River Basin Management Plans – Groundwater Classification

Water Balance

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An Agency within the Department of the Environment
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NIEA Northern Ireland Environment Agency
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1.0 Purpose

This paper describes the method used to assess the Water Framework Directive (WFD) quantitative status of groundwater bodies with respect to the overall balance between abstraction and available resource.

2.0 Background

For the WFD, groundwater bodies must be classified as good or poor for both chemical status (in relation to a large range of pollution pressures) and quantitative status (in relation to groundwater abstraction pressures).

The assessment of the balance between abstraction and available resource is one of four tests that have been developed for groundwater body quantitative classification, based on WFD requirements and guidance provided at an EC and UK level[1]. The four tests consider the impacts of groundwater abstraction both on the groundwater body itself, and also on the ecological receptors which depend on it. The worst result from all four tests is taken as the overall quantitative status result for each groundwater body.

A water balance estimation was undertaken in order to obtain an indication of whether, across an entire groundwater body, the level of groundwater abstraction is such that it may be unsustainable with respect to how much water is replenishing the body (recharge) and how much water is required to support ecological flow needs. The scale of analysis is such that it is intended only to identify where resources overall may be approaching or exceeding a critical point. Other quantitative tests were undertaken to look in more detail at the potential for local impact from groundwater abstraction.

Estimation of ecological flow needs on a groundwater body-scale is a complex issue especially where surface water bodies cross over more than one groundwater body. Where groundwater abstraction pressures are relatively low, which is the case for most of Northern Ireland, consideration of the proportion of abstraction to recharge along with other lines of evidence such as water level trends and whether there is any indication of saline intrusion can allow a determination of whether the overall abstraction rate is sustainable or not.

3.0 Classification

This assessment has been undertaken to support the following element of classification:

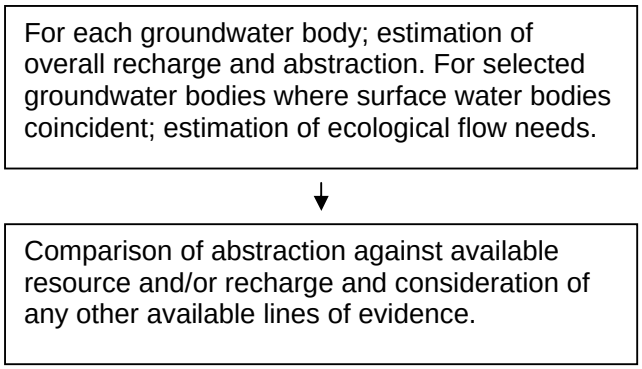
Quantitative Classification

- Water Balance

[1] UK Technical Advisory Group on the Water Framework Directive. Paper 11b(ii): Groundwater Quantitative Classification for the purposes of the Water Framework Directive. This paper can be downloaded from the www.wfduk.org web site.

4.0 Assessment Process

The following assessment process was undertaken, managed within a GIS-based project.



Long-term annual recharge was estimated for each groundwater body using 1971-2000 rainfall (Ppn) and Potential Evapotranspiration (PE) Meteorological Office data, along with an average baseflow index (BFI)[(2)] value for the groundwater body. To approximate Actual Evapotranspiration, PE was multiplied by 0.95 to reflect the fact that AE is always less than PE.

Recharge = BFI (Ppn – 0.95PE)

For poorly productive aquifers (class Bp(f) and Bl(f)) a maximum recharge rate of 100mm/annum was defined to reflect the limited potential for such strata to accept recharge due to low bulk permeability and storage.

Total groundwater abstraction volumes were estimated from the latest NIEA abstraction dataset.

Ecological flow needs were as calculated for designated surface water bodies by NIEA. A basic 100% connection (impact) between a groundwater abstraction and its associated surface water body (abstraction in surface water body catchment) was assumed. For groundwater bodies where there is relatively good co-incidence between surface water bodies and the groundwater body a total ecological flow need was calculated by summing individual flow requirements. For these bodies the available resource (recharge- total ecological flow) was compared against abstraction and where the available resource quantity exceeded abstraction volume good status was assigned.

(recharge – ecological flow needs) – abstraction = surplus (good status)/deficit (poor status)

For those bodies where there is a more complex relationship between the groundwater body area and cross-cutting surface water bodies, assigning portions of ecological flow was not considered feasible. For those bodies a comparison was made between abstraction volume and recharge volume based upon guidance for water balance assessment described in SNIFFER Report WFD53. For any body where abstraction exceeds 20% of recharge consideration was given to whether poor status should be assigned. This analysis was also carried out for those bodies where total ecological flow needs had been estimated.

(2) derived from the hydrology of soil types (HOST) dataset for Northern Ireland

5.0 Outcome

Based upon the analysis undertaken, all groundwater bodies with the exception of one were determined to be not at risk and subsequently assigned as being at good status. The groundwater body determined to be at “poor status” is GBNI4NE005 Belfast which comprises the Permo-Triassic Sandstone aquifers which lie beneath the greater Belfast and Newtownards/Comber areas. The aquifer discharges into Belfast and Strangford Loughs. The 20% abstraction to recharge ratio used to identify potentially “poor status” groundwater bodies is considered to be quite precautionary.

The sandstone aquifer system has historically been one of the most utilised groundwater resources. There is some anecdotal evidence that, in the past, a small number of groundwater sources close to the coastal boundary of the aquifer were abandoned due to increasing salinity. Chemical monitoring of some boreholes close to Strangford Lough show electrical conductivity (EC) and chloride concentrations above expected natural background levels.

The aquifer is overlain by a variety of superficial deposits including: sand and gravel, glacial till and estuarine clay. This makes estimating recharge to the aquifer a complex matter. With abstraction licensing only recently introduced in Northern Ireland there is little historical (or even recent) data on actual abstraction rates. To date there has been only limited systematic monitoring of groundwater levels so long-term trends across the aquifer cannot be reviewed in detail. These factors introduce a significant degree of uncertainty into the water balance estimation.

Groundwater abstraction pressures in Northern Ireland are not significant compared to many areas in the rest of the UK and Ireland. Overall, abstraction from groundwater bodies is generally only a very small proportion of recharge therefore confidence can be high in assigning good status under this overall water balance test. For those bodies with abstraction less than 10% of recharge and/or where abstraction was not significant with respect to available resource, high confidence determination has been made. For those bodies where abstraction exceeds 10%, low confidence was assigned.

6.0 River Basin Planning Cycle

With the Belfast groundwater body still being utilised for public water supply and with some new major industrial sources being developed there is a requirement, during the River Basin Management Plan (RBMP) period, to further assess the different elements of the water balance to more accurately determine the significance of groundwater abstraction within this important aquifer resource. This will need to be supported by more detailed analysis of the groundwater chemistry and water level data currently being collected as part of the WFD monitoring programme.

References

SNIFFER WFD53 Report, 2005: Criteria for WFD Groundwater ‘Good Quantitative’ Status and a Framework for the Assessment of Groundwater Abstractions. www.sniffer.org.uk

Northern Ireland Environment Agency
17 Antrim Road
Lisburn
BT28 3AL

www.ni environment.gov.uk

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