WFD Pressures and Impacts Assessment Methodology

GUIDANCE ON THE APPLICATION OF GROUNDWATER RISK ASSESSMENT SHEETS SWRA 1-6 AND GWDTERA 1-9 TO AREAS DESIGNATED FOR THE PROTECTION OF HABITATS AND SPECIES

Paper by the Working Group on Groundwater

Guidance document no. GW11

This is a guidance paper on the **Application of Groundwater Risk Assessment Sheets SW 1-6 and GWDTE 1-9 to areas designated for the protection of habitats and species**. It documents the principles to be adopted by River Basin Districts and authorities responsible for implementing the Water Framework Directive in Ireland.

REVISION CONTROL TABLE

Status	Approved by National Technical Co-ordination Group	WFD Requirement	Relevant EU Reporting Sheets	Date
Final	March 2005	Pressures and Impacts	GWPI 1, 2,3, 4, 5, 6, 7 & 8	December 2004

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1. Purpose

This paper sets out guidance on the assessment of risk to areas designated for the protection of habitats and species from groundwater abstraction and diffuse and point source pollutants (WFD Groundwater Risk Assessment Sheets SWRA1 to SWRA6 and GWDTERA1 to GWDTERA9, see Appendix). Specific guidance on turloughs (risk assessment sheet GWDTERA2a) is given in Guidance Document GW9 (GW WG, 2004). Principles of risk characterisation and the Risk Assessment sheets are given in Guidance Document GW8 (GW WG, 2004).

2. Background

2.1 Sites Designated for the Protection of Habitats and Species

Article 6 of the Directive states that Member States shall ensure the establishment of a register of all areas "*designated as requiring special protection under specific Community legislation for . . . . the conservation of habitats and species directly depending on water*". Annex IV sets out that these shall include "*areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection, including relevant Natura 2000 sites designated under Directive 92/43/EEC* (The Habitats and Species Directive) *and Directive 79/409/EEC*" (The Birds Directive).

The first tier of the Register of Protected Areas in the Republic of Ireland is composed of Special Areas of Conservation (SACs), designated under the Habitats Directive, and Special Protection Areas (SPAs), designated under the Birds Directive. Only sites on this first tier of the Register are reported to Brussels as part of the Article 5 Report. Second and Third Tiers to the Register will be developed to include sites designated under National Legislation, such as Natural Heritage Areas (NHAs) designated under the Wildlife (Amendment) Act 2000. These lower tiers will be taken into account within the River Basin Management Plan process.

SACs and SPAs are designated for habitats or species considered of international or Community importance, which are listed as Qualifying Interests under the Habitats and Birds Directives . Each SAC/SPA is likely to be designated for a number of Qualifying Interests. The National Parks and Wildlife Service (NPWS) of the Department of Environment, Heritage and Local Government identified which of the Qualifying Interests found in Ireland are water dependent. Data on SACs/SPAs and their Qualifying Interests is available through the GIS Water Dependent Sites (WDS) tool (ERTDI project 2000-W-DS/10, http://www.epa.ie/EnvironmentalResearch/). The tool consists of Access database and GIS elements which allow access to data on SACs and SPAs as held by the NPWS (DEHLG).

2.2 Groundwater dependence: Surface Waters & Groundwater Dependent Terrestrial Ecosystems and Species

NPWS also identified the Qualifying Interests (habitats and species) where the maintenance or improvement of groundwater status is an important factor in their protection. Groundwater dependent habitats are listed in Table 1 and groundwater dependent species in Table 2. Groundwater dependent

habitats include both surface (open) water habitats (e.g. Hard oligo-mesotrophic lakes) and Groundwater Dependent Terrestrial Ecosystems (GWDTEs, e.g. alkaline fens).

2.3 Sensitivity of Habitat and Species to changes in Groundwater Quality/Quantity

The sensitivities of Habitats Directive Qualifying Interests to changes in the quantity and quality of groundwater were assigned by NPWS, based on expert judgement (Table 1 and Table 2). The specific sensitivities of surface water habitats to nitrate and phosphate are outlined in Section 4.2 below. Specific sensitivities have not yet been assigned to bird species considered qualifying interests under the Birds Directive. An appropriate assessment of bird sensitivities will be undertaken by NPWS within the next year.

3. Data Limitations

3.1 Supporting Data

Definitions of groundwater dependence and sensitivities have been based on expert judgement. A comprehensive review of the literature on the relationships between water status and the conservation status of habitats and species will be conducted as part of the NS SHARE project. Further work is required to establish quantitative relationships between habitats/species and changes in groundwater quantity and quality.

3.2 Mapping Data

Maps are available illustrating the area and extent of SACs/SPAs. NPWS are working to produce digital maps of the area and extent of the specific Qualifying Interests within these SACs/SPAs.

4. Risk Assessment

4.1 SAC Screening Procedure

The application of the groundwater Risk Assessment sheets to groundwater dependent habitats and species within SACs, was preceded by the following screening process, elaborated upon below:

- Listing of the groundwater dependent Qualifying Interests (habitats and species) for the SAC;
- Identification of which groundwater Risk Assessments (RA) should be run;
- Assessment of the quality of the available maps;
- Where map quality was sufficient, the catchments of the qualifying interests were delineated;
- Where map data were insufficient, NPWS was contacted for further data;
- Risk Assessment was prioritised, where necessary.

Groundwater risk assessments were not specifically applied to SPAs, as information on bird species sensitivities to groundwater was not available in 2004. These data will be made available by NPWS in 2005. However, as most SPAs are also SACs, the risk assessments were applied to the other groundwater dependent qualifying interests present.

Table 1 Surface water ecosystems and terrestrial ecosystems directly dependent on groundwater. * Indicates priority habitats

EU Habitat Code	EU Annex I Habitat	Number of SACs	Type	Sensitivity to changes in Groundwater Quantity	Sensitivity to changes in Groundwater Quality
1150	* Coastal lagoons	25	SW	low - high	Moderate - high
1330	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	38	GWDTE	low - moderate	low
1410	Mediterranean salt meadows (*Juncetalia maritimi*)	33	GWDTE	low - moderate	low
2170	Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*)	11	GWDTE	high	high
2190	Humid dune slacks	15	GWDTE	high - extreme	high - extreme
21A0	Machairs (* in Ireland)	19	GWDTE	high - extreme	moderate - high
3110	Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*)	32	SW	moderate	extreme
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*	9	SW	moderate	high
3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.	18	SW	high	high-extreme
3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation	9	SW	moderate	moderate
3160	Natural dystrophic lakes and ponds	10	SW	low	extreme
3180	* Turloughs	43	GWDTE	high	moderate - extreme
3260	Watercourses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	21	SW	moderate	moderate
3270	Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation	1	GWDTE	moderate	low
4010	Northern Atlantic wet heaths with *Erica tetralix*	37	GWDTE	low - (extreme)	high
6410	*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)	13	GWDTE	low - moderate	low - moderate
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	3	GWDTE	moderate	moderate
7110	* Active raised bogs	51	GWDTE	low - (extreme)**	low -(high)**
7120	Degraded raised bogs still capable of natural regeneration	53	GWDTE	low - (extreme)**	low -(high)**
7130	Blanket bog (* if active bog)	50	GWDTE	low - (extreme)**	low -(high)**
7140	Transition mires and quaking bogs	16	GWDTE	extreme	moderate
7150	Depressions on peat substrates of the *Rhynchosporion*	62	GWDTE	low	moderate
7210	* Calcareous fens with *Cladium mariscus* and species of *Caricion davallianae*	17	GWDTE	extreme	high
7220	* Petrifying springs with tufa formation (*Cratoneurion*)	19	GWDTE	extreme	extreme
7230	Alkaline fens	39	GWDTE	extreme	high
8310	Caves not open to the public	9	GWDTE	extreme	high
91D0	* Bog woodland	11	GWDTE	extreme	low
91E0	*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-padion*, *Alnion incanae*, *Salicion albae*)	23	GWDTE	moderate	low - high

GWDTE – Groundwater Dependent Terrestrial Ecosystem; SW – Surface Water, Aquatic Ecosystem; ** when fen present

Table 2 Species directly dependent on groundwater.

EU Species Code	EU Annex II Species	Number of SACs	Sensitivity to changes in Groundwater Quantity	Sensitivity to changes in Groundwater Quality
1013	*Vertigo geyeri*	10	extreme	extreme
1014	*Vertigo angustior*	11	high	high
1016	*Vertigo moulinsiana*	7	high	high
1092	*Austropotamobius pallipes*	13	high	moderate
1393	*Drepanocladus vernicosus*	7	extreme	extreme
1528	*Saxifraga hirculus*	4	extreme	extreme

4.1.1 Listing of groundwater dependent Qualifying Interests for the SAC

The GIS WDS tool developed under ERTDI project 2000-W-DS/10 was used to list the groundwater dependent Qualifying Interests for each SAC. (The WDS tool contains tables and maps of groundwater dependent SACs/SPAs. The site details form, which can be opened via the WDS Viewer or Arc View, details the Qualifying Interests of each SAC under the following forms/tabs: Habitats (Annex I), Invertebrates, Vertebrates, Plants, Birds and Fish.) It is important to note that most SACs have a number of Qualifying Interests.

4.1.2 Identification of which Risk Assessments should be run

The Qualifying Interest habitats were divided into surface, open-water features and GWDTEs using Table 1.

4.1.3 Assessment of quality of available maps

Available maps (SAC/SPA and Discovery Series maps) were assessed to determine whether their quality was sufficient to allow the Qualifying Interests, i.e. habitats and species, to be located and their catchments delineated.

4.1.4 Where map quality sufficient, delineation of the catchments of the qualifying interests

The SAC/SPA map, in combination with the Discovery Series maps, was used to locate the Qualifying Interests within each SAC and the catchments were delineated. Discovery Series Maps were used, where possible, to determine the location of lakes. Only catchments for lakes larger than 5 ha were delineated, unless otherwise instructed by NPWS. For many SACs, catchments were delineated for a number of habitats/species, e.g. in Lough Corrib SAC (000297), the catchment of Lough Corrib was delineated for SW risk assessments and the catchment of the eastern fen-complex was delineated for GWDTE risk assessments. Details on how the catchments of habitats in large SAC complexes were delineated are given in Section 4.3 below.

4.1.5 Where map data insufficient, NPWS contacted for further data

Difficulties in delineating the catchment of the Qualifying Interests arose where it is located within a large SAC-complex. When the RBD projects had difficulty identifying the location of the Qualifying Interest within the SAC they contacted NPWS for further details, before attempting to carry out the risk assessment.

4.1.6 Prioritise Risk Assessments

Where there was a need to determine the order in which the Risk Assessments were applied to groundwater dependent habitats/species in SACs/SPAs, priority was given to habitats and species with high sensitivity to changes in groundwater quantity and quality and to areas with high Pressures/Impact Potential.

4.2 Groundwater Risk Assessments SWRA2 and SWRA3

The principal behind identifying sensitive surface water receptors was to apply more stringent criteria to nutrient sensitive ecosystems in SACs. One habitat (coastal lagoons) with high sensitivity to nitrate and phosphate and five lake habitats with high/moderate sensitivity to phosphate were identified (Table 3). The SWRA2 and SWRA3 risk assessments were applied to lagoons/lakes within SACs.

Table 3 Sensitivity of Annex I surface water habitats to diffuse nutrients.

EU Habitat Code	EU Annex I Habitat	NO_3 Sensitivity	PO_4 Sensitivity
1150	* Coastal Lagoons	high	high
3110	Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*)	-	high
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*	-	high
3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.	-	high
3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation	-	moderate
3160	Natural dystrophic lakes and ponds	-	high

4.2.1 SWRA2 Groundwater dependent ecosystems in rivers, lakes, estuaries and lagoons – diffuse mobile inorganics, NO_3

Provision was made in risk assessment sheet SWRA2 to identify high sensitivity ecosystems in Table C (Risk category). Coastal lagoons are currently the only surface water ecosystem identified as having High Sensitivity to nitrate under risk assessment sheet SWRA2.

4.2.2 SWRA3 Groundwater dependent ecosystems in rivers, lakes, estuaries and lagoons – diffuse mobile inorganics, PO_4

Provision was made in risk assessment sheet SWRA3 to identify lakes and lagoons with high sensitivity to phosphate in Table C (Risk category). For all five habitats identified as having high sensitivity to phosphate (Table 3 this document), the more stringent criteria were applied in Table D, "Risk category of groundwater body adjusted using available impact data" of the SWRA3 risk assessment.

4.3 Catchment Delineation

The process of delineating catchment areas of groundwater dependent ecosystems should be seen in the context of the overall Article 5 risk assessment. It was a screening exercise using existing data to prioritise our activities in the river basin management cycle. The points below provide some specific details of how this task was carried out:

- Groundwater Dependent Ecosystems risk assessments only applied to SACs for this Article 5 report.
- The risk assessments comprised sheets SWRA1 – SWRA6 for Groundwater Dependent Rivers, Lakes, Lagoons and Estuaries and sheets GWDTERA1 – GWDTERA9 for Groundwater Dependent Terrestrial Ecosystems.
- The GIS WDS tool developed under ERTDI project 2000-W-DS/10 was used to identify whether an SAC contains a Groundwater Dependent Ecosystems. The EU Habitat Code (e.g. 7230 = alkaline fen) was used to attribute a receptor sensitivity (as designated by NPWS in Table 1 of this document) for Table C of the risk assessment sheets.
- Delineating the catchment area to a Groundwater Dependent Ecosystem involved the following steps:

1. The SAC was split where it traversed one or more groundwater bodies (GWB). In this way large SACs were apportioned to several GWBs.
2. Within each of these GWBs, the catchment area of the relevant portion of the SAC was delineated by clipping contiguous river water bodies.
3. The catchment area was further reduced by using groundwater flow lines where available.
4. The risk assessment was applied to this area.

- These Groundwater Dependent Ecosystem catchment areas were only delineated as separate GWBs if the risk category was 1a or 1b.
- Specific issues for point sources
    1. No quarries put GWB or dependent ecosystem at risk, unless indicated by expert review (Section F of risk sheets).
    2. The national list of point sources with assigned risk category was used.
    3. A Groundwater Dependent SAC was only considered at risk if it contained or was down gradient of an activity that resulted in a 1a or 1b risk category.
- The outcome of the groundwater dependent ecosystems risk assessments was sent to National Parks and Wildlife Service for final review (Section F of risk sheets).
- Where it was not clear how to delineate the catchment area of a particular Qualifying Interest in an SAC without collecting further detailed information, the NPWS was contacted for advice.

Beyond the Article 5 report, detailed hydrogeological and ecological investigations may be required in specific cases to accurately delineate catchment areas to allow implementation of programmes of measures.

5. Membership of Groundwater Working Group

Organisation	Representative(s)
Geological Survey of Ireland (GSI)	Donal Daly (Convenor) Geoff Wright Vincent Fitzsimons Coran Kelly Taly Hunter Williams Monica Lee
Camp Dresser McKee (CDM)	Henning Moe
Compass Informatics Ltd.	Paul Mills
Department of the Environment, Heritage and Local Government (DEHLG)	Pat Duggan Jim Ryan (NPWS) Aine O'Connor (NPWS)
Environment and Heritage Service/ Geological Survey of Northern Ireland (EHS/GSNI)	Peter McConvey
Environmental Protection Agency (EPA)	Margaret Keegan Micheal McCarthaigh
RPS-Kirk McClure Morton (RPS-KMM)	Grace Glasgow Kieran Fay
O'Callaghan Moran (OCM)	Sean Moran Gerry Baker
O'Neill Groundwater Engineering (OGE)	Shane O'Neill
Shannon Pilot River Basin – EPA/TCD Research Fellow	Garrett Kilroy

Southeastern River Basin District (SERBD)	Colin Byrne
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Trinity College, Dublin (TCD)	Paul Johnston Catherine Coxon

6. References

ERTDI project 2000-W-DS/10, http://www.epa.ie/EnvironmentalResearch/

Directive 92/43/EEC The Habitats and Species Directive

Directive 79/409/EEC The Birds Directive

Grennan, E. (1996) *Small Scale Study of former Mine Sites in Ireland*. Compiled by Sligo Institute of Technology and presented to the EPA.

WFD-GW (2001) *The EU Water Framework Directive: Statistical aspects of the identification of groundwater pollution trends, and aggregation of monitoring results*. WFD-GW Trend/ Federal Ministry of Agriculture and Forestry, Austria.

Working Group on Groundwater (2004) Guidance Document GW8: *Methodology for Risk Characterisation of Ireland's Groundwater*, 69 pp.

Working Group on Groundwater, Sub-committee on Turloughs (2004) Guidance Document GW9: *Guidance on the Assessment of Pressures and Impacts on Groundwater Dependent Terrestrial Ecosystems – Risk Assessment Sheet GWDTERA2a – Turloughs*, 19 pp.

Working Group on Groundwater (2004) Guidance Document GW10: *Verifying the Predictive Risk Assessment Methodology for Mobile Diffuse Inorganic Pollutants (NO_3)*. Geological Survey of Ireland for Working Group on Groundwater, 18 pp.

7. Appendix – Risk Assessment Sheets

7.1 Groundwater Risk Assessment SWRA1

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA1**
Receptor type	Groundwater Dependent Ecosystems in Rivers and Lakes
Pressure type	Abstraction
WFD objective	Quantitative status
Assessment area	Surface extent of the groundwater body

Note: Further information and explanation is given in the Groundwater Working Group Report GW5 (2004) "Guidance on the Assessment of the Impact of Groundwater Abstractions".

A. Recharge Estimation

a) Effective Rainfall Estimation

- Obtained from recently produced Meteorological Service maps.

b) Recharge Coefficient

- The Recharge coefficient is the proportion of Effective Rainfall that may become Recharge.
- It should be determined by using Table 1 (below).

c) Applying a Recharge Cap on Poorly productive Aquifers

- A recharge cap is applied to poorly productive aquifers, as they are not capable of accepting the available recharge due to their low transmissivity.
- The recharge cap for Locally Important aquifers, which are moderately productive only in local zones (**Ll**) is 200mm/yr, whereas the cap for Poor Aquifers (**Pl & Pu**) is 100mm/yr.

B. Impact potential

IMPACT POTENTIAL		**Aquifer Type**	
		Bedrock	***Sand/gravel***
GWABS as a % of average recharge	>30%	High	High
	20 to 30%	High	Moderate
	10 to 20%	Moderate	Low
	2 to 10%	Low	Low
	<2%	Negligible	Negligible

C. Risk category based on predictive risk assessment and available impact data

Potential Impact	**Evidence for GW level decline**	**No/ insufficient evidence for GW level decline**	**Evidence of no GW decline**
High	At Significant Risk (1a)	Probably at risk (1b)	Not at significant risk (low confidence) (2a) to Not at significant risk (2b) based on confidence in the data
Moderate	At Significant Risk (1a)	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)
Low	At Significant Risk (1a) to Probably at risk (1b) based on confidence in the data	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)

Table 1 Recharge Coefficients for different hydrogeological settings

Vulnerability category		**Hydrogeological setting**	**Recharge coefficient (rc)**		
			Min (%)	*Inner Range*	*Max (%)*
Extreme	1.i	Areas where rock is at ground surface	60	80-90	100
	1.ii	Sand/gravel overlain by 'well drained' soil	60	80-90	100
		Sand/gravel overlain by 'poorly drained' (gley) soil			
	1.iii	Till overlain by 'well drained' soil	45	50-70	80
	1.iv	Till overlain by 'poorly drained' (gley) soil	15	25-40	50
	1.v	Sand/ gravel aquifer where the water table is ≤ 3 m below surface	70	80-90	100
	1.vi	Peat	15	25-40	50
High	2.i	Sand/gravel aquifer, overlain by 'well drained' soil	60	80-90	100
	2.ii	High permeability subsoil (sand/gravel) overlain by 'well drained' soil	60	80-90	100
	2.iii	High permeability subsoil (sand/gravel) overlain by 'poorly drained' soil			
	2.iv	Moderate permeability subsoil overlain by 'well drained' soil	35	50-70	80
	2.v	Moderate permeability subsoil overlain by 'poorly drained' (gley) soil	15	25-40	50
	2.vi	Low permeability subsoil	10	23-30	40
	2.vii	Peat	0	5-15	20
Moderate	3.i	Moderate permeability subsoil and overlain by 'well drained' soil	25	30-40	60
	3.ii	Moderate permeability subsoil and overlain by 'poorly drained' (gley) soil	10	20-40	50
	3.iii	Low permeability subsoil	5	10-20	30
	3. iv	Basin peat	0	3-5	10
Low	4.i	Low permeability subsoil	2	5-15	20
	4.ii	Basin peat	0	3-5	10
High to Low	5.i	High Permeability Subsoils (Sand & Gravels)	60	90	100
	5.ii	Moderate Permeability Subsoil overlain by well drained soils	25	60	80
	5.iii	Moderate Permeability Subsoils overlain by poorly drained soils	10	30	50
	5.iv	Low Permeability Subsoil	2	20	40
	5.v	Peat	0	5	20

7.2 Groundwater Risk Assessment SWRA2

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA2**
Receptor type	Groundwater dependent ecosystems in rivers, lakes, estuaries and lagoons
Pressure type	Diffuse – mobile inorganics (NO_3)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers**
Vertical pathway***	Soil & subsoil	'Wet' soil	L	L	L	L
		Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	L
		High	H	H	H	L
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to Low**	H	H	H	M

* These aquifers are not considered to be contributing a significant proportion of water to rivers and lakes and therefore are not included in pathway susceptibility.
** For areas where complete vulnerability map is not available form GSI.
*** The 'wet' soil and low permeability subsoil layers take precedence over the vulnerability layers.

B. Impact potential

IMPACT POTENTIAL*		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage	High	High	Moderate	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	Moderate	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Low	Low	Low	Low
	<1.0 LU ha^{-1} or <3% tillage	Negligible	Negligible	Negligible	Negligible

*Deriving Impact Potential
Individual Impact Potential maps are derived for the three types of pressures: cattle/sheep, pigs/poultry and tillage i.e. each grid cell within the maps will have three Impact Potential categories.
The ***highest*** Impact Potential category is taken for each cell, regardless of the type of pressure.
Within each GWB, the total area of **'H' plus 'M'** Impact Potential is used to determine whether the GWB is 'at risk' (see C below).

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		>50%	*25-50%**	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity (nitrate-limited ecosystems)	1b	1b	1b	2a	2a	2b
	Moderate (Rivers)	1b	1b	2a	2a	2b	2b

*The basis for this threshold is given in Guidance Document no. GW10 (GW WG, 2004).

D. Risk category of groundwater body adjusted using available impact data

PREDICTIVE RISK CATEGORY	Adjustments made using available groundwater impact data	
	Data criteria	*Adjusted risk category*
1b	Weighted mean NO_3-N >11.3 mg l^{-1}	1a or 1b, depending on level of confidence in the monitoring data
2a 2b	Weighted mean NO_3-N 5.65-11.3 mg l^{-1}	1b or 2a, depending on level of confidence in the monitoring data
2b	Weighted mean NO_3-N 2.0-5.65 mg l^{-1}	2a
	Weighted mean NO_3-N <2.0 mg l^{-1}	2b

7.3 Groundwater Risk Assessment SWRA3

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA3**
Receptor type	Groundwater Dependent Ecosystems in river, lake, estuary and lagoon Water Bodies
Pressure type	Diffuse – low mobility inorganics (PO_4)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (horizontal pathway)**						
			Karst aquifers		*Fissured aquifers*		*Intergranular aquifers*	*Poorly productive aquifers*	
Vertical pathway	Soil & karst features		Dry soil	Wet soil	Dry soil	Wet soil	n/a	Dry soil	Wet soil
	Vulnerability: Extreme	0-1 m soil & subsoil	E	E	E	H	n/a **	H	M
		1-3 m soil subsoil	E	E*	H	M	n/a	M	L
	High		M		M		M	L	
	Moderate		L		L		L	L	
	Low		L		L		L	L	
	High to low***		M		M		M	L	

n/a = not applicable

* This ranking allows for bypass of the soil/subsoil at swallow holes; where swallow holes are absent, the appropriate ranking is 'H'. However, the default ranking is 'E'.

** Where sand/gravel aquifers are classed as 'extremely' vulnerable due to the presence of a shallow water table, the pathway susceptibility is considered to be moderate.

*** For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL*		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage	High	High	Low	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	High	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Moderate	Low	Low	Low
	0.5-1.0 LU ha^{-1} or <3% tillage	Moderate	Negligible	Negligible	Negligible
	<0.5 LU ha^{-1}	Low	Negligible	Negligible	Negligible

*Deriving Impact Potential

Individual Impact Potential maps are derived for the three types of pressures: cattle/sheep, pigs/poultry and tillage i.e. each grid cell within the maps will have three Impact Potential categories.

The ***highest*** Impact Potential category is taken for each cell, regardless of the type of pressure.

Within each GWB, the total area of **'H' plus 'M'** Impact Potential is used to determine whether the GWB is 'at risk' (see C below).

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity*	1b	1b	2a	2a	2a	2b
	Moderate	1b	2a	2a	2a	2b	2b

* high sensitivity refers to certain sensitive lakes and lagoons

D. Risk category of groundwater body adjusted using available impact data (*)

Adjustments for rivers and lakes in GWB		
Predictive Risk Category	*Data Criteria***	*Adjusted risk category*
1b	MRP > 60 µg l^{-1}	1a
2a	MRP 30-60 µg l^{-1}	1b
2b	MRP 30-60 µg l^{-1} [1]20-30 µg l^{-1}	2a or 1b, depending on level of confidence in the monitoring data
	MRP < 30µg l^{-1} [1]<20 µg l^{-1}	2b

* Note: generally only MRP data will be available for groundwater, in which case only river criteria can apply.
** Median unfiltered Molybdate Reactive Phosphorus based on Phosphorus regulations which indicate that when in-river median MRP> 30µg l^{-1} the Q-value is generally less than Q4 (reference: McGarrigle *et al*. (2002) Appendix I). The 60 µg l^{-1} threshold is taken from SEPA, but is used here to highlight particular hotspots.

[1] For protected areas (SPA and SAC) more stringent criteria apply. The 20 µg l^{-1} threshold is taken from McGarrigle *et al*. (2002) Appendix I, which indicates that when in-river median MRP> 20 µg l^{-1} the Q-value is generally less than Q4-5.

7.4 Groundwater Risk Assessment SWRA4

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA4**
Receptor type	Groundwater Dependent Ecosystems in River & Lake Water Bodies
Pressure type	Diffuse – mobile organics (pesticides and PAHs)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater bodies contributing significant flows to surface waters (i.e. productive aquifers).

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Sub-soil	Low permeability subsoil*	L	L	L	L
	Vulnerability	Extreme	E	E	H	M
		High	H	H	H	L
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to low**	H	H	H	M

* In areas where GSI subsoil permeability map is unavailable, use vulnerability map alone.
** For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

* Pressure magnitude
The pressures that are considered to pose a significant threat to groundwater are: urban and industrial areas, tillage, major roads and railways.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Proportion of assessment area with high and moderate impact potential**					
		>50%	*25-50%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity (all GW bodies)	1b	1b	1b	2a	2a	2b
	Moderate/Low sensitivity	n/a	n/a	n/a	n/a	n/a	n/a

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available groundwater impact data**	
	*Data criteria***	*Adjusted risk category*
1b	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05 µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01 µg/l in more than 2 samples, OR Maximum trace organic >100 µg/l in any one sample.	1a or 1b, depending on level of confidence in the monitoring data
2a	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01µg/l in more than 2 samples, OR Maximum total trace organic >0.1 µg/l in any one sample.	1b
2b	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01µg/l in more than 2 samples, OR Maximum total trace organic >0.1 µg/l in any one sample.	2a or 1b, depending on level of confidence in the monitoring data

** copied from SEPA approach.

7.5 Groundwater Risk Assessment SWRA5

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA5**
Receptor type	Groundwater Dependent Ecosystems in Rivers, Lakes & Estuaries
Pressure type	Clustered on-site systems & Leaking Urban Sewerage Systems* – inorganics (N & P)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

* Both pressures are assumed to produce similar pollutants. Nitrates and phosphate are the pollutants considered in this RA.

A. Pathway susceptibility

Table A1

PATHWAY SUSCEPTIBILITY FOR NITRATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	M*
		High	H	H	H	M*
		Moderate	M	M	M	L*
		Low	L	L	L	L*
		High to Low	H	H	H	M*

*In poorly productive aquifers where denitrification is not considered likely to occur, these categories should be the same as the karst and fissured aquifers categories.

Table A2

PATHWAY SUSCEPTIBILITY FOR PHOSPHATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	n/a *	H
		High	M	M	n/a *	M
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to Low**	M	M	M	M

*Where sand/gravel aquifers are classed as 'extremely' vulnerable due to the presence of a shallow water table, the pathway susceptibility is considered to be moderate.
**Where complete GSI vulnerability map is not available.

B. Impact Potential

The presence of urban and discontinuous urban fabric from CORINE and/or built up areas from the Ordnance Survey maps make up the pressure layer on the groundwater body.

IMPACT POTENTIAL		**Nitrate Pathway Susceptibility (from Table A1)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

IMPACT POTENTIAL		**Phosphate Pathway Susceptibility (from Table A2)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Proportion of assessment area with high and moderate impact potential**					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Pollutant	Phosphate	1b	1b	1b	2a	2a	2b
	Nitrate	1b	2a	2a	2a	2b	2b

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by GSI, EPA, local authorities or RBD consultants	1a
2a	Where significant impacts are known to occur by GSI, EPA, local authorities or RBD consultants	1b or 1a, depending on confidence in data and/or degree of impact.

7.6 Groundwater Risk Assessment SWRA6

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA6**
Receptor type	Groundwater dependent ecosystems in River, Lake and Estuary Water Bodies
Pressure type	Mining – mobile inorganics
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

As mines are generally deep, this is not a factor in the RA process. The value of the groundwater resource is taken into account in considering the potential impacts.

B. Impact potential

		Impact Potential
Pressure magnitude	High (based largely on expert judgement)*	High
	Low (based largely on expert judgement)	Low

*expert judgement provided by Grennan (1996), RPS-KMM and EPA.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Impact potential (from Table B)**	
		High	*Low*
Receptor Sensitivity	High sensitivity*	n/a	n/a
	Moderate	1b	2a

*not applicable – see RA sheet GWDTERA4.

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by GSI, EMD, EPA, RBD consultants or local authorities	1a
2a	Where impacts are known to occur by GSI, EMD, EPA, RBD consultants or local authorities	1b or 1a, depending on confidence in data and/or degree of impact.

7.7 Groundwater Risk Assessment GWDTERA1

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA1**
Receptor type	Groundwater Dependent Terrestrial Ecosystems (incl. turloughs)
Pressure type	Abstraction
WFD objective	Quantitative status
Assessment area	Catchment area of ecosystem

A. Recharge Estimation

a) Effective Rainfall Estimation

- Obtained from recently produced Meteorological Service maps.

b) Recharge Coefficient

- The Recharge coefficient is the proportion of Effective Rainfall that may become Recharge.
- It should be determined by using Table 1 (below).

c) Applying a Recharge Cap on Poorly productive Aquifers

- A recharge cap is applied to poorly productive aquifers, as they are not capable of accepting the available recharge due to their low transmissivity.
- The recharge cap for Locally Important aquifers, which are moderately productive only in local zones (**Ll**) is 200mm/yr, whereas the cap for Poor Aquifers (**Pl & Pu**) is 100mm/yr.

B. Catchment Area of GWDTE

The RA applies to the area contributing water to the GWDTE. Therefore, the catchment area of the GWDTE must be delineated, even if only approximately. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For instance, the surface water catchment may be used where it equates closely to the catchment area. Alternatively, groundwater flow lines (estimated, in most instances) may be used.

C. Impact potential

The impact of abstraction may result from general abstraction in the catchment area and/or from wells in the immediate vicinity of the boundary of the GWDTE. Impacts can also be caused by drainage; only arterial drainage is considered in this assessment.

C1. Potential impact resulting from abstraction in GWDTE catchment area

Use Table below.

IMPACT POTENTIAL ↘		**GWDTE Sensitivity to Abstraction**	
		High	*Moderate to Low*
GWABS as a % of average recharge in 'catchment' of GWTDE	>20%	High	High
	10 to 20%	High	Moderate
	5 to 10%	High	Low
	<5%	Moderate	Low

C2. Local abstraction & arterial drainage

Use Table below.

IMPACT POTENTIAL			GWDTE Sensitivity to Abstraction	
			High	*Moderate to Low*
Local abstractions & arterial drainage	>10 m^3/d	Within GWDTE	High	Moderate/low
	>100 m^3/d	Within GWDTE	High	High
		Within 100 m of boundary	High	Moderate/low
	>500 m^3/d.	Within GWDTE	High	High
		Within 100 m of boundary	High	High
		Within 500 m of boundary	High	Moderate/low
	Arterial drainage	Within 100 m of boundary	High	High

D. Risk category based on predictive risk assessment and available impact data

Potential Impact	**Evidence for GW level decline**	**No/ insufficient evidence for GW level decline**	**Evidence of no GW decline**
High	At Significant Risk (1a)	Probably at risk (1b)	Not at significant risk (low confidence) (2a) to Not at significant risk (2b) based on confidence in the data
Moderate	At Significant Risk (1a)	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)
Low	At Significant Risk (1a) to Probably at risk (1b) based on confidence in the data	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)

Table 1 Recharge coefficients for different hydrogeological settings

VULNERABILITY CATEGORY		Hydrogeological setting	Recharge coefficient (rc)		
			Min (%)	*Inner Range*	*Max (%)*
Extreme	1.i	Areas where rock is at ground surface	60	80-90	100
	1.ii	Sand/gravel overlain by 'well drained' soil	60	80-90	100
		Sand/gravel overlain by 'poorly drained' (gley) soil			
	1.iii	Till overlain by 'well drained' soil	45	50-70	80
	1.iv	Till overlain by 'poorly drained' (gley) soil	15	25-40	50
	1.v	Sand/ gravel aquifer where the water table is ≤ 3 m below surface	70	80-90	100
	1.vi	Peat	15	25-40	50
High	2.i	Sand/gravel aquifer, overlain by 'well drained' soil	60	80-90	100
	2.ii	High permeability subsoil (sand/gravel) overlain by 'well drained' soil	60	80-90	100
	2.iii	High permeability subsoil (sand/gravel) overlain by 'poorly drained' soil			
	2.iv	Moderate permeability subsoil overlain by 'well drained' soil	35	50-70	80
	2.v	Moderate permeability subsoil overlain by 'poorly drained' (gley) soil	15	25-40	50
	2.vi	Low permeability subsoil	10	23-30	40
	2.vii	Peat	0	5-15	20
Moderate	3.i	Moderate permeability subsoil and overlain by 'well drained' soil	25	30-40	60
	3.ii	Moderate permeability subsoil and overlain by 'poorly drained' (gley) soil	10	20-40	50
	3.iii	Low permeability subsoil	5	10-20	30
	3. iv	Basin peat	0	3-5	10
Low	4.i	Low permeability subsoil	2	5-15	20
	4.ii	Basin peat	0	3-5	10
High to Low	5.i	High Permeability Subsoils (Sand & Gravels)	60	90	100
	5.ii	Moderate Permeability Subsoil overlain by well drained soils	25	60	80
	5.iii	Moderate Permeability Subsoils overlain by poorly drained soils	10	30	50
	5.iv	Low Permeability Subsoil	2	20	40
	5.v	Peat	0	5	20

7.8 Groundwater Risk Assessment GWDTERA2a

Summary details on pressures, receptors and WFD objective

RA Sheet	GWDTERA2a
Receptor type	Groundwater Dependent Terrestrial Ecosystems: Turloughs
Pressure type	Diffuse – low mobility inorganics (PO_4)
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

Note: Further information and explanation is given in the Groundwater Working Group Report GW9 (2004)

A. Pathway susceptibility

Catchment area of the turlough

The RA applies to the area contributing water to the GWDTE. Therefore, the catchment area of the GWDTE must be delineated, even if only approximately. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For turlough catchments this will include an assessment of the flow types in the catchment i.e. epikarstic, conduit type, or a combination thereof, and identification of dominant flow routes. Delineation will then include one or more of topographic, bedrock or groundwater catchment delineation.

PATHWAY SUSCEPTIBILITY				**Flow Regime (horizontal pathway)**			
				Karst aquifers		*Poorly productive and/or fissured aquifers contributing surface waters to turlough catchment.*	
Vertical pathway	Soil & contributing area			*Dry soil*	*Wet soil*	*<50 m from a stream channel*	*Remainder of catchment area*
	Vulnerability	Extreme	0-1 m soil & subsoil	E	E	E	H
			1-3 m soil subsoil	E	E*		
		High		M			
		Moderate		L			
		Low		L			

n/a = not applicable

*This ranking allows for bypass of the soil/subsoil at swallow holes; where swallow holes are absent, the appropriate ranking is 'H'. However, the default ranking is 'E'.

B. Impact potential

	IMPACT POTENTIAL	**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage Heavily fertilized forestry on peat* Q value < 4** in surface water	High	High	Low	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	High	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Moderate	Low	Low	Low
	0.5-1.0 LU ha^{-1} or <3% tillage	Moderate	Negligible	Negligible	Negligible
	<0.5 LU ha^{-1}	Low	Negligible	Negligible	Negligible

*Heavily fertilized forestry (on peat) corresponds almost completely to Sitka spruce. This measure is taken to be a surrogate measure of associated nutrient load from forestry.

**Q value of surface water contributed by poorly productive and/or fissured aquifers and/or of any surface waters within the catchment area. A Q value of ≥4 corresponds to <30µg/l MRP

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of turlough catchment with high and moderate impact potential					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	Extreme sensitivity*	1b	1b	1b	2a	2a	2b
	High sensitivity	1b	1b	2a	2a	2b	2b
	Moderate sensitivity	1b	2a	2a	2b	2b	2b

*Extreme, high and moderate receptor sensitivity classes were defined by NPWS using turlough vegetation data.

D. Risk category of turlough catchment adjusted using available impact data

Adjustments for turlough catchment						
Predictive Risk Category	**Turlough data Criteria***			**Groundwater data criteria*****		
	*High/moderate sensitivity receptors***	*Extremely sensitive receptors*	*Adjusted Risk Category*	*High/moderate sensitivity receptors***	*Extremely sensitive receptors*	*Adjusted Risk Category*
1b	Total P > 30 µg l^{-1}	Total P >10 µg l^{-1}	1a	MRP >30 µg l^{-1}	MRP >10 µg l^{-1}	1a
2a	Total P 20-30 µg l^{-1}		1b	MRP 20-30 µg l^{-1}		1b
2b	Total P 10-20 µg l^{-1}	Total P <10 µg l^{-1}	2a or 1b depending on confidence in the monitoring data	MRP 10-20 µg l^{-1}	MRP <10 µg l^{-1}	2a or 1b depending on confidence in the monitoring data
	Total P <10 µg l^{-1}		2b	MRP <10µg l^{-1}		2b

* Mean TP of turlough water, based on a mean of monthly sampling during the flood period, but excluding the extreme beginning and end of the flood period. Thresholds are based on the Phosphorus Regulations' standards for total phosphorus (TP) in lakes, which indicate that when mean TP ≤10 µg l^{-1} the lake is oligotrophic and >10 to ≤20 µg l^{-1} mesotrophic. (Reference: McGarrigle *et al*. (2002) Appendix I).

** Sensitivity of receptor (turlough) is that defined by NPWS from turlough vegetation studies.

*** Groundwater data is expressed as median unfiltered Molybdate Reactive Phosphorus (MRP). As many turloughs are conduit fed it is assumed that there will be very little attenuation in phosphorus concentrations in groundwater discharges to the turlough. For this reason it was considered more appropriate to use lake rather than river phosphorus regulation standards. See note (*) above.

E. Additional Impact data

In addition to the type of phosphorus data described in Table D above, a number of turloughs have been assessed by the Ecological sub-group of the Turloughs Working Group, and the degree to which they are impacted has been described qualitatively. These data may be used to adjust the risk category of the turlough catchment, with the proviso that the data apply only to the immediate turlough basin and not the catchment, and that the data may not be consistent, as they reflect the focus of the visiting ecologist.

F. Expert Review Recommendations

Expert review of the outcome of this risk assessment is recommended by EPA staff with field experience of the catchment area of the GWDTE and knowledge of surface water impacts.

Final expert review is recommended by National Parks and Wildlife Service staff who may recommend upgrading of the risk category based on available impact data and local knowledge of the SAC/SPA involved.

7.9 Groundwater Risk Assessment GWDTERA2b

Summary details on pressures, receptors and WFD objective

RA Sheet	GWDTERA2b
Receptor type	Groundwater Dependent Terrestrial Ecosystems (excluding turloughs)
Pressure type	Diffuse – low mobility inorganics (PO_4)
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

Note: Further information and explanation is given in the Groundwater Working Group Report GW11 (2004)

A. Pathway susceptibility

Catchment area of the GWDTE

The RA applies to the area contributing water to the GWDTE. Therefore, the catchment area of the GWDTE must be delineated, even if only approximately. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow.

Table A1

PATHWAY SUSCEPTIBILITY				Flow Regime (horizontal pathway)						
				Karst aquifers		*Fissured aquifers*		*Intergranular aquifers*	*Poorly productive aquifers*	
Vertical pathway	Soil & karst features			*Dry soil*	*Wet soil*	*Dry soil*	*Wet soil*	*n/a*	*Dry soil*	*Wet soil*
	Vulnerability	Extreme	0-1 m soil & subsoil	E	E	E	H	n/a **	H	M
			1-3 m soil & subsoil	E	E*	H	M	n/a	M	L
		High		M		M		M	L	
		Moderate		L		L		L	L	
		Low		L		L		L	L	
		High to low***		M		M		M	L	

n/a = not applicable

* This ranking allows for bypass of the soil/subsoil at swallow holes; where swallow holes are absent, the appropriate ranking is 'H'. However, the default ranking is 'E'.

** Where sand/gravel aquifers are classed as 'extremely' vulnerable due to the presence of a shallow water table, the pathway susceptibility is considered to be moderate.

*** For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL*		Pathway Susceptibility (from Table A)			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage	High	High	Low	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	High	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Moderate	Low	Low	Low
	0.5-1.0 LU ha^{-1} or <3% tillage	Moderate	Negligible	Negligible	Negligible
	<0.5 LU ha^{-1}	Low	Negligible	Negligible	Negligible

*Deriving Impact Potential

Individual Impact Potential maps are derived for the three types of pressures: cattle/sheep, pigs/poultry and tillage i.e. each grid cell within the maps will have three Impact Potential categories.

The ***highest*** Impact Potential category is taken for each cell, regardless of the type of pressure.

Within each GWB, the total area of **'H' plus 'M'** Impact Potential is used to determine whether the GWB is 'at risk' (see C below).

C. Risk category based on predictive risk assessment

RISK CATEGORY		PROPORTION OF ASSESSMENT AREA WITH HIGH AND MODERATE IMPACT POTENTIAL					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	Extreme sensitivity*	1b	1b	1b	2a	2a	2b
	High/Moderate	1b	1b	2a	2a	2b	2b

*Receptor sensitivity refers to certain sensitive GWDTE as determined by NPWS

D. Risk category of GWDTE adjusted using available groundwater data (*)

Adjustments for GWDTE catchment			
PREDICTIVE RISK CATEGORY	**Groundwater data criteria****		
	*High/moderate sensitivity receptors***	*Extremely sensitive receptors*	*Adjusted Risk Category*
1b	MRP >30 µg l^{-1}	MRP >15 µg l^{-1}	1a
2a	MRP 20-30 µg l^{-1}		1b
2b	MRP 15-20 µg l^{-1}	MRP <15 µg l^{-1}	2a or 1b depending on confidence in the monitoring data
	MRP <15 µg l^{-1}		2b

* Note: generally only MRP data will be available for groundwater, in which case only river criteria can apply.
** Groundwater data are expressed as median unfiltered Molybdate Reactive Phosphorus (MRP) based on Phosphorus regulations which indicate that when in-river median MRP >15µg l^{-1}, >20µg l^{-1} and > 30µg l^{-1} the Q-value is generally less than Q5, Q4-5 and Q4 respectively. (Reference: McGarrigle *et al*. (2002) Appendix I).

E. Expert Review Recommendations

Expert review of the outcome of this risk assessment is recommended by EPA staff with field experience of the catchment area of the GWDTE and knowledge of surface water impacts.

Final expert review is recommended by National Parks and Wildlife Service staff who may recommend upgrading of the risk category based on available impact data and local knowledge of the SAC/SPA involved.

7.10 Groundwater Risk Assessment GWDTERA3

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA3**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Clustered on-site systems & Leaking Urban Sewerage Systems* – inorganics (N & P)
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

* Both pressures are assumed to produce similar pollutants. Nitrates and phosphate are the pollutants considered in this RA.

A. Pathway susceptibility

Table A1

PATHWAY SUSCEPTIBILITY FOR NITRATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	M*
		High	H	H	H	M*
		Moderate	M	M	M	L*
		Low	L	L	L	L*
		High to Low	H	H	H	M*

*In poorly productive aquifers where denitrification is not considered likely to occur, these categories should be the same as the karst and fissured aquifers categories.

Table A2

PATHWAY SUSCEPTIBILITY FOR PHOSPHATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	n/a *	H
		High	M	M	n/a *	M
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to Low**	M	M	M	M

*Where sand/gravel aquifers are classed as 'extremely' vulnerable due to the presence of a shallow water table, the pathway susceptibility is considered to be moderate.
**Where complete GSI vulnerability map is not available.

B. Impact Potential

The presence of urban and discontinuous urban fabric from CORINE and/or built up areas from the Ordnance Survey maps make up the pressure layer on the groundwater body.

IMPACT POTENTIAL		Nitrate Pathway Susceptibility (from Table A1)			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

IMPACT POTENTIAL		Phosphate Pathway Susceptibility (from Table A2)			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Pollutant	Phosphate	1b	1b	1b	2a	2a	2b
	Nitrate	1b	2a	2a	2a	2b	2b

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by NPWS or RBD consultants	1a
2a	Where significant impacts are known to occur by NPWS or RBD consultants	1b or 1a, depending on confidence in data and/or degree of impact.

7.11 Ground Water Risk Assessment GWDTERA4

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA4**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Mining
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	**E**	**E**	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, GSI, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

ASSESSMENTS MADE ON THE BASIS OF PREDICTIONS FROM PRESSURE-SUSCEPTIBILITY ANALYSIS		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

7.12 Ground Water Risk Assessment GWDTERA5

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA5**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Quarries
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	**E**	**E**	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, GSI, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

7.13 Ground Water Risk Assessment GWDTERA6

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA6**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Landfills
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	**E**	**E**	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

7.14 Ground Water Risk Assessment GWDTERA7

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA7**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Oil industry infrastructure
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	**E**	**E**	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

7.15 Ground Water Risk Assessment GWDTERA8

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA8**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Contaminated land
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	**E**	**E**	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

7.16 Ground Water Risk Assessment GWDTERA9

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA9**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Urban Wastewater Discharges
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	**E**	**E**	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		