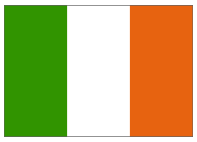

WFD Surface Water Hydrology Risk Assessment Methodology

GUIDANCE ON THRESHOLDS AND METHODOLOGY TO BE APPLIED IN IRELAND'S RIVER BASIN DISTRICTS

Paper by the Working Group on Characterisation and Risk Assessment

Surface water guidance document

This is a guidance paper on the application of a proposed **Surface Water Hydrological Risk Assessment** methodology. It documents the principles to be adopted by River Basin Districts and authorities responsible for implementing the Water Framework Directive in Ireland. This is a working draft describing a method that will evolve as it is trialled, and will be amended accordingly.

REVISION CONTROL TABLE

Status	Approved by National Technical Coordination Group	WFD Requirement	Relevant EU Reporting sheets	Date
Final	12th November 2004	Impacts and Pressures	SWB 3 – Provisional identification of artificial and heavily modified water bodies SWPI 5 - Significant water abstractions from surface water SWPI 6 - Significant water flow regulations and morphological alterations	November 2004

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Acronyms

HMWB	Heavily Modified Water Body
LWB	Lake Water Body
pHMWB	potential Heavily Modified Water Body
RWB	River Water Body
TWB	Transitional Water Body
WB	Water body
WFD	Water Framework Directive

1. Introduction

The purpose of this document is to provide guidance on the assessment of abstraction and flow regulation pressures on surface waters. This risk assessment was undertaken in accordance with the requirements under Article 5 of the Water Framework Directive. Member states are required to undertake '*a review of the impact of human activity on the status of surface waters and on ground waters*'. Annex II specifies further under the identification of pressures the '*estimation and identification of significant water abstractions for urban, industrial, agricultural and other uses, including seasonal variations and total annual demand, and loss of water in distribution systems*' and the '*estimation and identification of the impact of significant water flow regulation, including water transfer and diversion, on overall flow characteristics and water balances*'. This assessment determined the likelihood of surface waters failing to meet the Directive's environmental objectives.

The United Kingdom Technical Advisory Group's (UK TAG) guidance document 7b on '*Abstraction and flow regulation pressures on surface waters*' and the Environment and Heritage Service of Northern Ireland's (EHS) guidance on '*Water resources methodology for the assessment of abstraction and flow regulation pressures on surface waters and transitional waters in Northern Ireland*' were reviewed in the development of the Irish Surface Water Hydrology Risk assessment methodology. Thresholds proposed for application in Ireland were adopted from these guidance documents.

The Irish methodology involves the compilation of a database of abstractions, discharges and major flow regulation structures within each RBD. Q95%ile flows were calculated for each water body at the furthest downstream point of the water body. In addition, the sensitivity of surface waters was designated as high, as a conservative approach was adopted in the Irish risk assessment methodology. If a major flow regulation structure was present within a water body, that WB was designated as 1a: At risk. Total abstractions minus total discharges were calculated using available data to determine nett abstractions for each water body. Nett abstractions were then compared with Q95%ile flows (low flows), and reported as a percentage of the low flow figure. This figure was then compared with thresholds for high sensitivity surface waters from EHS and UK TAG guidance documents. A risk category 1a, 1b, 2a or 2b was then assigned to each water body within each RBD.

The Risk Assessment Working Group in Ireland agreed to the adoption of a four-category risk classification scheme:

1a	At risk
1b	Probably at risk
2a	Probably not at risk
2b	Not at risk

Example

A river water body has a low flow rate of 9,610.48 m^3/day. Total abstractions minus total discharges is equal 2,400.00 m^3/day, and this nett abstraction represents 24.97% of the low flow. As no major flow regulation structure is present within the water body, the risk category assigned is 1b: probably at significant risk.

2. Aims and scope

- This aim of this document is to outline the pressures that present the potential for hydrological risk to surface water bodies and to describe the methodology employed in this risk assessment.
- The aim of the methodology is to determine the degree of abstraction risk that water bodies in Ireland are subjected to. The deviation from Q95%ile flow was used to determine the risk category in line with EHS and UK TAG guidance thresholds.
- This guidance document deals with hydrological elements only; morphological and pollution elements are dealt with under separate guidance documents.
- As in UKTAG and EHS guidance methodologies, coastal water bodies were not considered in the Irish hydrological risk assessment process.

Note:
The hydrology risk assessment, along with the assessment of morphological alterations, is important in characterising Heavily Modified Water Bodies (HMWBs). The hydrology and morphology risk assessments served as a screening step for the provisional identification of HMWBs. Water bodies which identified as being At Risk:1a following the hydrology risk assessment process, proceeded for further consideration as potential HMWBs (pHMWB).

3. Pressures

As stated above, the aim of this assessment was to determine the water bodies in Ireland that are at risk or not at risk from the combined pressures of abstraction and flow regulation, with the aim of ensuring that there is adequate flow to support the biological elements. An assessment was therefore made of the change in natural low flow conditions due to the pressures of abstraction and flow regulation in each water body.

Significant pressures considered included abstraction and flow regulation pressures such as;

- Groups of abstraction
- Groups of flow regulation structures
- Single large abstraction
- Single large flow regulation structure
- Combinations of the above

4. Datasets

Each RBD compiled its own register of abstractions, discharges and flow regulation structures. This register may have been supplemented by Local Authority information, information obtained directly from industries themselves and data from the National Drinking Water survey. Only surface water abstraction data was required. Surface water spring abstractions and groundwater abstractions were excluded from this assessment. Groundwater abstractions were dealt under ground water risk assessment.

Completeness of datasets

As datasets were often incomplete e.g. lack of data for small industries, agricultural abstractions etc., or values were based on assumptions e.g. discharge estimates from discharge licences are assumed to be half of the discharge licence limit, an assessment of data confidence was appropriate. This was determined by assessing the risk/pressure, completeness of datasets, quality of data and cause/effect of known pressures and impacts (EHS). Low confidence data may have been sufficient where there was a low risk of hydrological impact but increasing confidence was required as the level of risk increases (UK TAG). Data confidence was RBD specific, and was incorporated in the assessment by each RBD.

Table 1: Datasets required for surface water hydrology risk assessment determination

DATA	DESCRIPTION	DATA CONFIDENCE
Abstractions – general comments	• An abstraction register was compiled from information collected from industries, Local Authority information and the National Drinking Water register. • the abstraction rate per day was calculated • the magnitude of the abstraction was considered and water body sensitivity was assumed to be high	• **M at best due to gaps in datasets e.g. abstractions info from smaller industries and agricultural abstractions.**
IPC licences	• For industries which discharge the water they abstract e.g. cooling water for power plants, fish farms –the same volume as contained in the abstraction register was used. The WB in which the activity occurred was noted.	• **M**
Section 4 licences	• It was assume that water is abstracted from public water supply if information had not been gathered from the industry itself.	• **M**
Drinking water abstractions	• Local Authority information on public, group and private water supply abstractions. Information such as source, abstraction rate per day, and population served should was collected. The abstraction rate total was calculated. Where only the population rate served was known, it was assumed that the population uses 240 l/day per head. • And/or the National Drinking Water supply register. • the above two were compared	• **M**
Impoundments register	• RBD specific – a dataset of major impoundments was compiled. The presence of a significant impoundment i.e. any structure being considered as heavily modified traversing the whole width of the river or lake outlet that impounds water upstream and can regulate flow downstream automatically place the water body (lake or river) upstream at risk (1a)	• **H**
Discharges to surface waters	• the discharge rate per day was calculated.	• **M** **(no actual discharge volumes reported, discharges estimated from OSPAR guidelines)**
IPC licences	• Calculate the discharge rate per day – this was assumed to be half that of the limit on the	• **M**

	licence (OSPAR HARP Guidelines, 2000).	
Section 4	• Local Authority information. the discharge per day was calculated – this was assumed to be half that of the limit on the licence (OSPAR HARP Guidelines, 2000).	• **M**
WWTPs	• **the WWTP discharge rate per day was calculated. Using the operating population equivalent, or the designed population equivalent (if the operating is not known) a discharge of 0.13 m^3 per day per inhabitant was assumed (OSPAR HARP Guidelines, 2000).**	• **M**

Additional datasets/GIS layers required to carry out the risk assessment were;

- Normalised Q95%ile flow map (m^3/s) / km^2 (Figure 1)
- Nested and un-nested river catchments (RWBs)
- Lake waterbodies (LWBs)
- Transitional waterbodies (TWBs)

Preparation of the Normalised Q95%ile flow map

Using hydrometric summary data from the EPA and the Rivers Agency (Northern Ireland), normalised Q95%ile values (Q95%ile value [m^3/s] /catchment area [km^2]) were calculated for 471 gauging stations across the Republic of Ireland and Northern Ireland (379 in the Republic of Ireland and 92 in Northern Ireland).

The point data were contoured using ArcGIS software by converting the data to a raster image using the Inverse Distance Weighted method to the power of 7 (resulted in the smoothest contours) at a resolution of 50m. Stations with catchment areas greater than 10km^2 were used because these were representative of the scale of the RWB units being analysed. The raster map was converted back to a feature dataset using a Quantile classification (32 classes) and the median values of the normalised Q95%ile between the contours were calculated. The attribute table of the low flow contour map contained two columns; (1) the range between the contours; (2) the median values of the normalised Q95%iles.

UK TAG Guidance refers to other methodologies for the calculation of low flow data e.g. modelling of catchment characteristics which may include calibration by comparison with an analogous catchment or short term monitoring. However, as detailed host soil layers were not available for Ireland, low flows were calculated from measured data. Low flow data calculated reflected available monitoring information. What was developed is a screening tool suitable for initial characterisation. More detailed analysis may be required as part of further characterisation for WBs at risk.

5. Thresholds

Thresholds for rivers, lakes and transitional waters are detailed in Table 2-4 below. Detailed GIS notes on how the assessment was carried out are included in Appendix 1.

Table 2: Risk assessment thresholds for rivers (from EHS)

Rivers - 95%ile flow, high sensitivity	**2b**	**2a**	**1b**	**1a**
	<5%	5-10%	10-40%	>40%

Table 3: Risk assessment thresholds for lakes (from EHS)

Lakes - 95%ile flow, high sensitivity	**2b**	**2a**	**1b**	**1a**
	<10%	10-15%	15-40%	>40%

Table 4: Risk assessment thresholds for transitional waters (from EHS)

Transitional - 95%ile flow, high sensitivity	**2b**	**2a**	**1b**	**1a**
	<10%	10-25%	25-50%	>50%

5. Overall limitations and considerations

1) Any lakes located outside of the RWBs shapefile were not considered.
2) Any abstractions located outside of the RWBs and TWBs shapefile were not considered.
3) Abstractions exceeding 100% of low flow were encountered. This was because a worst case scenario was used.
4) Negative values for abstraction as a percentage of low flow were also encountered This was because: (a) water may have been taken from one water body and discharged into another; (b) water discharged by licensed industries may have been taken from groundwater and discharged to surface waters; (c) the amounts being discharged into the RWBs were not accounted for in the abstraction register.
5) The assessment was incomplete for a number of reasons (a) the abstraction register may not have been complete within each RBD (b) the discharge amounts were based on assumptions, therefore actual data were not used (c) mean annual flows were not calculated.
6) The assumption that all rivers, lakes and transitional waters were at high sensitivity, was a conservative assumption.

APPENDIX 1

GIS Methodolgy – preparation of datasets and application of thresholds

The Irish guidance on abstraction and flow regulation pressures was developed following the methodology developed by UK TAG and EHS on abstraction and flow regulation pressures on surface waters.

The risk assessment was carried out for rivers, lakes and transitional waters.

Irish assumptions & rules

- measured flow parameters were used to generate map for GIS analysis
- UK TAG/EHS thresholds were applied
- A single Q95%ile threshold was used
- Degree of water body sensitivity –highest sensitivity was assumed
- Linkage of groundwater and surface water quantitative assessment - if groundwater at risk (1a or 1b) then surface water probably at risk (1b)

Rivers

Abstractions and discharges

The nested RWBs with the normalised (Q95%ile) low flow map (by a union or intersection, i.e. overlaying the two layers) were combined. New columns in the resulting attribute table were created to determine the area of each polygon and the volume of water that flowed within them each day[1]. The shapefile was dissolved (i.e. to aggregate the features) based on the attribute '*seg_cd_t*' (the code used for each river water body) and sum the volume of flow in each polygon was used to determine the flow of water per day in each nested RWB.

The abstraction and discharge data (points) were joined to the volumes of flow in each RWB to determine the percentage of the Q95%ile flow that was abstracted. This information was reattributed to the un-nested RWBs and the risk category table for rivers was applied (thresholds from EHS).

Table 2: Risk assessment thresholds for rivers (from EHS)

Rivers - 95%ile flow, high sensitivity	**2b**	**2a**	**1b**	**1a**
	<5%	5-10%	10-40%	>40%

Major flow regulation structure

Assessment referred to the lake water body containing the dam or weir. The presence of such a structure placed the water body it is located in at risk – 1a.

Thresholds for rivers were adopted from EHS and UK TAG guidelines.

[1] Volume of 95%ile flow per day = [((Normalised 95%ile flow value m^3/s) * Area km^2) / 1,000,000 m^2] x 86400 (secs in a day)

Lakes >50ha

The un-nested RWBs shapefile were intersected, that is joined to the flow, abstraction and discharge summaries with the lake waterbodies (LWBs). This meant that the nested RWB data upstream (i.e. all abstraction information) of each lake was attached. Manual verification was required to ensure that any overlap of LWBs across more than one RWB was related to the inflow of streams/rivers into the lake. If a particular RWB was not related to the inflow into a lake then it was removed from the attribute table.

The shapefile was dissolved based on the attribute '*seg_cd*'(code for each lake) and the sum of each of the volumes of water that flow, (the abstractions minus the discharge data) was calculated, so that LWBs that are located within more that one RWB were considered. The risk category thresholds for lakes was then applied.

Lakes <50ha

Lakes which were in protected areas i.e. SACs and SPAs, plus drinking water abstraction lakes which are <50ha were included in this assessment.

There were too many lakes <50ha to manually verify the nested RWBs that are related to the inflow of water. Therefore, the midpoint of the lakes <50ha was calculated and the point was spatially joined to the summary data for the nested RWB i.e. it was assumed that the lakes lies within one nested RWB. This data was then reattributed to the lakes <50ha's.

Table 3: Risk assessment thresholds for lakes (from EHS)

Lakes - 95%ile flow, high sensitivity	**2b**	**2a**	**1b**	**1a**
	<10%	10-15%	15-40%	>40%

Major flow regulation structure

Presence or absence of significant dams or weirs on the lake outlet. Assessment referred to the lake water body containing the dam. The presence of such a structure places the water body it lies within at risk – 1a.

Thresholds for lakes were adopted from EHS guidance.

Transitional Waters

Normalised (Q95%ile) low flow values were not known within the transitional water bodies (TWBs) and so this risk assessment considered the risk of abstraction on TWBs by determining the water flowing into the TWBs from the nested RWBs, and the abstraction from and discharges into the nested RWBs and the TWBs.

Two shapefiles needed to be created:

1) A shapefile of merged RWBs that flow into each TWB based on the attribute '*ms_cd*'(coding for the TWBs)

2) A shapefile of merged TWBs that were abstracted from and discharged into upstream of each TWB based on the attribute '*ms_cd*'(coding for TWBs).

The merged RWBs shapefile with the normalised Q95%ile shapefile were combined and the volume of water flowing into each TWB was calculated. The abstraction and discharge data were joined to the resulting shapefile. Also, the abstraction and discharge data were joined to the merged TWBs. These two attribute tables were joined based on the attribute '*ms_cd*'(coding for TWBs) the overall abstractions minus the discharges was calculated, and the percentage of abstraction compared to flow was determined within the RWBs. . Then apply the risk category table for transitional waters.

Thresholds for transitional waters adopted from EHS guidance.

Table 4: Risk assessment thresholds for transitional waters (EHS)

Transitional - 95%ile flow, high sensitivity	**2b**	**2a**	**1b**	**1a**
	<10%	10-25%	25-50%	>50%

Major flow regulation structure

The presence of a major flow regulation structure (e.g. Tidal barrages), placed the water body in which it is located at risk – 1a.

References

OSPAR Guidelines for harmonised quantification and reporting procedures for nutrients (HARP-NUT). 2000.

UK TAG WP Task 7b. Guidance on abstraction and flow regulation pressures on surface waters (final).

EHS. Water resources methodology for the assessment of abstraction and flow regulation pressures on surface waters and transitional waters in Northern Ireland.