

## Groundwater Response Matrix for Out Wintering Pads (OWPs)

An explanation of the role of groundwater protection responses in a groundwater protection scheme is given in *Groundwater Protection Schemes* (DoELG/EPA/GSI, 1999).

The role of the groundwater response matrix is to provide an initial evaluation of the general suitability of a site for an OWP, from a hydrogeological perspective, as part of the desk study. It can also be used to indicate the measures that may be required to meet the required specification.

The geological and hydrogeological data that place a site within a response category is general to an area, and not specific to a site. It is therefore incumbent on the developer to demonstrate that the site conditions of a specific site are determined, before a decision is taken on the suitability or otherwise of a site. Examples of uncertainty on available data can include depth to rock values (and hence vulnerability ratings) and the presence of sand/gravel.

A risk assessment approach is taken in the development of this response matrix. The appropriate response to the risk of groundwater contamination from an OWP in the different hydrogeological settings in Ireland (see Table 1) is given by the assigned response category (**R**) appropriate to each protection zone – see Table 2.

**Table 1 Matrix of Groundwater Protection Zones**

Vulnerability Rating	Source Protection Area		RESOURCE PROTECTION AREA						
	Inner (SI)	Outer (SO)	Aquifer Category						
			Regionally Important Aquifer			Locally Important Aquifer		Poor Aquifer	
			Rk	Rf	Rg	Lg	Ll/Lm	Pl	Pu
Extreme	SI/E	SO/E	Rk/E	Rf/E	Rg/E	Lg/E	Ll/E	Pl/E	Pu/E
High	SI/H	SO/H	Rk/H	Rf/H	Rg/H	Lg/H	Ll/H	Pl/H	Pu/H
Moderate	SI/M	So/m	Rk/M	Rf/M	Rg/M	Lg/M	Ll/M	Pl/M	Pu/M
Low	SI/L	SO/L	Rk/L	Rf/L	Rg/L	Lg/L	Ll/L	Pl/L	Pu/L
	→	→	→	→	→	→	→	→	→

↓→ directions of decreasing risk to groundwater

**Table 2 Response Matrix for OWPs**

Vulnerability Rating	Source Protection Area		RESOURCE PROTECTION AREA						
	Inner (SI)	Outer (SO)	Aquifer Category						
			Regionally Important Aquifer			Locally Important Aquifer		Poor Aquifer	
			Rk*	Rf	Rg	Lg	Ll/Lm	Pl	Pu
Extreme	R4	R3 <sup>4</sup>	R3 <sup>3</sup>	R3 <sup>2</sup>	R4	R4	R3 <sup>1</sup>	R3 <sup>1</sup>	R3 <sup>1</sup>
High	R2 <sup>4</sup>	R2 <sup>3</sup>	R2 <sup>2</sup>	R2 <sup>1</sup>	R2 <sup>1</sup>	R2 <sup>1</sup>	R1	R1	R1
Moderate	R2 <sup>4</sup>	R2 <sup>3</sup>	R2 <sup>2</sup>	R1	R1	R1	R1	R1	R1
Low	R2 <sup>3</sup>	R2 <sup>3</sup>	R2 <sup>2</sup>	R1	R1	R1	R1	R1	R1

\*A small proportion of the country (~0.6%) is underlain by locally important karstic aquifers (Lk); in these areas, the groundwater protection responses for the Rk groundwater protection zone shall apply.

**R1** Acceptable, subject to normal good practice (i.e. investigation, construction, operation and maintenance in accordance with DAFF Minimum Specification Sxxx) and to meeting the following requirements:

1. The OWP shall be underlain by either a subsoil liner or a geomembrane liner.

2. Where a subsoil liner is used:
  - the OWP should be underlain by at least 1.0 m of cohesive subsoil. An upper portion of the subsoil, which will vary in thickness depending on the level of risk posed by the OWP, shall have a permeability of less than  $1 \times 10^{-8}$  m/s.
  - Where this is present in situ, (i.e. the subsoil is classed as CLAY (using BS5930) or, in certain situations, SILT/CLAY, has a clay content of >13% (where the particle size distribution is adjusted by excluding materials larger than 20 mm), and is free from preferential flowpaths, the surface of the excavated portion of the tank will require plastering with remoulded subsoil.
  - Where the subsoil is considered to have a permeability of greater than  $1 \times 10^{-8}$  m/s (i.e. is classed as SILT or, in certain situations, SILT/CLAY, and the clay content is <13% but >10%,) the subsoil must be enhanced by compaction to achieve the required permeability standard. Where the subsoil is classed as SAND, GRAVEL or SILT (in circumstances where the clay content is <10%), suitable subsoil must be provided for the liner or alternatively a geomembrane liner must be used.

Where a geomembrane liner is used:

- the liner should be underlain by at least 0.15 m subsoil (the upper 0.05 m is Sand) and overlain by 0.2 m of low to moderate permeability subsoil. The permeability of this subsoil may range from high to low, i.e. subsoil types SAND to CLAY. (Alternative wording 'The texture of the subsoil may range from sand to clay.')
3. For subsoil liners, the upper 0.5m shall have a permeability of less than  $1 \times 10^{-8}$  m/s.
  4. Where the subsoil is sand/gravel, the upper 0.75 m of the liner shall be installed with a permeability of less than  $1 \times 10^{-8}$  m/s. Alternatively, a geomembrane liner may be used.
  5. The OWP shall be at least 60 m away from any well or spring used for potable water.

**R2<sup>1</sup>** Acceptable, subject to normal good practice, meeting requirements 1, 2, 4 and 5 above, and the following additional requirement:

6. For subsoil liners, the OWP should be underlain by at least 1m of cohesive subsoil, of which the upper 0.75 m shall be installed with a permeability of less than  $1 \times 10^{-8}$  m/s. For geomembrane liners, the minimum thickness of subsoil beneath the liner shall be 0.15 m (0.05 m sand) and 0.2 m above the liner.

**R2<sup>2</sup>** Acceptable, subject to normal good practice, meeting design requirements 1, 2, 4, 5 and 6 above, and the following additional requirements:

7. The OWP shall be at least 15 m away from karst features that indicate enhanced zones of high bedrock permeability (e.g. swallow holes and dolines (collapse features)).
8. The site assessment shall pay particular attention to the possibility of instability in these karst areas.

**R2<sup>3</sup>** Acceptable, subject to normal good practice, meeting requirements 1, 2, 4, 5, 6, 7 (in karst areas) and 8 (in karst areas).

**R2<sup>4</sup>** Acceptable, subject to normal good practice, meeting requirements 1, 2, 4, 5, 6, 7 (in karst areas) and 8 (in karst areas), and the following additional requirement:

9. Where microbial pathogens and/or high nitrate concentrations are known to be present in the water supply source, more detailed site investigation and/or restrictive design requirements may be necessary.

**R3<sup>1</sup>** Not generally acceptable, unless requirements 1, 2, 3, 4 and 5 can be met (<sup>see Note 1</sup>).

**R3<sup>2</sup>** Not generally acceptable, unless requirements 1, 2, 4, 5 and 6 can be met (<sup>see Note 1</sup>).

**R3<sup>3</sup>** Not generally acceptable, unless requirements 1, 2, 4, 5, 6, 7 and 8 can be met (<sup>see Note 1</sup>).

**R3<sup>4</sup>** Not generally acceptable, unless requirements 1, 2, 4, 5, 6, 7 (in karst areas), 8 (in karst areas), and 9 can be met (<sup>see Note 1</sup>).

**R4** Not acceptable

Note 1: Achieving the required minimum subsoil thickness beneath the ponds is unlikely to be achievable.