eastern
river basin district

ABSTRACTION PRESSURE ASSESSMENT

BACKGROUND DOCUMENT
TO THE
WATER MATTERS REPORT

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Section 1
Introduction

The national abstraction project is developing methods to examine the effects of abstractions from surface and ground water 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).

The EU Water Framework Directive (WFD) required characterisation of pressures from significant water abstractions, including a national risk assessment and regulation on 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 EPA in the national Article V report, "The Characterisation and Analysis of Ireland's River Basin Districts" (EPA, 2005).

Table 1 presents the number of water bodies "at risk" or "probably at risk" from abstraction pressures from the initial characterisation in 2005. For surface waters, the risk assessments compared net abstractions (total abstractions minus total discharges) to an estimate of Q_{95} 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." Risk levels for lakes and transitional waters were then derived from the results of the riverine risk assessment. The initial risk characterisation for groundwater was based on a predictive methodology developed by the UK Technical Advisory Group (TAG) and adopted by the WFD National Technical Coordination Group for consistent application in all of Ireland's RBDs.

Table 1.1: Initial Characterisation Risks for Abstraction Pressures

Risk Level	Rivers	Lakes	Transitional Waters	Ground Waters
Water Bodies At Risk (1a)	95	111	6	6
Water Bodies Probably at Risk (1b)	107	16	5	36
Total No. of Water Bodies	4,467	805	196	757
% of 1a or 1b of Total	5	16	6	6

Section 2
Study Rationale

Even though Table 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 industrial sectors; (2) reducing the leakage from public water supplies; (3) restricting development; and (4) identifying and building the infrastructure for alternative sources of water.

Section 3
Objectives

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. For rivers and lakes, this entails efforts to establish linkages between water quantity and ecology. For groundwater, this entails reducing uncertainty associated with the Article V risk assessment and to establish important linkages between ground and surface waters where these are considered to be at risk from meeting environmental status objectives. It also entails incorporating the outcomes of a relevant parallel study on groundwater dependent terrestrial ecosystems (GWDTEs) or wetlands, led by the EPA and the National Parks and Wildlife Service (NPWS).

The work is proposed to facilitate the development of Programmes of Measures (PoMs) and methodology for the assessment of the sustainability of surface and groundwater abstractions. Surface water and ground water are addressed in separate tasks below. However, the task of updating the National Register of Abstractions deals with both surface and ground water and is discussed below.

Section 4
Technical Approach

4.1 National Register of Abstractions

The national register of abstractions has been updated with input from each RBD and local authorities; this is an on-going process. The updated register is considered an improvement over 2005 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). 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, all abstractions have been assigned as either surface water or groundwater, and new or revised volumes of abstractions have been added where available. It is believed that most, if not all, public and group water schemes have been identified and included, but it is unlikely that all industrial and miscellaneous small private abstraction schemes (e.g., schools, hospitals) are captured in the new register.

The register currently includes over 530 surface water abstractions, including those from rivers, streams, lakes and estuaries. Table 4.1 summarises all surface water abstractions included in the national register, as reported by individual RBD projects.

Table 4.1: Summary of Surface Water Abstractions for Supply Purposes

River Basin District	Total No. Abstractions	Total Estimated Abstraction (m3/day)
Northwest	92	96,913
Neagh-Bann	14	18,273
Shannon	116	142,122
West	116	222,562
East	33	554,818
Southeast	46	115,440
Southwest	114	191,139

Data on abstraction volumes is available for over 90% of the abstraction points. Over 1.3 million m^3/day is currently being abstracted from the over 400 surface water abstractions that have abstraction rates. Approximately 367 abstraction points supply more than 100 m^3/day, whilst over 100 points supply less than 100 m^3/day. Among the supplies with known abstraction rates, the median surface water abstraction is 410 m^3/day.

Table 4.2 summarises all groundwater abstractions included in the national register, as reported by individual RBD projects.

Table 4.2: Summary of Groundwater Abstractions for Supply Purposes

River Basin District	Total No. Wells	Public	Private/GWS/ Industrial	Total Estimated Abstraction (m3/day)
Northwest	64	29	35	34,003
Neagh-Bann	41	34	7	23,820
Shannon	843	172	671	144,117
West	182	22	160	42,779
East	249	86	163	39,590
Southeast	180	116	64	153,387
Southwest	315	163	152	96,053

Table 4.2 incorporates supply wells and springs that serve public supply and industrial purposes. It does not include wells or springs used for domestic purposes whereby water is returned to septic systems. A provisional breakdown of groundwater abstractions by county is provided in Figure 1. The numbers presented are believed to provide a reasonably complete picture of total abstractions, although a few scenarios have yet to be fully verified, notably related to mine dewatering and quarry abstractions.

Approximately 530,000 m^3/day is presently being abstracted from almost 1,900 identified supply wells or springs. The highest total groundwater abstractions occur in the Shannon and Southeastern RBDs. The single largest groundwater abstraction nationally is associated with the Lisheen mine in Tipperary North, at 65,000 m^3/day, or more than 10% of the national total. Approximately 100 abstraction points nationally supply more than 1,000 m^3/day, while a further 500 abstraction points produce greater than 100 m^3/day. The majority of supply wells and springs produce between 10-100 m^3/day.

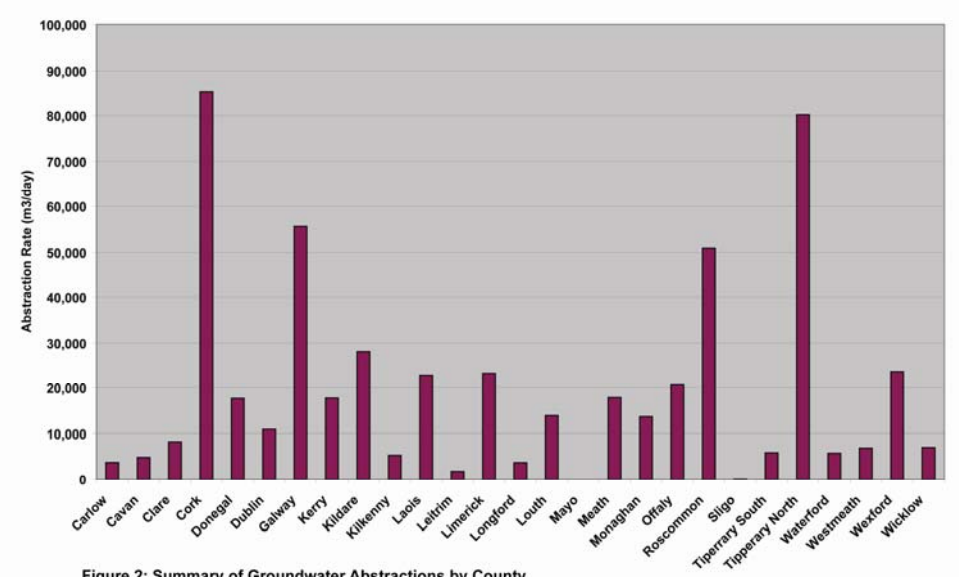


Figure 1: Summary of Groundwater Abstractions by County

4.2 Surface Water Abstraction Pressures

The national surface water abstraction project is constructing methods for use as planning-level assessment tools for abstractions from rivers and lakes. The work on the surface water abstractions is on-going. The project is targeted to be completed in mid-2008. The national surface water pressure assessment for abstractions includes several tasks described below.

For rivers, a method is being piloted for determining instream flows that are needed to support the fish community, where the natural flows will be altered by abstractions. The pilot area is the lowland rivers of the Central Plain, and two fish species – brown trout and Atlantic salmon – are being evaluated. The output of this work is planned to be a series of curves that would describe how changes in stream flow (as caused by abstractions) would change habitat available to trout and salmon. Ireland's regulatory agencies would then establish the degree of habitat loss that is considered acceptable to achieve 'good' ecological status or maintain 'high' ecological status where it currently exists, from which minimum instream flow requirements can be determined.

A technical assessment of the literature and practices in other countries is also being undertaken to determine if fish are a sufficient aquatic plant/animal group upon which to assess surface water abstraction pressures in rivers.

For lakes, a review of available data and discussions with experts are being held to understand whether the degree to which abstraction pressures is having an impact on the ecological status of the lake. From this understanding a set of metrics will be developed that can be used to examine existing and future abstraction pressures.

The goal is to develop methods that could be an integral part of a future abstractions assessment process or regulatory programme for surface waters.

4.2.1 Rivers

The project brief included separate tasks to evaluate minimum instream flow requirements based on effects to (1) macroinvertebrates and (2) fish. The work for macroinvertebrates was intended to use EPA's data on "Q values", a measure of the degree of organic pollution that has been collected triennially for many years. After consultation with Irish experts, it was concluded that this Q-value index was not a suitable basis to assess abstraction pressures. This work has been replaced with a technical assessment based on literature review and experience in other countries to determine whether a method based on fish is sufficient to assess abstraction pressures in rivers by evaluating:

- which plant and animal groups are affected by abstraction pressures, and
- whether a specific species present in Ireland can be identified as sensitive.

Hydraulic and biological modelling using PHABSIM (Physical Habitat Simulation) software is being used to pilot a method to evaluate abstraction pressures on fish in rivers. The pilot will assess abstraction impacts on the habitat of two salmonids -- Atlantic salmon and brown trout -- in lowland rivers of the Central Plain region (the pink area in Figure 2).

These fish were selected for study because they are widespread throughout the country (absences being related either to pollution or physical barriers for passage) and because river flows are an important and sensitive factor in a salmonid's life cycle. Further, the relationships between river flow and sustained salmonid fisheries have been the subject of much research and are at least conceptually understood.

In order to be able to apply this method across a region of Ireland, the rivers of that region should have similar habitat/flow relationships. The selection of a target group of rivers requires understanding how Ireland's physical geography influences the nature of its rivers. Figure 2 depicts the physiographic regions developed for this study: coastal (green), lowland karst (blue), drumlin (tan), and central plain (pink). The Central Plain region was selected as a study region because (1) it has a large number of stream types of similar nature that allow for the application of a method to be used over much of its physiographic region, (2) a large number of new or expanded supplies are expected to be sought in this region in the coming years due to population growth.

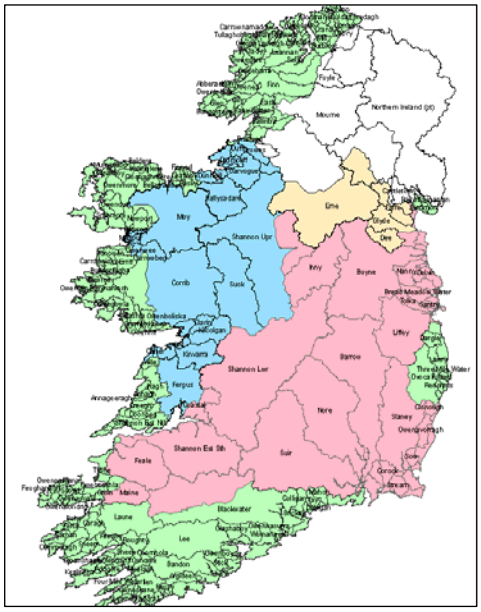


Figure 2: Physiographic Regions in Ireland

The habitat and hydraulic characteristics of 30 randomly selected stream segments across the Central Plain region are being measured during the summer-early fall 2007 to create input data for the PHABSIM model (Figure 3 shows these segments). The model will use this information along with habitat preferences of different life stages (spawning, fry, juvenile and adult) of trout and salmon to describe preferential relationships between these fish and each of the following physical habitat features: depth, velocity and substrate. The habitat preferences are being based on both the experience of previous researchers and Irish fisheries experts.

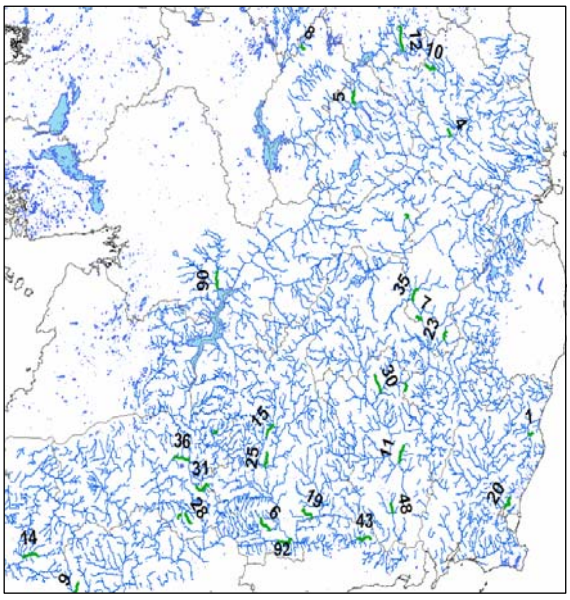


Figure 3: Study Stream Segments in Central Plain Region

The PHABSIM model will first be used to establish habitat vs. flow relationships for the current conditions for each stream segment. Then, the model will be used to simulate how the available habitat changes with reduced river flow, as a result of potential abstractions. The results from the individual stream segments will be aggregated to define typical habitat changes for lowland rivers in the Central Plain. It is anticipated that the results will yield regional patterns that can be used to examine current and future abstraction pressures for lowland rivers in the Central Plain region.

4.2.2 Lakes

The existing risk assessment methodology assessed abstraction pressures for lakes based on a computation of the percentage of low flow in rivers contributing to a lake that is taken by an abstraction. However, the fraction of low flow entering a lake is not a robust indicator of ecological status because most lakes have residence times that are far longer than a low flow period. Instead, the results of the Initial Characterisation phase can be viewed as indicating lakes that might be affected by abstraction pressures because there are net abstractions in their contributing watersheds.

The approach for this task is to build from the list of lakes potentially affected by abstractions and develop more lake-relevant measures of ecological health related to abstractions. A literature review (notably EPA lake water quality documents) and anecdotal sources indicate that abstractions are a relatively minor factor in the deterioration of lake water quality across the country. Overall, water abstractions would not appear to be causing a decrease in the ecological status of lakes.

Lakes potentially affected by abstractions will be characterised to describe their existing topology, morphological and watershed parameters, lake level fluctuations, locations of abstraction (in-lake or watershed) and magnitude of net abstraction pressure etc. This data will be examined for commonalities among those lakes that appear to be affected by abstractions. The commonalities could include lake size, median depth, or ratio of net abstraction to lake volume or lake inflow. The findings will be used to develop metrics that can be readily assessed to indicate if an existing or proposed abstraction would affect ecological status. The objective is to base the metrics on hydrologic or hydrodynamic parameters, where possible, such as flushing rate and lake level changes.

An initial analysis of lake level data for 21 lakes has been undertaken to understand the primary factors that influence interannual level fluctuations. These fluctuations were found to be more variable than anticipated, not correlating well among lakes (even in the same region) or with rainfall.

The next steps are to continue to refine the list of lakes potentially affected by abstractions. For these lakes, calculations will be performed using available data to compare lake inflow and volume with net abstractions in the catchment to describe how abstractions might be affecting lake flushing rate or levels.

4.3 Future Supplies

Increasing population and forecasted climate change will require new or expanded public and private water supplies. Industrial growth is adding new abstractions, although not on the same scale as local authority efforts to meet the growing domestic water demands. The ability to provide new/expanded sources of supply from surface water resources is limited.

If too much water is abstracted, rivers have reduced flow and lakes have lower water levels potentially resulting in unsustainable water supplies unsustainable and/or negative impacts on aquatic plants and animals and wetland areas. In extreme cases river beds may dry up, lake shores can become exposed.

The increasing use of surface water for water supply means new and expanded schemes will require increased attention to determine if they are affecting ecological status and how they are to be monitored and managed. This study will provide a tool to determine what minimum instream flow requirements are needed to support healthy fish populations in rivers and metrics to assess impacts on aquatic plant and animal communities in lakes.

4.4 Groundwater Abstraction Risk

The national groundwater abstraction risk assessment that was submitted by Ireland to Europe in 2005 has been updated and revised on the basis of new soil/subsoil and groundwater vulnerability mapping, as well as an updated national register of abstractions. Identified quantitative impacts are localised, and groundwater abstraction is generally not considered to be a significant water management issue. However, abstraction pressures are expanding in line with national growth, and expanded use of groundwater resources will require improved monitoring and centralised water resources management. The revised risk assessment builds on the work carried out by individual river basin district projects as part of Water Framework Directive implementation in Ireland. A national groundwater recharge map has been developed from GIS processing of related hydrogeological inputs, and forms an important basis for assessment of new and significant groundwater abstractions.

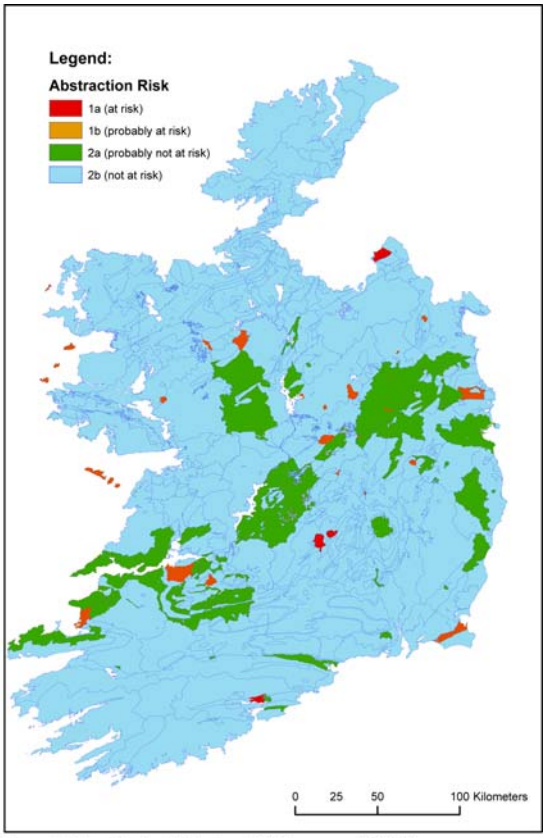
The remaining tasks to be carried out are:

(a) preparing a report on the work associated with the revised national risk assessment;

(b) developing technical guidance towards establishing a suitable national groundwater abstraction registry and/or licensing system.

The project is targeted to be completed in December 2007.

Figure 4: Groundwater Abstraction Risk Assessment (2005)



The initial groundwater abstraction risk assessment, summarised in Figure 4, was based on comparing estimated abstraction levels against computed recharge for each groundwater body across the country. Recharge was computed by applying recharge coefficients associated with defined physical scenarios to a national map of effective rainfall based on a 30-year mean annual rainfall map developed by Met Eireann. The recharge coefficients were assigned on the basis of physical scenarios involving different soil type and texture classes and groundwater vulnerability categories, which in turn are defined by depth and subsoil permeability criteria (GSI, 1999). Criteria for abstraction risk were based on relative percentages of abstraction vs. recharge volumes computed for each groundwater body, as defined by the UK TAG.

Where groundwater level data were available, these could be used to support or overwrite the predictive risk results, and to add confidence to the risk assignments. Because groundwater abstraction impacts can also be of a local nature, water level trends could also be used to justify subdividing the officially designated groundwater bodies, to reduce the perceived risk across otherwise much larger areas.

Only 6 groundwater bodies were considered to be at risk, while a further 36 were considered to be "probably at risk", involving less certainty and reduced confidence in the assessment. Of the 36 "probably at risk" cases, only 12 were the direct result of abstraction rates or saline intrusion issues, while 24 were associated with GWDTEs. The saline intrusion test was based on assessing rates of abstractions and distance from seawater, and most of the "probably at risk" cases involve the islands off the coast of Galway and Mayo. The test for GWDTEs was based on volumes abstracted at different distances from the boundaries of preliminary mapped wetland areas, or the presence of arterial drainage, also as a function of distance from wetland boundaries. Some of the "probably at risk" GWDTEs are very small, but nonetheless ecologically significant.

The initial risk characterisation of 2005 represents an important first step in the understanding of groundwater abstraction issues nationally, and importantly, provided the opportunity to define what merits or requires further study. On the basis of these results and subsequent discussions among the National Technical Coordination Group, groundwater was added as a component to the abstraction pressure assessment to be implemented nationally ahead of the Programmes of Measures phase of the WFD.

4.5 Groundwater Abstraction Pressure Assessment

The updated national groundwater pressure assessment includes several tasks that link groundwater to surface waters and wetlands. As a first measure, it provides an update on the 2005 risk assessment following the same UK TAG methodology, but incorporating new (and improved) information as follows:

- An updated national register of abstractions;
- Recent national maps of soils and subsoils produced by Teagasc in 2006;
- A new national map of groundwater vulnerability derived from GSI with input from RBD projects;
- Consideration of additional recharge coefficients for an expanded set of physical scenarios.

4.5.1 Updated Recharge Estimation

The revised risk assessment also includes updates to important inputs which are used to compute diffuse recharge spatially across Ireland. The most significant updates relate to the assigned distribution of recharge coefficients which define the proportion of effective rainfall that becomes recharge. Recharge coefficients depend largely on the permeability and thickness of the soils, subsoils and bedrock overlying groundwater. Recharge coefficients have been defined for several new combinations of soil and subsoil scenarios, and reflect the recently published national soil and subsoil maps by Teagasc (2006) as well as the new (2006) national groundwater vulnerability map of Ireland, collated and published by GSI, and reproduced in Figure 5. In areas not yet covered by detailed GSI mapping, recharge coefficients were assigned according to subsoil permeability indicated by either GSI drilling or Teagasc subsoil mapping.

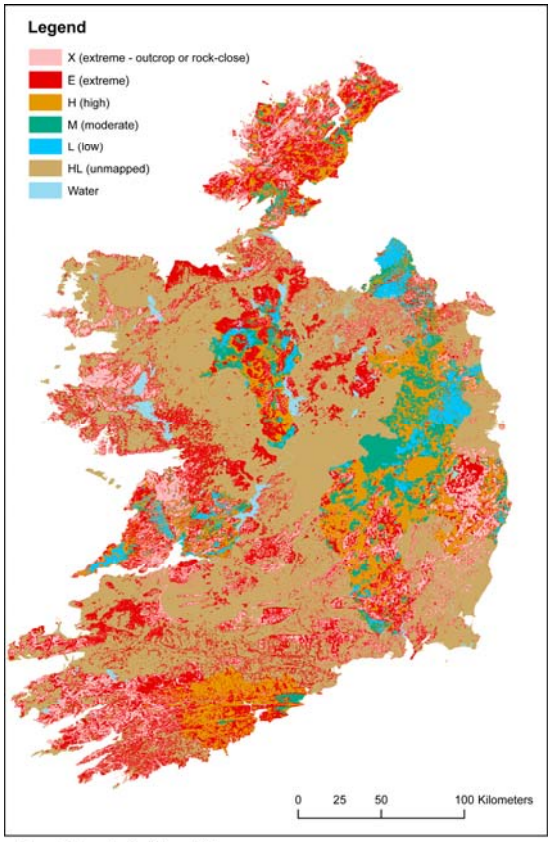


Figure 5: Groundwater Vulnerability

In computing recharge, particular attention was given to poorly productive aquifers (PPAs). These represent a particular hydrogeological scenario and cover two-thirds of Ireland. They are characterised by low storage and transmissive properties. PPAs are not capable of accepting all the recharge that may be available, resulting in rejected recharge and discharges to local streams via shallow pathways. As a result, PPAs incorporate small, localised groundwater flow systems.

To account for rejected recharge, a maximum recharge limit or 'cap' is used. Based on GSI estimates of throughflow in aquifers classified as poor (Pl and Pu), a maximum recharge rate of 100 mm/yr is used for most poorly productive aquifers. Areas underlain by locally important but generally unproductive aquifers (except for local zones, Ll) such as the Calp limestone, are capped slightly higher at 150-200 mm/yr.

Table 3 summarises the recharge computations for all groundwater bodies by the major types of groundwater flow regimes. Computed recharge ranges from 60 to 890 mm/yr. The higher values are associated with vulnerable groundwater scenarios in high rainfall areas, and are mostly associated with sand and gravel as well as karst aquifers.

Based on this work, a national groundwater recharge map has been produced which is intended to be made available online (e.g., through the GSI or EPA), and be updated as new subsoil information becomes available in counties undergoing continued GSI vulnerability mapping. Further improvement could be made if a national effective rainfall map was developed with the assistance of Met Eireann.

Some of the mapping layers associated with recharge calculations do not extend to islands, and recharge estimates for such values were developed independent of the GIS-based methodology. Abstraction risks associated with island scenarios is therefore assigned based on the site-specific knowledge of respective RBD projects and local authorities.

Table 4.3: Summary of Computed Recharge by Flow Regime for all Groundwater Bodies

	Computed Recharge (m3/day per km2)			Computed Recharge (mm/yr)		
Flow Regime	Average	Min	Max	Average	Min	Max
Sand and Gravel	1,030	413	2,112	376	151	771
Karst	711	189	2,449	260	69	894
Fissured	618	163	1,600	226	60	584
Poorly Productive	385	166	1,264	140	61	461

4.5.2 Updated Groundwater Abstraction Risk Assessment (2007)

Results of the updated groundwater abstraction risk assessment are shown in Figure 6. Overall, patterns of risk are similar to those from 2005. Identified quantitative impacts are localised around the Bog of the Ring wellfield in Fingal, Knockatallon area wells in Monaghan, Lisheen mine in Tipperary North, Galmoy mine on the Kilkenny/Laois border, Midleton area wells in Cork, and the Fardystown supply in Wexford.

Each river basin district project has had the opportunity to examine each potential risk case to ensure that site-specific knowledge and analysis is adequately and appropriately considered. As part of the reporting of the abstraction study, details on abstractions and site-specific water balances will be included to the extent possible.

All schemes deemed to be either "at risk" or "probably at risk" are included in the new EPA water level monitoring programme. Additional wells associated with "not at risk" scenarios are also included for long-term trend monitoring.

Saline intrusion is reported in a few localised cases in the west of Ireland. Supply wells on Inishmaan and Inisheer have reportedly been affected, and Inishmaan is seasonally operating a small-scale desalination unit in line with increased demands. Well operators in karst areas along the coast in Galway and Kerry are reportedly also experiencing seasonal salinity problems, and these cases are presently being investigated further. Despite the mentioned occurrences, saline intrusion is not wide-spread, and is not considered a major water management issue. Future groundwater supply development in coastal areas and on islands must be accompanied by proper studies and monitoring, and given the growing demands for water in coastal populated areas, this should involve regulatory agencies.

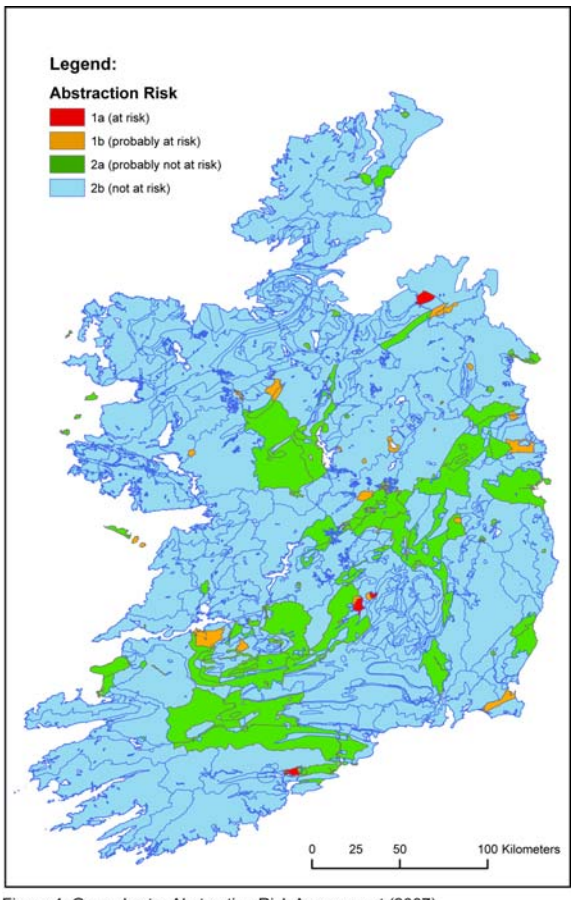


Figure 6: Groundwater Abstraction Risk Assessment (2007)

Changes to the delineation of groundwater dependent terrestrial ecosystems (GWDTEs) have not yet been effected and so there are no changes to the 2005 risk assessment of related groundwater bodies. An ongoing national study of GWDTEs by the EPA and NPWS are improving the resolution of wetlands mapping, and when ready, is expected to influence the outcome of risk analysis and subsequent monitoring. GWDTEs will be subject to specialised monitoring as part of EPA's WFD-related monitoring programme.

4.6 Future Supplies

While available groundwater resources vary across the country, groundwater is increasingly being explored for public and private supplies. Some rivers and lakes are reaching their capacity as primary sources of water supply and questions are being raised over the health and status of freshwater aquatic ecosystems. Industrial growth is adding new abstractions, although not on the same scale as local authority efforts to meet the growing domestic water demands. There are several large-scale groundwater exploration schemes currently underway in counties such as Meath, Kildare, Wexford, and Louth. These are partly driven by Environmental Impact Assessment regulations and partly by concerns over local ecological impacts. Even counties with limited groundwater resources such as Wicklow are exploring groundwater options to augment present supplies. The housing boom in commuter belt and rural areas are adding to overall abstractions but this is regarded less as a quantity and more as a quality issue, on account of the return of water through septic systems in unsewered areas. The various national studies led by individual river basin district projects are drawing attention to a variety of water management issues which combined will broaden the understanding of groundwater and surface water interactions, and impact how groundwater is monitored and managed.

The increasing use of groundwater as a primary source of water supply implies that new schemes will require increased regulatory attention in the context of WFD-required water resources management. As a separate and ongoing task, the present study is looking at the feasibility and technical elements associated with potential, future groundwater abstraction licensing.

Section 5
Project Schedule

This abstraction pressures project including seasonal field work is scheduled to extend over a 24 month period and will be completed in June 2008.

Acknowledgement

The ERBD project wishes to acknowledge the contribution of EPA, GSI and individual river basin districts in discussing the procedures and revised risk assessment results. Staff at the GSI were instrumental in developing relevant soil and subsoil permeability classes and guiding the recharge assessment.

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