CDM

eastern
river basin district

Dublin City Council
Comhairle Cathrach Bhaile Átha Cliath

Eastern River Basin District Project

Abstractions - National POM/Standards Study Revised Risk Assessment Methodology for Surface Water Abstractions from Lakes

January 2009

Final Report

Document Control Sheet

Client	Dublin City Council			
Project	Eastern River Basin District – Abstractions National POM/Standards Study			
Report	Revised Risk Assessment Methodology for Surface Water Abstractions from Lakes			
Date	January 2009			
Project No: 39325	**Document Reference:** 39325/AB40/DG51 – S			
Version	**Author**	**Reviewed**	**Checked**	**Date**
Draft 01	Peter Shilland	B. Kolb		June 2008
Draft 02	Peter Shilland	B. Kolb		July 2008
Draft 03	Peter Shilland/ Lorraine Gaston/ Henning Moe	B. Kolb		October 2008
Draft Final 04	Peter Shilland/ Lorraine Gaston/ Henning Moe	B. Kolb	R. O'Carroll	December 2008
Final 05	Peter Shilland/ Lorraine Gaston/ Henning Moe	B. Kolb	R. O'Carroll	January 2009

Distribution	Copy No.
Master	01
DCC – Tom Leahy	02
DCC – Ray Earle	03
Website www erbd.ie	04
	05

Acknowledgements

The consultants would like to thank all those who have provided data, information and advice during this study.

Particular thanks go to the Steering Group for the National Programme of Measures & Standards Study on Abstraction Pressures:

- Brian McKeown and Brian Smyth, Dublin City Council (Chairmen);
- Ray Earle, Project Co-ordinator, Eastern River Basin District Project;
- Oliver Fogarty, Department of the Environment, Heritage & Local Government;
- PJ Shaw, Department of Communications, Energy & Natural Resources;
- Donal Daly, Deirdre Tierney, Micheál MacCarthaigh, Catherine Bradley & Rebecca Quinn, Environmental Protection Agency;
- David Harrington, Wicklow County Council;
- Edwina Moore & Cliona Murphy, Kildare County Council;
- Tim O'Leary, Meath County Council;
- Jimmy King & Trevor Champ Central Fisheries Board;
- Eileen Loughman, Health Service Executive (Kildare);
- Lily Byrne, Health Service Executive (Dublin North East); and
- Aine O'Connor, National Parks and Wildlife Service.

A special word of thanks is extended to Deirdre Tierney for her help with development of the methodology for the lakes task.

The following organisations have provided data for use in this project:

- Environmental Protection Agency;
- Office of Public Works;
- Electricity Supply Board International; and
- Central Fisheries Board.

Special thanks to Peter Close of the Northern Ireland Environment and Heritage Service who made a presentation to the steering group.

Table of Contents

Appendices

List of Figures

List of Tables

Executive Summary

A national study of abstraction pressures of 127 lakes judged to be 'at risk' or 'potentially at risk' in the Article V Initial Characterisation has been carried out as part of the Further Characterisation phase of WFD implementation in Ireland. The principal objectives of the study were to:

- Reduce uncertainty in the Initial Characterisation results so status can be assigned;
- Better understand the causes and processes of the pressures;
- Provide data to inform the selection of management measures and programmes of measures (POMs) by the river basin districts (RBDs).

Abstraction pressures manifest in lakes as increased fluctuation in water levels and a change in residence time. While abstraction pressures likely affect fewer lakes in Ireland than eutrophication, they can also result in deterioration of the ecological health of lakes.

The most significant abstraction effects on lakes are driven by changes in the range of water level fluctuations. These result in changes to the frequency of shoreline immersion or emersion, which affects the degree of desiccation, and the duration of the low (or high) water events, which affects the ability of plants/animals to recover from the perturbation in their habitat. The depth/area of the shallow littoral zone also changes and thus the degree that wave action can affect sediments, plants, and animals.

Biota respond differently to changes in water level. On average, macrophytes are more likely to be impacted by abstraction pressures than other biotic groups as even small changes may result in a large shift in macrophyte communities. Loss or deterioration to littoral macrophytes can result in secondary impacts to macroinvertebrate and fish communities, who use the vegetation for habitat and food. In addition, fish that spawn in littoral shallows can be directly impacted through loss of habitat.

Abstractions from the lake itself or the lake's catchment would increase the lake's residence time, increasing the available time for nutrient uptake by algae, periphyton and macrophytes. In general, impacts due to residence time will be considerably smaller than those related to increase water level fluctuation.

A three-stage process was undertaken to identify lakes where abstraction-related Programmes of Measures may be required. They involved; calculation of the ratio of net abstractions to inflow, consideration of lake bathymetries and residence times, and a site-specific assessment of lakes.

The first stage was based on comparing the ratio of net abstractions within lakes and their catchments with the long-term median inflows (Q50) to those lakes. The analysis was performed for the 127 lakes classified as 1a/1b during the Initial Characterisation phase. The Initial Characterisation risk assessments compared net

abstractions (total abstractions minus total discharges) to an estimate of Q95 flows. Risk levels were set at threshold values for highly sensitive surface waters established in guidance documents from the UK and Northern Ireland (except in cases when a dam or weir was present which defaulted the assessment to "at risk").

Uncertainty in the Initial Characterisation was reduced by basing the inflow calculations on the actual catchment for the lake, using a more ecologically relevant measure (Q50 versus the previous Q95) of inflow, and using improved methods for estimating inflows that account for catchment-specific hydrology. In addition, uncertainty was reduced by taking into account improvements in an updated abstractions register and an updated discharges register. The ratio of net abstraction to surface water inflow was used to refine the similar calculations made during the Initial Characterisation risk assessment. Expert judgement was used to set a threshold value of 0.1 for the ratio of net abstractions to inflow; lakes where this ratio was less than 0.1 would be designated 'probably not at risk' from abstraction pressures. A total of 78 lakes of the initial 127 lakes remained at risk following the screening. Based on this threshold, it is recommended that 49 lakes are reclassified as water bodies probably not at risk (2a) from abstraction pressures.

A key finding of the Stage 1 screening was that the lakes that remained in the risk assessment were predominately small lakes located in small catchments with no to few inflowing streams. Figure ES-1 shows that 65% of the 78 lakes that remained at risk had catchments less than 2 km^2, and that all but 10% of the lakes had catchments less than 10 km^2. This finding indicates the need to focus additional monitoring efforts on lakes in small catchments.

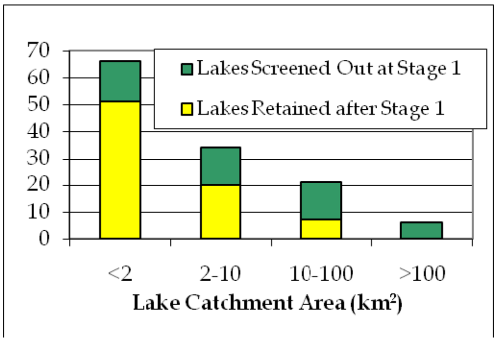

Figure ES-1: Count of Lakes by Catchment Area and Stage 1 Screening Results

The 78 1a/1b lakes remaining after the Stage 1 analysis was subject to a second stage of screening using available data that involves general consideration of the individual lake bathymetries and the lake residence times. Abstraction-related impacts are dependent on the bathymetry of individual lakes, with those subject to the greatest shoreline exposure due to over-abstraction being the most vulnerable to decline in their ecological status. The goal of Stage 2 was to set another threshold for screening lakes prior to individual lake assessments in Stage 3. While the available data allowed for some insights into potential for abstraction-related impacts, insufficient data were available to set screening thresholds. Thus all 78 lakes were carried in Stage 3.

Stage 3 involved individual assessments of the remaining lakes using data that could be gathered on lake-specific attributes. The goals of Stage 3 were to (1) determine if any additional lakes could be determined to be 'not at risk' from abstraction pressures and (2) recommend lakes for priority lake-level monitoring to assist with further assessment of abstraction impacts.

Available data was gathered for the lakes at risk from abstractions including general data and information about the catchment characteristics. Ecological data was also compiled from various sources. Abstractions data was verified and information on water levels and evidence of fluctuations was gathered during the desktop study and also during the field visits. Information on other pressures was screened on GIS and also verified with field visits. A lakes sensitivity rating was estimated, based on their basin shape, area and mean depth, after SNIFFER WFD48.

This stage also involved a site-specific assessment of the groundwater-dependent lakes. Using Darcy's flow calculations it was possible to show which lakes had low estimated groundwater inflow rates compared to the net abstraction and therefore possible to indicate that lakes that were at higher risk from abstraction pressures.

The outcomes of Stage 3 were that (1) no additional lakes could be screened as not being at risk from abstraction pressures and (2) 14 ungauged lakes were recommended for priority lake-level monitoring either because they appear to be a greater relative risk from abstraction pressures than the remaining at risk lakes or they are good candidates to study the effects of lake-level fluctuation on ecology in the absence of other pressures (Table ES-1).

Table ES-1: Lakes Prioritised for Future Monitoring

Lake	County	Existing Gauge?	At 'High' Risk	Ecological Monitoring
Lough Bofinna	Cork	No	✓	
Tooreen Lough	Cork	No		✓
Cullionboy Lough	Donegal	No	✓	
Lough Gorman	Donegal	No	✓	✓
Naglea Lough	Donegal	No	✓	
Lough Anaserd	Galway	No		✓
Lough Illauntrasna	Galway	No		✓
Loughaunore	Galway	No		✓
Brackan Lough	Meath	No	✓	
Lough Bane	Meath	Yes	✓	
Corconnelly Lough	Monaghan	No	✓	
Killcoran Lough	Monaghan	No	✓	
Spring Lough	Monaghan	No	✓	
Lough Labe	Sligo	No		✓
Carrigavantry Reservoir	Waterford	No	✓	
Lough Lene	Westmeath	Yes	✓	
Lough Owel	Westmeath	Yes	✓	

Level data (along with improved data on daily abstraction volumes, bathymetry, and inflows) are needed for the lakes at relatively greater risk from abstractions to allow water budgets to be conducted. Level data (along with ecological data) would permit comparison of abstraction pressures in the selected lakes. Other factors considered in the selection of lakes for further monitoring were the lake's physical and ecological sensitivity in the case of protected *Chara* lakes or lakes with Arctic char populations.

This study identified 79 lakes at high risk from abstraction pressures and recommended monitoring programmes to determine if this risk reflects impacts on the lake's ecology. It is important to carry out these monitoring programmes to better understand the impacts from abstraction to Irish lakes because the financial and political costs of returning a water body affected by abstractions to good quantitative or ecological status is likely to be significant. Supplementary measures were recommended to address particular data and information gaps that have come to light during this POMS study, and guidance was provided to how to capture missing information that would enhance the understanding of the effects of abstraction pressures on lakes. Programmes of measures specific to lake abstractions were identified and include:

- The need to create and have a process for updating a thorough national register of abstractions

- Daily metering of abstracted volumes

- Additional lake-level monitoring. While ideally every lake with an abstraction would monitor water level on a minimum of a daily basis, recommendations are included in Table ES-1 for priority lakes for monitoring

- Conducting water budgets for lakes at risk from abstractions

- Further establishing a link between the water level fluctuations and its effect on the ecology.

Section 1 Introduction

1.1 Overview

The EU Water Framework Directive (WFD) required characterisation of pressures from significant water abstractions, including a national risk assessment and regulation of the quantitative status of all types of water bodies, both surface and ground waters. An initial abstraction pressure assessment was performed in Ireland by individual river basin district (RBD) projects and reported by the Environmental Protection Agency (EPA) in the national Article V report, *The Characterisation and Analysis of Ireland's River Basin Districts* (EPA, 2005).

Section 1.3 describes the method used for this "Initial Characterisation" in 2005 and Table 1-1 presents the number of surface water bodies "at risk" or "probably at risk" from abstraction pressures. The risk assessments compared net abstractions (total abstractions minus total discharges) to an estimate of Q95 flows at the downstream end of river water bodies. Risk levels were set at threshold values for highly sensitive surface waters established in guidance documents from the UK and Northern Ireland; except in cases when a dam or weir was present which defaulted the assessment to "at risk". Risk levels for lakes were then derived from the results of the riverine risk assessment.

Table 1-1: Initial Characterisation Risks for Abstraction Pressures

Risk Level	Rivers	Lakes
Water Bodies At Risk (1a)	95	111
Water Bodies Probably at Risk (1b)	107	16
Total No. of Water Bodies	4,467	805
% of 1a or 1b of Total	5	16

Even though Table 1-1 would suggest that abstraction pressures are not, in general, considered a significant risk to Irish water bodies, abstraction pressures are growing in line with national growth, and further examination of relevant water bodies is important because the financial and political costs of returning a water body affected by abstractions to good quantitative or ecological status is likely to be significant. The types of measures that could be needed are: (1) implementing water conservation programmes for the domestic and non-domestic sectors; (2) restricting development; and (3) identifying and building the infrastructure for alternative sources of water.

A National Programme of Measures & Standards Study of abstraction pressures on lakes was established as part of the Further Characterisation phase of Water Framework Directive (WFD) implementation in Ireland. The principal objectives of the study were to:

- Reduce uncertainty in the Initial Characterisation results so status can be assigned;
- Better understand the causes and processes of the pressures; and
- Provide data to inform the selection of management measures and programmes of measures (POMs) by the river basin districts (RBDs).

In effect, this study refines the results of the Initial Characterisation and provides guidance on assessing which lake and catchment types and size and what abstraction levels are likely to result in negative ecological impacts. This study is intended to address specific questions raised by the initial results and to improve confidence in the predicted risk assessment for all water body types. The work will better focus lake monitoring programmes and the development of Programmes of Measures (PoMs) by exploring a methodology for the assessment of the sustainability of surface water abstractions.

The remainder of this report is organised as follows: Section 1.2 describes the potential impacts on lake ecology that result from abstraction pressures, while Section 1.3 provides more details on the method used to evaluate abstraction pressures in the Initial Characterisation. Section 2 describes the three-stage approach used to re-examine the risk from abstraction pressures in the 127 1a/1b lakes listed in Table 1-1. Sections 3 through 6 presents the results of the three-stage technical approach. Section 7 summarises the findings of the study.

1.2 Overview of Abstraction Effects on Lake Ecology

Traditionally, the ecological health of a lake has been evaluated based on its trophic status as many lakes have become culturally eutrophied by accelerating their natural rate of nutrient input. The increase in nutrients can be delivered directly to the lake (*e.g.,* discharge of treated wastewater effluent) or enter via inflowing streams and stem from increased development pressure in the lake's catchment and the increased use of artificial fertilizers since the mid 20th century. Impacts of eutrophication can include excessive algal growth (including toxic algal blooms), lower dissolved oxygen levels, and fish kills. EPA (2006) concluded in *Water Quality in Ireland 2005* that "nutrient enrichment, resulting in eutrophication, is the principal pressure on lake quality in Ireland".

While abstraction pressures, which manifest in lakes as increased fluctuation in water levels and a change in residence time, likely affect fewer lakes in Ireland than eutrophication, they can also result in deterioration of the ecological health of lakes. Wantzen and Rothhaupt (2008) note that while many studies have been conducted on the effects of water level fluctuations and the need for instream flows to protect the ecology of rivers, lakes have not yet received as much attention.

Water levels in lakes naturally fluctuate both intra- and inter-annually depending on climatic conditions. Water level fluctuations are the principal hydrological change related to lake biota. Natural patterns of water level fluctuations are vital for the survival of many species, and guarantee productivity in lakes as well as biodiversity (Wantzen and Rothhaupt, 2008). Biota respond differently to changes in water level; Coops *et al.* (2003) note that even small changes may result in a large shift in macrophyte communities.

Abstractions can increase the magnitude of water level changes in a lake and may also increase the frequency and amplitude of water level fluctuations compared to natural conditions. Abnormally low water levels during periods of high net abstraction from the lake (*e.g.* peak abstraction periods or abstraction during a drought period) will particularly impact the lake's shallow littoral zones. The littoral zone is typical defined as extending from the shore just above the influence of the waves and spray to a depth where well-mixed surface waters still reach the lake bed in summer (Horne and Goldman, 1994). This zone supports the lake's main populations of macrophytes and macroinvertebrates. The shallow portion of the littoral zone is that most likely to be impacted by abstractions.

Changes from the water level regime can cause drying out of biota, increased exposure to wave action, freezing and changes in light penetration or water temperature. The significance of these effects depends largely on the extent, duration and timing as well as the biota's ability to recover. In the case of severe abstraction impacts, the volume withdrawn can exceed the ability of the lake's catchment to restore the water level to typical seasonal high levels resulting in the long-term decline in the lake water level.

Macrophytes can become more exposed due to decreases in water level, and if roots are exposed for a prolonged period this could result in desiccation. Also sudden changes in water levels that greatly exceed normal fluctuations in water levels pose more of a risk to lake vegetation. A recent Irish example is Lough Bane, Co. Meath, where abstractions caused the lake level to drop so low it exposed sub-littoral banks of vegetation; this resulted in a decline in the species diversity and a change in the zonation of vegetation (Roden, 2008). Macrophytes are especially sensitive to alterations in the water regime, associated with flowering and seed dispersal periods.

The ability of plant communities to migrate up or down the shore in times of low water levels is still not completely understood. James *et al.* (2002) found that some species could migrate down 1.5 metres as a result of low water levels and remained there for three years after the water levels had returned to normal.

With a decrease in water levels, macrophytes located lower in the littoral zone can become more exposed to wave action and they may not be adapted to and could become uprooted. This is the case for *Charophyte* species, which are particularly sensitive (Byrne and O'Leary, 2008).

Alteration in water level can also alter the light penetration, which could in turn effect the growth of macrophytes as light is one of the major limiting factors of vegetation growth (Barko and Smart, 1981). The limitation of light affects different species differently. The vegetated zone in peat lakes are limited due to low light penetration and so would be more sensitive to these changes in water level regimes.

Macroinvertebrate populations in the littoral zone can also be affected by fluctuations in water levels both directly due to exposure to air, changes in light levels and indirectly due to changes in the habitat i.e. the performance of macrophytes. Macroinvertebrates are more tolerant to water level change as they, generally, are mobile and can keep pace with certain rates of water level changes. Other macroinvertebrates such as Chironomids can bury themselves in the substrate up to 20 cm in depth for up to 3 months (Kaster and Jacobi, 1978).

Phytoplankton are insensitive to water level changes as they are free floating. However they can be affected by changes in the residence time because of the effect of nutrient availability. Abstractions from the lake itself or the lake's catchment would increase the lake's residence time, increasing the available time for nutrient uptake by algae, periphyton and macrophytes. There is also the potential for nutrients buried in sediments to become released when exposed during times of low water levels.

Fish are mobile and less susceptible to water level changes; however their success can be impacted, by the availability of suitable substrate for spawning which is the case for pike and salmonids (Byrne and O'Leary, 2008), including Arctic char (Igoe *et al.*, 2003). The littoral zone is also a major feeding ground for fish especially trout (King *pers. comm.*, 2008). Also changes in water levels or velocities can impair the access of some fish to associated rivers (James *et al.*, 2002).

Desiccation of adjoining wetlands around the lake margin can also occur from prolonged exposure due to decreases in water levels. These wetland areas can be major feeding and nesting habitats for birds. Fragmentation of these wetlands can also effect the numbers of birds the wetlands can support.

Also if the water level decline is high relative to the average depth of the lake, then the lake may become subject to changes in temperature, which could affect dissolved oxygen levels, result in abnormally low winter temperatures in the deep water (profundal zone), or result in less suitable habitat for temperature-sensitive species.

The key factor of an ecologically acceptable water level regime is that they should be suitable for macrophytes as they are the primary producers sensitive to water level regime change. Phytoplankton while primary producers are generally insensitive to changes in the water level regime. Fish and macroinvertebrates are mobile and largely dependent on macrophytes.

1.3 The Initial Risk Assessment Method

1.3.1 Method Used

The methodology used in Ireland to evaluate the risk from abstraction pressures for the Initial Article V Characterisation was extended from methods developed by the United Kingdom Technical Advisory Group's (UK TAG) guidance document 7b *Abstraction and Flow Regulation Pressures on Surface Waters* and the Environment and Heritage Service's (EHS) guidance *Water Resources Methodology* *for the Assessment of Abstraction and Flow Regulation Pressures on Surface Waters and Transitional Waters in Northern Ireland.*

In general, the approach of these documents is to estimate a particular flow in the water body and compare the 'net abstraction' to that flow, where the net abstraction is the sum of all abstractions in the upstream catchment minus all discharges in that same catchment. The risk level is then set based on the percentage that the net abstraction was to the flow.

The method used in Ireland for assessing risks from surface water hydrology pressures is documented in *Guidance on Thresholds and Methodology to be Applied in Ireland's River Basin Districts* (November 2004). Net abstractions in rivers were compared to Q95 flow estimates for river water bodies (RWBs). For lakes, net abstractions were compared to sum Q95 flows entering a lake when the lake was greater than 50 hectares, whilst for lakes less than 50 hectares were assigned the Q95 flow of the RWB that coincided with the midpoint of the lake. The November 2004 guidance described the derivation of Q95 flows for RWBs as follows:

> *The Q95 values for the initial risk assessment were prepared using hydrometric data from EPA and Northern Ireland's Rivers Agency for 471 gauging stations where the catchment area exceeded 10 km^2. These Q95 values were first normalised using the catchment area of the hydrometric gage. The 471 data points were then interpolated onto a 50-metre resolution grid using GIS software to develop contours. The interpolated raster values in each grid cell were then binned together to represent groups of cells that had values that fell within one of 32 quantile classifications. The median value of the grid cells within each binned group was selected to be the representative Q95 flow. The Q95 value assigned to each river water body (RWB) was, therefore, the median Q95 value that coincided with the furthest downstream location in each RWB.*

1.3.2 Comments on Method Used

The document *Guidance on Thresholds and Methodology to be applied in Ireland's River Basin Districts: WFD Surface Water Hydrology Risk Assessment Method* (November 2004) acknowledged some of the limitations in the adopted method. Regarding determination of flows for river water bodies, the document notes that the UKTAG documents refer to calculation of low flows data based on catchment characteristics or short-term monitoring. At that time, data needed (soils layers) to calculate low flows did not exist, so the flows had to be estimated using available hydrometric data. The document acknowledges that "what was developed was a screening tool suitable for initial characteristation" and that "more detailed analysis may be required as part of further characterisation for waterbodies at risk".

In evaluating how the risk method was applied to lakes, two steps are potentially problematic. First is the use of Q95 as the flow metric for lake abstraction pressures and second is the use of Q95 values developed from contouring measured data across catchment boundaries. Each of these is discussed below along with a description of how this study alters the methodology to improve the risk assessment.

Section 1.2 discusses the changes in lake hydrology that affect its ecology; these are primarily lake level fluctuation and change in residence time. Changes to the low flows entering a lake will have no significant effect on either of these factors. Thus, the Q95 flow is not a ecologically relevant metric for looking at abstraction pressures. In this study, the Q50 (or median) flow is used as the ecologically relevant metric.

The decision to contour Q95 values across catchment boundaries does not follow standard hydrologic procedures and can lead to errors in estimated flows. River flows are primarily determined by catchment size, precipitation and land-use-based runoff characteristics (*e.g.*, forest vs urban). The method used in the Initial Characterisation accounts for catchment size by normalising Q95 values by catchment area, but does not capture other catchment characteristics. In this study, improvements in the estimate of Q50 flows were made by (1) delineating the actual catchment for each lake of interest and (2) applying one of two estimation methods that consider relevant catchment characteristics. For catchments with developed stream networks, the newly developed (2008) EPA /ESBI method for estimating flows in ungauged catchments was used, whilst Q50s for lakes catchments without tributary streams were estimated with the Rational Formula (Section 3.4).

Both of these changes provide a stronger basis for evaluating potential impacts from abstractions on lake ecology.

This study was limited to review of the 127 lakes judged to be 'at risk' or 'probably at risk' from abstraction pressures in the Initial Characterisation. Given the limitations of the method used for the Initial Characterisation, it is possible that some abstraction lakes have been unnecessarily screened out as not being at risk, particularly those in smaller catchments or in catchments without developed stream networks. It is recommended that a future study review the remaining lake catchments in the country that could be affected by abstraction pressures to allow the potential for impact to be determined on parameters relevant to the lake's ecology.

Section 2
Technical Approach

2.1 Approach and Three-stage Methodology

The approach for this task is to build from the list of 127 lakes potentially affected by abstractions (those evaluated as 1a/1b – at risk or probably at risk – in the Initial Characterisation) and develop more lake-relevant measures of ecological health related to abstractions.

The analyses described below build on available data or data that could be determined from available GIS data for the 127 lakes and their catchments. Data were sought on existing topology, bathymetry, morphological and catchment parameters, lake level fluctuations, locations of abstractions (in lake or its catchment) catchment land use, soils and bedrock.

A three-stage process was undertaken to identify lakes where abstraction-related Programmes of Measures may be required (Figure 2-1). The first stage of the process is based on comparing the ratio of net abstractions within lakes and their catchments to the long-term median inflows (Q50) to those lakes. The analysis was performed for the 127 lakes classified as 1a/1b by the Initial Characterisation study.

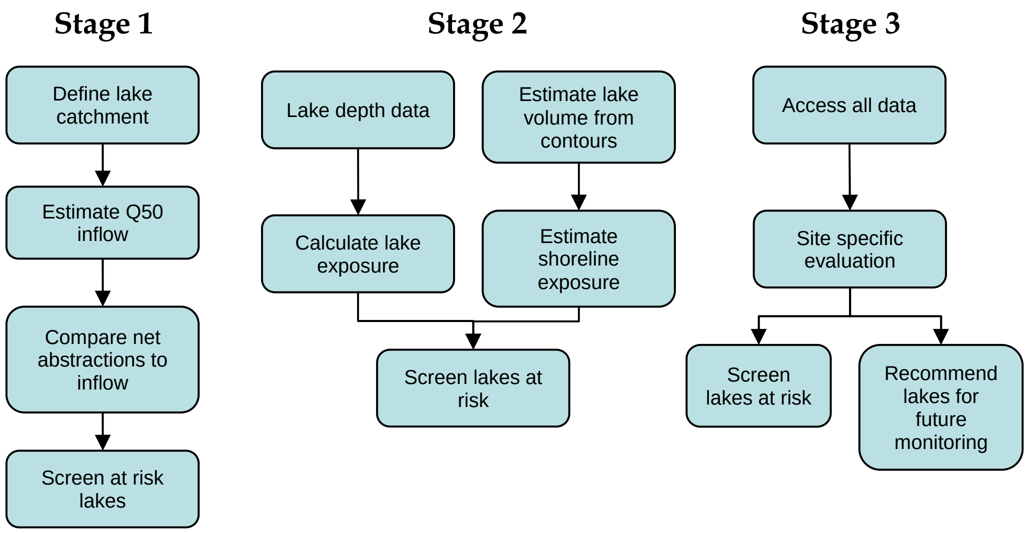

Figure 2-1: Three-stage Methodology for Further Assessment of Lake Abstraction Impacts

Seventy-eight of the 127 1a/1b lakes that was considered potentially to be at risk from abstractions following the Stage 1 analysis was subject to a second stage of screening. In this stage of screening, available data that involves general consideration of the individual lake bathymetries and the lake residence times were used.

Following Stage 2 of the screening, 78 lakes still considered to be potentially at risk were subject to a Stage 3 screening process involving a detailed study of lake-specific attributes. From these lakes recommendations are made on those to target for lake-level monitoring to assist with further assessment of abstraction impacts.

2.2 Initial Tasks

Initial tasks included analysis of lake level fluctuations and the update of the known abstractions assembled by each RBD as part of the Initial Characterisation. These tasks are described in the following sections.

2.2.1 Lake Level Analysis

An initial analysis of lake level data for 21 lakes was undertaken to understand typical and interannual water level fluctuations. These lakes represent those for which EPA water level data is available and include three lakes with known abstractions (Lough Anure, Co. Donegal, Lough Oughter and Lough Skeagh, both Co. Cavan). The lakes with level measurements are located in the north and west of Ireland (most are in Cavan, with several each in Mayo, Donegal and Galway).

The lake level fluctuation was determined for each hydrological year (May-April) in the record. The mean annual lake fluctuation across all 21 lakes was about 1.2 metres (the average record is 18 years). Individual lakes had average annual fluctuations ranging from 0.4 m to 2.7 m; while standard deviations of the annual fluctuation were typically 0.2 to 0.3 m. The lakes with abstractions were among the extreme annual average fluctuations (Lough Oughter: mean = 2.7 m, standard deviation = 0.4 m; Lough Skeagh: mean = 0.6 m, standard deviation = 0.1 m; Lough Anure: mean = 0.9 m, standard deviation = 0.4 m), such that the change in the annual average fluctuation across all lakes was minimal when they were excluded.

Two comparisons were performed to attempt to understand the annual water level fluctuations. First, the trend in fluctuations from year-to-year were examined to determine if inter-annual fluctuations followed similar patterns. Few similarities were found, even with lakes in the same region. The second comparison with annual rainfall also indicated a high degree of variability, with no apparent correlation. Due to a lack of lake-specific data that would be needed to better understand each lake’s water budget (such as volume, outlet configurations, stage-discharge relationships, annual withdrawals *etc*.), lake level data were not further investigated.

Even though the reason for the variations in water level fluctuations were not readily explained, this data set provides baseline information on the degree of natural fluctuation in levels in Irish lakes. The data indicates that many Irish lake ecosystems have natural water level fluctuations of greater than 1 metre. The presence of the natural biota means that the lake's biota are resilient (or are adapted) to the normal variation in their lake's level.

In relation to abstractions the question that remains is the degree to which that lake's biota will be affected by large fluctuation in level. Because the littoral zone is the area most impacted by the fluctuations, the risk of ecological harm from water level fluctuations is a function of the extent of the littoral area of an individual lake and the sensitivity of natural biotia found there. Karr and Chu (1999) note that "highly disturbed systems tend to be resilient to stress; this can be the case for natural variations in river flow or lake level. That a biota can sustain itself -- it is very resilient -- when faced with normal environmental variations, even when that variation is large. However the same biota may not be able to withstand even the smallest disturbance outside the range of its evolutionary experience."

Also, one-off or severe fluctuations may be more critical than the annual average. The biota will respond to an individual event and a reduction in water level even if it only occurs in one year may have a dramatic impact. Some lakes, have sensitive littoral species (*e.g., Chara*) whose communities are impacted by relatively small water level fluctuations. This emphasises the need for lake abstractions to be metered and correlated to changes in the lakes water level.

2.2.2 Register of Abstractions

As part of this project, the national register of abstractions has been updated with input from each RBD and local authorities; responsiveness was variable and all information received was used to update the register. The updated register is considered an improvement over the version used as part of the Article V Initial Characterisation as records have been cross- and error-checked, new abstractions have been added or removed as appropriate and some wells have been removed (*e.g.*, if decommissioned), and new or revised volumes of abstractions have been added where available. The register does not include domestic wells, as these are too numerous and considered less important from a resource quantity point of view. Most of the domestic abstractions are returned to ground via septic systems, and whilst this has an impact groundwater quality, it has less of an impact on quantities.

In addition, every abstraction was assigned as either surface water or groundwater, where groundwater abstractions include springs. It is believed that most public and group water schemes have been identified and included, but it is unlikely that all small private abstraction schemes (particularly agricultural abstractions) are captured in the updated register.

Section 3
Stage 1 Screening

Stage 1 screening uses the ratio of net abstraction to surface water inflow to refine the similar calculations made in the Article V Risk Assessment. In this report, the average surface water inflow to the lake is used as this is a more ecologically significant hydrologic parameter for lake health than the extreme low flows used in the Article V Risk Assessment (see Section 1.3).

3.1 Lake Catchment Delineation

Lake catchments for the 127 1a/1b lakes were delineated for the most part by GIS analysis based on the Digital Terrain Model (DTM) data. Some of the catchment delineations were subsequently modified to correct for apparent errors. Two catchment areas were calculated manually as the catchments are cross-border with Northern Ireland and the DTM data for Northern Ireland was not available under existing license agreements. One catchment was estimated manually due to the very low relief in the vicinity of the lake. As an example, Figure 3-1 shows the GIS-based delineation of the catchment for Muckno Mill Lough in Co. Monaghan. Several calculated particle stream-lines (based on DTM data) are shown, as are the locations of the streams flowing into and flowing out of the lake.

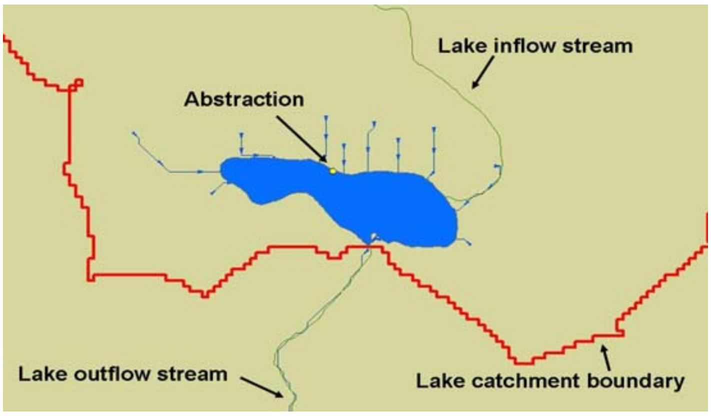

Figure 3-1: Example Catchment Delineation

Table A-1 in Appendix A presents the lake catchment areas for the 127 1a/1b lakes. Figure 3-2 shows the distribution of catchment areas for 127 1a/1b lakes. The 1a/1b lakes largely have small catchments -- 52% (66) of the lakes have catchment areas smaller

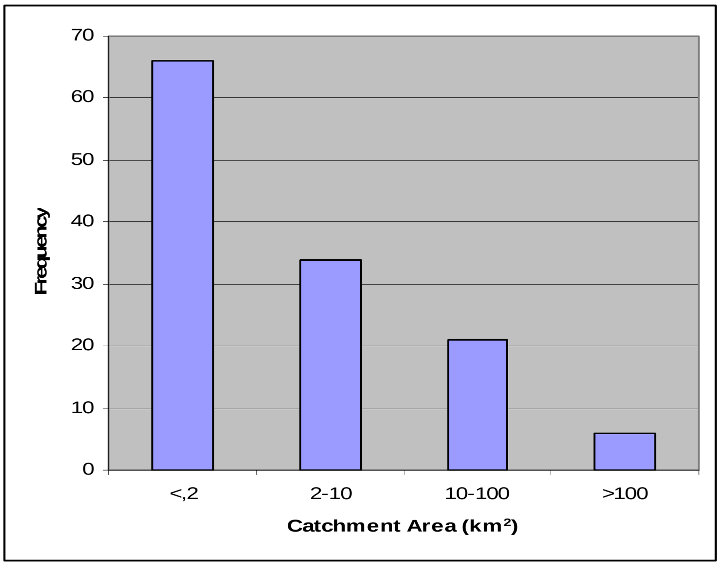

Figure 3-2: Histogram of Catchment Areas for 127 1a/1b Lakes

than 2 km^2, while 79% (100 lakes) have catchment areas of less than 10 km^2. Only 6 lakes have catchment areas greater than 100 km^2.

3.2 Abstraction Data

The documented abstractions located within the 127 1a/1b lakes and within their catchments are presented in Table B-1 of Appendix B. These abstractions are from the Abstractions Register described in Section 2.3.2. The abstraction data includes the amount abstracted in cubic meters per day (m^3/d, or 1,000 l/d) and the population served. In some cases, the abstracted amount is estimated based on the number of population served, using an estimated daily consumption rate of 0.2 m^3/d.

Apart from the potential for omission of an abstraction in the register and for the inclusion of an inactive abstraction, the location data (Easting and Northing) present another potential source of error. The location data in the National register are not considered accurate and in some instances are known to be in error by several hundred meters. The location of the lake abstraction in Muckno Mill Lough in Co. Monaghan (Figure 3-1) appears to be reasonably accurate, being in the lough and close to the shore.

Figure 3-3: Lough Illauntrasna, Gorumna Island, Co. Galway

In contrast, however, is the plotted abstraction location near Lough Illauntrasna on Gorumna Island, Co. Galway (Figure 3-3), which lies several hundred meters east of the lough, even beyond the lake catchment. The actual location of the abstraction point has been verified to be within Lough Illauntrasna itself. In cases like Lough Illauntrasna, where we have been able to confirm that the abstraction was from the lake itself, we have changed the abstractions register to move the abstraction to a location in the centre the lake and added a comment indicating the change to its Northing and Easting values.

It is important that responsible bodies maintain accurate records of the locations of abstraction intake points to avoid error in the national abstraction registers.

3.3 Discharge Data

Information on the location and volume of discharges is needed to complete the net abstraction calculation for each lake. The register of discharges has been updated with the most recently-available data from the South Western River Basin

District (SWRBD) Programme of Measures & Standards Study on Municipal & Industrial Regulations; they collected information on municipal and industrial point source discharges from:

1. Waste water treatment plants (WWTPs);
2. Integrated Prevention and Pollution Control (IPPC) industries licensed by the EPA; and
3. Section 4 (Water Pollution Act) discharges from other industries licensed by Local Authorities.

The documented water discharges located within the 127 1a/1b lakes and within their catchments are presented in Appendix D. The discharges were provided as maximum hourly or daily rates.

IPPC and Section 4 industrial abstractions from lakes and from streams within the lake catchments will be substantially balanced by the discharges from these industries and businesses, with the water largely being used as cooling or process water, then discharged. The discharge data for the IPPC and Section 4 industries are incomplete and the discharges are provided as maximum hourly or daily rates. The discharge rates for IPPC and Section 4 industries are not reported to any central databases, and so flow limits set in licences are currently the only source of discharge information. This creates difficulty in reconciling the abstraction and discharge data.

WWTPs discharges present a greater challenge in determining their relationship to the volume of potable water abstractions and to the volume of water abstracted for industrial use then discharged to the WWTP. The potable water abstraction(s) may not lie within the catchment of the lake under study and the discharge from the WWTP may result in a net discharge to the lake, with discharges exceeding abstractions.

Discharge data for the WWTPs are provided as average daily flows, where available. Population data are available for the WWTPs and were used to estimate discharge flows in the absence of registered flows, using an estimated to be 0.2 m^3/day per person.

3.4 Surface Inflow Estimation

Estimates of the median discharge (Q50) of the lake-influent streams are obtained or derived from several sources; these include hydrometric gauge records, estimates made with the EPA/ESBI method for Q50 flows in karst and non-karst catchments, and the rational method. The median discharge data are subsequently compared to the net abstractions within a lake catchment.

The most reliable median discharge data are those generated from long-term gauges providing mean daily flows. Hydrometric gauge locations collected by the Local Authorities/ EPA (LA/EPA) and the Office of Public Works (OPW) were reviewed to identify gauges which measured flow, upstream of the 127 1a/1b lakes and none were found.

Several hydrometric gauges were identified on the streams outflowing from the 1a/1b lakes in this study. The OPW maintains gauges on lake-outflowing streams within close proximity to several of the 1a/1b lakes in this study. However, the only OPW gauge with Q50 data available with sufficient length of record is that on the Blackwater River near Lough Ramor (Station no. 07004).

Nine other hydrometric gauges maintained by the LA/EPA are located at the outflow points of 1a/1b lakes and for which a sufficient record and data are available for calculation of Q50 flows. These data are presented in Table D-1 in Appendix C, and the Q50 flows are summarised in Table 3-1. The median discharges from lakes derived using gauge records can provide an order of magnitude check on Q50 values derived from other methods providing (1) the net abstraction from the lake or its catchment is not a significant portion of the Q50 flow and (2) the gauge record is sufficiently long.

Table 3-1: Comparison of Q50 Estimates by Gauging, EPA/ESBI and Rational Methods

Lake Catchment	Q_{50} by OPW/EPA Gauging (m^3/sec)	Q_{50} by EPA/ESBI Method (m^3/sec)	Q_{50} by Rational Method (m^3/sec)
Anure	1.3	0.959	-
Bawn	0.884	0.958	-
Drumore	-	2.411	2.451
Easky	0.401	0.288	-
Eske	3.03	2.459	-
Glen	3.222	3.714	-
Inniscarra	-	20.581	19.101
Lickeen	-	0.172	0.190
Moher	0.245	0.182	-
Muckno Mill	0.353	0.334	-
Ramor	3.52	2.778	3.234
Sillan	0.693	0.765	-
Skeagh (Upper)	0.131	-	0.070

Three methods were used in this study to estimate median surface inflows; they are:

1. EPA/ESBI Non-karst Method;

2. EPA/ESBI Karst Method; and

3. Rational Method.

Both of the EPA/ESBI methodologies (karst and non-karst) derive 'natural flow' values by separate methods for streams. Discharge estimates for streams with catchments containing a significant component of conduit karst are derived using the EPA/ESBI Karst Method; discharges for streams with catchments containing all other rock types are estimated using the EPA/ESBI Non-karst Method. These methods were applied in catchments with a defined drainage network where flows in streams constitute the vast majority of the surface water inflow to the lake (i.e., inflow is not via direct overland flow).

A form of the Rational Method is used to estimate Q50 discharges into lakes without defined drainage networks where estimates could not be made using the EPA/ESBI method. Section 6.3 further provides estimates of groundwater inflow to lakes considered to have a strong hydraulic connections with groundwater.

3.4.1 EPA/ESBI Non-Karst Method

The EPA/ESBI Non-Karst method is based on a comparison of the study stream to the five closest reference streams within the EPA/ESBI dataset of 115 non-karst natural streams.

The eight significant hydrogeologic factors for the catchment area in the EPA/ESBI methodology (in descending order of weighting) are:

1. Rainfall (average annual 1961-1990);
2. Percentage of 'made' land;
3. Percentage of high-permeability subsoil;
4. Percentage of poorly-drained soil;
5. Percentage of well-drained soil;
6. Percentage of low-permeability subsoil;
7. Percentage of diffuse karst; and
8. FARL (flood attenuation from reservoirs & lakes).

FARL accounts for attenuation of flow from lakes in the same catchment but upgradient from the lake of interest. The FARL calculation is a function of the area of the upgradient lake, the area of the subcatchment of the upgradient lake and the total catchment area. For example, flow estimates for the catchment of Lough Ramor would utilise the FARL parameter because Loughs Skeagh, Acurry, Nadreegeal and Drumkeery are located within its catchment.

Results of the median discharge estimates by the EPA/ESBI Non-karst Method are presented in Table C-1 of Appendix C.

3.4.2 EPA/ESBI Karst Method

The EPA/ESBI Karst method was developed in the same manner as the EPA/ESBI Non-Karst Method. However, only 11 natural-flow gauging stations are located on streams with conduit karst geology. Thus, the EPA/ESBI Karst method is only used for catchments with significant karst, which was defined as catchments where the percentage of the conduit karst rock type (GIS code = RkcLk) is greater than 45%. In these catchments the Q50 flow is determined by using the average figure of 2.693 for the log of the Q50 flow in mm.

Results of the median discharge estimates by the EPA/ESBI Non-Karst Method are presented in Table C-2 of Appendix C.

3.4.3 Rational Method

A form of the Rational Method is employed in this study to estimate median discharges for catchments where the EPA/ESBI method would not apply. Additional consideration is given to in Section 5.3 to lakes where groundwater surrounding most of the lake is considered to be in strong hydraulic connection with the lake water. This is considered the case of lakes surrounded by bog or have small catchments surrounded by conduit karst, where surface waters of the lake and the surrounding groundwater are considered to be a direct expression of the same water body.

The Rational Formula considers the entire drainage area as a single unit and estimates the runoff to the lake. The method also assumes that rainfall is evenly distributed over the drainage area - a reasonable assumption for the small catchments it is applied to in this study.

The Rational Formula is:

$$Q = 0.28 * C * I * A$$

where:

Q	=	Annual average inflow (m^3/sec)
C	=	Runoff coefficient
I	=	Annual average rainfall (mm/hr)
A	=	Drainage area (km^2)

The runoff coefficient of the Rational Formula is derived for different land covers. Values range between 0 and 1, with the highest runoff coefficients associated with impermeable ground cover (generally artificial) or with water bodies themselves. Low coefficients are associated with permeable ground cover such as grassland and woodland. The land uses considered in this study are the seven CORINE categories of bogs, forestry, other, other agricultural land, pasture, urban and water.

The runoff coefficients employed in this study are listed in Table 3-2. These values were derived initially from published values then modified based on comparison of the median discharges derived by this method with those derived from the EPA/ESBI Non-Karst Method (Table 3-1).

Within each catchment, the proportions of each CORINE land type are calculated and an overall catchment runoff coefficient determined using the areas of the different land cover as weighting factors.

Table 3-2: Runoff Coefficients used for Rational Formula

CORINE Category	Runoff Coefficient
Bogs	0.9
Forestry	0.2
Other	0.3
Other Agricultural Land	0.35
Pasture	0.35
Urban	0.75
Water	1.0

As adapted for this study, the coefficient values represent the processes in the catchment that affect the delivery of surface inflows to the lake. The Rational Method is intended for estimation of peak discharges, whereas in the small catchments to which this study applies the Method, surface runoff and water that infiltrates to groundwater are likely to be discharged from the catchment, assuming coincident surface and groundwater catchments.

Results of the median discharge estimates by the Rational Method are presented in Table C-3 of Appendix C.

Table 3-1 presents the estimates of the median discharge (Q50) values derived from the Rational Method described above with results for the same catchments derived from OPW/EPA gauge data and from the EPA/ESBI Non-Karst Method. The values derived by the Rational Method compare closely to those derived using the EPA/ESBI method, with a maximum difference of 16% in the values. The Q50 values for the OPW and EPA gauging data also agree with those estimated using all three methods, with most estimates being with 15% different and all but one within 30%.

Figure 3-4 shows an example of a lake for which the median discharge to the lake was estimated by the Rational Method. Naminna Lough in Co. Clare has a catchment of approximately 70 ha of roughly equal parts CORINE categories ‘forestry’, ‘bog’ and ‘other’. As shown on Figure 3-4, there is no defined drainage network in the catchment.

3.5 Groundwater-dependent Lakes

Of the 127 1a/1b lakes, 18 are considered potentially to be in the category of groundwater-dependent lakes (GWD). These lakes are generally small lakes within small catchments that are either surrounded (or largely surrounded) by conduit karst bedrock, or surrounded by bog. These lakes generally do not have a defined stream pattern feeding the lakes nor an outlet stream. In most instances, the catchments have no streams at all and the groundwater surrounding most of the lake is considered to be in strong hydraulic connection with the lake water.

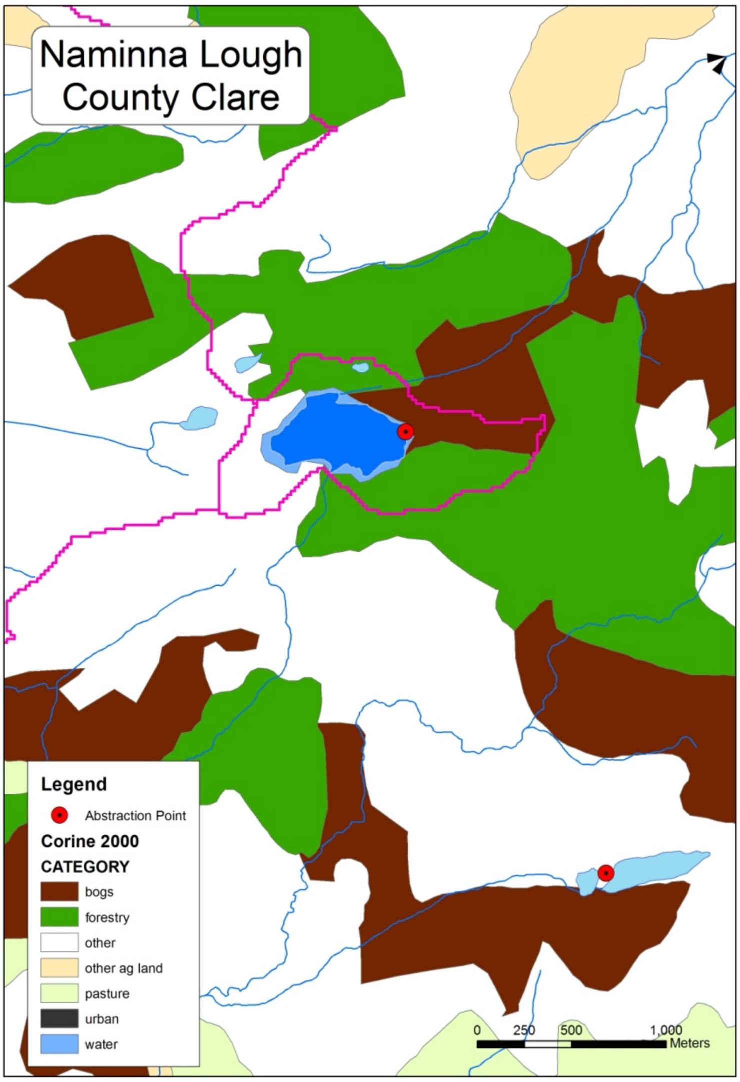

Figure 3-4: Example of Lake with Surface Inflow Estimated using the Rational Method

Lakes considered in the GWD category may also receive significant inflow from overland flow, but an assessment of the contribution of overland flow versus groundwater contribution and direct net precipitation on the lake would require development of a lake-specific water budget.

Of the 18 lakes in the GWD category, conduit karst surrounds 10 lakes in Counties Limerick, Mayo, Sligo, Roscommon and Clare, bedrock with karstic features underlies four of the lakes in Counties Westmeath, Donegal, Meath and Monaghan and bog surrounds three of the lakes in Donegal and Galway. The nature of the recharge to Bofinna Lough in Co. Cork was unclear at this stage (See Section 5.3).

The bog lakes - Loughs Aughrusbeg and Illauntrasna in Galway and Lough Birroge in Donegal - have catchments ranging from 0.5 to 1.4 km^2 and the karst catchments range between 0.3 and 4.8 km^2. All three bog examples and Bofinna

Lough are in areas of poorly-productive bedrock, yet support abstractions of up to 1,500 m^3/day (two @ < 100 m3/day; one @ 600 m^3/day; and one @ 1500 m^3/day). The abstraction rates for the karst lakes range from about 115 m^3/day (Holan Lough) to about 5,000 m^3/day (Grange Lough and Lough Lene).

For the Stage 1 screening, the Rational Method described above in Section 3.4.3 was used to estimate recharge to the lakes in the GWD category and the results are presented in Table C-4 of Appendix C. This is considered a conservative approach, particularly for lakes likely to be supported by karst-derived groundwater. Groundwater inflows to the lakes that pass the Stage 1 screening are examined in Section 5.3.

3.6 Net Abstractions

Net abstractions for the lake catchments are the summation of the abstractions listed in the national abstractions register minus any known discharges from the national discharge register. The discharge register contains municipal and industrial point source discharge information for urban waste water treatment plants, industries with an IPPC license granted by EPA and Section 4 discharges from industries licensed by Local Authorities.

As discussed in Section 2.3.2, the abstractions register was updated through inquiries to the Local Authorities throughout Ireland and it is believed that most public and group water schemes have been identified and included, but it is unlikely that all small private abstraction schemes (especially agricultural) are captured.

Section 3.3 discussed the incomplete data available for industrial and municipal discharges. However, very few such discharges are listed within the catchments of the 127 1a/1b lakes. In total, nine catchments of 1a/1b lakes include registered WWTP discharges, two catchments include registered IPPC discharges (one of which is listed as a zero discharge), and ten catchments include Section 4 discharges (two of which are listed as zero discharges). While these low numbers may reflect omission of data from the registers, it is also likely that the numbers of discharges within the catchments used for drinking water are restricted by the Local Authorities. Of the lake catchments that do contain discharges, they are largely restricted to the 30 largest catchments. The total discharges and net abstractions for each of the 127 catchments are listed in Table D-1 of Appendix D.

3.7 Ratio of Net Abstractions to Lake Inflow

Table E-1 also includes the ratio of net abstractions (abstractions – discharges) to lake inflow (Q50 - as derived from the methods described above) for each of the 127 lake catchments. The data are ranked by ratio; catchments with the greatest proportion of abstractions to inflow have the highest ratios.

Two lake catchments have ratios of less than zero, indicating that registered point source discharges within the catchment exceed the registered abstractions, so that the net abstraction values are negative. The values for the negative ratios are small (-0.025 for Lough Annagh and -0.012 for Lough Drumlona) indicating that the net discharge amounted to about 1-2% of the estimated annual average inflows for these loughs.

Six lakes are listed in Table E-1 with neither registered abstractions nor registered discharges in the catchment; their inclusion is likely due to the presence of either a dam or a weir on the lake (in the Initial Risk Assessment method a catchment with a dam or weir was automatically assigned to the "at risk" [1a] category).

As a first-stage screening for at-risk lakes, a threshold level of 0.3 for the ratio of net abstractions to inflow was presented to the project steering group at the 13 March 2008 meeting. The project steering group indicated that a threshold level of 0.3 was unacceptably high. Consequently, a revised threshold value of 0.1 was proposed. The threshold value of 0.1 for the ratio of net abstractions to lake inflow is considered a conservative approach using scientific judgement and was not adopted on the basis of quantitative ecological parameters. Figure 3-5 shows the 0.1 threshold level on the cumulative distribution curve of ratios for all 1a/1b lakes. With the net abstraction to inflow ratio of 0.1 used as the threshold value for screening out lakes not considered to be at risk, 49 of the 127 catchments have a ratio lower than the 0.1 threshold value and 78 lakes were retained for further study.

Of the 78 lakes that remained after the screening, 71 lake catchments have ratios ranging from 0.1 to 0.82, while one lake had a ratio of 0.939, and six lakes have ratios exceeding 1.0, indicating a greater level of net abstraction from the catchments provided by surface inflow. The seven lakes with the highest ratios were subject to additional investigation to verify data, as these lakes would appear to be at extremely high risk for over-abstraction.

Characteristics of the seven lakes -- including the net abstractions to inflows ratio, catchment and lake areas, and soils data for the catchment -- are summarised in the Table 3-3. The seven catchments and their lakes are generally very small in extent. Except Grange Lough in Co. Roscommon, all of the catchments are less than 1 km^2 in area; the lake areas range from in size from 3 ha (Cullionboy) to 14 ha (Killcoran). The underlying bedrock is poorly productive for four of the seven lakes, productive fissured rock in the case of Carrigavantry, conduit karst in the case of Grange Lough and karstified bedrock in the case of Spring Lough. Other features common to these seven lakes is that none has a registered discharge within the catchment and all inflows were estimated by the Rational Method.

Follow-up enquires were made to the Local Authorities in Counties Monaghan, Donegal, Meath, Waterford, and Roscommon in an attempt to validate the abstraction and discharge data, and to obtain quantitative or anecdotal information regarding the effects of lake abstractions on lake levels.

Co. Monaghan

Killcorran Lough, Spring Lough and Corconnelly Lough are in Co. Monaghan. Monaghan County Council report no known problems with the abstractions from these lakes nor is the local authority aware of any significant lake level variation in Killcorran or Corconnelly Loughs. The County Council report that the abstraction level from Kilcorran Lough has been increased from 730 m^3/d to 1,032 m^3/d and that the abstraction level from Corconnelly Lough has been decreased from 1,500m^3/d to 1,300 m^3/d.

Revision of the abstraction rates for Kilcorran and Corconnelly Loughs changes to the catchments' ratios of net abstractions to inflow. The value for Kilcorran Lough increases from 0.939 to 1.325 and for Corconnelly Lough the ratio decreases from 3.472 to 3.009.

Table 3-3: Lakes with Net Abstractions to Inflow Ratios > 1.0

Lake County	Catchment Area, including lake area (km^2)	Lake Area (km^2)	Estimated Q_{50} (m^3/sec)	Initial Abstn. (m^3/s)	Revised Abstn. (m^3/s)	Initial Ratio	Revised Ratio [1]	Soils
Brackan Lough Meath	0.750	0.076	0.008	0.010	0.008	**1.266**	**1.013**	Peat/Dry soils
Killcoran Lough Monaghan	0.472	0.144	0.009	0.008	0.012	**0.939**	**1.325**	Peat/Dry soils
Carrigavantry Reservoir Waterford	0.720	0.119	0.011	0.017	0.017	**1.578**	**1.578**	Peat/Dry soils
Cullionboy Lough Donegal	0.078	0.029	0.003	0.004	0.005	**1.466**	**1.606**	Peat & Wet soils
Grange Lough Roscommon	2.785	0.078	0.035	0.057	0.057	**1.634**	**1.634**	Peat and wet soils
Spring Lough Monaghan	0.816	0.103	0.010	0.021	0.021	**2.083**	**2.083**	Peat and wet soils
Corconnelly Lough Monaghan	0.354	0.056	0.005	0.017	0.015	**3.472**	**3.009**	Peat and dry soils

[1] Revised net abstraction: inflow ratios are calculated using revised abstraction volume described in the text below.

Co. Donegal

Donegal County Council is not aware of any problems attributable to over abstraction of Cullionboy Lough. They also report that the abstraction level from Cullionboy Lough has been increased from 380m^3/d to 416m^3/d. This change in abstraction resulted in a change in the ratios of net abstractions to inflow from 1.466 to 1.605.

In the early draft of this report, the net abstraction: inflow ratio for Naglea Lough was also greater than 1.0. Discussions with the County Council indicated that the lake level in Naglea Lough had been declining due to over-abstraction, and thus, the abstraction volume was reduced from 767m^3/d to 565m^3/d, and that the level has been increased over the last two years. At the reduced abstraction level, the ratio for Nagela Lough changed from 1.11 to 0.817.

Co. Meath

Meath County Council reports no problems supplying water from Brackan Lough and also that there is no significant fluctuation in lake level. The County Council has re-checked the abstraction volume and now estimate it to be 700 m^3/d, instead of the previously-reported 875 m^3/d. They also report that the Brackan Lough abstraction is derived partly via direct abstraction from the lake (2/3s or 467 m^3/d) and partly from 2 boreholes located very close to the lake (1/3, or 233 m^3/d). According to the County Council, the water derived from the wells is induced flow from the lake.

Revision of the abstraction rate for Brackan Lough to 700 m^3/d from 875 m^3/d decreases the ratio of net abstractions to inflow from 1.266 to 1.013. Although the majority of the abstraction from the boreholes at Lough Brackan may be derived from induced flow from the lake, it is likely that some portion of the abstraction is also derived from groundwater.

Co. Roscommon

There are two Grange Loughs in Roscommon. The current abstraction is from the smaller Grange Lough. Roscommon County Council has just proposed a new abstraction of up to 4,000 m^3/day from the larger Grange Lough, increasing to about 13,000 m^3/day in 20-25 years time. The plans include abandoning the current abstraction in the smaller Grange Lough.

The distribution of ratios for all of the 1a/1b lakes are presented in Figures 3-5 and 3-6. These figures include revision to the ratios as presented in Table 3-3. Figure 3-5 shows the cumulative distribution of the ratios for all catchments; Figure 3-6 shows the same distribution but without the outlier point for Corconnelly Lough in Co. Monaghan, the ratio for which is 3.009.

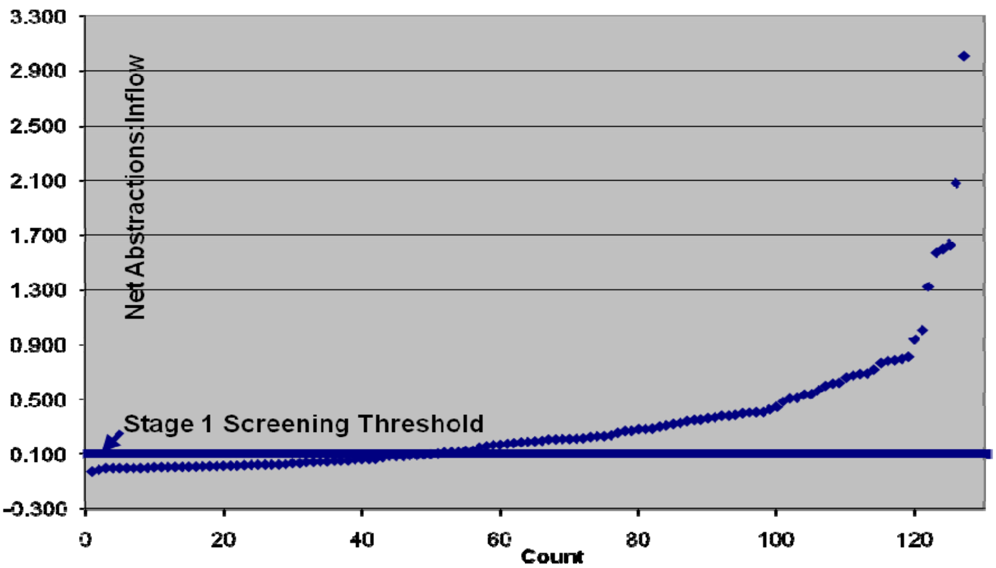

Figure 3-5: Ratios of Lake Catchment Net Abstractions to Inflow for all Lakes

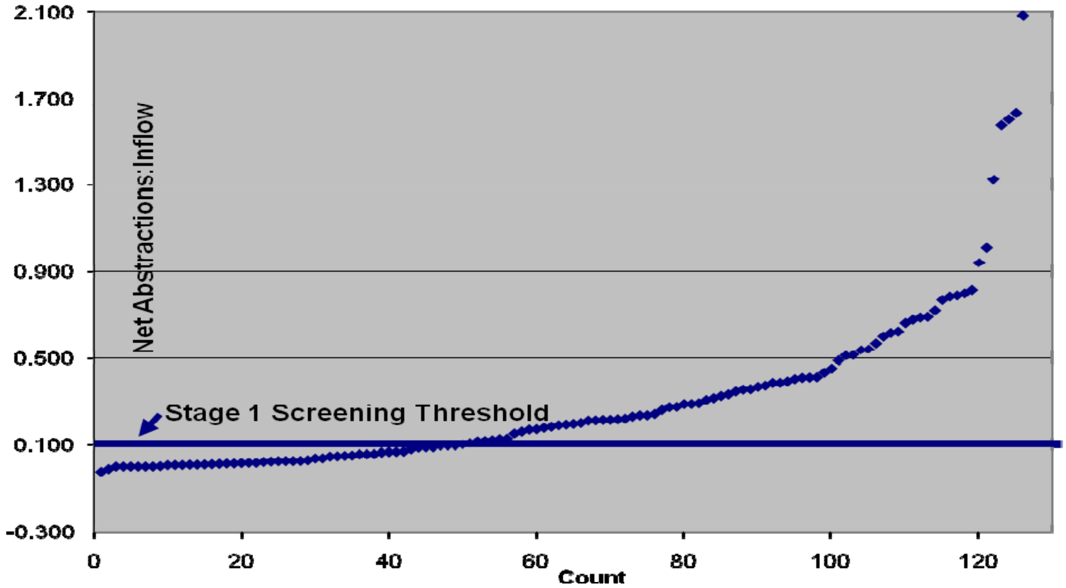

Figure 3-6: Ratios of Lake Catchment Net Abstractions to Inflow for all Lakes with Outlier Removed

3.8 Stage 1 Summary

A threshold value of 0.1 for the ratio of net abstractions to inflow was proposed for the first stage of screening for those at risk from over-abstraction. Figure 3-7 provides the distribution of lakes by area of their catchment and the results of the Stage 1 screening analysis. 65% of the lakes retained after the first stage screening have catchment areas less than 2 km². This finding has important implications for the focus on future lake monitoring and other data collection efforts on small lake catchments, which thus far tend to have been focused on larger Irish lakes (refer to Section 5.4 for monitoring recommendations). The seven lakes with catchments greater than 10 km² that were retained after Stage 1 screening are: both Glensamole Reservoirs (Co. Dublin), Doo Lough (West Clare), Ballyshunnock (Co. Waterford), Lough Lene (Co. Westmeath), Lough Garty and the Nadreegeal Loughs (Co. Cavan).

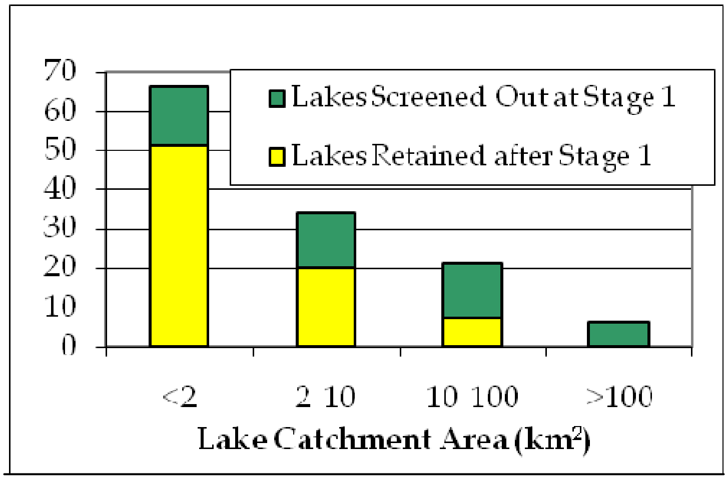

Figure 3-7: Count of Lakes by Catchment Area and Stage 1 Screening Results

Derivation of the net abstraction: inflow ratio is subject to several sources of error. The most significant potential sources of error appear to be the accuracy and completeness of the data for abstractions and for discharges within the catchments. While significant effort was expended to update the National Abstractions Register and the IPPC, WWTP and Section 4 discharge registers, the records are incomplete, and many records could be out-of-date or have inaccurate volumetric, population or location data.

The proportion of actual – or potential – lake recharge from groundwater introduces another element of uncertainty into the analysis and screening of lakes for those at risk from over abstraction. Lakes subtended by very productive aquifers such as conduit karst and fractured limestone can derive substantial recharge from groundwater to compensate for lake abstractions. Thus, the assessment of groundwater-dependent lakes in Stage 1, which only considers surface inflows has given a conservative result toward keeping these lakes in a 1a/1b category. Section 6.3 further examines groundwater-dependent lakes.

Using a threshold value of 0.1 for the ratio of net abstractions to inflow, 78 lakes of the initial 127 lakes remain at risk following the Stage 1 screening described above. Based on this threshold, it is recommended that the 49 lakes listed in Table 3-4 are reclassified as water bodies probably not at significant risk (2a). These lakes will not be considered further under the current study.

The screening of the 127 1a/1b lakes in this project should be an ongoing process. As better data become available for abstractions and discharges, as well as stream gauging data and lake-level monitoring data, then ratios of net abstractions to inflows should be recalculated periodically. The recommendations section addresses some of the data needs identified during execution of Stage 1 that would allow for improvements of future assessments of abstraction pressures on lakes.

Table 3-4: Lakes Proposed for Reclassification to Water Bodies Probably Not at Risk (2a) from Abstractions

No.	WFD Code	Lake Name	County	Article V Risk	Revised Risk Assessment
1	IE_NW_36_517	Annagh Lough	Cavan	1a	2a
2	IE_NW_36_432	Ardan Lough	Cavan	1a	2a
3	IE_EA_07_275	Ramor Lough	Cavan	1a	2a
4	IE_NW_36_385	Cullinaghan Lough	Cavan	1a	2a
5	IE_NW_36_513	Kilywilly Lough	Cavan	1b	2a
6	IE_NW_36_363	Tacker Lough	Cavan	1b	2a
7	IE_NW_36_528	Sillan Lough	Cavan	1a	2a
8	IE_NW_36_468	Clonty Lough	Cavan	1a	2a
9	IE_SH_27_123	Ballybeg Lough	Clare	1a	2a
10	IE_SH_27_120	Rosroe Lough	Clare	1a	2a
11	IE_SW_20_158	Curraghalicky Lake	Cork	1b	2a
12	IE_SW_19_138	Inniscarra Reservoir	Cork	1a	2a
13	IE_SW_20_148	Abisdealy Lough	Cork	1a	2a
14	IE_SW_20_153	Coolkellure Lake	Cork	1a	2a

No.	WFD Code	Lake Name	County	Article V Risk	Revised Risk Assessment
15	IE_NW_36_715	Golagh Lough	Donegal	1a	2a
16	IE_NW_38_83	Anure Lough	Donegal	1a	2a
17	IE_NW_37_188	Eske Lough	Donegal	1b	2a
18	IE_NW_38_47	Kiltooris Lough	Donegal	1a	2a
19	IE_NW_38_57	Birroge Lough	Donegal	1a	2a
20	IE_NW_38_22	Glen Lough	Donegal	1a	2a
21	IE_NW_37_140	Meenaviller (Lough)	Donegal	1a	2a
22	IE_NW_37_194	Croagh Lough	Donegal	1a	2a
23	IE_WE_32_436	Aughrusbeg Lough	Galway	1b	2a
24	IE_WE_32_474	Tully (Lough)	Galway	1a	2a
25	IE_WE_32_479	Ballynakill Lough	Galway	1a	2a
26	IE_WE_30_332	Coolin Lough	Galway	1a	2a
27	IE_SW_21_440	Cummer Lough	Kerry	1a	2a
28	IE_SH_23_59	Acummeen (Lough)	Kerry	1a	2a
29	IE_SW_21_429	Coomclogherane Lake	Kerry	1a	2a
30	IE_SW_21_405	Dromtine Lough	Kerry	1b	2a
31	IE_NW_35_160	Melvin Lough	Leitrim	1b	2a
32	IE_WE_35_131	Anarry (Lough)	Leitrim	1a	2a
33	IE_NW_36_201	Nabellbeg (Lough)	Leitrim	1a	2a
34	IE_WE_32_428	Lugacolliee Lake	Mayo	1b	2a
35	IE_WE_34_402	Washpool Lough	Mayo	1a	2a
36	IE_WE_32_432	Ard (Lough)	Mayo	1a	2a
37	IE_WE_32_364	Ballin Lough	Mayo	1a	2a
38	IE_NB_06_54	Ervey Lough	Meath	1a	2a
39	IE_NW_36_525b	Drumlona Lough	Monaghan	1b	2a
40	IE_NB_03_3	Grove Lough	Monaghan	1a	2a
41	IE_NW_36_526	Inner Lough	Monaghan	1a	2a
42	IE_NW_36_525a	Drumore Lough	Monaghan	1b	2a
43	IE_NW_36_647	White Lough	Monaghan	1a	2a
44	IE_NB_03_79	Glaslough Lake	Monaghan	1a	2a
45	IE_NB_06_234	Monalty Lough	Monaghan	1a	2a
46	IE_NB_06_244	Muckno Mill Lough	Monaghan	1a	2a
47	IE_NW_36_623	Bawn Lough	Monaghan	1a	2a
48	IE_NW_36_415	Drumgole Lough	Monaghan	1a	2a
49	IE_WE_35_136	Easky Lough	Sligo	1a	2a

Section 4
Stage 2 Screening

Lakes retained following the Stage 1 screening described in Section 3 were examined further based on bathymetric parameters and lake shoreline development parameters in this section. The main aim was to screen out further lakes that might not be at risk from abstractions.

Abstraction-related impacts are dependent on the bathymetry of individual lakes, with those subject to the greatest shoreline exposure due to over-abstraction (or shoreline immersion due to rising water levels) being the most vulnerable to declines in their ecological status.

The most important aspects of lake water level changes include the range of water level fluctuation, which establishes the area of the shallow littoral zone, frequency of shoreline immersion or emersion, which affects the degree of desiccation, and the duration of the low (or high) water events.

4.1 Shoreline Development Ratio

This ratio is used in limnology studies as a measure of the extent of littoral areas, by assessing how dendritic a lake is. Dendritic systems usually have numerous coves and bays, or extensive littoral areas and, therefore, the potential for greater biological activity.

It is noted that the accuracy and resolution of the GIS data may affect the ability to resolve the lake dendricity when bays on a small scale are too small to be resolved at the mapping scale. This will tend to bias the dendricity of small lakes towards a lower value than those of larger lakes, on which bays can be resolved at the mapping scale.

The shoreline development ratio is the ratio of the shoreline length (LS) to the circumference of a circle of area equal to the surface area (A) of the lake. Large ratios indicate very irregular or dendritic systems and highly dendritic lakes can reach a ratio of 15 or higher. The shoreline development ratio (SDR) is calculated as:

$$SDR = LS/(2(\pi A)^{0.5})$$

where LS is the shoreline length (km) and A is the lake area in km^2.

Figure 4-1 shows the cumulative distribution of the shoreline development ratios for all 127 lakes. The distribution is relatively linear from values of 1 up to values just over 2. The shoreline development ratios for 111 of the 127 lakes fall along this linear distribution; the remaining 26 lakes have values increasing from 2.13 to 5.88, with Inniscarra Reservoir in Co. Cork having the highest value. The distribution of the shoreline development ratio for only the lakes remaining after the Stage 1 screening differs (Figure 4-2).

The data set used for Figure 4-2 removed one outlier, the Nadreegeal Loughs in Co. Cavan, which have an artificially high shoreline development ratio because two loughs are considered as a single waterbody, being linked by a canal. Lough Anaserd in Co. Galway is the remaining outlier and appears to be naturally dendritic. For the remaining 78 lakes retained from the Stage 1 screening, the cumulative distribution is quite linear, with values between 1.11 and 2.07. This indicates that the shoreline development ratio is not a strong differentiating factor for Stage 2 screening.

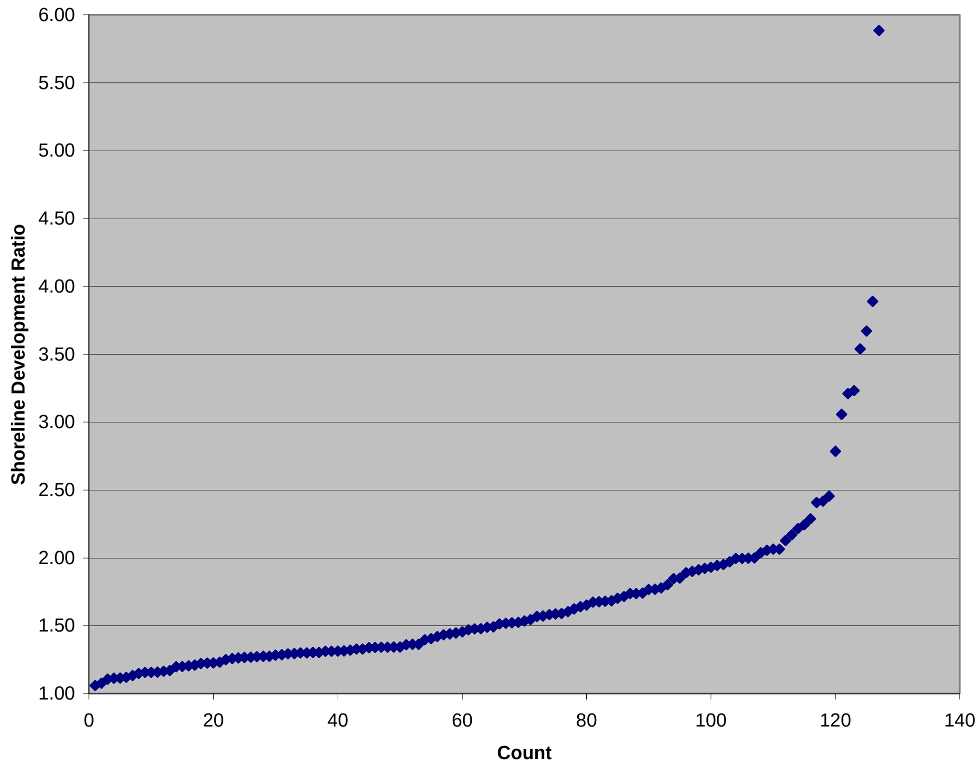

Figure 4-1 Shoreline Development Ratio for all 1a/1b Lakes

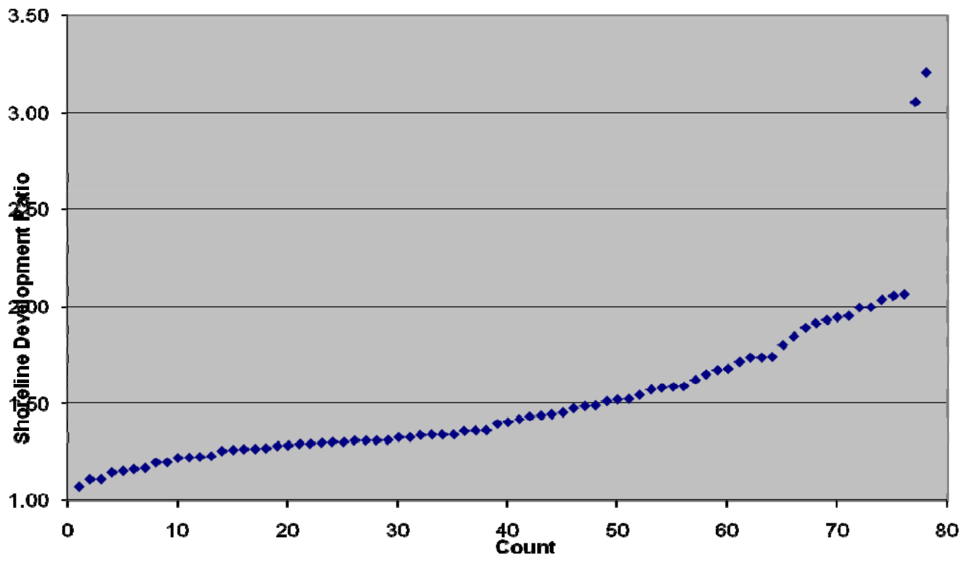

Figure 4-2 Shoreline Development Ratio for Lakes with Net Abstraction : Inflow Ratio > 0.1

4.2 Lake Bathymetry

Bathymetric maps are essentially a topographic map of the lake bottom that shows depth contours of the lake basin. A bathymetric map allows for the determination of several lake characteristics, such as maximum lake depth, mean lake depth and the lake volume. Lake bathymetry reports and maps are available for 24 of the 78 1a/1b lakes retained from the Stage 1 screening. Lake depth and volume data are available for an additional three lakes. The bathymetric maps and reports will be provided to the EPA. Bathymetry maps are also used in Section 5 to examine basin form.

4.2.1 Lake Hydraulic Residence Time

Hydraulic residence time is the time required to refill an empty lake with its natural inflow. The overall hydraulic residence time is calculated by dividing the lake volume by the average inflow, ideally factoring groundwater seepage to the lake. Calculation of the overall residence time assumes that the lake water is not stratified and the lake can be treated as a homogeneous unit. However, larger and deeper lakes tend to be more stratified, with deeper water mixing infrequently with surface water. Such lakes are often better considered as several distinct units.

Table 4-1 presents the estimated residence times for lakes retained from the Stage 1 screening and for which lake volume data is available. The residence time is calculated simply as the lake volume divided by the Q50 surface inflow values. As all of the lakes are relatively shallow, there is not likely to be significant lake stratification. The contribution of groundwater inflow to the lake is not considered in the calculation of residence time; in the case of, Cavetown (Roscommon), Holan

(Mayo), Lene (Westmeath), Bane (Meath) and Labe (Sligo) Loughs, which are subtended by conduit karst or influenced by karstic features, the contribution of groundwater seepage is expected to be significant and the lake retention time will be shorter than the tabulated estimates.

Table 4-1 indicates that eight of the lakes are subject to a monthly abstraction that is greater than 5% of that lake's volume: Moher (Mayo); Illauntrasna (Galway); Loughaunore (Galway); Fawna (Galway); Nambrackkeagh (Galway); Carrowlustia (Sligo); Callee (Kerry) and Tooreen (Kerry). In the case of Carrowlustia, the estimated monthly abstraction of 76% of the lake volume significantly exceeds the value for the other lakes. Lough Carrowlustia is relatively small (4.35 ha) and has a relatively high abstraction rate of 5,900 m^3/day. The estimated median inflow to the lake is also relatively high, at more than twice the abstraction rate.

4.2.2 Bathymetric Mapping

Bathymetry of lakes is crucial to determining the potential shoreline exposure resulting from fluctuations in water level, as the shoreline ecosystem will suffer when exposed or immersed for prolonged periods. The most important aspects of lake water level changes include the range of water level fluctuation, which establishes the area of the shallow littoral zone, frequency of shoreline immersion or emersion, which affects the degree of desiccation, and the duration of the low (or high) water events.

Quantifying the effects of over-abstraction on the shallow littoral habitat requires an understanding of shoreline slope and wave exposure; information that is generally not available for Irish lakes. The areal extent of the affected littoral zone will be dependent on shoreline slope and the drop in water level. The water level drop in turn is a factor of the lake volume, the ratio of the abstractions to lake volume, and the significance of the abstraction-related water-level change relative to other climatic variations affecting lake levels.

The bathymetric reports were compiled principally by the Western, South Western, and Eastern River Basin Districts and indicate that many of the loughs have shallow littoral zones in part, if not all, of the lake. The lakes in general are shallow, averaging just over 5 metres mean depth; six of the loughs have a mean depth of less than 3 m (Nadreegeal Loughs, Skeagh Lough Upper, Illauntrasna, Fawna, Nambrackkeagh and Tooreen Loughs).

In general, the shallowest lakes will be impacted over a greater area from over abstraction, while deeper loughs, with more steeply shelving littoral zones will be impacted over a greater vertical zone. If a large abstraction depletes the water level below the littoral zone in deeper lakes, then that would deplete the macrophytes and other biota. However, in a shallow lake with an extensive littoral zone, the loss of littoral area would be greater than in a deeper lake, particularly for those lakes where the majority of the lake area may be littoral.

Table 4-1 Monthly Abstractions as Percentage of Lake Volumes and Estimated Lake Residence Times

Lake Name	County	Lake Volume (m^3)	Monthly Abstraction (m^3)	Monthly Abstraction (as % of Volume)	Q50 Inflow m^3/s	Lake Residence Time (days)
Anaserd (Lough)	Galway	2,794,800	26,460	0.95%	0.085	381
Doo Lough	Clare	7,304,080	105,000	1.44%	0.589	144
Acorrymore (Lough)	Mayo	2,720,718	41,550	1.53%	0.093	339
Talt (Lough)	Sligo	8,664,150	233,670	2.70%	0.144	696
Loughaunwillan	Galway	2,189,257	67,980	3.11%	0.132	192
Nadreegeal Loughs	Cavan	3,892,810	130,080	3.34%	0.067	672
Cummernamuck (Lake)	Kerry	682,066	23,850	3.50%	0.042	188
Aille Lough	Mayo	164,922	5,850	3.55%	0.005	382
Lickeen Lough	Clare	3,285,360	126,000	3.84%	0.172	221
Skeagh Lough Upper	Cavan	1,348,380	64,500	4.78%	0.070	223
Moher Lough	Mayo	1,446,247	102,240	7.07%	0.182	92
Illauntrasna (Lough)	Galway	162,822	19,230	11.81%	0.018	105
Loughaunore	Galway	190,808	27,030	14.17%	0.027	82
Fawna (Lough)	Galway	22,778	4,080	17.91%	0.006	44
Nambrackkeagh (Lough)	Galway	91,277	19,080	20.90%	0.020	53
Carrowlustia Lough	Sligo	233,463	177,330	75.96%	0.158	17
Eirk Lough	Kerry	269,514	11,730	2.50%	0.025	125
Callee Lough	Kerry	1,772,452	45,420	8.10%	0.081	253
Mount Eagle Lough	Kerry	300,679	15,000	2.10%	0.021	166
Tooreen Lough	Kerry	69,917	6,000	8.58%	0.015	54
*Lene	Westmeath	35,214,750	135,000	0.38%	0.254	1605
*Labe (Lough)	Sligo	271,015	3,990	1.47%	0.015	209
*Bofinna Lough	Cork	318,923	45,000	2.40%	0.024	154
*Holan (Lough)	Mayo	217,385	3,450	1.59%	0.006	419
*Bane (Lough)	Meath	3,953,580	120,000	3.04%	0.060	763

*Note *: The contribution of groundwater inflow to the lake is not considered in the calculation of residence time*

The bathymetric map of Lough Acorrymore indicates that it has a relatively steeply-sloping shoreline relative to the other lakes for which reports are available. The average depth of Lough Acorrymore is nearly 20 m. Of the remaining loughs for which bathymetric maps are available, Lough Holan has a relatively steeply-sloping littoral zone (and an average depth of over 7 m) and Lough Talt has a relatively steeply-sloping littoral zone on its west side and an average depth of about 10 m. Lough Callee in Co. Kerry has an average depth of nearly 10 m and a maximum depth of nearly 27 m, but without steep lake-bed gradients. In Section 5.2 basin form which is a measure shape of the lake is used to as an metric to show the sensitivity a lake has to abstractions.

4.3 Stage 2 Summary

Abstraction-related impacts are dependent on the bathymetry of individual lakes, with those subject to the greatest shoreline exposure due to over-abstraction (or shoreline immersion due to rising water levels) being the most vulnerable to declines in their ecological status. The most important aspects of lake water level changes include the range of water level fluctuation, which establishes the area of the shallow littoral zone, frequency of shoreline immersion or emersion, which affects the degree of desiccation, and the duration of the low (or high) water events.

Quantifying the effects of over-abstraction on the shallow littoral habitat requires an understanding of shoreline slope and wave exposure; information that is generally not available for Irish lakes. The areal extent of the affected shallow littoral zone will be dependent on shoreline slope and the drop in water level. The water level drop in turn is a factor of the lake volume, the ratio of the abstractions to lake volume, and the significance of the abstraction-related water-level change relative to other climatic variations affecting lake levels. Lake bathymetry reports and maps are available for 24 of the 78 lakes retained from the Stage 1 screening, while depth and volume data are available for another three lakes.

The linear distribution of the shoreline development ratios and the lack of bathymetric data for the lakes retained from the Stage 1 Screening limit the utility of the proposed Stage 2 screening techniques. However the methods used in Stage 1 and 2 to give a useful indication of the lakes with a more significant risk of abstractions effecting the ecological health of the lake's communities, by showing the lakes with:

- the highest ratios of net abstractions to lake inflow;
- the greatest shoreline development ratio;
- steeply-sloping and relatively shallow littoral zones or extensive shallow littoral zones; and
- greatest abstraction as a percentage of the lake volume

However, without bathymetry for all of the 78 lakes retained from Stage 1 screening – or even a majority of these lakes – it is not possible to propose a re-categorisation of those lakes.

Section 5
Stage 3 Site Specific Assessments and Monitoring

5.1 Objectives and Approach

The 78 lakes retained following the Stage 1 and 2 screening were examined on a site-specific basis with the main aims of:

- Reviewing information about lakes and examining any evidence of abstraction pressures, and conducting field visits to representative lakes,
- Determining if any additional lakes are not at risk from abstractions, including further evaluation of potential groundwater-dependent lakes identified in Stage 1, and
- Selecting lakes for future abstraction pressure evaluation, including recommending lakes for lake level monitoring for abstraction pressures.

The approach to Stage 3 is shown in Figure 5-1; this approach was developed with the aid of Deidre Tierney of the EPA. In Stages 1 and 2, data assessment focused primarily on readily available GIS data that allowed for all lakes to be ranked based on their ratio of net abstractions to lake inflow and examined using other morphometric parameters. In Stage 3, further information was obtained about the lakes that allowed for a desktop evaluation of the environmental setting, the ecology of the lake and the pressures on the lake.

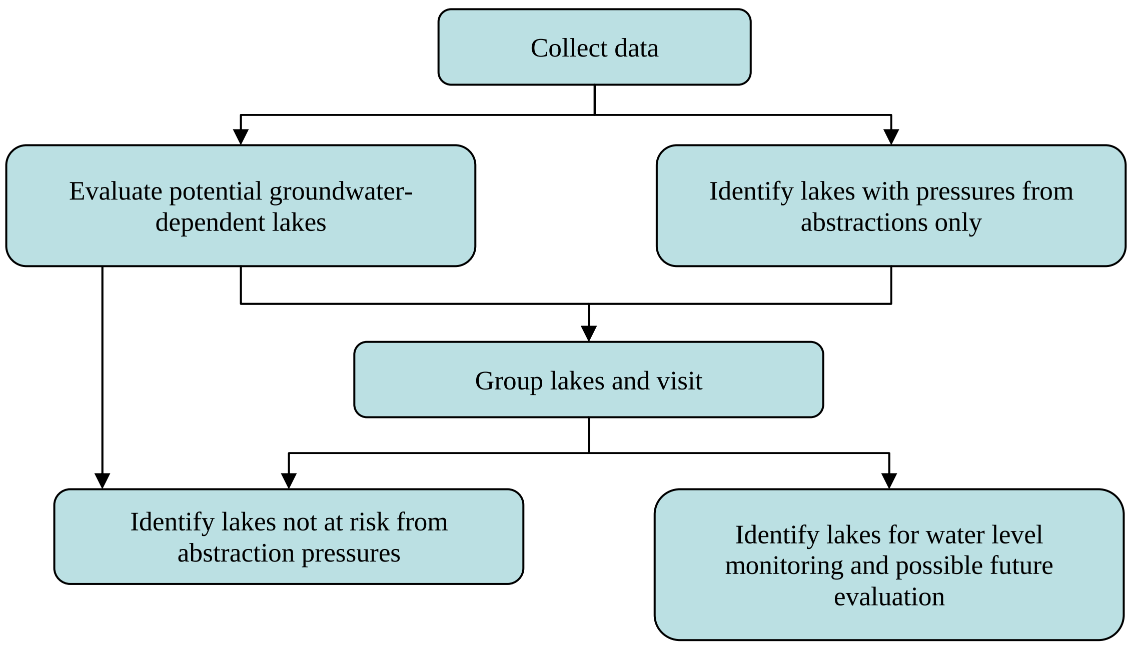

Figure 5-1: Approach to Stage 3

Following data collection, Stage 3 work proceeded on two tracks: (1) further evaluation of potentially groundwater dependent lakes to determine if the lakes had a sufficient strong connection with groundwater to mitigate any impacts at the current net abstraction level, and (2) further screening of lakes remaining after Stages 1 and 2 to those with only abstraction pressures. The Stage 3 screening process was completed using EPA's status classification, the results of the Article V risk characterisation and scrutiny of catchment activities to identify potential pressures other than abstraction pressures that could have an effect on the lakes' ecological health. Field visits were conducted at selected lakes to verify data collected in the desktop study and to look for any evidence of abstraction impacts.

From these lakes a selection are recommended as suitable for water level monitoring for the future monitoring of abstraction pressures. An emphasis was put on lakes with small catchments as the majority of those at risk have small catchments. The characteristics of an abstractions-related typology were identified to highlight lakes that may be more sensitive to abstractions.

5.2 Methodology

5.2.1 Data Collection and Review

For this stage of data collection, data was gathered and compiled about the environmental setting of the lakes, the ecology and pressures on the lake. The main data sources were;

- Environmental Protection Agency (EPA);
- National Parks and Wildlife Service (NPWS);
- Fisheries Boards;
- Teagasc;
- Geological Survey of Ireland (GSI);
- Ordnance Survey of Ireland (OSI);
- CORINE land use data; and
- River Basin District projects.

General environmental data about the lakes was gathered, which included the dominant soils, subsoils, aquifer type and bedrock from Teagasc and GSI data. Further bathymetry data was also collected from the River Basin Districts. Where water level data was available it was compared against daily rainfall records from the nearest Met Éireann rainfall gauge.

Data relating to other pressures on the lake systems was also compiled. The EPA Interim Status Classification for lakes was used as well as the Article V characterisation risk test results. Pressure data was also gathered from the CORINE land use data to examine pressures near the shore that may not have been captured in the risk tests or status classification. This was also verified using aerial photography and OSI Discovery Series maps.

5.2.1.1 Ecology

Lake ecology information was collected from several sources. The Western RBD, North Western RBD and the Western Regional Fisheries Board compiled some general ecological data during their bathymetry surveys. They noted the presence of reed beds, aquatic vegetation, *Chara* beds and algae (WRBD, 2006).

Biological monitoring data was obtained from the EPA and the Central Fisheries Board (CFB). A marcophyte species list was obtained from the EPA for the lakes at which macrophytes are monitored. Details on fish stocks, species richness and dominant species were obtained from CFB for the WFD surveillance monitoring sites. Table 5-1 shows the list of lakes for which the biological data was available.

Table 5-1: List of Lakes where Biological Monitoring Data was Obtained

Macrophyte (EPA)	Fish (CFB)
Acurry (Lough)	Bane (Lough)
Anaserd (Lough)	Cavetown Lough
Atrain (Lough)	Lene
Bane (Lough)	Talt (Lough)
Doo Lough	
Drumkeery Lough	
Garty Lough	
Lene	
Lickeen Lough	
Loughaunore	
Loughaunwillan	
Mill Lough	
Moher Lough	
Nadreegael Loughs	
Nambrackkeagh (Lough)	
Naminna (Lough)	
Talt (Lough)	
Skeagh (Lough)	
Upper Lough Skeagh	

Data was obtained from the NPWS about the lakes and neighbouring habitats within Special Areas of Conservation (SACs) and National Heritage Areas (NHAs). SACs are sites that have been identified to be of conservation importance in a European context under the Habitats Directive 1992, based on the habitats and species -- both plant and animal -- that they support. Habitats listed in Annex I are those habitat types of community interest whose conservation requires the designation of Special Areas of Conservation. In Ireland these habitats include raised bogs, blanket bogs, turloughs, sand dunes, machair, heaths, lakes, rivers, woodlands, estuaries and sea inlets (NPWS, 2008). Of the 78 lakes retained from Stage 1 and Stage 2 screening, 21 lakes are located within SACs and only 15 of these are SACs because the lakes themselves are Annex I lake habitats, as presented in Table 5-2.

Table 5-2: Lakes at Risk from Abstraction whose Habitats Conservation Requires a Special Areas of Conservation (SAC) Designation

Habitat Code	SAC – Annex I Habitats	Number of Lakes	Counties
3.	FRESHWATER HABITATS		
31.	**Standing water**		
3110	Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*)	6	Kerry, Galway, Sligo and Donegal
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*	2	Mayo and Waterford
3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.	4	Galway, Meath, Donegal and Westmeath
3150	Natural eutrophic lakes with *Magnopotamion*or *Hydrocharition* — type vegetation	2	Cavan
3160	Natural dystrophic lakes and ponds	1	Leitrim

One of these protected habitats known to be sensitive to water level change is "Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.". It is a habitat where the water is typically clear and the lake sediment usually has a high proportion of marl, a white clayey precipitate of calcium carbonate. Marl-forming stoneworts (*Chara* spp.) are often abundant and may form dense carpets in unpolluted waters, which are a major feeding ground for fish, especially trout. Decreasing water levels in these lakes (as occurs due to abstraction) reduces the water depth in the near-shore areas increasing the risk that wave action will uproot young *Chara* plants or cause resuspension of the fine marl sediment which may deposit and smother young *Chara* plants (King and Champ, 2000). Two of the four protected *Chara* lakes are groundwater dependent; Lough Lene and Lough Bane. The NPWS (2006) say that *Chara* lakes habitats have a high sensitivity to changes in groundwater quantity also. These lakes are also susceptible to eutrophication, which can also cause a decline in *Chara* populations (King and Champ, 2000).

NHAs are protected under the Wildlife Act 2000 and include the best remaining areas of Ireland's natural and semi-natural habitats. Sites may have been selected by virtue of having special scientific significance for one or more species, communities, habitats, landforms, geological or geomorphological features, or for a diversity of natural attributes. Depending on their quality and importance, NHAs may carry other designations including SAC; 27 of the 78 lakes are within NHAs, 16 of which are also SACs.

Arctic char were the first freshwater fish to recolonise Ireland after the last Ice Age, they are largely confined to deeper, colder lakes (Igoe *et al.*, 2003). There are 70 known lakes in Ireland with populations of artic char and 5 of these lakes are at risk from abstraction pressures. These include Lough Gortglass and Lough Lickeen, Co. Clare, Lough Naback, Co. Longford, Lough Talt, Co. Mayo and Lough Owel, Co. Westmeath. The status of Arctic char in three of these five lakes is "extinct" and only in one lake is it "healthy" (Lough Talt). Many pressures can effect the populations of Arctic char and water abstraction is one of these. If water levels are lowered during the spawning season (October – November) this could expose the clean gravel beds these use for spawning and affect their success (Igoe *et al.*, 2003).

5.2.2 Screening of Lakes to Eliminate Other Pressures

The 78 lakes remaining after the Stages 1 and 2 screening were subject to additional screening to identify those lakes that are likely to only be affected by abstraction pressures. The screens included:

- EPA's Interim Lake Status Classification;
- Article V Initial Risk Assessment results; and
- Evaluation of additional pressures in catchments of remaining lakes.

EPA's Interim Lake Status Classification (2008) focused on measures of enrichment in Irish lakes; enrichment is the main pressure affecting lakes. Irish lakes may also be subjected to acidification and hydromorphological pressures, but limited data is available to determine the impact of these. EPA used the most recent macrophyte data, general physical/chemical components from 2004 to 2007, fish communities and phytoplankton communities to classify lakes as being either high, good, moderate or poor status. Of the 78 lakes retained from Stage 1 and Stage 2 screening, the ones that were not at least of good status were screened out, leaving 42 lakes to be considered further in Stage 3 screening, as shown in Table 5-3.

The 42 remaining lakes were also checked against the Article V characterisation results to eliminate any further lakes that may be at risk of meeting good status from a pressure other than abstractions. Lakes were screened out if they were at risk or probably at risk from diffuse pollution from inflowing rivers (LD1) or overall from point source pollution, which was because of Section 4 licenses (LP4) in two cases. Lakes were also screened out if the overall morphological test results were at risk; in four instances intensive land use (LM4) was the cause and in one case morphological pressures including impoundments (LM3) was the cause. This screening eliminated a further five lakes from Stage 3 screening, leaving 37 lakes as displayed in Table 5-3.

Table 5-3: Lakes at Good or High Status and 2005 Risk Assessment

	WFD Code	Lake Name	County	Interim Status Classification Aug 08	2005 Risk Assessment	Risk Assessment Notes
1	IE_WE_33_1892	Acorrymore (Lough)	Mayo	G	N	
2	IE_EA_07_242	Acurry (Lough)	Cavan	G	N	
3	IE_WE_31_211	Anaserd (Lough)	Galway	G	N	
4	IE_NW_38_52	Anna (Lough)	Donegal	G	N	
5	IE_EA_07_270	Bane (Lough)	Meath	G	N	
6	IE_WE_32_269	Barnahallia Lough	Galway	G	N	
7	IE_SW_21_448	Bofinna (Lough)	Cork	G	N	
8	IE_SW_22_182	Callee (Lough)	Kerry	G	N	
9	IE_NW_36_460	Coragh Lough	Cavan	G	N	
10	IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	G	N	
11	IE_NW_37_210	Cullionboy Lough	Donegal	G	N	
12	IE_SW_21_369	Eirk Lough	Kerry	G	N	
13	IE_WE_32_526	Fawna (Lough)	Galway	G	N	
14	IE_NW_37_195	Glencoagh Lough	Donegal	G	N	
15	IE_NW_36_706	Gorman (Lough)	Donegal	G	N	
16	IE_NW_39_44	Gort Lough	Donegal	G	N	
17	IE_WE_34_458	Holan (Lough)	Mayo	G	N	
18	IE_WE_35_237	Labe (Lough)	Sligo	G	N	
19	IE_WE_35_96	Lackagh Lough	Leitrim	G	N	
20	IE_WE_31_120	Loughaunwillan	Galway	G	N	
21	IE_WE_32_406	Moher Lough	Mayo	G	N	
22	IE_NB_03_87	More (Lough)	Monaghan	G	N	
23	IE_SW_22_58	Mount Eagle Lough	Kerry	G	N	
24	IE_WE_32_422	Nambrackkeagh (Lough)	Galway	G	N	
25	IE_NW_38_29	Nameeltoge (Lough)	Donegal	G	N	
26	IE_SH_28_87	Naminna (Lough)	Clare	G	N	
27	IE_NW_38_678	Shannagh (Lough)	Donegal	G	N	
28	IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	G	N	
29	IE_NW_37_208	St. Peter's Lough	Donegal	G	N	
30	IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	G	N	
31	IE_SW_20_133	Tooreen Lough	Cork	G	N	
32	IE_NW_36_712	Unshin (Lough)	Donegal	G	N	
33	IE_WE_30_532	Aille Lough	Mayo	H	N	
34	IE_SH_26_705	Cavetown Lough	Roscommon	H	N	
35	IE_WE_31_1126	Illauntrasna (Lough)	Galway	H	N	
36	IE_WE_31_177	Loughaunore	Galway	H	N	
37	IE_WE_34_405	Talt (Lough)	Sligo	H	N	

	WFD Code	Lake Name	County	Interim Status Classification Aug 08	2005 Risk Assessment	Risk Assessment Notes
38	IE_NW_36_710	Columbkille Lough	Donegal	H	Y	LM Overall (LM4)
39	IE_SH_26_706	Grange Lough	Roscommon	H	Y	LD1
40	IE_WE_35_17	Carrowlustia	Sligo	G	Y	LM overall (LM3)
41	IE_EA_09_68	Glenasmole Reservoirs	Dublin	G	Y	LD Overall (LP4)
42	IE_EA_09_70	Glenasmole Reservoirs	Dublin	G	Y	LD Overall (LP4)

Note: Columbkille Lough, Grange Lough, Carrowlustia Lough and both Glenasmole Reservoirs removed from further consideration due to 2005 Risk Assessment results

The remaining 37 lakes were then assessed on an individual basis to consider pressures that may not have been captured in the status classifications or the risk tests. The CORINE land use data, aerial photography and OSI Discovery Series maps were utilised. The difference between the types of pasture was noted; primarily whether the productivity was high or low, as it was deemed that rough pasture would not impose a great pressure whereas improved pasture may. The type of forestry near to the shore was also recorded, as older coniferous plantations may have been planted right up to the shore resulting in greater risk of acidification. The proximity of houses to the shore was also noted as septic tanks could potentially contribute nutrients to the lake.

Table 5-4 lists the 16 lakes in total passed all of the pressures screening. It also provides a best guess of the location of the abstraction intake point as either from within the lake or from the lake's outlet stream. Of these, greater emphasis was given in the next section to prioritising the seven lakes with suspected withdrawals from the lake itself for field visits.

Table 5-4: Lakes that Passed All Pressures Screening

WFD Code	Lake Name	County	Location of Intake?
IE_WE_30_532	Aille Lough	Mayo	Lake
IE_WE_32_269	Barnahallia Lough	Galway	Lake
IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	Lake
IE_WE_32_526	Fawna (Lough)	Galway	Lake
IE_NW_37_195	Glencoagh Lough	Donegal	Lake
IE_WE_31_177	Loughaunore	Galway	Lake
IE_NW_38_29	Nameeltoge (Lough)	Donegal	Lake
IE_WE_33_1892	Acorrymore (Lough)	Mayo	Outlet
IE_SW_22_182	Callee (Lough)	Kerry	Outlet
IE_NW_37_210	Cullionboy Lough	Donegal	Outlet
IE_SW_21_369	Eirk Lough	Kerry	Outlet
IE_WE_35_237	Labe (Lough)	Sligo	Outlet
IE_WE_35_96	Lackagh Lough	Leitrim	Outlet
IE_SW_22_58	Mount Eagle Lough	Kerry	Outlet

WFD Code	Lake Name	County	Location of Intake?
IE_WE_32_422	Nambrackkeagh (Lough)	Galway	Outlet
IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	Outlet

5.2.3 Field Assessment of Representative Lakes

A field assessment of representative lakes was carried out to ground-truth and verify data already gathered, to examine the lakes for evidence of any effects of abstractions on the lake and lastly to help choose lakes suitable for future water level monitoring.

Lakes for field visits were selected from the list of 37 lakes in Table 5-3. While consideration was given to only visiting 16 lakes in Table 5-4, it became apparent that the majority of them had very small catchments (13 had catchments less than 1 km^2, while the remaining three had catchments less than 4 km^2), and thus, all 37 lakes were retained as candidate lakes for field visits to include a range of catchment size. Criteria for selecting lakes included: obtaining a representative sample lakes with different catchment areas, different net abstraction to inflow ratios, if lake was groundwater dependent. With these "base" lakes selected, additional lakes from the list of 37 were included if their location was along an expeditious driving route. Table 5-5 shows the grouping of the 37 lakes and the criteria by which certain lakes were selected for field visits.

The field visits were conducted between 29th September and the 2nd October 2008, twenty lakes were visited in total. At each lake a description of the following was made;

- *General information*: including the name, location, weather, access to lake shore, any structures;
- *Catchment information*: a general description, including agriculture, any houses near the shore, water features such as inflowing or outflowing streams;
- *Abstraction information*: the intake location, pump house location, abstraction volume and regime;
- *Water levels*: current water levels, evidence of past water levels, any shoreline exposure;
- *Basin shape*: the general shape of the basin, extent of littoral zones; and
- *Ecology*: terrestrial ecology, any wetlands, areas of aquatic vegetation.

The data gathered was combined with the data gathered from the desktop study and is summarised in the tables in Appendix E.

Table 5-5: Grouping of Representative Lakes

WFD Code	Lake Name	County	Area Category	Net Abs: Inflow Category	Overall Category	Visited in field	Reason for field visit
IE_WE_30_532	Aille Lough	Mayo	A1	I1	A1 – I1	✓	Passed all screening
IE_NW_38_52	Anna (Lough)	Donegal	A1	I1			
IE_WE_32_269	Barnahallia Lough	Galway	A1	I1		✓	Passed all screening
IE_SW_21_369	Eirk Lough	Kerry	A1	I1			
IE_WE_32_526	Fawna (Lough)	Galway	A1	I1			
IE_NW_37_195	Glencoagh Lough	Donegal	A1	I1		✓	Passed all screening
IE_WE_34_458	Holan (Lough)	Mayo	A1	I1		✓	GW
IE_WE_31_1126	Illauntrasna (Lough)	Galway	A1	I1		✓	Location
IE_WE_35_237	Labe (Lough)	Sligo	A1	I1		✓	GW
IE_WE_35_96	Lackagh Lough	Leitrim	A1	I1			
IE_WE_31_177	Loughaunore	Galway	A1	I1		✓	Passed all screening
IE_SW_22_58	Mount Eagle Lough	Kerry	A1	I1			
IE_WE_32_422	Nambrackkeagh (Lough)	Galway	A1	I1			
IE_SW_20_133	Tooreen Lough	Cork	A1	I1		✓	Location
IE_EA_07_242	Acurry (Lough)	Cavan	A1	I2	A1 – I2		
IE_SW_21_448	Bofinna (Lough)	Cork	A1	I2		✓	Location
IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	A1	I2			
IE_NW_37_210	Cullionboy Lough	Donegal	A1	I2		✓	Passed all screening
IE_NW_38_29	Nameeltoge (Lough)	Donegal	A1	I2			
IE_SH_28_87	Naminna (Lough)	Clare	A1	I2			
IE_NW_37_208	St. Peter's Lough	Donegal	A1	I2		✓	I2
IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	A1	I2			

WFD Code	Lake Name	County	Area Category	Net Abs: Inflow Category	Overall Category	Visited in Field	Reason for Field Visit
IE_WE_33_1892	Acorrymore (Lough)	Mayo	A2	I1	A2 – I1	✓	Passed all screening
IE_WE_31_211	Anaserd (Lough)	Galway	A2	I1		✓	A2
IE_SW_22_182	Callee (Lough)	Kerry	A2	I1			
IE_NW_36_460	Coragh Lough	Cavan	A2	I1			
IE_NW_36_706	Gorman (Lough)	Donegal	A2	I1		✓	A2
IE_NW_39_44	Gort Lough	Donegal	A2	I1			
IE_NB_03_87	More (Lough)	Monaghan	A2	I1			
IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	A2	I1			
IE_EA_07_270	Bane (Lough)	Meath	A2	I2	A2 – I2	✓	GW/ Effect known
IE_SH_26_705	Cavetown Lough	Roscommon	A3	I1	A3 – I1	✓	GW
IE_WE_31_120	Loughaunwillan	Galway	A3	I1		✓	Location
IE_WE_32_406	Moher Lough	Mayo	A3	I1		✓	Location
IE_NW_38_678	Shannagh (Lough)	Donegal	A3	I1			
IE_NW_36_712	Unshin (Lough)	Donegal	A3	I1		✓	Effect known
IE_WE_34_405	Talt (Lough)	Sligo	A3	I2	A3 – I2	✓	I2 and A3

Overall Category	Catchment Area (km^2)	Net Abstraction: Inflow
A1-I1	0.08 - 1	0.1 - 0.5
A1-I2	0.08 - 1	0.5 - 1.6
A2-I1	1 - 4	0.1 - 0.5
A2-I2	1 - 4	0.5 - 1.6
A3-I1	4 - 6.4	0.1 - 0.5
A3-I2	4 - 6.4	0.5 - 1.6

High rainfall during the summer of 2008 made it unlikely that low water levels resulting from lake abstractions would be observed during the field visits. Rainfall totals were above normal everywhere and were more than twice the average in the east and southeast of the country. Dublin Airport had its wettest summer since 1958, while it was the wettest summer at Cork Airport since records began there in 1962. A total of between 42 and 48 wetdays (days with 1mm or more rainfall) was recorded at most stations for the 3-month period, compared with the normal range for summer of between 32 and 38 wetdays (Met Éireann, 2008).

Despite the high rainfall there were a few instances where parts of shorelines were exposed and could possibly be attributed to abstractions from the lakes. This was the case for St. Peters Lough in Donegal (Figure 5-2) and Lough Acorrymore in Mayo. St. Peters Lough had extensive exposed shores and some raised banks and Lough Accorymore had some areas of cracked mud. One possible reason for exposed shorelines after such high rainfall could be abstraction related.

Figure 5-2: St. Peters Lough, Donegal – Showing Exposed Shores

The effects on ecology can not be judged from a single visit but would need to be monitored over time. From these visits it was possible to identify the shallows and shorelines that support aquatic vegetation. Identification of macrophytes was possible only in certain situations as the fieldwork took place in late September after the die-off period.

During the field visits, the location of intakes was also clarified for Lough Acorrymore in Mayo and Loughaunore in Galway. Instead of being on the outlet stream, the intakes abstract water directly from the lake.

The pressures information was also verified in the field. Seven lakes identified in Table 5-4 as likely having no other pressures were visited. Three of them were confirmed to have no other pressures; Loughaunore, Lough Acorrymore and Lough Labe. Barnahalia Lough was also confirmed to have no pressures; however, it is a small lake and so might be susceptible to agricultural pressures in the future. Non-abstraction pressures were identified at the remaining three lakes; Aille Lough, Glencoagh Lough and Cullionboy

Lough. There was intensive pasture in a field that neighboured Aille Lough and the lakeshore itself was riprapped with boulders. Glencoagh Lough had two houses near to the shore. Cullionboy Lough is a small lake, which had intensive pasture surrounding the lake.

5.2.4 Lakes Sensitivity to Abstractions

Available information of physical attributes was used to develop a typology - separate from the WFD lake typology - to help identify lakes that may be more sensitive to abstractions. This sensitivity typology is based on the one developed in the SNIFFER WFD48 report (Acreman *et al.*, 2006). The SNIFFER study used various chemical and physical attributes to estimate the effects on lake sensitivity to hydrological change. The SNIFFER report stressed that there is a lack of calibration data to identify effects in isolation or in combination, but proposed a risk-based system to flag increased sensitivity and to account for the effects of various lake attributes as a cumulative point score.

The attributes used in the SNIFFER study include the UK typology and a sensitivity calendar showing the critical life stages of certain species characteristic of these types, and physical factors such as depth altitude, area and basin form.

The SNIFFER WFD48 report places substantial weight on the lake's land cover and geology because the relationship between typology and biota is understood and a sensitivity calendar for the duration of critical life stages for species characteristic of different lake types was developed. The UK Tier 1 typology includes six categories; Peat, Low Alkalinity, Medium Alkalinity, High Alkalinity, Marl and Brackish.

In Ireland the existing lake typology is different to the UK as in Tier 1 there are three classifications based on alkalinity; <20 mg/l $CaCO_3$, 20 to 100 mg/l $CaCO_3$ and >100 mg/l $CaCO_3$ (Free *et al.*, 2007). Therefore it is not possible to transpose the sensitivity calendar into the Irish typology. The methodology proposed below bases the sensitivity typology only on physical attributes of the lakes.

5.2.4.1 Physical Attributes for Sensitivity Typology

The physical attributes proposed for the sensitivity typology here are lake size, lake depth and basin form, as described below. These attributes require knowledge of lake bathymetry data, and suitable data was available for 20 of the lakes.

Another physical metric developed in this study, shoreline development ratio (Section 5.1), was considered for inclusion but was not used the ratio for all but 2 lakes were quite similar indicating it might not be a sensitive metric for Irish lakes. Neither of the two lakes with high shoreline development ratios have available bathymetry data so they could not be included in the sensitivity typology.

Lake Size

Acreman *et al.* (2006) identified are several ways that lake size (area) can influence the sensitivity of a system to water level drawdown. The shallowest part of the lake bottom is exposed to wave action and so the sediment there is subject to frequent resuspension. If the water level changes, sediment on a different part of the lake bottom can be made available for resuspension. The magnitude of this effect increases with lake area as larger lakes have a longer fetch to generate waves.

Residence time is related to lake area and water level. The residence time is more sensitive to water level changes when the lake is stratified as the development of a thermocline reduces the volume of water involved in throughflow. Since the tendency for a lake to stratify in summer increases with area so to does the sensitivity to water level change, which would have consequences for the nutrient dynamics, phytoplankton populations and planktivorous fish (Acreman *et al.*, 2006).

In the sensitivity calculation, a score of 1 is given to a lake that is greater than 50 hectares in area. The 50-hectare threshold is adopted from SNIFFER WFD48, but it also corresponds to the area classes in the Irish typology.

Lake Depth

Acreman *et al.* (2006) consider shallower lakes to be more sensitive to changes in water levels as the resuspension of sediments and residence time also relates to depth. SNIFFER WFD48 assigns lakes with a mean depth of less than 3 metres a score of 1. It is proposed to use a similar assignment in the Irish methodology but to adopt a mean depth threshold of 4 metres for consistency with the Irish typology.

Basin Form

Basin form is a way of quantifying the shape of the lake basin or the slope. It is a metric developed by Håkanson (1981) which is defined by the relationship:

$$V_d = 3D_{mean}/D_{max}$$

where V_d is the basin form factor and D_{mean} and D_{max} are the lakes' mean and maximum depth respectively. Values of V_d range from 0.05 to 2.00 as shown in Table 5-6. Small values indicate convex basins, which means the lake bottom is relatively shallow and so changes in water level will have larger impacts on the lake bottom than other basins. Also there are larger littoral areas that will undergo changes with an alteration in lake levels (Acreman

Table 5-6: Basin Form and V_d Values (from Håkanson, 1981 and Acreman et al., 2006)

Basin Form	V_d	Description
Very Convex	0.05 – 0.33	Relatively shallow bottom
Convex	0.33 – 0.67	↕
Slightly convex	0.67 – 1.00	
Linear	1.00 – 1.33	
Concave	1.33 – 2.00	Trough like

et al., 2006). Concave basins are more trough-like in shape and will have steeper sides resulting in a smaller littoral area.

In the US study (Håkanson, 1981) it was found that slightly convex was the most common basin form and in the UK study (Acreman *et al.*, 2006) it was found that linear basin form was the most common. Basin form was calculated for the 20 Stage 3 Irish lakes with bathymetry data; eleven lakes (55%) were linear ; six lakes (30%) were slightly convex and the remaining three lakes (15%) were concave, as shown in Table 5-7. There were no very convex or convex types (V_d <0.67) present in the group of 20 Irish lakes at risk from abstraction.

Table 5-7: Calculated V_d Values for 20 Lakes at Risk from Abstraction Pressures

WFD Code	Lake Name	County	Mean Depth (m)	Max Depth (m)	V_d	***Basin Form***
IE_SW_20_133	Tooreen Lough	Cork	2.23	9.95	**0.67**	***Slightly convex***
IE_WE_32_406	Moher Lough	Mayo	3.87	17.00	**0.68**	
IE_WE_31_177	Loughaunore	Galway	3.33	13.30	**0.75**	
IE_WE_34_405	Talt (Lough)	Sligo	10.38	39.24	**0.79**	
IE_WE_31_1126	Illauntrasna (Lough)	Galway	2.45	9.04	**0.81**	
IE_WE_31_120	Loughaunwillan	Galway	6.28	21.50	**0.88**	
IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	2.32	6.81	**1.02**	***Linear***
IE_WE_30_532	Aille Lough	Mayo	3.53	10.28	**1.03**	
IE_SW_21_369	Eirk Lough	Kerry	4.43	12.42	**1.07**	
IE_WE_35_237	Labe (Lough)	Sligo	4.79	12.86	**1.12**	
IE_SW_22_182	Callee (Lough)	Kerry	9.94	26.62	**1.12**	
IE_WE_32_422	Nambrackkeagh (Lough)	Galway	1.17	3.07	**1.14**	
IE_WE_32_526	Fawna (Lough)	Galway	0.73	1.91	**1.15**	
IE_WE_35_17	Carrowlustia	Sligo	5.37	14.05	**1.15**	
IE_SW_22_58	Mount Eagle Lough	Kerry	7.54	18.85	**1.20**	
IE_SW_22_199	Cummernamuck (Lake)	Kerry	6.02	14.09	**1.28**	
IE_SW_20_150	Ballin Lough	Cork	4.11	9.39	**1.31**	
IE_SW_21_448	Bofinna (Lough)	Cork	3.68	8.30	**1.33**	***Concave***
IE_WE_33_1892	Acorrymore (Lough)	Mayo	19.63	37.49	**1.57**	
IE_WE_34_458	Holan (Lough)	Mayo	7.27	12.45	**1.75**	

The SNIFFER WFD48 study determined that very convex or convex lake forms (V_d <0.67) are more sensitive to water level change and a sensitivity score of 1 was assigned if the V_d was less than 0.67. None of the 20 Irish lakes were very convex or convex forms. However knowing that the slightly convex lakes are more sensitive than the linear and the concave types; for this study a score of 1 is given where the basin form is slightly convex (V_d <1.00), as these are generally shallower with more extensive littoral areas.

The basin forms were also compared with other physical attributes to examine if there was any relationship. The attributes examined included typology and alkalinity category, physiographic region, altitude, lake area, rock type and soil type. No correlations were discovered, although this could be due to the small data set used. The UK study found high correlations with the UK typology; the characteristic basin form for Peat, Low Alkalinity, and Medium Alkalinity was linear and for High Alkalinity it was a concave basin form (Acreman *et al.*, 2006).

5.2.4.2 Results of Lake Sensitivity to Abstractions

The overall lake sensitivity to abstractions was determined by summation of the scores (1 or 0) for basin form, lake surface area and mean depth, as described above. The SNIFFER WFD48 study also assessed the significance of altitude, but only modified the score for altitude in the case of the winter sensitivity. The sensitivity of Irish lakes to altitude is not considered in this study.

Table 5-8 shows the results of the sensitivity for the 20 abstraction lakes with bathymetry data. The basin form, area and depth results are displayed with the points given to each category and the sum total of sensitivity points for each lake.

Lough Talt is the only lake included with an area greater than 50 hectares and so the only lake awarded a sensitivity point for area. The six lakes that have a slightly convex basin form were also each given one point; Lough Talt was one of these lakes. Four of these lakes were also assigned a point as their mean depth was less than 4 metres; while Lough Talt and Loughaunwillan were the other two slightly convex lakes whose mean depth was greater than 4 metres. A further five lakes were awarded a point as they also have a mean depth of less than 4 metres.

In an attempt to calibrate the sensitivity results, lakes with high sensitivity were checked for known water level fluctuations and field observations of abstraction effects. No conclusions are drawn however, as bathymetry data are not available in many cases for lakes where effects are known or observed and there are currently no known effects of abstractions for the lakes with high sensitivity. For St. Peters Lough in Co. Donegal, for example, there were extensive exposed shores observed but no bathymetry data are available.

The sensitivity of these lakes has also been used as a guide for prioritising water level monitoring sites for the future assessment of abstraction pressures on lakes (refer to Section 5-4). Although physical attributes alone have been considered here, lakes with ecology that is known to be sensitive to water level change in the Irish context will also be taken into account when recommending monitoring sites, namely lakes that have important habitats for *Chara* spp.

Table 5-8: Calculated Sensitivity to Abstraction for 20 Lakes, Based on Physical Attributes (Based on SNIFFER WFD48)

WFD Code	Lake Name	County	Basin Form	V_d	if <1 then = 1 Note 1	Lake Area (m²)	if > 500,000 then = 1	Lake Mean Depth (m)	if < 4 then = 1 Note 2	Total Sensitivity Points
IE_WE_31_1126	Illauntrasna (Lough)	Galway	S. convex	0.81	1	66,500	0	2.45	1	**2**
IE_WE_31_177	Loughaunore	Galway	S. convex	0.75	1	57,327	0	3.33	1	**2**
IE_WE_32_406	Moher Lough	Mayo	S. convex	0.68	1	373,546	0	3.87	1	**2**
IE_WE_34_405	Talt (Lough)	Sligo	S. convex	0.79	1	973,500	1	10.38	0	**2**
IE_SW_20_133	Tooreen Lough	Cork	S. convex	0.67	1	31,330	0	2.23	1	**2**
IE_WE_31_120	Loughaunwillan	Galway	S. convex	0.88	1	348,374	0	6.28	0	**1**
IE_WE_30_532	Aille Lough	Mayo	Linear	1.03	0	46,745	0	3.53	1	**1**
IE_SW_21_448	Bofinna (Lough)	Cork	Concave	1.33	0	86,760	0	3.68	1	**1**
IE_WE_32_526	Fawna (Lough)	Galway	Linear	1.15	0	31,122	0	0.73	1	**1**
IE_WE_32_422	Nambrackkeagh (Lough)	Galway	Linear	1.14	0	78,177	0	1.17	1	**1**
IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	Linear	1.02	0	22,500	0	2.32	1	**1**
IE_WE_33_1892	Acorrymore (Lough)	Mayo	Concave	1.57	0	138,600	0	19.63	0	**0**
IE_SW_20_150	Ballin Lough	Cork	Linear	1.31	0	77,500	0	4.11	0	**0**
IE_SW_22_182	Callee (Lough)	Kerry	Linear	1.12	0	178,300	0	9.94	0	**0**
IE_WE_35_17	Carrowlustia	Sligo	Linear	1.15	0	43,500	0	5.37	0	**0**
IE_SW_22_199	Cummernamuck (Lake)	Kerry	Linear	1.28	0	113,800	0	6.02	0	**0**
IE_SW_21_369	Eirk Lough	Kerry	Linear	1.07	0	60,860	0	4.43	0	**0**
IE_WE_34_458	Holan (Lough)	Mayo	Concave	1.75	0	29,800	0	7.27	0	**0**
IE_WE_35_237	Labe (Lough)	Sligo	Linear	1.12	0	55,100	0	4.79	0	**0**
IE_SW_22_58	Mount Eagle Lough	Kerry	Linear	1.20	0	39,880	0	7.54	0	**0**

Note 1: SNIFFER WFD48 (2006) used 0.67 i.e. very convex and convex, here we used 1.00 – slightly convex as there were no very convex and convex basins

Note 2: SNIFFER WFD48 (2006) used mean depth of 3m after the UK typology, here it was decided to use 4m to be consistent with Irish typology

5.3 Groundwater-dependent Lakes

Stage 1 screening identified 13 potential "at risk" groundwater-dependent lakes. The Abstractions Steering Group also requested that the evaluation of groundwater-dependent lakes include Lough Owel in Co. Westmeath; Lough Owel was not previously considered in this report as it was not a 1a/1b lake as part of the Article V Risk Assessment, which are the group of lakes studied herein.

To assess the risk of over-abstraction individually, most of the lakes were visited in the field. Different sources of information were also checked as follows:

- Geological Survey of Ireland – database and mapping of karst features;
- Local authorities – hydrological assessments of lakes pertaining to existing or proposed new abstraction schemes;
- River Basin District projects – bathymetric survey data;
- EPA – hydrometric gauging data; and
- National Parks and Wildlife Service – reports on ecological features of each lake (including hydrological notes).

Specialists in Irish karst hydrogeology were also contacted for potential site-specific knowledge.

5.3.1 Physical and Hydrogeological Characteristics

The physical attributes of the 13 groundwater-dependent lakes, and their associated hydrogeological settings, are summarised in Tables 5-9 and 5-10 respectively.

5.3.1.1 Karst (Limestone) Lakes

Twelve of the 13 identified groundwater lakes are associated with the karst limestones of central and western Ireland. All occupy low-lying terrain (< 200 m OD) and most are characterised as hard-water, high-alkalinity lakes.

Seven of the 12 calcareous lakes are associated with karstic limestone aquifers in which conduit flow is regarded as the primary flow mechanism, as designated by the Rk_c attribute in Table 5-10. Rk_c aquifers are regionally important for water supply purposes and include some of the highest-yielding springs in Ireland. In Roscommon, Galway, and Clare, spring discharges of several thousand cubic metres per day have been measured, and flow rates can vary by several orders of magnitude between dry and wet weather periods. Tracer testing has demonstrated that flow rates of several hundred metres per day may apply. The degree of interconnection between groundwater and surface water in karstic terranes is high, which is reflected in similar water chemistries and hydraulic responses.

Three lakes, Owel, Bane, and Lene, are designated as Special Areas of Conservation (SAC) based on their ecological significance as hard-oligotrophic waters with benthic vegetation of *Chara* spp., as included in Annex I of the EU

Habitats Directive. Lough Owel also contains alkaline fens which are listed separately in Annex I of the Habitats Directive. Lough Owel is of particular ecological significance and is included on the RAMSAR list of wetlands of international interest (RAMSAR, 1971). The National Parks and Wildlife Service (NPWS) has mapped several groundwater dependent terrestrial ecosystems (GWDTEs) along its margins, comprising alkaline fens and transition mires. The whorl snail *Vertigo moulinsiana,* a rare species listed on Annex II of the European Habitats & Species Directive, and particularly sensitive to hydrological changes, has been recorded in Lough Owel. *Vertigo moulinsiana* is not protected under Irish law but has protection in its SAC under the Habitats Directive and the Republic of Ireland Habitats Regulations (Statutory Instrument 94 of 1997).

Only three of the lakes are subject to hydrometric gauging. Data recorders exist on Lene, Owel and Bane. Lene and Owel show annual lake level fluctuations in excess of 0.5 m. Bane shows larger fluctuations of up to 1 m. These water level fluctuations are relatively small compared to the annual fluctuations at 19 lakes without abstractions discussed in Section 2.2.1. The annual fluctuations at these "natural" lakes averaged 1.2 m/year; interannual fluctuations had a small variation with standard deviations at individual lakes between 0.2 and 0.3 m.

Only 3 lakes have been subject to detailed hydrological assessments; Grange, Lene, and Owel.

Roscommon County Council is presently considering relocating (and increasing) the present abstraction on Grange Lough to a different surface water body located further east (and also named Grange). The present abstraction would be abandoned. The main reason for abandoning the present abstraction is that the planned increased abstraction rate is deemed unsustainable for the present lake and therefore has to be moved to a larger water body. While logger data are not available, anecdotal information indicates that the present abstraction is causing lake level fluctuations of more than 3 m annually. The new abstraction is located on a water body that is in direct hydraulic communication with the Shannon river system, and the predicted drawdown from the increased abstraction is considerably smaller (a few centimetres only) (Roscommon County Council, 2008).

Lough Lene and the surrounding area has been subject of several hydrogeological studies. It is located in the Eastern River Basin District, but tracer test results indicate that the lake is discharging water naturally through shoreline swallow holes to springs that are located within the Shannon River Basin to the northwest (Quinlan, 2007). The hydrology of the Lough Lene area is undoubtedly complex. From available data, it is not possible to judge whether annual fluctuations of approximately 0.5 m in Lough Lene can be correlated to abstraction rates, as detailed (daily) records of abstraction rates do not exist.

Lough Owel is the main source of water for the town of Mullingar and surrounding areas. Information obtained from Westmeath County Council (WCC) suggests the sustainable yield of the lake (defined between lake level elevations 99.883 m OD and 98.908 m OD (327.7 ft OD and 324.5 ft OD) is 36,642 m^3/day (8,060,000 gallons per day). The County Council is presently abstracting 19,500

m^3/day from Lough Owel. Of the total sustainable yield, the County Council is entitled, under agreements with Waterways Ireland and the Central Fisheries Board to abstract a total of 20,750 m^3/day. The remaining 13,000 m^3/day is assigned to a fish farm run and monitored by the Central Fisheries Board.

5.3.1.2 Non-Karstic Lakes

One of the 13 groundwater-dependent lakes in Table 5-9 is not associated with karst limestones. Lough Bofinna in west Cork is a shallow lake associated with the Old Red Sandstone that underlies a significant portion of southeastern and southwestern Ireland. Lough Bofinna has a catchment area of only 0.56 km^2. There are no inflowing streams, and the lake is inferred to be supported by groundwater inflows.

It is expected that shallow groundwater contributes some baseflow to the lake. Since the lake sustains pumping at a daily rate of 1,500 m^3/day, it is also expected that one or more springs may contribute inflow. However, no springs are reported in this area; one local fisherman said the lake is spring-fed, but this could not be corroborated by others. During a site visit in September 2008, small seeps were observed on the western margin of the lake, trickling into small culverts presumably flowing into the lake (covered by vegetation so inflow points were not visible).

The lake is stocked weekly by the South Western Regional Fisheries Board, who also had no knowledge of any springs feeding the lake.

Most of the lake margin comprises pastures. Meadow grasses and marshes are present at the northern end of the lake and could be reflective of groundwater inputs.

5.3.2 Relative Groundwater Contributions

5.3.2.1 Karst (Limestone) Lakes

Groundwater that feeds karst lakes is expected to flow along three primary pathways:

- Flow through the shallow "epikarst", the interface zone between soil and rock (typically only a few metres thick);
- Flow through interconnected, enlarged conduits and cave systems; and
- "Diffuse" flow through interconnected fractures, fissures and joints (outside conduit systems).

The relative importance of different flow components cannot be accurately assessed for any given lake without site-specific study. However, inferences can be made on the basis of existing literature and GSI's national mapping of aquifer types (GSI, 2005). As a general rule, conduit flow is expected to be dominant in aquifer types designated as Rk_c in Table 5-10, whereas "diffuse" flow is expected to be dominant in aquifer types designated as Rk_d. The shallow epikarst would be

Table 5-9: Physical Attributes of 13 Groundwater-dependent Lakes

Lake Name	County	Surface Area (m²) [1]	Shoreline Length (m) [1]	Mean Depth (m) [2]	Lake Volume (m³)	Abstraction Volume (m³/d)	Estimated 50%ile Surface Inflow (m³/d) [3]	Net Abstraction: Surface Inflow Ratio	Existing Hydrometric Gauge?	Water Level Fluctuation	Inflow Points	Hydrological Assessment Available
Ballycar	Clare	26,675	843	na	na	418	605	0.69	No	No info	No springs, seeps or streams visible.	No
Bekan	Mayo	208,864	2,576	na	na	382	1,987	0.19	No	Limited	No springs, seeps or streams visible.	No
Bleach	Limerick	178,909	2,129	na	na	932	1,728	0.54	No	Anecdotally significant	Springs	No
Bofinna	Cork	86,763	1,399	3.7	319,289	1,500	2,074	0.72	No	Anecdotally significant (>1 m)	Small seeps	No
Cavetown	Roscommon	642,345	4,299	3.8	2,440,910	797	6,739	0.12	No	Anecdotally significant (>2 m)	Small spring, 4 inflowing small streams	No
Gorman	Donegal	74,527	1,660	na	na	740			No	No info	No springs, seeps or streams visible.	No
Grange	Roscommon	78,038	1,720	na	na	4,941	3,024	1.63	No	Anecdotally significant (>1 m)	No springs, seeps or streams visible.	Yes
Holan	Mayo	29,915	683	7.3	217,484	115	518	0.22	No	No info	No springs, seeps or streams visible.	No
Labe	Sligo	55,367	1,120	4.8	265,208	180	1,296	0.10	No	No info	Small seeps visible, one small stream. Bathymetric survey suggests the lake may be a collapse feature.	No
Lene	Westmeath	4,162,496	14,444	na	na	5,216	21,946	0.24	Data logger	approx. 0.5 m/yr	Springs	Yes
Spring	Monaghan	102,532	1,480	na	na	1,800			No	Anecdotally significant (>1 m)	Springs	No
Owel	Westmeath	10,217,811	18,237	na	na	19,548			Data logger	approx. 0.6 m/yr	Springs, small streamlets	Yes
Bane	Meath	754,474	4,999	5.2	3,953,446	4,000			Data logger	Significant - zero outflow from lake periodically	Springs	No

[1] - measured in GIS
[2] - from bathymetric surveys
[3] – from Stage 2

Table 5-10: Hydrological Setting of 13 Groundwater-dependent Lakes

Lake Name	County	Associated Rock Unit Group	Flow Regime [1]	Aquifer Type [1]	Groundwater Vulnerability [2]	Estimated Recharge (mm/yr) [2]
Ballycar	Clare	Dinantian Pure Bedded Limestone	KA	Rk_c	Moderate to Extreme	250
Bekan	Mayo	Dinantian Pure Bedded Limestone	KA	Rk_c	High to Low [3]	150
Bleach	Limerick	Dinantian Pure Unbedded Limestone	KA	Rk_c	Extreme	400
Bofinna	Cork	Old Red Sandstone	PP	Ll and Pl	Extreme	150
Cavetown	Roscommon	Dinantian Pure Bedded Limestone	KA	Rk_c	High to Extreme	200
Gorman	Donegal	Dinantian Pure Bedded Limestone	KA	Rk_d	Extreme	>500
Grange	Roscommon	Dinantian Pure Bedded Limestone	KA	Rk_c	Moderate to High	200
Holan	Mayo	Dinantian Pure Bedded Limestone	KA	Rk_c	High to Low [3]	170
Labe	Sligo	Dinantian Pure Bedded Limestone	KA	Rk_c	Extreme	>500
Lene	Westmeath	Dinantian Upper Impure Limestone	KA/FI	Lm [4]	Extreme	350
Spring	Monaghan	Dinantian Pure Bedded Limestone	KA	Rk_d	Moderate	160
Owel	Westmeath	Dinantian Upper Impure Limestone	PP/FI	Lm and Ll	Extreme	150
Bane	Meath	Dinantian Upper Impure Limestone	FI	Lm [4]	High to Extreme	450

[1] - As defined by the GSI

[2] - Assigned from the national groundwater recharge map, CDM (2008). Values averaged over surface water catchment of lake

[3] - Not yet mapped by the GSI, therefore assigned "High to Low"

[4] - GSI is considering reclassifying the Lough Lene area as Rkc

important to both. GSI's aquifer type designations represent the present understanding of primary flow mechanisms from interpretations of existing and available data. They apply on a regional scale but do not exclude potential variations or combinations of flow mechanisms on a local scale.

Water enters karstic aquifers by point and diffuse recharge. Point recharge occurs where surface runoff collects and infiltrates locally into dissolution features such as dolines and swallow holes. Diffuse recharge is more widespread and is restricted by subsoil and bedrock characteristics. Diffuse recharge will be higher where subsoils are thin and rocks are more permeable. This is reflected in Table 5-10, which includes estimates of long-term (30-year) average recharge for each lake catchment.

"Diffuse" groundwater flow gradients are expected to mimic topography. The areas that contribute groundwater to the lakes would therefore be similar in shape and size to their surface water catchments. In contrast, flow components of deeper conduit systems are unpredictable whereby flow can occur across catchment boundaries and recharge can occur over widely dispersed and fragmented areas. As an example, tracer testing at Lough Lene shows a groundwater connection to springs to the northwest and a surface water outlet to the Deel River in the southeast.

Table 5-11 summarises discharge rates to lakes calculated from the Darcy equation of groundwater flow. The discharge rates were approximated for the shallow "diffuse" flow component only, as Darcy flow conditions do not apply to conduit systems. The total depth of the shallow "diffuse" flow system will vary from one lake to another, but based on GSI's descriptions of related groundwater bodies, the shallow zone is assumed to extend 30 metres below ground surface (GSI, 2004).

The discharges in Table 5-10 were calculated for a range of hydraulic conductivity values between 1 and 10 m/d, and a relatively shallow hydraulic gradient of 0.01 m/m. Both inputs were taken from GSI's descriptions of related groundwater bodies.

The calculations further assume that groundwater discharges occur along the entire perimeter (shore length) of each lake, and that each lake acts as a shallow sink. To find out if this is actually the case would require additional study involving well construction and water level monitoring. If the lakes are part of a "flow-through" groundwater system, then discharges to each lake would be proportional to the shoreline length that acts as a discharge zone.

Table 5-11 is nonetheless useful as a check of the magnitude of abstractions against potential shallow groundwater discharges or inflows to each lake. The discharge values do not include groundwater contributions from conduits, as these can not be approximated in a similar manner. Flow contributions from karst-springs could be many times higher, but would need field study and measurements. The discharge values also do not take count of transient effects of drainage and groundwater storage, whether in the epikarst or in the bedrock. Although storage properties of karstic limestones are generally low, groundwater from storage will

Table 5-11: Groundwater Discharge Rates to the Lakes – Calculated by Darcy Flow

Lake	Aquifer Type	Hydraulic Conductivity (m/d)	Thickness (m)	Hydraulic Gradient (m/m)	Shore Length (m)	Darcy Flow Min. (m^3/d) [1]	Darcy Flow Max. (m^3/d) [3]	Lake Abstraction (m^3/day)	50%-ile Surface Inflow (m^3/day) [3]
Ballycar	Rk_c	1 - 10	30	0.01	843	253	2,528	418	605
Bekan	Rk_c	1 - 10	30	0.01	2,576	773	7,727	382	1,987
Bleach	Rk_c	1 - 10	30	0.01	2,129	639	6,386	932	1,728
Bofinna	Ll and Pl	1 - 10	15	0.05	1,399	1,049	10,493	1,500	2,074
Cavetown	Rk_c	1 - 10	30	0.01	4,299	1,290	12,897	797	6,739
Gorman	Rk_d	1 - 10	30	0.01	1,660	498	4,979	740	3,456
Grange	Rk_c	1 - 10	30	0.01	1,720	516	5,161	4,941	3,024
Holan	Rk_c	1 - 10	30	0.01	683	205	2,049	115	518
Labe	Rk_c	1 - 10	30	0.01	1,120	336	3,360	180	1,296
Lene	Lm	1 - 10	30	0.01	14,444	4,333	43,331	5,216	21,946
Spring	Rk_d	1 - 10	30	0.01	1,480	444	4,441	1,800	864
Owel	Lm and Ll	1 - 10	30	0.01	18,237	5,471	54,710	19,548	
Bane	Lm	1 - 10	30	0.01	4,999	1,500	14,997	4,000	5,184

[1] - using a hydraulic conductivity value of 1 m/d
[2] - using a hydraulic conductivity value of 10 m/d
[3] - calculated using the EPA/ESBI technique; see Section 3.1.4

supply some baseflow to lakes during dry-weather periods. Storativity is a property which describes the (volumetric) capacity of an aquifer to release water from storage (in this case, from interconnected fractures) in response to a decline in hydraulic head. Storativity values of 1-2% are reported for karstic aquifers in Ireland (Daly, 1985 and GSI, 2004).

The calculated minimum discharges are lower than present net abstraction rates for nine of the 12 calcareous lakes. With the exception of Grange Lough, the calculated maxima are several times greater. The lake level of Grange Lough is known to fluctuate considerably as a result of the present abstraction, and plans are underway by Roscommon County Council to abandon the present abstraction and upgrade the associated scheme by moving to a much larger source (also known as Grange Lough) which is connected directly to the Shannon River.

5.3.2.2 Non-Karstic Lakes

Lough Bofinna is hydrogeologically very different from the calcareous lakes. It is underlain by the ORS which is regarded as a poorly productive aquifer. Unless fault zones are encountered, permeability is expected to decrease rapidly with depth and groundwater flow is generally expected to occur in the upper 5-15 m of bedrock. Owing to its low-permeability nature and low storage properties, the ORS has a finite ability to accept recharge. During wet periods, some of the infiltrating water may be rejected, whereby shallow flow paths, including overland flow, become increasingly important.

For the discharge calculation, and because the ORS would be less permeable than the calcareous aquifers described above, a higher gradient of 0.05 was used and the thickness over which flow takes place was assumed to be 15 m, consistent with existing conceptual models of poorly productive rocks. Without evidence of faulting or springs contributing flow to the lake, the lower value of calculated discharge is assumed to be more representative on account of the expected lower permeability of the ORS. This would imply, in theory, that net abstraction approaches or exceeds the estimated groundwater discharge into the lake.

5.3.3 Findings

The calcareous lakes are unquestionably highly dependent on groundwater inflow. The greatest uncertainties surrounding estimated groundwater inputs to each lake are:

- Contributions from spring-flows;
- Relative discharge ratios between conduit-fed springs and shallow groundwater; and
- Knowledge about whether the lakes are hydraulic sinks or part of groundwater flow-through systems.

Contributions from springs are suspected in most if not all lakes, but springs may not be visible along the lake margins and spring flows have not been adequately explored or quantified to date.

The lowland positions and absence of natural drainage features (streams) entering and leaving the lakes indicate that most lakes act as sinks, at least for shallow ("diffuse") groundwater as defined in this report. Unknown karst features may exist (but have not yet been mapped) and may serve to transport water away from the lakes through conduits that are hidden from view (beneath lake level or submerged in vegetation). Only one lake, Lene, is known to export water away from the lake through such conduits.

Actual discharges of shallow groundwater are expected to fall within the range of the values shown in Table 5-11. For the calcareous lakes, it is expected that the higher end values apply, whereas for Lough Bofinna (ORS) it is expected that the lower end value would apply.

On the basis that the higher values apply for calcareous lakes, it would appear that lakes such as Labe, Cavetown and Bekan could be removed from the "at-risk" category, since the estimated groundwater discharge to net abstraction ratios are relatively high, exceeding 10:1. However, given the uncertainties described above and the fact that all of the lakes support ecological habitats (whether or not they are protected by the Habitats Directive), it is proposed that none of the lakes be removed from the "at-risk" category.

Grange is identified as a potentially unsustainable abstraction. If current plans to abandon this scheme proceed, then the at-risk assignment can be dropped in the future.

Existing groundwater-dependent lakes with data loggers (Owel, Bane, Lene) should continue to be monitored and reviewed in context of environmental supporting conditions for important ecological habitats.

On the basis of low estimated discharge to net abstraction ratios (<5:1), the following lakes should be prioritised for installation of lake level data recorders: Bofinna, Co., Cork, Gorman, Co. Donegal, and Spring, Co. Monaghan. The situation at Grange would warrant monitoring equipment as well, but the need should be tempered against the likelihood of plans to move and abandon this abstraction scheme.

5.4 Lakes Recommended for Future Monitoring

Future lake level monitoring will be the foundation on which abstraction impacts are judged, as changes in lake water level are the principal hydrological habitat parameter and therefore characterises the potential for impacts to the shallow littoral ecosystem. Ideally all abstraction lakes would have water level monitoring, especially ones that are considered to be at risk. It is imperative to correlate fluctuations in lake water levels with abstractions, meaning that both lake levels and abstractions should be metered in abstraction lakes. This allows the degree of natural lake level fluctuations by compared with the lake level fluctuations caused by abstractions.

As it may not be feasible to extensively monitor all abstraction lakes, here lakes have been prioritised for water level and other future monitoring for two reasons;

- The lake would appear to be a high risk for impact from abstraction and additional information is needed to allow for a site-specific assessment of the abstraction pressure; and

- The lake is subject only to abstraction pressures, and thus, the effect of abstraction pressures on the lake's ecology can be examined in isolation from other pressures.

5.4.1 Lakes at High Risk – Impact

Lakes are judged to be at high risk for impacts from abstraction pressures because;

- The Stage 1 calculations indicate that the ratio of net abstractions to surface inflows is greater than 1; that is, the abstraction is larger than the estimated inflow. These lakes were identified in Table 3-3;

- The results of the assessment of groundwater-dependent lakes indicates a low estimated discharge to net abstraction based on estimates of Darcy's inflows from groundwater (Section 6.3); and

- Other information was uncovered during this study that indicated a high risk of impact.

The lakes prioritised for monitoring and the reason for their inclusion is provided in Table 5-12. Note that Grange Lough was not included in Table 5-12 because of the current plans to abandon the scheme there. Unshin Lough also was not included because there appear to be plans to move the abstraction; the Lough Golagh And Breesy Hill SAC (SY 2164) report had noted: "This [abstraction in Lough Unshin] may account, due to fluctuating water levels, for the lack of fringing vegetation and the shoreline substrate consisting largely of bare boulders." Should these abstractions remain, the loughs should be included in a future monitoring programme.

The first objective of future monitoring programmes should be on understanding the physical effects of abstraction resulting in constructing a water budget. Before beginning any field work, the data used in this report, which resulted in the lake being included in the list of lakes at high risk for abstraction impacts, should be verified. Note that extensive efforts were made during this study to verify information with local authorities and the RBD projects. In nearly every case, updated abstraction information was obtained; as the initial data had only been gathered a few years earlier to conduct the Article V risk assessments, this raises questions about either the ability to provide accurate data (in general, flows are not metered) or the frequently changing conditions related to abstractions. If the lakes remain at high risk, then field work could include:

- Determining if there are other sources of water (such as transfers) into the lake;

- In most cases, adding capabilities for metering abstraction volumes, preferably on a daily basis;

- Adding water level data loggers collecting data on a daily basis;
- Reviewing the locations of existing precipitation and hydrometric gauges to determine if they can be used to develop a water budget, and, if not, adding gauges to collect this information;
- Collecting bathymetric data for the lake;
- Examining the lake's catchment to determine if the lakes are hydraulic sinks or part of groundwater flow-through systems (this may require installation of monitoring wells with water level data loggers);

Table 5-12: Lakes Prioritised for Monitoring due to Suspected Impacts from Abstraction Pressures

Lake County	Catchment Area, including lake area (km^2)	Lake Area (km^2)	Existing Gauge?	Reason for Inclusion
Brackan Lough Meath	0.750	0.076	No	Net Abstraction: Surface Inflow **>1**
Killcoran Lough Monaghan	0.472	0.144	No	Net Abstraction: Surface Inflow **>1**
Carrigavantry Reservoir Waterford	0.720	0.119	No	Net Abstraction: Surface Inflow **>1**
Cullionboy Lough Donegal	0.078	0.029	No	Net Abstraction: Surface Inflow **>1**
Spring Lough Monaghan	0.816	0.103	No	Net Abstraction: Surface Inflow **>1** **and** Low GW inflow to net abstraction
Corconnelly Lough Monaghan	0.354	0.056	No	Net Abstraction: Surface Inflow **>1**
Lough Owel Westmeath	23.3	10.2	Yes	Low GW inflow to net abstraction
Lough Bane Meath	4.0	0.75	Yes	Low GW inflow to net abstraction
Lough Lene Westmeath	13.1	4.16	Yes	Low GW inflow to net abstraction
Lough Gorman Donegal	2.42	0.078	No	Low GW inflow to net abstraction
Lough Bofinna Cork	0.56	0.086	No	Low GW inflow to net abstraction
Naglea Lough Donegal	0.38	0.070	No	At previous abstraction rate, lake experiencing lake level decline; reduced abstraction reversing this

- In the cases of groundwater-dependent lakes, determining if the lakes are spring fed and the contributions from spring flows; and

- In the cases of groundwater-dependent lakes in karstic settings, examining the relative contributions between surface inflows, conduit-fed springs and shallow groundwater.

5.4.2 "At Risk" Lakes with only Abstraction Pressures

This section prioritises the 37 lakes left after screening for good or high status for future monitoring, based on information collected during the site-specific evaluation of at risk lakes. The aim was to choose representative lakes from those at risk from abstraction pressures and to prioritise those lakes where abstraction pressures can be isolated from other pressures. In some cases lakes with low pressures are considered as it is difficult to find abstraction lakes isolated from all other pressures. Other factors were also taken into consideration such as lakes that may be more sensitive to abstraction pressures due to physical attributes (Section 6.2.4), lakes that are ecologically sensitive to water level change and groundwater-dependent lakes that are at risk based on the findings of Section 6.3. The assessment of groundwater-dependent lakes included Lough Owel at the request of the Abstractions Steering Group; it was not previously considered as it was not a 1a/1b lake as part of the Article V Risk Assessment. Thus, 38 lakes are evaluated for monitoring in this section.

Long-term monitoring of Water Framework Directive ecological parameters; macroinvertebrates, phytobenthos, macrophytes, phytoplankton and fish are recommended to be undertaken along with water level monitoring for these abstraction pressure only lakes, so the effects of abstraction pressures on the ecology can be examined.

About 60% of the lakes at risk have catchments less than 1 km^2. There is currently no water level monitoring on these small lakes and so they are of primary importance for future monitoring of abstraction pressures. Lakes with a smaller area can be considered more sensitive to water level change as larger lakes can have a greater diversity of habitats and so can be more resilient to change.

The lakes that were considered to be most sensitive to water level change, as determined using the sensitivity typology based on SNIFFER WFD48 (Section 6.2.4), were given priority for potential water level monitoring sites, especially in the cases where the sensitivity score was 2.

Freshwater habitats that are protected and are known to be highly sensitive to water level changes are also recommended to be monitored. This is the case for "Hard-Oligotrophic waters with benthic Vegetation of *Chara* spp." which is an Annex 1 habitat under the Habitats Directive.

Table 5-13 summarises all of the lakes that have been considered for future monitoring of lake levels for the assessment of abstraction pressures. The lakes are divided into separate categories that show the order of priority for monitoring.

- The lakes where the water levels are already monitored – *Already*;

- The lakes recommended for water level and ecological monitoring – *Category A*;
- The lakes that could be considered for monitoring – *Category B*;
- Not recommended for monitoring – *Category C*; and
- Already recommended for water level monitoring because lake judged to be at high risk for abstractions (see Table 5-12) – *Category D.*

Already Monitored

The lakes where water levels are already monitored were also assessed for their suitability as lakes to monitor future abstraction pressures. Five of the lakes have data loggers and three have staff gauges. A further three of the 78 lakes remaining after Stage 1 and Stage 2 screening have data loggers but are not considered for monitoring as they were screened out in Stage 3. These lakes are Lough Lene, Skeagh Lough Upper, and Nadreegeal Loughs, where monitoring should continue as the lakes remain in the at risk category.

The five lakes that have data loggers all have larger catchments; Lough Acorrymore, Lough Bane, Lough Owel, Moher Lough and Coragh Lough. Monitoring should continue at these lakes so that long-term trends can be established and the additional reasons;

- Lough Acorrymore is the only one that has no other pressures other than the abstraction. The other four lakes each have one or more pressures from pasture, forestry and housing.
- Two lakes – Loughs Bane and Owel – were recommended for continued monitoring in Section 6.4.1 because they are thought to be at high risk for abstraction-related impacts (Table 5-12). At Lough Bane, for instance, exposed marl can be seen along the shore (NPWS, 2000) and the outlet stream is even known to dry up in summer. However it is not certain how much of this can be attributed to abstractions and how much of it is natural as there is no correlation with rainfall levels recorded at a gauge just 15 km away from Lough Bane (Figure 5-3).
- Three of the lakes with data loggers will also be useful for the future assessment of abstraction pressures because they may be more sensitive to water level change. Moher Lough was shown to be more sensitive to water level change as it has a slightly convex basin shape and a mean depth of less than 4 metres. Lough Bane and Lough Owel have the Annex 1 habitat "Hard-Oligotrophic waters with benthic vegetation of *Chara* spp.", which is sensitive to water level change. Lough Owel has alkaline fens which are an Annex 1 habitat that is extremely sensitive to changes in groundwater availability.

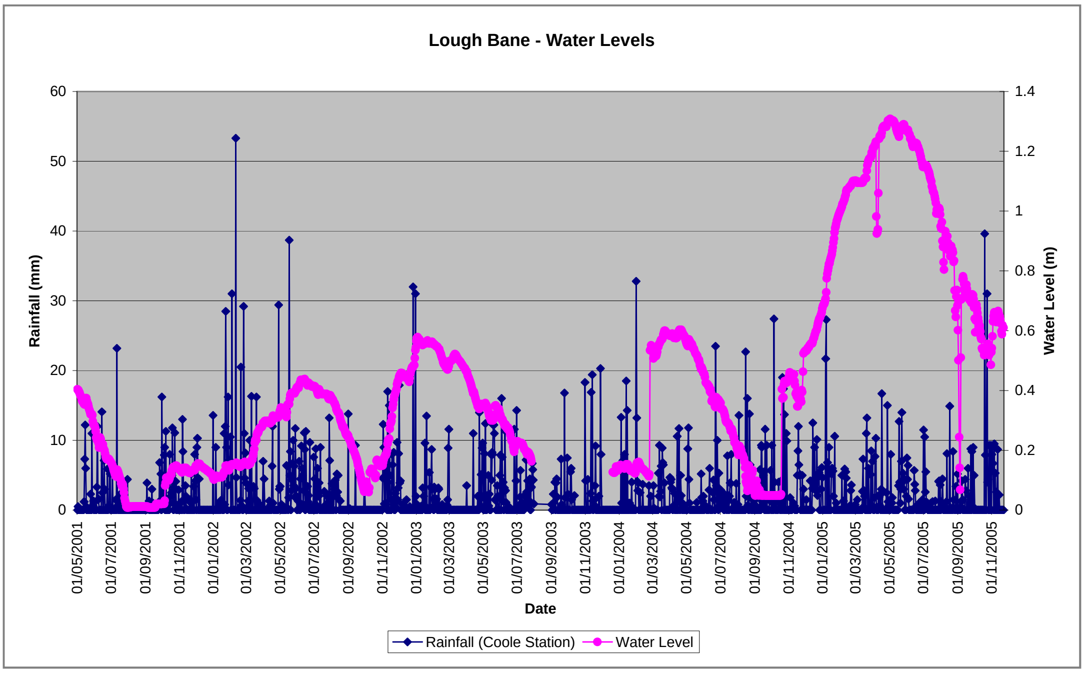

Figure 5-3: Lough Bane Water Levels Compared with Rainfall. (Coole is the nearest rainfall station)

It is also useful to continue monitoring the three lakes (Unshin, St Peters and Talt Loughs) with existing staff gauges and perhaps even upgrade the gauges to data loggers. At St. Peters Lough, exposed shores were seen at the time of the field visit which suggest over-abstraction from the lake. Lough Talt has a high net abstractions to lake inflow ratio, is considered sensitive to water level change as it is a large lake and has a slightly convex basin and it has a healthy population of Arctic char which should be protected.

Category A

Six lakes are recommended as suitable for water level and ecological monitoring for the assessment of abstraction pressures.

Four of the lakes have very small catchments (< 1 km^2), which is representative of the majority of lakes at risk from abstractions; Loughaunore, Tooreen Lough, Labe and Illauntrasna. Three have no pressures other than abstractions, while the third (Illauntrasna) could have a housing-related pressure. Three of the four are considered sensitive to changes in water level as a result of abstractions. Loughaunore in Galway was included as it is representative of an upland lake with a small catchment. Lough Labe was included because it is a groundwater-dependent lake considered to be a low risk from abstractions and would serve as a useful comparison to a control lake.

The two lakes with slightly larger lake catchments (up to 4 km^2) are Lough Gorman and Lough Anaserd. They both have low pressures and Lough Gorman is a groundwater-dependent lake which is also recommended as it is a lake at high risk from abstraction pressures. Lough Anaserd is a protected *Chara* lake.

Category B

If further monitoring sites are required, five additional suitable lakes are proposed in Category B.

Two lakes with the smallest catchments are suggested to supplement the monitoring of lakes in this category. Barnahallia Lough is proposed as it has low pressures, but as it is a small lake it may be susceptible to agricultural pressures in the future. Glencoagh Lough is proposed as it is near to St. Peters Lough, which has known abstraction effects. There are two houses near to the shore of Glencoagh Lough.

Lough Nameeltoge and Gort Lough are proposed as the screening showed them to have low pressures, though this was not confirmed by a field visit.

Lough Callee in Kerry is also suggested in this category as it is another upland lake with no pressures, and there are few lakes at risk from only abstraction pressures in Cork and Kerry.

Lough Shannagh is proposed as it is a protected *Chara* lake. Lough Shannagh also has pressures from nearby housing and a road and so may not be solely representative of abstraction pressures.

Category C

These are lakes that are not recommended for monitoring water levels for the future assessment of abstraction pressures. Many lakes fall into this category because the other pressures on the lake were too great and therefore any effects on the ecology could not be attributed to abstraction-related water level fluctuations. One lake is on an island so access is difficult.

Other lakes in this category are upland lakes with no pressures and are not recommended for monitoring as there are three upland lakes already recommended and therefore this category of lake is already represented.

Table 5-13: Lakes Suitable for Monitoring due to Ability to Isolate Abstraction Pressures

WFD Code	Lake Name	COUNTY	Overall Category	Visited in field	Ground-water Dependent	Sensitivity Points	Protected Habitat sensitive to WL change	Other Pressures	Main Reasons to monitor	Reason not to monitor	Monitor water levels?
IE_WE_31_177	Loughaunore	Galway	A1 – I1	✓		2		None	No Pressures. Sensitive. Upland lake		A
IE_SW_20_133	Tooreen Lough	Cork		✓		2		None	No Pressures. Sensitive		A
IE_WE_31_1126	Illauntrasna (Lough)	Galway		✓		2		Housing	Low pressures. Sensitive		A
IE_WE_35_237	Labe (Lough)	Sligo		✓	✓	0		None	No Pressures. Groundwater dependent lake.		A
IE_WE_32_269	Barnahallia Lough	Galway		✓		n/a		Pasture	Low pressures	Small susceptible to agricultural pressures	B
IE_NW_37_195	Glencoagh Lough	Donegal		✓		n/a		Housing	Beside St. Peters Lough	Housing	B
IE_WE_34_458	Holan (Lough)	Mayo		✓	✓	0		Pasture		Other pressures	C
IE_WE_30_532	Aille Lough	Mayo		✓		1		Pasture. Forestry		Other pressures	C
IE_NW_38_52	Anna (Lough)	Donegal				n/a		Forestry		Other pressures	C
IE_WE_32_526	Fawna (Lough)	Galway				1		None		Access - Located Island	C
IE_SW_21_369	Eirk Lough	Kerry				0		None		Upland lake	C
IE_WE_35_96	Lackagh Lough	Leitrim				n/a		None		Upland lake	C
IE_SW_22_58	Mount Eagle Lough	Kerry				0		None		Upland lake	C
IE_WE_32_422	Nambrackkeagh (Lough)	Galway				1		None		Upland lake	C
IE_NW_37_208	St. Peter's Lough	Donegal	A1 – I2	✓		n/a		Housing	Exposed shores	Housing	Already[SG]
IE_NW_38_29	Nameeltoge (Lough)	Donegal				n/a		None	No Pressures		B
IE_SH_28_87	Naminna (Lough)	Clare				n/a		Forestry		Other pressures	C
IE_NW_36_382	Toome Or Crinkill Lough	Monaghan				n/a		Forestry. Housing		Other pressures	C
IE_EA_07_242	Acurry (Lough)	Cavan				n/a		Pasture. Housing		Other pressures	C
IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford				n/a		None		Upland lake	C
IE_NW_37_210	Cullionboy Lough	Donegal		✓		n/a		Pasture	Surface inflow: net abstraction ratio >1	Other pressures	D
IE_SW_21_448	Bofinna (Lough)	Cork		✓	✓	1		Pasture. Road	Groundwater-dependent lake at high risk Sensitive	Other pressures	D
IE_NB_06_198	Spring Lough	Monaghan			✓	n/a		Pasture	Groundwater-dependent lake at high risk	Classified Moderate status	D
IE_WE_33_1892	Acorrymore (Lough)	Mayo	A2 – I1	✓		0		None	Exposed bank. Representative of upland lake.		Already[DL]
IE_NW_36_460	Coragh Lough	Cavan				n/a		Forestry		Other pressures	Already[DL]
IE_NW_36_706	Gorman (Lough)	Donegal		✓	✓	n/a		Housing	Low pressures. Groundwater dependent lake at high risk		A (D)
IE_WE_31_211	Anaserd (Lough)	Galway		✓		n/a	Hard oligo-mesotrophic waters with *Chara* spp.	Housing	Low pressures. Sensitive ecology		A
IE_NW_39_44	Gort Lough	Donegal				n/a		Housing	Low pressures	Other pressures	B
IE_SW_22_182	Callee (Lough)	Kerry				1		None		Upland lake	B

WFD Code	Lake Name	COUNTY	Overall Category	Visited in field	Ground-water Dependent	Sensitivity Points	Protected Habitat sensitive to WL change	Other Pressures	Main Reasons to monitor	Reason not to monitor	Monitor water levels?
IE_NB_03_87	More (Lough)	Monaghan	A2 – I1 Cont'd			n/a		Forestry		Other pressures	C
IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork				1		None		Upland lake	C
IE_EA_07_270	Bane (Lough)	Meath	A2 – I2	✓	✓	n/a	Hard oligo-mesotrophic waters with *Chara* spp.	Pasture. Housing	Known draw down in water level. Groundwater dependent lake at risk. Sensitive ecology.	Other pressures	Already[DL]
IE_WE_32_406	Moher Lough	Mayo	A3 – I1	✓		2		Pasture. Forestry. Housing	Sensitive	Other pressures	Already[DL]
IE_NW_36_712	Unshin (Lough)	Donegal		✓		n/a		Pasture		Other pressures	Already[SG]
IE_NW_38_678	Shannagh (Lough)	Donegal				n/a	Hard oligo-mesotrophic waters with *Chara* spp.	Housing. Road	Sensitive ecology	Other pressures	B
IE_SH_26_705	Cavetown Lough	Roscommon		✓	✓	n/a		Housing. Road		Other pressures	C
IE_WE_31_120	Loughaunwillan	Galway		✓		1		Housing. Road. Pasture		Other pressures	C
IE_WE_34_405	Talt (Lough)	Sligo	A3 – I2	✓		2	Arctic char	Housing. Road	High net abstractions:inflow. Sensitive	Other pressures	Already[SG]
IE_SH_26_703	Owel (Lough)	Westmeath	-	✓		n/a	Hard oligo-mesotrophic waters with *Chara* spp./ Alkaline fen & transition mire	Pasture. Arable. Forestry	Groundwater dependent lake at risk. Sensitive ecology	Other pressures	Already[DL]

Already[DL] = Data Logger

Already[SG] = Staff Gauge

A The lakes recommended for water level and ecological monitoring

B The lakes that could be considered for monitoring

C Not recommended for monitoring

D Already recommended for water level monitoring because lake judged to be at high risk for abstractions (see Table 5-12)

5.5 Stage 3 Summary

The Stage 3 site-specific assessment of lakes at risk from abstraction pressures had three main aims;

- Gather all the available information about the 78 lakes that remained after the Stage 1 screening;
- Examine if any of the groundwater-dependent lakes were not at risk from abstractions; and
- Select lakes suitable for the future assessment of abstraction pressures.

All available data was gathered for the lakes at risk from abstractions. This included general data and information about the catchment characteristics. Ecological data was also compiled from various sources. Abstractions data was verified and information on water levels and evidence of fluctuations was gathered during the desktop study and also during the field visits. Information on other pressures were screened on GIS and also verified with field visits.

An assessment of the groundwater-dependent lakes was carried out to examine groundwater inflows relative to abstraction pressures. It was concluded that there was not enough certainty to say any of the lakes in question were not at risk, but if the abstraction was removed from Grange Lough as planned then it could be omitted from the at risk category. It was possible to indicate that lakes that were at higher risk from abstraction pressures; Bofinna Gorman and Spring Lough were highlighted as lakes not currently monitored for water levels that had relatively low estimated groundwater inflow rates compared to the net abstraction.

There were no further changes to the risk assessment categories as a result of the Stage 3 site specific assessments, so 78 of the 127 lakes still remain 1a/1b and 49 are re-categorised as 2a.The final updated risk assessment file is contained in Appendix F.

Future lake level monitoring will be the foundation on which abstraction impacts are judged, as changes in water level are the principal hydrological habitat parameter characterise the potential for impacts to the shallow littoral ecosystem. It would therefore be preferable for water levels to be monitored in all abstraction lakes. Lakes were prioritised for future monitoring of abstraction pressures and selected on two bases: (1) they are considered to be at high risk of abstraction pressures or (2) they are thought to only be subject to abstraction pressures, so that any impacts to the lake's ecological health could be directly determined. Other factors considered in the selection were the lakes sensitivity rating, which was estimated based on their basin shape, area and mean depth, after SNIFFER WFD48. Also the ecological sensitivity was considered in the case of protected *Chara* lakes or lakes with Arctic char populations.

The suitability of lakes where the water level is already monitored was also assessed and they were recommended to be included in the future assessment of abstraction pressures. A total of fourteen lakes that currently do not have gauges, have been prioritised for water level monitoring for the future assessment of abstraction pressures, summarised in Table 5-14. Nine were prioritised as they are at high risk from abstractions (from Table 5-12) and five as there are no other pressures (from Table 5-13 – Category A). It is also recommended that the five with no other pressures undergo ecological monitoring to assess the effect of abstraction pressures on the lake ecology.

Table 5-14: Overall Lakes Prioritised for Future Monitoring

Lake	County	Existing Gauge?	At 'High' Risk	Ecological Monitoring
Lough Bofinna	Cork	No	✓	
Tooreen Lough	Cork	No		✓
Cullionboy Lough	Donegal	No	✓	
Lough Gorman	Donegal	No	✓	✓
Naglea Lough	Donegal	No	✓	
Lough Anaserd	Galway	No		✓
Lough Illauntrasna	Galway	No		✓
Loughaunore	Galway	No		✓
Brackan Lough	Meath	No	✓	
Lough Bane	Meath	Yes	✓	
Corconnelly Lough	Monaghan	No	✓	
Killcoran Lough	Monaghan	No	✓	
Spring Lough	Monaghan	No	✓	
Lough Labe	Sligo	No		✓
Carrigavantry Reservoir	Waterford	No	✓	
Lough Lene	Westmeath	Yes	✓	
Lough Owel	Westmeath	Yes	✓	

Section 6
Programmes of Measures

From the review of data relevant to abstraction lakes, recommendations for programmes of measures (POMS) have been developed to guide future research and protection of abstraction lakes. POMs are mitigation measures that would be required to ensure that WFD good ecological status objectives are met in all water bodies by year 2015, and that areas that are not yet impacted remain adequately protected in the future. Measures are essentially of two types:

- Basic measures, which are covered under existing statutory instruments (laws and regulations); and
- Supplementary measures, which are new recommended measures that could be voluntary or made statutory. They could take the form of codes of good practice, bye-laws, or one-off actions (*e.g.*, surveys and research).

The DEHLG is proposing new measures in the form of a new regulatory regime for abstractions, initially for groundwaters; a programme for surface waters is expected to follow. This would be supported by decision support tools and monitoring programmes in this newly recognised area. In addition, water conservation allocations are being made available to local authorities under the Water Services Investment Programme to identify and substantially reduce the levels of unaccounted for water.

Basic measures will not be sufficient to address abstraction pressures in some lakes and site-specific (supplementary) measures will be needed. These will need to be evaluated on a waterbody-specific basis. In general potential measures either focus on reducing the demand on the water supply or making more water available in the catchment. A menu of potential measures that could be considered during the individual assessment include:

- Support for voluntary initiatives such as water conservation and rainwater harvesting schemes;
- Changes to plumbing codes to promote water conservation;
- Reducing abstracted volumes by altered abstraction timing, conjunctive use, altering compensation flows, or reducing abstraction volume;
- Use of additional storage or alternative water sources;
- Water metering programmes for residential users and cost recovery mechanisms;
- Daily metering of abstracted volumes;
- Support for water re-use;

- Reduce unaccounted for water losses by continued investment in watermains rehabilitation;

- Where feasible in developed areas, promote infiltration of stormwater runoff;

- Introduction of a new code of water conservation good practice – this could be used as a planning condition for all operations including private or unregulated activities in high status or protected areas; and

- Impose restrictions on new developments in areas where abstraction limits capacity has been reached until further upgrade of facilities is put in place demand has been reduced, or new supplies, operation schemes, or facilities (e.g., storage) have been identified.

Below are some recommended supplementary measures that address particular data and information gaps that have come to light during this POMS study. Guidance is provided of how to capture such missing information and how it would enhance the understanding of the effects of abstraction pressures on lakes. These have been divided into three areas; the national abstractions register, conducting water budgets, and linking abstractions to effects on lake ecology.

6.1 Abstractions Register

As part of this project, a register of abstractions in Ireland was complied from individual RBD registers and updated with input from each RBD and local authorities. In total 34 local authorities were contacted, and 24 of them responded. All information received was used to update the register.

The updated register is considered an improvement over the version used as part of the Article V Initial Characterisation as the database was cleaned and most of the gaps were filled in, namely the nature of the abstraction and the type. Every abstraction was assigned as either surface water or groundwater (where groundwater abstractions include springs) and whether it was from a lake, river, well or spring. The type of supply was identified, whether it was a public supply, a private supply or a group water scheme.

Records were cross- and error-checked, new abstractions have been added or decommissioned ones were removed as appropriate. New or revised volumes of abstractions have been added where available.

It is believed that most public and group water schemes have been identified and included, but it is unlikely that all small private abstraction schemes (particularly agricultural) are captured in the updated register. The register does not include domestic wells, as these are too numerous and considered less important from a resource quantity point of view. Most of the domestic abstractions are returned to ground via septic systems, and whilst this has an impact groundwater quality, it has less of an impact on quantities.

The quality of the data in the national abstractions register depends largely on the quality of the local authority records. Some local authorities do not keep a digital database of abstractions and mostly private supplies are not recorded by the local authorities. Often the coordinates are inaccurate, for example they can just be the coordinates for the town location rather than the abstraction location, and where possible the coordinates were rectified in the national abstractions register. The abstraction data includes the amount abstracted in cubic meters per day (m^3/d, or 1,000 l/d) and the population served. In some cases, the abstracted amount is estimated based on the number of population served as the abstraction rate is not measured.

Although the register is current as of September 2008, it is possibly already outdated in the sense that some schemes may have been modified or upgraded in the period since the abstractions were last verified with local authorities and private entities. The register is therefore an ever changing database, which needs to be regularly updated.

Thus, a system for creating a comprehensive register and updating that register needs to be developed. A national regulatory agency (e.g., EPA) should be responsible for this register. The register could be initially populated by canvassing public and private water suppliers as well as individual public and private users. Lessons learned from a similar registration programme in Northern Ireland should be sought out in developing a national registration programme for Ireland.

6.2 Lake Water Balances

The first objective of future monitoring programmes should be on understanding the physical effects of abstraction resulting in constructing a water budget. This should be done especially in the cases where lakes are at high risk from abstractions or for proposed new abstractions. Some of the essential tasks required for water budgets are listed below;

- Determining if there are other sources of water (such as transfers) into the lake;
- In most cases, adding capabilities for metering abstraction volumes, preferably on a daily basis;
- Adding water level data loggers collecting data on a daily basis at a minimum;
- Reviewing the locations of existing precipitation and hydrometric gauges to determine if they can be used to develop a water budget, and, if not, adding gauges to collect this information;
- Collecting bathymetric data for the lake;
- Examining the lake's catchment to determine if the lakes are hydraulic sinks or part of groundwater flow-through systems (this may require installation of monitoring wells with water level data loggers);
- In the cases of groundwater-dependent lakes, determining if the lakes are spring fed and the contributions from spring flows; and

- In the cases of groundwater-dependent lakes in karstic settings, examining the relative contributions between surface inflows, conduit-fed springs and shallow groundwater.

Some of the elements to a lake water budget are described in more detail in the following sections, referring to current limitations and recommending future improvements.

6.2.1 Hydrometric Data

Two types of hydrometric data are useful in evaluating abstraction pressures on lakes; flow and lake-level data.

Estimates of lake inflows from surface processes could be improved if hydrometric stations were located on influent streams to lakes; only 10 of the 1a/1b lakes had nearby stream gauges and these were located on the lake's outflowing stream. The lack of a network of hydrometric gauges hinders the calculation of the surface water recharge to lakes, although in many instances there are no significant influent streams to the small 1a/1b lakes which could be gauged. In general, the relative paucity of hydrometric gauges on small catchments precludes estimates that could be made using a gauge transposition method. A long-term recommendation is to establish an expanded network of stream gauges in Ireland to provide records of actual flows, particularly in small catchments.

Future lake level data will be the foundation on which abstraction impacts are judged as changes in water level are the principal hydrological habitat parameter that characterises the potential for impacts to the shallow littoral ecosystem. Ideally all abstraction lakes would have water level monitoring, especially ones that are considered to be at risk. As this may not be feasible, lakes have been prioritised for water level monitoring. Separate from the national hydrometric network it could be a requirement for abstractors to install a gauge to monitor lake level.

6.2.2 Abstraction Data

The requirement for the updating of the national abstractions register is discussed in Section 6.1.

There is also a need for actual daily abstraction rates to be recorded and made available in a digital format. Daily records would allow for water level fluctuations to be assessed to determine how much of this is natural and how much can be attributed to abstractions.

6.2.3 Discharge Data

The register of discharges used in this study has been updated with the most recently-available data from the South Western River Basin District (SWRBD) for municipal and industrial point source discharges from urban waste water treatment plants, IPPC-licensed industries and Section 4-licensed industries.

The discharge data for the IPPC and Section 4 industries are incomplete and the discharges are provided as maximum permissible hourly or daily rates as per the licence limits. The discharge rate for IPPC and Section 4 industries are not reported to any central databases, and so flow limits set in licences are currently the only source of discharge information. Discharge data for the WWTPs are provided as average daily flows, where available. Population data are available for most WWTPs and were used to estimate discharge flows in the absence of flow data.

It is likely that many industrial abstractions are balanced by the corresponding discharges, with no significant quantitative effect on the catchments. Industrial discharges may include a component of public water supply derived from outside a lake's catchment, resulting in a net discharge and this level of information should be reviewed for significant industrial water users. The database of discharges should be updated regularly to include changes in actual average discharge rates, add discharges not previously included, and remove inactive discharges. Where the discharge data is being determined using population equivalents, necessary steps should be taken to allow measurement of WWTP flow.

6.2.4 Bathymetry Data

Quantifying the effects of over-abstraction on the shallow littoral habitat requires an understanding of shoreline slope and wave exposure; information that is generally not available for Irish lakes. The areal extent of the affected shallow littoral zone will be dependent on shoreline slope and the drop in water level. The water level drop in turn is a factor of a lake's stage-volume relationship, the ratio of the abstractions to lake volume, and the significance of the abstraction-related water-level change relative to other climatic variations affecting lake levels. When mapping lake vegetation bathymetric maps can be used to extrapolate limits of different vegetation types and therefore the extent of habitats. Lake bathymetry reports and maps are available for 24 of the 78 lakes retained from the Stage 1 screening, while depth and volume data are available for another three lakes. It is recommended that all lakes at risk from abstractions have bathymetry surveys conducted, if they have not already been done.

6.2.5 Groundwater-dependent Lakes

Some lakes have very small surface catchment areas and do not have apparent inflow or outlet streams. Such lakes are considered to be mostly groundwater-dependent, that is, they are fed and hydraulically influenced by groundwater discharges. Such lakes either serve as hydraulic sinks or are part of a flow-through system, whereby the lake acts as a natural storage reservoir.

Groundwater-dependent lakes also receive direct recharge from precipitation and overland flow, and the assessment of relative contributions from each component would require lake-specific study.

In the absence of location-specific groundwater data, the natural zones of (flow) contribution to groundwater-dependent lakes are assumed to be similar in size and shape to their surface catchments. The principal exception would be lakes situated in karst terrains. Zones of contribution in karstic limestones are notoriously unpredictable, and the consideration of equivalent surface catchments as indicators of contributing areas can be misleading.

Small groundwater-dependent lakes that are subject to significant abstractions should be subject to individual assessments of the surrounding aquifer, including groundwater level monitoring and hydraulic testing. In karst terrains, dye tracer tests may also be warranted.

6.3 Ecology

Future monitoring programmes should also work towards further establishing a link between the water level fluctuations and its effect on the ecology. The natural water level regime and its links with the lake ecology need to be understood in greater detail before the effect of changing the regime as a result of water abstractions can be understood fully i.e. to what degree of water level fluctuation is the biota adapted to even in the absences of abstractions. The expansion of lake monitoring activities, both water levels and ecological monitoring, to include natural lake systems and also abstraction lakes is necessary moving forwards.

The habitat requirements vary seasonally for biota and so they can be more sensitive to water level changes due to abstractions at certain times of year. Acreman *et al.* (2006) developed a sensitivity calendar showing the critical life stages for species characteristic of different lake typologies in the UK. It would be very useful to develop a similar understanding of the critical life stages of biota in Ireland.

Studies have also been carried out on individual lakes and their ecology and water levels. One such study was on Lough Bane, Co. Meath which is a protected SAC *Chara* lake, examining the effect of excessive abstraction on the vegetation and the lakes conservation status (Roden, 2008). The report was requested by the EC, because in recent years the abstraction of water has resulted in the lake level dropping and exposing sub-littoral banks of vegetation. The vegetation was sampled and mapped and compared with two control sites without abstractions. It was found that the vegetation in all sites were similar but less disturbed in the control sites. Roden recommended water levels must be prevented from being dropped much below half the depth of the current littoral zone to restore Lough Bane's vegetation to its former zonation. This depth was chosen as only true aquatic plants are found below this depth and any exposure to drying would be damaging. It was also recommended to monitor vegetation along two transects annually for the next three years to establish if it is recovering.

So it is important that further research within Ireland is carried out to link changes in water level to effects on the ecology both on a national scale and a site specific basis.

Section 7 Conclusions

A national study of abstraction pressures of 127 lakes judged to be 'at risk' or 'potentially at risk' in the Article V Initial Characterisation has been carried out as part of the Further Characterisation phase of WFD implementation in Ireland. The principal objectives of the study were to:

- Reduce uncertainty in the Initial Characterisation results so status can be assigned;
- Better understand the causes and processes of the pressures; and
- Provide data to inform the selection of management measures and programmes of measures (POMs) by the river basin districts (RBDs).

The Initial Characterisation risk assessments compared net abstractions (total abstractions minus total discharges) to an estimate of Q95 flows. Risk levels were set at threshold values for highly sensitive surface waters established in guidance documents from the UK and Northern Ireland; except in cases when a dam or weir was present which defaulted the assessment to "at risk".

Uncertainty in the Initial Characterisation was reduced by taking into account improvements in an updated abstractions register and an updated discharges register. The average surface water inflow to the lake is used here, as this is a more ecologically significant hydrologic parameter for lake health rather than extreme low flows as used in the Initial Characterisation. Also an improved method for estimating flows was used which directly uses basin hydrology (the EPA/ESBI method). The ratio of net abstraction to surface water inflow was used to refine the similar calculations made in the Initial Characterisation risk assessment.

Using a threshold value of 0.1 for the ratio of net abstractions to inflow which was based on the distribution of the ratio of net abstractions to inflow on a cumulative frequency curve, a total of 78 lakes of the initial 127 lakes remained at risk following the screening. Based on this threshold, it is recommended that the 49 lakes listed were reclassified as water bodies probably not at risk (2a) from abstraction pressures.

The process of re-evaluating the risk of the 127 1a/1b lakes has revealed the likelihood that some of the lakes that were evaluated 'not at risk' (2a/2b) in the initial risk assessment might have been misclassified. Thus, it is recommended that all the remaining lakes with abstraction pressures be examined for the potential for impacts related to changes in inflows or levels due to abstractions.

Available data was gathered for the lakes at risk from abstractions to better understand the lakes. This included general data and information about the catchment characteristics. Ecological data was also compiled from various sources.

Abstractions data was verified and information on water levels and evidence of fluctuations was gathered during the desktop study and also during the field visits. Information on other pressures was screened using GIS and also verified with field visits.

Abstraction-related impacts are dependent on the bathymetry of individual lakes, with those subject to the greatest shoreline exposure due to over-abstraction being the most vulnerable to declines in their ecological status. The most important aspects of lake water level changes include the range of water level fluctuation, which establishes the area of the shallow littoral zone, frequency of shoreline immersion or emersion, which affects the degree of desiccation, and the duration of the low (or high) water events. Available water level data for Irish lakes was examined. The mean annual lake fluctuation across all 21 lakes was about 1.2 metres (the average record is 18 years). Individual lakes had average annual fluctuations ranging from 0.4 m to 2.7 m; while standard deviations of the annual fluctuation were typically 0.2 to 0.3 m.

An assessment of the groundwater-dependent lakes was carried out to examine groundwater inflows relative to abstraction pressures. It was concluded that there was not enough certainty to say any of the lakes in question were not at risk, but if the abstraction was removed from Grange Lough, Co. Roscommon, as planned then it could be omitted from the at risk category. It was possible to indicate that lakes that were at higher risk from abstraction pressures; Bofinna, Co. Cork, Gorman, Co. Donegal and Spring Lough, Co. Monaghan, were highlighted as lakes not currently monitored for water levels that had relatively low estimated groundwater inflow rates compared to the net abstraction.

This re-assessment of risk of abstraction pressures on lakes identified 79 lakes with likely risk. Recommendations have been made to develop monitoring programmes for a subset of these lakes to better understand either the existence of the impact or the types of impacts. Monitoring is the preferred first step as the financial and political costs of returning a water body affected by abstractions to good quantitative or ecological status is likely to be significant. Future lake level monitoring will be the foundation on which abstraction impacts are judged, as changes in water level are the principal hydrological habitat parameter characterise the potential for impacts to the shallow littoral ecosystem. It would therefore be preferable for water levels to be monitored in all abstraction lakes. Fourteen lakes were prioritised for future monitoring of abstraction pressures. The prioritised lakes were chosen based on the results of the quantitative analysis herein, and on the lake's physical and ecological sensitivity. Two monitoring programmes were recommended:

- Firstly, water budgets should be conducted for lakes that are considered to be at 'high' risk of abstraction pressures
- Secondly, lakes thought to only be subject to abstraction pressures so that any impacts to the lake's ecological health could be directly determined.

Section 8 References

Acreman, M.C., Dunbar, M.J., Hannaford, J., Bragg, O.M., Black, A.R., Rowan, J.S. and King, J. (2006). Development of environmental standards (Water resources), Stage 3: Environmental standards. SNIFFER, Report WFD48, Edinburgh.

Barko, J.W. and Smart, R.M. (1981). Comparative influences of light and temperature on the growth and metabolism of selected submerged freshwater macrophytes. *Ecological Monographs*, **51(2)**, 219–236.

Byrne, C. and O'Leary, C (2008). Extracting Water from Lakes and Rivers and its effect on their Ecology. 24th Annual Environmental Conference - Water the Challenges for Users. 39- 44.

CDM, (2008). Groundwater Abstractions Pressures Assessment. Draft Report. Prepared for Dublin City Council. June 2008.

Coops, H., Beklioglu, M., and Crisman, T.L. (2003). The role of water-level fluctuations in shallow lake ecosystems – workshop conclusions. *Hydrobiologia*, **5006-509**, 23-27.

Daly, D. (1985). Groundwater in County Galway with particular reference to its Protection from Pollution. Geological Survey of Ireland report for Galway County Council.

EPA (2006). Water Quality in Ireland 2005. Wexford, EPA

Free, G., Little, R., Tierney, T., Donnelly, K. and Caroni, R. (2007). A Referenced Based Typology and Ecological Assessment System for Irish Lakes. 2002-W-FS-1-M1. EPA, Wexford.

GSI, (2004). Descriptions of individual groundwater bodies across Ireland. Prepared for each River Basin District project. December 2004.

GSI, (2005). National mapping of aquifer types across Ireland. Prepared for each River Basin District project. March 2005.

Håkanson, L. (1981). *A Manual of Lake Morphometry.* New York, Berlin Heidelberg.

Horne, A. and Goldman, C. (1994). *Limnology*. New York, McGraw-Hill.

Igoe, F., O'Grady, M.F., Tierney, D. and Fitzmaurice, P. (2003). Artic Char Salvelinus Alpinus (L.) in Ireland – A Millenium Reiveiw of it's Distrubtion and Status with Conservation Recommendations. Biology and Environment: Proceedings of the Royal Irish Academy. **VOL. 103B, NO. 1**, 9–22.

James, M., Mark, A., and Single, M. (2002). Lake Level Management. Ministry for the Environment. Wellington.

Karr, J.R. and Chu, E.W. (1999). *Restoring Life in Running Waters: Better Biological Monitoring*. Washington D.C., Island Press.

Kaster, J.L. and Jacobi, G.Z.(1978). Benthic macroinvertebrates of a fluctuating reservoir. *Freshwater Biology*, **8**, 283 – 290.

King, J.J. and Champ, T. (2000). Baseline Water Quality Investigations On Lough Carra, Western Ireland with Reference to Water Chemistry Phytoplankton and Aquatic Plants. Biology and Environment: Proceedings of the Royal Irish Academy. **VOL. 100B, NO. 1**, 13–25.

Met Éireann (2008). The Weather of Summer 2008. Online <http://www.met.ie/climate/monthly_summarys/summer08.pdf>. Visited on 20/10/2008.

NPWS (2000). Lough Bane and Lough Glass. Site Synopsis 002120.

NPWS (2006). Surface Water Ecosystems and Terrestrial ecosystems directly dependent on Groundwater.

NPWS (2008). Special Areas of Conservation. Online <http://www.npws.ie/en/ProtectedSites/SpecialAreasofConservationSACs/ > Visited on 04/09/2008.

Quinlan, C. (2007). Dye tracer test results in vicinity of Lough Lene, County Westmeath. Ph.D. Thesis, Trinity College Dublin.

RAMSAR, (1971). The RAMSAR Convention on Wetlands. Updated List of Wetlands of International Importance. October 2008.

Roscommon County Council, (2008). North East Roscommon Water Supply Scheme – Proposed Abstraction from Grange Lough. Hydrological Assessment. Hyder Consulting

Roden, C. (2008). The Effect of Excessive Water Abstraction on the Vegetation and Conservation Status of Lough Bane, County Meath/ Westmeath. Special Area of Conservation no 002120.

Wantzen, K.M. and Rothhaupt, K.O. (2008). Ecological effects of water-level fluctuations in lakes: an urgent issue. *Hydrobiologia*, **613**, 1-4.

WRBD (2006). Bathymetric Survey of Lakes in the Western Regional Fisheries Board. Online <http://www.westernrbd.ie/PDF/Bathymetric_Survey_Of_Lakes_In_The_Western_RFB/Bathymetry%20Survey%20WRFB%20Region%202006.pdf> Visited on 04/09/2008.

Appendix A
Lake Catchment Data

Table A-1: Watershed Areas of 127 1a/1b Lakes

HydroCode	Name	Catchment area excluding lake (Ha)	Shape_Area (Ha) with lakes	Catchment area excluding lake (sq km)	Area in SqKm including lake
	LAKES > 10,000 HECTARES				
IE_SW_19_138	Inniscarra Reservoir	78081.39	78571.36	780.8139	785.7136
IE_EA_07_275	Ramor Lough	23638.59	24351.20	236.3859	243.5120
IE_NW_36_526	Inner Lough	19145.12	19206.52	191.4512	192.0652
IE_NW_35_160	Melvin Lough	16428.00	18634.36	164.2800	186.3436
IE_NW_38_22	Glen Lough	12262.79	12430.52	122.6279	124.3052
IE_NW_36_647	White Lough	12223.11	12276.92	122.2311	122.7692
	LAKES > 1,000 HECTARES; <10,000 HECTARES				
IE_NB_06_234	Monalty Lough	8530.01	8545.40	85.3001	85.4540
IE_NW_36_363	Tacker Lough	7764.30	7820.96	77.6430	78.2096
IE_NW_37_188	Eske Lough	7625.90	8012.76	76.2590	80.1276
IE_NW_36_623	Bawn Lough	6509.84	6540.36	65.0984	65.4036
IE_NW_36_528	Sillan Lough	5130.50	5292.68	51.3050	52.9268
IE_SH_27_120	Rosroe Lough	4999.50	5108.24	49.9950	51.0824
IE_NW_38_83	Anure Lough	3559.23	3692.36	35.5923	36.9236
IE_NW_36_385	Cullinaghan Lough	3274.72	3304.08	32.7472	33.0408
IE_NW_36_513	Kilywilly Lough	3069.12	3125.40	30.6912	31.2540
IE_EA_09_68	Glenasmole Reservoirs	2756.69	2775.84	27.5669	27.7584
IE_EA_09_70	Glenasmole Reservoirs	2574.98	2582.92	25.7498	25.8292
IE_SH_28_82	Doo Lough	2151.89	2282.32	21.5189	22.8232
IE_NB_06_244	Muckno Mill Lough	2110.53	2124.64	21.1053	21.2464
IE_NW_36_430	Garty Lough	1998.22	2080.76	19.9822	20.8076
IE_NW_36_525b	Drumlona Lough	1742.59	1795.28	17.4259	17.9528
IE_EA_07_273	Nadreegeal Loughs	1184.23	1268.84	11.8423	12.6884
IE_NW_36_468	Clonty Lough	1144.80	1155.44	11.4480	11.5544
IE_NB_06_54	Ervey Lough	1135.35	1147.32	11.3535	11.4732
IE_SE_16_463	Ballyshunnock	1097.13	1116.44	10.9713	11.1644
	LAKES > 100 HECTARES; <1,000 HECTARES				
IE_WE_35_136	Easky Lough	932.26	1051.44	9.3226	10.5144
IE_EA_07_274	Lene	888.23	1304.48	8.8823	13.0448
IE_WE_35_17	Carrowlustia	836.88	841.16	8.3688	8.4116
IE_SH_28_85	Lickeen Lough	824.44	908.68	8.2444	9.0868
IE_SW_20_158	Curraghalicky Lake	801.16	826.96	8.0116	8.2696
IE_EA_07_268	Drumkeery Lough	793.65	806.68	7.9365	8.0668
IE_NB_03_79	Glaslough Lake	778.49	799.92	7.7849	7.9992
IE_NW_36_525a	Drumore Lough	702.48	763.20	7.0248	7.6320
IE_WE_32_406	Moher Lough	596.29	632.72	5.9629	6.3272
IE_SW_20_148	Abisdealy Lough	566.19	581.88	5.6619	5.8188
IE_NW_38_47	Kiltooris Lough	505.22	548.68	5.0522	5.4868
IE_WE_32_479	Ballynakill Lough	505.21	566.76	5.0521	5.6676
IE_SH_26_705	Cavetown Lough	489.05	553.28	4.8905	5.5328
IE_WE_34_405	Talt Lough	469.97	567.32	4.6997	5.6732
IE_WE_31_120	Loughaunwillan	423.12	460.16	4.2312	4.6016
IE_NW_36_715	Golagh Lough	421.86	482.28	4.2186	4.8228
IE_NW_36_712	Unshin Lough	399.98	427.16	3.9998	4.2716
IE_NW_38_678	Shannagh Lough	389.96	416.92	3.8996	4.1692
IE_SH_27_123	Ballybeg Lough	353.01	372.96	3.5301	3.7296
IE_EA_07_267	Skeagh Lough Upper	341.91	403.20	3.4191	4.0320
IE_NW_36_517	Annagh Lough	312.14	347.36	3.1214	3.4736
IE_WE_31_211	Anaserd Lough	308.49	390.69	3.0849	3.9069
IE_SW_20_153	Coolkellure Lake	300.78	304.36	3.0078	3.0436
IE_WE_34_402	Washpool Lough	300.70	345.44	3.0070	3.4544
IE_NW_36_316	Graddum Lough	276.92	289.16	2.7692	2.8916
IE_SH_26_706	Grange Lough	270.64	278.44	2.7064	2.7844
IE_EA_07_270	Bane Lough	237.93	313.38	2.3794	3.1338

HydroCode	Name	Catchment area excluding lake (Ha)	Shape_Area (Ha) with lakes	Catchment area excluding lake (sq km)	Area in SqKm including lake
IE_NW_36_684	Namachree Lough	235.50	252.20	2.3550	2.5220
IE_NW_36_706	Gorman Lough	234.50	241.95	2.3449	2.4195
IE_NW_36_421	Annaghierin Lough	229.37	242.00	2.2937	2.4200
IE_NW_36_635	Baraghy Lough	212.97	237.42	2.1297	2.3742
IE_WE_30_332	Coolin Lough	202.55	231.40	2.0255	2.3140
IE_NW_36_415	Drumgole Lough	200.92	209.36	2.0092	2.0936
IE_SW_20_150	Ballin Lough	193.37	201.12	1.9337	2.0112
IE_SH_27_122	Gortglass Lough	191.77	222.04	1.9177	2.2204
IE_NW_36_460	Coragh Lough	188.18	202.12	1.8818	2.0212
IE_NB_36_383	Nagarnaman Lough	174.90	193.12	1.7490	1.9312
IE_SW_22_182	Callee Lough	172.57	190.40	1.7257	1.9040
IE_WE_33_1892	Acorrymore Lough	169.36	183.28	1.6936	1.8328
IE_NB_03_87	More Lough	158.33	173.03	1.5833	1.7303
IE_NW_39_44	Gort Lough	152.88	156.72	1.5288	1.5672
IE_SW_21_440	Cummer Lough	150.94	162.24	1.5094	1.6224
IE_WE_32_474	Tully Lough	147.45	191.32	1.4745	1.9132
IE_NW_36_448	Kill Lough	134.30	146.04	1.3430	1.4604
IE_SE_17_5	Belle Lake	131.63	158.16	1.3163	1.5816
IE_SH_25_90	Bleach Lough	131.59	149.48	1.3159	1.4948
IE_NW_36_618	Atrain Lough	129.36	144.36	1.2936	1.4436
IE_WE_32_428	Lugacolliee Lake	125.43	158.92	1.2543	1.5892
IE_NW_36_331	Cornalara Lough	121.97	128.60	1.2197	1.2860
IE_SW_20_53	Skeagh Lough Schull Reservoir	120.11	122.36	1.2011	1.2236
IE_NW_36_420	Naglare Lough	113.57	119.96	1.1357	1.1996
IE_NW_36_346	Naback Lough	112.43	124.28	1.1243	1.2428
IE_SW_21_429	Coomclogherane Lake	106.38	118.36	1.0638	1.1836
IE_WE_35_131	Anarry Lough	104.30	115.36	1.0430	1.1536
	LAKES > 10 HECTARES; <100 HECTARES				
IE_NW_36_432	Ardan Lough	96.26	125.44	0.9626	1.2544
IE_WE_32_364	Ballin Lough	93.98	132.72	0.9398	1.3272
IE_WE_34_341	Bekan Lough	93.79	114.68	0.9379	1.1468
IE_WE_32_436	Aughrusbeg Lough	93.32	143.54	0.9332	1.4354
IE_NW_37_195	Glencoagh Lough	89.87	98.52	0.8987	0.9852
IE_NW_36_597	Mill Lough	81.37	93.52	0.8137	0.9352
IE_NW_36_382	Toome Or Crinkill	78.14	86.72	0.7814	0.8672
IE_SW_21_405	Dromtine Lough	76.84	83.28	0.7684	0.8328
IE_NB_06_198	Spring Lough	71.39	81.64	0.7139	0.8164
IE_SH_28_87	Naminna Lough	69.87	90.12	0.6987	0.9012
IE_NB_06_209	Brackan Lough	67.05	74.64	0.6705	0.7464
IE_SH_23_59	Acummeen Lough	63.27	70.08	0.6327	0.7008
IE_SW_22_199	Cummernamuck Lake	62.70	74.08	0.6270	0.7408
IE_WE_31_177	Loughaunore	61.43	66.94	0.6143	0.6694
IE_SE_17_8	Carrigavantry Reservoir	60.07	72.00	0.6007	0.7200
IE_NW_37_208	St.Peter's Lough	57.24	73.72	0.5724	0.7372
IE_WE_35_237	Labe Lough	54.38	59.92	0.5438	0.5992
IE_NW_38_57	Birroge Lough	54.28	62.28	0.5428	0.6228
IE_SH_27_193	Ballycar Lough	53.33	56.00	0.5333	0.5600
IE_SW_22_58	Mount Eagle Lough	51.17	55.16	0.5117	0.5516
IE_WE_35_96	Lackagh Lough	50.84	57.56	0.5084	0.5756
IE_NW_38_52	Anna Lough	50.03	83.60	0.5003	0.8360
IE_SW_21_369	Eirk Lough	49.31	55.40	0.4931	0.5540
IE_SW_21_448	Bofinna Lough	47.76	56.44	0.4776	0.5644
IE_NW_36_324	Cornaseer Lough	44.64	49.64	0.4464	0.4964
IE_EA_07_242	Acurry Lough	42.05	61.40	0.4205	0.6140
IE_WE_31_1126	Illauntrasna Lough	41.34	49.68	0.4134	0.4968

Table A-1: Watershed Areas of 127 1a/1b Lakes

HydroCode	Name	Catchment area excluding lake (Ha)	Shape_Area (Ha) with lakes	Catchment area excluding lake (sq km)	Area in SqKm including lake
IE_SE_16_314	Crotty's Lough or Coumgaurha Lough	40.49	44.04	0.4049	0.4404
IE_WE_32_432	Ard Lough	39.82	43.85	0.3982	0.4385
IE_NW_36_409	Killynenagh Lough	39.20	46.16	0.3920	0.4616
IE_NW_38_29	Nameeltoge Lough	36.87	45.12	0.3687	0.4512
IE_NW_36_201	Nabellbeg Lough	35.82	37.04	0.3582	0.3704
IE_WE_32_422	Nambrackkeagh Lough	35.63	43.36	0.3563	0.4336
IE_SW_20_133	Tooreen Lough	34.87	38.00	0.3487	0.3800
IE_NB_03_3	Grove Lough	34.79	35.96	0.3479	0.3596
IE_NW_37_194	Croagh Lough	33.72	43.56	0.3372	0.4356
IE_NW_36_329	Killcoran Lough	32.85	47.20	0.3285	0.4720
IE_SH_28_64	Keagh Lough	31.39	38.36	0.3139	0.3836
IE_NW_38_688	Naglea Lough	31.39	38.52	0.3139	0.3852
IE_WE_34_458	Holan Lough	30.69	33.68	0.3069	0.3368
IE_NW_36_192	Corconnelly Lough	29.82	35.44	0.2982	0.3544
IE_NW_36_710	Columbkille Lough	17.91	24.36	0.1791	0.2436
IE_WE_32_269	Barnahallia Lough	15.31	18.28	0.1531	0.1828
IE_WE_32_526	Fawna Lough	12.24	15.32	0.1224	0.1532
IE_NW_37_140	Meenaviller Lough	12.10	13.76	0.1210	0.1376
LAKES > 1 HECTARE; <10 HECTARES					
IE_WE_30_532	Aille Lough	6.29	10.92	0.0629	0.1092
IE_NW_37_210	Cullionboy Lough	4.89	7.77	0.0490	0.0777
IE_WE_35_188	Nacroagh Lough	1.63	2.04	0.0163	0.0204

Appendix B
Abstraction Data for 1a/1b Lakes

Appendix C
Median Discharge Estimates

Table C-1: Q50 Estimates Derived by EPA/ESBI Non-Karst Method

Sample set of ungauged catchments coinciding with hydrometric gauges. Data from ungauged catchments to be entered below. Result returned in columns AB & AC			General						SOIL - % of Catchment Area						SUBSOIL -% of Catchment Area					AQUIFER- - % of Catchment Area					log of 50%ile in mm over catchment	50%ile m³/s
STATION NO. (if applicable)	WATERBODY	LOCATION	AREA (including lake area)km²	RAIN AVE 61-90	Total STREAM Len	DRAINAGE DENSITY	Farl	Slope	Per WET	Per DRY	Per PEAT	Per MADE	Per WATER	Per ALLUVMIN	Per 0 E	Per 4 H	Per 3 M	Per 2 L	Per 1 M/L	Per PU PL	Per 2 LL	Per 3 LM RF	Per 4 RKC RK	Per 5 RKD LK	Weighted Average of 5 closest gauges	Weighted Average of 5 closest gauges
	Abisdealy Lough	IE_SW_20_148	5.823	1503	0.0	0.000	**0.836**		25.36	71.25	0.72		2.67		46.63			2.56	50.80	16.85	79.10				2.858	**0.133**
	Anure Lough	IE_NW_38_83	36.924	1609	47.6	1.289	**0.790**		24.67	0.23	69.99	0.37	4.72		25.67		0.39	69.99	3.95	95.48					2.913	**0.959**
	Ballynakill Lough	IE_WE_32_479	5.668	1385	2.8	0.494	**0.670**		32.45	18.39	38.15		11.00		27.77			37.57	34.66	89.20					2.822	**0.119**
	Ballyshunnock	IE_SE_16_463	11.164	1258	11.4	1.021	**0.868**		20.52	70.49			2.53	6.44	7.46		6.44	83.50	2.59	100.00					2.752	**0.200**
	Bawn Lough	IE_NW_36_623	65.404	1068	45.0	0.687	**0.867**		43.58	41.81	9.12	0.30	4.50	0.69	24.70		0.99	9.13	65.18	95.08					2.665	**0.958**
	Carrowlustia	IE_WE_35_17	8.412	1460	19.4	2.310	**0.929**		18.00	16.04	64.35		0.53	1.06	11.54	5.94	1.06	81.46			54.46	14.84	30.68		2.773	**0.158**
	Coolkellure Lake	IE_SW_20_153	3.045	2068	1.9	0.614	**0.892**		57.78	41.03			1.17		47.81	2.26			49.93	98.30					2.838	**0.066**
	Coragh Lough	IE_NW_36_460	2.021	998	0.0	0.000	**0.737**		68.02	15.20	6.18	3.03	6.89	0.65	22.10		3.69	6.77	67.44	91.97					2.556	**0.023**
	Curraghalicky Lake	IE_SW_20_158	8.270	1764	10.4	1.258	**0.823**		34.43	57.59	4.8		3.12	0.03	34.34		0.03	58.17	7.44		97.24				2.953	**0.236**
	Doo Lough	IE_SH_28_82	22.823	1571	29.3	1.283	**0.760**		26.58	0.57	65.77		6.96	0.11	18.37		0.11	81.52			94.46				2.910	**0.589**
	Drumgole Lough	IE_NW_36_415	1.635	934	1.4	0.673	**0.799**		59.71	22.01	11.06		7.21		14.20			11.06	74.73	91.30					2.570	**0.019**
	Drumkeery Lough	IE_EA_07_268	8.067	1097	3.6	0.441	**0.779**		77.63	3.31	7.12		9.37	2.56	12.68		2.56	7.12	77.63	88.78					2.551	**0.091**
	Drumlona Lough	IE_NW_36_525b	17.554	1024	18.0	1.000	**0.807**		69.16	12.11	12.99	0.34	4.26	1.13	5.42		1.48	12.99	80.11	95.33					2.565	**0.205**
	Drumore Lough	IE_NW_36_525a	199.260	1030	174.1	0.873	**0.871**		58.97	26.42	9.33	0.44	2.79	2.02	16.24	0.01	2.46	9.35	71.91	96.77					2.589	**2.451**
	Easky Lough	IE_WE_35_136	10.173	1765	18.1	1.786	**0.657**		7.50	0.02	79.48		12.48	0.52	20.00		0.53	79.47		88.15					2.951	**0.288**
	Ervey Lough	IE_NB_06_54	11.473	1186	13.4	1.165	**0.898**		84.63	4.10	7.17	0.01	1.25	2.84	4.97		2.85	7.17	85.00	98.16					2.572	**0.136**
	Eske Lough	IE_NW_37_188	80.128	1985	173.2	2.161	**0.780**		47.19	5.93	39.89		5.83	1.15	38.00	0.07	1.15	39.89	20.89	77.48	7.93	6.25	2.94		2.986	**2.459**
	Garty Lough	IE_NW_36_430	20.808	1045	18.2	0.876	**0.800**		76.72	10.06	6.40	0.16	5.06	1.60	17.01		1.77	6.40	74.82	95.21					2.554	**0.237**
	Glaslough Lake	IE_NB_03_79	7.999	948	4.7	0.588	**0.834**		19.00	62.42	13.15	0.01	3.08	2.32	7.37	2.29	2.34	13.15	74.84		16.50	79.02			2.552	**0.090**
	Glen Lough	IE_NW_38_22	124.305	1700	185.9	1.496	**0.807**		34.55	3.39	56.80	0.02	4.48	0.76	40.03	0.01	0.78	56.80	2.38	94.53	1.05				2.974	**3.714**
	Glenasmole Reservoirs	IE_EA_09_70	25.829	1436	51.2	1.982	**0.914**		33.10	14.80	50.65	0.01	0.73	0.70	29.10	10.80	0.71	50.65	8.73	87.44	10.88				2.833	**0.558**
	Glenasmole Reservoirs	IE_EA_09_68	27.758	1459	52.8	1.901	**0.870**		31.61	19.33	47.13	0.05	0.95	0.93	29.69	11.77	0.98	47.13	10.43	81.36	16.67				2.834	**0.600**
	Golagh Lough	IE_NW_36_715	4.823	1704	2.2	0.450	**0.646**		10.55	0.20	73.55		15.69		17.67			73.54	8.78	71.67	7.70		3.70		2.948	**0.136**
	Gort Lough	IE_NW_39_44	1.567	1225	1.9	1.180	**0.844**		63.76	14.52	18.93		2.78		71.47			18.93	9.59	100.00					2.690	**0.024**
	Gortglass Lough	IE_SH_27_122	2.220	1233	0.0	0.000	**0.629**		28.68	30.94	22.46		17.66	0.25	66.30		0.25	33.44			82.99				2.769	**0.041**
	Inner Lough	IE_NW_36_526	190.979	1062	171.1	0.891	**0.919**		58.63	27.16	9.34	0.29	2.50	2.08	16.15	0.01	2.37	9.34	72.13	97.12					2.577	**2.286**
	Inniscarra Reservoir	IE_SW_19_138	785.714	1729	828.7	1.055	**0.849**		27.81	62.00	4.65	0.32	1.58	3.61	37.09	2.20	3.93	4.64	52.14	29.87	67.23			0.01	2.917	**20.581**
	Lickeen Lough	IE_SH_28_85	9.087	1431	11.5	1.261	**0.695**		61.07	0.54	28.33		9.48	0.57	12.31		0.57	87.12			90.08				2.777	**0.172**
	Moher Lough	IE_WE_32_406	6.428	1851	4.7	0.737	**0.762**		29.70	26.86	37.30	0.01	6.11		19.95		0.01	37.29	42.75	93.88					2.951	**0.182**
	Muckno Mill Lough	IE_NB_06_244	21.246	1129	20.2	0.950	**0.918**		47.15	42.76	5.90	0.10	0.66	3.41	17.46		3.51	5.90	73.12	99.02					2.696	**0.334**
	Nadreegeal Loughs	IE_EA_07_273																							2.580	**0.000**
	Ramor Lough	IE_EA_07_275	244.088	1097	245.8	1.007	**0.809**		67.32	14.92	10.73	0.58	3.80	2.65	9.30	1.23	2.94	11.33	75.20	95.92		0.03			2.555	**2.778**
	Shannagh Lough	IE_NW_38_678	4.169	1138	4.7	1.118	**0.745**		55.95	21.50	16.08		6.46		30.65			16.08	53.27	93.22					2.666	**0.061**
	Sillan Lough	IE_NW_36_528	52.927	1088	41.1	0.777	**0.810**		58.25	28.86	6.21	0.36	5.22	1.10	17.97	0.07	1.46	6.88	73.62	95.38					2.659	**0.765**
	Tacker Lough	IE_NW_36_363	78.210	1083	60.6	0.774	**0.793**		59.36	26.46	7.28	0.29	5.64	0.97	17.75	0.05	1.22	7.80	73.18	94.58					2.658	**1.128**
	Talt Lough	IE_WE_34_405	5.673	1466	4.9	0.860	**0.585**		11.53	23.59	47.60	0.01	17.28		28.70	5.70	0.01	47.60	18.00	83.67					2.904	**0.144**
	White Lough	IE_NW_36_647	122.769	1062	113.2	0.922	**0.931**		54.73	31.79	9.03	0.40	1.32	2.71	17.52	0.02	3.11	9.04	70.30	98.25					2.568	**1.441**
	Monalty Lough	IE_NB_06_234	85.5	970	48.7	**0.570**	**0.945**		25.08	62.83	5.77	1.93	0.96	3.35	9.93	1.79	5.29	5.80	77.17	48.79		1.50	48.78		2.693	**1.336**
	Kiltooris Lough	IE_NW_38_47	5.5	1380	4.8	**0.878**	**0.653**		62.05	13.84	12.87		11.22		78.63	1.83		12.87	6.65	86.65					2.828	**0.116**
	Unshin Lough	IE_NW_36_712	4.3	1613	3.0	**0.693**	**0.749**		9.04	0.48	82.75		7.72		14.42			82.75	2.82	93.57					2.936	**0.117**

Table C-2: Q50 Estimates Derived by EPA/ESBI Karst Method

Sample set of ungauged catchments coinciding with hydrometric gauges. Data from ungauged catchments to be entered below. Result returned in columns AB & AC				General						SOIL - % of Catchment Area						SUBSOIL -% of Catchment Area					AQUIFER- - % of Catchment Area						log of 50%ile in mm over catchment	50%ile m³/s
STATION NO. (if applicable)	*WATERBODY*	*LOCATION*		AREA (including lake area)km²	RAIN AVE 61-90	Total STREAM Len	DRAINAGE DENSITY	Farl	Slope	Per WET	Per DRY	Per PEAT	Per MADE	Per WATER	Per ALLUVMIN	Per 0 E	Per 4 H	Per 3 M	Per 2 L	Per 1 M/L	Per PU PL	Per 2 LL	Per 3 LM RF	Per 4 RKC RK	Per 5 RKD LK		Weighted Average of 5 closest gauges	Weighted Average of 5 closest gauges
	Clonty Lough	IE_NW_36_468		11.554	1090	13.8	1.191	**0.904**		85.98	0.64	8.68		0.99	3.70	62.78		3.77	33.51			69.44		28.73			2.538	**0.126**
	Rosroe Lough	IE_SH_27_120		51.082	1188	27.1	0.531	**0.747**		13.89	49.55	27.40	0.36	8.47	0.33	28.91		0.69	27.75	42.63		44.18	4.67	40.67			2.729	**0.868**
	Cullinaghan Lough	IE_NW_36_385		33.040	1111	30.4	0.921	**0.763**		72.97	2.86	16.05	2.59	3.77	1.74	39.59		4.33	56.87			35.70		58.51			2.693	**0.517**
	Killywilly Lough	IE_NW_36_513		31.254	1108	31.1	0.995	**0.834**		72.49	2.91	16.96	2.73	3.05	1.83	40.90		4.56	54.52			36.39		58.59			2.693	**0.489**
	Melvin Lough	IE_NW_35_160		186.343	1406	287.9	1.545	**0.656**		32.32	5.93	23.31	0.10	9.60	1.74	22.97	1.95	48.07			4.65	21.54	33.13	27.02			2.848	**4.167**

Table C-3:Q50 Estimates Derived by Rational Method

Nacroagh Lough					
avg ann rainfall	1423	mm/yr			
avg hourly rainfall	0.162443	mm/h			
avg.ann evaporation	660	mm/yr			
avg. hourly evaporation	0.075342	mm/h			
net hourly rainfall	0.0871				
	C	area(km2)	Q m3/sec		
Forestry	0.2	0.0255	0.00023197		
water w/ net rainfall	1	0.004	9.7553E-05		
Total w/net prec			0.000		
Total			0		

Graddum Lough			
avg ann rainfall	1119	mm/yr	
avg hourly rainfall	0.12774	mm/h	
avg.ann evaporation	678	mm/yr	
avg. hourly evaporation	0.077397	mm/h	
net hourly rainfall	0.050342		
	C	area(km2)	Q m3/sec
pasture	0.35	2.475	0.030983
other	0.3	0.293	0.003144
water w/ net rainfall	1	0.122	0.00172
Total w/net prec			0.036
Total			0.038

Atrain Lough					
avg ann rainfall	978	mm/yr			
avg hourly rainfall	0.111644	mm/h			
avg.ann evaporation	673	mm/yr			
avg. hourly evaporation	0.076826	mm/h			
net hourly rainfall	0.034817				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.193	0.01305273		
water w/ net rainfall	1	0.25	0.00243721		
Total w/net prec			0.015		
Total			0.021		

Naback Lough			
avg ann rainfall	1073	mm/yr	
avg hourly rainfall	0.122489	mm/h	
avg.ann evaporation	665	mm/yr	
avg. hourly evaporation	0.075913	mm/h	
net hourly rainfall	0.046575		
	C	area(km2)	Q m3/sec
pasture	0.35	0.882	0.010587
urban	0.75	0.05	0.001286
bogs	0.9	0.186	0.005741
water w/ net rainfall	1	0.118	0.001539
Total w/net prec			0.019
Total			0.022

Kill Lough					
avg ann rainfall	1091	mm/yr			
avg hourly rainfall	0.124543	mm/h			
avg.ann evaporation	681	mm/yr			
avg. hourly evaporation	0.07774	mm/h			
net hourly rainfall	0.046804				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.245	0.01519554		
water w/ net rainfall	1	0.21	0.00275205		
Total w/net prec			0.018		
Total			0.023		

Nabellbeg Lough			
avg ann rainfall	1529	mm/yr	
avg hourly rainfall	0.174543	mm/h	
avg.ann evaporation	620	mm/yr	
avg. hourly evaporation	0.070776	mm/h	
net hourly rainfall	0.103767		
	C	area(km2)	Q m3/sec
bogs	0.9	0.373	0.016406
water w/ net rainfall	1	0.012	0.000349
Total w/net prec			0.017
Total			0.017

Cornaseer Lough					
avg ann rainfall	1050	mm/yr			
avg hourly rainfall	0.119863	mm/h			
avg.ann evaporation	675	mm/yr			
avg. hourly evaporation	0.077055	mm/h			
net hourly rainfall	0.042808				
	C	area(km2)	Q m3/sec		
pasture	0.35	0.387	0.00454592		
forestry	0.2	0.06	0.00040274		
water w/ net rainfall	1	0.049	0.00058733		
Total w/net prec			0.006		
Total			0.007		

Annaghierin Lough			
avg ann rainfall	1083	mm/yr	
avg hourly rainfall	0.12363	mm/h	
avg.ann evaporation	710	mm/yr	
avg. hourly evaporation	0.08105	mm/h	
net hourly rainfall	0.04258		
	C	area(km2)	Q m3/sec
pasture	0.35	2.294	0.027794
water w/ net rainfall	1	0.126	0.001502
Total w/net prec			0.029
Total			0.032

Cornalara Lough					
avg ann rainfall	1122	mm/yr			
avg hourly rainfall	0.128082	mm/h			
avg.ann evaporation	720	mm/yr			
avg. hourly evaporation	0.082192	mm/h			
net hourly rainfall	0.04589				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.111	0.01394533		
other ag land	0.35	0.108	0.00135562		
water w/ net rainfall	1	0.066	0.00084805		
Total w/net prec			0.016		
Total			0.018		

Spring Lough			
avg ann rainfall	845	mm/yr	
avg hourly rainfall	0.096461	mm/h	
avg.ann evaporation	758	mm/yr	
avg. hourly evaporation	0.08653	mm/h	
net hourly rainfall	0.009932		
	C	area(km2)	Q m3/sec
pasture	0.35	0.701	0.006627
urban	0.75	0.013	0.000263
water w/ net rainfall	1	0.102	0.000284
Total w/net prec			0.007
Total			0.01

Table C-3:Q50 Estimates Derived by Rational Method

Namachree Lough					
avg ann rainfall	1069	mm/yr			
avg hourly rainfall	0.122032	mm/h			
avg.ann evaporation	718	mm/yr			
avg. hourly evaporation	0.081963	mm/h			
net hourly rainfall	0.040068				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.33	0.01590565		
other ag land	0.35	1.025	0.01225811		
water w/ net rainfall	1	0.166	0.00186238		
Total w/net prec			0.030		
Total			0.034		

Killynenagh Lough			
avg ann rainfall	985	mm/yr	
avg hourly rainfall	0.112443	mm/h	
avg.ann evaporation	693	mm/yr	
avg. hourly evaporation	0.07911	mm/h	
net hourly rainfall	0.033333		
	C	area(km2)	Q m3/sec
pasture	0.35	0.207	0.002281
other ag land	0.35	0.181	0.001995
water w/ net rainfall	1	0.069	0.000644
Total w/net prec			0.005
Total			0.006

Anagh Lough					
avg ann rainfall	1017	mm/yr			
avg hourly rainfall	0.116096	mm/h			
avg.ann evaporation	678	mm/yr			
avg. hourly evaporation	0.077397	mm/h			
net hourly rainfall	0.038699				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.662	0.01890923		
forestry	0.2	0.19	0.00123526		
other	0.3	1.152	0.01123437		
other ag land	0.35	0.001	1.1377E-05		
water w/ net rainfall	1	0.466	0.0050494		
Total w/net prec			0.036		
Total			0.047		

Corconnelly Lough			
avg ann rainfall	987	mm/yr	
avg hourly rainfall	0.112671	mm/h	
avg.ann evaporation	685	mm/yr	
avg. hourly evaporation	0.078196	mm/h	
net hourly rainfall	0.034475		
	C	area(km2)	Q m3/sec
pasture	0.35	0.2984	0.003295
water w/ net rainfall	1	0.056	0.000541
Total w/net prec			0.004
Total			0.005

Baraghy Lough					
avg ann rainfall	1045	mm/yr			
avg hourly rainfall	0.119292	mm/h			
avg.ann evaporation	703	mm/yr			
avg. hourly evaporation	0.080251	mm/h			
net hourly rainfall	0.039041				
	C	area(km2)	Q m3/sec		
pasture	0.35	2.085	0.02437498		
water w/ net rainfall	1	0.288	0.00314827		
Total w/net prec			0.028		
Total			0.034		

Killcoran Lough			
avg ann rainfall	1145	mm/yr	
avg hourly rainfall	0.130708	mm/h	
avg.ann evaporation	691	mm/yr	
avg. hourly evaporation	0.078881	mm/h	
net hourly rainfall	0.051826		
	C	area(km2)	Q m3/sec
pasture	0.35	0.329	0.004214
water w/ net rainfall	1	0.143	0.002075
Total w/net prec			0.006
Total			0.009

Mill Lough					
avg ann rainfall	1052	mm/yr			
avg hourly rainfall	0.120091	mm/h			
avg.ann evaporation	678	mm/yr			
avg. hourly evaporation	0.077397	mm/h			
net hourly rainfall	0.042694				
	C	area(km2)	Q m3/sec		
pasture	0.35	0.804	0.00946224		
urban	0.75	0.0007	1.7653E-05		
other ag land	0.35	0.008	9.4152E-05		
water w/ net rainfall	1	0.121	0.00144647		
Total w/net prec			0.011		
Total			0.014		

Grove Lough			
avg ann rainfall	1026	mm/yr	
avg hourly rainfall	0.117123	mm/h	
avg.ann evaporation	711	mm/yr	
avg. hourly evaporation	0.081164	mm/h	
net hourly rainfall	0.035959		
	C	area(km2)	Q m3/sec
pasture	0.35	0.348	0.003994
water w/ net rainfall	1	0.011	0.000111
Total w/net prec			0.004
Total			0.004

Naglare Lough					
avg ann rainfall	1133	mm/yr			
avg hourly rainfall	0.129338	mm/h			
avg.ann evaporation	690	mm/yr			
avg. hourly evaporation	0.078767	mm/h			
net hourly rainfall	0.050571				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.136	0.01439893		
water w/ net rainfall	1	0.063	0.00089207		
Total w/net prec			0.015		
Total			0.017		

Acurry Lough			
avg ann rainfall	1127	mm/yr	
avg hourly rainfall	0.128653	mm/h	
avg.ann evaporation	689	mm/yr	
avg. hourly evaporation	0.078653	mm/h	
net hourly rainfall	0.05		
	C	area(km2)	Q m3/sec
pasture	0.35	0.341	0.004299
water w/ net rainfall	1	0.272	0.003808
Total w/net prec			0.008
Total			0.014

Table C-3:Q50 Estimates Derived by Rational Method

Toome or Crinkill Lough					
avg ann rainfall	1059	mm/yr			
avg hourly rainfall	0.12089	mm/h			
avg.ann evaporation	719	mm/yr			
avg. hourly evaporation	0.082078	mm/h			
net hourly rainfall	0.038813				
	C	area(km2)	Q m3/sec		
pasture	0.35	0.45	0.00533127		
other ag land	0.35	0.332	0.00393329		
water w/ net rainfall	1	0.085	0.00092374		
Total w/net prec			0.010		
Total			0.012		

Skeagh Lough Upper			
avg ann rainfall	1099	mm/yr	
avg hourly rainfall	0.125457	mm/h	
avg.ann evaporation	703	mm/yr	
avg. hourly evaporation	0.080251	mm/h	
net hourly rainfall	0.045205		
	C	area(km2)	Q m3/sec
pasture	0.35	2.584	0.03177
other	0.3	0.308	0.003246
other ag land	0.35	0.215	0.002643
water w/ net rainfall	1	0.923	0.011683
Total w/net prec			0.049
Total			0.07

Nagarnaman Lough					
avg ann rainfall	1034	mm/yr			
avg hourly rainfall	0.118037	mm/h			
avg.ann evaporation	730	mm/yr			
avg. hourly evaporation	0.083333	mm/h			
net hourly rainfall	0.034703				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.127	0.01303666		
other ag land	0.35	0.548	0.00633903		
water w/ net rainfall	1	0.255	0.00247781		
Total w/net prec			0.022		
Total			0.028		

Lene			
avg ann rainfall	1039	mm/yr	
avg hourly rainfall	0.118607	mm/h	
avg.ann evaporation	702	mm/yr	
avg. hourly evaporation	0.080137	mm/h	
net hourly rainfall	0.03847		
	C	area(km2)	Q m3/sec
pasture	0.35	7.339	0.085305
other	0.3	0.782	0.007791
urban	0.75	0.263	0.006551
water w/ net rainfall	1	4.66	0.050196
Total w/net prec			0.150
Total			0.254

Brackan Lough					
avg ann rainfall	864	mm/yr			
avg hourly rainfall	0.09863	mm/h			
avg.ann evaporation	770	mm/yr			
avg. hourly evaporation	0.0879	mm/h			
net hourly rainfall	0.010731				
	C	area(km2)	Q m3/sec		
pasture	0.35	0.273	0.00263875		
other ag land	0.35	0.155	0.00149819		
forestry	0.2	0.242	0.00133664		
water w/ net rainfall	1	0.075	0.00022534		
Total w/net prec			0.006		
Total			0.008		

Bane Lough			
avg ann rainfall	1075	mm/yr	
avg hourly rainfall	0.122717	mm/h	
avg.ann evaporation	705	mm/yr	
avg. hourly evaporation	0.080479	mm/h	
net hourly rainfall	0.042237		
	C	area(km2)	Q m3/sec
pasture	0.35	2.069	0.024882
other ag land	0.35	0.064	0.000744
water w/ net rainfall	1	0.998	0.011803
Total w/net prec			0.037
Total			0.06

Crotty's Lough or Coumgaurha Lough					
avg ann rainfall	1588	mm/yr			
avg hourly rainfall	0.181279	mm/h			
avg.ann evaporation	712	mm/yr			
avg. hourly evaporation	0.081279	mm/h			
net hourly rainfall	0.1				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.354	0.0161715		
other	0.3	0.05	0.00076137		
water w/ net rainfall	1	0.035	0.00098		
Total w/net prec			0.018		
Total			0.019		

Meenaviller Lough			
avg ann rainfall	2016	mm/yr	
avg hourly rainfall	0.230137	mm/h	
avg.ann evaporation	770	mm/yr	
avg. hourly evaporation	0.0879	mm/h	
net hourly rainfall	0.142237		
	C	area(km2)	Q m3/sec
bogs	0.9	0.12	0.006959
other	0.3	0.001	1.93E-05
water w/ net rainfall	1	0.016	0.000637
Total w/net prec			0.008
Total			0.008

Belle Lake					
avg ann rainfall	1017	mm/yr			
avg hourly rainfall	0.116096	mm/h			
avg.ann evaporation	805	mm/yr			
avg. hourly evaporation	0.091895	mm/h			
net hourly rainfall	0.024201				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.099	0.01250376		
forestry	0.2	0.07	0.0004551		
other	0.3	0.096	0.0009362		
water w/ net rainfall	1	0.31	0.00210064		
Total w/net prec			0.016		
Total			0.024		

Gorman Lough			
avg ann rainfall	1420	mm/yr	
avg hourly rainfall	0.1621	mm/h	
avg.ann evaporation	695	mm/yr	
avg. hourly evaporation	0.079338	mm/h	
net hourly rainfall	0.082763		
	C	area(km2)	Q m3/sec
pasture	0.35	0.979	0.015552
other ag land	0.35	1.349	0.02143
water w/ net rainfall	1	0.074	0.001715
Total w/net prec			0.039
Total			0.04

Table C-3:Q50 Estimates Derived by Rational Method

Carrigavantry Reservoir					
avg ann rainfall	1080	mm/yr			
avg hourly rainfall	0.123288	mm/h			
avg.ann evaporation	809	mm/yr			
avg. hourly evaporation	0.092352	mm/h			
net hourly rainfall	0.030936				
	C	area(km2)	Q m3/sec		
other ag land	0.35	0.268	0.00323803		
pasture	0.35	0.103	0.00124447		
other	0.3	0.229	0.00237156		
water w/ net rainfall	1	0.119	0.00103079		
Total w/net prec			0.008		
Total			0.011		

Keagh Lough					
avg ann rainfall	1390	mm/yr			
avg hourly rainfall	0.158676	mm/h			
avg.ann evaporation	768	mm/yr			
avg. hourly evaporation	0.087671	mm/h			
net hourly rainfall	0.071005				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.311	0.01243574		
pasture	0.35	0.002	3.11E-05		
water w/ net rainfall	1	0.069	0.00137181		
Total w/net prec			0.014		
Total			0.016		

Naminna Lough					
avg ann rainfall	1610	mm/yr			
avg hourly rainfall	0.18379	mm/h			
avg.ann evaporation	768	mm/yr			
avg. hourly evaporation	0.087671	mm/h			
net hourly rainfall	0.096119				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.157	0.00727147		
other	0.3	0.169	0.00260908		
forestry	0.2	0.317	0.00326264		
water w/ net rainfall	1	0.256	0.00688979		
Total w/net prec			0.020		
Total			0.026		

Acummeen Lough					
avg ann rainfall	1992	mm/yr			
avg hourly rainfall	0.227397	mm/h			
avg.ann evaporation	741	mm/yr			
avg. hourly evaporation	0.084589	mm/h			
net hourly rainfall	0.142808				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.632	0.0362162		
water w/ net rainfall	1	0.068	0.00271907		
Total w/net prec			0.039		
Total			0.041		

Ballin Lough					
avg ann rainfall	1590	mm/yr			
avg hourly rainfall	0.181507	mm/h			
avg.ann evaporation	786	mm/yr			
avg. hourly evaporation	0.089726	mm/h			
net hourly rainfall	0.091781				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.674	0.02977656		
other ag land	0.35	0.259	0.00460701		
water w/ net rainfall	1	0.077	0.00197879		
Total w/net prec			0.036		
Total			0.038		

Columbkille Lough			
avg ann rainfall	1444	mm/yr	
avg hourly rainfall	0.16484	mm/h	
avg.ann evaporation	704	mm/yr	
avg. hourly evaporation	0.080365	mm/h	
net hourly rainfall	0.084475		
	C	area(km2)	Q m3/sec
bogs	0.9	0.018	0.000748
other	0.3	0.16	0.002215
water w/ net rainfall	1	0.064	0.001514
Total w/net prec			0.004
Total			0.006

Anna Lough			
avg ann rainfall	1830	mm/yr	
avg hourly rainfall	0.208904	mm/h	
avg.ann evaporation	739	mm/yr	
avg. hourly evaporation	0.084361	mm/h	
net hourly rainfall	0.124543		
	C	area(km2)	Q m3/sec
bogs	0.9	0.457	0.024058
forestry	0.2	0.042	0.000491
other	0.3	0.068	0.001193
water w/ net rainfall	1	0.375	0.013077
Total w/net prec			0.039
Total			0.048

Croagh Lough			
avg ann rainfall	1912	mm/yr	
avg hourly rainfall	0.218265	mm/h	
avg.ann evaporation	705	mm/yr	
avg. hourly evaporation	0.080479	mm/h	
net hourly rainfall	0.137785		
	C	area(km2)	Q m3/sec
bogs	0.9	0.294	0.016171
other	0.3	0.04	0.000733
water w/ net rainfall	1	0.098	0.003781
Total w/net prec			0.021
Total			0.023

St.Peter's Lough			
avg ann rainfall	1471	mm/yr	
avg hourly rainfall	0.167922	mm/h	
avg.ann evaporation	749	mm/yr	
avg. hourly evaporation	0.085502	mm/h	
net hourly rainfall	0.08242		
	C	area(km2)	Q m3/sec
bogs	0.9	0.137	0.005797
pasture	0.35	0.067	0.001103
other ag land	0.35	0.326	0.005365
water w/ net rainfall	1	0.204	0.004708
Total w/net prec			0.017
Total			0.022

Glencoagh Lough			
avg ann rainfall	1471	mm/yr	
avg hourly rainfall	0.167922	mm/h	
avg.ann evaporation	730	mm/yr	
avg. hourly evaporation	0.083333	mm/h	
net hourly rainfall	0.084589		
	C	area(km2)	Q m3/sec
bogs	0.9	0.64	0.027083
pasture	0.35	0.007	0.000115
other ag land	0.35	0.194	0.003193
water w/ net rainfall	1	0.142	0.003363
Total w/net prec			0.034
Total			0.037

Table C-3:Q50 Estimates Derived by Rational Method

Skeagh Lough Schull Reservoir					
avg ann rainfall	1465	mm/yr			
avg hourly rainfall	0.167237	mm/h			
avg.ann evaporation	780	mm/yr			
avg. hourly evaporation	0.089041	mm/h			
net hourly rainfall	0.078196				
	C	area(km2)	Q m3/sec		
bogs	0.9	1.135	0.04783325		
other ag land	0.35	0.066	0.00108169		
water w/ net rainfall	1	0.022	0.00048169		
Total w/net prec			0.049		
Total			0.05		

Naglea Lough			
avg ann rainfall	1138	mm/yr	
avg hourly rainfall	0.129909	mm/h	
avg.ann evaporation	768	mm/yr	
avg. hourly evaporation	0.087671	mm/h	
net hourly rainfall	0.042237		
	C	area(km2)	Q m3/sec
bogs	0.9	0.082	0.002684
pasture	0.35	0.176	0.002241
other ag land	0.35	0.055	0.0007
water w/ net rainfall	1	0.071	0.00084
Total w/net prec			0.006
Total			0.008

Tooreen Lough					
avg ann rainfall	1587	mm/yr			
avg hourly rainfall	0.181164	mm/h			
avg.ann evaporation	813	mm/yr			
avg. hourly evaporation	0.092808	mm/h			
net hourly rainfall	0.088356				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.27	0.01232642		
other ag land	0.35	0.07	0.00124279		
water w/ net rainfall	1	0.03	0.00074219		
Total w/net prec			0.014		
Total			0.015		

Nameeltoge Lough			
avg ann rainfall	1236	mm/yr	
avg hourly rainfall	0.141096	mm/h	
avg.ann evaporation	746	mm/yr	
avg. hourly evaporation	0.08516	mm/h	
net hourly rainfall	0.055936		
	C	area(km2)	Q m3/sec
bogs	0.9	0.373	0.013262
water w/ net rainfall	1	0.082	0.001284
Total w/net prec			0.015
Total			0.017

Abisdealy Lough					
avg ann rainfall	1490	mm/yr			
avg hourly rainfall	0.170091	mm/h			
avg.ann evaporation	798	mm/yr			
avg. hourly evaporation	0.091096	mm/h			
net hourly rainfall	0.078995				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.526	0.02254595		
pasture	0.35	4.399	0.07332671		
other	0.3	0.461	0.00658662		
other ag land	0.35	0.165	0.00275038		
water w/ net rainfall	1	0.265	0.00586146		
Total w/net prec			0.111		
Total			0.118		

Tully Lough			
avg ann rainfall	1441	mm/yr	
avg hourly rainfall	0.164498	mm/h	
avg.ann evaporation	774	mm/yr	
avg. hourly evaporation	0.088356	mm/h	
net hourly rainfall	0.076142		
	C	area(km2)	Q m3/sec
bogs	0.9	1.055	0.043733
other ag land	0.35	0.418	0.006738
water w/ net rainfall	1	0.439	0.009359
Total w/net prec			0.060
Total			0.071

Coomclogherane Lough					
avg ann rainfall	2030	mm/yr			
avg hourly rainfall	0.231735	mm/h			
avg.ann evaporation	712	mm/yr			
avg. hourly evaporation	0.081279	mm/h			
net hourly rainfall	0.150457				
	C	area(km2)	Q m3/sec		
bogs	0.9	1.064	0.06213468		
water w/ net rainfall	1	0.119	0.00501321		
Total w/net prec			0.067		
Total			0.07		

Fawna Lough			
avg ann rainfall	1427	mm/yr	
avg hourly rainfall	0.1629	mm/h	
avg.ann evaporation	801	mm/yr	
avg. hourly evaporation	0.091438	mm/h	
net hourly rainfall	0.071461		
	C	area(km2)	Q m3/sec
bogs	0.9	0.123	0.005049
water w/ net rainfall	1	0.03	0.0006
Total w/net prec			0.006
Total			0.006

Cummer Lough					
avg ann rainfall	2127	mm/yr			
avg hourly rainfall	0.242808	mm/h			
avg.ann evaporation	737	mm/yr			
avg. hourly evaporation	0.084132	mm/h			
net hourly rainfall	0.158676				
	C	area(km2)	Q m3/sec		
bogs	0.9	1.499	0.09172032		
pasture	0.35	0.009	0.00021416		
water w/ net rainfall	1	0.113	0.0050205		
Total w/net prec			0.097		
Total			0.1		

Lugacolliee Lough			
avg ann rainfall	2226	mm/yr	
avg hourly rainfall	0.25411	mm/h	
avg.ann evaporation	703	mm/yr	
avg. hourly evaporation	0.080251	mm/h	
net hourly rainfall	0.173858		
	C	area(km2)	Q m3/sec
bogs	0.9	1.236	0.079148
water w/ net rainfall	1	0.353	0.017184
Total w/net prec			0.096
Total			0.104

Table C-3:Q50 Estimates Derived by Rational Method

Dromtine Lough					
avg ann rainfall	2590	mm/yr			
avg hourly rainfall	0.295662	mm/h			
avg.ann evaporation	772	mm/yr			
avg. hourly evaporation	0.088128	mm/h			
net hourly rainfall	0.207534				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.734	0.05468803		
other ag land	0.35	0.034	0.00098515		
water w/ net rainfall	1	0.064	0.00371901		
Total w/net prec			0.059		
Total			0.061		

Acorrymore Lough			
avg ann rainfall	1756	mm/yr	
avg hourly rainfall	0.200457	mm/h	
avg.ann evaporation	748	mm/yr	
avg. hourly evaporation	0.085388	mm/h	
net hourly rainfall	0.115068		
	C	area(km2)	Q m3/sec
bogs	0.9	1.693	0.085522
water w/ net rainfall	1	0.139	0.004478
Total w/net prec			0.090
Total			0.093

Eirk Lough					
avg ann rainfall	2453	mm/yr			
avg hourly rainfall	0.280023	mm/h			
avg.ann evaporation	728	mm/yr			
avg. hourly evaporation	0.083105	mm/h			
net hourly rainfall	0.196918				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.185	0.01305466		
other	0.3	0.308	0.00724475		
water w/ net rainfall	1	0.06	0.00330822		
Total w/net prec			0.024		
Total			0.025		

Aille Lough			
avg ann rainfall	1545	mm/yr	
avg hourly rainfall	0.17637	mm/h	
avg.ann evaporation	710	mm/yr	
avg. hourly evaporation	0.08105	mm/h	
net hourly rainfall	0.09532		
	C	area(km2)	Q m3/sec
bogs	0.9	0.055	0.002444
other ag land	0.35	0.007	0.000121
water w/ net rainfall	1	0.046	0.001228
Total w/net prec			0.004
Total			0.005

Mount Eagle Lough					
avg ann rainfall	1580	mm/yr			
avg hourly rainfall	0.180365	mm/h			
avg.ann evaporation	748	mm/yr			
avg. hourly evaporation	0.085388	mm/h			
net hourly rainfall	0.094977				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.376	0.01708997		
other	0.3	0.135	0.00204534		
water w/ net rainfall	1	0.039	0.00103715		
Total w/net prec			0.020		
Total			0.021		

Ard Lough			
avg ann rainfall	1710	mm/yr	
avg hourly rainfall	0.195205	mm/h	
avg.ann evaporation	721	mm/yr	
avg. hourly evaporation	0.082306	mm/h	
net hourly rainfall	0.1129		
	C	area(km2)	Q m3/sec
bogs	0.9	0.416	0.020464
water w/ net rainfall	1	0.04	0.001264
Total w/net prec			0.022
Total			0.023

Callee Lough					
avg ann rainfall	2377	mm/yr			
avg hourly rainfall	0.271347	mm/h			
avg.ann evaporation	692	mm/yr			
avg. hourly evaporation	0.078995	mm/h			
net hourly rainfall	0.192352				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.611	0.04177985		
other	0.3	1.114	0.02539157		
water w/ net rainfall	1	0.178	0.0095868		
Total w/net prec			0.077		
Total			0.081		

Coolin Lough			
avg ann rainfall	1790	mm/yr	
avg hourly rainfall	0.204338	mm/h	
avg.ann evaporation	730	mm/yr	
avg. hourly evaporation	0.083333	mm/h	
net hourly rainfall	0.121005		
	C	area(km2)	Q m3/sec
bogs	0.9	1.711	0.088105
other ag land	0.35	0.294	0.005887
water w/ net rainfall	1	0.308	0.010435
Total w/net prec			0.104
Total			0.112

Cummernamuck Lake					
avg ann rainfall	1950	mm/yr			
avg hourly rainfall	0.222603	mm/h			
avg.ann evaporation	768	mm/yr			
avg. hourly evaporation	0.087671	mm/h			
net hourly rainfall	0.134932				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.627	0.03517212		
water w/ net rainfall	1	0.113	0.00426923		
Total w/net prec			0.039		
Total			0.042		

Lackagh Lough			
avg ann rainfall	1482	mm/yr	
avg hourly rainfall	0.169178	mm/h	
avg.ann evaporation	656	mm/yr	
avg. hourly evaporation	0.074886	mm/h	
net hourly rainfall	0.094292		
	C	area(km2)	Q m3/sec
bogs	0.9	0.505	0.02153
other	0.3	0.002	2.84E-05
water w/ net rainfall	1	0.067	0.001769
Total w/net prec			0.023
Total			0.025

Table C-3:Q50 Estimates Derived by Rational Method

Loughaunore					
avg ann rainfall	1406	mm/yr			
avg hourly rainfall	0.160502	mm/h			
avg.ann evaporation	788	mm/yr			
avg. hourly evaporation	0.089954	mm/h			
net hourly rainfall	0.070548				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.614	0.0248342		
water w/ net rainfall	1	0.055	0.00108644		
Total w/net prec			0.026		
Total			0.027		

Anarry Lough			
avg ann rainfall	1355	mm/yr	
avg hourly rainfall	0.15468	mm/h	
avg.ann evaporation	705	mm/yr	
avg. hourly evaporation	0.080479	mm/h	
net hourly rainfall	0.074201		
	C	area(km2)	Q m3/sec
bogs	0.9	0.47	0.01832
forestry	0.2	0.571	0.004946
water w/ net rainfall	1	0.11	0.002285
Total w/net prec			0.026
Total			0.028

Nambrackkeagh Lough					
avg ann rainfall	1541	mm/yr			
avg hourly rainfall	0.175913	mm/h			
avg.ann evaporation	791	mm/yr			
avg. hourly evaporation	0.090297	mm/h			
net hourly rainfall	0.085616				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.356	0.01578153		
water w/ net rainfall	1	0.077	0.00184589		
Total w/net prec			0.018		
Total			0.02		

More Lough			
avg ann rainfall	1270	mm/yr	
avg hourly rainfall	0.144977	mm/h	
avg.ann evaporation	685	mm/yr	
avg. hourly evaporation	0.078196	mm/h	
net hourly rainfall	0.066781		
	C	area(km2)	Q m3/sec
bogs	0.9	0.283	0.010339
forestry	0.2	0.526	0.00427
other ag land	0.35	0.665	0.009448
water w/ net rainfall	1	0.254	0.004749
Total w/net prec			0.029
Total			0.034

Barnahallia Lough					
avg ann rainfall	1356	mm/yr			
avg hourly rainfall	0.154795	mm/h			
avg.ann evaporation	799	mm/yr			
avg. hourly evaporation	0.09121	mm/h			
net hourly rainfall	0.063584				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.148	0.00577322		
other ag land	0.35	0.005	7.5849E-05		
water w/ net rainfall	1	0.029	0.00051631		
Total w/net prec			0.006		
Total			0.007		

Cullionboy Lough			
avg ann rainfall	1880	mm/yr	
avg hourly rainfall	0.214612	mm/h	
avg.ann evaporation	715	mm/yr	
avg. hourly evaporation	0.081621	mm/h	
net hourly rainfall	0.132991		
	C	area(km2)	Q m3/sec
other ag land	0.35	0.049	0.001031
water w/ net rainfall	1	0.028	0.001043
Total w/net prec			0.002
Total			0.003

Loughaunwillan					
avg ann rainfall	1327	mm/yr			
avg hourly rainfall	0.151484	mm/h			
avg.ann evaporation	795	mm/yr			
avg. hourly evaporation	0.090753	mm/h			
net hourly rainfall	0.060731				
	C	area(km2)	Q m3/sec		
pasture	0.35	1.43	0.02122897		
bogs	0.9	1.942	0.07413385		
urban	0.75	0.421	0.0133927		
other ag land	0.35	0.388	0.00576003		
water w/ net rainfall	1	0.418	0.00710791		
Total w/net prec			0.122		
Total			0.132		

Ardan Lough			
avg ann rainfall	1025	mm/yr	
avg hourly rainfall	0.117009	mm/h	
avg.ann evaporation	678	mm/yr	
avg. hourly evaporation	0.077397	mm/h	
net hourly rainfall	0.039612		
	C	area(km2)	Q m3/sec
pasture	0.35	0.841	0.009644
water w/ net rainfall	1	0.416	0.004614
Total w/net prec			0.014
Total			0.023

Drumore Lough					
avg ann rainfall	1030	mm/yr			
avg hourly rainfall	0.11758	mm/h			
avg.ann evaporation	709	mm/yr			
avg. hourly evaporation	0.080936	mm/h			
net hourly rainfall	0.036644				
	C	area(km2)	Q m3/sec		
pasture	0.35	180.65	2.08159943		
bogs	0.9	0.93	0.02755603		
forestry	0.2	1.18	0.00776968		
urban	0.75	1.42	0.03506233		
other	0.3	7.14	0.07051973		
other ag land	0.35	3.49	0.04021468		
water w/ net rainfall	1	4.49	0.04606863		
Total w/net prec			2.309		
Total			2.411		

Nadregeel Lough			
avg ann rainfall	1099	mm/yr	
avg hourly rainfall	0.125457	mm/h	
avg.ann evaporation	690	mm/yr	
avg. hourly evaporation	0.078767	mm/h	
net hourly rainfall	0.046689		
	C	area(km2)	Q m3/sec
pasture	0.35	3.6	0.044261
other	0.3	0.12	0.001265
other ag land	0.35	0.354	0.004352
water w/ net rainfall	1	0.49	0.006406
Total w/net prec			0.056
Total			0.067

Table C-3:Q50 Estimates Derived by Rational Method

Anaserd Lough					
avg ann rainfall	1412	mm/yr			
avg hourly rainfall	0.161187	mm/h			
avg.ann evaporation	806	mm/yr			
avg. hourly evaporation	0.092009	mm/h			
net hourly rainfall	0.069178				
	C	area(km2)	Q m3/sec		
other	0.3	0.284	0.00384528		
other ag land	0.35	2.79	0.04407181		
water w/ net rainfall	1	0.82	0.01588329		
Total w/net prec			0.064		
Total			0.085		

Table C-4: Q50 Estimates Derived for GWD Lakes by Rational Method

Birroge Lough					
avg ann rainfall	1391	mm/yr			
avg hourly rainfall	0.158789954	mm/h			
avg.ann evaporation	783	mm/yr			
avg. hourly evaporation	0.089383562	mm/h			
net hourly rainfall	0.069406393				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.573	0.022929		
water w/ net rainfall	1	0.08	0.001555		
Total w/net prec			0.024		
Total			0.026		

Ballybeg Lough					
avg ann rainfall	1238	mm/yr			
avg hourly rainfall	0.141324201	mm/h			
avg.ann evaporation	782	mm/yr			
avg. hourly evaporation	0.089269406	mm/h			
net hourly rainfall	0.052054795				
	C	area(km2)	Q m3/sec		
other	0.3	0.186	0.002208		
other ag land	0.35	0.162	0.002244		
pasture	0.35	1.685	0.023337		
urban	0.75	0.244	0.007241		
forestry	0.2	0.9	0.007123		
water w/ net rainfall	1	0.54	0.007871		
Total w/net prec			0.050		
Total			0.064		

Bleach Lough					
avg ann rainfall	1007	mm/yr			
avg hourly rainfall	0.114954338	mm/h			
avg.ann evaporation	790	mm/yr			
avg. hourly evaporation	0.090182648	mm/h			
net hourly rainfall	0.024771689				
	C	area(km2)	Q m3/sec		
other	0.3	0.275	0.002655		
other ag land	0.35	0.07	0.000789		
pasture	0.35	0.972	0.01095		
water w/ net rainfall	1	0.178	0.001235		
Total w/net prec			0.016		
Total			0.02		

Table C-4: Q50 Estimates Derived for GWD Lakes by Rational Method

Cavetown Lough					
avg ann rainfall	1122	mm/yr			
avg hourly rainfall	0.128082192	mm/h			
avg.ann evaporation	658	mm/yr			
avg. hourly evaporation	0.075114155	mm/h			
net hourly rainfall	0.052968037				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.09	0.002905		
forestry	0.2	0.03	0.000215		
other	0.3	0.33	0.00355		
other ag land	0.35	1.73	0.021715		
pasture	0.35	1.85	0.023221		
water w/ net rainfall	1	0.74	0.010975		
Total w/net prec			0.063		
Total			0.078		

Grange Lough					
avg ann rainfall	1080	mm/yr			
avg hourly rainfall	0.123287671	mm/h			
avg.ann evaporation	665	mm/yr			
avg. hourly evaporation	0.075913242	mm/h			
net hourly rainfall	0.047374429				
	C	area(km2)	Q m3/sec		
pasture	0.35	2.706	0.032694		
water w/ net rainfall	1	0.078	0.001035		
Total w/net prec			0.034		
Total			0.035		

Cavetown Lough					
avg ann rainfall	1122	mm/yr			
avg hourly rainfall	0.128082192	mm/h			
avg.ann evaporation	658	mm/yr			
avg. hourly evaporation	0.075114155	mm/h			
net hourly rainfall	0.052968037				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.09	0.002905		
forestry	0.2	0.03	0.000215		
other	0.3	0.33	0.00355		
other ag land	0.35	1.73	0.021715		
pasture	0.35	1.85	0.023221		
water w/ net rainfall	1	0.74	0.010975		
Total w/net prec			0.063		
Total			0.078		

Table C-4: Q50 Estimates Derived for GWD Lakes by Rational Method

Bofinna Lough					
avg ann rainfall	1748	mm/yr			
avg hourly rainfall	0.199543379	mm/h			
avg.ann evaporation	777	mm/yr			
avg. hourly evaporation	0.08869863	mm/h			
net hourly rainfall	0.110844749				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.308	0.015488		
pasture	0.35	0.169	0.003305		
water w/ net rainfall	1	0.086	0.002669		
Total w/net prec			0.021		
Total			0.024		

Illauntrasna Lough					
avg ann rainfall	1312	mm/yr			
avg hourly rainfall	0.149771689	mm/h			
avg.ann evaporation	797	mm/yr			
avg. hourly evaporation	0.090981735	mm/h			
net hourly rainfall	0.058789954				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.38	0.014342		
other ag land	0.35	0.01	0.000147		
pasture	0.35	0.03	0.00044		
water w/ net rainfall	1	0.08	0.001317		
Total w/net prec			0.016		
Total			0.018		

Aughrusbeg Lough					
avg ann rainfall	1356	mm/yr			
avg hourly rainfall	0.154794521	mm/h			
avg.ann evaporation	808	mm/yr			
avg. hourly evaporation	0.092237443	mm/h			
net hourly rainfall	0.062557078				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.524	0.02044		
other ag land	0.35	0.42	0.006371		
water w/ net rainfall	1	0.49	0.008583		
Total w/net prec			0.035		
Total			0.048		

Ballin Lough					
avg ann rainfall	1480	mm/yr			
avg hourly rainfall	0.168949772	mm/h			
avg.ann evaporation	732	mm/yr			
avg. hourly evaporation	0.083561644	mm/h			
net hourly rainfall	0.085388128				
	C	area(km2)	Q m3/sec		
pasture	0.3	0.9	0.012773		
water w/ net rainfall	1	0.41	0.009803		
Total w/net prec			0.023		
Total			0.032		

Table C-4: Q50 Estimates Derived for GWD Lakes by Rational Method

Washpool Lough					
avg ann rainfall	1385	mm/yr			
avg hourly rainfall	0.158105023	mm/h			
avg.ann evaporation	680	mm/yr			
avg. hourly evaporation	0.077625571	mm/h			
net hourly rainfall	0.080479452				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.3	0.06804		
other ag land	0.35	1.25	0.11025		
pasture	0.35	1.48	0.130536		
water w/ net rainfall	1	0.4	0.009014		
Total w/net prec			0.318		
Total			0.41		

Bekan Lough					
avg ann rainfall	1268	mm/yr			
avg hourly rainfall	0.144748858	mm/h			
avg.ann evaporation	649	mm/yr			
avg. hourly evaporation	0.074086758	mm/h			
net hourly rainfall	0.0706621				
	C	area(km2)	Q m3/sec		
other	0.3	0.15	0.001824		
other ag land	0.35	0.28	0.003972		
pasture	0.35	0.45	0.006383		
water w/ net rainfall	1	0.257	0.005791		
Total w/net prec			0.018		
Total			0.023		

Holan Lough					
avg ann rainfall	1335	mm/yr			
avg hourly rainfall	0.15239726	mm/h			
avg.ann evaporation	674	mm/yr			
avg. hourly evaporation	0.076940639	mm/h			
net hourly rainfall	0.075456621				
	C	area(km2)	Q m3/sec		
other ag land	0.35	0.11	0.001643		
pasture	0.35	0.196	0.002927		
water w/ net rainfall	1	0.029	0.000613		
Total w/net prec			0.005		
Total			0.006		

Labe Lough					
avg ann rainfall	1246	mm/yr			
avg hourly rainfall	0.142237443	mm/h			
avg.ann evaporation	651	mm/yr			
avg. hourly evaporation	0.074315068	mm/h			
net hourly rainfall	0.067922374				
	C	area(km2)	Q m3/sec		
bogs	0.9	0.292	0.010466		
other	0.3	0.185	0.00221		
water w/ net rainfall	1	0.055	0.001046		
Total w/net prec			0.014		
Total			0.015		

Table C-4: Q50 Estimates Derived for GWD Lakes by Rational Method

Ballycar Lough					
avg ann rainfall	1083	mm/yr			
avg hourly rainfall	0.123630137	mm/h			
avg.ann evaporation	792	mm/yr			
avg. hourly evaporation	0.090410959	mm/h			
net hourly rainfall	0.033219178				
	C	area(km2)	Q m3/sec		
other	0.3	0.09	0.000935		
pasture	0.35	0.44	0.005331		
water w/ net rainfall	1	0.02	0.000186		
Total w/net prec			0.006		
Total			0.007		

Appendix D
Net Abstraction:Inflow Estimates

Table D-1: Ratio of Net Abstractions to Inflow

No.	WATERBODY	LOCATION	AREA (including lake area) km²	Risk level	50%ile Inflow* m³/s	Estimation Method	Abstractions m3/day	Abstractions m3/sec	WWTP Discharges** (m3/sec)	WWTP avg daily	WWTP Population	WWTP Discharge Estimate*** (m3/sec)	IPC Discharge Max Volume m3	IPPC Discharge**** (m3/sec)	S4 MAX FLOW DAILY (m3/d)	Section 4 Discharge**** (m3/sec)	Total Discharge (m3/sec)	Net Abstractions m3/sec	Net Abstractions:Inflow
1	IE_NW_36_517	Annagh Lough	3.474	1a	0.047	Rational	0	0.000							400.0	0.00116	0.0012	-0.001	-0.025
2	IE_NW_36_525b	Drumlona Lough	17.953	1b	0.205	ESBI Non-Karst	0	0.000	0.0024	210	916	0.0024					0.0024	-0.002	-0.012
3	IE_NW_36_432	Ardan Lough	1.254	1a	0.023	Rational	0	0.000									0.0000	0.000	0.000
4	IE_SH_27_123	Ballybeg Lough	3.730	1a	0.064	Rational	0	0.000									0.0000	0.000	0.000
5	IE_NW_36_415	Drumgole Lough	2.094	1a	0.019	ESBI Non-Karst	0	0.000									0.0000	0.000	0.000
6	IE_NW_36_715	Golagh Lough	4.823	1a	0.136	ESBI Non-Karst	0	0.000									0.0000	0.000	0.000
7	IE_NB_03_3	Grove Lough	0.360	1a	0.004	Rational	0	0.000									0.0000	0.000	0.000
8	IE_NW_38_83	Anure Lough	36.924	1a	0.959	ESBI Non-Karst	14	0.000									0.0000	0.000	0.000
9	IE_NW_37_188	Eske Lough	80.128	1b	2.459	ESBI Non-Karst	415	0.005									0.0000	0.005	0.002
10	IE_NW_36_526	Inner Lough	192.065	1a	2.286	ESBI Non-Karst	2526	0.029		1185	5444	0.0137					0.0137	0.016	0.007
11	IE_WE_32_428	Lugacolliee Lake	1.589	1b	0.104	Rational	67	0.001									0.0000	0.001	0.007
12	IE_EA_07_275	Ramor Lough	243.512	1a	3.350	Gage	3850	0.045	0.0100		5500	0.0100	10500	0.0025	2333.5	0.00675	0.0193	0.025	0.008
13	IE_NW_35_160	Melvin Lough	186.344	1b	4.167	ESBI Karst	3842	0.044	0.0077	669	700	0.0077					0.0077	0.037	0.009
14	IE_NW_36_525a	Drumore Lough	7.632	1b	2.451	ESBI Non-Karst	3076	0.036		1185	5444	0.0137					0.0137	0.022	0.009
15	IE_SW_20_158	Curraghalicky Lake	8.270	1b	0.236	ESBI Non-Karst	200	0.002									0.0000	0.002	0.010
16	IE_WE_32_436	Aughrusbeg Lough	1.435	1b	0.048	Rational	46	0.001									0.0000	0.001	0.011
17	IE_NW_36_647	White Lough	122.769	1b	1.441	ESBI Non-Karst	2526	0.029	0.0110	975	4528	0.0110					0.0110	0.018	0.013
18	IE_WE_34_402	Washpool Lough	3.454	1a	0.410	Rational	499	0.006									0.0000	0.006	0.014
19	IE_NW_38_47	Kiltooris Lough	5.487	1a	0.116	ESBI Non-Karst	144	0.002									0.0000	0.002	0.014
20	IE_NW_36_385	Cullinaghan Lough	33.041	1a	0.517	ESBI Karst	740	0.009									0.0000	0.009	0.017
21	IE_NB_03_79	Glaslough Lake	7.999	1a	0.090	ESBI Non-Karst	136	0.002									0.0000	0.002	0.017
22	IE_NW_36_513	Kilywilly Lough	31.254	1b	0.489	ESBI Karst	740	0.009									0.0000	0.009	0.018
23	IE_WE_32_474	Tully (Lough)	1.913	1a	0.071	Rational	131	0.002									0.0000	0.002	0.021
24	IE_SH_27_120	Rosroe Lough	51.082	1a	0.868	ESBI Karst	1873	0.022			720	0.0017					0.0017	0.020	0.023
25	IE_NB_06_234	Monalty Lough	85.454	1a	1.336	ESBI Karst	5239	0.061	0.0255	2200	30883	0.0255	0		33.0	0.00176	0.0273	0.033	0.025
26	IE_NB_06_244	Muckno Mill Lough	21.246	1a	0.334	ESBI Non-Karst	735	0.009									0.0000	0.009	0.025
27	IE_WE_32_479	Ballynakill Lough	5.668	1a	0.119	ESBI Non-Karst	262	0.003									0.0000	0.003	0.025
28	IE_WE_30_332	Coolin Lough	2.314	1a	0.112	Rational	252	0.003									0.0000	0.003	0.026
29	IE_SW_19_138	Inniscarra Reservoir	785.714	1a	20.581	ESBI Non-Karst	62080	0.719			9710	0.0225			33900.0	0.09809	0.1206	0.598	0.029
30	IE_NW_36_363	Tacker Lough	78.210	1b	1.128	ESBI Non-Karst	3815	0.044							850.0	0.00246	0.0025	0.042	0.037
31	IE_NW_38_57	Birroge Lough	0.623	1a	0.026	Rational	84	0.001									0.0000	0.001	0.037
32	IE_SW_21_440	Cummer Lough	1.622	1a	0.100	Rational	391	0.005									0.0000	0.005	0.045
33	IE_SH_23_59	Acummeen (Lough)	0.701	1a	0.041	Rational	164	0.002									0.0000	0.002	0.046
34	IE_NW_36_528	Sillan Lough	52.927	1b	0.765	ESBI Non-Karst	3405	0.039							850.0	0.00246	0.0025	0.037	0.048
35	IE_NW_38_22	Glen Lough	124.305	1a	3.714	ESBI Non-Karst	15980	0.185									0.0000	0.185	0.050
36	IE_NB_06_54	Ervey Lough	11.473	1a	0.136	ESBI Non-Karst	650	0.008									0.0000	0.008	0.055
37	IE_WE_35_131	Anarry (Lough)	1.154	1a	0.028	Rational	135	0.002									0.0000	0.002	0.056
38	IE_NW_36_201	Nabellbeg (Lough)	0.370	1a	0.017	Rational	83	0.001									0.0000	0.001	0.057
39	IE_SW_21_429	Coomclogherane Lake	1.184	1a	0.070	Rational	384	0.004									0.0000	0.004	0.063
40	IE_SW_21_405	Dromtine Lough	0.833	1b	0.061	Rational	348	0.004									0.0000	0.004	0.066
41	IE_NW_37_140	Meenaviller (Lough)	0.138	1a	0.008	Rational	46	0.001									0.0000	0.001	0.067
42	IE_NW_36_468	Clonty Lough	11.554	1a	0.126	ESBI Karst	740	0.009									0.0000	0.009	0.068
43	IE_NW_37_194	Croagh Lough	0.436	1a	0.023	Rational	158	0.002									0.0000	0.002	0.080
44	IE_SW_20_148	Abisdealy Lough	5.819	1b	0.133	ESBI Non-Karst	1000	0.012									0.0000	0.012	0.087
45	IE_WE_32_432	Ard (Lough)	0.439	1a	0.023	Rational	176	0.002									0.0000	0.002	0.089
46	IE_NW_36_623	Bawn Lough	65.404	1a	0.958	ESBI Non-Karst	7357	0.085							35.0	0.00010	0.0001	0.085	0.089
47	IE_WE_35_136	Easky Lough	10.514	1a	0.288	ESBI Non-Karst	2391	0.028									0.0000	0.028	0.096
48	IE_SW_20_153	Coolkellure Lake	3.044	1a	0.066	ESBI Non-Karst	550	0.006									0.0000	0.006	0.096
49	IE_WE_32_364	Ballin Lough	2.011	1a	0.032	Rational	267	0.003									0.0000	0.003	0.097
50	IE_WE_35_237	Labe Lough	0.599	1a	0.015	Rational	133	0.002									0.0000	0.002	0.103
51	IE_WE_35_96	Lackagh Lough	0.576	1a	0.025	Rational	236	0.003									0.0000	0.003	0.109
52	IE_SH_26_705	Cavetown Lough	5.533	1a	0.078	Rational	797	0.009									0.0000	0.009	0.118
53	IE_WE_31_211	Anaserd Lough	3.907	1a	0.085	Rational	882	0.010									0.0000	0.010	0.120
54	IE_NW_36_346	Naback (Lough)	1.243	1a	0.022	Rational	235	0.003									0.0000	0.003	0.124
55	IE_WE_32_269	Barnahallia Lough	0.183	1a	0.007	Rational	78	0.001									0.0000	0.001	0.129
56	IE_NW_38_678	Shannagh Lough	4.169	1a	0.061	ESBI Non-Karst	688	0.008									0.0000	0.008	0.131
57	IE_SW_20_133	Tooreen Lough	0.380	1a	0.015	Rational	200	0.002									0.0000	0.002	0.154
58	IE_NW_36_420	Naglare (Lough)	1.200	1a	0.017	Rational	240	0.003									0.0000	0.003	0.163
59	IE_WE_33_1892	Acorrymore (Lough)	1.833	1a	0.093	Rational	1385	0.016									0.0000	0.016	0.172
60	IE_NW_36_712	Unshin Lough	4.272	1a	0.117	ESBI Non-Karst	1760	0.020									0.0000	0.020	0.174
61	IE_SW_21_369	Eirk Lough	0.554	1a	0.025	Rational	391	0.005									0.0000	0.005	0.181
62	IE_NW_36_684	Namachree (Lough)	2.522	1a	0.034	Rational	546	0.006									0.0000	0.006	0.186
63	IE_WE_34_341	Bekan Lough	1.147	1b	0.023	Rational	382	0.004									0.0000	0.004	0.192
64	IE_NW_36_430	Garty Lough	20.808	1a	0.237	ESBI Non-Karst	4000	0.046									0.0000	0.046	0.195
65	IE_WE_31_120	Loughaunwillan Lough	4.602	1a	0.132	Rational	2266	0.026									0.0000	0.026	0.199
66	IE_NW_36_331	Cornalara Lough	1.286	1a	0.018	Rational	315	0.004									0.0000	0.004	0.203
67	IE_SW_20_150	Ballin Lough	1.327	1a	0.038	Rational	700	0.008									0.0000	0.008	0.213
68	IE_NW_36_706	Gorman (Lough)	2.419	1a	0.040	Rational	740	0.009									0.0000	0.009	0.214
69	IE_SW_22_182	Callee (Lough)	1.904	1a	0.081	Rational	1514	0.018									0.0000	0.018	0.216
70	IE_WE_32_406	Moher Lough	6.327	1a	0.182	ESBI Non-Karst	3408	0.039									0.0000	0.039	0.217
71	IE_SW_22_199	Cummernamuck (Lake)	0.741	1a	0.042	Rational	795	0.009									0.0000	0.009	0.219
72	IE_WE_34_458	Holan Lough	0.337	1a	0.006	Rational	115	0.001									0.0000	0.001	0.222
73	IE_SW_20_53	Skeagh Lough [Schull Reservoi	1.224	1a	0.050	Rational	1000	0.012									0.0000	0.012	0.231

Table D-1: Ratio of Net Abstractions to Inflow

No.	WATERBODY	LOCATION	AREA (including lake area) km^2	Risk level	50%ile Inflow* m^3/s	Estimation Method	Abstractions m3/day	Abstractions m3/sec	WWTP Discharges** (m3/sec)	WWTP avg daily	WWTP Population	WWTP Discharge Estimate*** (m3/sec)	IPC Discharge Max Volume m3	IPPC Discharge**** (m3/sec)	S4 MAX FLOW DAILY (m3/d)	Section 4 Discharge**** (m3/sec)	Total Discharge (m3/sec)	Net Abstractions m3/sec	Net Abstractions:Inflow
78	IE_SW_22_58	Mount Eagle Lough	0.552	1a	0.021	Rational	500	0.006									0.0000	0.006	0.276
79	IE_NW_36_460	Coragh Lough	2.021	1a	0.023	ESBI Non-Karst	550	0.006									0.0000	0.006	0.277
80	IE_SH_28_82	Doo Lough	22.823	1a	0.589	ESBI Non-Karst	14715	0.170							0.0	0.00000	0.0000	0.170	0.289
81	IE_NW_36_316	Graddum Lough	2.892	1a	0.038	Rational	950	0.011									0.0000	0.011	0.289
82	IE_SH_27_122	Gortglass Lough	2.220	1a	0.041	ESBI Non-Karst	1037	0.012									0.0000	0.012	0.293
83	IE_NW_36_421	Annaghierin Lough	2.420	1a	0.032	Rational	850	0.010									0.0000	0.010	0.307
84	IE_SH_28_85	Lickeen Lough	9.087	1a	0.172	ESBI Non-Karst	4694	0.054									0.0000	0.054	0.316
85	IE_NB_03_87	More (Lough)	1.730	1a	0.034	Rational	958	0.011									0.0000	0.011	0.326
86	IE_NW_36_635	Baraghy Lough	2.374	1a	0.034	Rational	980	0.011									0.0000	0.011	0.334
87	IE_EA_09_68	Glenasmole Reservoirs	27.758	1a	0.600	ESBI Non-Karst	18000	0.208									0.0000	0.208	0.347
88	IE_EA_07_267	Skeagh Lough Upper	4.032	1a	0.070	Rational	2150	0.025									0.0000	0.025	0.355
89	IE_SH_28_64	Keagh (Lough)	0.384	1a	0.016	Rational	494	0.006									0.0000	0.006	0.357
90	IE_WE_32_422	Nambrackkeagh (Lough)	0.434	1a	0.020	Rational	636	0.007									0.0000	0.007	0.368
91	IE_EA_09_70	Glenasmole Reservoirs	25.829	1a	0.558	ESBI Non-Karst	18000	0.208							0.0	0.00000	0.0000	0.208	0.373
92	IE_NW_36_618	Atrain (Lough)	1.444	1a	0.021	Rational	700	0.008									0.0000	0.008	0.386
93	IE_WE_31_177	Loughaunore	0.669	1a	0.027	Rational	901	0.010									0.0000	0.010	0.386
94	IE_EA_07_268	Drumkeery Lough	8.067	1a	0.091	ESBI Non-Karst	3100	0.036							60.0	0.00017	0.0002	0.036	0.392
95	IE_NW_36_710	Columbkille Lough	0.244	1a	0.006	Rational	209	0.002									0.0000	0.002	0.403
96	IE_NW_38_52	Anna (Lough)	0.836	1a	0.048	Rational	1697	0.020									0.0000	0.020	0.409
97	IE_NW_36_409	Killynenagh Lough	0.462	1a	0.006	Rational	213	0.002									0.0000	0.002	0.411
98	IE_WE_31_1126	Illauntrasna Lough	0.497	1a	0.018	Rational	641	0.007									0.0000	0.007	0.412
99	IE_WE_35_17	Carrowlustia	8.412	1a	0.158	ESBI Non-Karst	5911	0.068									0.0000	0.068	0.433
100	IE_WE_30_532	Aille Lough	0.109	1a	0.005	Rational	195	0.002									0.0000	0.002	0.451
101	IE_NW_39_44	Gort Lough	1.567	1a	0.024	ESBI Non-Karst	1015	0.012									0.0000	0.012	0.489
102	IE_NW_36_324	Cornaseer Lough	0.496	1a	0.007	Rational	310	0.004									0.0000	0.004	0.513
103	IE_NW_37_208	St. Peter's Lough	0.737	1a	0.022	Rational	982	0.011									0.0000	0.011	0.517
104	IE_SH_25_90	Bleach Lough	1.495	1a	0.020	Rational	932	0.011									0.0000	0.011	0.539
105	IE_NW_36_382	Toome Or Crinkill Lough	0.867	1a	0.012	Rational	563	0.007									0.0000	0.007	0.543
106	IE_NW_36_448	Kill Lough	1.460	1a	0.023	Rational	1136	0.013									0.0000	0.013	0.572
107	IE_NB_36_383	Nagarnaman (Lough)	1.931	1a	0.028	Rational	1460	0.017									0.0000	0.017	0.604
108	IE_EA_07_242	Acurry (Lough)	0.614	1a	0.014	Rational	750	0.009									0.0000	0.009	0.620
109	IE_WE_34_405	Talt Lough	5.673	1a	0.144	ESBI Non-Karst	7789	0.090									0.0000	0.090	0.626
110	IE_SE_16_463	Ballyshunnock	11.164	1b	0.200	ESBI Non-Karst	11500	0.133									0.0000	0.133	0.666
111	IE_NW_38_29	Nameeltoge (Lough)	0.451	1a	0.017	Rational	1000	0.012									0.0000	0.012	0.681
112	IE_SH_27_193	Ballycar Lough	0.560	1a	0.007	Rational	418	0.005									0.0000	0.005	0.691
113	IE_WE_35_188	Nacroagh (Lough)	0.020	1b	0.000	Rational	24	0.000									0.0000	0.000	0.694
114	IE_SW_21_448	Bofinna Lough	0.564	1a	0.024	Rational	1500	0.017									0.0000	0.017	0.723
115	IE_EA_07_270	Bane (Lough)	3.134	1a	0.060	Rational	4000	0.046									0.0000	0.046	0.772
116	IE_SE_17_5	Belle Lake	1.582	1a	0.024	Rational	1632	0.019									0.0000	0.019	0.787
117	IE_SE_16_314	Crotty's or Coumgaurha Lough	0.440	1a	0.019	Rational	1300	0.015									0.0000	0.015	0.792
118	IE_SH_28_87	Naminna (Lough)	0.901	1a	0.026	Rational	1800	0.021									0.0000	0.021	0.801
119	IE_NW_38_668	Naglea (Lough)	0.385	1a	0.008	Rational	565	0.007									0.0000	0.007	0.817
120	IE_EA_07_273	Nadreegeal Loughs	12.688	1a	0.067	Rational	5475	0.063							85.5	0.00025	0.0002	0.063	0.942
121	IE_NB_06_209	Brackan (Lough)	0.746	1a	0.008	Rational	700	0.008									0.0000	0.008	1.013
122	IE_NW_36_329	Killcoran Lough	0.472	1a	0.009	Rational	1030	0.012									0.0000	0.012	1.325
123	IE_SE_17_8	Carrigavantry Reservoir	0.720	1a	0.011	Rational	1500	0.017									0.0000	0.017	1.578
124	IE_NW_37_210	Cullionboy Lough	0.078	1a	0.003	Rational	416	0.005									0.0000	0.005	1.605
125	IE_SH_26_706	Grange Lough	2.784	1a	0.035	Rational	4941	0.057									0.0000	0.057	1.634
126	IE_NB_06_198	Spring Lough	0.816	1a	0.010	Rational	1800	0.021									0.0000	0.021	2.083
127	IE_NW_36_192	Corconnelly Lough	0.354	1a	0.005	Rational	1300	0.015									0.0000	0.015	3.009

NOTES:

* For Rational Method,derived based on total precipitation on lake

** From UWWTP Discharge Register

*** Estimated as 0.2 m3/person/day or actual

**** Estimated as 25% of Daily Maximum Discharge or equivalent of abstraction (where known)

Lough Melvin Calculation compromised due to lack of soils data for NI

Appendix E
Stage 3: Site-specific Lake Data

Table E-1: Stage 3 General Lake Data

General							Bathymetry										
CDM Code	EU Code	Lake Name	County	RBD	Hydro Area	GWD Lake	Bathy. data	Photo	Vehicular access	Signposted	Access Notes	Area (ha)	Altitude (m)	Mean Depth (m)	Max Depth (m)	Deepest part (m)	Rock outcrops
1	IE_WE_33_1892	Acorrymore (Lough)	Mayo	WE	33	No	Yes	Yes	Good	Yes	Good road, Achill Island	13.92	187.90	19.63	37.49	-	-
2	IE_EA_07_242	Acurry (Lough)	Cavan	EA	7	No	No	No	Good	-	-	19.35	189.00	-	-	-	-
3	IE_WE_31_211	Anaserd (Lough)	Galway	WE	31	No	No	Yes	-	No	Gated track	82.20	7.60	-	-	-	-
4	IE_NW_38_52	Anna (Lough)	Donegal	NW	38	No	No	No	Difficult	-	-	33.57	168.50	-	-	-	-
5	IE_EA_07_270	Bane (Lough)	Meath	EA	7	Yes	Yes	Yes	-	No	WW on north shore	75.45	113.20	5.24	16.00	-	-
6	IE_WE_32_269	Barnahallia Lough	Galway	WE	32	No	No	No	Difficult	No	Track off main road	2.97	22.10	-	-	-	-
7	IE_SW_21_448	Bofinna (Lough)	Cork	SW	21	Yes	Yes	Yes	-	-	-	8.68	138.80	3.68	8.30	-	-
8	IE_SW_22_182	Callee (Lough)	Kerry	SW	22	No	Yes	Yes	Difficult	-	Carrauntoohil	17.83	332.10	9.94	26.62	-	-
9	IE_NW_36_460	Coragh Lough	Cavan	NW	36	No	No	No	-	-	-	13.94	79.50	-	-	-	-
10	IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	SE	16	No	No	No	-	-	-	3.55	417.70	-	21.00	-	-
11	IE_NW_37_210	Cullionboy Lough	Donegal	NW	37	No	No	Yes	Difficult	-	track and gates	2.88	115.70	-	-	-	-
12	IE_SW_21_369	Eirk Lough	Kerry	SW	21	No	Yes	Yes	Difficult	-	-	6.09	338.10	4.43	12.42	-	-
13	IE_WE_32_526	Fawna (Lough)	Galway	WE	32	No	No	No	-	-	Innisboffin Island	3.08	45.00	0.73	1.91	-	-
14	IE_NW_37_195	Glencoagh Lough	Donegal	NW	37	No	No	Yes	-	-	Gated track. Beside St Peters Lough	8.65	103.20	-	-	-	-
15	IE_NW_36_706	Gorman (Lough)	Donegal	NW	36	Yes	No	Yes	-	-	Gated track. Access to lake shore difficult - reed be	7.45	80.00	-	-	-	-
16	IE_NW_39_44	Gort Lough	Donegal	NW	39	No	No	No	-	-	-	3.84	87.20	-	-	-	-
17	IE_WE_34_458	Holan (Lough)	Mayo	WE	34	Yes	Yes	Yes	-	-	-	2.99	21.80	7.27	12.45	-	-
18	IE_WE_35_237	Labe (Lough)	Sligo	WE	35	Yes	Yes	Yes	-	No	Track to pumphouse	5.54	144.50	4.79	12.86	-	-
19	IE_WE_35_96	Lackagh Lough	Leitrim	WE	35	No	No	No	-	-	Inaccessible - no data recorded	6.72	395.70	-	-	-	-
20	IE_WE_31_120	Loughaunwillan	Galway	WE	31	No	Yes	Yes	Good	No	Main road Carraroe	37.04	3.30	6.28	21.50	2.1	Yes
21	IE_WE_32_406	Moher Lough	Mayo	WE	32	No	Yes	Yes	Good	Yes	Main road Clifden - Westport	36.43	86.80	3.87	17.00	15.2	No
22	IE_NB_03_87	More (Lough)	Monaghan	NB	3	No	No	No	-	-	-	14.70	179.40	-	-	-	-
23	IE_SW_22_58	Mount Eagle Lough	Kerry	SW	22	No	Yes	Yes	Difficult	-	-	3.99	223.60	7.54	18.85	-	-
24	IE_WE_32_422	Nambrackkeagh (Lough)	Galway	WE	32	No	No	No	-	No	Track off main road	7.73	67.30	1.17	3.07	-	-
25	IE_NW_38_29	Nameeltoge (Lough)	Donegal	NW	38	No	No	No	-	-	-	8.25	127.90	-	-	-	-
26	IE_SH_28_87	Naminna (Lough)	Clare	SH	28	No	No	No	-	-	-	20.25	168.70	-	-	-	-
27	IE_NW_38_678	Shannagh (Lough)	Donegal	NW	38	No	No	No	-	-	-	26.96	18.20	-	-	-	-
28	IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	SW	20	No	Yes	Yes	-	-	-	2.25	68.70	2.32	6.81	-	-
29	IE_NW_37_208	St. Peter's Lough	Donegal	NW	37	No	No	Yes	-	-	gated track and across field	16.48	111.80	-	-	-	-
30	IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	NW	36	No	No	No	-	-	-	8.58	103.70	-	-	-	-
31	IE_SW_20_133	Tooreen Lough	Cork	SW	20	No	Yes	Yes	-	-	-	3.13	81.80	2.23	9.95	-	-
32	IE_NW_36_712	Unshin (Lough)	Donegal	NW	36	No	No	Yes	-	-	-	27.18	102.90	-	-	-	-
33	IE_WE_30_532	Aille Lough	Mayo	WE	30	No	Yes	Yes	Good	Yes	Stocked lake - good access provided by WRFB	4.63	62.00	3.53	10.28	-	No
34	IE_SH_26_705	Cavetown Lough	Roscommon	SH	26	Yes	No	Yes	Good	Yes	Road all around it	64.23	81.10	3.80	20.00	-	-
35	IE_WE_31_1126	Illauntrasna (Lough)	Galway	WE	31	Yes	Yes	Yes	Average	No	Main road to Lettermullen	8.34	11.00	2.45	9.04	9	-
36	IE_WE_31_177	Loughaunore	Galway	WE	31	No	Yes	Yes	Good	No	Access from old weir/water works	5.51	84.90	3.33	13.30	14.3	No
37	IE_WE_34_405	Talt (Lough)	Sligo	WE	34	No	Yes	Yes	Good	Yes	Main road	97.35	135.00	10.38	39.24	-	-
38	IE_NW_36_710	Columbkille Lough	Donegal	NW	36	No	No	No	-	-	-	6.45	131.30	-	-	-	-
39	IE_SH_26_706	Grange Lough	Roscommon	SH	26	Yes	No	No	-	-	-	7.80	38.80	-	-	-	-
40	IE_WE_35_17	Carrowlustia	Sligo	WE	35	No	Yes	Yes	-	-	-	4.28	110.30	5.37	14.05	-	-
41	IE_EA_09_68	Glenasmole Reservoirs	Dublin	EA	9	No	No	No	-	-	-	7.94	141.00	-	-	-	-
42	IE_EA_09_70	Glenasmole Reservoirs	Dublin	EA	9	No	No	No	-	-	-	19.15	168.20	-	-	-	-
43	IE_NW_36_421	Annaghierin Lough	Cavan	NW	36	No	No	No	-	-	-	12.63	117.90	-	-	-	-
44	IE_SW_20_150	Ballin Lough	Cork	SW	20	No	Yes	Yes	-	-	-	7.75	86.30	4.11	9.39	-	-
45	IE_NW_36_635	Baraghy Lough	Monaghan	NW	36	No	No	No	-	-	-	24.45	128.70	-	-	-	-
46	IE_NW_36_192	Corconnelly Lough	Monaghan	NW	36	No	No	No	-	-	-	5.62	83.90	-	-	-	-
47	IE_NW_36_331	Cornalara Lough	Cavan	NW	36	No	No	No	-	-	-	6.63	150.10	-	-	-	-
48	IE_NW_36_324	Cornaseer Lough	Cavan	NW	36	No	No	No	-	-	-	5.00	119.00	-	-	-	-
49	IE_SW_22_199	Cummernamuck (Lake)	Kerry	SW	22	No	Yes	Yes	-	-	-	11.38	129.60	6.02	14.09	-	-
50	IE_SH_27_122	Gortglass Lough	Clare	SH	27	No	No	No	-	-	-	30.27	64.50	-	-	-	-
51	IE_NW_36_316	Graddum Lough	Cavan	NW	36	No	No	No	-	-	-	12.24	98.80	-	-	-	-
52	IE_SH_28_64	Keagh (Lough)	Clare	SH	28	No	No	No	-	-	-	6.97	182.80	-	-	-	-
53	IE_NW_36_329	Killcoran Lough	Monaghan	NW	36	No	No	No	-	-	-	14.35	69.30	-	-	-	-
54	IE_NW_36_409	Killynenagh Lough	Cavan	NW	36	No	No	No	-	-	-	6.96	80.50	-	-	-	-
55	IE_EA_07_273	Nadreegeal Loughs	Cavan	EA	7	No	Yes	Yes	-	-	WW eastern end of N lough and southern end of S	84.61	102.80	2.4	-	-	-
56	IE_NB_36_383	Nagarnaman (Lough)	Monaghan	NB	36	No	No	No	-	-	-	18.22	150.70	-	-	-	-
57	IE_NW_36_420	Naglare (Lough)	Cavan	NW	36	No	No	No	-	-	-	6.39	173.60	-	-	-	-
58	IE_NW_36_684	Namachree (Lough)	Monaghan	NW	36	No	No	No	-	-	-	16.70	116.60	-	-	-	-
59	IE_NB_06_198	Spring Lough	Monaghan	NB	6	Yes	No	No	-	-	-	10.25	37.70	-	-	-	-
60	IE_NW_36_618	Atrain (Lough)	Cavan	NW	36	No	No	No	-	-	-	15.00	49.00	-	-	-	-
61	IE_SH_27_193	Ballycar Lough	Clare	SH	27	Yes	No	No	-	-	-	2.67	28.30	-	-	-	-
62	IE_SE_16_463	Ballyshunnock	Waterford	SE	16	No	No	No	-	-	-	19.31	81.20	-	16.00	-	-
63	IE_SE_17_5	Belle Lake	Waterford	SE	17	No	No	No	-	-	-	26.53	34.70	-	12.50	-	-
64	IE_SH_24_90	Bleach Lough	Limerick	SH	24	Yes	No	No	-	-	-	17.89	6.50	-	-	-	-
65	IE_NB_06_209	Brackan (Lough)	Meath	NB	6	No	No	No	-	-	-	7.59	49.70	-	-	-	-
66	IE_SE_17_8	Carrigavantry Reservoir	Waterford	SE	17	No	No	No	-	-	-	11.93	70.70	-	-	-	-
67	IE_SH_28_82	Doo Lough	Clare	SH	28	No	No	No	-	-	-	130.43	86.40	-	-	-	-
68	IE_NW_36_448	Kill Lough	Cavan	NW	36	No	No	No	-	-	-	11.74	87.80	-	-	-	-
69	IE_EA_07_274	Lene	Westmeath	EA	7	Yes	No	Yes	-	-	-	416.25	92.00	-	-	-	-
70	IE_SH_28_85	Lickeen Lough	Clare	SH	28	No	No	No	-	-	-	84.24	67.60	-	-	-	-
71	IE_WE_35_188	Nacroagh (Lough)	Leitrim	WE	35	No	No	No	-	-	Inaccessible - no data recorded	0.41	291.80	-	-	-	-
72	IE_NW_38_668	Naglea (Lough)	Donegal	NW	38	No	No	No	-	-	-	7.13	78.30	-	-	-	-
73	IE_NW_36_430	Garty Lough	Cavan	NW	36	No	No	No	-	-	-	82.54	67.50	-	-	-	-
74	IE_NW_36_597	Mill Lough	Cavan	NW	36	No	No	No	-	-	-	12.15	56.80	-	-	-	-
75	IE_WE_30_341	Bekan Lough	Mayo	WE	30	Yes	No	No	-	-	-	20.89	108.00	-	-	-	-
76	IE_EA_07_268	Drumkeery Lough	Cavan	EA	7	No	No	No	-	-	-	13.03	139.00	-	-	-	-
77	IE_NW_36_346	Naback (Lough)	Longford	NW	36	No	No	No	-	-	-	11.85	128.60	-	-	-	-
78	IE_EA_07_267	Skeagh Lough Upper	Cavan	EA	7	No	Yes	Yes	-	-	WW southern end of lough	61.29	149.00	2.20	15.17	-	-
79	IE_SH_26_703	Owel (Lough)	Westmeath	SH	26	Yes	No	Yes	Good	Yes	-	1021.78	-	-	-	-	Islands

Table E-1: Stage 3 General Lake Data

				Typology		Hydrometrics					Other		
CDM Code	EU Code	Lake Name	County	Alkalinity	Lake Typology	Hydrometic gauge	Hydro. Respon.	Hydro. Code	Water level	WL Fluctuation Comment	Weir at outlet	Moorings	Other Comment
1	IE_WE_33_1892	Acorrymore (Lough)	Mayo	-	3	Data logger	EPA	33072	Low	Yes - cracked mud	Yes	No	Corrie lake
2	IE_EA_07_242	Acurry (Lough)	Cavan	-	-	No	-	-	-	-	-	-	-
3	IE_WE_31_211	Anaserd (Lough)	Galway	11.15	-	No	-	-	High	-	-	No	-
4	IE_NW_38_52	Anna (Lough)	Donegal	-	-	No	-	-	-	-	-	-	-
5	IE_EA_07_270	Bane (Lough)	Meath	132.53	-	Data logger	EPA	07072	-	Yes - Outflow dries up in summer (CFB). E	-	-	lake is fed by springs
6	IE_WE_32_269	Barnahallia Lough	Galway	-	-	No	-	-	-	-	-	-	confused with other lake
7	IE_SW_21_448	Bofinna (Lough)	Cork	-	1	No	-	-	-	-	-	-	-
8	IE_SW_22_182	Callee (Lough)	Kerry	-	4	No	-	-	-	-	-	-	-
9	IE_NW_36_460	Coragh Lough	Cavan	-	-	Data logger	EPA	36075	-	Annual fluctuation of about 0.8m	-	-	-
10	IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	-	13 or 3	No	-	-	-	-	-	-	-
11	IE_NW_37_210	Cullionboy Lough	Donegal	-	-	No	-	-	High	-	-	No	Bowl shape
12	IE_SW_21_369	Eirk Lough	Kerry	-	1	No	-	-	-	-	-	-	-
13	IE_WE_32_526	Fawna (Lough)	Galway	-	1	No	-	-	-	-	-	-	-
14	IE_NW_37_195	Glencoagh Lough	Donegal	-	-	No	-	-	High	-	Yes	No	Bowl shape
15	IE_NW_36_706	Gorman (Lough)	Donegal	-	-	No	-	-	High	-	-	No	-
16	IE_NW_39_44	Gort Lough	Donegal	-	-	No	-	-	-	-	-	-	-
17	IE_WE_34_458	Holan (Lough)	Mayo	-	11	No	-	-	-	-	-	-	-
18	IE_WE_35_237	Labe (Lough)	Sligo	-	11	No	-	-	Low	Was higher - moss on rock	-	No	~80% groundwater fed and 1 small stream
19	IE_WE_35_96	Lackagh Lough	Leitrim	-	-	No	-	-	-	-	-	-	-
20	IE_WE_31_120	Loughaunwillan	Galway	-	7	No	-	-	High	-	No	Yes	-
21	IE_WE_32_406	Moher Lough	Mayo	-	1	Data logger	EPA	07074	High	Annual fluctuation of about 0.2m	Yes	Yes	-
22	IE_NB_03_87	More (Lough)	Monaghan	-	-	No	-	-	-	-	-	-	-
23	IE_SW_22_58	Mount Eagle Lough	Kerry	-	1	No	-	-	-	-	-	-	-
24	IE_WE_32_422	Nambrackkeagh (Lough)	Galway	-	1	No	-	-	-	-	-	-	-
25	IE_NW_38_29	Nameeltoge (Lough)	Donegal	-	-	No	-	-	-	-	-	-	-
26	IE_SH_28_87	Naminna (Lough)	Clare	-	-	No	-	-	-	-	-	-	acid sensitive water
27	IE_NW_38_678	Shannagh (Lough)	Donegal	-	-	No	-	-	-	-	-	-	-
28	IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	-	5.5	No	-	-	-	-	-	-	-
29	IE_NW_37_208	St. Peter's Lough	Donegal	-	-	Staff gauge	Don. Co Co	37072	Low	High bank and exposed beach	-	No	-
30	IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	-	-	No	-	-	-	-	-	-	-
31	IE_SW_20_133	Tooreen Lough	Cork	-	5	No	-	-	-	-	-	-	-
32	IE_NW_36_712	Unshin (Lough)	Donegal	-	-	Staff gauge	Don. Co Co	36170	High	-	-	No	Depp lake not much shallows
33	IE_WE_30_532	Aille Lough	Mayo	-	5	No	-	-	High	-	No	Yes	boulders placed around edge
34	IE_SH_26_705	Cavetown Lough	Roscommon	149.00	-	No	-	-	Low	Signs it was higher	No	No	3 or 4 inflowing streams drain poor mrshland and are spring fed
35	IE_WE_31_1126	Illauntrasna (Lough)	Galway	-	1	No	-	-	High	Yes	No	No	-
36	IE_WE_31_177	Loughaunore	Galway	-	1	No	-	-	Mid	Yes	No	No	not much following out of outflow
37	IE_WE_34_405	Talt (Lough)	Sligo	73.00	8	Staff gauge	Sli. Co Co	34076	Low	Some beach	No	Yes	-
38	IE_NW_36_710	Columbkille Lough	Donegal	-	-	No	-	-	-	-	-	-	-
39	IE_SH_26_706	Grange Lough	Roscommon	-	-	No	-	-	-	-	-	-	-
40	IE_WE_35_17	Carrowlustia	Sligo	-	11	No	-	-	-	-	-	-	-
41	IE_EA_09_68	Glenasmole Reservoirs	Dublin	-	-	No	-	-	-	-	-	-	-
42	IE_EA_09_70	Glenasmole Reservoirs	Dublin	-	-	No	-	-	-	-	-	-	-
43	IE_NW_36_421	Annaghierin Lough	Cavan	-	-	No	-	-	-	-	-	-	-
44	IE_SW_20_150	Ballin Lough	Cork	-	5	No	-	-	-	-	-	-	-
45	IE_NW_36_635	Baraghy Lough	Monaghan	-	-	No	-	-	-	-	-	-	-
46	IE_NW_36_192	Corconnelly Lough	Monaghan	-	-	No	-	-	-	-	-	-	-
47	IE_NW_36_331	Cornalara Lough	Cavan	-	-	No	-	-	-	-	-	-	-
48	IE_NW_36_324	Cornaseer Lough	Cavan	-	-	No	-	-	-	-	-	-	-
49	IE_SW_22_199	Cummernamuck (Lake)	Kerry	-	3	No	-	-	-	-	-	-	-
50	IE_SH_27_122	Gortglass Lough	Clare	-	-	No	-	-	-	-	-	-	-
51	IE_NW_36_316	Graddum Lough	Cavan	-	-	No	-	-	-	-	-	-	-
52	IE_SH_28_64	Keagh (Lough)	Clare	-	-	No	-	-	-	-	-	-	-
53	IE_NW_36_329	Killcoran Lough	Monaghan	-	-	No	-	-	-	-	-	-	-
54	IE_NW_36_409	Killynenagh Lough	Cavan	-	-	No	-	-	-	-	-	-	-
55	IE_EA_07_273	Nadreegeal Loughs	Cavan	40.00	-	Data logger	EPA	07073	-	Annual fluctuation of about 0.8m	-	-	-
56	IE_NB_36_383	Nagarnaman (Lough)	Monaghan	-	-	No	-	-	-	-	-	-	-
57	IE_NW_36_420	Naglare (Lough)	Cavan	-	-	No	-	-	-	-	-	-	-
58	IE_NW_36_684	Namachree (Lough)	Monaghan	-	-	No	-	-	-	-	-	-	-
59	IE_NB_06_198	Spring Lough	Monaghan	-	-	No	-	-	-	Yes - dropped due to abstraction (SY)	-	-	-
60	IE_NW_36_618	Atrain (Lough)	Cavan	-	-	No	-	-	-	Yes - natural - drainage insufficient (SY)	-	-	-
61	IE_SH_27_193	Ballycar Lough	Clare	-	-	No	-	-	-	-	-	-	-
62	IE_SE_16_463	Ballyshunnock	Waterford	-	7	No	-	-	-	-	-	-	-
63	IE_SE_17_5	Belle Lake	Waterford	-	5	No	-	-	-	-	-	-	-
64	IE_SH_24_90	Bleach Lough	Limerick	-	-	No	-	-	-	-	-	-	-
65	IE_NB_06_209	Brackan (Lough)	Meath	-	-	No	-	-	-	-	-	-	-
66	IE_SE_17_8	Carrigavantry Reservoir	Waterford	-	-	No	-	-	-	-	-	-	-
67	IE_SH_28_82	Doo Lough	Clare	11.00	-	No	-	-	-	-	-	-	-
68	IE_NW_36_448	Kill Lough	Cavan	-	-	No	-	-	-	-	-	-	-
69	IE_EA_07_274	Lene	Westmeath	97.00	-	Data logger	EPA	07074	-	Annual fluctuation of about 0.5m	-	-	-
70	IE_SH_28_85	Lickeen Lough	Clare	21.00	-	No	-	-	-	-	-	-	-
71	IE_WE_35_188	Nacroagh (Lough)	Leitrim	-	-	No	-	-	-	-	-	-	-
72	IE_NW_38_668	Naglea (Lough)	Donegal	-	-	No	-	-	-	-	-	-	-
73	IE_NW_36_430	Garty Lough	Cavan	35.00	-	No	-	-	-	-	-	-	-
74	IE_NW_36_597	Mill Lough	Cavan	-	-	No	-	-	-	Yes - natural - drainage insufficient (SY)	-	-	-
75	IE_WE_30_341	Bekan Lough	Mayo	-	-	No	-	-	-	-	-	-	-
76	IE_EA_07_268	Drumkeery Lough	Cavan	-	-	No	-	-	-	-	-	-	-
77	IE_NW_36_346	Naback (Lough)	Longford	-	-	No	-	-	-	-	-	-	-
78	IE_EA_07_267	Skeagh Lough Upper	Cavan	20.00	-	Data logger	EPA	07071	-	Annual fluctuation of about 0.6m	-	-	no obvious streams
79	IE_SH_26_703	Owel (Lough)	Westmeath	-	-	Data logger	Westmeath Co Co	25072	-	Annual fluctuation of about 0.5m	-	Yes	-

Table E-2: Stage 3 Lakes Ecological Data

							Ecological Observations				
CDM Code	EU Code	Lake Name	County	RBD	GWD Lake	EPA Macrophyte data	Reed beds	Vegetation	Chara beds	Algae	Field Notes
1	IE_WE_33_1892	Acorrymore (Lough)	Mayo	WE	No	No	Absent	Sparse	-	-	-
2	IE_EA_07_242	Acurry (Lough)	Cavan	EA	No	Yes	-	-	-	-	-
3	IE_WE_31_211	Anaserd (Lough)	Galway	WE	No	Yes	Sparse	Common	Common	-	-
4	IE_NW_38_52	Anna (Lough)	Donegal	NW	No	No	-	-	-	-	-
5	IE_EA_07_270	Bane (Lough)	Meath	EA	Yes	Yes	Common	Common	Common	-	Common reed (Phagmites australis) dominates.
6	IE_WE_32_269	Barnahallia Lough	Galway	WE	No	No	Common	Common	-	-	-
7	IE_SW_21_448	Bofinna (Lough)	Cork	SW	Yes	No	-	-	-	-	-
8	IE_SW_22_182	Callee (Lough)	Kerry	SW	No	No	-	-	-	-	-
9	IE_NW_36_460	Coragh Lough	Cavan	NW	No	No	Common	Common	-	-	-
10	IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	SE	No	No	-	-	-	-	-
11	IE_NW_37_210	Cullionboy Lough	Donegal	NW	No	No	Sparse	Common	-	Absent	Rush common
12	IE_SW_21_369	Eirk Lough	Kerry	SW	No	No	-	-	-	-	-
13	IE_WE_32_526	Fawna (Lough)	Galway	WE	No	No	-	-	-	-	-
14	IE_NW_37_195	Glencoagh Lough	Donegal	NW	No	No	Sparse	Common	-	-	Rush, grasses, bull rush, freshwater mint
15	IE_NW_36_706	Gorman (Lough)	Donegal	NW	Yes	No	Abundant	Common	Absent	Absent	Common reed (Phagmites australis) dominates. Some Water lily present
16	IE_NW_39_44	Gort Lough	Donegal	NW	No	No	-	-	-	-	-
17	IE_WE_34_458	Holan (Lough)	Mayo	WE	Yes	No	Common	-	-	-	-
18	IE_WE_35_237	Labe (Lough)	Sligo	WE	Yes	No	Sparse	Common	Absent	-	Rush common
19	IE_WE_35_96	Lackagh Lough	Leitrim	WE	No	No	-	-	-	-	-
20	IE_WE_31_120	Loughaunwillan	Galway	WE	No	No	Sparse	Common	Sparse	Abundant	Bulrush and common reed
21	IE_WE_32_406	Moher Lough	Mayo	WE	No	Yes	Common	Common	Absent	Absent	Rushes, sedges, common reed
22	IE_NB_03_87	More (Lough)	Monaghan	NB	No	No	-	-	-	-	-
23	IE_SW_22_58	Mount Eagle Lough	Kerry	SW	No	No	-	-	-	-	-
24	IE_WE_32_422	Nambrackkeagh (Lough)	Galway	WE	No	Yes	-	-	-	-	-
25	IE_NW_38_29	Nameeltoge (Lough)	Donegal	NW	No	No	-	-	-	-	-
26	IE_SH_28_87	Naminna (Lough)	Clare	SH	No	Yes	-	-	-	-	-
27	IE_NW_38_678	Shannagh (Lough)	Donegal	NW	No	No	-	-	Common	-	-
28	IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	SW	No	Yes	-	-	-	-	-
29	IE_NW_37_208	St. Peter's Lough	Donegal	NW	No	No	-	Common	-	-	Rush common
30	IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	NW	No	No	-	-	-	-	-
31	IE_SW_20_133	Tooreen Lough	Cork	SW	No	No	-	-	-	-	-
32	IE_NW_36_712	Unshin (Lough)	Donegal	NW	No	No	Absent	Sparse	-	-	-
33	IE_WE_30_532	Aille Lough	Mayo	WE	No	No	Sparse	Sparse	Absent	Absent	Some pondweed
34	IE_SH_26_705	Cavetown Lough	Roscommon	SH	Yes	No	Common	Common	Common	-	Common reed dominant
35	IE_WE_31_1126	Illauntrasna (Lough)	Galway	WE	Yes	No	Common	Common	Sparse	Sparse	-
36	IE_WE_31_177	Loughaunore	Galway	WE	No	Yes	Sparse	Common	Absent	Sparse	Rush and water lily
37	IE_WE_34_405	Talt (Lough)	Sligo	WE	No	Yes	Sparse	Common	Common	-	Bottle sedge dominant

Table E-2: Stage 3 Lakes Ecological Data

CDM Code	EU Code	Lake Name	County	RBD	GWD Lake	EPA Macrophyte data	Reed beds	Vegetation	Chara beds	Algae	Field Notes
							Ecological Observations				
38	IE_NW_36_710	Columbkille Lough	Donegal	NW	No	No	-	-	-	-	-
39	IE_SH_26_706	Grange Lough	Roscommon	SH	Yes	No	-	-	-	-	-
40	IE_WE_35_17	Carrowlustia	Sligo	WE	No	No	-	-	-	-	-
41	IE_EA_09_68	Glenasmole Reservoirs	Dublin	EA	No	No	-	-	-	-	-
42	IE_EA_09_70	Glenasmole Reservoirs	Dublin	EA	No	No	-	-	-	-	-
43	IE_NW_36_421	Annaghierin Lough	Cavan	NW	No	No	-	-	-	-	-
44	IE_SW_20_150	Ballin Lough	Cork	SW	No	No	-	-	-	-	-
45	IE_NW_36_635	Baraghy Lough	Monaghan	NW	No	No	-	-	-	-	-
46	IE_NW_36_192	Corconnelly Lough	Monaghan	NW	No	No	-	-	-	-	-
47	IE_NW_36_331	Cornalara Lough	Cavan	NW	No	No	-	-	-	-	-
48	IE_NW_36_324	Cornaseer Lough	Cavan	NW	No	No	-	-	-	-	-
49	IE_SW_22_199	Cummernamuck (Lake)	Kerry	SW	No	No	-	-	-	-	-
50	IE_SH_27_122	Gortglass Lough	Clare	SH	No	No	-	-	-	-	-
51	IE_NW_36_316	Graddum Lough	Cavan	NW	No	No	-	-	-	-	-
52	IE_SH_28_64	Keagh (Lough)	Clare	SH	No	No	-	-	-	-	-
53	IE_NW_36_329	Killcoran Lough	Monaghan	NW	No	No	Common	Common	-	-	-
54	IE_NW_36_409	Killynenagh Lough	Cavan	NW	No	No	-	-	-	-	-
55	IE_EA_07_273	Nadreegeal Loughs	Cavan	EA	No	Yes	-	-	-	-	-
56	IE_NB_36_383	Nagarnaman (Lough)	Monaghan	NB	No	No	-	-	-	-	-
57	IE_NW_36_420	Naglare (Lough)	Cavan	NW	No	No	-	-	-	-	-
58	IE_NW_36_684	Namachree (Lough)	Monaghan	NW	No	No	-	-	-	-	-
59	IE_NB_06_198	Spring Lough	Monaghan	NB	Yes	No	Common	Common	Common	-	-
60	IE_NW_36_618	Atrain (Lough)	Cavan	NW	No	Yes	-	-	-	-	-
61	IE_SH_27_193	Ballycar Lough	Clare	SH	Yes	No	Common	Common	-	-	-
62	IE_SE_16_463	Ballyshunnock	Waterford	SE	No	No	-	-	-	-	-
63	IE_SE_17_5	Belle Lake	Waterford	SE	No	No	Common	Common	-	-	-
64	IE_SH_24_90	Bleach Lough	Limerick	SH	Yes	No	Common	Common	-	-	-
65	IE_NB_06_209	Brackan (Lough)	Meath	NB	No	No	-	-	-	-	-
66	IE_SE_17_8	Carrigavantry Reservoir	Waterford	SE	No	No	-	Common	-	-	-
67	IE_SH_28_82	Doo Lough	Clare	SH	No	Yes	-	-	-	-	-
68	IE_NW_36_448	Kill Lough	Cavan	NW	No	No	-	-	-	-	-
69	IE_EA_07_274	Lene	Westmeath	EA	Yes	Yes	-	-	-	-	-
70	IE_SH_28_85	Lickeen Lough	Clare	SH	No	Yes	-	-	-	-	-
71	IE_WE_35_188	Nacroagh (Lough)	Leitrim	WE	No	No	-	-	-	-	-
72	IE_NW_38_668	Naglea (Lough)	Donegal	NW	No	No	-	-	-	-	-
73	IE_NW_36_430	Garty Lough	Cavan	NW	No	Yes	-	-	-	-	-
74	IE_NW_36_597	Mill Lough	Cavan	NW	No	Yes	-	-	-	-	-
75	IE_WE_30_341	Bekan Lough	Mayo	WE	Yes	No	-	-	-	-	-
76	IE_EA_07_268	Drumkeery Lough	Cavan	EA	No	Yes	-	-	-	-	-
77	IE_NW_36_346	Naback (Lough)	Longford	NW	No	No	-	-	-	-	-
78	IE_EA_07_267	Skeagh Lough Upper	Cavan	EA	No	Yes	-	-	-	-	-
79	IE_SH_26_703	Owel (Lough)	Westmeath	SH	Yes	Yes	-	Common	Common	-	-

Table E-2: Stage 3 Lakes Ecological Data

				Fisheries										
CDM Code	EU Code	Lake Name	County	Fishery status	Angling status	Stocked	Angling boats	Angling controlled by	CFB Data	Species Richness	Species	Arctic Char	Arctic Char - Last record	Arctic Char Status
1	IE_WE_33_1892	Acorrymore (Lough)	Mayo	Brown trout	Fair	No	No	No	No	-	-	No	-	-
2	IE_EA_07_242	Acurry (Lough)	Cavan	Brown trout	-	Yes	-	Laragh Angling	No	-	-	No	-	-
3	IE_WE_31_211	Anaserd (Lough)	Galway	Brown trout	-	Yes	-	Clifden Angling	No	-	-	No	-	-
4	IE_NW_38_52	Anna (Lough)	Donegal	Brown trout	-	-	-	-	No	-	-	No	-	-
5	IE_EA_07_270	Bane (Lough)	Meath	Brown trout	Good	Yes	-	ERFB	Yes	5	Perch most common	No	-	-
6	IE_WE_32_269	Barnahallia Lough	Galway	-	-	-	-	-	No	-	-	No	-	-
7	IE_SW_21_448	Bofinna (Lough)	Cork	-	-	-	-	-	No	-	-	No	-	-
8	IE_SW_22_182	Callee (Lough)	Kerry	-	-	-	-	-	No	-	-	No	-	-
9	IE_NW_36_460	Coragh Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
10	IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	-	-	-	-	-	No	-	-	No	-	-
11	IE_NW_37_210	Cullionboy Lough	Donegal	-	-	-	-	-	No	-	-	No	-	-
12	IE_SW_21_369	Eirk Lough	Kerry	-	-	-	-	-	No	-	-	No	-	-
13	IE_WE_32_526	Fawna (Lough)	Galway	-	-	-	-	-	No	-	-	No	-	-
14	IE_NW_37_195	Glencoagh Lough	Donegal	-	-	-	-	-	No	-	-	No	-	-
15	IE_NW_36_706	Gorman (Lough)	Donegal	-	-	No	No	-	No	-	-	No	-	-
16	IE_NW_39_44	Gort Lough	Donegal	-	-	-	-	-	No	-	-	No	-	-
17	IE_WE_34_458	Holan (Lough)	Mayo	Brown trout	Poor	No	No	No	No	-	-	No	-	-
18	IE_WE_35_237	Labe (Lough)	Sligo	Rainbow trout	Fair	With rainbows in the past	No	No	No	-	-	No	-	-
19	IE_WE_35_96	Lackagh Lough	Leitrim	-	-	-	-	-	No	-	-	No	-	-
20	IE_WE_31_120	Loughaunwillan	Galway	Trout	Poor	No	No	-	No	-	-	No	-	-
21	IE_WE_32_406	Moher Lough	Mayo	Trout	Good	Yes	9	WRFB	No	-	-	No	-	-
22	IE_NB_03_87	More (Lough)	Monaghan	Trout	-	Yes	-	-	No	-	-	No	-	-
23	IE_SW_22_58	Mount Eagle Lough	Kerry	-	-	-	-	-	No	-	-	No	-	-
24	IE_WE_32_422	Nambrackkeagh (Lough)	Galway	-	-	-	-	-	No	-	-	No	-	-
25	IE_NW_38_29	Nameeltoge (Lough)	Donegal	-	-	-	-	-	No	-	-	No	-	-
26	IE_SH_28_87	Naminna (Lough)	Clare	Trout	-	-	-	-	No	-	-	No	-	-
27	IE_NW_38_678	Shannagh (Lough)	Donegal	-	-	-	-	-	No	-	-	No	-	-
28	IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	-	-	-	-	-	No	-	-	No	-	-
29	IE_NW_37_208	St. Peter's Lough	Donegal	-	-	-	-	-	No	-	-	No	-	-
30	IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	-	-	-	-	-	No	-	-	No	-	-
31	IE_SW_20_133	Tooreen Lough	Cork	-	-	-	-	-	No	-	-	No	-	-
32	IE_NW_36_712	Unshin (Lough)	Donegal	Trout	-	-	-	-	No	-	-	No	-	-
33	IE_WE_30_532	Aille Lough	Mayo	Trout	Good	No	2	WRFB	No	-	-	No	-	-
34	IE_SH_26_705	Cavetown Lough	Roscommon	Brown trout	Good	-	-	-	Yes	5	Roach most comon/ n	No	-	-
35	IE_WE_31_1126	Illauntrasna (Lough)	Galway	Trout	Poor	No	No	-	No	-	-	No	-	-
36	IE_WE_31_177	Loughaunore	Galway	-	Poor	No	No	-	No	-	-	No	-	-
37	IE_WE_34_405	Talt (Lough)	Sligo	Brown trout	Good	-	-	-	Yes	5	Brown trout most com	Yes	1997	Healthy

Table E-2: Stage 3 Lakes Ecological Data

				Fisheries										
CDM Code	**EU Code**	**Lake Name**	**County**	**Fishery status**	**Angling status**	**Stocked**	**Angling boats**	**Angling controlled by**	**CFB Data**	**Species Richness**	**Species**	**Arctic Char**	**Arctic Char - Last record**	**Arctic Char Status**
38	IE_NW_36_710	Columbkille Lough	Donegal	-	-	-	-	-	No	-	-	No	-	-
39	IE_SH_26_706	Grange Lough	Roscommon	-	-	-	-	-	No	-	-	No	-	-
40	IE_WE_35_17	Carrowlustia	Sligo	-	-	-	-	-	No	-	-	No	-	-
41	IE_EA_09_68	Glenasmole Reservoirs	Dublin	-	-	-	-	-	No	-	-	No	-	-
42	IE_EA_09_70	Glenasmole Reservoirs	Dublin	-	-	-	-	-	No	-	-	No	-	-
43	IE_NW_36_421	Annaghierin Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
44	IE_SW_20_150	Ballin Lough	Cork	Rainbow trout	Excellent	Yes	Yes	NWRFB	No	-	-	No	-	-
45	IE_NW_36_635	Baraghy Lough	Monaghan	-	-	-	-	-	No	-	-	No	-	-
46	IE_NW_36_192	Corconnelly Lough	Monaghan	-	-	-	-	-	No	-	-	No	-	-
47	IE_NW_36_331	Cornalara Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
48	IE_NW_36_324	Cornaseer Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
49	IE_SW_22_199	Cummernamuck (Lake)	Kerry	-	-	-	-	-	No	-	-	No	-	-
50	IE_SH_27_122	Gortglass Lough	Clare	-	-	-	-	-	No	-	-	Yes	1982	Extinct
51	IE_NW_36_316	Graddum Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
52	IE_SH_28_64	Keagh (Lough)	Clare	-	-	-	-	-	No	-	-	No	-	-
53	IE_NW_36_329	Killcoran Lough	Monaghan	-	-	-	-	-	No	-	-	No	-	-
54	IE_NW_36_409	Killynenagh Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
55	IE_EA_07_273	Nadreegeal Loughs	Cavan	-	-	-	-	-	No	-	-	No	-	-
56	IE_NB_36_383	Nagarnaman (Lough)	Monaghan	-	-	-	-	-	No	-	-	No	-	-
57	IE_NW_36_420	Naglare (Lough)	Cavan	-	-	-	-	-	No	-	-	No	-	-
58	IE_NW_36_684	Namachree (Lough)	Monaghan	-	-	-	-	-	No	-	-	No	-	-
59	IE_NB_06_198	Spring Lough	Monaghan	-	-	-	-	-	No	-	-	No	-	-
60	IE_NW_36_618	Atrain (Lough)	Cavan	-	-	-	-	-	No	-	-	No	-	-
61	IE_SH_27_193	Ballycar Lough	Clare	-	-	-	-	-	No	-	-	No	-	-
62	IE_SE_16_463	Ballyshunnock	Waterford	-	-	-	-	-	No	-	-	No	-	-
63	IE_SE_17_5	Belle Lake	Waterford	-	-	-	-	-	No	-	-	No	-	-
64	IE_SH_24_90	Bleach Lough	Limerick	-	Good	-	-	-	No	-	-	No	-	-
65	IE_NB_06_209	Brackan (Lough)	Meath	-	-	-	-	-	No	-	-	No	-	-
66	IE_SE_17_8	Carrigavantry Reservoir	Waterford	-	-	-	-	-	No	-	-	No	-	-
67	IE_SH_28_82	Doo Lough	Clare	-	-	-	-	-	No	-	-	No	-	-
68	IE_NW_36_448	Kill Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
69	IE_EA_07_274	Lene	Westmeath	-	-	-	-	-	Yes	6	Perch most comon	No	-	-
70	IE_SH_28_85	Lickeen Lough	Clare	-	-	-	-	-	No	-	-	Yes	1964	Extinct
71	IE_WE_35_188	Nacroagh (Lough)	Leitrim	-	-	-	-	-	No	-	-	No	-	-
72	IE_NW_38_668	Naglea (Lough)	Donegal	-	-	-	-	-	No	-	-	No	-	-
73	IE_NW_36_430	Garty Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
74	IE_NW_36_597	Mill Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
75	IE_WE_30_341	Bekan Lough	Mayo	-	-	-	-	-	No	-	-	No	-	-
76	IE_EA_07_268	Drumkeery Lough	Cavan	-	-	-	-	-	No	-	-	No	-	-
77	IE_NW_36_346	Naback (Lough)	Longford	-	-	-	-	-	No	-	-	Yes	1977	Extinct
78	IE_EA_07_267	Skeagh Lough Upper	Cavan	-	-	-	-	-	No	-	-	No	-	-
79	IE_SH_26_703	Owel (Lough)	Westmeath	Brown trout	Good	Yes	Yes	SHRFB	Yes	8	Perch most common	Yes	1886, 1995	Extinct and reintroduced

Table E-2: Stage 3 Lakes Ecological Data

				Protected Area								
CDM Code	EU Code	Lake Name	County	SAC	NHA	SPA	GWDTE	Protected Area Name	Site Code	Info. Available	Habitats - relevant to lakes	Other Notes
1	IE_WE_33_1892	Acorrymore (Lough)	Mayo	Y	Y			Croaghaun/Slievemore	001955	Site Synopsis	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	-
2	IE_EA_07_242	Acurry (Lough)	Cavan					-	-	-	-	-
3	IE_WE_31_211	Anaserd (Lough)	Galway	Y	Y			Slyne Head Peninsula	002074	Site Synopsis	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	Slender Naiad. Quillwort, bulbous rush, pipewort, alternate water-milfoil, awlwort
4	IE_NW_38_52	Anna (Lough)	Donegal	Y	Y	Y		Lough Nillan Bog (Carrickatlieve)	000165	Site Synopsis	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	Bog
5	IE_EA_07_270	Bane (Lough)	Meath	Y				Lough Bane And Lough Glass	002120	Site Synopsis	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	Also fen vegetation
6	IE_WE_32_269	Barnahallia Lough	Galway	Y				Barnahallia Lough	002118	Site Synopsis	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	Shoreweed, water lobelia, water milfoil, bulbous rush, pipewor, white water lily and pondweedsRenswamp/ fen. Slender naiad
7	IE_SW_21_448	Bofinna (Lough)	Cork					-	-	-	-	-
8	IE_SW_22_182	Callee (Lough)	Kerry	Y	Y			Killarney National Park, Macgillycuddy'S Reeks And Caragh River Catchment	000365	Site Synopsis	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	Species poor
9	IE_NW_36_460	Coragh Lough	Cavan		Y			Dromore Lakes	000001	Site Synopsis	Interdrumlin lakes - Water fowl	Some swamp and marsh, wet grassland and recovering felled plantation
10	IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	Y	Y			Comeragh Mountains	001952	Site Synopsis	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	-
11	IE_NW_37_210	Cullionboy Lough	Donegal					-	-	-	-	-
12	IE_SW_21_369	Eirk Lough	Kerry	Y	Y			Killarney National Park, Macgillycuddy'S Reeks And Caragh River Catchment	000365	Site Synopsis	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	-
13	IE_WE_32_526	Fawna (Lough)	Galway	Y	Y			Inishbofin And Inishshark	000278	Site Synopsis	Coastal	-
14	IE_NW_37_195	Glencoagh Lough	Donegal					-	-	-	-	-
15	IE_NW_36_706	Gorman (Lough)	Donegal		Y			Carricknahorna Lough And Lough Gorman	002068	Site Synopsis	Marl Lakes and fen	Fen veg. black bog-rush and variegated horsetail
16	IE_NW_39_44	Gort Lough	Donegal					-	-	-	-	-
17	IE_WE_34_458	Holan (Lough)	Mayo					-	-	-	-	-
18	IE_WE_35_237	Labe (Lough)	Sligo	Y	Y			Bricklieve Mountains & Keishcorran	001656	Management Plan	Mountains and grassland	Naturally spawning rainbow trout. Crayfish
19	IE_WE_35_96	Lackagh Lough	Leitrim	Y				Boleybrack Mountain	002032	Site Synopsis	Natural dystrophic lakes and ponds	-
20	IE_WE_31_120	Loughaunwillan	Galway	-	-	-		-	-	-	-	-
21	IE_WE_32_406	Moher Lough	Mayo					-	-	-	-	-
22	IE_NB_03_87	More (Lough)	Monaghan					-	-	-	-	-
23	IE_SW_22_58	Mount Eagle Lough	Kerry					-	-	-	-	-
24	IE_WE_32_422	Nambrackkeagh (Lough)	Galway	-	-	-		-	-	-	-	-
25	IE_NW_38_29	Nameeltoge (Lough)	Donegal					-	-	-	-	-
26	IE_SH_28_87	Naminna (Lough)	Clare		Y			Lough Naminna Bog NHA	002367	Site Synopsis	Blanket bog	Otter
27	IE_NW_38_678	Shannagh (Lough)	Donegal	Y	Y			Ballyhoorisky Point To Fanad Head	001975	Management Plan	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	Nutrient poor lake. Slender Naiad
28	IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork					-	-	-	-	-
29	IE_NW_37_208	St. Peter's Lough	Donegal					-	-	-	-	-
30	IE_NW_36_382	Toome Or Crinkill Lough	Monaghan					-	-	-	-	-
31	IE_SW_20_133	Tooreen Lough	Cork	Y	Y			Barley Cove To Ballyrisode Point	001040	Site Synopsis	Coastal	-
32	IE_NW_36_712	Unshin (Lough)	Donegal	Y				Lough Golagh And Breesy Hill	002164	Management Plan	Blanket bog (*active only)	lack of fringing vegetation
33	IE_WE_30_532	Aille Lough	Mayo					-	-	-	-	-
34	IE_SH_26_705	Cavetown Lough	Roscommon					-	-	-	-	-
35	IE_WE_31_1126	Illauntrasna (Lough)	Galway	-	-	-		-	-	-	-	-
36	IE_WE_31_177	Loughaunore	Galway	-	-	-		-	-	-	-	-
37	IE_WE_34_405	Talt (Lough)	Sligo	Y	Y			Lough Hoe Bog	000633	Management Plan	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	Bottle sedge, water lobelia, bog pondweed, and rushes. Vertigo geyeri. Crayfish

Table E-2: Stage 3 Lakes Ecological Data

				Protected Area								
CDM Code	EU Code	Lake Name	County	SAC	NHA	SPA	GWDTE	Protected Area Name	Site Code	Info. Available	Habitats - relevant to lakes	Other Notes
38	IE_NW_36_710	Columbkille Lough	Donegal					-	-	-	-	-
39	IE_SH_26_706	Grange Lough	Roscommon					-	-	-	-	-
40	IE_WE_35_17	Carrowlustia	Sligo					-	-	-	-	-
41	IE_EA_09_68	Glenasmole Reservoirs	Dublin	Y	Y		Y	Glenasmole Valley	001209	Site Synopsis	Petrifying springs with tufa formation (Cratoneurion)	-
42	IE_EA_09_70	Glenasmole Reservoirs	Dublin	Y	Y			Glenasmole Valley	001209	Site Synopsis		-
43	IE_NW_36_421	Annaghierin Lough	Cavan					-	-	-	-	-
44	IE_SW_20_150	Ballin Lough	Cork					-	-	-	-	-
45	IE_NW_36_635	Baraghy Lough	Monaghan					-	-	-	-	-
46	IE_NW_36_192	Corconnelly Lough	Monaghan					-	-	-	-	-
47	IE_NW_36_331	Cornalara Lough	Cavan					-	-	-	-	-
48	IE_NW_36_324	Cornaseer Lough	Cavan					-	-	-	-	-
49	IE_SW_22_199	Cummernamuck (Lake)	Kerry	Y	Y			Killarney National Park, Macgillycuddy'S Reeks And Caragh River Catchment	000365	Site Synopsis	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	-
50	IE_SH_27_122	Gortglass Lough	Clare		Y			Gortglass Lough	001015	Site Synopsis	Acid lake with arctic char	Stoney bottom which grows quillwort etc.
51	IE_NW_36_316	Graddum Lough	Cavan					-	-	-	-	-
52	IE_SH_28_64	Keagh (Lough)	Clare					-	-	-	-	-
53	IE_NW_36_329	Killcoran Lough	Monaghan		Y			Kilcorran Lough	001838	Site Synopsis	Marl lake	Potamogeton and well developed swamps
54	IE_NW_36_409	Killynenagh Lough	Cavan					-	-	-	-	-
55	IE_EA_07_273	Nadreegeal Loughs	Cavan					-	-	-	-	-
56	IE_NB_36_383	Nagarnaman (Lough)	Monaghan					-	-	-	-	-
57	IE_NW_36_420	Naglare (Lough)	Cavan					-	-	-	-	-
58	IE_NW_36_684	Namachree (Lough)	Monaghan					-	-	-	-	-
59	IE_NB_06_198	Spring Lough	Monaghan		Y			Spring And Corcrin Loughs	001671	Site Synopsis	Small calcareous lake	Narrow shelf of calcareous mud - stonewort.
60	IE_NW_36_618	Atrain (Lough)	Cavan	Y	Y	Y		Lough Oughter And Associated Loughs	000007	Site Synopsis	Natural euthrophic lakes with Magnopotamion or Hydrocharition-type vegetation	Variety of fringing vegetation
61	IE_SH_27_193	Ballycar Lough	Clare		Y			Ballycar Lough	000015	Site Synopsis	Small calcareous lake	Bog vegetation invading fen
62	IE_SE_16_463	Ballyshunnock	Waterford					-	-	-	-	-
63	IE_SE_17_5	Belle Lake	Waterford		Y			Belle Lake	000659	Site Synopsis	Lake in south east	2 rare species - quillwort and waterwort. 4 species of Potamogeton. Ash and oak woodland
64	IE_SH_24_90	Bleach Lough	Limerick		Y			Dromore & Bleach Loughs	001030	Site Synopsis	Low lying lakes and fen	Common reed & great fen sedge. Lakes fed by drains running through the fen.
65	IE_NB_06_209	Brackan (Lough)	Meath					-	-	-	-	-
66	IE_SE_17_8	Carrigavantry Reservoir	Waterford		Y			Carrickavrantry Reservoir	000660	Site Synopsis	Lake	Interesting collection of frindging plants
67	IE_SH_28_82	Doo Lough	Clare					-	-	-	-	-
68	IE_NW_36_448	Kill Lough	Cavan					-	-	-	-	-
69	IE_EA_07_274	Lene	Westmeath	Y				Lough Lene	002121	Site Synopsis	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	Pondweeds and stoneworts and rushes
70	IE_SH_28_85	Lickeen Lough	Clare					-	-	-	-	-
71	IE_WE_35_188	Nacroagh (Lough)	Leitrim					-	-	-	-	-
72	IE_NW_38_668	Naglea (Lough)	Donegal					-	-	-	-	-
73	IE_NW_36_430	Garty Lough	Cavan					-	-	-	-	-
74	IE_NW_36_597	Mill Lough	Cavan	Y	Y			Lough Oughter And Associated Loughs	000007	Site Synopsis	Natural euthrophic lakes with Magnopotamion or Hydrocharition-type vegetation	Variety of fringing vegetation
75	IE_WE_30_341	Bekan Lough	Mayo					-	-	-	-	-
76	IE_EA_07_268	Drumkeery Lough	Cavan					-	-	-	-	-
77	IE_NW_36_346	Naback (Lough)	Longford		Y			Lough Naback	001449	Site Synopsis	Oligotrophic lake	Arctic char
78	IE_EA_07_267	Skeagh Lough Upper	Cavan					-	-	-	-	-
79	IE_SH_26_703	Owel (Lough)	Westmeath	Y	Y	Y	Y	Lough Owel	000688	Site Synopsis	Hard oligo-mesotrophic waters with *Chara* spp.	Arctic char/ Alkaline fen & transition mire

Table E-3: Stage 3 Lakes Environmental Setting and Pressures Data

					Environmental Setting		
CDM Code	EU Code	Lake Name	County	RBD	Physiographic Region	Rock Type	Soil Type
1	IE_WE_33_1892	Acorrymore (Lough)	Mayo	WE	Coastal	Precambrian Quartzites, Gneisses & Schists	Wet Soils
2	IE_EA_07_242	Acurry (Lough)	Cavan	EA	Central	Silurian Metasediments and Volcanics	Wet Soils
3	IE_WE_31_211	Anaserd (Lough)	Galway	WE	Coastal	Granites & other Igneous Intrusive rocks	Wet Soils
4	IE_NW_38_52	Anna (Lough)	Donegal	NW	Coastal	Precambrian Quartzites, Gneisses & Schists	Peat Soils
5	IE_EA_07_270	Bane (Lough)	Meath	EA	Central	Dinantian Upper Impure Limestones	Dry Soils
6	IE_WE_32_269	Barnahallia Lough	Galway	WE	Coastal	Precambrian Quartzites, Gneisses & Schists	Wet Soils
7	IE_SW_21_448	Bofinna (Lough)	Cork	SW	Coastal	Devonian Old Red Sandstones	Dry Soils
8	IE_SW_22_182	Callee (Lough)	Kerry	SW	Coastal	Devonian Old Red Sandstones	Wet/ Peat Soils
9	IE_NW_36_460	Coragh Lough	Cavan	NW	Drumlin	Silurian Metasediments and Volcanics	Wet Soils
10	IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	SE	Central	Devonian Old Red Sandstones	Wet Soils
11	IE_NW_37_210	Cullionboy Lough	Donegal	NW	Coastal	Precambrian Quartzites, Gneisses & Schists	Wet/ Peat Soils
12	IE_SW_21_369	Eirk Lough	Kerry	SW	Coastal	Devonian Old Red Sandstones	Wet/ Peat Soils
13	IE_WE_32_526	Fawna (Lough)	Galway	WE	Coastal	Granites & other Igneous Intrusive rocks	Wet Soils
14	IE_NW_37_195	Glencoagh Lough	Donegal	NW	Coastal	Dinantian Sandstones	Wet/ Peat Soils
15	IE_NW_36_706	Gorman (Lough)	Donegal	NW	Coastal	Dinantian Pure Bedded Limestones	Peat Soils
16	IE_NW_39_44	Gort Lough	Donegal	NW	Coastal	Precambrian Quartzites, Gneisses & Schists	Wet/ Peat Soils
17	IE_WE_34_458	Holan (Lough)	Mayo	WE	Karst	Dinantian Pure Bedded Limestones	Peat Soils
18	IE_WE_35_237	Labe (Lough)	Sligo	WE	Karst	Dinantian Pure Bedded Limestones	Peat/ Dry Soils
19	IE_WE_35_96	Lackagh Lough	Leitrim	WE	Karst	Namurian Sandstones	Peat Soils
20	IE_WE_31_120	Loughaunwillan	Galway	WE	Coastal	Granites & other Igneous Intrusive rocks	Dry Soils
21	IE_WE_32_406	Moher Lough	Mayo	WE	Coastal	Ordovician Metasediments	Peat Soils
22	IE_NB_03_87	More (Lough)	Monaghan	NB	Drumlin	Dinantian Mixed Sandstones, Shales and Limestones	Wet Soils
23	IE_SW_22_58	Mount Eagle Lough	Kerry	SW	Coastal	Devonian Old Red Sandstones	Wet Soils
24	IE_WE_32_422	Nambrackkeagh (Lough)	Galway	WE	Coastal	Precambrian Quartzites, Gneisses & Schists	Peat Soils
25	IE_NW_38_29	Nameeltoge (Lough)	Donegal	NW	Coastal	Precambrian Quartzites, Gneisses & Schists	Wet/ Peat Soils
26	IE_SH_28_87	Naminna (Lough)	Clare	SH	Coastal	Namurian Undifferentiated	Peat Soils
27	IE_NW_38_678	Shannagh (Lough)	Donegal	NW	Coastal	Precambrian Quartzites, Gneisses & Schists	Wet Soils
28	IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	SW	Coastal	Devonian Old Red Sandstones	Wet Soils
29	IE_NW_37_208	St. Peter's Lough	Donegal	NW	Coastal	Dinantian Sandstones	Wet/ Peat Soils
30	IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	NW	Drumlin	Silurian Metasediments and Volcanics	Wet/ Dry/ Peat Soils
31	IE_SW_20_133	Tooreen Lough	Cork	SW	Coastal	Devonian Old Red Sandstones	Wet Soils
32	IE_NW_36_712	Unshin (Lough)	Donegal	NW	Coastal	Precambrian Quartzites, Gneisses & Schists	Peat Soils
33	IE_WE_30_532	Aille Lough	Mayo	WE	Karst	Dinantian Sandstones	Peat/ Wet Soils
34	IE_SH_26_705	Cavetown Lough	Roscommon	SH	Karst	Dinantian Pure Bedded Limestones	Wet/ Dry/ Peat Soils
35	IE_WE_31_1126	Illauntrasna (Lough)	Galway	WE	Coastal	Granites & other Igneous Intrusive rocks	Peat/ Wet Soils
36	IE_WE_31_177	Loughaunore	Galway	WE	Coastal	Granites & other Igneous Intrusive rocks	Peat Soils
37	IE_WE_34_405	Talt (Lough)	Sligo	WE	Karst	Precambrian Quartzites, Gneisses & Schists	Dry Soils

Table E-3: Stage 3 Lakes Environmental Setting and Pressures Data

				Pressures				
CDM Code	EU Code	Lake Name	County	Catchment Landuse	Pasture Intensitivity at shore	Forestry Details	Housing	Main environmental threats
1	IE_WE_33_1892	Acorrymore (Lough)	Mayo	Bog	None	None	No	Sheep grazing
2	IE_EA_07_242	Acurry (Lough)	Cavan	Pasture	High/ Low	None	Yes	-
3	IE_WE_31_211	Anaserd (Lough)	Galway	Scrub	None	None	Yes	Housing
4	IE_NW_38_52	Anna (Lough)	Donegal	Bog/ Pasture	None	Conifer	No	-
5	IE_EA_07_270	Bane (Lough)	Meath	Pasture	High/ Low	None	Yes	Pasture
6	IE_WE_32_269	Barnahallia Lough	Galway	Bog/ Pasture	None	None	No	Agriculture
7	IE_SW_21_448	Bofinna (Lough)	Cork	Bog/ Pasture	High	None	Yes	Pasture
8	IE_SW_22_182	Callee (Lough)	Kerry	Scrub	None	None	No	-
9	IE_NW_36_460	Coragh Lough	Cavan	Forestry/ Pasture	Low	Bellamont forest	No	-
10	IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	Bog	None	None	No	-
11	IE_NW_37_210	Cullionboy Lough	Donegal	Other ag.	None	None	Yes	Pasture - cattle and sheep. Housing
12	IE_SW_21_369	Eirk Lough	Kerry	Bog/ Natural grassland	None	None	No	-
13	IE_WE_32_526	Fawna (Lough)	Galway	Arable	None	None	No	-
14	IE_NW_37_195	Glencoagh Lough	Donegal	Pasture/ Bog/ Arable	Low	None	Yes	2 Houses near shore/ Rough pasture, cattle and sheep
15	IE_NW_36_706	Gorman (Lough)	Donegal	Other ag.	None	None	Yes	Sheep grazing, 2 houses
16	IE_NW_39_44	Gort Lough	Donegal	Bog	Low	None	Yes	-
17	IE_WE_34_458	Holan (Lough)	Mayo	Pasture/ Other ag.	High	None	Yes	Pasture
18	IE_WE_35_237	Labe (Lough)	Sligo	Natural grassland	Low	None	No	Agriculture
19	IE_WE_35_96	Lackagh Lough	Leitrim	Bog	None	None	No	-
20	IE_WE_31_120	Loughaunwillan	Galway	Pasture/ Other ag.	High	None	Yes	Housing and road
21	IE_WE_32_406	Moher Lough	Mayo	Other ag./ Forestry/ Bog	None	Mixed	Yes	Pasture, Housing, Forestry and Vehicle access
22	IE_NB_03_87	More (Lough)	Monaghan	Bog/ Other ag./ Pasture	None	Conifer	?	-
23	IE_SW_22_58	Mount Eagle Lough	Kerry	Natural grassland/ Bog	None	None	No	-
24	IE_WE_32_422	Nambrackkeagh (Lough)	Galway	Bog	None	None	No	-
25	IE_NW_38_29	Nameeltoge (Lough)	Donegal	Bog	None	None	No	-
26	IE_SH_28_87	Naminna (Lough)	Clare	Forestry/ Bog/ Grassland	None	Conifer	No	Forestry
27	IE_NW_38_678	Shannagh (Lough)	Donegal	Pasture	Low	None	Yes	-
28	IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	Bog	None	None	No	-
29	IE_NW_37_208	St. Peter's Lough	Donegal	Pasture/ Arable	Low	None	No	Rough pasture
30	IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	Other ag.	Low	Broadleaf	Yes	-
31	IE_SW_20_133	Tooreen Lough	Cork	Scrub/ Bog/ Pasture	High	None	No	-
32	IE_NW_36_712	Unshin (Lough)	Donegal	Scrub/ Forestry/ Bog	High	Conifer	No	Rough pasture
33	IE_WE_30_532	Aille Lough	Mayo	Bog/ Forestry	None	None	No	Pasture
34	IE_SH_26_705	Cavetown Lough	Roscommon	Pasture/ Bog/ Forestry	High	Mixed	Yes	Pasture, forestry, amenity, housing
35	IE_WE_31_1126	Illauntrasna (Lough)	Galway	Bog	None	None	Yes	Housing
36	IE_WE_31_177	Loughaunore	Galway	Bog	None	None	No	Grazing, turf cutting
37	IE_WE_34_405	Talt (Lough)	Sligo	Pasture/ Bog Woodland	Low	None	Yes	Road and housing

Appendix F
Revised Risk Assessment Results

EU Code	Lake Name	County	RBD	Initial Risk	Revised Risk
IE_EA_07_242	Acurry (Lough)	Cavan	ERBD	1a	1a
IE_EA_07_273	Nadreegeal Loughs	Cavan	ERBD	1a	1a
IE_EA_07_268	Drumkeery Lough	Cavan	ERBD	1a	1a
IE_EA_07_267	Skeagh Lough Upper	Cavan	ERBD	1a	1a
IE_EA_09_68	Glenasmole Reservoirs	Dublin	ERBD	1a	1a
IE_EA_09_70	Glenasmole Reservoirs	Dublin	ERBD	1a	1a
IE_EA_07_270	Bane (Lough)	Meath	ERBD	1a	1a
IE_EA_07_274	Lene	Westmeath	ERBD	1a	1a
IE_NB_06_209	Brackan (Lough)	Meath	NBRBD	1a	1a
IE_NB_03_87	More (Lough)	Monaghan	NBRBD	1a	1a
IE_NB_36_383	Nagarnaman (Lough)	Monaghan	NBRBD	1a	1a
IE_NB_06_198	Spring Lough	Monaghan	NBRBD	1a	1a
IE_NW_36_460	Coragh Lough	Cavan	NWRBD	1a	1a
IE_NW_36_421	Annaghierin Lough	Cavan	NWRBD	1a	1a
IE_NW_36_331	Cornalara Lough	Cavan	NWRBD	1a	1a
IE_NW_36_324	Cornaseer Lough	Cavan	NWRBD	1a	1a
IE_NW_36_316	Graddum Lough	Cavan	NWRBD	1a	1a
IE_NW_36_409	Killynenagh Lough	Cavan	NWRBD	1a	1a
IE_NW_36_420	Naglare (Lough)	Cavan	NWRBD	1a	1a
IE_NW_36_618	Atrain (Lough)	Cavan	NWRBD	1a	1a
IE_NW_36_448	Kill Lough	Cavan	NWRBD	1a	1a
IE_NW_36_430	Garty Lough	Cavan	NWRBD	1a	1a
IE_NW_36_597	Mill Lough	Cavan	NWRBD	1a	1a
IE_NW_38_52	Anna (Lough)	Donegal	NWRBD	1a	1a
IE_NW_37_210	Cullionboy Lough	Donegal	NWRBD	1a	1a
IE_NW_37_195	Glencoagh Lough	Donegal	NWRBD	1a	1a
IE_NW_36_706	Gorman (Lough)	Donegal	NWRBD	1a	1a
IE_NW_39_44	Gort Lough	Donegal	NWRBD	1a	1a
IE_NW_38_29	Nameeltoge (Lough)	Donegal	NWRBD	1a	1a
IE_NW_38_678	Shannagh (Lough)	Donegal	NWRBD	1a	1a
IE_NW_37_208	St. Peter's Lough	Donegal	NWRBD	1a	1a
IE_NW_36_712	Unshin (Lough)	Donegal	NWRBD	1a	1a
IE_NW_36_710	Columbkille Lough	Donegal	NWRBD	1a	1a
IE_NW_38_668	Naglea (Lough)	Donegal	NWRBD	1a	1a
IE_NW_36_346	Naback (Lough)	Longford	NWRBD	1a	1a
IE_NW_36_382	Toome Or Crinkill Lough	Monaghan	NWRBD	1a	1a
IE_NW_36_635	Baraghy Lough	Monaghan	NWRBD	1a	1a
IE_NW_36_192	Corconnelly Lough	Monaghan	NWRBD	1a	1a
IE_NW_36_329	Killcoran Lough	Monaghan	NWRBD	1a	1a
IE_NW_36_684	Namachree (Lough)	Monaghan	NWRBD	1a	1a
IE_SE_16_314	Crotty's Lough or Coumgaurha (Lough)	Waterford	SERBD	1a	1a
IE_SE_16_463	Ballyshunnock	Waterford	SERBD	1b	1b
IE_SE_17_5	Belle Lake	Waterford	SERBD	1a	1a
IE_SE_17_8	Carrigavantry Reservoir	Waterford	SERBD	1a	1a
IE_SH_28_87	Naminna (Lough)	Clare	ShRBD	1a	1a
IE_SH_27_122	Gortglass Lough	Clare	ShRBD	1a	1a
IE_SH_28_64	Keagh (Lough)	Clare	ShRBD	1a	1a
IE_SH_27_193	Ballycar Lough	Clare	ShRBD	1a	1a
IE_SH_28_82	Doo Lough	Clare	ShRBD	1a	1a
IE_SH_28_85	Lickeen Lough	Clare	ShRBD	1a	1a
IE_SH_24_90	Bleach Lough	Limerick	ShRBD	1a	1a
IE_SH_26_705	Cavetown Lough	Roscommon	ShRBD	1a	1a
IE_SH_26_706	Grange Lough	Roscommon	ShRBD	1a	1a
IE_SW_21_448	Bofinna (Lough)	Cork	SWRBD	1a	1a
IE_SW_20_53	Skeagh Lough [Schull Reservoir]	Cork	SWRBD	1a	1a
IE_SW_20_133	Tooreen Lough	Cork	SWRBD	1a	1a
IE_SW_20_150	Ballin Lough	Cork	SWRBD	1a	1a
IE_SW_22_182	Callee (Lough)	Kerry	SWRBD	1a	1a
IE_SW_21_369	Eirk Lough	Kerry	SWRBD	1a	1a
IE_SW_22_58	Mount Eagle Lough	Kerry	SWRBD	1a	1a
IE_SW_22_199	Cummernamuck (Lake)	Kerry	SWRBD	1a	1a
IE_WE_31_211	Anaserd (Lough)	Galway	WRBD	1a	1a
IE_WE_32_269	Barnahallia Lough	Galway	WRBD	1a	1a
IE_WE_32_526	Fawna (Lough)	Galway	WRBD	1a	1a
IE_WE_31_120	Loughaunwillan	Galway	WRBD	1a	1a

EU Code	Lake Name	County	RBD	Initial Risk	Revised Risk
IE_WE_32_422	Nambrackkeagh (Lough)	Galway	WRBD	1a	1a
IE_WE_31_1126	Illauntrasna (Lough)	Galway	WRBD	1a	1a
IE_WE_31_177	Loughaunore	Galway	WRBD	1a	1a
IE_WE_35_96	Lackagh Lough	Leitrim	WRBD	1a	1a
IE_WE_35_188	Nacroagh (Lough)	Leitrim	WRBD	1b	1b
IE_WE_33_1892	Acorrymore (Lough)	Mayo	WRBD	1a	1a
IE_WE_34_458	Holan (Lough)	Mayo	WRBD	1a	1a
IE_WE_32_406	Moher Lough	Mayo	WRBD	1a	1a
IE_WE_30_532	Aille Lough	Mayo	WRBD	1a	1a
IE_WE_30_341	Bekan Lough	Mayo	WRBD	1b	1b
IE_WE_35_237	Labe (Lough)	Sligo	WRBD	1a	1a
IE_WE_34_405	Talt (Lough)	Sligo	WRBD	1a	1a
IE_WE_35_17	Carrowlustia	Sligo	WRBD	1a	1a
IE_SH_26_703	Owel (Lough)	Westmeath	ShRBD	2b	1b
IE_EA_07_275	Ramor Lough	Cavan	ERBD	1a	2a
IE_NB_06_54	Ervey Lough	Meath	NBRBD	1a	2a
IE_NB_03_3	Grove Lough	Monaghan	NBRBD	1a	2a
IE_NB_03_79	Glaslough Lake	Monaghan	NBRBD	1a	2a
IE_NB_06_234	Monalty Lough	Monaghan	NBRBD	1a	2a
IE_NB_06_244	Muckno Mill Lough	Monaghan	NBRBD	1a	2a
IE_NW_36_517	Annagh Lough	Cavan	NWRBD	1a	2a
IE_NW_36_432	Ardan Lough	Cavan	NWRBD	1a	2a
IE_NW_36_385	Cullinaghan Lough	Cavan	NWRBD	1a	2a
IE_NW_36_513	Kilywilly Lough	Cavan	NWRBD	1b	2a
IE_NW_36_363	Tacker Lough	Cavan	NWRBD	1b	2a
IE_NW_36_528	Sillan Lough	Cavan	NWRBD	1a	2a
IE_NW_36_468	Clonty Lough	Cavan	NWRBD	1a	2a
IE_NW_36_715	Golagh Lough	Donegal	NWRBD	1a	2a
IE_NW_38_83	Anure Lough	Donegal	NWRBD	1a	2a
IE_NW_37_188	Eske Lough	Donegal	NWRBD	1b	2a
IE_NW_38_47	Kiltooris Lough	Donegal	NWRBD	1a	2a
IE_NW_38_57	Birroge Lough	Donegal	NWRBD	1a	2a
IE_NW_38_22	Glen Lough	Donegal	NWRBD	1a	2a
IE_NW_37_140	Meenaviller (Lough)	Donegal	NWRBD	1a	2a
IE_NW_37_194	Croagh Lough	Donegal	NWRBD	1a	2a
IE_NW_35_160	Melvin Lough	Leitrim	NWRBD	1b	2a
IE_NW_36_201	Nabellbeg (Lough)	Leitrim	NWRBD	1a	2a
IE_NW_36_415	Drumgole Lough	Monaghan	NWRBD	1a	2a
IE_NW_36_525b	Drumlona Lough	Monaghan	NWRBD	1b	2a
IE_NW_36_526	Inner Lough	Monaghan	NWRBD	1a	2a
IE_NW_36_525a	Drumore Lough	Monaghan	NWRBD	1b	2a
IE_NW_36_647	White Lough	Monaghan	NWRBD	1a	2a
IE_NW_36_623	Bawn Lough	Monaghan	NWRBD	1a	2a
IE_SH_27_123	Ballybeg Lough	Clare	ShRBD	1a	2a
IE_SH_27_120	Rosroe Lough	Clare	ShRBD	1a	2a
IE_SH_23_59	Acummeen (Lough)	Kerry	ShRBD	1a	2a
IE_SW_20_158	Curraghalicky Lake	Cork	SWRBD	1b	2a
IE_SW_19_138	Inniscarra Reservoir	Cork	SWRBD	1a	2a
IE_SW_20_148	Abisdealy Lough	Cork	SWRBD	1a	2a
IE_SW_20_153	Coolkellure Lake	Cork	SWRBD	1a	2a
IE_SW_21_440	Cummer Lough	Kerry	SWRBD	1a	2a
IE_SW_21_429	Coomclogherane Lake	Kerry	SWRBD	1a	2a
IE_SW_21_405	Dromtine Lough	Kerry	SWRBD	1b	2a
IE_WE_32_436	Aughrusbeg Lough	Galway	WRBD	1b	2a
IE_WE_32_474	Tully (Lough)	Galway	WRBD	1a	2a
IE_WE_32_479	Ballynakill Lough	Galway	WRBD	1a	2a
IE_WE_30_332	Coolin Lough	Galway	WRBD	1a	2a
IE_WE_35_131	Anarry (Lough)	Leitrim	WRBD	1a	2a
IE_WE_32_428	Lugacolliee Lake	Mayo	WRBD	1b	2a
IE_WE_34_402	Washpool Lough	Mayo	WRBD	1a	2a
IE_WE_32_432	Ard (Lough)	Mayo	WRBD	1a	2a
IE_WE_32_364	Ballin Lough	Mayo	WRBD	1a	2a
IE_WE_35_136	Easky Lough	Sligo	WRBD	1a	2a