

APPENDICES

Appendix A

Ground Water Body Delineation

South Eastern River Basin District Management System Initial Characterisation Report

It is estimated that there will be 80 groundwater bodies in the South Eastern River Basin District, 36 of which are nearing completion. The remaining groundwater bodies which include sand and gravels overlying bedrock groundwater bodies will be completed in early 2003. Information on groundwater bodies will be gathered under a range of headings based on the Initial and Further Characterisation requirements of the Directive.

The Preliminary Identification of Groundwater Bodies has been undertaken by the GSI in accordance with the recommendations of the Groundwater Working Group.

Each Groundwater Body will have a unique identification number. Information will be provided on the location of the groundwater body for example the surface water catchment or sub catchment it is located in and the relevant hydrometric area. The areal extent of the groundwater body is also indicated. Associated protected areas including ecosystems and abstraction points are referenced.

Hydrogeological characteristics described include descriptions of the geology and the aquifers, overlying strata, recharge and discharge mechanisms, groundwater flow paths, hydrochemical signature and groundwater surface water interactions. A conceptual model is presented of the groundwater body. It is expected that the models will include two or possibly three dimensional schematics of the groundwater body where the available information allows for such detail. In particular it would assist water managers to visualise groundwater movement and the interactions with surface water.

For practical assessment reasons information for each groundwater body will be prepared primarily in tabular form. An initial groundwater body characterisation table was developed by the GSI. The format of the table is expected to evolve as more information becomes available during the further characterisation process being undertaken by the Project Team. An example of the summary and detailed information that will be available on a typical groundwater body table is included in this appendix.

The groundwater body delineation tables developed by the GSI are being used in the completion of initial and further characterisation. Again this information is compiled in tabular form.

The characterisation process involves the completion of a series of steps briefly described below;

1. Assessment of Monitoring Data.

All available data on groundwater quality and abstraction has been compiled for each local authority area in the SERBD. As part of the preliminary assessment programme groundwater quality and quantity was assessed at hydrometric area scale. It is currently be revised to groundwater body scale now that the delineation process is nearing completion

2. Mapping and Assessment of Pressures.

Point sources of pollution such as wastewater treatment plants, trade effluent licenced discharges, landfills IPC licensed facilities in the SERBD have been identified. Information is also being compiled in relation to diffuse sources of pollution from agriculture. This data is currently being assessed at groundwater body scale as part of the further characterisation process.

Delineate 'extremely' vulnerable areas using depth to rock data supplied by GSI and subsoil map produced by Teagasc. Data from Teagasc is not expected until later in 2003. A vulnerability assessment is currently being developed for portions of the SERBD for which vulnerability data is either absent or incomplete. The assessment programme will target Carlow, Wexford and portions of South Tipperary and Waterford.

3. Examine groundwater bodies in terms of ecosystems, pressures, trends and pollution risk.
The project team in consultation with the GW WG and DUCHAS and the EPA will assess the impacts on Protected Areas identified over groundwater bodies.
4. Undertake water balances on groundwater bodies, assess quantitative status and delineate groundwater bodies potentially likely to be 'at risk'.
Based on abstraction data and hydrometric data gathered in each local authority area the Project Team in consultation with EPA, GSI and GW WG are currently updating the initial water balance calculations developed by the GSI.
5. Assess the qualitative status and delineate groundwater bodies potentially likely to be 'at risk'.
Assessments of qualitative status was undertaken at hydrometric scale during the preliminary assessment programme. The process is currently being refined to groundwater body level now that delineation virtually complete. The assessment is being undertaken by consultant, in consultation with EPA, GSI and GW WG.

Decide on New Monitoring Points, Install them where necessary and Commence Monitoring

The identification of groundwater monitoring points in each groundwater body is underway. As part of the on-going characterisation process existing monitoring points are being screened to assess their suitability for use in the monitoring programme. Where there are insufficient monitoring points recommendations for the installation of new points will be made in consultation with EPA, GSI and GW WG. It is anticipated that monitoring of delineated groundwater bodies will commence in mid-2003.

Undertake 'Further Characterisation'

Delineate groundwater bodies 'at risk'.

The process of further characterisation is underway in the SERBD.

GSI approach to Groundwater Body Delineation

Step 1: Aquifer Delineation and Description

1. Compile rock units for the Basin in approximate stratigraphical order.
2. Group rock units (e.g. pure limestones, impure limestones (separated into supra-reef, i.e. Calp-type, and sub-reef, i.e. ABL), Waulsortian, Silurian sediments, ORS, Granite/Metamorphics, sand/gravel, etc.).
3. Compile hydrogeological data for each individual rock unit into holistic table.
4. Check if there is significant variation between individual rock units in the group (e.g. in the ORS, between conglomerates and the rest). If there is significant variation, explain the variation and sub-divide out the relevant units.
5. Check if there is significant regional variation for each group of rock units (e.g. ORS and Waulsortian in south are different to the midlands/north). Try to explain the variation.
6. Assign aquifer classification to each group of rock units on (as far as practicable at this stage) a country-wide basis (i.e. not RBD basis). Where regional variations exist, try to justify the basis for drawing a boundary.
7. Produce digital aquifer map for inclusion in RBD GIS.
8. Produce digital vulnerability map from existing mapping (approx. 45% of country) for inclusion in RBD GIS.
9. Report on each aquifer/rock unit

Step 2: Preliminary Groundwater Body Delineation and Description

1. Use hydrometric unit areas as a starting point for now. As decisions on surface water body boundaries are decided on, these may have to be considered.
2. Group aquifers into 4 categories to assist in delineating the boundaries: -
 - ◆ Karstic (Rk) aquifers;
 - ◆ Gravel (Rg and Lg) aquifers;
 - ◆ Productive fractured bedrock (Rf and Lm) aquifers;
 - ◆ Poorly productive bedrock (Ll, Pl and Pu) aquifers.

South Eastern River Basin District Management System Initial Characterisation Report

3. Print map of each hydrometric area showing these groups, together with other relevant information such as location of gauging stations, groundwater monitoring points, etc.
4. Delineate groundwater body boundaries using the following hierarchy (taken largely from the Commission guidance, with the exception of *iii*), which is considered to be appropriate to the situation in Ireland): -
 - i.) No flow, or relatively low flow, geological boundaries (this requirements is to facilitate water balance calculations and also because these boundaries separate more or less distinct hydrogeological flow systems).
 - ii.) Boundaries based on groundwater highs (Comment: these will generally be the groundwater highs that coincide with surface water catchment boundaries.
 - iii.) Boundaries based on differing flow systems (e.g. karst Vs intergranular) (*Comment: This appears to contradict i.*). However it is a justifiable approach in situations (most of Ireland) where the quantitative status is good. It does not prevent water balance calculations being made at the initial stage, prior to making a further sub-division based on the flow regime. It is felt that, for instance, the flow regime in many karst areas will have specific implications for the management measures needed for those areas.)
 - iv.) Boundaries based on flow lines. (Comment: These boundaries will only be used to separate out GW Bodies which have a different status.)
5. Fill in Initial Characterisation Table.
6. Draw up a small number of conceptual models which will fit the limited range of situations we envisage in Ireland, and then allocate each GW Body to one of these. Prepare a set block diagrams for our 'typical' hydrogeological settings.
7. If at all possible, group the groundwater bodies for the purpose of describing them.
 - i.) Provide Delineated Groundwater Body data to the RBD consultants

The remaining steps are being completed by the Project Team based on the information provided by the GSI.

**South Eastern River Basin District Management System
Initial Characterisation Report**

Groundwater Delineation Table as completed by GSI

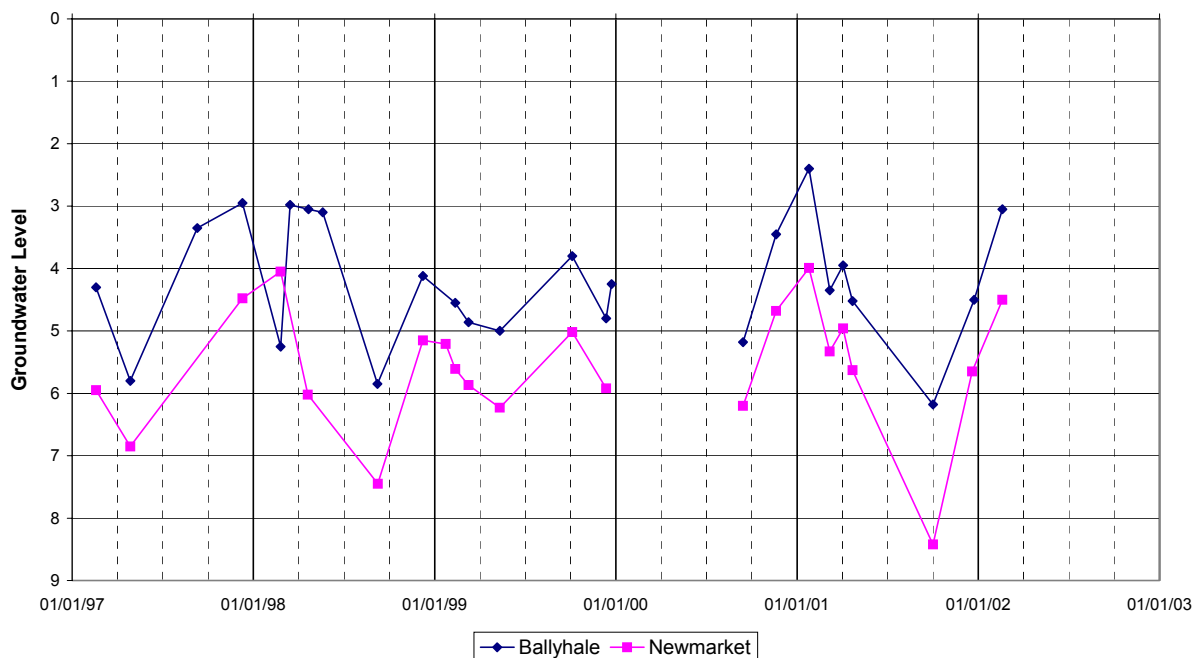
Thomastown GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water bodies	Associated terrestrial ecosystems	Area (km ²)
15 – Nore Kilkenny Co Co	Glory, Caherlesk Stream, Nore,	Kilkeasy Bog, Thomastown	85
Topography	This aquifer lies on the boundary between the Nore and the Suir basins. The southern boundary is located along the foothills of the Silurian South Kilkenny Uplands. The elevations drop to the north and the land surface becomes much flatter. Drainage in this area is to the north despite the fact that the Nore is flowing to the south. Most surface drainage is flowing towards the Kings River east of Callan, which then contributes to the flow of the Nore, returning the water to the south.		
Geology and Aquifers	Aquifer type(s)	Rf: Regionally Important fractured aquifer. Daly (1988) described a gradual change from sandstone to shale moving upwards from the Kiltorcan into the Porters Gate Formation, which means that separate aquifer classifications for each formation cannot be made.	
	Main aquifer lithologies	KT : Kiltorcan Formation – Yellow & red sandstone & green mudstone PG : Porters Gate Formation – Sandstones shales and thin limestones	
	Key structures.	The rocks have undergone at least one major phase of structural deformation. The zone of cleaner sandstones around the contact with the two formations is likely to have reacted in a more brittle manner to the deformation, allowing the development of a denser network of fracturing and fracture permeability than in the shalier sandstones elsewhere in the aquifer. Significant faults are expected to cut the aquifer every kilometre (Daly, 1988)	
	Key properties	Transmissivity 75 – 1800m ² /d, the highest values are likely to be associated with low-lying areas close to anticlines or faults. Storage Coefficient – 3.9 x 10 ⁻⁶ . Field observations in the South Kilkenny area suggest that vertical and horizontal permeability are about equal. There will be a reduction in the transmissivity of this aquifer in the eastern part of the South Kilkenny Uplands and also at depth in the centre of the basin where the Kiltorcan Formation is thinner.	
	Thickness	Geophysical borehole logging data suggest that significant water movements occur at depths of over 60m where the aquifer is not confined by overlying shaley limestones. Where confined, active groundwater circulation is expected to be much more limited, but some deep flow has been inferred from mineral exploration boreholes at depths of over 200m (Daly, 1985).	
Overlying Strata	Lithologies	To the south the subsoil cover of this aquifer is very thin. In the north where towards the central lowlands the subsoil overlying this groundwater body is glacial till. In the area of Thomastown in the Nore flood plain there is also an area of sand and gravel.	
	Thickness	The thickness of the subsoil will increase to the north and there is more deposition at the lower elevations.	
	% area aquifer near surface	There are significant areas of rock close to surface to the south.	
	Vulnerability	Vulnerability is Extreme to the south as the elevation increase and subsoil cover reduces. There are areas of lower vulnerability to the south.	
Recharge	Main recharge mechanisms	Groundwater recharge is from the elevated peaks to the south and also directly to the rock where the subsoil cover is thinner.	
	Est. recharge rates	[Recharge estimates will be added at a later date]	
Discharge	Springs and large known abstractions	Thomastown well 9 (360m ³ /d)	
	Main discharge mechanisms	Water table maps suggest that the discharge area for this aquifer is at Thomastown and in the Knocktopher/Ballyhale area. Zones of more concentrated discharge occur into the Nore River near Thomastown and the Little Arrigle River near Ballyhale; both zones lying just up-slope of the area where the aquifer becomes confined by lower permeability shaly limestones. There is no obvious discharge zone for groundwaters moving at depth, yet there is evidence to suggest some natural flow does take place. It is most likely that this groundwater flows, via large faults and complex pathways into shallower groundwaters.	

South Eastern River Basin District Management System Initial Characterisation Report

Hydrochemical Signature	The bedrock here is considered to be Siliceous although there is some mixing in the upper layers of the Porters Gate Formation between Siliceous and Calcareous layers. Waters were 'soft' to 'moderately hard' in the sandstones and 'hard' to 'very hard' in the shales and limestones of the upper parts of the Portersgate Formation. The hydrochemical signature varied between calcium bicarbonate and calcium-magnesium bicarbonate and the average electric conductivity level is 698 (µs/cm) at Thomastown and 371 (µs/cm) at Windgap. Daly suggests that the signature depends on the thickness of overlying subsoil, with calcium magnesium waters being associated with areas of thicker subsoil. The lower layers of these formations are Siliceous where as the upper layers tend to be Calcareous.
Groundwater Flow Paths	There are numerous small springs and streams across most of the area where the aquifer occurs close to the surface. In this region, Daly (1985) suggests that recharge is actively occurring, that groundwater flow paths are typically in the order of a few hundred metres, and that most discharge occurs into small streams and springs.
Groundwater & surface water interactions.	The water table in the area of Thomastown is assumed to be controlled by topography, with a good hydraulic connection between the river and the groundwater (Buckley 2002).
Conceptual model	This aquifer is defined by the extent of the Kiltorcan Sandstone to the south, the Porters Gate Formation to the North and the Boundary of the Nore Basin to the east and west. Groundwater recharges from the south in the South Kilkenny Uplands, travels north on to the central lowland plains of the Nore. A certain portion of the groundwater will travel into the confined aquifer while there will be some discharge at the geological contact to the north into the associated surface water bodies. The strata in this area of Southern Kilkenny appear to be more permeable owing to the proximity of the Hercynian deformation front in the south of Ireland and the greater intensity of faulting and jointing associated with it. The rock formations above and below this aquifer are considered aquitards and are therefore confine it.
Attachments	(Figure 1) EPA Groundwater levels at Ballyhale and Newmarket (Figure 2) GSI Groundwater Levels at Ballyhale
Instrumentation	Stream gauge: 15018, EPA Borehole Hydrograph: KIK102 (Ballyhale), KIK116 (Newmarket). GSI Borehole Hydrograph : Ballyhale KNY 31/72 (S503358) EPA Representative Monitoring boreholes: Thomastown WS (#32 - S589415), Windgap (#48 -S420358)
Information Sources	Buckley. R (2002). Kilkenny Co Co Groundwater Protection Scheme. Geological Survey of Ireland Daly, E.P. (1988). The Kiltorcan Sandstone Aquifer. <i>Proceedings of Eighth Annual International Association of Hydrogeologists (Irish Branch) Seminar</i> , Portlaoise, 1988. Daly E.P. (1994). Groundwater Resources of the Nore River Basin. Geological Survey of Ireland.
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Groundwater levels in the Thomastown GWB



**South Eastern River Basin District Management System
Initial Characterisation Report**

<ul style="list-style-type: none"> ➤ Impact ➤ Risk assessment ➤ Status 	<p>Water Balance: Rainfall- Evapotranspiration= Groundwater Recharge + Runoff Rainfall Recharge=Groundwater Recharge+ Runoff (dependent on topography, subsoil thickness and permeability) Groundwater Recharge=Rainfall Recharge-Water losses (i.e. Runoff and Abstractions)</p> <p><i>NB Take account of whether abstracted water is recharged back to gw body, e.g. via percolation areas, or exported from gw body</i></p> <p>None likely as water levels appear stable.</p> <p>None likely as water levels appear stable.</p>
<p>Chemical Status</p> <ul style="list-style-type: none"> ➤ Drivers ➤ Pressures <ul style="list-style-type: none"> - Point - Diffuse ➤ Vulnerability ➤ Protected areas <ul style="list-style-type: none"> - Drinking water - Aquatic species - Habitats/species ➤ Impact <ul style="list-style-type: none"> - Probable - Actual (as shown by monitoring) ➤ Risk assessment ➤ Status 	<p>WWTP's, Fish farming, Abattoir, Septic Tanks.</p> <p>Three WWTP's; Thomastown (Extreme Vulnerability) and Kilmoganny (High Vulnerability) on the Kiltorcan Formation and Ballyhale WWTP on the Porter's Gate Formation on an area of High Vulnerability. Six Section Section 4 Industries, one at Thomastown on the Porter's Gate Formation (High Vulnerability), and five at Goatsbridge, Ballyduff and Thomastown, on an area of High Vulnerability, Ballyhale (High Vulnerability) and Callan (Extreme Vulnerability) on the Kiltorcan Fm. Refer to MapInfo Files in Point Sources Folder. Awaiting diffuse sources data assessment.</p> <p>60% High Vulnerability to the north of the groundwater body, the remaining 40% Extreme Vulnerability to the south of the groundwater body with some areas of Moderate to Low Vulnerability to the southwest. (Based on Kilkenny Groundwater Protection Scheme Vulnerability map).</p> <p>Sensitive receptors and most sensitive receptor to the quality of water: None</p> <p>One sample from Windgap GWS (on an area of Moderate Vulnerability) exceeded the GSI threshold of 25mg/l for Nitrate (NO₃) by 17mg/l on 10/00. Three samples from Thomastown marginally exceeded the GSI threshold for (NO₃). Chloride exceeded the GSI threshold of 30mg/l in all but one sample from Thomastown WS. Both faecal and total coliforms were reported over the monitoring period in both sources. Not at Risk-Generally good quality with the exception of chloride and bacterial contamination although additional monitoring locations are required.</p> <p>Good- More certainty required</p>
<p>Monitoring Point Recommendations</p>	<p>Only two existing monitoring point . Additional point(s) needed subject to discussion with GSI and GW WG</p>