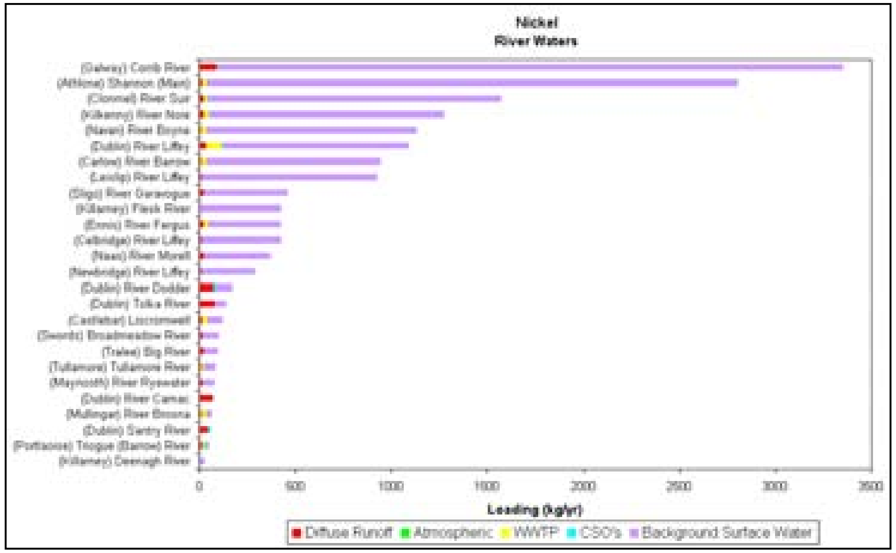


Figure 4.26: Nickel for Transitional Waters

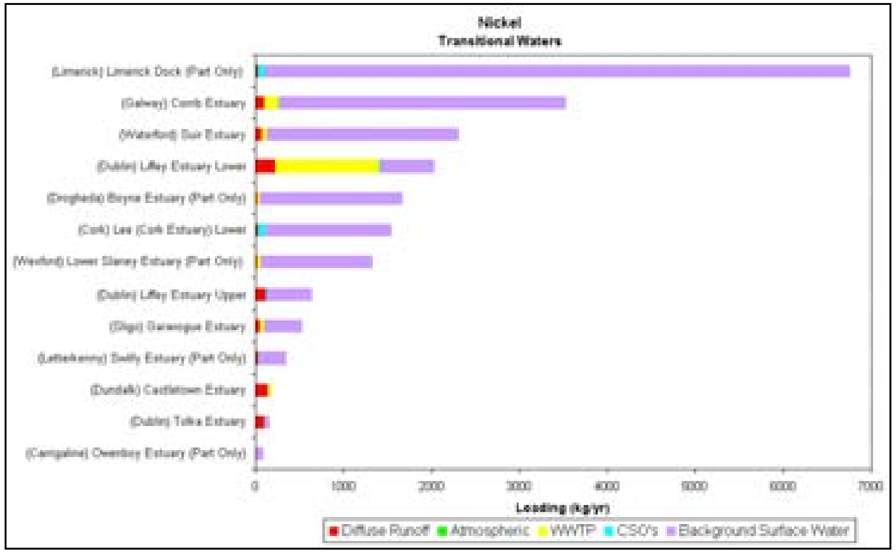


Figure 4.27: Zinc for River Waters

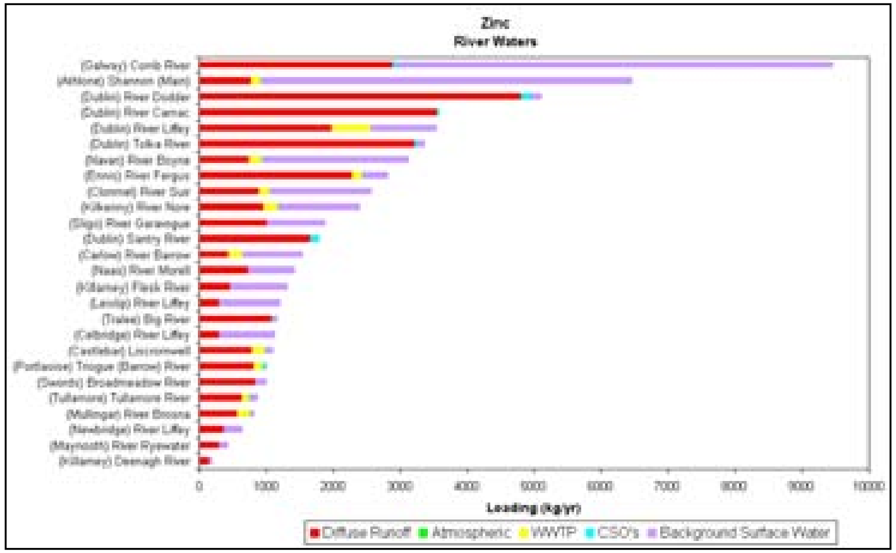
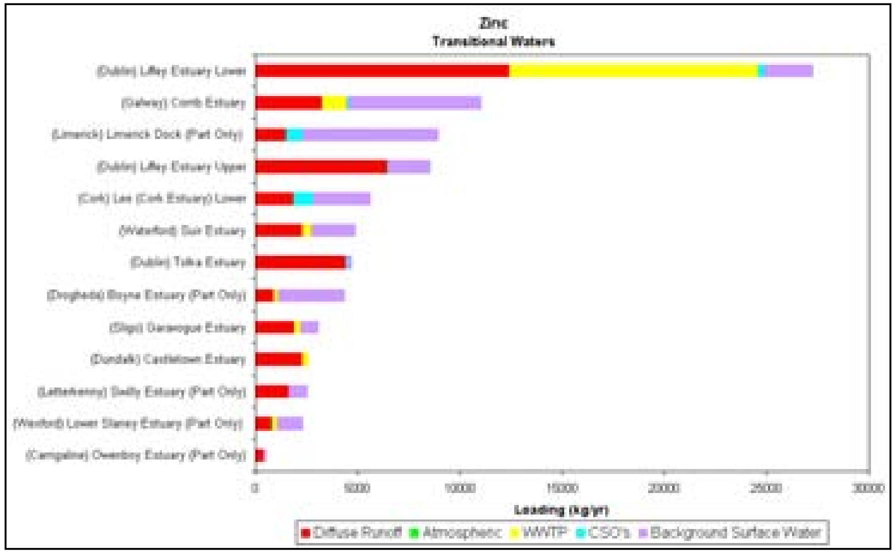


Figure 4.28: Zinc for Transitional Waters



4.2 Scenario 2 - Urban Pressure Ranking

For this scenario the cumulative annual loadings for the four urban pressures generated specifically within the study urban catchment footprints were estimated and assessed namely:

- Diffuse urban catchment surface water runoff
- WWTP discharges
- Combined sewer overflow (CSO) discharges
- Atmospheric deposition (direct to surface waters)

Figures 4.29 - 4.56 have been compiled for each of the 14 study parameters using the estimated cumulative annual loading data from the various urban pressure loading matrices detailed throughout Section 3 for each of the four urban pressures.

The majority of the WWTP discharges are located in transitional waters. The figures show that some of these WWTPs make a significant contribution to the cumulative annual loadings for many of the 14 study parameters for transitional waters. The figures also show for the metals that the diffuse urban catchment surface water runoff contributes significant cumulative annual loadings to the surface waters.

It should be remembered however for the reasons outlined previously in Section 3.8.6.5 that the actual cumulative annual loadings from the diffuse urban catchment surface water runoff will be somewhat less than those shown in Figures 4.29 – 4.56 because of the overestimation problem caused by the use of surrogate EMC data from Europe to estimate cumulative annual loadings. Although the extent of any overestimation for the cumulative annual loadings for the metals cannot be determined it is not likely to be overly significant.

The data suggests that the ***diffuse urban catchment surface water runoff pressure is the main contributor of metals to virtually all of the urban river waterbodies.***

Additionally the data also suggests that the WWTPs contribute significant loadings, both nutrients and metals, to many of the receiving surface waterbodies.

The data suggests that the CSOs make a significant nutrient contribution to many of the surface river waterbodies – particularly in those small highly urbanised catchments with small cumulative annual river flows and larger CSO spills.

The same comments apply for atmospheric deposition, point sources and groundwater inflows as stated previously in Section 4.1

In summary therefore Figures 4.29 – 4.56 show that in general for most of the nutrients the four urban pressures can be ranked (in decreasing order) in terms of overall cumulative annual loading contribution as follows:

- WWTP discharges (Largest)
- Diffuse urban catchment surface water runoff

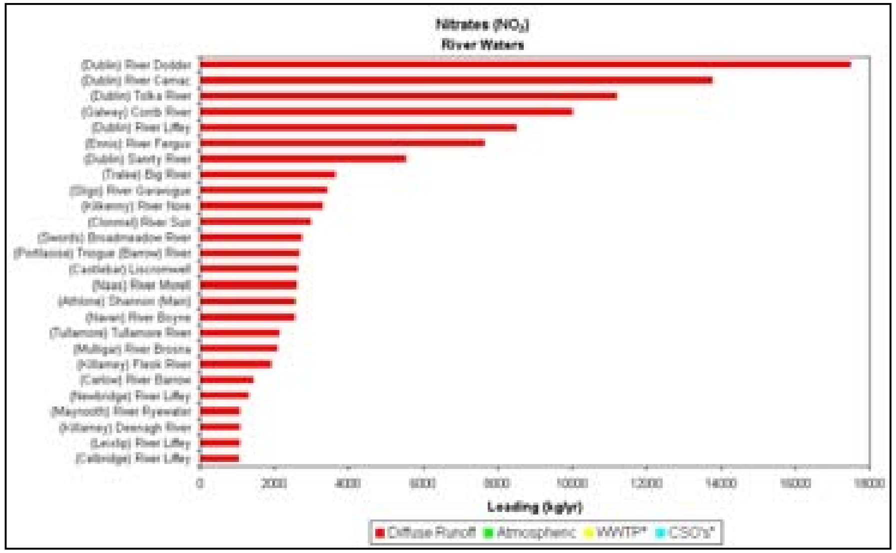
- Combined sewer overflow (CSO) discharges
- Atmospheric deposition (direct to surface waters) - (Smallest)

Whereas for most of the metals from the 14 study parameters the four urban pressures can be ranked (taking into consideration the likely effects of overestimations from the diffuse catchment surrogate EMC data) in terms of overall cumulative annual loading contribution as follows:

- Diffuse urban catchment surface water runoff (Largest)
- WWTP discharges
- Combined sewer overflow (CSO) discharges
- Atmospheric deposition (direct to surface waters) - (Smallest)

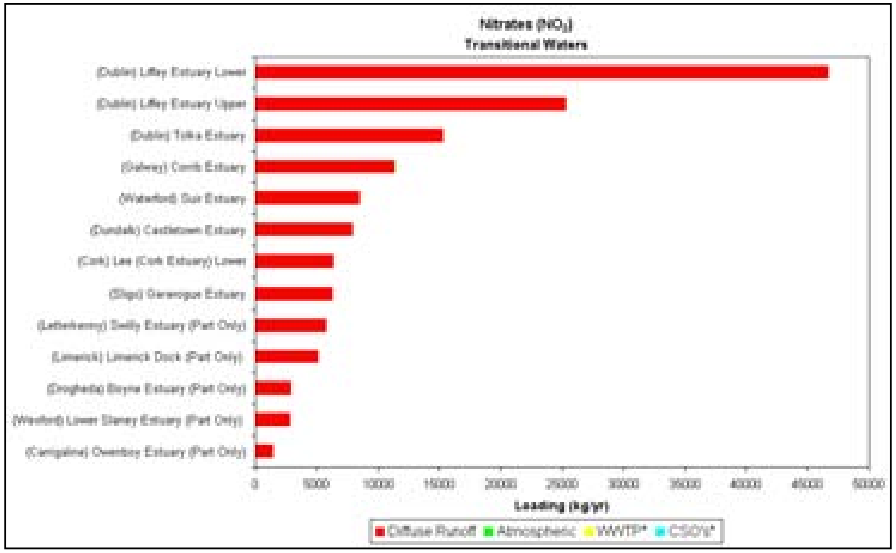
As for reasons stated previously to understand the complexity of the individual urban pressures for individual study parameters across both urban river and transitional surface water types it is necessary for the reader to study each urban pressure / parameter / urban surface water individually.

Figure 4.29: Nitrates for River Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.30: Nitrates for Transitional Waters

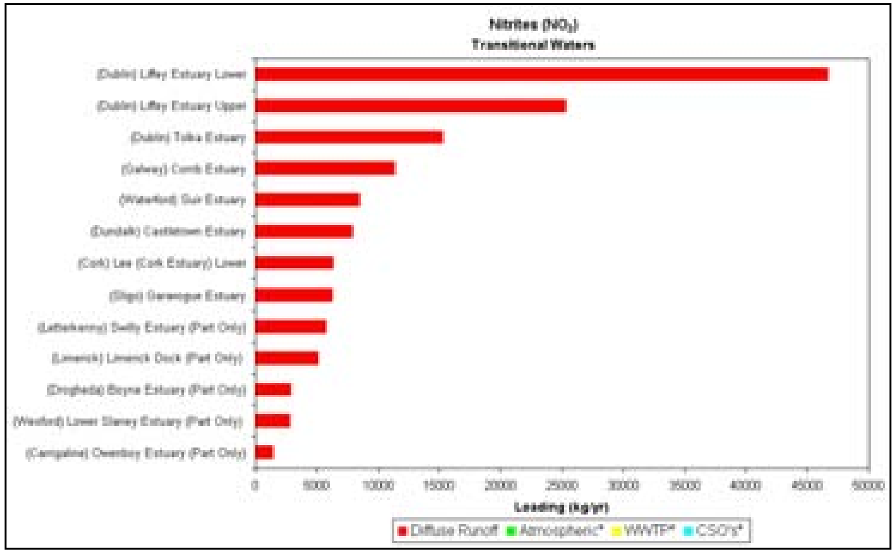


* No cumulative annual loading was estimated for these urban pressures.

Figure 4.31: Nitrites for River Waters

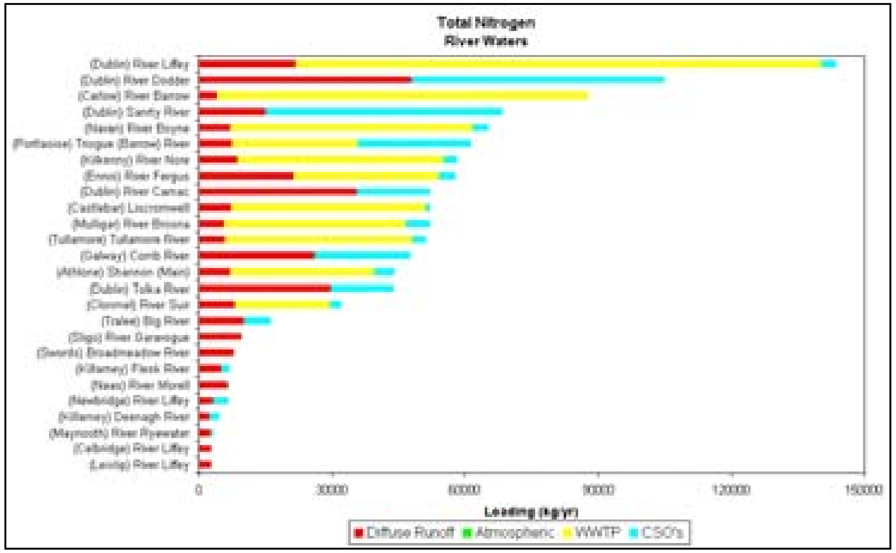
* No cumulative annual loading was estimated for these urban pressures.

Figure 4.32: Nitrites for Transitional Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.33: Total Nitrogen for River Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.34: Total Nitrogen for Transitional Waters

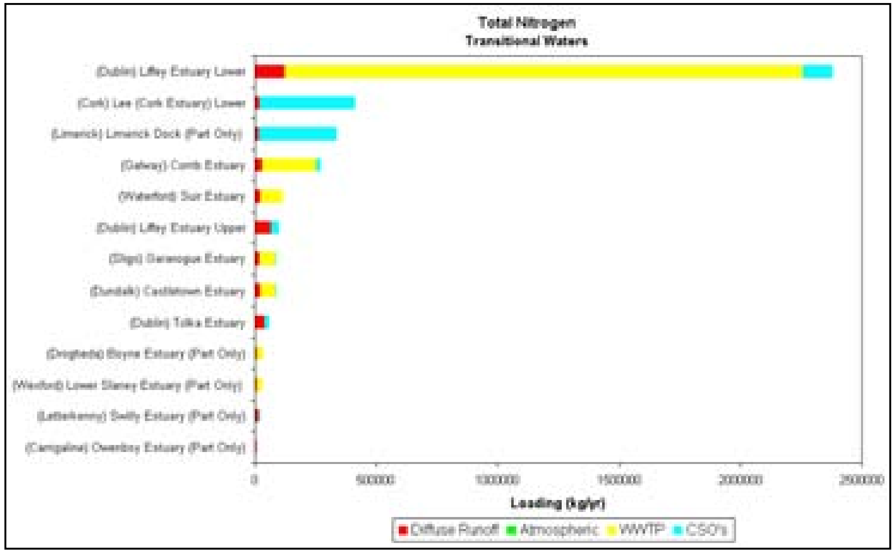
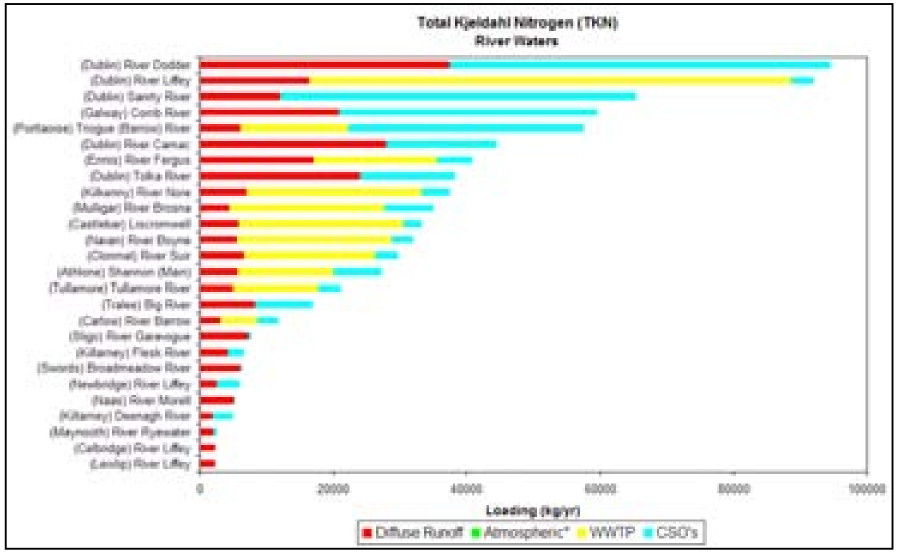
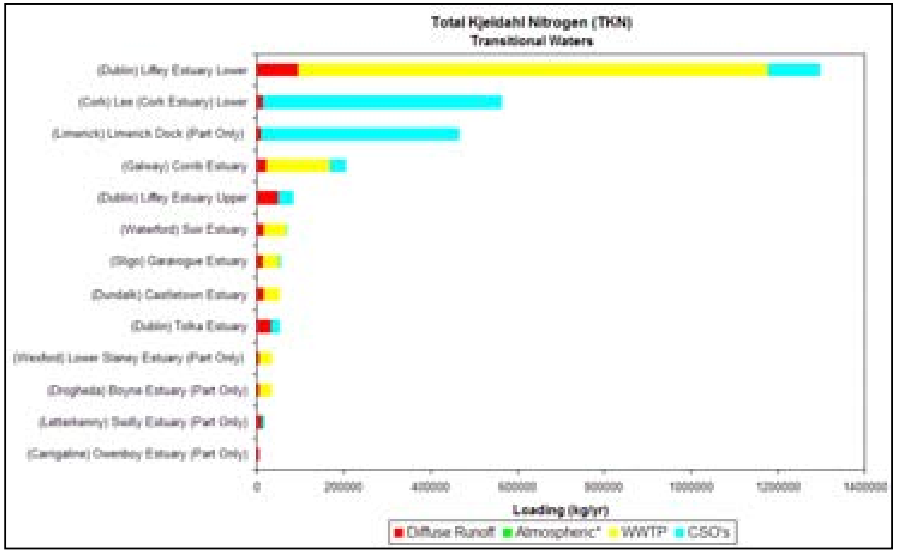


Figure 4.35: Total Kjeldahl Nitrogen for River Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.36: Total Kjeldahl Nitrogen for Transitional Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.37: Total Phosphorous for River Waters

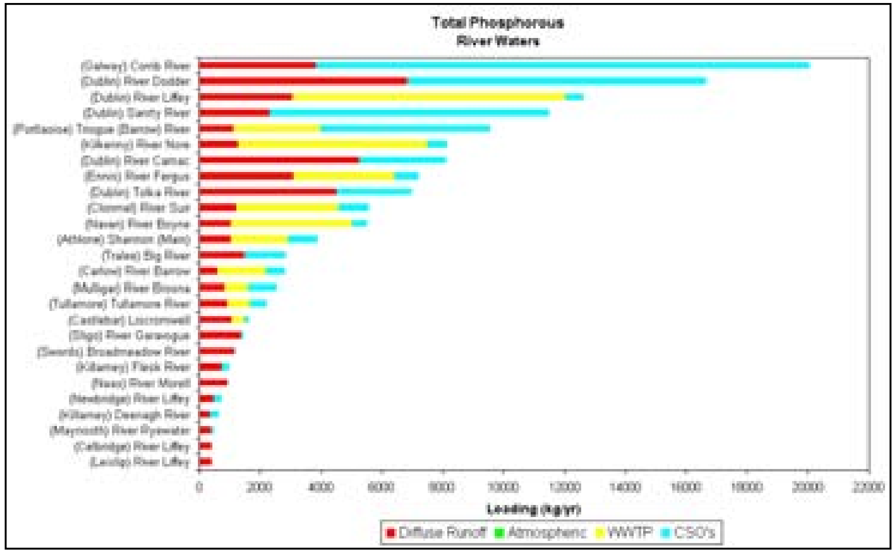


Figure 4.38: Total Phosphorous for Transitional Waters

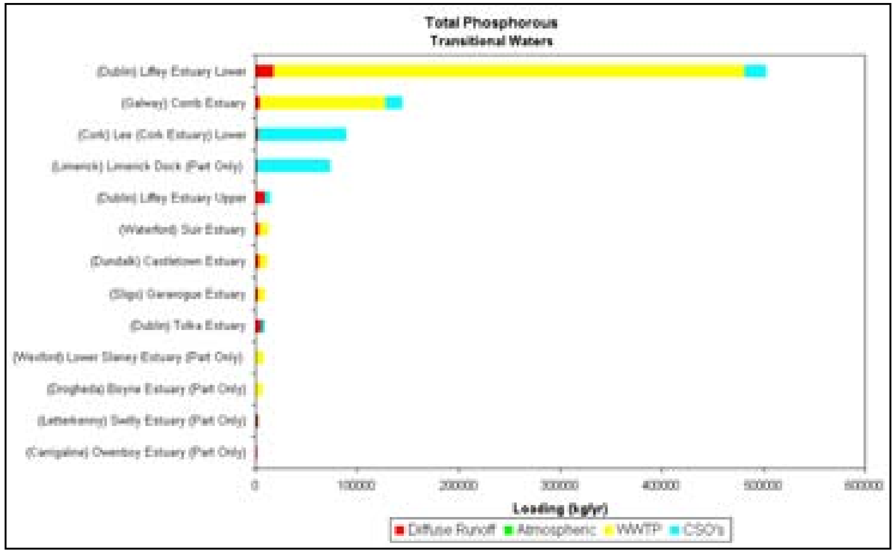
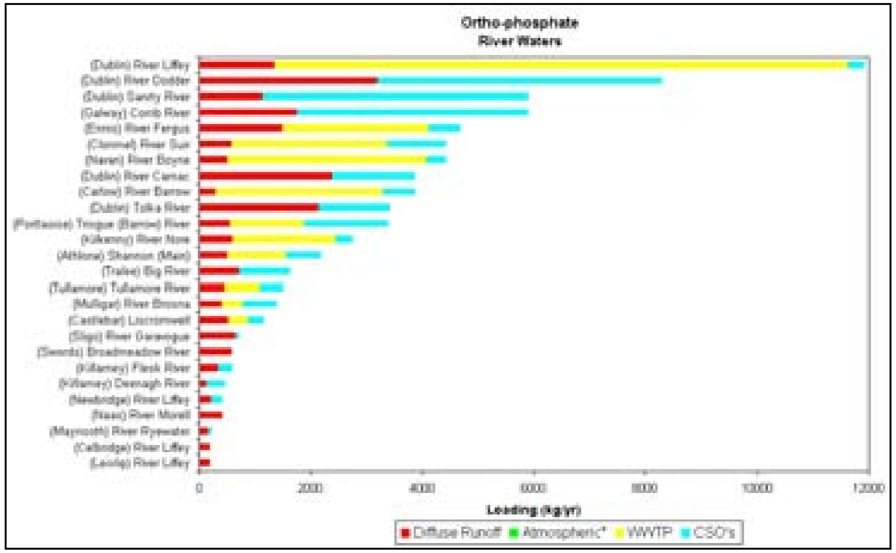
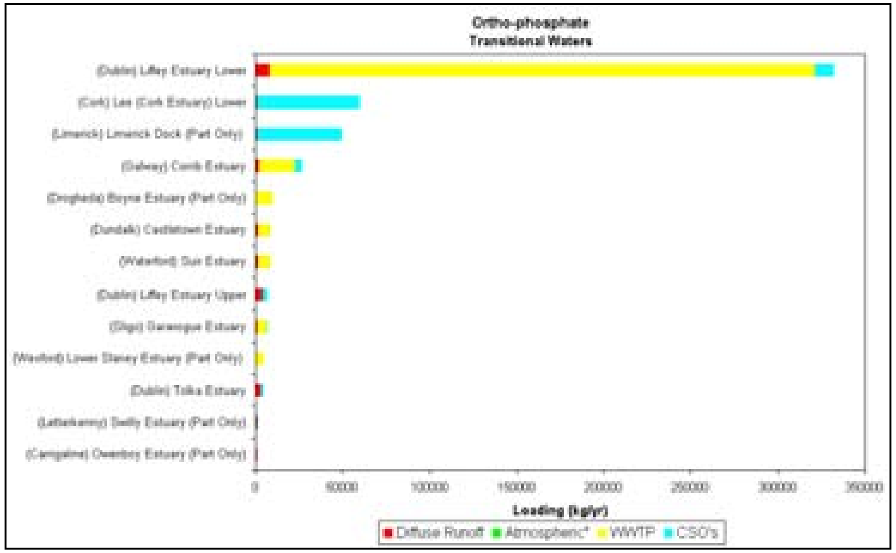


Figure 4.39: Ortho-phosphate for River Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.40: Ortho-phosphate for Transitional Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.41: Cadmium for River Waters

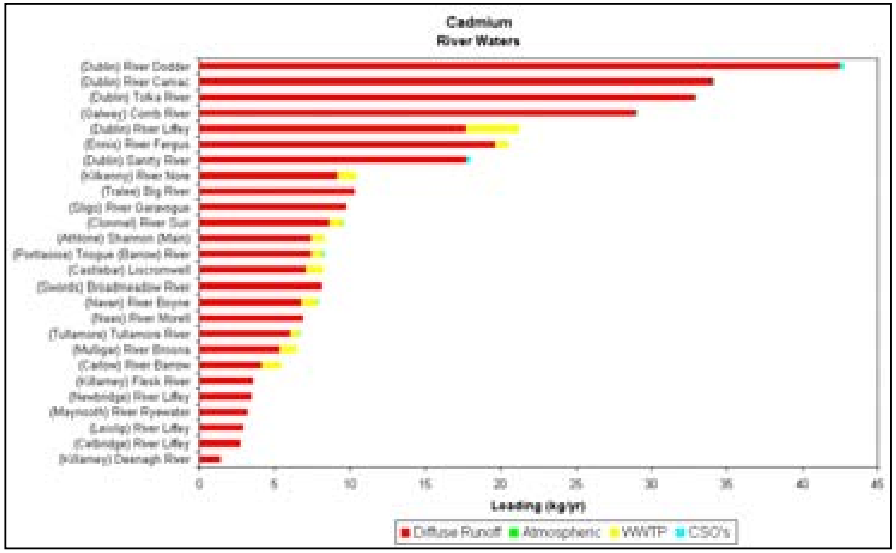


Figure 4.42: Cadmium for Transitional Waters

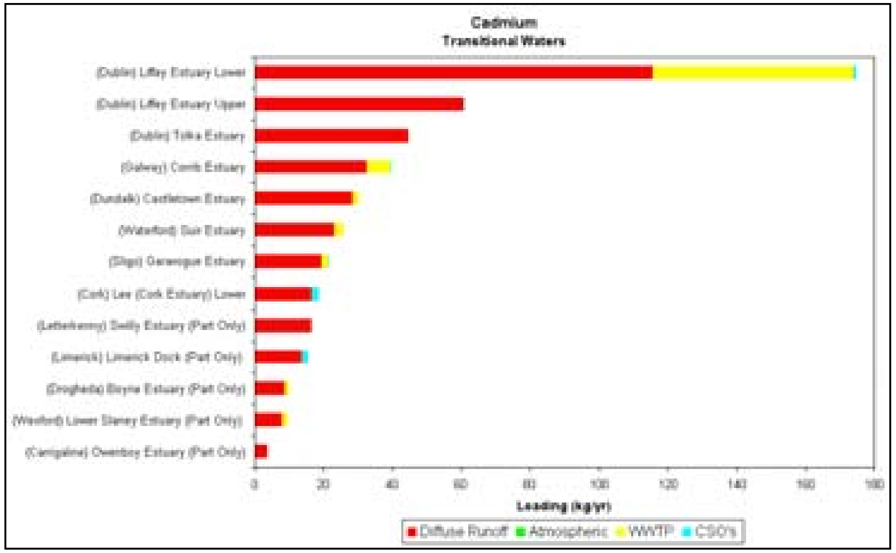


Figure 4.43: Chromium for River Waters

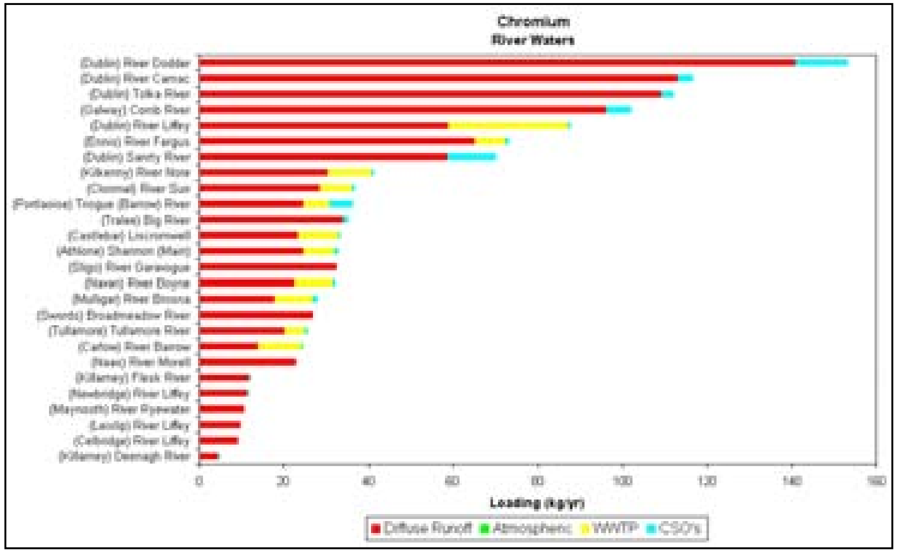


Figure 4.44: Chromium for Transitional Waters

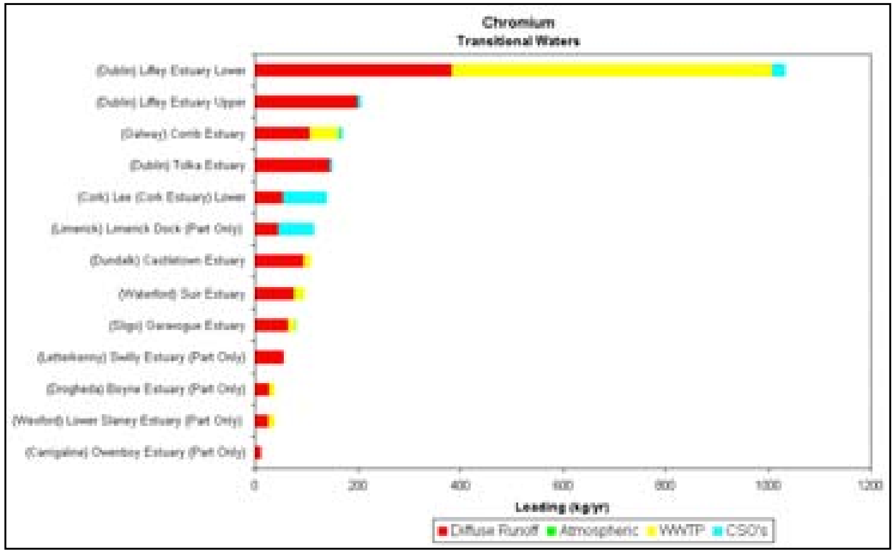


Figure 4.45: Copper for River Waters

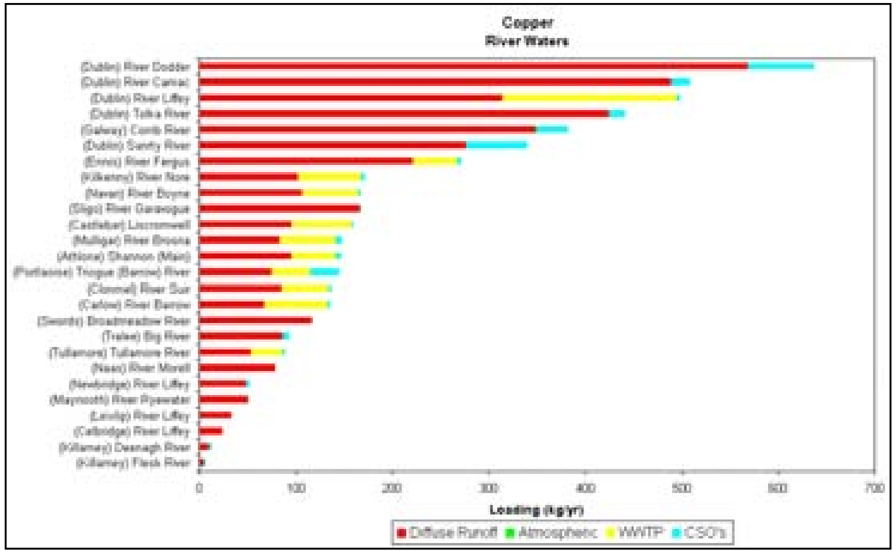


Figure 4.46: Copper for Transitional Waters

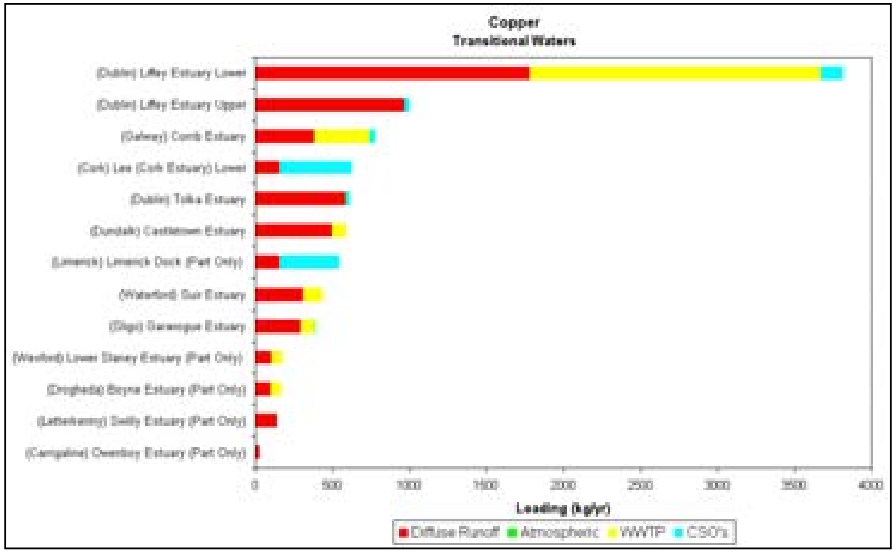
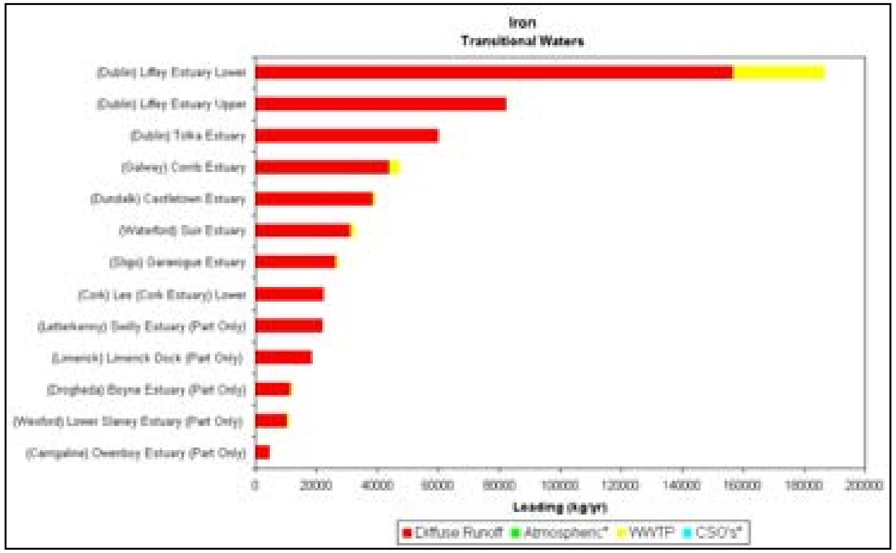


Figure 4.47: Iron for River Waters

* No cumulative annual loading was estimated for these urban pressures.

Figure 4.48: Iron for Transitional Waters



* No cumulative annual loading was estimated for these urban pressures.

Figure 4.49: Lead for River Waters

Figure 4.50: Lead for Transitional Waters

Figure 4.51: Mercury for River Waters

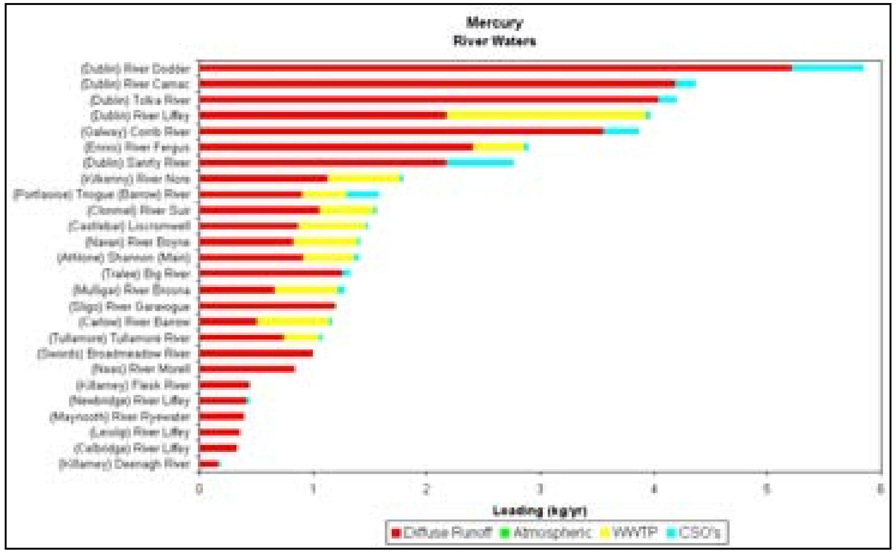


Figure 4.52: Mercury for Transitional Waters

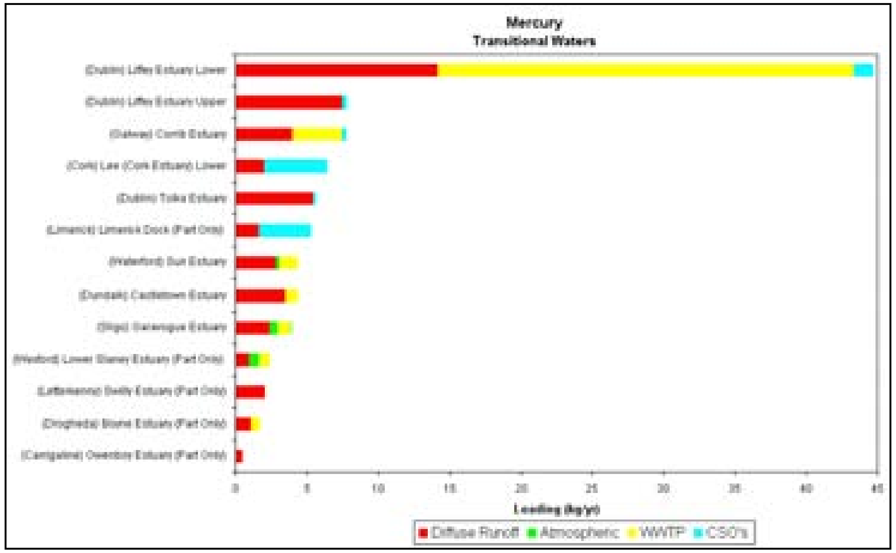


Figure 4.53: Nickel for River Waters

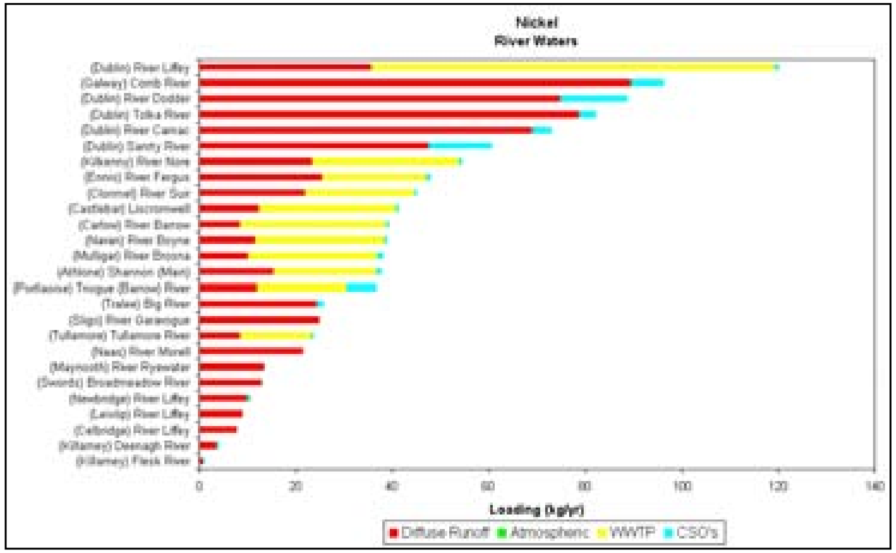


Figure 4.54: Nickel for Transitional Waters

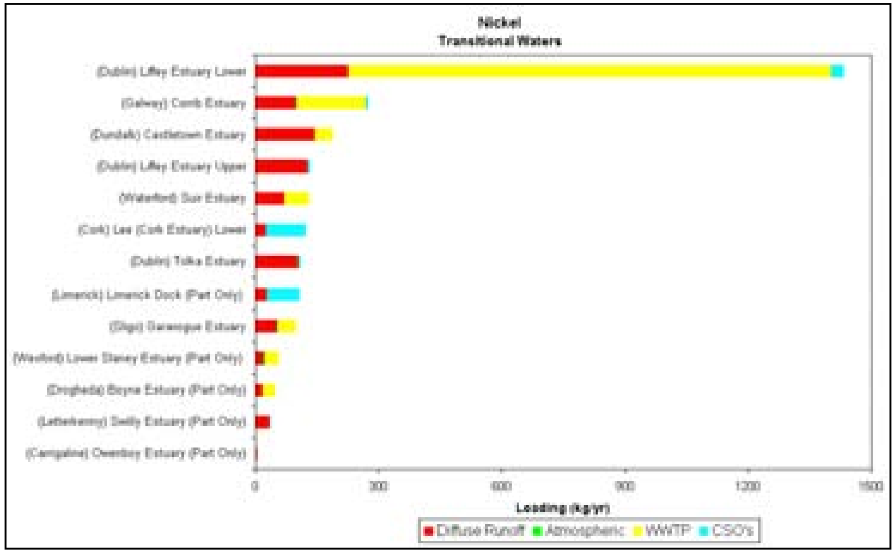
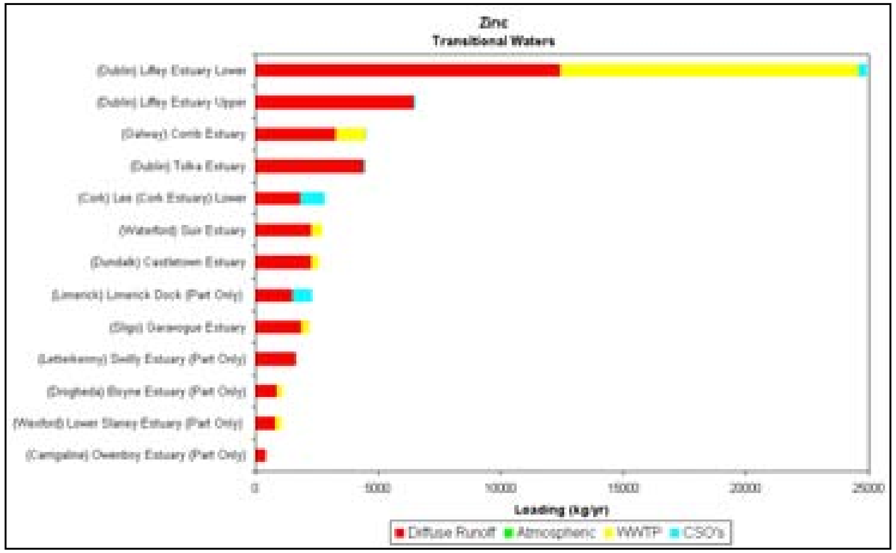


Figure 4.55: Zinc for River Waters

Figure 4.56: Zinc for Transitional Waters



5 Project Findings & Potential Measures

The urban pressures surface waters study involved undertaking a macro level assessment of current (and possibly future) water quality status in river and transitional surface waters within urban areas using a consistent cumulative assessment methodology which did not involve an extensive period of study for each surface water. The cumulative assessment was intended to highlight:

- The type, nature and scale of the individual urban pressures affecting the urban surface waters.
- Whether (and for what parameters) urban pressures impair ecological status, as measured through compliance with supplied chemical water quality standards.
- Provide an initial understanding of the magnitude of impairment in surface waters.

In addition to the above the study was also intended to provide a robust understanding of sewerage collection system combined sewer overflows (CSOs) including CSO locations, number and frequency of spills and the water quality of the spills.

The study initially involved undertaking a comprehensive assessment to identify the individual urban pressures that affect the surface waters and to estimate the scale of these urban pressures. Once the type and scale of the urban pressures was identified an assimilative capacity impact assessment was undertaken (based upon an average cumulative annual loading scenario) for both river and transitional surface waters located within the study urban catchment areas where the resulting concentrations were compared to proposed or surrogate water quality standards.

Because of the complex nature and scale of the project a project methodology involving eight key stages was adopted. As the project progressed many issues arose with each project stage. In many instances alternative approaches were developed to overcome these issues.

However, even with the adoption of alternative approaches, not all of the issues which arose were comprehensively resolved during this study. Nevertheless the work done under this study has provided for the first time a comprehensive body of work which focuses on urban pressures in Irish urban surface waters – both river and transitional waters. Furthermore the work from this study has provided

- a detailed understanding of both the type and scale of urban pressures,
- an understanding of the impacts of urban pressures on receiving urban surface waters,
- a comprehensive understanding of the location nature and scale of urban pressures specific to CSOs,

In general, ***the conduct of this study has highlighted the need for additional data gathering, databases, IT data integration and technical guidance***. The general categories of these needs are listed below. Table 5.1 provides a list of the specific difficulites/issues that have arisen during the progress of this study, along with suggested actions to address each difficulty/issue (i.e. the actions necessary to ensure a detailed understanding of both urban pressures and their contribution to ecological impairment as measured against chemical water quality standards).

- Additional monitoring – water quality/flow in receiving waters and discharges
- Rationalisation/standardisation of technical guidance procedures and methodologies for implementing studies and planning projects so as to facilitate Regulatory Compliance reporting requirements.
- Rationalisation/standardisation of the guidance documents for preparing reporting & document templates so as to facilitate Regulatory Compliance reporting requirements.
- Generation of comprehensive datasets – mapping, river flows etc
- Integrated knowledge sharing among Government bodies
- Need for further studies – water quality and flow studies to address data gaps
- Greater use of Information Management & and Information Management Systems integration
- Comprehensive implementation of existing Policies and Regulations

The reader is reminded that the information detailed in the tables is based upon the issues which surround the assessment of urban pressures for only the parameters of interest to this study i.e. those listed in Table 3.5. Furthermore the reader is reminded that the tables are based primarily on the findings from an urban pressures assessment of existing urban catchment conditions in conjunction with the results of an assimilative capacity assessment which was undertaken for a single flow condition, which in the case of rivers was the average cumulative annual river flow and for transitional waters the cumulative annual tidal inflow.

Therefore any future implementation/adoption of the suggestions/measures in this report must be pursued specifically as follows;

- Within the specific context of this urban pressures study for surface waters.
- Within the context of the existing Legislation specific to Ireland in terms of Basic Measures as specified in the list of Key Legislation presented at the start of this Report in advance of the Executive Summary.
- Within the context of any new/additional Legislation which may have to be developed specifically for Ireland to address the list of Supplementary Measures which have been identified as part of the preparation of the River Basin Management Plans. These Supplemenary Measures are specified in the list of Key Legislation presented at the start of this Report in advance of the Executive Summary.
- Within the context of the planned overall reporting requirements of the Water Framework Directive River Basin Management Plans to be prepared for Ireland.

Finally, any future implementation/adoption of the suggestions/Measures in this report must also be pursued specifically in the context of the many data gaps that resulted in the incorporation of much surrogate data. For example, and as stated throughout this report, the use of surrogate data is likely to have resulted in an overestimation of the cumulative annual loadings (kg/yr) for a number of the parameters of interest to this study. This view is partly supported by the results from Local Authotities river monitoring programmes. For example the Local Authorities currently undertake river monitoring programmes under a wide range of Regulations including;

- S.I. No. 293 of 1988 – European Communities (Quality of Salmonid Waters) Regulations, 1988.
- S.I. No. 257 of 1998 – Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorous) Regulations, 1998.
- S.I. No. 12 of 2001 – Water Quality (Dangerous Substances) Regulations, 2001.
- S.I. No. 722 of 2003 – European Communities (Water Policy) Regulations, 2003.

In all cases the Local Authority river monitoring is undertaken using accredited testing facilities. The monitoring results from these programmes are reported to the Environmental Protection Agency at the frequencies required and form part of the National datasets returned to the European Environment Agency.

Having consulted with Dublin City Council during this study for example, to validate/calibrate the pollutant loadings estimated from this macro level study, we are aware that their river monitoring results would suggest that the estimating procedures used for this current study to derive the macro cumulative annual loadings for a number of the 14 parameters appear to be overestimating the cumulative annual loadings on a number of highly urbanised Dublin rivers including the Liffey, Dodder, Tolka, Camac and Santry.

Whilst it is acknowledged that the implementation of the DCC river monitoring sampling programmes may not be specifically aligned to enable the estimation of cumulative annual pollutant loadings in river waterbodies nevertheless we would strongly advocate that the scale of any likely overestimation of cumulative annual pollutant loads from this study should be investigated further and clearly understood before any of the Basic or Supplementary measures involving the installation of hard infrastructure (Capital Construction Costs) are considered further.

Full implementation of the comprehensive list of suggested Actions/Measures as detailed in Table 5.1 will ensure that more detailed cumulative annual pollution estimation can be achieved, which will in turn enable all relevant and appropriate Basic and Supplementary Measures as listed in the List of Key Legislation to be fully implemented with confidence.

Table 5.1: Suggested Actions / Measures

Project Stage	Project Stage Description	Issue	Implications	Suggestions / Measures	Category of Suggestion / Measure
Stage 2	Boundary Catchment Definition	The development horizons in the Local Area Development Plans across the Country vary between Local Authorities.	Particularly difficult to undertake national strategic (or detailed local) studies - requiring access to land use / planning / development data – to a common baseline.	Local Area Plans could be developed nationally to a common timeframe/programme and prepared to a common Development Horizon.	Rationalisation/standardisation of technical guidance procedures. Rationalisation/standardisation of the guidance documents for reporting. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Comprehensive implementation of existing Policies and Regulations.
Stage 2	Boundary Catchment Definition	The formats used to develop the Local Area Development Plans vary between Local Authorities.	Particularly difficult to undertake national strategic (or detailed local) studies - requiring access to land use / planning / development data – which is in multiple formats.	Local Area Plans could be developed and rolled out nationally using a consistent national format.	Rationalisation/standardisation of technical guidance procedures. Rationalisation/standardisation of the guidance documents for reporting. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Comprehensive implementation of existing Policies and Regulations.
Stage 2	Boundary Catchment Definition	The methodology used to define catchment boundaries varies between Local Authorities.	Particularly difficult to undertake national strategic (or detailed local) studies - requiring access to land use / planning / development data – when the definition of catchment boundary varies across Local Authorities.	The methodology for defining catchment boundaries could be standardised via the introduction of a national format.	Rationalisation/standardisation of technical guidance procedures. Rationalisation/standardisation of the guidance documents for reporting. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Comprehensive implementation of existing Policies and Regulations.
Stage 3	Land Use Definition	Land use zoning definitions vary between Local Authorities.	Particularly difficult to undertake national strategic (or detailed local) studies - requiring access to land use / planning / development data – when the definitions of land use vary across Local Authorities.	The methodology for land use zoning/planning could be standardised via the introduction of national guidance.	Rationalisation/standardisation of technical guidance procedures. Rationalisation/standardisation of the guidance documents for reporting. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Comprehensive implementation of existing Policies and Regulations.

Table 5.1: Suggested Actions / Measures

Project Stage	Project Stage Description	Issue	Implications	Suggestions / Measures	Category of Suggestion / Measure
Stage 3	Land Use Definition	Spatial distribution planning for future/forecasting of development varies between Local Authorities	Particularly difficult to undertake national strategic (or detailed local) studies - requiring access to future/forecast land use / planning / development data – when the spatial planning approach varies across Local Authorities.	The methodology for spatial planning for future/forecast development could be standardised via the introduction of national guidance.	Rationalisation/standardisation of technical guidance procedures.
					Rationalisation/standardisation of the guidance documents for reporting.
					Generation of comprehensive datasets – mapping, river flows etc.
					Integrated knowledge sharing between Government bodies.
					Greater use of Information Management and Information Management Systems integration.
					Comprehensive implementation of existing Policies and Regulations.
Stage 4	Pollutant list derivation	Absence of Event Mean Concentration data for urban runoff parameters specific to Irish land uses.	Surrogate data was introduced from a European study. Loading estimates and assimilative capacities based upon this data are likely to be subject to change.	Consideration could be given to commissioning a study to derive this type of data.	Need for further studies – water quality and flow studies.
Stage 6	CSO Source Loadings	There is a lack of information relating to the spill performance of CSOs.	A lack of knowledge in this area will make it impossible for Local Authorities to understand the scale of CSO spills. Furthermore it will inhibit Local Authorities ability to demonstrate compliance with CSO performance standards which will be set in future by the EPA.	1 A national CSO register could be prepared.	Rationalisation/standardisation of technical guidance procedures.
				2 CSO discharges could be licenced.	Rationalisation/standardisation of the guidance documents for reporting.
				3 Sewer network models could be commissioned for those remaining urban areas where the population exceeds 10,000 and no model currently exists.	Generation of comprehensive datasets – mapping, river flows etc.
				4 Consideration could be given to implementing a sewer network modelling programme for smaller catchments containing CSOs and with a population of less than 10,000.	Integrated knowledge sharing between Government bodies.
				5 The methodology for reporting CSO performance could be standardised via the introduction of national guidance.	Greater use of Information Management and Information Management Systems integration.
				6 Consideration could be given to continuous monitoring of CSOs with known large and frequent discharges.	Comprehensive implementation of existing Policies and Regulations.
					Need for further studies – water quality and flow studies.
					Additional monitoring - water quality and flow.

Table 5.1: Suggested Actions / Measures

Project Stage	Project Stage Description	Issue	Implications	Suggestions / Measures	Category of Suggestion / Measure
Stage 6	CSO Source Loadings	In those cases where sewer network models exist they would appear to have been developed to a range of standards, differing levels of detail, using differing modelling techniques, and a lack of consistency in the presentation and reporting templates.	This will inhibit Local Authorities ability to demonstrate compliance with CSO standards which will be set under the Waste Water Discharge Regulations – 2007. Furthermore it will restrict both the Local Authorities ability to provide an effective service	1 The methodology for undertaking sewer network modelling could be standardised via the introduction of national guidance.	Rationalisation/standardisation of technical guidance procedures
				2 The possibility of pooling sewer network modelling skills could be considered to enable the development of one/more modelling centres of excellence to service the country.	Rationalisation/standardisation of the guidance documents for reporting.
					Generation of comprehensive datasets – mapping, river flows etc.
					Integrated knowledge sharing between Government bodies.
					Greater use of Information Management and Information Management Systems integration.
					Comprehensive implementation of existing Policies and Regulations.
Stage 6	CSO Source Loadings	Once constructed the existing models are generally not updated for regular use.	This will inhibit Local Authorities ability to demonstrate compliance with CSO standards which will be set under the Waste Water Discharge Regulations – 2007. Furthermore it will restrict both the Local Authorities ability to provide an effective service	1 The methodology for undertaking sewer network modelling could be standardised via the introduction of national guidance.	Rationalisation/standardisation of technical guidance procedures.
				2 The possibility of pooling sewer network modelling skills could be considered to enable the development of one/more modelling centres of excellence to service the country.	Rationalisation/standardisation of the guidance documents for reporting.
				3 The need for updated models could be made a mandatory requirement for Local Authorities	Generation of comprehensive datasets – mapping, river flows etc.
					Integrated knowledge sharing between Government bodies
					Greater use of Information Management and Information Management Systems integration.
					Comprehensive implementation of existing Policies and Regulations.
Stage 6	CSO Source Loadings	There is no CSO discharge water quality concentration data available for CSOs in Ireland.	Surrogate data was introduced from a UK study. Assimilative capacity impact assessments based upon this data as reported in this study are likely to change.	Consideration could be given to commissioning a study to derive CSO spill quality data.	Need for further studies – water quality and flow studies.
Stage 6	Point Source Loadings	Whilst most commercial/industrial businesses across Ireland have IPPC discharge licences setting upper limits on both volume and quality of discharge to the environment the licence limits are not linked to any monitoring of actual discharges in the receiving waters. Therefore it is not possible to determine actual volumes and quality of industrial discharges.	Without sufficient discharge flow and quality data it is not possible to derive annual discharge loadings to the environment. It is also questionable in many cases as to whether compliance with the current IPPC licence limits can be accurately determined.	More comprehensive monitoring and self reporting of industrial discharges	Integrated knowledge sharing between Government bodies.
					Greater use of Information Management and Information Management Systems integration.
					Comprehensive implementation of existing Policies and Regulations.
					Additional monitoring - water quality and flow.
Stage 6	Groundwater Loadings	It was not possible to develop a loading matrix to estimate the cumulative annual discharge of pollution loadings from groundwaters into the adjacent surface waters.	This urban pressure could not be estimated or ranked against the other urban pressures.	Further research required and detailed hydrogeology assessment/modelling required.	Need for further studies – water quality and flow studies

Table 5.1: Suggested Actions / Measures

Project Stage	Project Stage Description	Issue	Implications	Suggestions / Measures	Category of Suggestion / Measure
Stage 6	Waste Water Treatment	Comprehensive influent and effluent flow monitoring data is not available for many of the Irish WWTPs. In addition comprehensive influent and effluent load/composition monitoring data is not available for many of the WWTPs for the parameters of interest to this study.	A loading matrix has been produced listing cumulative annual loading estimates for the WWTP influents and effluents corresponding to the study urban areas. The loading matrix has been prepared using a combination of data from Ringsend WWTP plus surrogate data from a UK report based upon UK WWTPs. It is likely that the UK data will lead to an overestimation of cumulative annual loadings.	A comprehensive influent/effluent continuous flow monitoring programme needs to be designed and implemented for WWTPs across Ireland.A targeted influent/effluent load/composition sampling/monitoring programme needs to be designed and implemented for selected sizes and types of WWTPs to determine effluent discharge characteristics. These data should be self reported monthly to a centralized database.	Need for further studies – water quality and flow studies. Comprehensive implementation of existing Policies and Regulations. Additional monitoring - water quality and flow.
Stage 6	Waste Water Treatment	Irish specific research data for parameter removal rates through WWTPs for many of the parameters of interest to this study could not be sourced..	The loading matrix produced for the cumulative annual loading estimates for the WWTP has been prepared using a combination of data from Ringsend WWTP plus surrogate data from a study of UK WWTP influent and effluent compositions. The adoption of surrogate is likely to lead to an overestimation of cumulative annual loadings.	A pilot study should be done of a number of WWTPs across Ireland to monitor influent and effluent concentrations for the parameters of interest for this study. This pilot may need to be extended further to include a wider range of parameters of interest under other Directives such as The Dangerous Substances Directive.	Need for further studies – water quality and flow studies. Additional monitoring - water quality and flow.
Stage 6	Atmospheric Deposition Loadings	There is a significant shortage of atmosperic monitoring data available for Ireland for many of the parameters of interest to this study. Furthermore there is a significant shortage of data in Ireland relating to estimation of the annual atmospheric deposition loading rates from the limited atmospheric monitoring data.	Although this urban pressure has been estimated it has been assessed based upon data sourced largely from one site within Ireland. Therefore the atmospheric loading matrix used for the study does not cater for regional/spatial variations. This approach is likely to lead to under/over estimation of cumulative annual deposition loadings for some of the study areas.	A wider atmospheric monitoring programme should be considered for a wider range of parameters than currently being monitored. Additionally further work should be done to quantify atmospheric deposition across the country.	Need for further studies – Atmospheric deposition rates. Additional monitoring - Air quality.
Stage 6	Diffuse Urban Runoff Loadings	There is no national database of concentration data available relating to the quality of overland surface water flows for Irish catchments/landuses.	Although this urban pressure has been estimated , and a cumulative annual loading matrix prepared, it has been assessed based upon surrogate Event Mean Concentration (EMC) data sourced largely from Europe - which in turn is partially based upon American data. The adoption of surrogate is likely to lead to an overestimation of cumulative annual loadings.	Consideration should be given to implementing pilot catchment runoff studies aligned to standardised/generic land uses. The objective would be to produce runoff loading concentrations per rainfall event/cumulative annual rainfall for a selected range of parameters.	Greater use of Information Management and Information Management Systems integration. Need for further studies - Surfacewater runoff concentration and EMC studies. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration.
Stage 6	Diffuse Urban Runoff Loadings	The existing sewer network models used to determine the surface water runoff were built to different standards and in some cases using different versions of the sewer network modelling software.	For those study catchments where surface water runoff volumes were generated the difference in modelling standards and software versions will lead to some inconsistency between the volumes generated for the different study areas.	When the existing models are being updated the opportunity should be taken to update them using standardised technical guidance and reporting procedures. Particular attention should be given to the need for a national programme for the updating/upkeep of completed sewer network models.	Rationalisation/standardisation of technical guidance procedures. Rationalisation/standardisation of the guidance documents for reporting. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Comprehensive implementation of existing Policies and Regulations. Need for further studies - Complete the sewer network modelling programme.

Table 5.1: Suggested Actions / Measures

Project Stage	Project Stage Description	Issue	Implications	Suggestions / Measures	Category of Suggestion / Measure
Stage 6	Diffuse Urban Runoff Loadings	The sewer network models were not available for all 33 study urban areas and surface water runoff volumes had to be interpolated for those catchments with no runoff models.	In those study areas where no models exist the surface water runoff volumes are estimated/inferred from modelled areas with similar catchment characteristics. This will lead to some slight over or underestimation of surface water runoff volumes for the unmodelled urban areas.	The sewer network modelling programme should be completed for those study areas where no models currently exist. All future modelling should be done to a standardised technical and reporting brief. Particular attention should be given to the need for a national programme for the updating/upkeep of completed sewer network models.	Rationalisation/standardisation of technical guidance procedures. Rationalisation/standardisation of the guidance documents for reporting. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Comprehensive implementation of existing Policies and Regulations. Need for further studies - Complete the sewer network modelling programme.
Stage 6	Diffuse Urban Runoff Loadings	Surfacewater runoff factors by landuse zoning category were not available for Ireland. To overcome this problem surrogate landuse runoff factors were derived based largely upon the Wallingford Procedure with some level of benchmarking against runoff factors from the USA.	Although this urban pressure has been estimated, and a cumulative annual loading matrix prepared for surface water runoff loadings, it has been prepared based upon surrogate runoff factors sourced largely from the UK. Therefore the use of surrogate data may lead to some under/over estimation of the cumulative annual loadings.	There should be a gradual move towards the introduction of standardised landuse classification/zoning procedures across Ireland. Once the landuse classification/zonings have been rationalised - at some stage in the future - consideration could be given to undertaking a pilot study to establish surface water runoff factors for Ireland.	Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Need for further studies - Catchment/landuse surface water runoff pilot studies.
Stage 6	Diffuse Urban Runoff Loadings	Land use zoning definitions vary between Local Authorities.	Particularly difficult to undertake national strategic (or detailed local) studies - requiring access to land use / planning / development data – when the definitions of land use vary across Local Authorities.	The methodology for land use zoning/planning could be standardised via the introduction of national guidance.	Rationalisation/standardisation of technical guidance procedures. Rationalisation/standardisation of the guidance documents for reporting. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Comprehensive implementation of existing Policies and Regulations.
Stage 6	Upstream Background Loadings	There is a general lack of continuous river flow record data upstream of many of the study urban areas. All cumulative annual average flow estimates were produced by the EPA for the study urban areas using available national river long term flow records in conjunction with interpolations where no long term flow records existed.	The annual average cumulative flows entering many of the study urban area surface waters are based upon interpolations/inference from flow records for rivers in nearby/adjacent catchments. The use of this data on the study must be flagged accordingly.	There will be a general need to update and possibly extend the national hydrometric network. The procedures for the collecting / processing / and interpretation of the hydrometric data may also need to be updated and standardised. In the future it will be necessary to ensure both the integrity and the data consistency coming from the hydrometric network.	Rationalisation/standardisation of technical guidance procedures. Rationalisation/standardisation of the guidance documents for reporting. Generation of comprehensive datasets – mapping, river flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Additional monitoring - flow. Need for further studies - Revisit loading matrix at future stage as more flow data becomes available.

Table 5.1: Suggested Actions / Measures

Project Stage	Project Stage Description	Issue	Implications	Suggestions / Measures	Category of Suggestion / Measure
Stage 6	Upstream Background Loadings	Whilst there are many ongoing national water quality monitoring programmes for rivers the results from many of these programmes are not sufficient for the purposes of undertaking a national macro level urban pressures study. In many cases the parameters of interest to this study have not been monitored to any great extent in rivers.	Although this urban pressure has been estimated, and a cumulative annual loading matrix prepared for upstream background loadings, it has been prepared based upon the limited sampling/monitoring datasets which are currently available within Ireland.	The current WFD Surveillance monitoring programme is not fully operational as of yet and data is only available from 66 of 180 planned sites nationally. As the WFD surveillance monitoring programme comes fully onstream the current loading matrix could be revisited and updated.	Generation of comprehensive datasets – sampling/monitoring. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Additional monitoring - water quality. Need for further studies - Revisit loading matrix at future stage as more sampling/monitoring data becomes available.
Stage 6	Upstream Background Loadings	A number of sampling/programmes are testing for the study metals. However for virtually all metals the laboratory test is a detection limit test. This means that actual metals concentrations (which are lower than the test detection limit) are not being recorded under many of the monitoring programmes.	Although this urban pressure has been estimated, and a cumulative annual loading matrix prepared for upstream background loadings, it has been prepared based upon mostly test detection limit values. In effect therefore the cumulative annual loading matrix will be producing overestimates of annual loadings for the metals parameters.	In the future consideration will have to be given to lowering the test detection limits for a number of the study metals if "quantification" - as opposed to "estimation" of - cumulative annual loadings in the receiving surface waters is necessary.	Generation of comprehensive datasets – sampling/monitoring. Greater use of Information Management and Information Management Systems integration. Additional monitoring - water quality, lowering of test detection limits. Integrated knowledge sharing between Government bodies.
Stage 7	Assimilative Capacity	There is a general lack of tidal data corresponding to many of the study urban area transitional surface waters. Thus the annual average low and high tide levels were estimated using Proudman Institute tide prediction software.	The assimilative capacity assessments of the transitional surface waters (based upon cumulative annual flow into the transitional surface waters) are based upon predicted tidal as opposed to recorded tidal information.	Consideration should be given to broadening the national network of tidal gauges by adding additional tidal gauges – and wherever possible sited close to transitional waterbodies.	Generation of comprehensive datasets – tidal level/flows etc. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Additional monitoring - Tides. Need for further studies - Revisit assimilative capacity assessment at future stage as more tide data becomes available.
Stage 7	Assimilative Capacity	There is no information regarding the surface area of the transitional surface waters corresponding to various tide levels. The only transitional waterbody contour which exists corresponds to the single contour which was prepared for the WFD Article V Report. This single contour was used to represent both high and low tidal conditions.	The methodology adopted for estimating cumulative annual flows into the transitional surface waters was based upon the tidal prism method. Because of the difficulty in defining the surface water contour corresponding to both the mean annual high and mean annual low tide a single waterbody contour was used for all tidal ranges. This will lead to a substantial overestimation of the annual tidal inflow to the transitional water.	The transitional waterbody surface contours should be defined for a range of tidal conditions - High, Low, Mean Annual high and low etc. In addition consideration should be given to improving the overall bathymetry data for the transitional waterbodies.	Generation of comprehensive datasets – transitional surface waterbody contour mapping. Integrated knowledge sharing between Government bodies. Greater use of Information Management and Information Management Systems integration. Need for further studies - Revisit assimilative capacity assessment at future stage as more tide data becomes available.

6 Conclusions and Recommendations

6.1 Conclusions

Urban areas pose a risk of pollution to surface and ground waters, but assessing the risk is complex because of the myriad of potential pollution sources found there. In an urban setting, it can be complicated to develop an understanding of the cumulative risk that these many sources pose to a water body, while at the same time determining the contribution to the cumulative risk assessment that is attributable to individual (or types of) pollution sources. This latter step, however, is fundamental for the selection of measures to remedy pollution sources. Similarly, the assimilative capacity of the receiving water body needs to be determined before a rational Programme of Measures can be derived.

To improve the understanding of both the individual scale and the combined cumulative impact of urban pressures in Irish waterbodies a macro level urban pressures further characterisation study was commissioned in December 2005. The study required the assessment of the urban surface and ground waters within each of 33 urban areas across Ireland with a 2002 Census population of 10,000 or more. The 33 study urban catchment areas extended to some 983 km^2 and contained a total of 26 urban river waters and 13 urban transitional waters. The study officially commenced in February 2006. The study was progressed as two parallel stages with a surface waters study and a groundwaters study. This report has been prepared to deal specifically with the detail, implementation and findings of the surface waters study.

Whilst there were many facets to this wide ranging macro level study of urban surface waters the main original overriding objectives for the study were to:

- Undertake an assessment of the impacts (through compliance with supplied chemical water quality standards) of urban pressures in Irish urban waters for a range of up to 14 parameters including nutrients and selected metals.
- Gather missing data and improve data layers in the national GIS
- Conduct additional analyses to characterise CSOs in Ireland
- Estimate the type and scale of individual urban pressures in urban surface waters
- Develop an assessment methodology that considers assimilative capacity of the urban surface waters in Ireland based upon the combined cumulative loadings from all urban pressures
- Develop rankings for urban pressures

A Project Steering Group (PSG) was appointed to provide technical oversight and guidance plus final project signoff. The full PSG held seven progress / technical meetings during the progress of the project. In recognition of the complexity of the study the early meetings of the PSG focused both on the technical direction of the project and the likely final study output. The early objectives set by the PSG included;

- Reduce the uncertainty in the WFD Article V Initial Characterisation by addressing gaps that exist in the current understanding of urban pollution sources and pressures/impacts, including discharges from CSOs

- Develop a better understanding of the causes and processes which contribute to the urban pressures

- Obtain additional information about CSO operation and to develop criteria that address, in a simple way, the potential for these overflows to impact the ecological status of the receiving water.

- Develop a predictive urban assessment tool which can be used to nationally characterise urban surface waters, both river and transitional/estuarine, as either having sufficient or insufficient assimilative capacity for the pollutant loads from the urban area itself.

- Develop a ranking system that will be applied nationally to rank the individual urban pressure impacts in terms of scale thereby ensuring that the various RBDs will be sufficiently informed so as to enable them to develop and prioritise suitable and appropriate Programmes of Measures (POMs).

To meet these overall objectives a multi - stage methodology was developed to progress the study. The overall methodology included individual stages to define;

- the extent of the urban catchments.
- the number and extent of the urban rivers and transitional waters.
- the landuse/zonings for each of the urban catchments
- the parameter pollutant list to be assessed
- selection of urban pressures to be included in assessment
- the annual average flow conditions for the urban rivers and transitional waters
- “indicative” water quality standards
- water quality assimilative capacity impact assessments
- ranking of urban pressures

Project Steering Group approval/sign off was sought and received at the completion of each project stage.

However as the project developed numerous difficulties arose at each stage which had to be overcome. These difficulties were overcome by adopting a series of alternative approaches including:

- A decision was made to rerun all existing hydraulic sewer network models nationally to determine yearly CSO spill performance. - In total a significant remodelling programme was planned and implemented involving rerunning 18 sewer network models for 18 of the 33 study urban areas. This approach was a significant departure from the original project methodology which proposed intermittent field monitoring of the response of a small number of CSOs to rainfall events followed by interpolation of results nationally to estimate/characterise CSO performance.

- A number of the studies, existing and planned, which were to inform the CSO water quality aspect of the study did not materialise. - Surrogate data from a CSO study in the UK had to be adopted for use on the study.

- National river flow data was not as readily available as originally envisaged. Eventually the EPA provided annual average river flow data. In many cases the annual average river flow data was estimated by EPA due to lack of adequate flow records. No Q95 river flow data was available from the EPA records. - The study progressed on the basis of the estimated EPA data for annual average river flows. No assimilative capacity assessment was undertaken of rivers for the Q95 flow condition.

- Tidal annual flow volume data for the transitional surface waters did not exist due to a shortage of relevant tide level data and transitional waterbody bathymetry. Proudman Institute Poltips tide prediction software was adopted to estimate tidal ranges in transitional waters, and in conjunction with a simplified approach to the definition of the underlying bathymetry, the tidal prism methodology was used to calculate transitional waterbody volumes.

- ***Final National chemical water quality standards (EQS) were not provided for the study. A combination of draft "indicative" EQS from the EPA plus a number of study specific "indicative" surrogate EQS from USA were used for the assimilative capacity assessments.***

- Comprehensive influent and effluent water quality data does not exist for WWTPs for many of the 14 parameters of interest to this study. Surrogate water quality data has been adopted for WWTPs from a UK study with the exception of the Ringsend WWTP in Dublin where monitored data exists for many of the study parameters.

- Comprehensive water quality data does not exist for incoming upstream rural catchment flows into the urban waters for many of the 14 parameters from this study. Water quality data has been adopted from the Jul – Dec 2007 EPA WFD Surveillance Monitoring Programme (data available for 66 of a planned 180 monitoring sites). But much of this data, particularly for metals, is analysed at detection limits. The EPA advised that the study should proceed on the basis of either the detection test limit data or a variation thereof in the absence of any other data. ***Therefore overall cumulative annual loading estimates using this upstream river inflow data, for metals are being overestimated.***

- Comprehensive water quality data does not exist for diffuse urban surface water runoff linked to land use and runoff for many of the 14 parameters from this study within the urban surface waters being assessed. Surrogate land use water quality runoff concentration data – Event Mean Concentration (EMC) data has been adopted from a European study. ***Therefore overall cumulative annual loading estimates using this EMC data for metals are likely to be over estimated.***

- Although seven urban pressures were highlighted during the early stages of the study for assessment eventually only five of the seven were included in the study mainly because of data limitations.

Cumulative annual urban pollution loadings (kg/yr) entering the urban surface waters were estimated for five of the seven identified urban pressures. In each case a cumulative annual loading matrix was prepared containing estimated cumulative annual pollution loads (kg/yr) for up to 14 parameters including nutrients and a number of metals classed as either toxics or Dangerous Substances. The five cumulative annual loading matrices are:

- Incoming loadings from upstream catchment
- Diffuse urban catchment surface water runoff
- WWTP discharges
- Combined sewer overflow (CSO) discharges
- Atmospheric deposition (direct to surface waters)

The combined cumulative annual loading matrix representing all five urban pressure types is detailed as Table 3.41.

The cumulative loading assessments for the combination of the five estimated urban pressure types as presented in Figures 4.1 – 4.28 show that for most rivers and many of the transitional waters the diffuse urban pressure is the dominant pressure in particular for the study metal parameters. In contrast for many of the rivers and most of the transitional waters the WWTP urban pressure is the dominant pressure for the majority of the nutrient parameters. In a very small number of highly urbanized rivers and transitional waters the CSO urban pressure is significant. This is symptomatic of the fact that those particular waters are in very highly urbanized settings which experience relatively low cumulative annual stream flows and equally contain high numbers/concentrations of CSOs.

Water quality assimilative capacity impact assessments were prepared for the 26 urban rivers and the 13 urban transitional waters within the 33 study urban areas. In all cases the water quality assimilative capacity impact assessments were prepared for the 14 study parameters.

Whilst most of the water quality assimilative capacity impact assessments are based upon the cumulative annual loadings estimates from all five urban pressures for an individual study parameter - in a small number of cases these was no cumulative annual loading data available for an individual urban pressure for a small number of individual study parameters. The reader is referred to Figures 4.1 to 4.56 in Section 4 to obtain a more detailed understanding of the urban pressure data gaps by individual study parameter.

The assimilative capacity impact assessments highlight a number of urban river and transitional waters which ***appear*** to exceed the ***'indicative' study Water Quality Standards*** for a number of the study parameters. The urban river water bodies include the:

- Santry and Camac rivers (Dublin)

- Dodder and Tolka rivers (Dulin)
- Brosna river (Mullingar)
- Triogue (Barrow) river (Portlaoise)

Whilst the urban transitional water bodies include the:

- Dublin Liffey Estuary Upper transitional water (Dublin)
- Swilly Estuary transitional water (Letterkenny)
- The Boyne Estuary transitional water (Drogheda)
- Limerick Dock transitional water (Limerick)

Co incidentially in many cases the urban river waterbodies showing the ***apparent*** exceedances correspond to highly urbanised catchments with low annual stream inflows. ***Therefore in reality these particular urban river waterbodies will be the first to show any likely significant effects from urban pressures on ecological status.***

Whilst it is acknowledged that there is likely to be significant overestimation of pollutant loads for all of the assessed urban waters – primarily because of both the use of surrogate and detection limit analysis data - it is not currently possible to determine the scale of such overestimation for the above small group of urban waters. This issue has been highlighted previously in Section 5 of this Report which confirms that at least one of the Local Authorities, Dublin City Council, has indicated that the monitoring results from their statutory monitoring programmes (which are reported to the Environmental Protection Agency, and form part of the National datasets returned to the European Environment Agency), would suggest that the estimating techniques used in this study may be over predicting yearly pollution loads.

Therefore we must conclude that a more detailed/comprehensive waterbodies quality sampling monitoring programme should be instigated for these highly urbanized urban waterbodies to establish EQS compliance or failure.

Throughout this report – and Section 3 in particular - many difficulties have been highlighted regarding the datasets that were available to undertake this study. Extensive difficulties were encountered at each stage of the project which required the introduction of many alternative approaches and the introductions of surrogate data. Generally these difficulties highlight the need for;

- Additional monitoring – water quality/flow
- Rationalisation/standardisation of technical guidance procedures and methodologies for implementing studies and planning projects so as to facilitate Regulatory Compliance reporting requirements.
- Rationalisation/standardisation of the guidance documents for preparing reporting & document templates so as to facilitate Regulatory Compliance reporting requirements.

- Generation of comprehensive datasets – mapping, river flows etc
- Integrated knowledge sharing between Government bodies
- Further studies – water quality and flow studies
- Greater use of information management & and information management systems integration
- Comprehensive implementation of existing policies/regulations/measures

Section 5 of this report comprehensively details all of the problems encountered in implementing this study and provides a comprehensive list of suggested Actions/Measures for overcoming these problems in the future.

Overall however by adopting both the project methodology as outlined throughout this Report in conjunction with the various alternative approaches - including the use of surrogate data etc - it has been possible to undertake for the first time across Irish urban areas a comprehensive assessment to:

- Characterise CSO spill performance – spill frequency and water quality
- Identify, classify and quantify individual urban pressures
- Assess assimilative capacities in urban surface waters from the cumulative impact of urban pressures as measured against chemical water quality standards

With regard to CSOs the study has also highlighted a number of interesting facts most notably;

- For the majority of the re-modelled urban catchments the predicted cumulative annual CSO spill is only of the order of 5 – 10 % of the overall cumulative annual flow in the sewer network. The remaining 90 - 95% of the cumulative annual sewer network flow discharges to the downstream WWTP.
- In all cases the sewer network re-modelling showed that for the future catchment post implementation of the main drainage recommendations there is a significant reduction in the cumulative annual CSO spill volumes to the receiving waters.

Both of these facts are particularly significant as they demonstrate firstly that the cumulative annual CSO spill volumes are not the most significant urban pressure (for the parameters of interest to this study) when compared to the influent flows to the downstream WWTP, and secondly that the continued roll out of the main drainage programme is providing secondary water quality benefits particularly in relation to compliance with chemical water quality standards (EQS).

Therefore whilst concluding that all of the objectives of this study have been achieved it is acknowledged that in some areas further follow on future work is required to improve both the detail and accuracy of datasets presented herein, which will in turn enable the assimilative capacity impact assessment work presented in this report to be further refined/updated prior to the implementation of Programmes of Measures.

6.2 Recommendations

Given that the urban pressures study of rivers and transitional waters in Ireland is the first extensive national study of its type in Ireland it was to be expected that the study had the potential to generate an extensive list of problems/issues that would require further clarification/resolution. To an extent some of the problems highlighted by this study will be addressed in part (or are currently being addressed) as the implementation of the Water Framework Directive progresses. For example;

- The significant lack of urban surface water quality data that was encountered on this study will be addressed in part as the EPA continue to roll out and implement in full their Surveillance Monitoring Programme.
- The lack of bathymetric data for the urban transitional waters may be fully overcome as a result of the coastal LIDAR project currently being undertaken.
- The EPA planned network of national tidal gauges for transitional waterbodies.
- The full implementation of current EU Directives such as the Urban Waste Water Treatment Regulations and the Dangerous Substances Regulations etc.
- The EPA programme to improve and enhance the national hydrometric network for flow recording in rivers.
- The introduction of the national LIMS database and EDEN projects.

However even with these advances there will still remain many additional issues which will have to be considered if there is to be a greater and more detailed understanding of urban pressures in Ireland in the future. Many of these issues have already been referred to in Table 5.1.

To a certain extent the final form of any recommendations from this study should be partly influenced by the priorities that will be set for both completing the detailed understanding of urban pressures and any follow on subsequent development of Programmes of Measures/Actions which will be necessary to address the problems attributed mainly to urban pressures. At this stage it is not known what form these priorities may take.

On this basis we have developed a comprehensive listing of the main recommendations that we foresee at this juncture;

Need for further studies – water quality and flow studies.

- Consider the need to increase the number of atmospheric monitoring stations nationally and to widen the suite of parameters tested at these stations.
- Consider the need to undertake pilot studies to convert atmospheric monitoring concentrations into atmospheric deposition loadings to land.
- Consider the need for the development of a CSO parameter based discharge effluent quality table for Irish CSOs.

- Consider the need for the development of an Event Mean Concentration (EMC) database for water quality concentration surface water runoff values from Irish landuse types.

- Consider the need to develop water quality concentration data for influents into Irish WWTPs.

- Consider the need to develop water quality concentration data for effluents from Irish WWTPs.

- Initiate a special study to quantify the migration of parameters of interest from rivers into adjacent groundwaters and vice versa.

- Establish background water quality levels in urban waters for the parameters of interest to this study

- Embark on a series of detailed pilot studies for a number of urban waterbodies, specifically those most likely to be impacting ecological status including the Santry, Camac, Dodder, Tolka, Brosna, and Triogue urban rivers and the Dublin Liffey Estuary Upper and the Letterkenny – Swilly transitional urban waters.

Rationalisation/standardisation of technical guidance procedures.

- Standardise the procedures/technical guidance for undertaking sewer network modelling – model build, verification/calibration and optioneering/solutions development.

- Introduce the need for annual time series modelling analysis for all sewer network modelling studies.

- Complete the main drainage programme (including sewer network modelling) nationally for the remainder of the 33 study urban areas where no models currently exist.

- Standardise the procedures for the development and reporting of development plans and introduce standardised landuse/zoning classifications.

Rationalisation/standardisation of the guidance documents for reporting.

- Standardise the final reporting for sewer network modelling studies.

Comprehensive implementation of existing Policies and Regulations.

- Finalise the chemical water quality standards for the parameters of interest to this study

- Continue with the rollout of the main drainage upgrade programme.

- Review the implementation of IPPC Licencing in accordance with the findings of this report – flow and quality – so that annual cumulative discharge loadings can be calculated.

Greater use of information management and information management systems integration.

- Gather specific data from pilot catchments to assist in the process of calibrating and sensitivity testing the surrogate data adopted for this study.

Integrated knowledge sharing between Government bodies.

- Consider the need to retrofit controls for the collection/treatment of urban surface water discharges prior to discharge into highly urbanized streams – for example improved drainage systems such as Sustainable Drainage Systems (SuDS) solutions etc.

- Consider the gradual introduction of Sustainable Drainage Systems (SuDS) solutions on new build developments.

Generation of comprehensive datasets – mapping, river flows etc.

- Implement detailed effluent monitoring – flow and quality – for all IPPCs so as to be able to calculate cumulative annual discharge loadings to the environment.

- Wherever possible consider adopting lower detection limits for analysis of metals so that the concentrations in surface waters can be more accurately quantified.

- Consider the need to extend WFD water quality sampling programmes to include sites specific to the urban surface waters, particularly at the upstream boundary of the urban area catchment so as to facilitate more detailed estimation of incoming loads from upstream.

Additional monitoring –flow/quality

- Consider the installation of hydrometric flow sites specific to the urban surface waters, particularly at the upstream boundary of the urban area catchment so as to facilitate more detailed estimation of incoming loads from upstream and to facilitate the assimilative capacity impact assessments for the urban river waters.

- Introduction of protocols between Government/Statutory bodies regarding the standardisation of electronic datasets and the subsequent sharing/exchange of such datsets between Departments.

- Consider re-running the methodologies presented in this report at key intervals when updated datsets become available.

Whilst we accept that the recommendations list is extensive we believe it reflects the diverse scale and range of issues that are presented by urban pressures on surface waterbodies. We believe that the recommendations should be implemented in stages with each stage or group of stages to be followed by a post project appraisal. This phased approach will enable the cumulative benefits of the implemented recommendations to be assessed at key intervals thereby allowing for a future change in implementation strategy should this be necessary.

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APPENDIX A

Detailed Listing of Externally Distributed Supporting Documents Generated Under the Study

Table A.1: Schedule of Project Deliverables

Project Stage	Document Title	Document Reference	Doc Revision	Document Issue Date to Steering Group	Circulation/Review Period	Uploaded to ERBD Website	Steering Group Document Signoff
Stage 1 – Project Inception	DG 01 UP 40 Urban Press Pos Paper uncosted Rev 1	39325/UP40/DG01 - S	Rev 1	MM 04 19-Jun-06	3.5 months	N	Y
Stage 1 – Project Inception	DG 01 UP40 Urban Press Pos Paper uncosted Rev 2	39325/UP40/DG01 - S	Rev 2 (Final)	CO_50 29-Sep-06	3.5 months	Y	Y MM 07 – 4 Oct 06
Stage 2 – Boundary Catchment Definition	DG-18_Catchment Definition Methodology Rev 2	39325/UP40/DG18 - S	Draft Rev 2 Sep-06	CO_50 29-Sep-06	One Week	Y	Y MM 07 – 4 Oct 06
Stage 2 – Boundary Catchment Definition	DG-18 Catchment Definition Methodology Final Rev 01	39325/UP40/DG18 - S	Final Rev 01 Nov-06	Via Web Upload	Since Previous Issue – No new review	Y	Y MM 23 – 16 Oct 07
Stage 3 – Land Use Definition	DG_19_Land Use Reclassification Methodology Rev_2	39325/UP40/DG19 - S	Rev 2	29/11/06 Email CO_83	One Week	N	Y MM 12 – 7 Dec 2006
Stage 3 – Land Use Definition	DG_19_Land Use Reclassification Methodology Rev_4	39325/UP40/DG19 - S	Final 01	3-Apr-07 Email CO_119	6.5 months	Y	Y MM 23 – 16 Oct 07
Stage 3 – Land Use Definition	DG_19_Land Use Reclassification Methodology Rev_5	39325/UP40/DG19 - S	Final 02	11-Jan-08 Email CO_210	Since Previous Issue – No new review	Y	N/A
Stage 4 – Pollutant List	DG 17 UP 40 Pollutant List Methodology Draft Rev 2	39325/UP40/DG17 - S	Draft Rev 2 Sep-06	CO_50 29-Sep-06	One Week	Y	Y MM 07 – 4 Oct 06
Stage 4 – Pollutant List	DG 17 UP40 Pollutant List Methodology Final Rev 01	39325/UP40/DG17 - S	Final Rev 1 Nov-06	CO_211 11-Jan-08	Since Previous Issue – No new review	Y	N/A
Stage 6 – Pollutant Loadings	DG 25 UP40 WWTP Loadings Methodology Draft Rev 2	39325/UP40/DG25 - S	Draft 2	3-Apr-07 CO_119	Two weeks	Y	Y MM 23 – 16 Oct 07
Stage 6 – Pollutant Loadings	DG 25 UP 40 WWTP Loadings Methodology Final 02	39325/UP40/DG25 - S	Final 02	6-Dec-07 CO_197	Since Previous Issue – No new review	Y	N/A
Stage 6 – Pollutant Loadings	DG25 UP40 WWTP Loadings Methodology Final 03	39325/UP40/DG25 - S	Final 03	4-Mar-08 CO_239	Since Previous Issue – No new review	Y	N/A
Stage 6 – Pollutant Loadings	DG 34 Point Source Loadings – Draft 02	39325/UP40/DG34 -- S	Draft 02	23-May-07 CO_ 148	One Week	Y	Y MM 23 – 16 Oct 07
Stage 6 – Pollutant Loadings	DG 34 Point Source Loadings-Final 01	39325/UP40/DG34 – S	Final 01	6-Dec-07 CO_197	Since Previous Issue – No new review	Y	N/A
Stage 6 – Pollutant Loadings	DG_43 CSO Source Loadings – Draft 01	39325/UP40/DG43 – S	Draft 1	29-Aug-07 CO_180	Two Weeks	Y	Y MM 23 – 16 Oct 07
Stage 6 – Pollutant Loadings	DG_43 CSO Source Loadings-Final 01	39325/UP40/DG43 – S	Final 01	6-Dec-07 CO_ 197	Since Previous Issue – No new review	Y	N/A
Stage 6 – Pollutant Loadings	DG44 Urban Catchment Diffuse Runoff – Draft 02	39325/UP40/DG44 – S	Draft 02	29-Aug-07 CO_180	Two Weeks	Y	Y MM 23 – 16 Oct 07
Stage 6 – Pollutant Loadings	DG 44 Urban Catchment Diffuse Runoff – Final 01	39325/UP40/DG44 – S	Final 01	6-Dec-07 CO_ 197	Since Previous Issue – No new review	Y	N/A
Stage 6 – Pollutant Loadings	DG 30 UP 40 Atmospheric Loadings Methodology Rev 1	39325/UP40/DG30 – S	Final 01 - Draft	3-Apr-07 CO_119	Two Weeks	Y	Y MM 23 – 16 Oct 07

Project Stage	Document Title	Document Reference	Doc Revision	Document Issue Date to Steering Group	Circulation/Review Period	Uploaded to ERBD Website	Steering Group Document Signoff
Stage 6 – Pollutant Loadings	DG 30 UP40 Atmospheric Loadings Methodology Rev 2 – Final	39325/UP40/DG30 – S	Final 02	CO_212 11-Jan-08	Since Previous Issue – No new review	Y	N/A
Stage 6 – Pollutant Loadings	DG_66 Incoming Upstream Loadings to Urban Areas – Draft01	39325/UP40/DG66 – S	Draft 01	25-Apr-08 CO_244	Two Weeks	Y	
Stage 7 – Assimilative Capacity	DG51 Confirmation of indicative water quality standards – Final 01	39325/UP40/DG51 – S	Final 01	6-Dec-07 CO_197	Standards set by external parties – Limited Steering Group input	Y	N/A
Stage 7 – Assimilative Capacity	DG51 Confirmination of indicative water quality standards – Final 03	39325/UP40/DG51 – S	Final 03				
Stage 7 – Assimilative Capacity	Urban pressures Surface Waters – Draft Study Output (Formats and Details)	39325/UP40/DG68 – S	Draft 1	MM 23 16-Oct-07	4 Weeks	N	Steering Group sign off on the formats for presentation of graphs/ data etc
Stage 8 - Final Report	Final Report for Urban Pressures Surface Waters	39328/UP40/DG48	Draft 01	CO_253, CO_254 31-Jul-08	Sub Steering Group	N	N/A
Stage 8 - Final Report	Final Report for Urban Pressures Surface Waters	39328/UP40/DG48	Draft 02	CO_255 17-Oct-08	Sub Steering Group	Y	N/A
Stage 8 - Final Report	Final Report for Urban Pressures Surface Waters	39328/UP40/DG48	Final Rev – 1	MM_32 12-Dec-08	Two weeks	N	Y
Stage 8 – Final Report	Final Report for Urban Pressures Surface Waters	39328/UP40/DG48	Final Rev – 2	16-Mar-09	N/A	Y	Complete

APPENDIX B

National Water Sampling Programmes and Associated Monitored Parameters

Table B.1: National Water Sampling / Monitoring Programmes

Urban Area/ Catchment Name	Surface Water Name	Monitoring Programme	Sampling Location / Reference	Upstream/ Downstream/ Intermediate	Nitrates	Nitrites	Total N	Nitrogen (TKN)	Total P	Ortho-phosphate	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Zn
Athlone	Shannon (River)	WFD - POM	1	d/s				Y	Y			Y	Y				Y	Y
		EPA	1	d/s	Y					Y								
		EPA	2	int	Y					Y								
		EPA	3	int						Y								
		EPA - LIMS	4	d/s		Y				Y								
Carlow	River Barrow (River)	EPA - LIMS	A	u/s		Y				Y	Y	Y	Y	Y	Y		Y	Y
Carrigaline	Owenboy Estuary (Part Only) (Transitional)	-	-	--	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Castlebar	Liscromwell (River)	EPA - LIMS	A	int		Y				Y								
		EPA – LIMS	B	int					Y	Y								
		EPA – LIMS	C	int		Y				Y								
		EPA – LIMS	D	d/s		Y				Y	Y	Y	Y	Y	Y	Y	Y	Y
		EPA – LIMS	E	u/s	Y	Y				Y								
Celbridge	River Liffey (River)	WFD - POM	A	int				Y	Y			Y	Y		Y		Y	Y
		EPA	A	int	Y	Y				Y								
		EPA	B	int	Y					Y								
		EPA	C	d/s	Y	Y				Y								
Clonmel	River Suir (River)	EPA – LIMS	A	d/s							Y	Y	Y	Y	Y		Y	Y
Cork	Lee (Cork Estuary) Lower (Transitional)	OSPAR	B	u/s			Y		Y	Y	Y		Y		Y			Y
		WFD - POM	A	u/s				Y	Y			Y	Y		Y		Y	Y
Drogheda	Boyne Estuary (Part Only) (Transitional)	OSPAR	A	u/s			Y		Y	Y	Y		Y		Y			Y
		WFD - POM	A	d/s				Y	Y			Y	Y		Y	Y	Y	Y
		EPA	A	int		Y				Y								
		EPA	B	u/s	Y	Y				Y								
		EPA	C	u/s		Y				Y								
		EPA – LIMS	D	u/s						Y								
Dundalk	Castletown Estuary (Transitional)	EPA – LIMS	A	u/s						Y	Y	Y	Y	Y	Y		Y	Y
		EPA – LIMS	B	u/s						Y	Y	Y	Y	Y	Y		Y	Y
		EPA – LIMS	C	u/s						Y	Y	Y	Y	Y	Y		Y	Y
		EPA – LIMS	D	d/s						Y	Y	Y	Y	Y	Y		Y	Y
		EPA – LIMS	E	u/s						Y								
		EPA – LIMS	F	u/s						Y		Y	Y		Y		Y	Y
		EPA – LIMS	G	u/s						Y	Y		Y	Y	Y		Y	Y
Ennis	River Fergus (River)	OSPAR	A	int			Y		Y	Y	Y		Y		Y			Y
Kilkenny	River Nore (River)	EPA – LIMS	A	u/s		Y				Y	Y	Y	Y	Y	Y	Y	Y	Y
Letterkenny	Swilly Estuary (Part Only) Transitional	EPA – LIMS	A	d/s						Y								
Leixlip	River Liffey (River)	EPA	A	d/s	Y	Y			Y									
		EPA	B	d/s		Y			Y									
		EPA	C	u/s		Y				Y								
Limerick	Limerick Dock (Part Only) Transitional)	OSPAR	A	u/s			Y		Y	Y	Y		Y		Y			Y

Table B.1: National Water Sampling / Monitoring Programmes (continued)

Urban Area/ Catchment Name	Surface Water Name	Monitoring Programme	Sampling Location / Reference	Upstream/ Downstream/ Intermediate	Nitrates	Nitrites	Total N	Nitrogen (TKN)	Total P	Ortho-phosphate	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Zn
Maynooth	*River Ryewater (River)*	*EPA*	*A*	*d/s*		*Y*			*Y*									
		EPA	*B*	*u/s*	*Y*	*Y*				*Y*								
		EPA	*C*	*u/s*	*Y*	*Y*												
Mullingar	*River Brosna (River)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naas	*River Morell (River)*	*EPA*	*A*	*u/s*		*Y*				*Y*								
		EPA	*B*	*d/s*	*Y*	*Y*				*Y*								
		EPA	*C*	*d/s*	*Y*	*Y*				*Y*								
Navan	*River Boyne (River)*	*EPA*	*A*	*u/s*	*Y*	*Y*				*Y*								
		EPA	*B*	*int*		*Y*				*Y*								
		EPA	*C*	*int*	*Y*	*Y*				*Y*								
		EPA	*D*	*int*		*Y*				*Y*								
		EPA	*E*	*u/s*		*Y*				*Y*								
		EPA	*F*	*d/s*		*Y*				*Y*								
Newbridge	*River Liffey (River)*	*EPA*	*A*	*d/s*		*Y*				*Y*								
		EPA	*B*	*u/s*		*y*				*y*								
Portlaoise	*Triogue (Barrow) River (River)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swords	*Broadmeadow River (River)*	*EPA*	*A*	*d/s*	*Y*	*Y*				*Y*								
		EPA	*B*	*u/s*	*Y*	*Y*				*Y*								
		EPA	*C*	*u/s*	*Y*	*Y*				*Y*								
		EPA	*D*	*d/s*	*Y*	*Y*				*Y*								
		EPA	*E*	*d/s*	*Y*	*Y*				*Y*								
		EPA – LIMS	*F*	*d/s*														
Tralee	*Big River (River)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tullamore	*Tullamore River (River)*	*EPA*	*A*	*d/s*	*Y*	*Y*				*Y*								
Waterford	*Lower Suir Estuary (Transitional)*	*WFD - POM*	*A*	*d/s*				*Y*	*Y*		*Y*	*Y*	*Y*		*Y*	*Y*	*Y*	*Y*
Wexford	*Lower Slaney Estuary (Part Only) (Transitional)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dublin	*River Dodder (River)*	*OSPAR*	*A*	*int*			*Y*		*Y*	*Y*	*Y*		*Y*		*Y*			*Y*
		EPA – LIMS	*A*	*int*			*Y*		*Y*		*Y*	*Y*	*Y*	*Y*	*Y*		*Y*	*Y*
		EPA	*A*	*u/s*	*Y*	*Y*				*Y*								
		EPA	*K*	*d/s*	*Y*	*Y*				*Y*								
Dublin	*River Camac (River)*	*EPA*	*B*	*u/s*		*Y*				*Y*								
		EPA	*I*	*d/s*	*Y*	*Y*				*Y*								
Dublin	*River Liffey (River)*	*OSPAR*	*B*	*d/s*			*Y*		*Y*	*Y*	*Y*		*Y*		*Y*			*Y*
		EPA – LIMS	*B*	*d/s*			*Y*		*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*		*Y*	*Y*
		EPA	*C*	*u/s*	*Y*	*Y*				*Y*								
		EPA	*G*	*d/s*	*Y*	*Y*				*Y*								
Dublin	*Tolka River (River)*	*OSPAR*	*C*	*int*			*Y*		*Y*	*Y*	*Y*		*Y*		*Y*			*Y*
		EPA – LIMS	*C*	*int*			*Y*		*Y*		*Y*	*Y*	*Y*	*Y*	*Y*		*Y*	*Y*
		EPA	*D*	*u/s*	*Y*	*Y*				*Y*								
		EPA	*L*	*d/s*	*Y*	*Y*				*Y*								
		EPA	*M*	*d/s*	*Y*	*Y*				*Y*								

Table B.1: National Water Sampling / Monitoring Programmes (continued)

Urban Area/ Catchment Name	Surface Water Name	Monitoring Programme	Sampling Location / Reference	Upstream/ Downstream/ Intermediate	Nitrates	Nitrites	Total N	Nitrogen (TKN)	Total P	Ortho-phosphate	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Zn
Dublin	*Santry River (River)*	*EPA*	*E*	*u/s*	*Y*	*Y*				*Y*								
		EPA	*F*	*d/s*	*Y*	*Y*				*Y*								
Dublin	*Liffey Estuary Upper (Transitional)*	*OSPAR*	*B*	*u/s*			*Y*		*Y*	*Y*	*Y*		*Y*		*Y*			*Y*
		EPA – LIMS	*B*	*u/s*			*Y*		*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*		*Y*	*Y*
		EPA	*H*	*u/s*		*Y*				*Y*								
		EPA	*J*	*u/s*	*Y*	*Y*				*Y*								
Dublin	*Liffey Estuary Lower (Transitional)*	*WFD - POM*	*A*	*int*				*Y*	*Y*			*Y*	*Y*		*Y*		*Y*	*Y*
		WFD - POM	*C*	*d/s*				*Y*	*Y*		*Y*	*Y*	*Y*		*Y*	*Y*	*Y*	*Y*
		EPA	*J*	*u/s*	*Y*	*Y*				*Y*								
Dublin	*Tolka Estuary (Transitional)*	*EPA*	*L*	*u/s*	*Y*	*Y*				*Y*								
Galway	*Corrib Estuary (Transitional)*	*WFD - POM*	*A*	*int*				*Y*				*Y*	*Y*		*Y*		*Y*	*Y*
Galway	*Corrib River (River)*	*EPA – LIMS*	*B*	*d/s*		*Y*				*Y*								
		EPA – LIMS	*C*	*int*		*Y*				*Y*	*Y*	*Y*	*Y*	*Y*	*Y*		*Y*	*Y*
		EPA – LIMS	*D*	*int*		*Y*	*Y*		*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*		*Y*	*Y*
		EPA – LIMS OSPAR	*E*	*u/s*		*Y*				*Y*	*Y*	*Y*	*Y*	*Y*	*Y*		*Y*	*Y*
			F	*int*			*Y*		*Y*	*Y*	*Y*		*Y*		*Y*			*Y*
Killarney	*Deenagh River (River)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Killarney	*Flesk River (River)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sligo	*Garavogue Estuary (Transitional)*	*OSPAR*	*A*	*u/s*			*Y*		*Y*	*Y*	*Y*		*Y*		*Y*			*Y*
		EPA – LIMS	*B*	*u/s*		*Y*			*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
		EPA – LIMS	*D*	*u/s*		*Y*				*Y*								
Sligo	*River Garavogue (River)*	*OSPAR*	*A*	*d/s*			*Y*		*Y*	*Y*	*Y*		*Y*		*Y*			*Y*
		EPA – LIMS	*B*	*d/s*		*Y*			*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
		EPA – LIMS	*C*	*u/s*		*Y*				*Y*								
		EPA – LIMS	*D*	*d/s*		*Y*				*Y*								
		EPA – LIMS	*E*	*u/s*						*Y*								
Balbriggan	*N/A*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bray	*N/A*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greystones	*N/A*	-	-	-	-	-	-	-	-	-	-		--	-	-	-	-	-
Malahide	*N/A*	-	-	-	-	-	=	--	-	-	-	-	-	-	-	-	-	-

Table B.2: Local Authority Dangerous Substance Implementation Reports

Source for Information (Local Authority or EPA)	CDM Reference	Urban Area Name	Surface Water Name	Hardness	Location	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Zinc
Westmeath	DI_164	Athlone	Shannon (Main)										
Carlow County Council	DI_155	Carlow	River Barrow		D/S		Y	Y		Y		Y	Y
EPA	DI_182	Carrigaline	Owenboy Estuary (Part Only)										
Mayo County Council	DI_177, DI_181	Castlebar	Liscromwell		D/S	Y	Y	Y	Y	Y	Y	Y	Y
Kildare County Council	DI_175	Celbridge	River Liffey	>100	Int		Y	Y		Y		Y	Y
EPA	DI_180	Clonmel	River Suir	250	U/S		Y	Y		Y		Y	Y
EPA	DI_180	Clonmel	River Suir	250	D/S		Y	Y		Y		Y	Y
EPA	DI_182	Cork	Lee (Cork Estuary) Lower										
Louth	DI_156, CI_245	Drogheda	Boyne Estuary (Part Only)										
Louth	DI_156, CI_245	Dundalk	Castletown Estuary										
EPA	DI_182	Ennis	River Fergus										
Kilkenny County Council	DI_158	Kilkenny	River Nore		U/S		Y	Y		Y		Y	Y
Kilkenny County Council	DI_158	Kilkenny	River Nore		D/S		Y	Y		Y		Y	Y
EPA	DI_180	Letterkenny	Swilly Estuary (Part Only)										
Kildare County Council	DI_175	Leixlip	River Liffey	>100	Int		Y	Y		Y		Y	Y
Limerick City Council	DI_157	Limerick	Limerick Dock (Part Only)	>100	U/S		Y			Y		Y	
Kildare County Council	DI_175	Maynooth	River Ryewater										
Westmeath County Council		Mullingar	River Brosna										
Kildare County Council	DI_175	Naas	River Morell										
Meath County Council	DI_162	Navan	River Boyne	364	U/S		Y	Y		Y		Y	Y
Meath County Council	DI_162	Navan	River Boyne		D/S		Y	Y		Y		Y	Y
Kildare County Council	DI_175	Newbridge	River Liffey	>100	Int		Y	Y		Y		Y	Y
Kildare County Council	DI_175	Newbridge	River Liffey	>100	D/S		Y	Y		Y		Y	Y
Laois	DI_176	Portlaoise	Triogue (Barrow) River	349	D/S		Y	Y		Y		Y	Y
DCC	DI_173	Swords	Broadmeadow River										
EPA	CI_246	Tralee	Big River										
Offaly County Council	DI_172	Tullamore	Tullamore River	358	D/S		Y	Y		Y		Y	Y
Waterford County	DI_174	Waterford	Suir Estuary	250	U/S		Y	Y		Y		Y	Y
Wexford County Council	DI_160	Wexford	Lower Slaney Estuary (Part Only)										
Dublin City Council	DI_173	Dublin	River Dodder										
Dublin City Council	DI_173	Dublin	River Camac										
Kildare County Council	DI_175	Dublin	River Liffey	>100	U/S		Y	Y		Y		Y	Y
Meath County Council	DI_162	Dublin	Tolka River	292	U/S		Y	Y		Y		Y	Y
Dublin City Council	DI_173	Dublin	Santry River										
Dublin City Council	DI_173	Dublin	Liffey Estuary Upper		U/S								
Dublin City Council	DI_173	Dublin	Liffey Estuary Lower	237	U/S		Y	Y		Y		Y	Y
Dublin City Council	DI_173	Dublin	Tolka Estuary	160	U/S		Y	Y		Y		Y	Y
Galway County Council	DI_159	Galway	Corrib Estuary		U/S		Y	Y		Y		Y	Y
Galway County Council	DI_159	Galway	Corrib River	155	Int			Y					Y
Killarney County Council	DI_158	Killarney	Deenagh River										
Killarney County Council	DI_158	Killarney	Flesk River										
EPA	DI_180	Sligo	Garavogue Estuary										
EPA	DI_180	Sligo	River Garavogue		U/S		Y	Y		Y		Y	Y
		Balbriggan	NONE PROPOSED										
		Bray	NONE PROPOSED										
		Greystones	NONE PROPOSED										
		Malahide	NONE PROPSED										

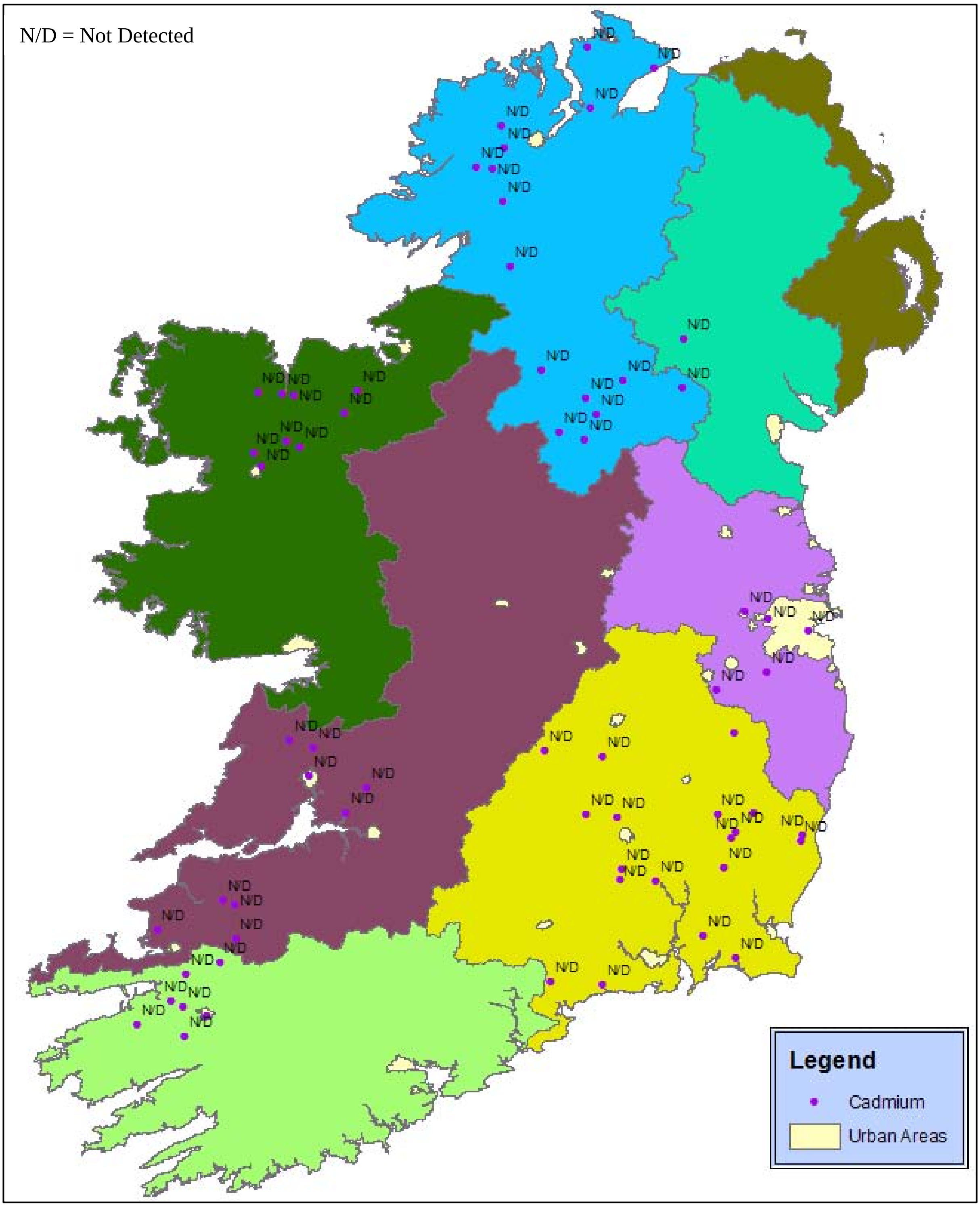
Table B.3: Water Framework Directive Surveillance Monitoring Programme

Site No.	CDM Reference	RBD	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Zinc
1	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
2	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
3	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
4	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
5	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
6	DI_197	IE - Neagh Bann	✓	✓	✓	✓	✓	✓	✓	✓
7	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
8	DI_197	IE - Shannon	✓	✓	✓	✓	✓	x	✓	✓
9	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
10	DI_197	IE - South Western	✓	✓	✓	✓	✓	✓	✓	✓
11	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
12	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
13	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
14	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
15	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
16	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
17	DI_197	IE - South Eastern	x	x	x	x	x	✓	x	x
18	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
19	DI_197	IE - Eastern	✓	✓	✓	✓	✓	✓	✓	✓
20	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
21	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
22	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
23	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
24	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
25	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
26	DI_197	IE - Shannon	✓	✓	✓	✓	✓	✓	✓	✓
27	DI_197	IE - Shannon	✓	✓	✓	✓	✓	✓	✓	✓
28	DI_197	IE - Shannon	✓	✓	✓	✓	✓	✓	✓	✓
29	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
30	DI_197	IE - South Western	✓	✓	✓	✓	✓	✓	✓	✓
31	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
32	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
33	DI_197	IE - Shannon	✓	✓	✓	✓	✓	✓	✓	✓
34	DI_197	IE - South Western	✓	✓	✓	✓	✓	✓	✓	✓
35	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
36	DI_197	IE - South Western	✓	✓	✓	✓	✓	✓	✓	✓
37	DI_197	IE - Eastern	✓	✓	✓	✓	✓	✓	✓	✓
38	DI_197	IE - Eastern	✓	✓	✓	✓	✓	✓	✓	✓
39	DI_197	IE - Eastern	✓	✓	✓	✓	✓	✓	✓	✓
40	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
41	DI_197	IE - South Western	✓	✓	✓	✓	✓	✓	✓	✓
42	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
43	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
44	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
45	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
46	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
47	DI_197	IE - Shannon	✓	✓	✓	✓	✓	✓	✓	✓
48	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
49	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
50	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
51	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
52	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
53	DI_197	IE - South Western	✓	✓	✓	✓	✓	✓	✓	✓
54	DI_197	IE - Shannon	✓	✓	✓	✓	✓	✓	✓	✓
55	DI_197	IE - Eastern	✓	✓	✓	✓	✓	✓	✓	✓
56	DI_197	IE - South Western	✓	✓	✓	✓	✓	✓	✓	✓
57	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
58	DI_197	IE - South Eastern	x	x	x	x	x	✓	x	x
59	DI_197	IE - Shannon	✓	✓	✓	✓	✓	✓	✓	✓
60	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
61	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
62	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓
63	DI_197	IE - Western	✓	✓	✓	✓	✓	✓	✓	✓
64	DI_197	IE - Shannon	✓	✓	✓	✓	✓	✓	✓	✓
65	DI_197	IE - South Eastern	✓	✓	✓	✓	✓	✓	✓	✓
66	DI_197	IE - North Western	✓	✓	✓	✓	✓	✓	✓	✓

APPENDIX C

Water Framework Directive Surveillance Monitoring Network – Median Results Values July 07 – Dec 08

Figure C.1: Surveillance Monitoring Programme – Cadmium Results (mg/l)

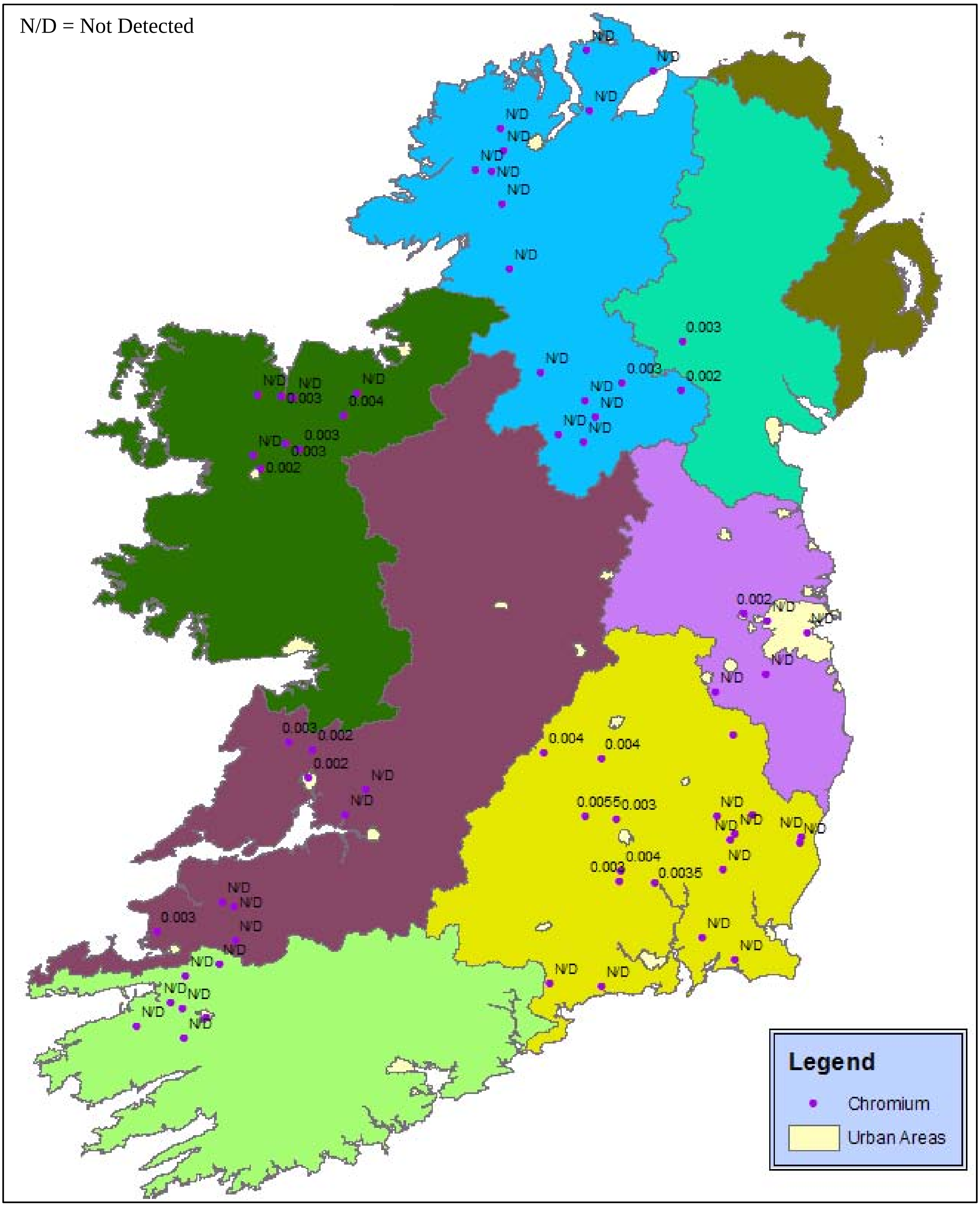


CADMIUM

Detection limits used for this parameter.

Detection Limit <0.0001mg/l

Figure C.2: Surveillance Monitoring Programme – Chromium Results (mg/l)

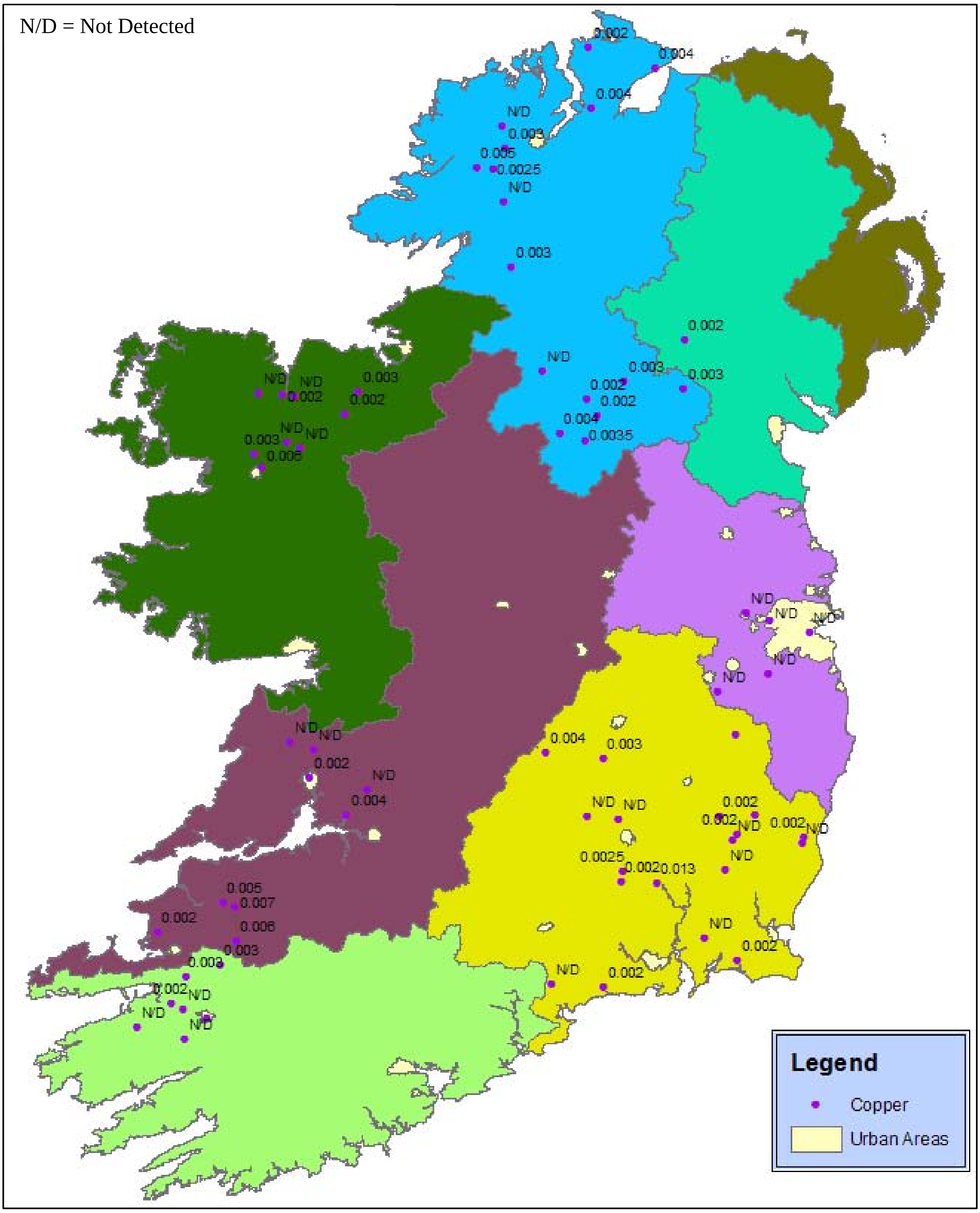


CHROMIUM

Detection limits used for this parameter.

Detection Limit <0.001mg/l

Figure C.3: Surveillance Monitoring Programme – Copper Results (mg/l)

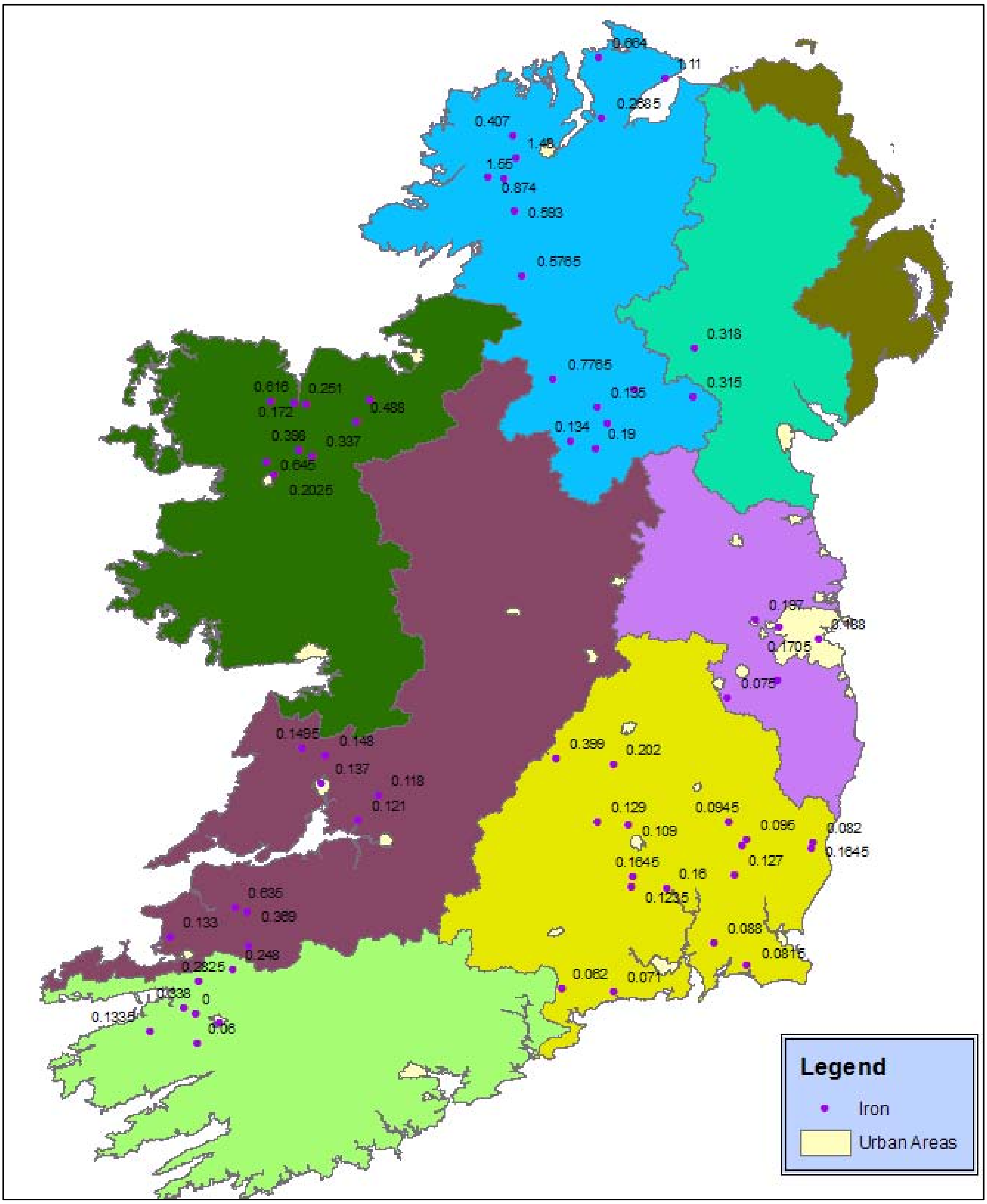


COPPER

Detection limits used for this parameter.

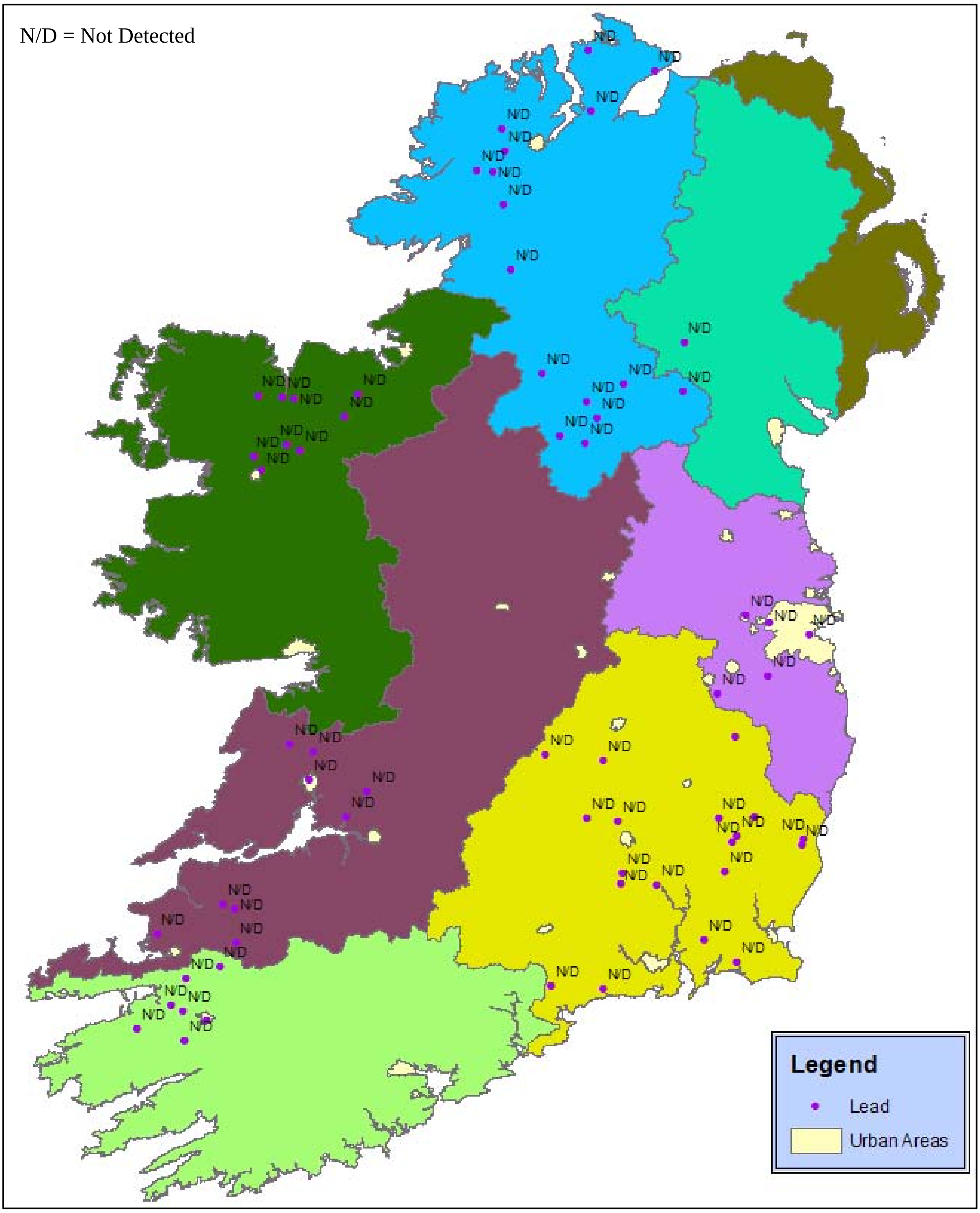
Detection Limit <0.001mg/l

Figure C.4: Surveillance Monitoring Programme – Iron Results (mg/l)



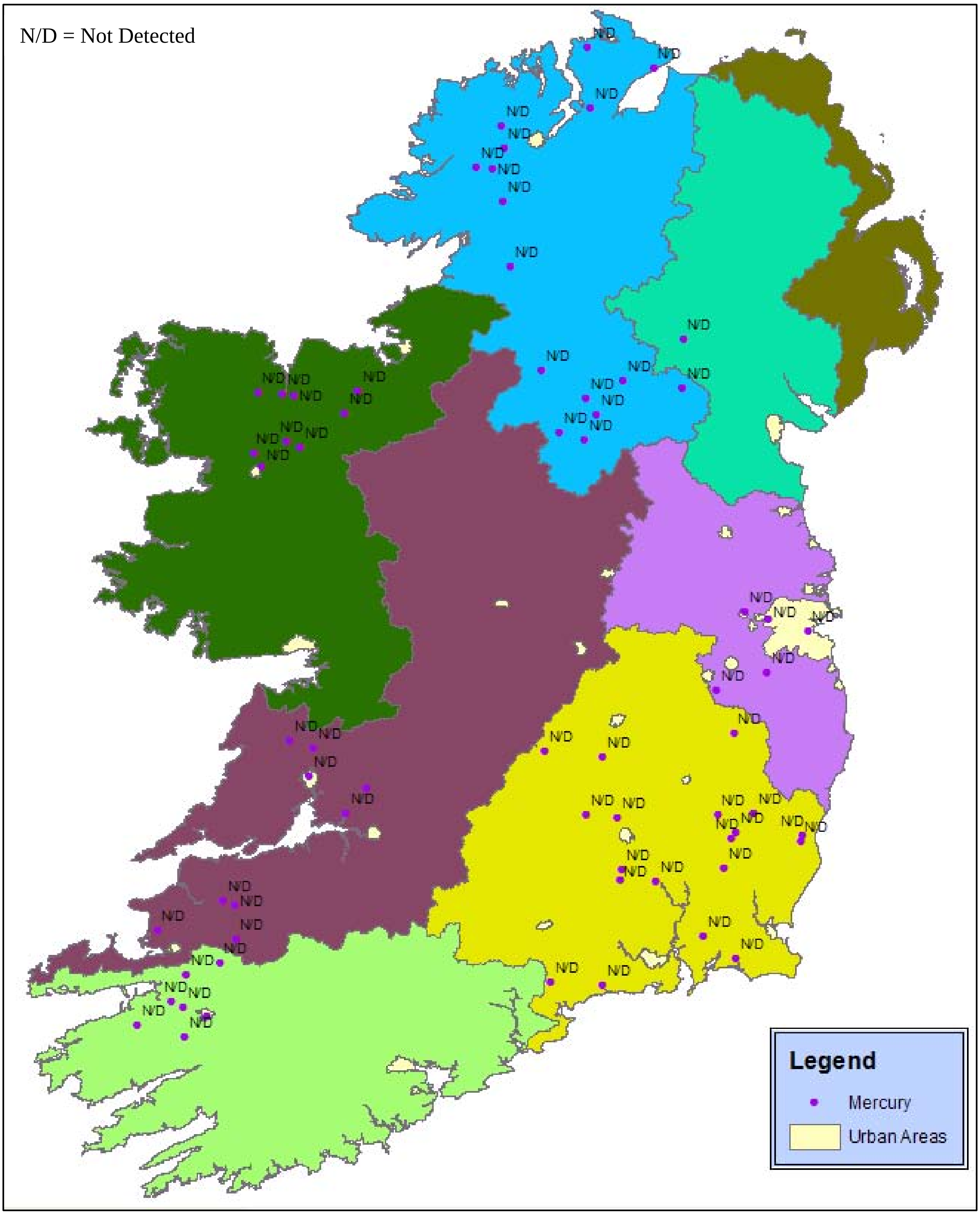
CDM

Figure C.5: Surveillance Monitoring Programme – Lead Results (mg/l)



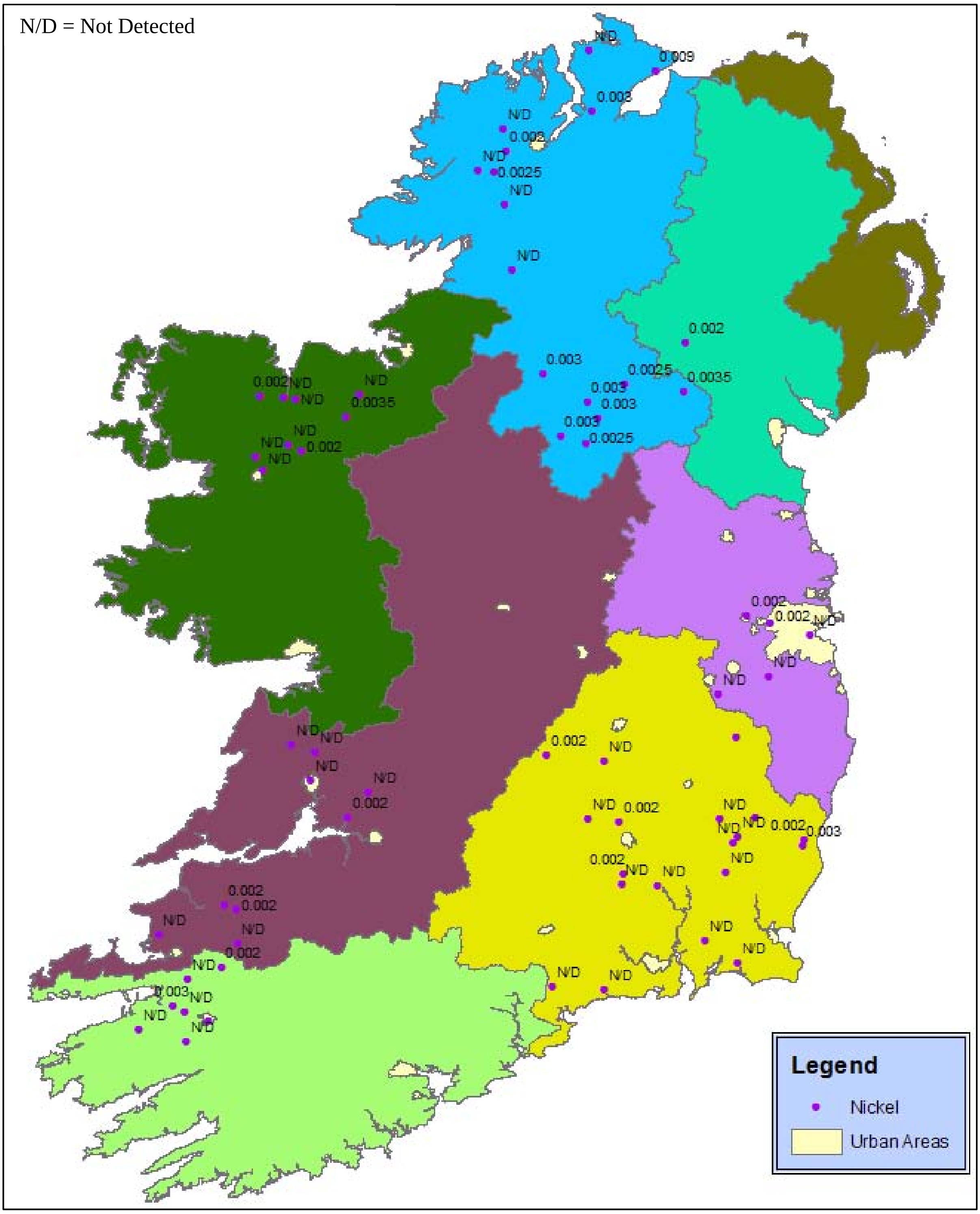
LEAD
Detection limits used for this parameter.
Detection Limit <0.001mg/l

Figure C.6: Surveillance Monitoring Programme – Mercury Results (mg/l)



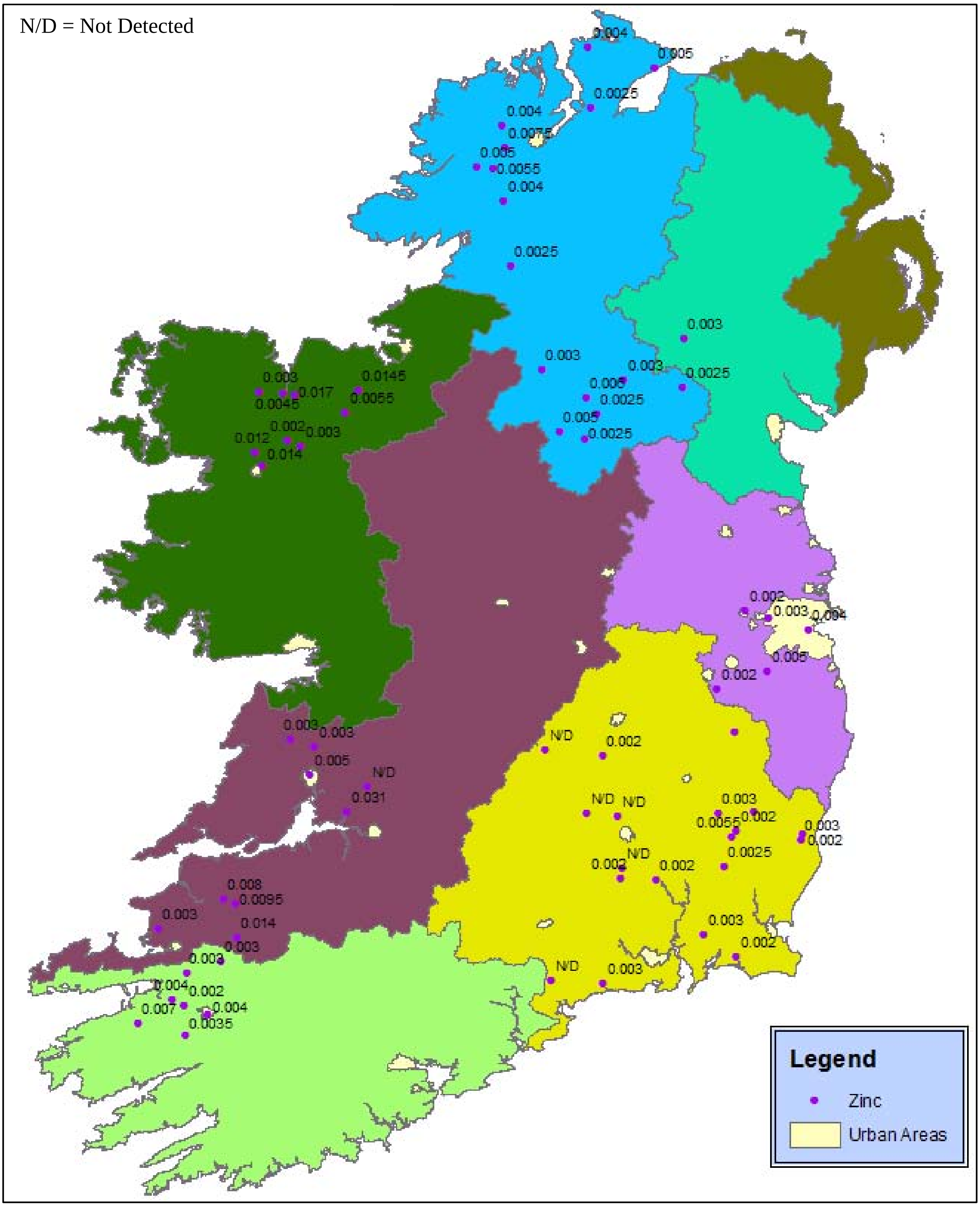
MERCURY
Detection limits used for this parameter.
Detection Limit <0.0001mg/l

Figure C.7: Surveillance Monitoring Programme – Nickel Results (mg/l)



NICKEL
Detection limits used for this parameter.
Detection Limit <0.001mg/l

Figure C.8: Surveillance Monitoring Programme – Zinc Results (mg/l)



ZINC
Detection limits used in some cases for this parameter.
Detection Limit <0.001mg/l

APPENDIX D

Urban Area Catchments

Figure D.1: Athlone - Assessed Urban Waters

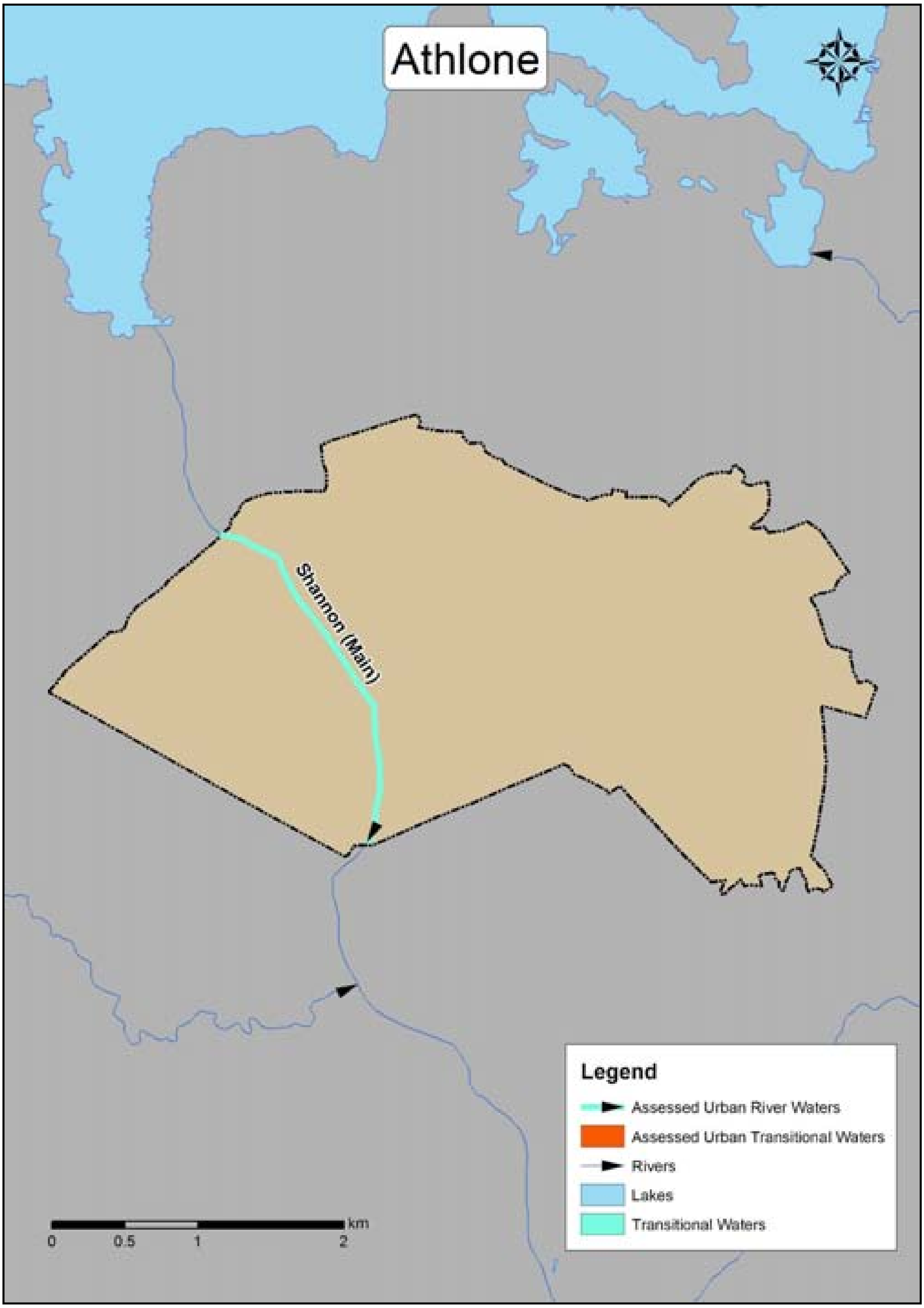


Figure D.2: Carlow - Assessed Urban Waters

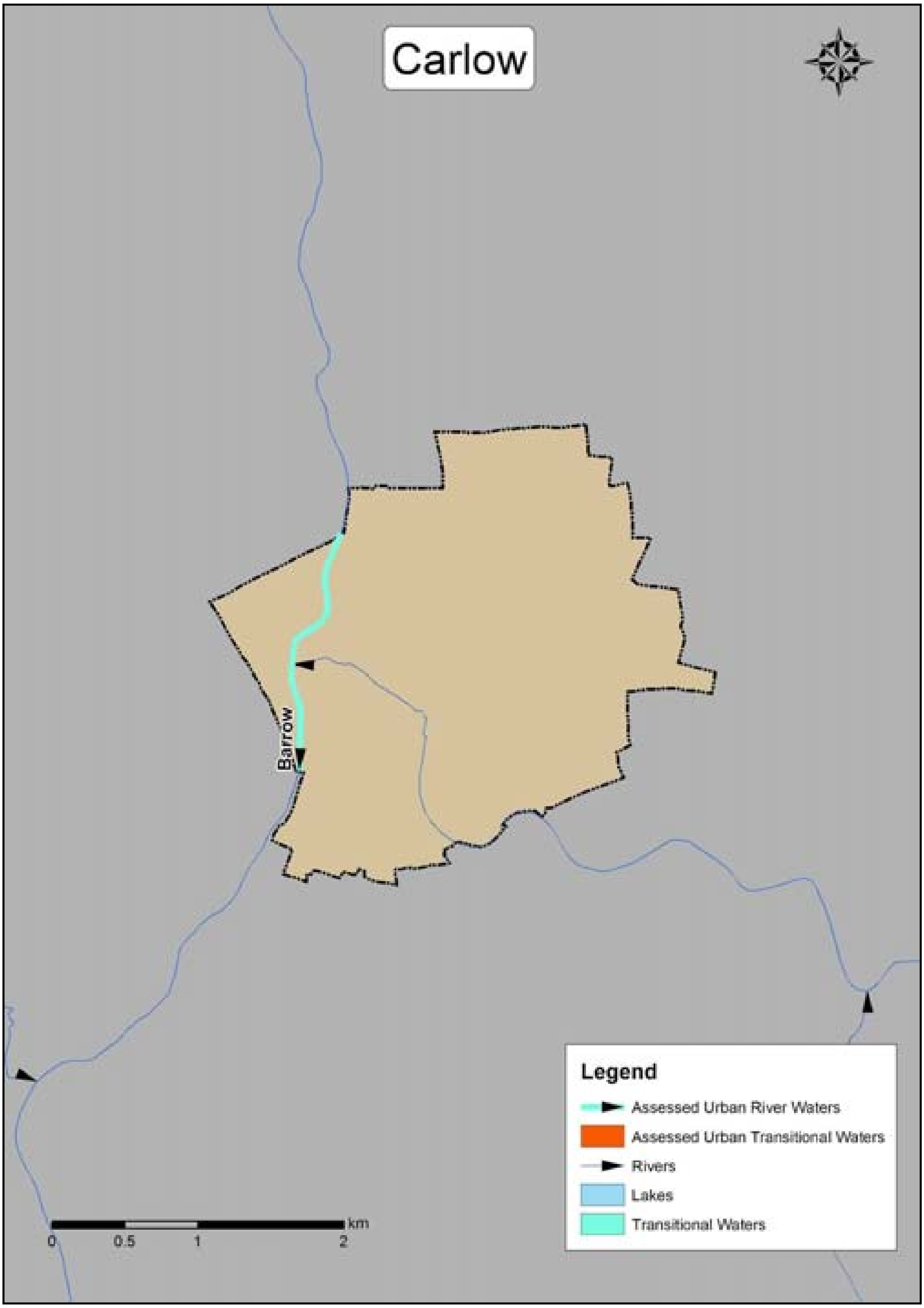
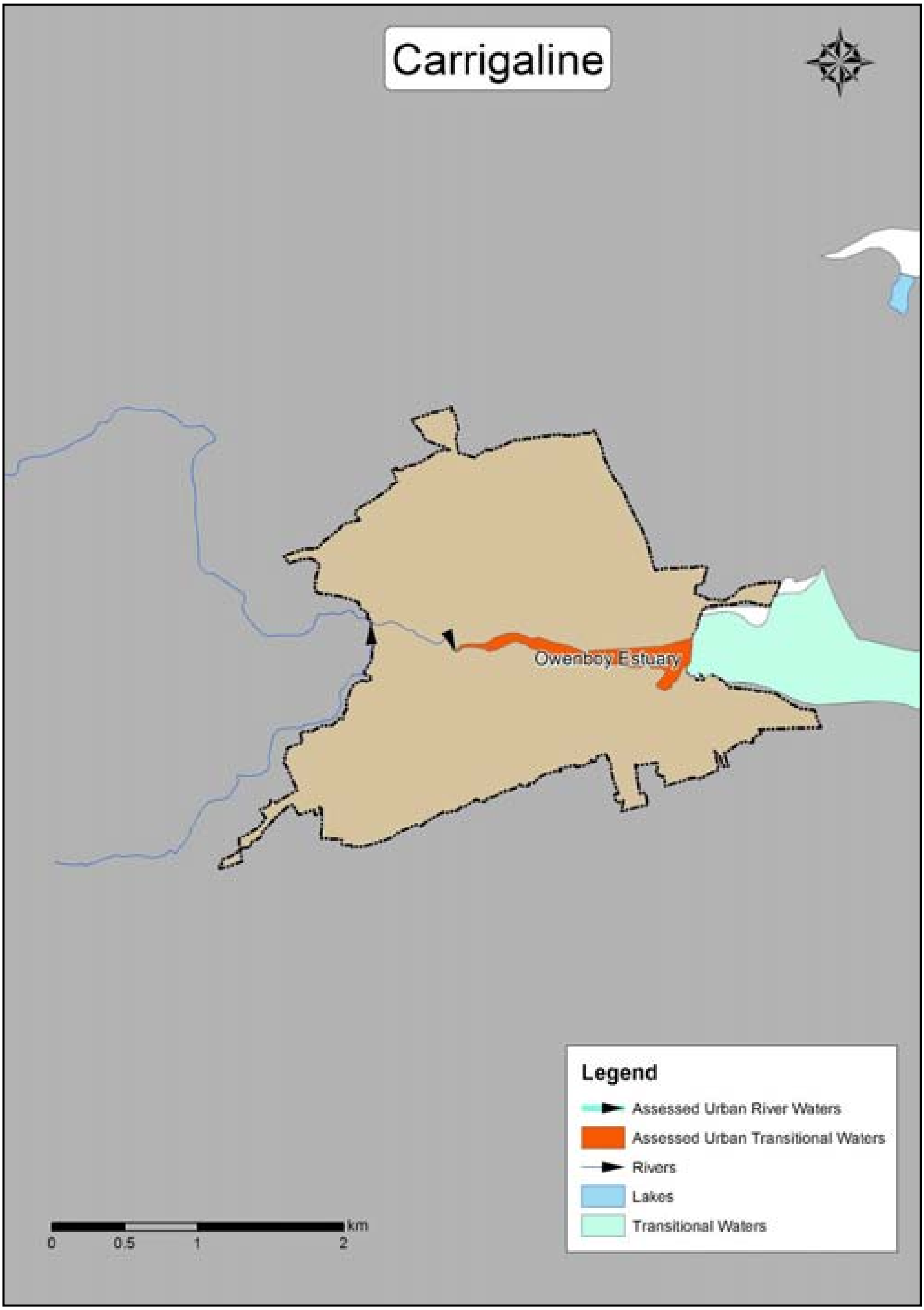


Figure D.3: Carrigaline - Assessed Urban Waters



CDM

Figure D.4: Castlebar - Assessed Urban Waters

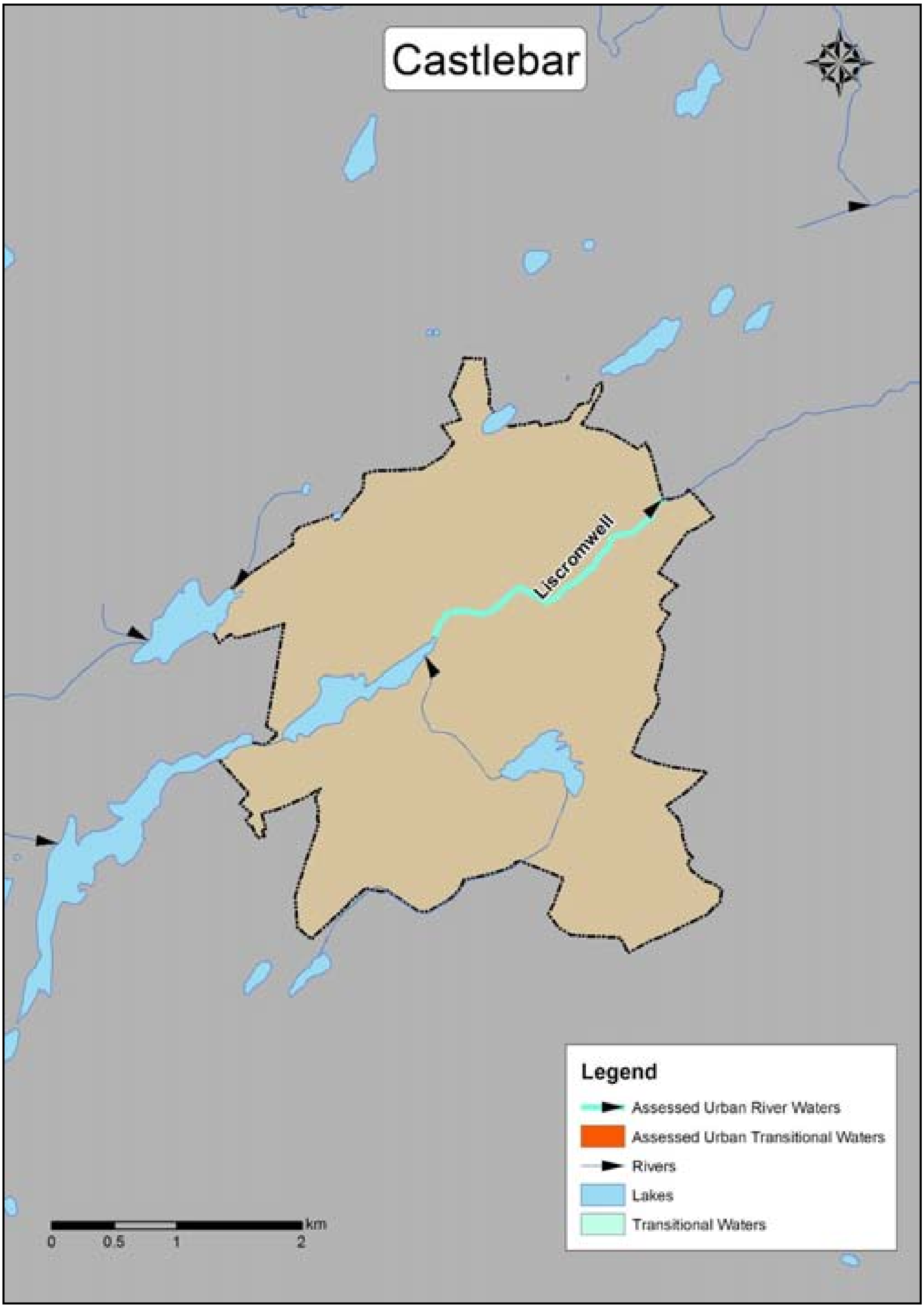


Figure D.5: Celbridge - Assessed Urban Waters

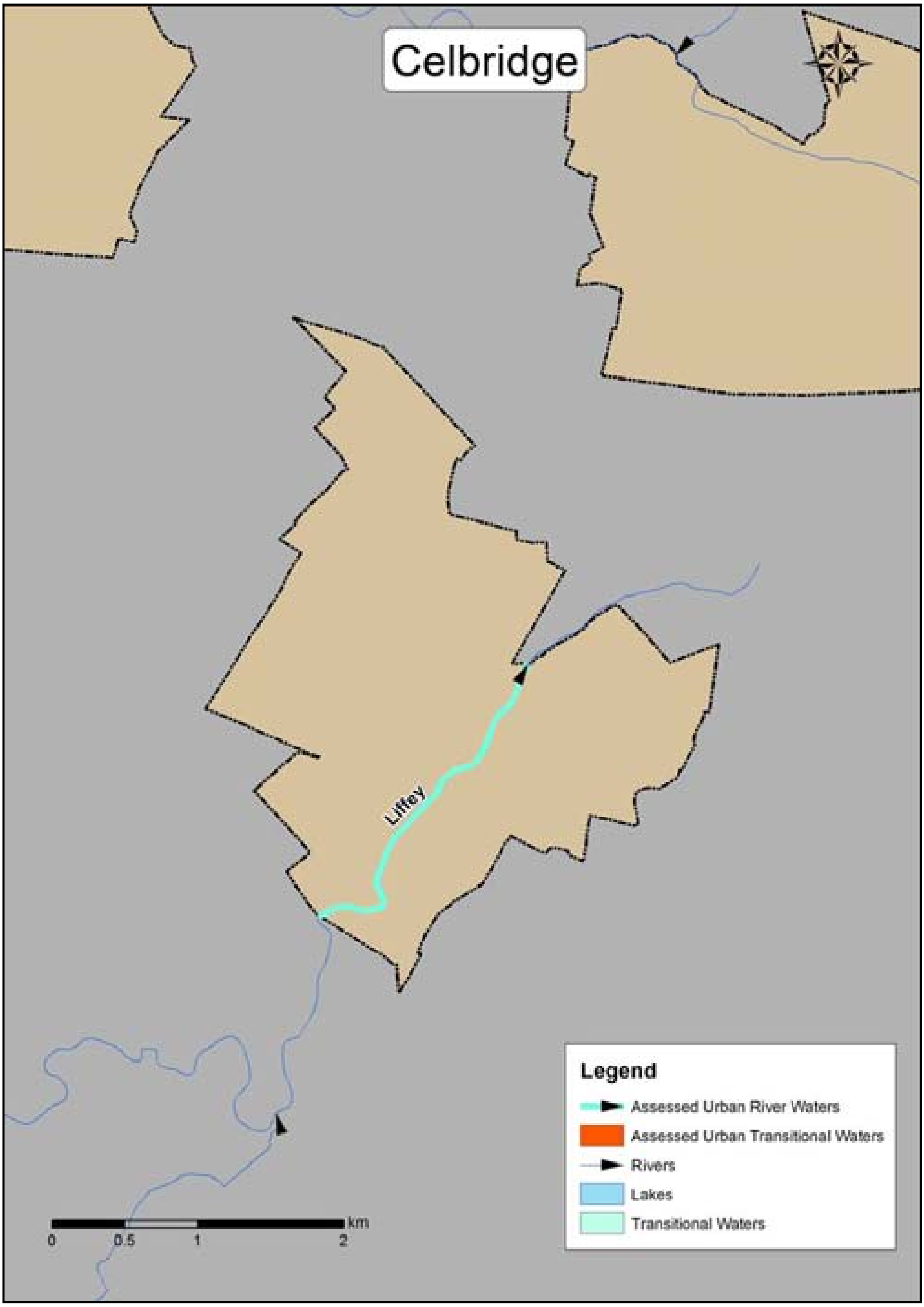


Figure D.6: Clonmel - Assessed Urban Waters

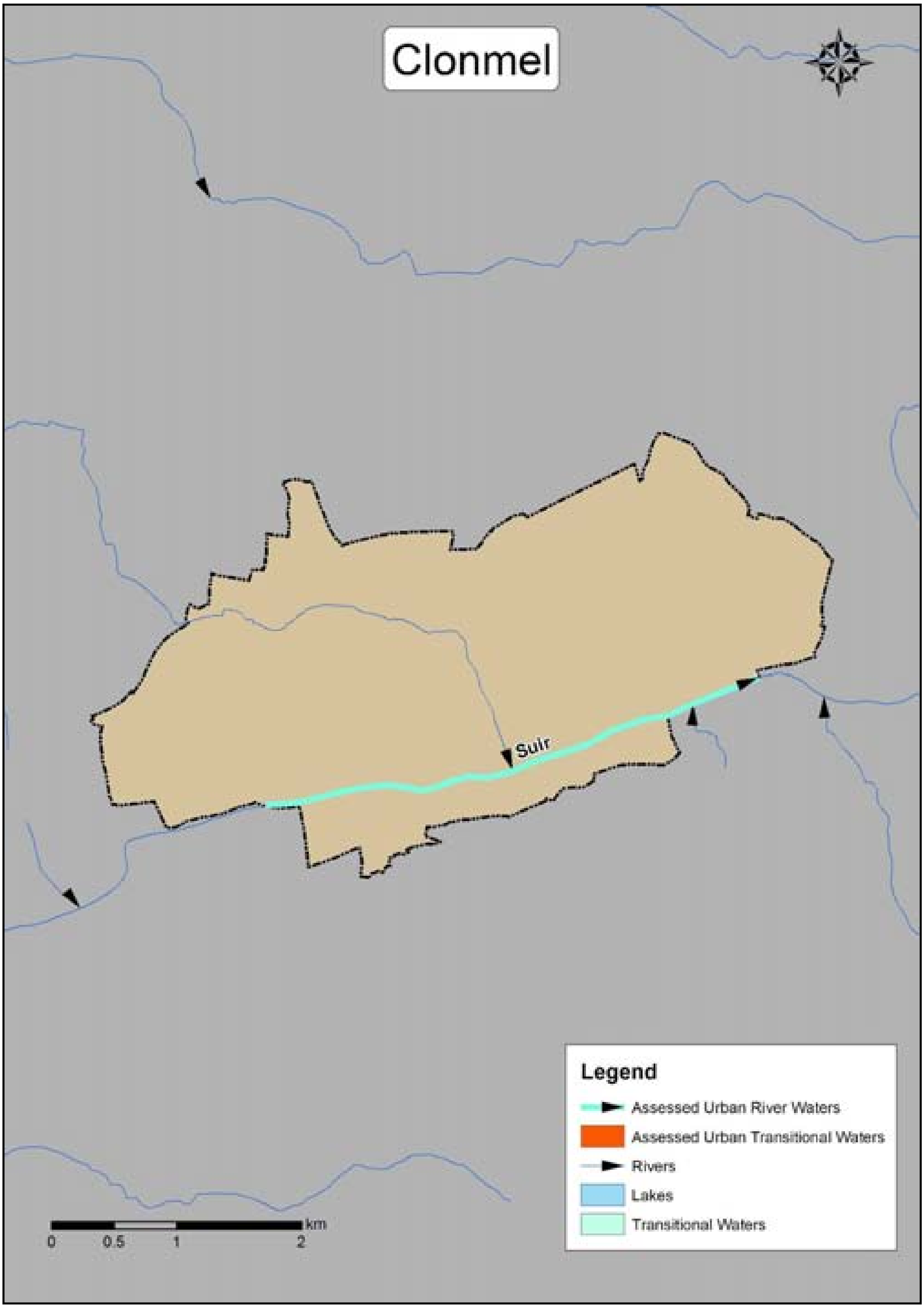
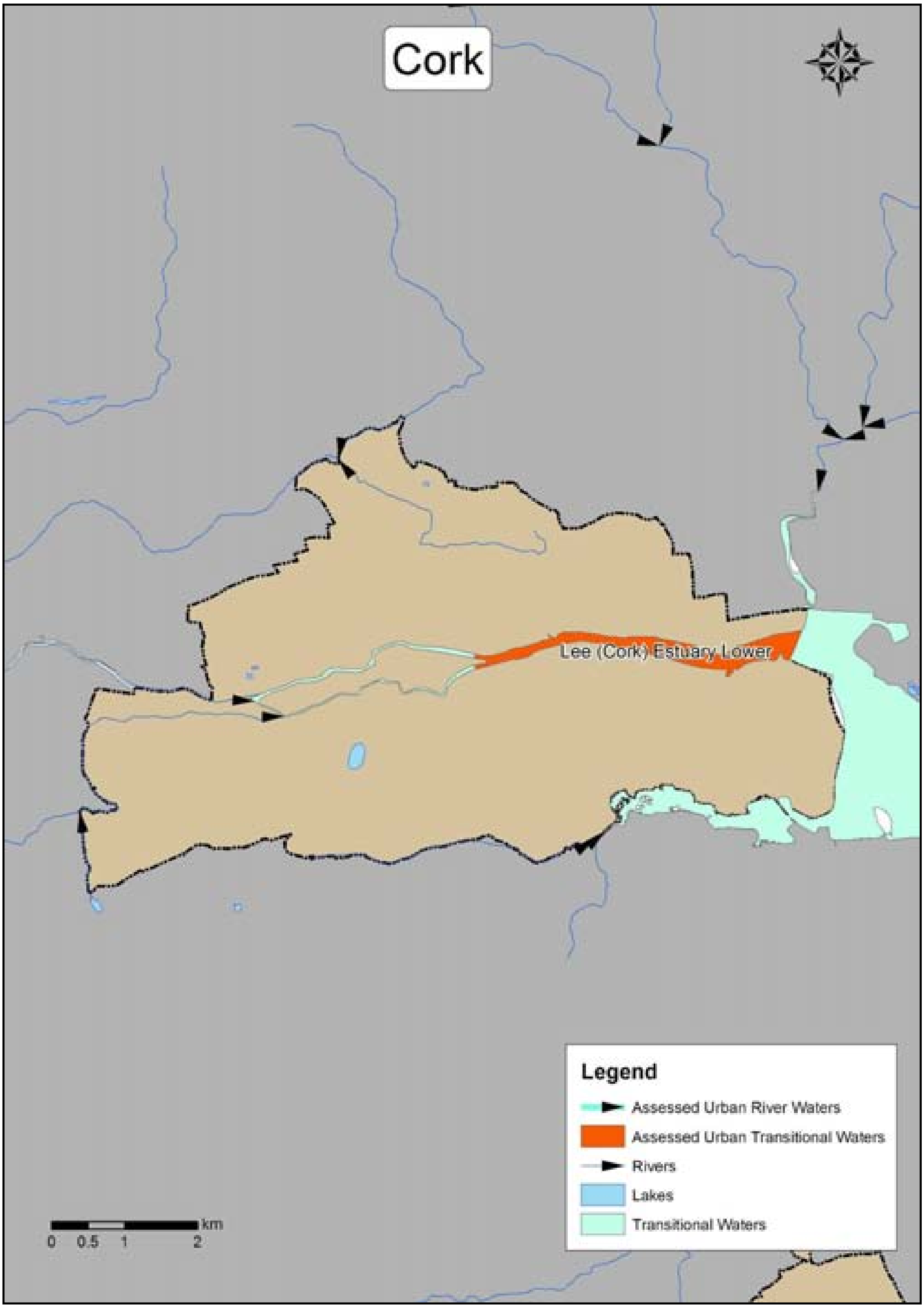


Figure D.7: Cork - Assessed Urban Waters



CDM

Figure D.8: Drogheda - Assessed Urban Waters

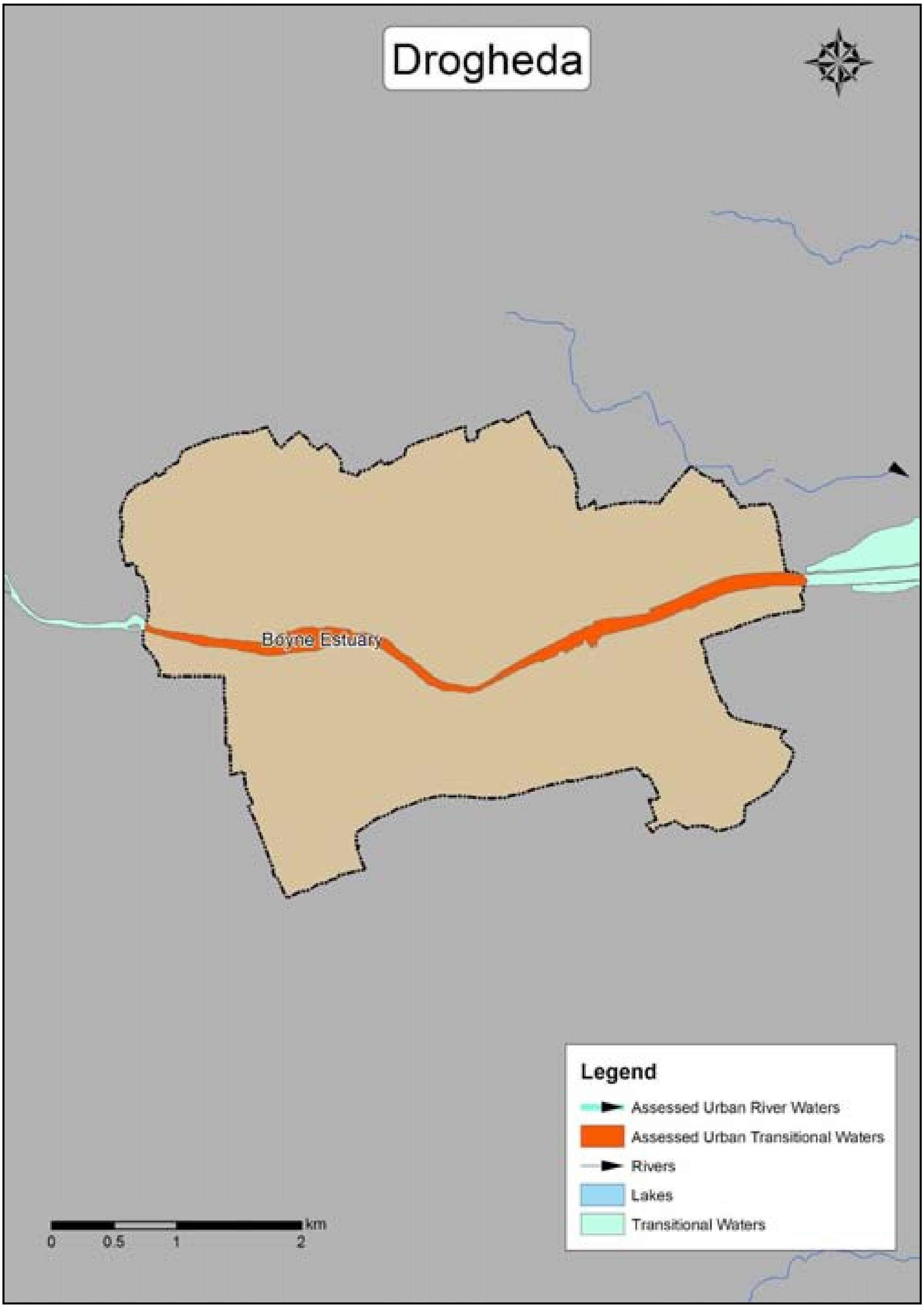


Figure D.9: Dublin - Assessed Urban Waters

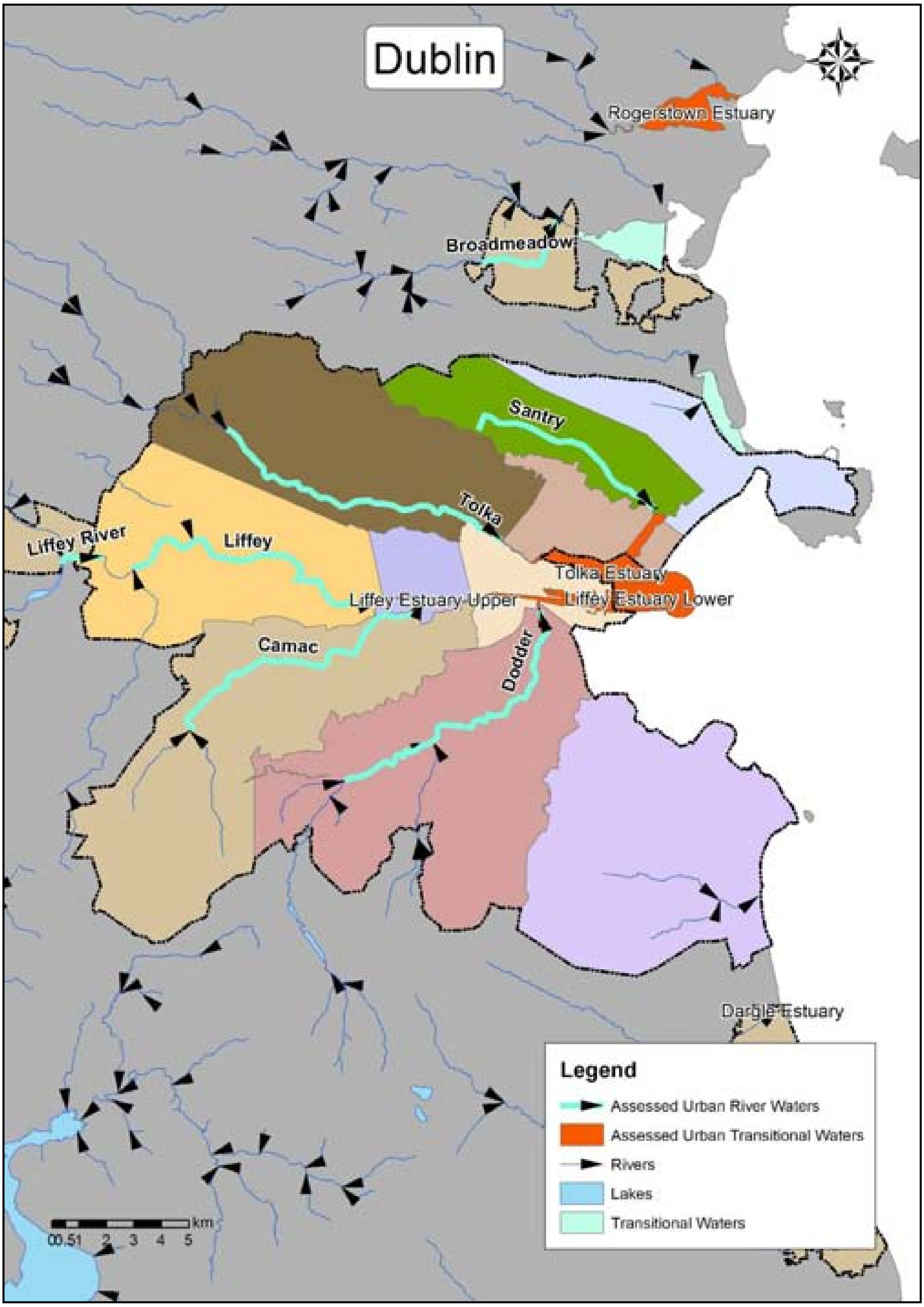


Figure D.10: Dundalk - Assessed Urban Waters

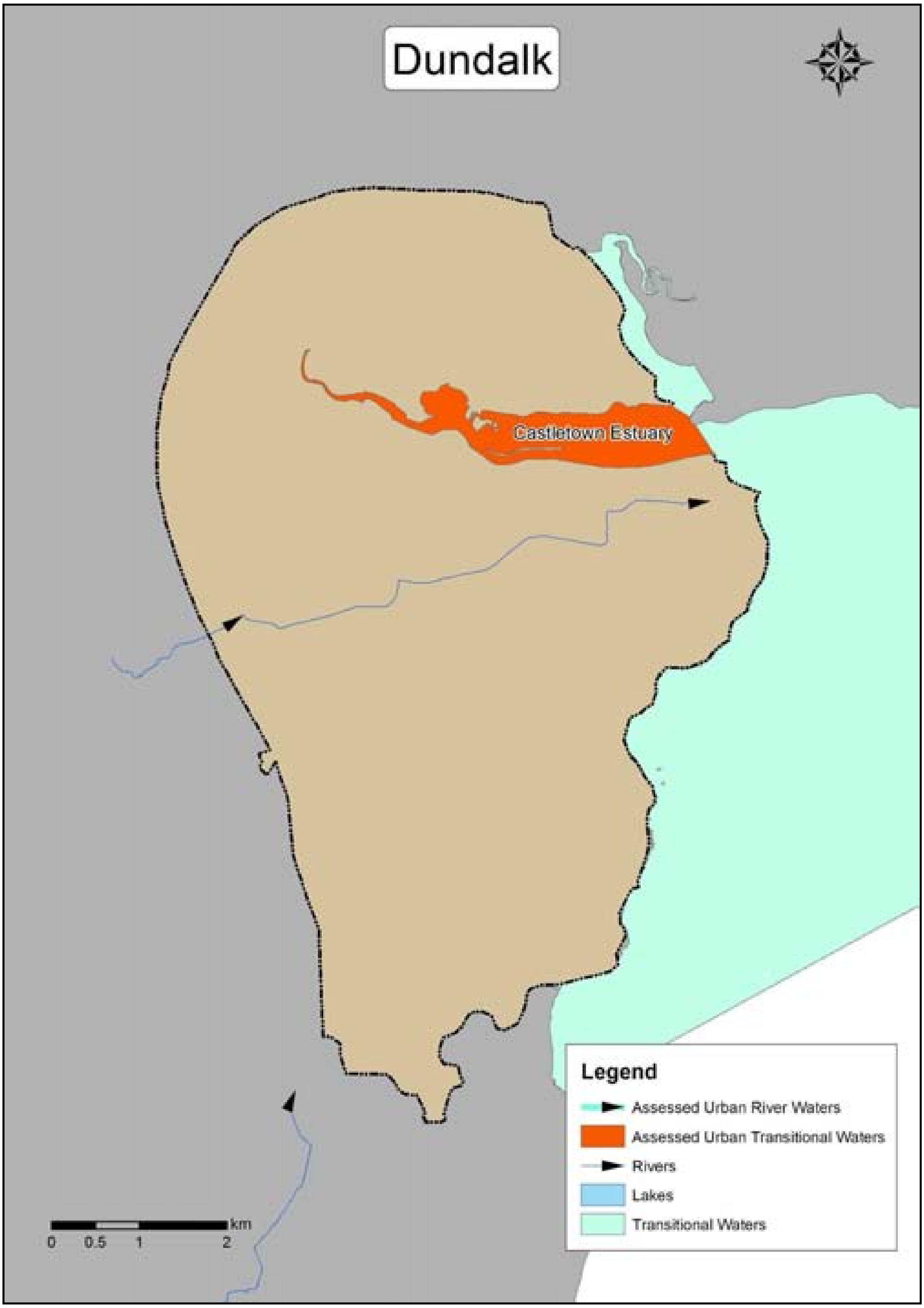


Figure D.11: Ennis - Assessed Urban Waters

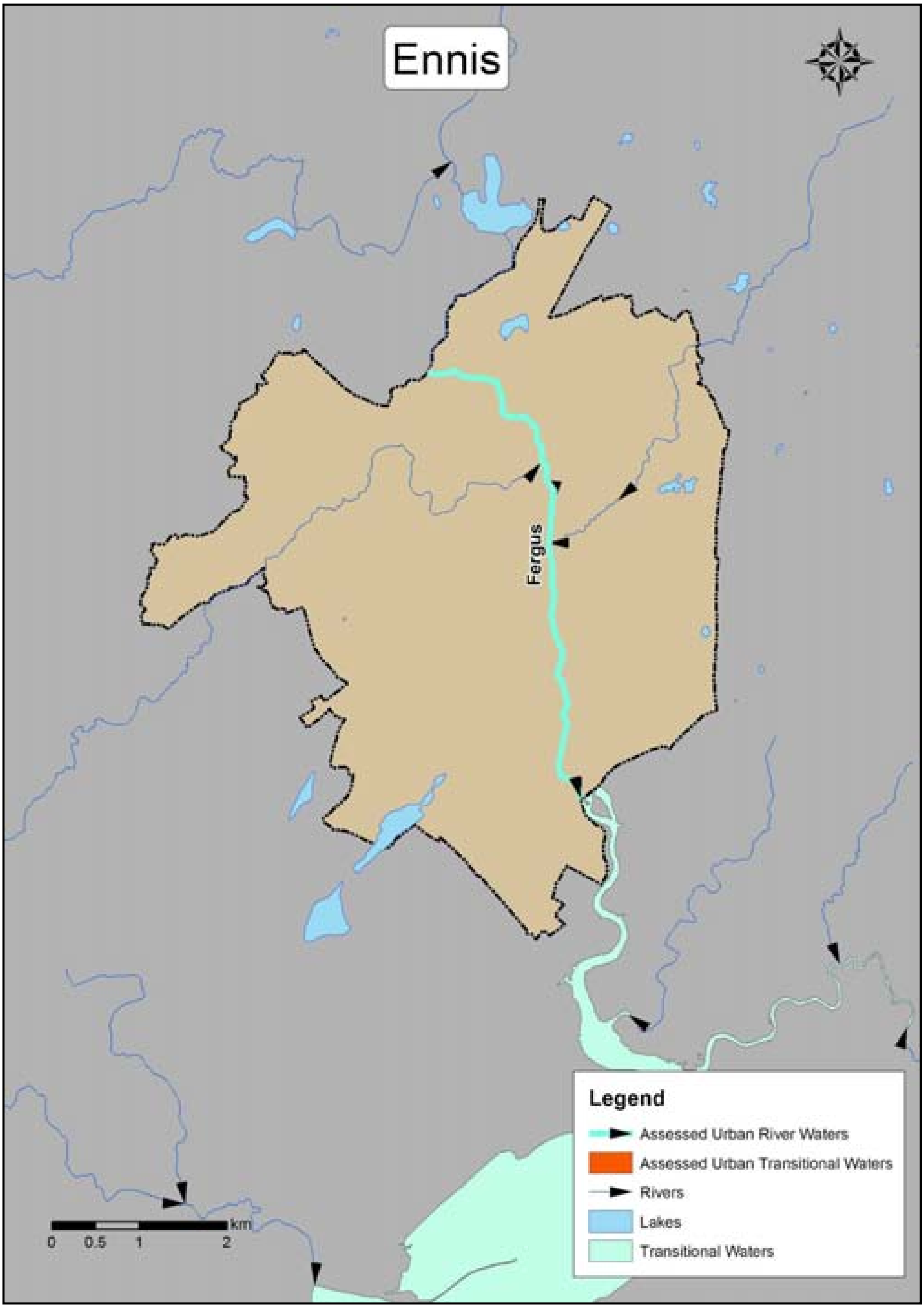


Figure D.12: Galway - Assessed Urban Waters

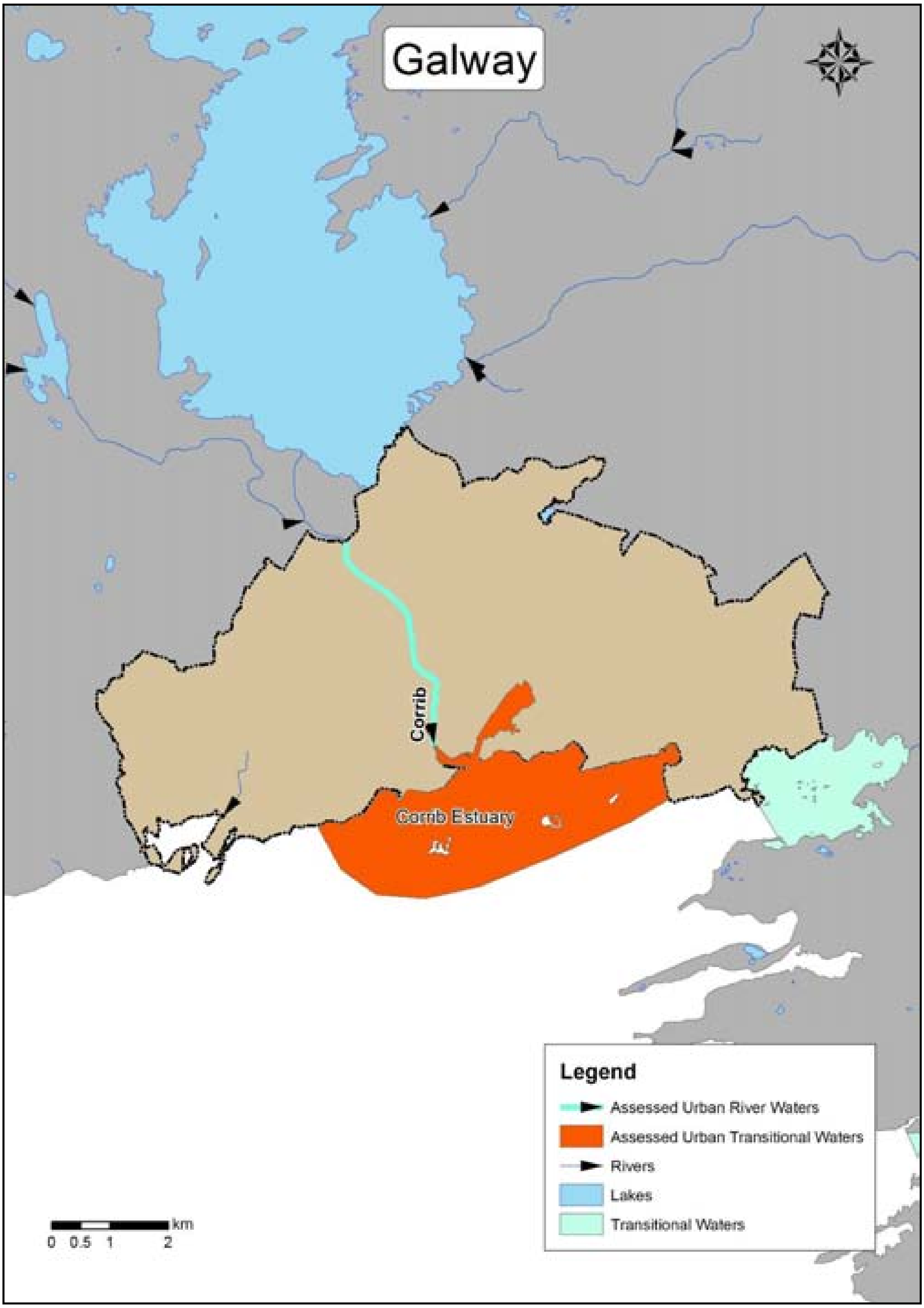


Figure D.13: Kilkenny - Assessed Urban Waters

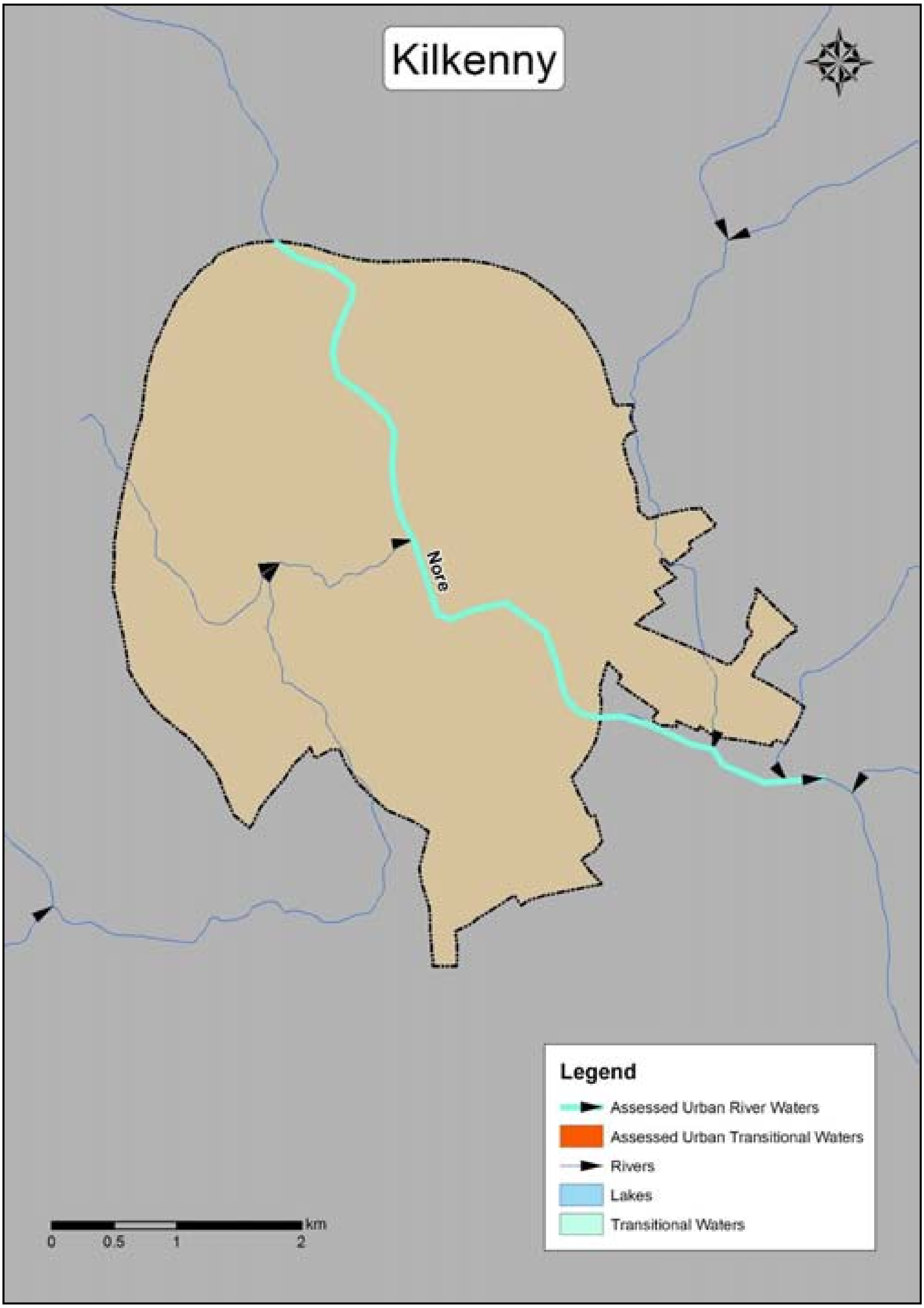


Figure D.14: Killarney - Assessed Urban Waters

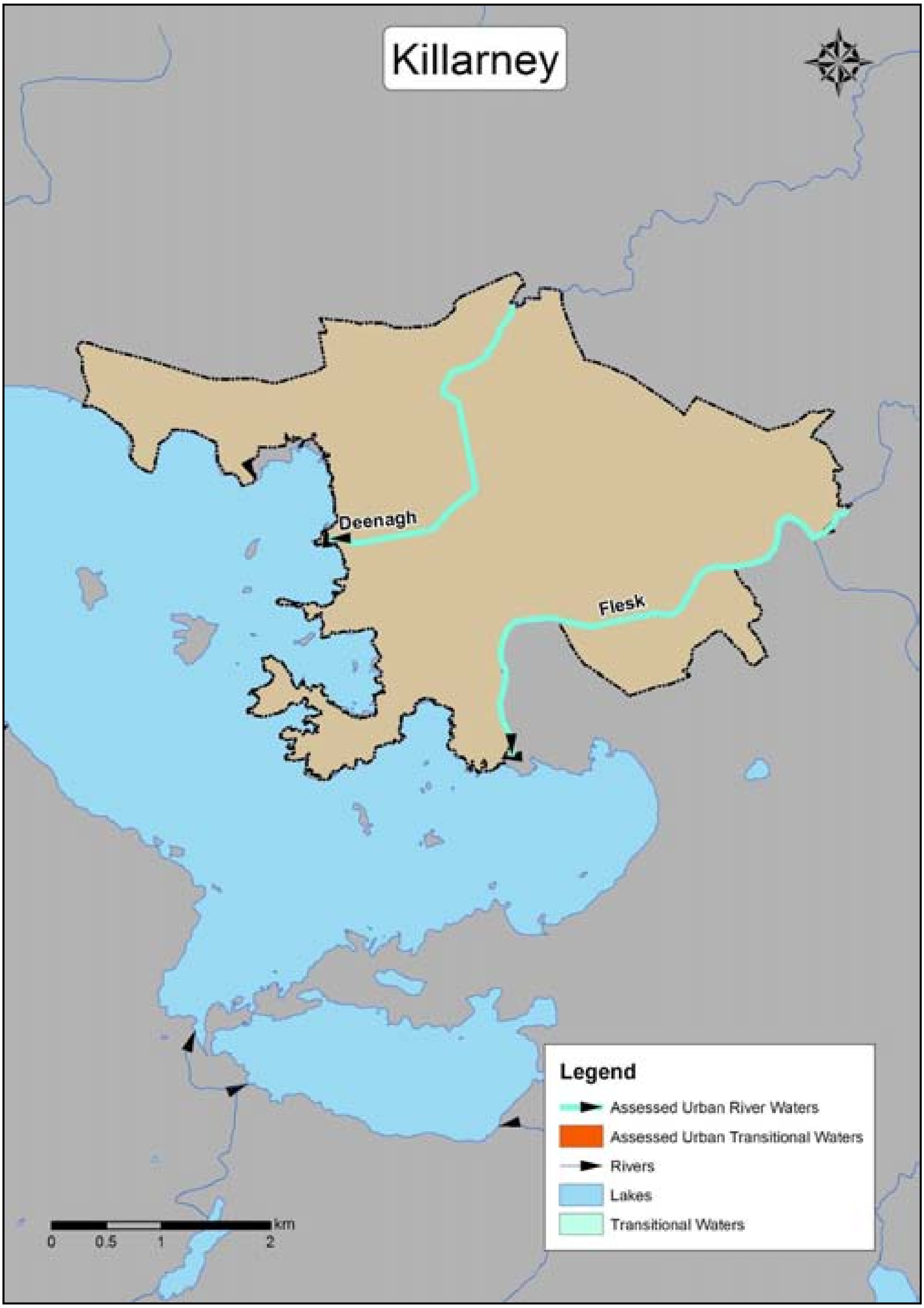
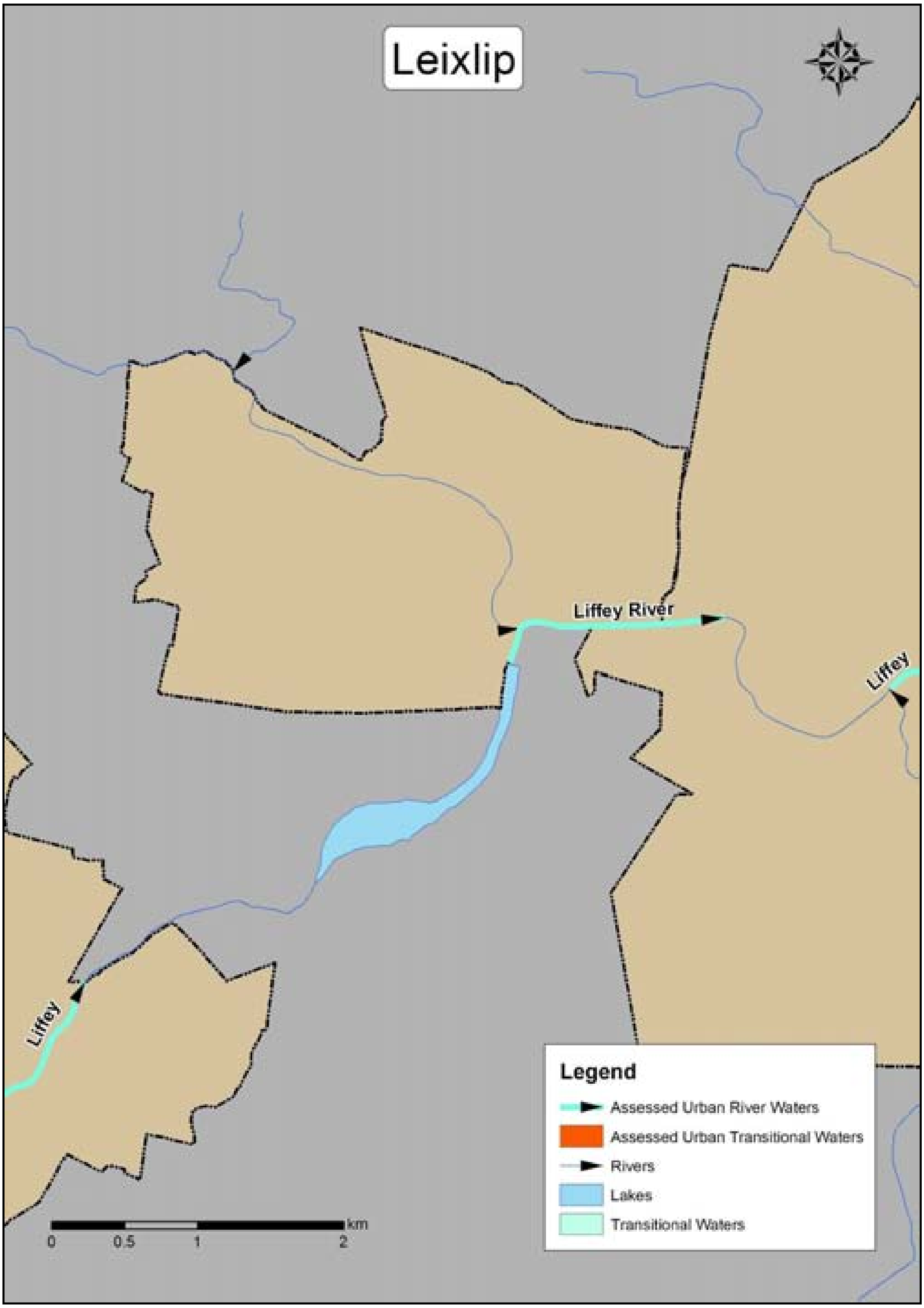


Figure D.15: Leixlip - Assessed Urban Waters



CDM

Figure D.16: Letterkenny - Assessed Urban Waters

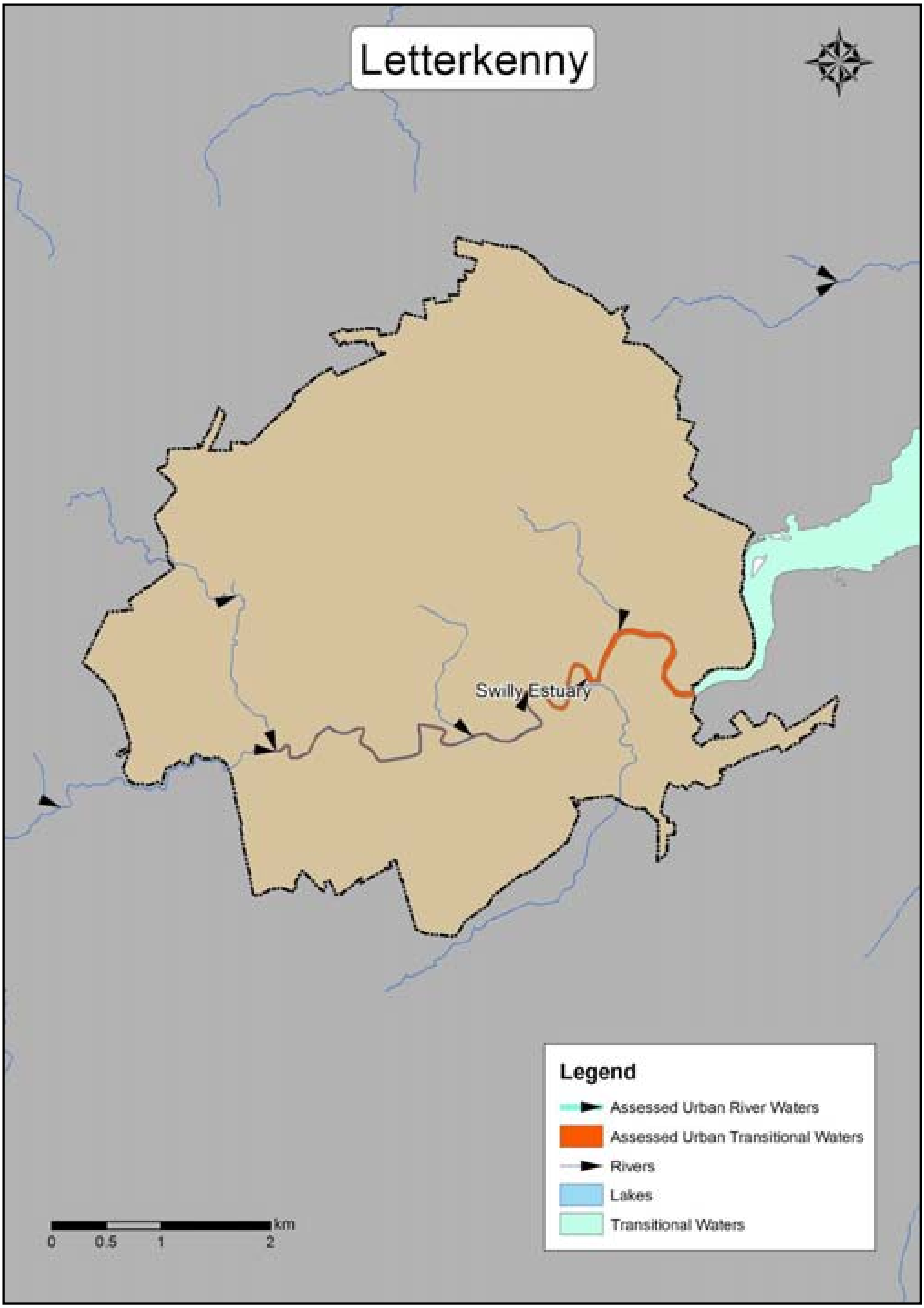


Figure D.17: Limerick - Assessed Urban Waters

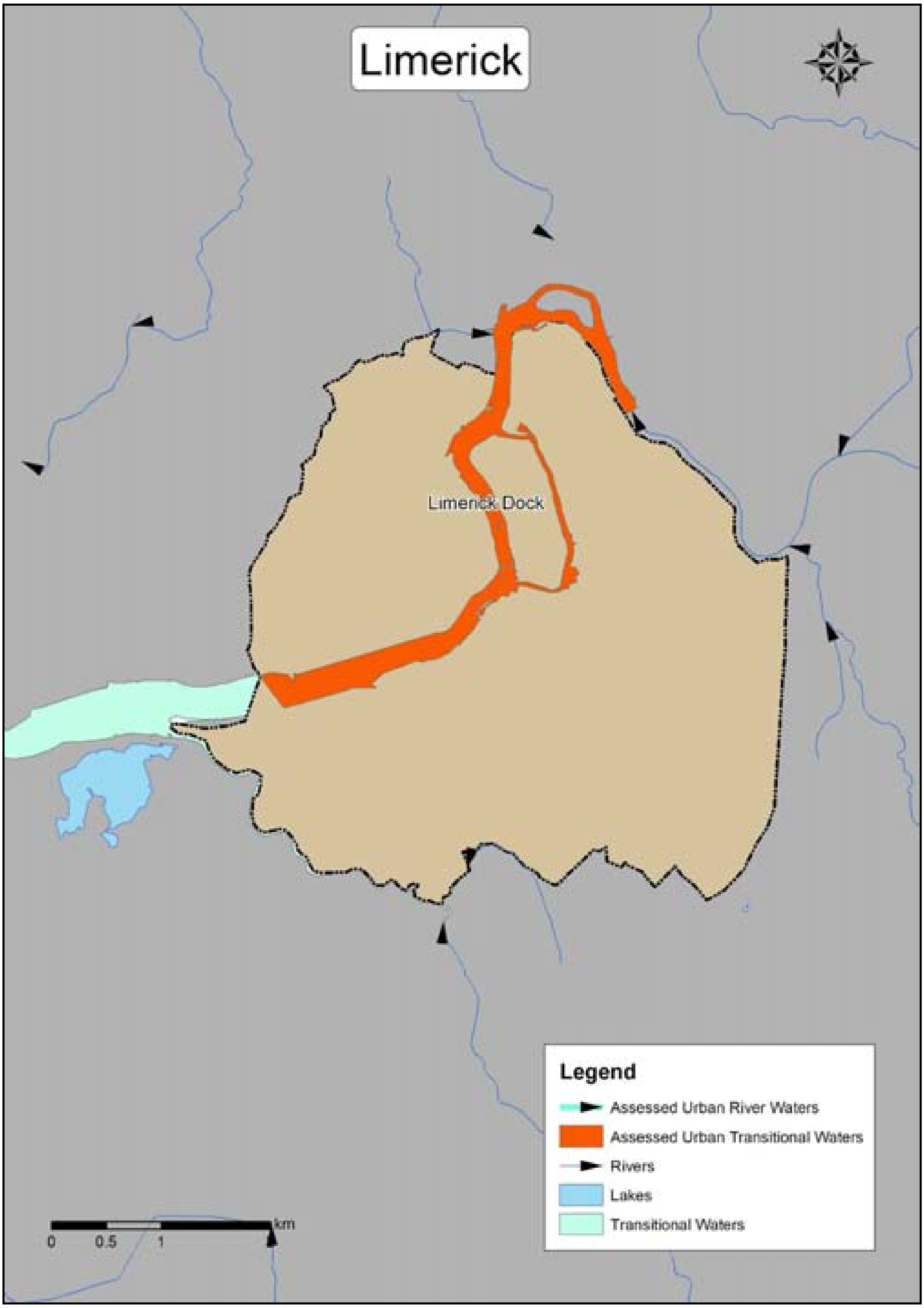


Figure D.18: Maynooth - Assessed Urban Waters

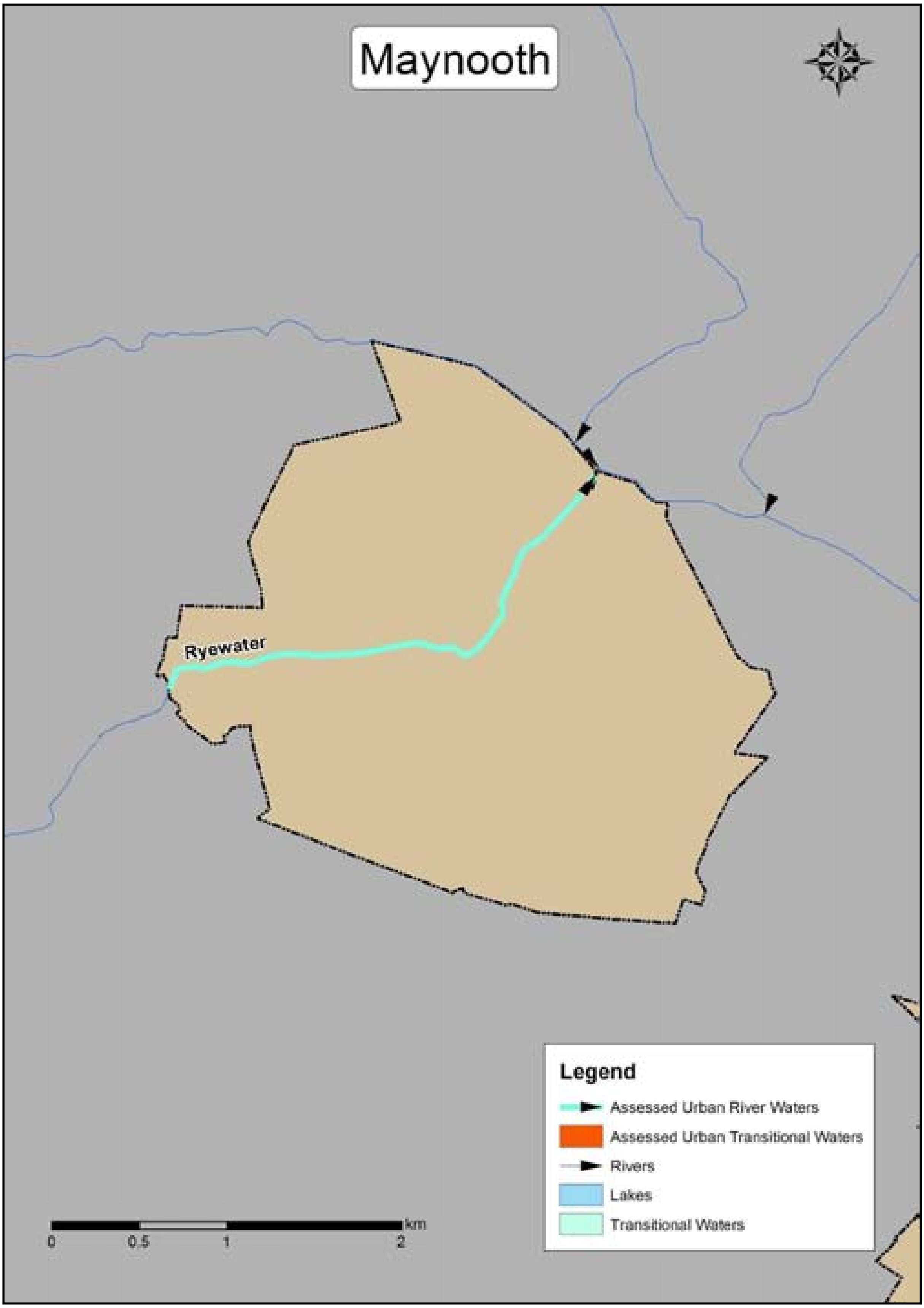


Figure D.19: Mullingar - Assessed Urban Waters

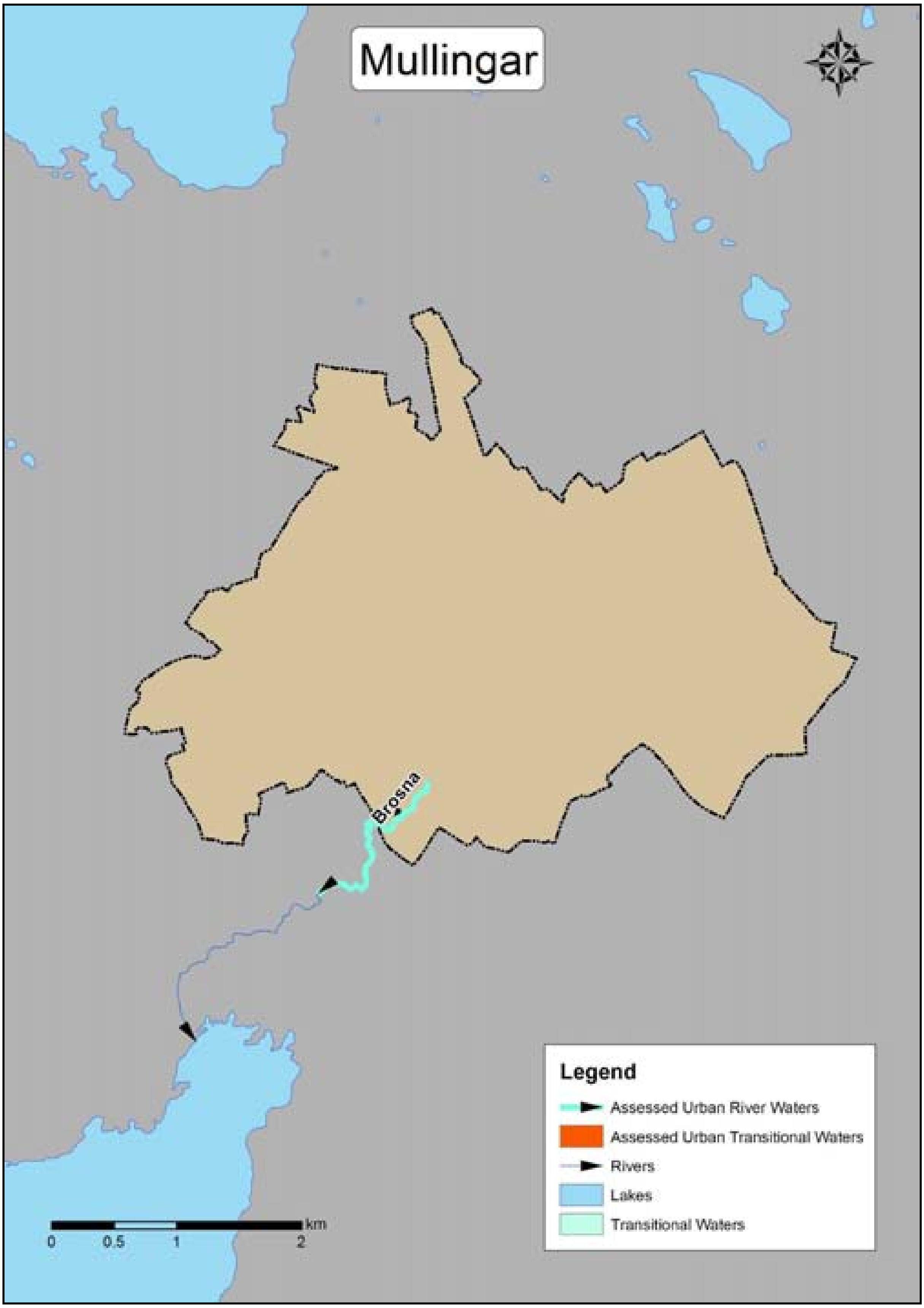


Figure D.20: Naas - Assessed Urban Waters

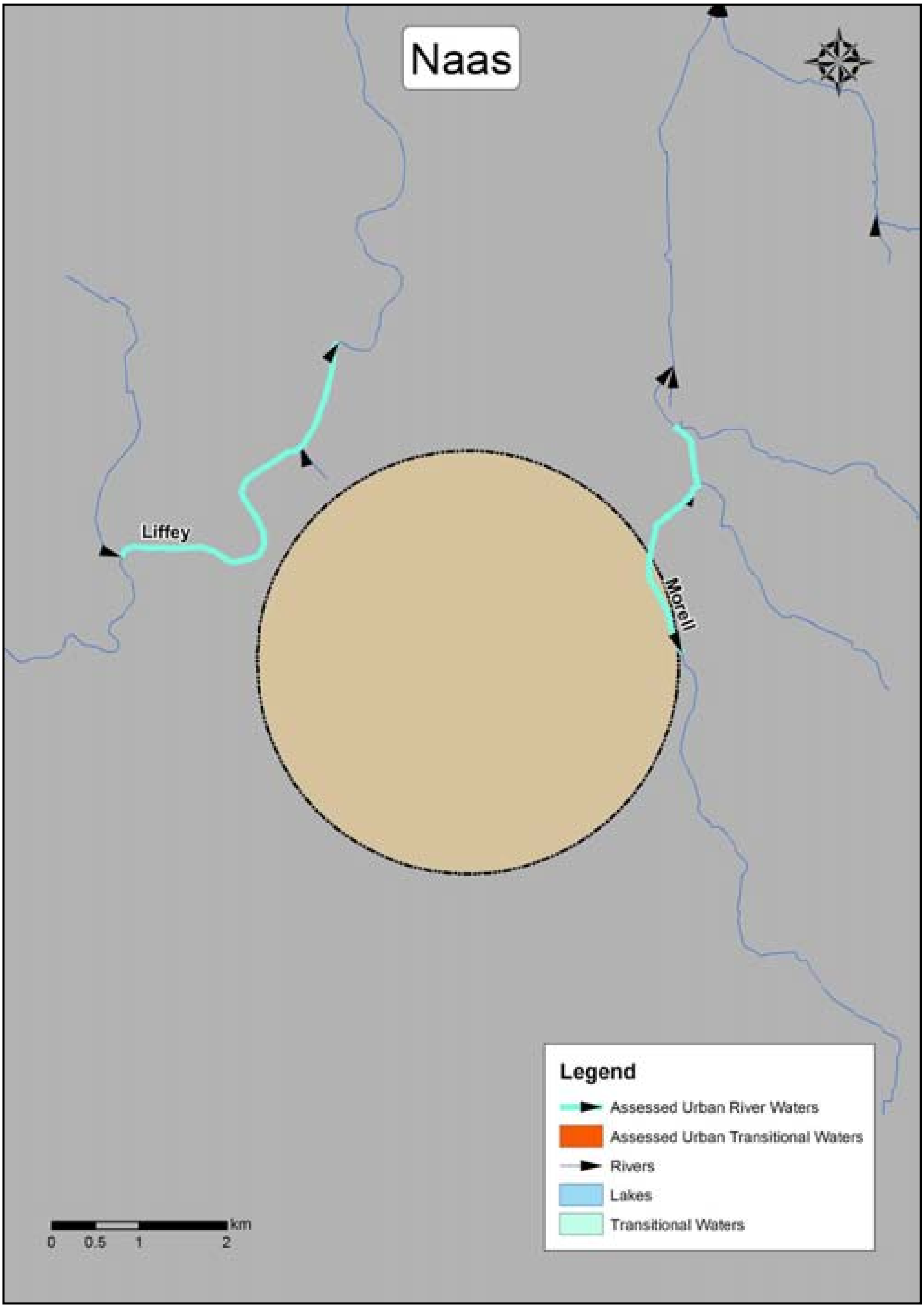


Figure D.21: Navan - Assessed Urban Waters

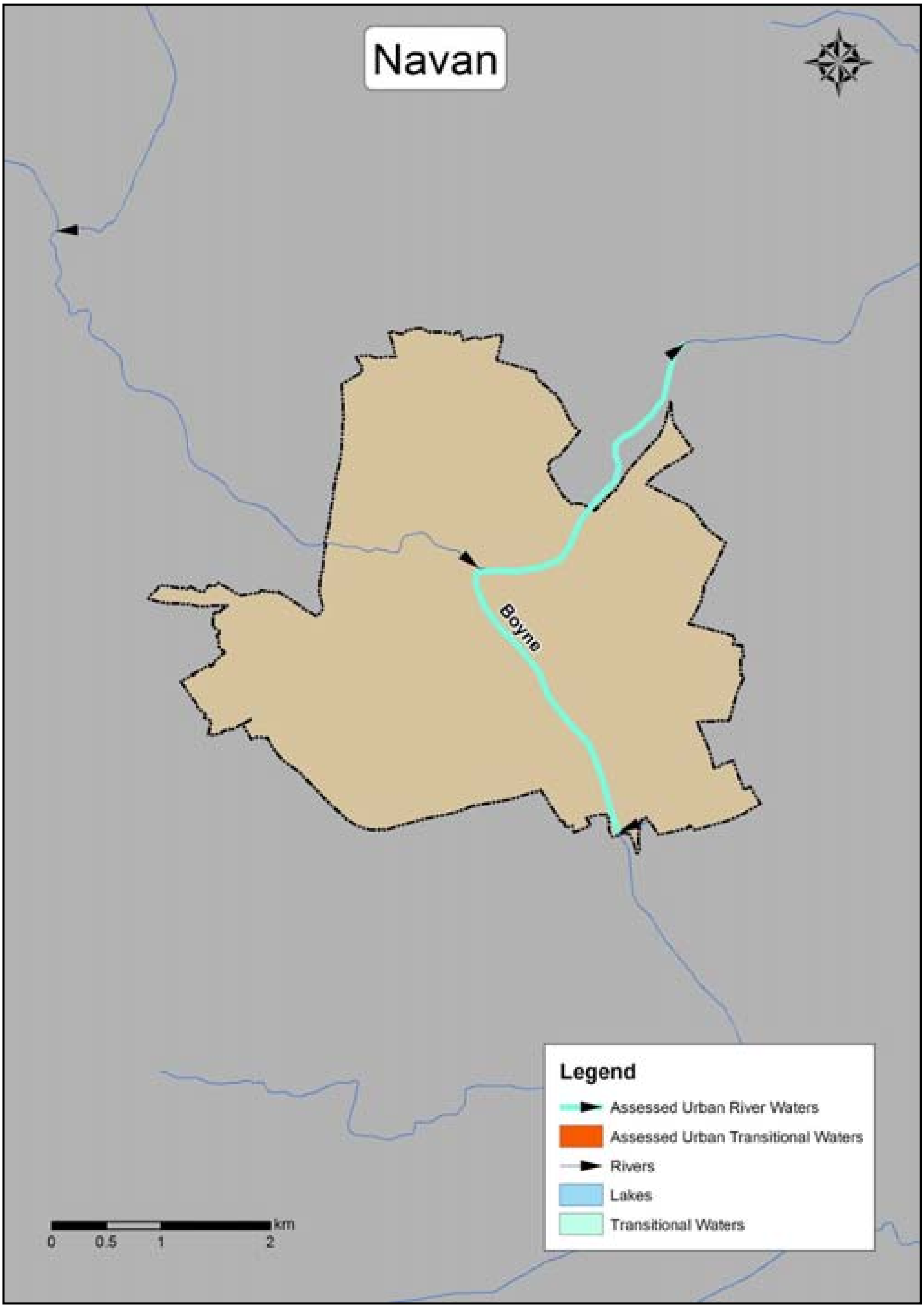


Figure D.22: Newbridge - Assessed Urban Waters

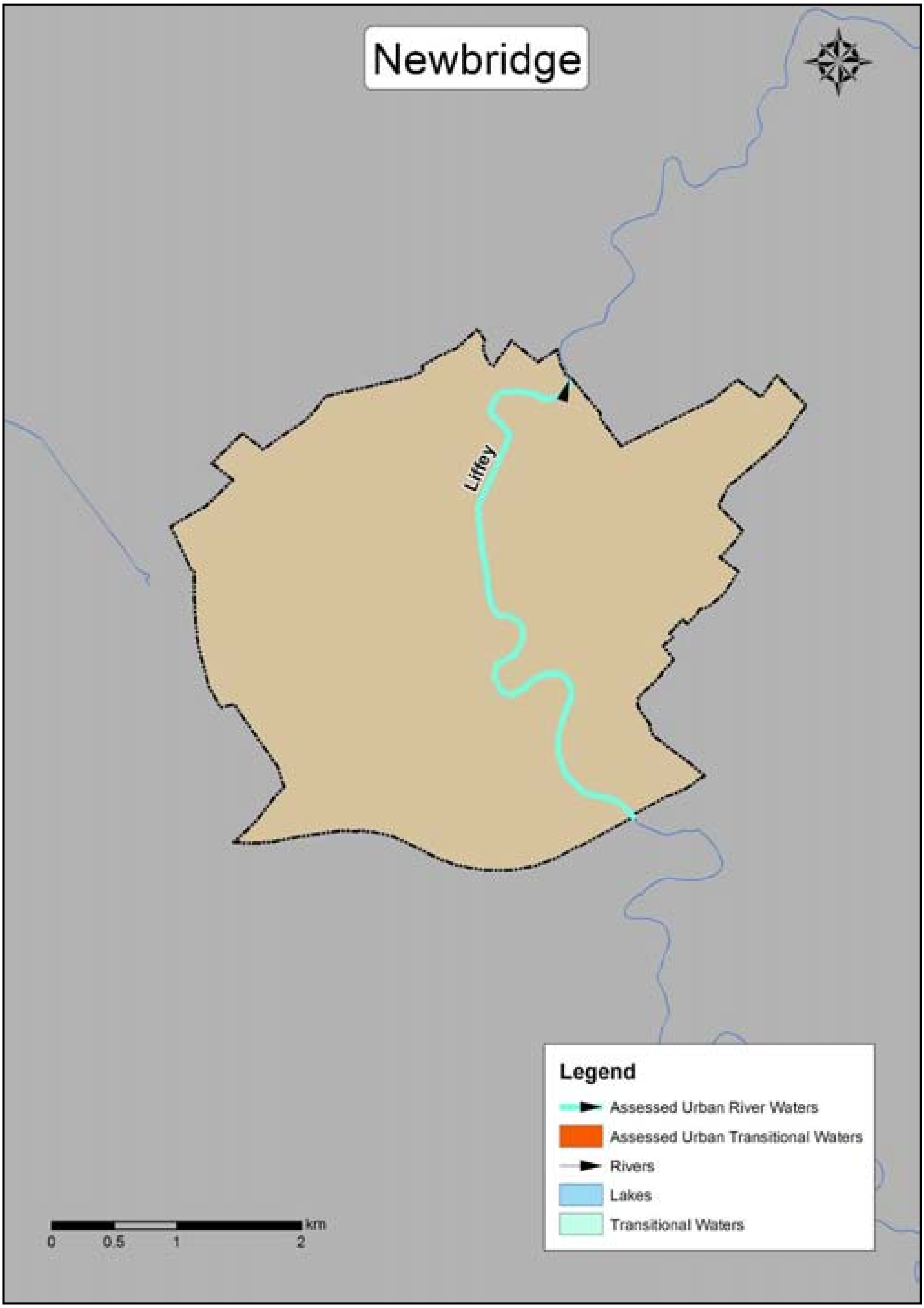


Figure D.23: Portlaoise - Assessed Urban Waters

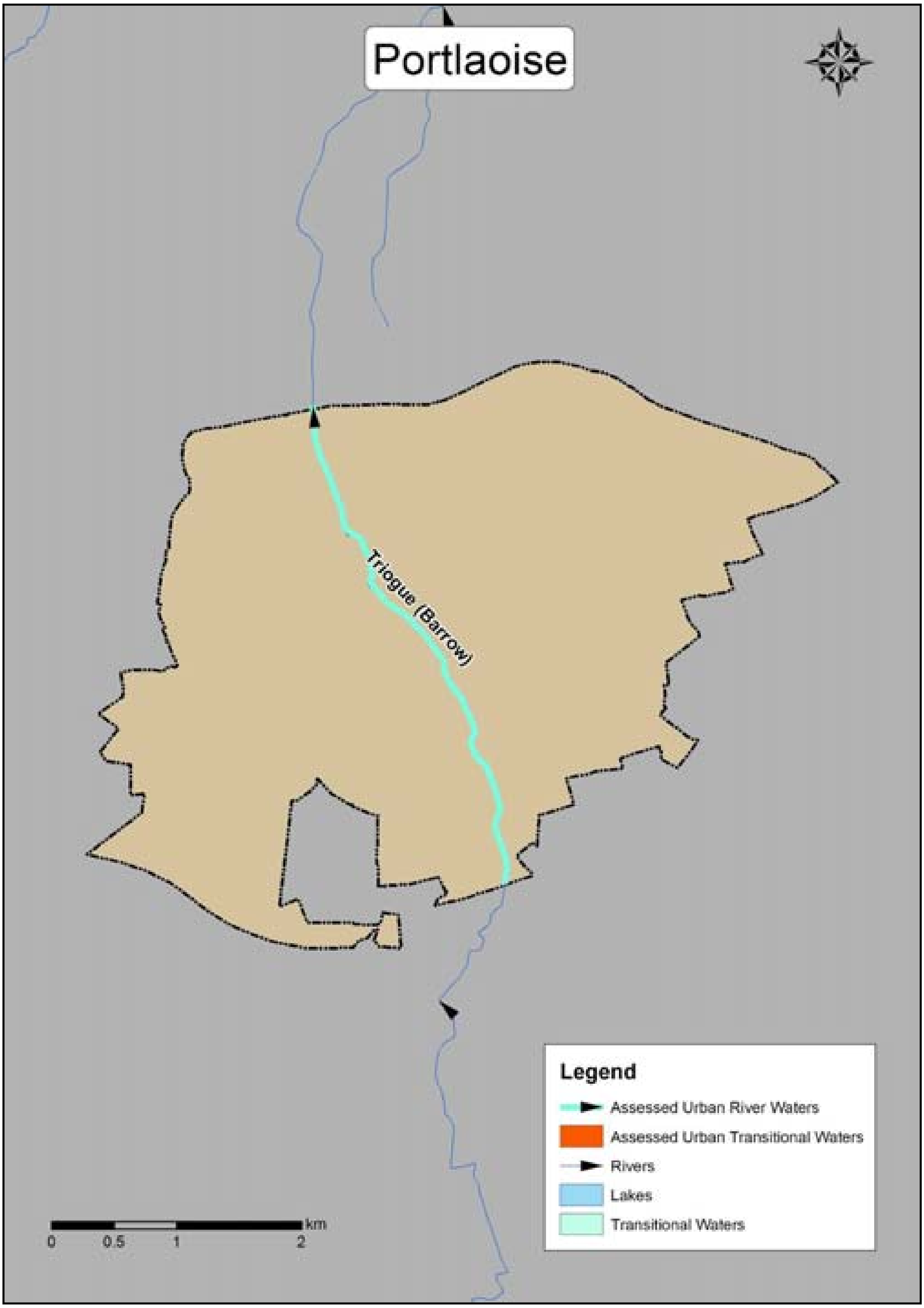


Figure D.24: Sligo - Assessed Urban Waters

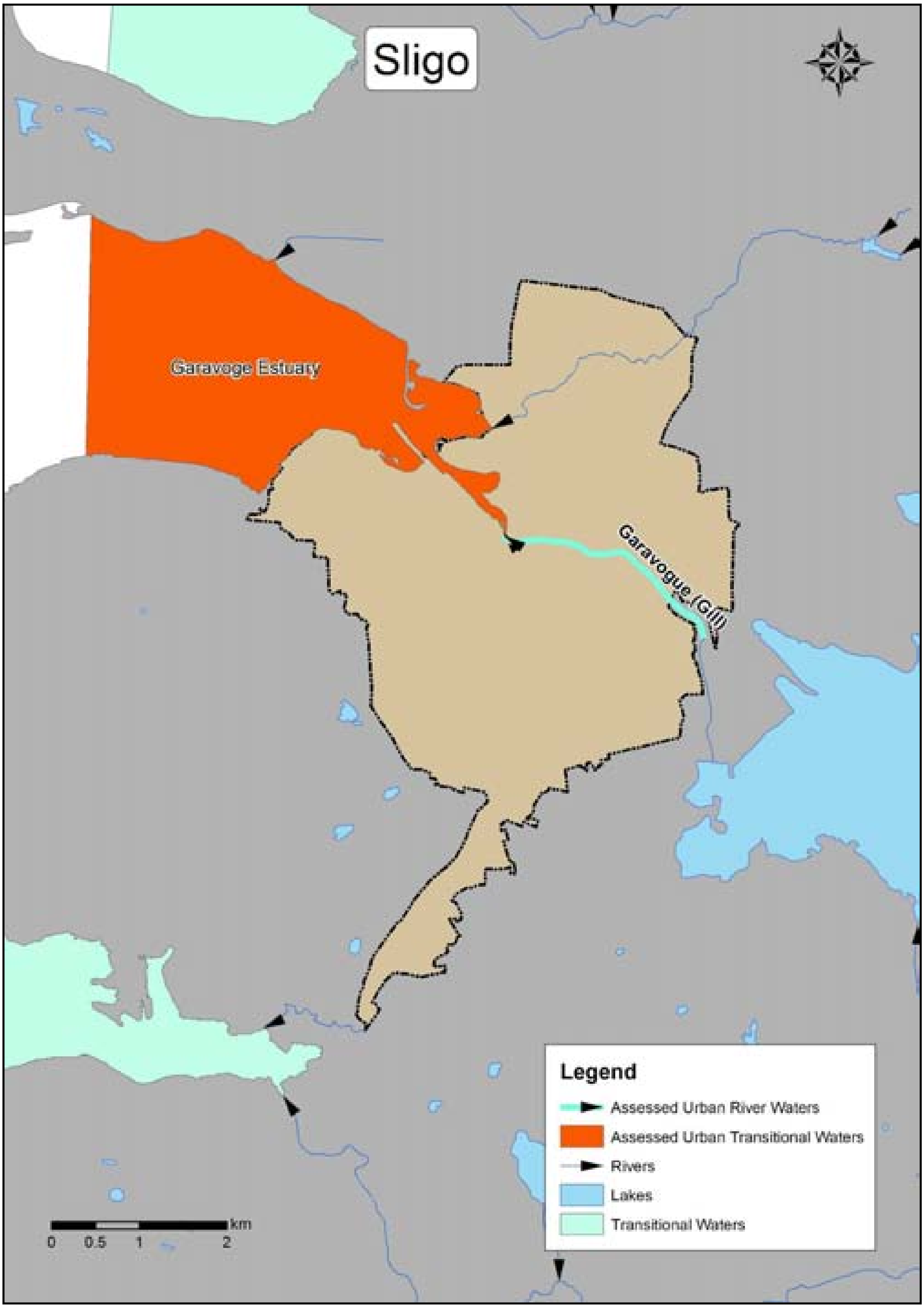
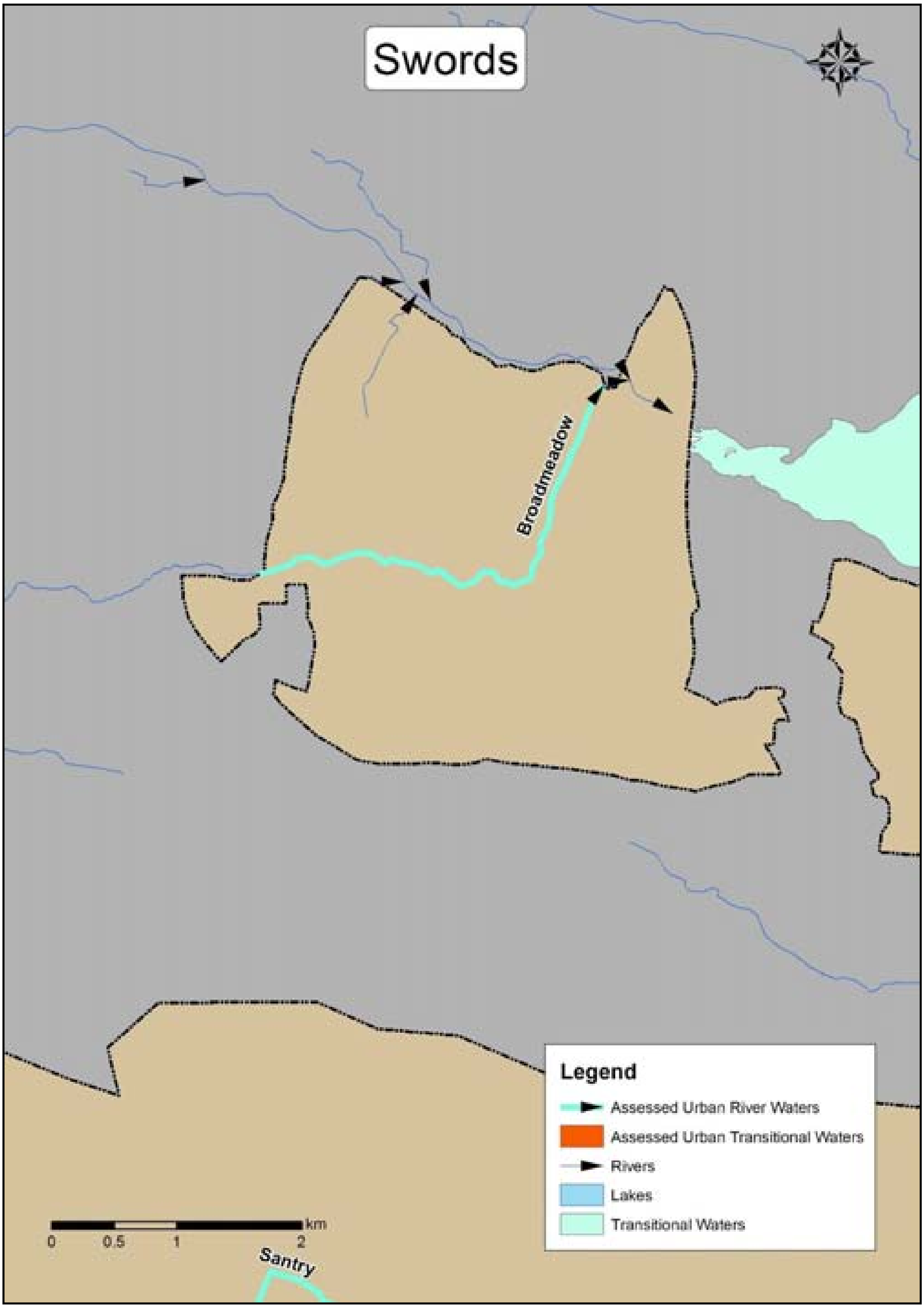


Figure D.25: Swords - Assessed Urban Waters



CDM

Figure D.26: Tralee - Assessed Urban Waters

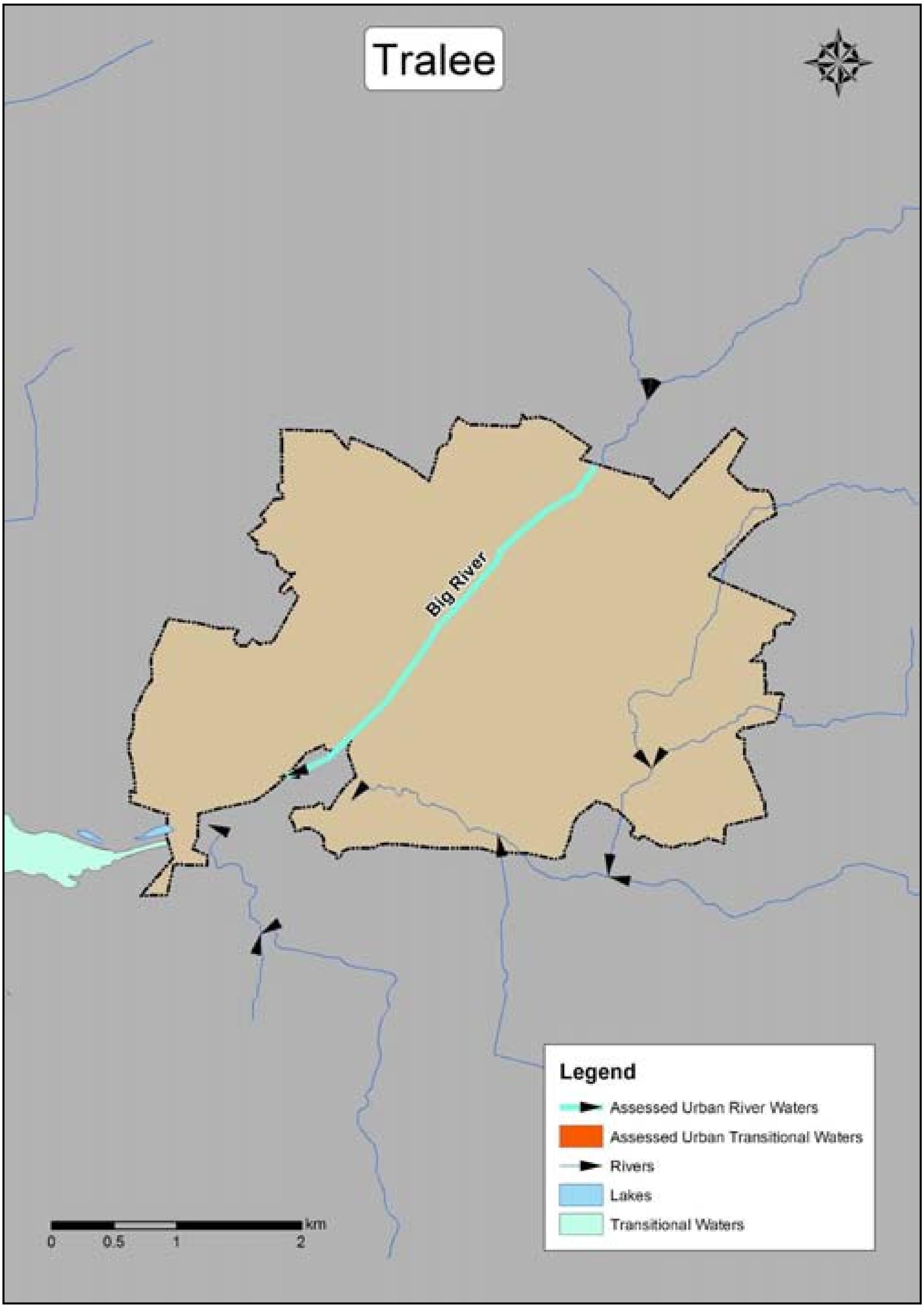


Figure D.27: Tullamore - Assessed Urban Waters

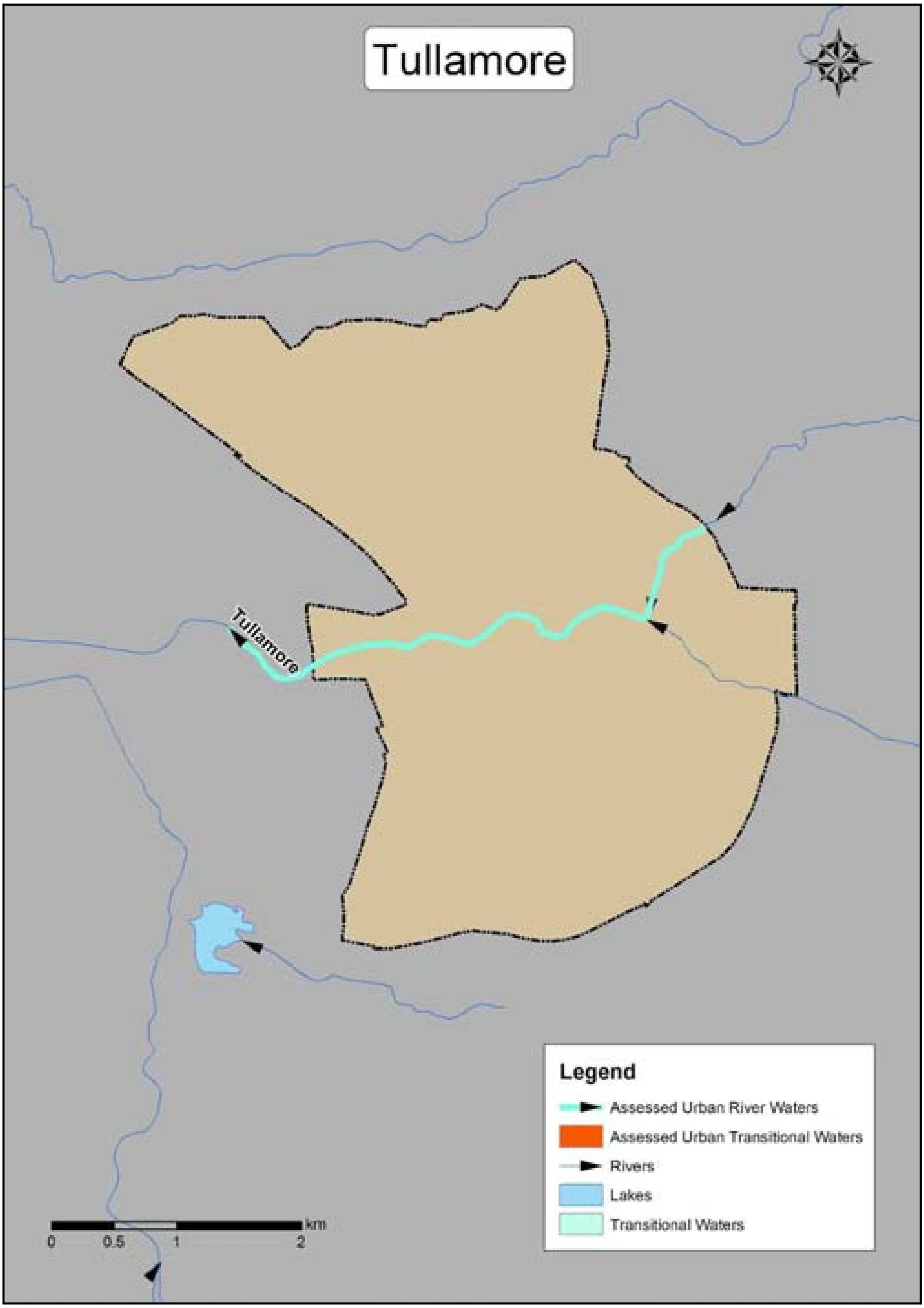


Figure D.28: Waterford - Assessed Urban Waters

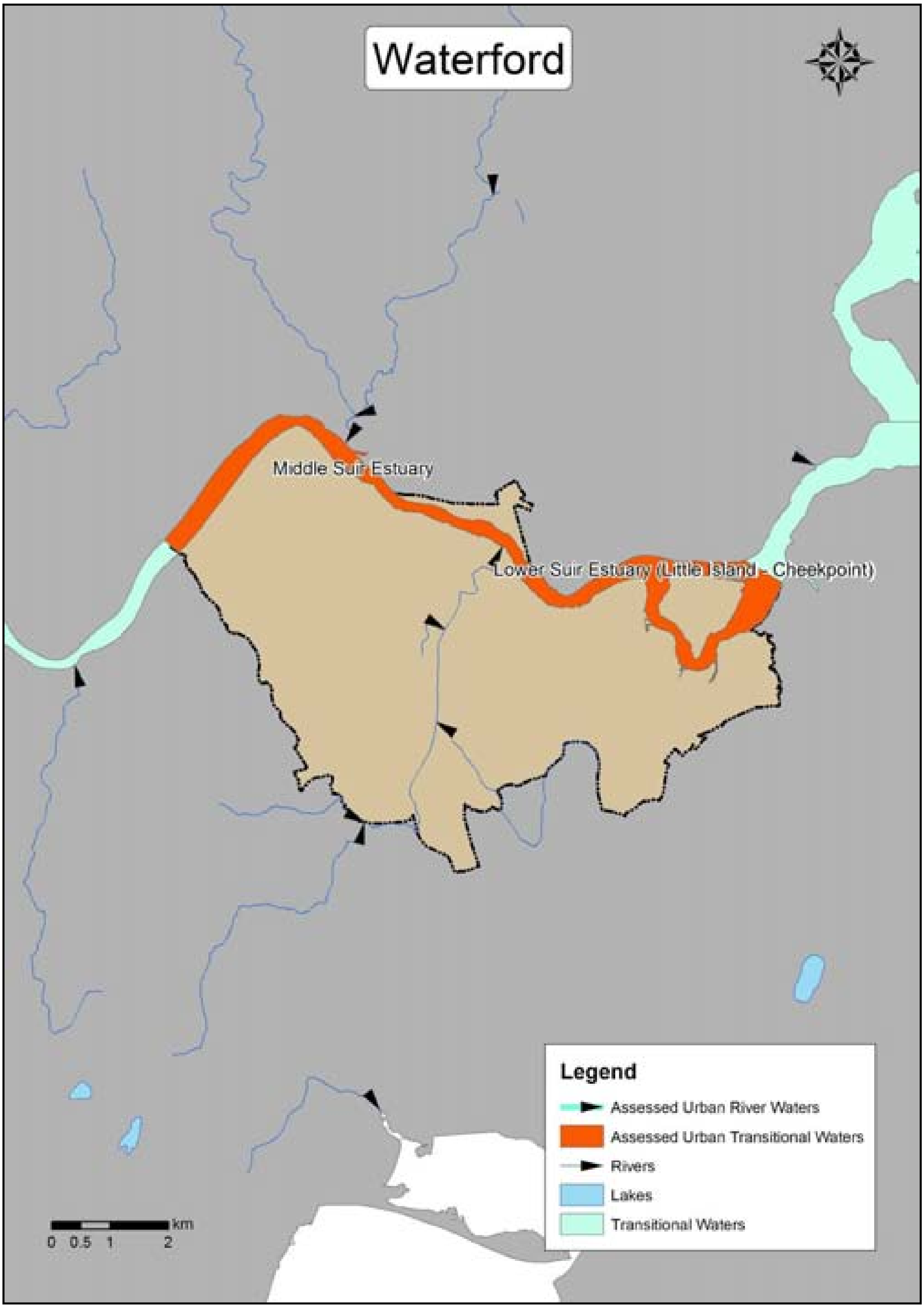
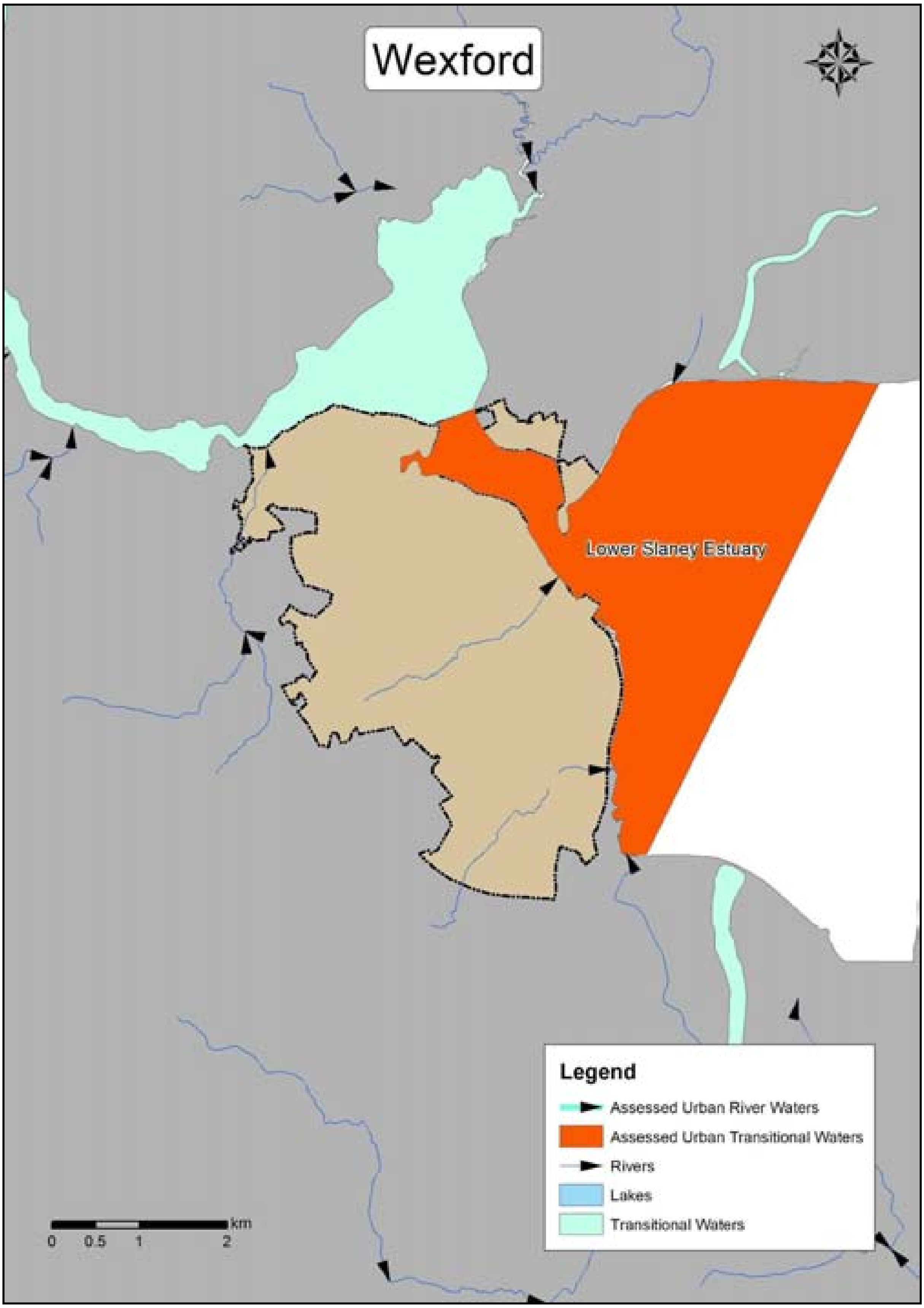


Figure D.29: Wexford - Assessed Urban Waters



APPENDIX E

Data Archive

The data archive is attached as a CD to this Appendix. The contents of the data archive are as follows;

Project CD

- Folder 1: Final Report – PDF
- Folder 2: Supporting Information
  - Sub Folder 1: Final Supporting Reports - PDF
  - Sub Folder 2: Study Urban Area Catchment Boundaries – ArcMap
  - Sub Folder 3: Urban Area Catchment Land Uses – ArcMap
  - Sub Folder 4: Urban Area Catchment River Waterbodies – ArcMap
  - Sub Folder 5: Urban Area Catchment Transitional Waterbodies – ArcMap
  - Sub Folder 6: Study Urban Area Waterbody Diffuse Runoff Catchments – ArcMap
  - Sub Folder 7: Urban Area Catchment Sewer Model Results – Excel
  - Sub Folder 8: Urban Area Catchment Combined Sewer Overflow Details – Excel
  - Sub Folder 9: Methodologies / Tools - Excel

For clarity all the above information/files/data have been collated in a colour coded format in Table E.1 overleaf.

Table E.1: Data Archive (1 of 2)

Sub Folder 1 Final Supporting Reports	CDM Document Reference	Revision Number	Urban Area	Urban Area Name	Waterbodies	Sub Folder 2 Study Urban Area Catchment	Sub Folder 3 Urban Area Catchment Land	Sub Folder 4 Urban Area Catchment River Waterbodies	Sub Folder 5 Urban Area Catchment Transitional Waterbodies	Sub Folder 6 Study Urban Area Waterbody Diffuse Runoff
Stage 1 - Project Inception	DG 01	Final Rev 2	1	Athlone	Shannon (Main)	✓	✓	✓		✓
Stage 2 - Boundary Catchment Definition	DG 16	Final Rev 1	2	Balbriggan	None Assessed	✓	✓			✓
Stage 3 - Land Use Definition	DG 19	Final Rev 2	3	Bray	None Assessed	✓	✓			✓
Stage 4 - Pollutant List	DG 17	Final Rev 1	4	Carlow	River Barrow	✓	✓	✓		✓
Stage 6 - Pollutant Loadings	DG 25	Final Rev 3	5	Carrigaline	Owenboy Estuary (Part Only)	✓	✓		✓	✓
	DG 30	Final Rev 2	6	Castlebar	Liscromwell	✓	✓	✓		✓
	DG 34	Final Rev 1	7	Celbridge	River Liffey	✓	✓	✓		✓
	DG 43	Final Rev 1	8	Clonmel	River Suir	✓	✓	✓		✓
	DG 44	Final Rev 1	9	Cork	Lee (Cork Estuary) Lower	✓	✓		✓	✓
	DG 66	Draft 1	10	Drogheda	Boyne Estuary (Part Only)	✓	✓		✓	✓
Stage 7 - Assimilative Capacity	DG 51	Final Rev 3	11	Dublin		✓	✓			
					River Dodder			✓		✓
					River Camac			✓		✓
					River Liffey			✓		✓
					Tolka River			✓		✓
					Santry River			✓		✓
					Liffey Estuary Upper				✓	✓
					Liffey Estuary Lower				✓	✓
					Tolka Estuary				✓	✓
			12	Dundalk	Castletown Estuary	✓	✓		✓	✓
			13	Ennis	River Fergus	✓	✓	✓		✓
			14	Galway		✓	✓			
					Corrib Estuary				✓	✓
					Corrib River			✓		✓
			15	Greystones	None Assessed	✓	✓			✓
			16	Kilkenny	River Nore	✓	✓	✓		✓
			17	Killarney		✓	✓			
					Deenagh River			✓		✓
					Flesk River			✓		✓
			18	Letterkenny	Swilly Estuary (Part Only)	✓	✓		✓	✓
			19	Leixlip	River Liffey	✓	✓	✓		
			20	Limerick	Limerick Dock (Part Only)	✓	✓		✓	✓
			21	Malahide	None Assessed	✓	✓			✓
			22	Maynooth	River Ryewater	✓	✓	✓		✓
			23	Mullingar	River Brosna	✓	✓	✓		✓
			24	Naas	River Morell	✓	✓	✓		✓
			25	Navan	River Boyne	✓	✓	✓		✓
			26	Newbridge	River Liffey	✓	✓	✓		✓
			27	Portlaoise	Triogue (Barrow) River	✓	✓	✓		✓
			28	Sligo		✓	✓			
					Garavogue Estuary				✓	✓
					River Garavogue			✓		✓
			29	Swords	Broadmeadow River	✓	✓	✓		✓
			30	Tralee	Big River	✓	✓	✓		✓
			31	Tullamore	Tullamore River	✓	✓	✓		✓
			32	Waterford	Suir Estuary	✓	✓		✓	✓
			33	Wexford	Lower Slaney Estuary (Part Only)	✓	✓		✓	✓

PDF From Word File

ArcMap files (GIS)

Table E.1: Data Archive (2 of 2)

Sub Folder 1						Sub Folder 7		Sub Folder 8			Sub Folder 9
						Urban Area Catchment Sewer Model Results		Urban Area Catchment Combined Sewer Overflow Details			
Final Supporting Reports	CDM Document Reference	Revision Number	Urban Area	Urban Area Name	Waterbodies	CSO Details	Catchment Model Data	Existing Exceedance Summary	Future Exceedance Summary	Annual Rainfall	Methodologies / Tools
Stage 1 - Project Inception	DG 01	Final Rev 2	1	Athlone	Shannon (Main)	✓	✓	✓	✓	TUCSON RAINFALL DATA	Calculation Method for River Flows
Stage 2 - Boundary Catchment Definition	DG 10	Final Rev 1	2	Balbriggan	None Assessed						Method for Calculation of Total Flow for Transitional Waterbodies
Stage 3 - Land Use Definition	DG 15	Final Rev 2	3	Bray	None Assessed						Estimation Methodology for Diffuse Runoff Cumulative Loading
Stage 4 - Pollutant List	DG 17	Final Rev 1	4	Carlow	River Barrow						Estimation Methodology for Upstream Cumulative Loading
Stage 6 - Pollutant Loadings	DG 25	Final Rev 2	5	Carrigaline	Owenboy Estuary (Part Only)	x	✓	✓	✓	TUCSON RAINFALL DATA	Estimation Methodology for WWTP Cumulative Loading
	DG 30	Final Rev 2	6	Castlebar	[illegible]						Estimation Methodology for Atmospheric Cumulative Annual Loading
	DG 34	Final Rev 1	7	Celbridge	River Liffey	✓	✓	✓	✓	GDSDS RAINFALL FILES	Estimation Methodology for CSO Cumulative Annual Loading
	DG 43	Final Rev 1	8	Clonmel	River Suir	✓	✓	✓	✓	TUCSON RAINFALL DATA	Methodology for Assimilative Capacity Assessment
	DG 44	Final Rev 1	9	Cork	Lee (Cork Estuary) Lower						
	DG 46	Draft 1	10	Drogheda	Boyne Estuary (Part Only)						
Stage 7 - Assimilative Capacity	DG 51	Final Rev 2	11	Dublin		✓	✓	✓	✓	GDSDS RAINFALL FILES	
					River Dodder						
					River Camac						
					River Liffey						
					Tolka River						
					Santry River						
					Liffey Estuary Upper						
					Liffey Estuary Lower						
					Tolka Estuary						
			12	Dundalk	Castletown Estuary						
			13	Ennis	River Fergus	✓	✓	✓	✓	TUCSON RAINFALL DATA	
			14	Galway							
					Corrib Estuary						
					Corrib River						
			15	Greystones	None Assessed						
			16	Kilkenny	River Nore						
			17	Killarney							
					Deenagh River						
					Flesk River						
			18	Letterkenny	Swilly Estuary (Part Only)	✓	✓	✓	✓	TUCSON RAINFALL DATA	
			19	Leixlip	River Liffey	✓	✓	✓	✓	GDSDS RAINFALL FILES	
			20	Limerick	Limerick Dock (Part Only)	✓	✓	✓	✓	TUCSON RAINFALL DATA	
			21	Malahide	None Assessed						
			22	Maynooth	River Ryewater	✓	✓	✓	✓	GDSDS RAINFALL FILES	
			23	Mullingar	River Brosna	✓	✓	✓	✓	TUCSON RAINFALL DATA	
			24	Naas	River Morell	✓	✓	✓	✓	GDSDS RAINFALL FILES	
			25	Navan	River Boyne						
			26	Newbridge	River Liffey	✓	✓	✓	✓	GDSDS RAINFALL FILES	
			27	Portlaoise	Triogue (Barrow) River	✓	✓	✓	✓	TUCSON RAINFALL DATA	
			28	Sligo		✓	✓	✓	x	TUCSON RAINFALL DATA	
					Garavogue Estuary						
					River Garavogue						
			29	Swords	Broadmeadow River	✓	✓	✓	✓	GDSDS RAINFALL FILES	
			30	Tralee	Big River						
			31	Tullamore	Tullamore River						
			32	Waterford	Suir Estuary						
			33	Wexford	Lower Slaney Estuary (Part Only)						

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