**Newcastle West GWB: Summary of Initial Characterisation.**

| Hydrometric Area<br>Local Authorities | Associated surface water features | Associated terrestrial ecosystem(s) | Area ($km^2$) |
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| 24 - Deel/ Shannon Estuary<br>Limerick Co. Co. | Rivers: Deel, Daar, Dooally, Arra, Bunoke, Owenskaw;<br>Streams: Ahavarraga, Slewnaun, Ballytraley, Ehernagh, Glashanakirka, Lisheenine. | - | 101 |

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| **Topography** | The GWB is roughly ‘Ɛ’-shaped. Most of the ground in this GWB is flat-lying, with elevations in the range 30-120 mAOD. Elevations are highest at the SE boundary, where they are just over 120 mAOD. Ground elevation generally decreases northwards and eastwards, and is lowest where the River Deel exits the GWB. Most of the GWB is between 40 and 90 mAOD. Drainage densities are high, particularly in the southern two-thirds of the GWB where streams drain eastwards off the Ballylongford GWB, and then flow northwards across areas underlain by thick subsoils. | |
| **Geology and Aquifers** | Aquifer categories | **$Rk^d$:** Regionally important karstified aquifer dominated by diffuse flow. |
| | Main aquifer lithologies | Dinantian Pure Unbedded Limestones. |
| | Key structures | The rocks form part of a system of two tight major folds, whose axes are orientated ENE-WSW. Overall, the strata dip north, west and south, roughly at right angles to the edges of the GWB. Measured dip angles are between $10^o$ and $40^o$ and reflect the steep mounds of the Waulsortian limestones as well as the folding. N-S, E-W and NE-SW trending faults displace the rock units; they are mapped at the edges of the body, and although no faults or minor folds are mapped in the centre of this area, they will be present. |
| | Key properties | Transmissivity in the diffusely karstified aquifers is in the range 20–2000 $m^2$/d. In this area of the country, the median value will probably be towards the lower-middle end of the range. At Croom and Fedamore WSs (in the adjacent Fedamore GWB), transmissivities are 120 $m^2$/d [estimate range 95–145 $m^2$/d] and 34 $m^2$/d [estimate range 23–41 $m^2$/d], respectively. Specific yield will be low, on the order of a few percent. Groundwater gradients within the karstic aquifer are low, ranging from approximately 0.005 to 0.01.<br>*(data sources: Rock Unit Group Aquifer Chapters, Limerick GWPS Report, Source Reports, see references; estimation from maps)* |
| | Thickness | The Dinantian Pure Unbedded Limestones attain maximum thicknesses of more than 1200 m. However, the effective flowing thickness is likely to be about 30 m, although much deeper inflows can occur if associated with faults or dolomitisation. An epikarstic layer at least a couple of metres thick is likely to exist at the top of the bedrock. In the vicinity of Newcastle West, borehole logs indicate three main production zones: a high permeability karstified band in the upper 10–15 m of bedrock; a middle zone from 35–50 m, where north/south trending fractures, spaced at between 500 m and 800 m apart, have been preferentially dolomitised; and a lower fractured zone at a depth of over 100 m. |
| **Overlying Strata** | Lithologies | GSI mapping indicates that much of the GWB is covered by Limestone Till, with ‘Till with Gravel’ pods occurring also. Along the courses of the Rivers Deel, Bunoke and Daar, there are areas of Undifferentiated Alluvium. |
| | Thickness | Subsoil thickness data indicate a range of 0–36 m. Thicker subsoils are found in the southern two-thirds of the GWB, where there are very few outcrops recorded, and subsoils range in thickness from 3-36 m and are mostly greater than 7 m thick. In the remaining area (north of the Ballytraley Stream), subsoils range from 0-12 m thick, and again tend to decrease in thickness northwards. There are no extensive areas of rock outcrop in this GWB. The majority of the scattered outcrops occur in the northernmost part. |
| | % area aquifer near surface | *[Information to be added at a later date]* |
| | Vulnerability | *[Information to be added at a later date]* |
| **Recharge** | Main recharge mechanisms | Diffuse recharge will occur over the groundwater body via rainfall soaking through the subsoil and directly to the aquifer via outcrop. Where subsoils are thick and low permeability, rainfall will runoff. |
| | Est. recharge rates | *[Information to be added at a later date]* |

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| **Discharge** | Springs and large known abstractions ($m^3$/d) | Tobergal (South West) RWSS (1195 $m^3$/d – GSI database; 1250 $m^3$/d – EPA database); Castlemahon WS (76 $m^3$/d – GSI database); Ballygowan (??? $m^3$/d); Castlemahon Co-Op Poultry (725 $m^3$/d – EPA database); Golden Vale Creamery (Belville) (68 $m^3$/d – EPA database); Golden Vale Creameries (Newcastle West) (27 $m^3$/d – EPA database); Golden Vale Creameries (Rathkeale) (59 $m^3$/d – EPA database); Baptist's Well (Tobernanbastia, Mahoonagh) (unknown, EPA database); Danganbeg No. 1 and No. 2 (unknown, EPA database).<br><br>There are a number of large springs in this rock unit, several of which are thermal:<br>• Cregan's Well, which lies south of Newcastlewest (NGR 12656, 13133), is a large thermal spring yielding approximately 1140 $m^3$/d at temperatures of up to 14°C. The supply is believed to come from the deep Waulsortian Limestones beneath the overlying Visean rocks along a major fault (Murphy and Brück, 1989).<br>• Another large warm spring in the townland of Camas, known locally as Sconse Well (NGR 12839, 12865), has a similar yield to that at Cregan's Well and is also warm (12.8–13°C). It is located to the south-east of Cregan's Well on the axis of the Corronoher anticline (Murphy and Brück, 1989).<br>• A large Council supply at Tobergal Spring (South West RWSS) (NGR 13161, 12788) yields 1640 $m^3$/d through four springs. The group is slightly warm ranging from 13.4–14.1°C suggesting a deep origin for the groundwater. The chemical analyses however, when compared with other samples from the Waulsortian, show that the water is softer than one would expect although it is high in magnesium suggesting a dolomite aquifer. The source is not far from the Namurian scarp to the west and it is likely that the softer recharge waters from there are mixing with the up welling deeper waters from the dolomitic limestones.<br><br>*[More information may be added at a later date]* |
| | Main discharge mechanisms | The main discharges are to the streams and rivers crossing the GWB, particularly the Rivers Deel and Bunoke, and to springs. Deakin (1995) considers that, even in areas where subsoils appear to be generally thick and low permeability, the rivers are in hydraulic continuity with the bedrock aquifer. From a study at the Tobergal public supply (springs), an upward-directed head gradient is indicated. Specific dry weather flows are relatively low (0.3 – 1.4 l/s/$km^2$). |
| | Hydrochemical Signature | Limited hydrochemical data are available for this GWB. The hydrochemistry of the Waulsortian limestone aquifer in the Fedamore GWB (adjacent to this GWB) shows a very hard (370–430 mg/l as $CaCO_3$), calcium-bicarbonate type water with high alkalinities (330–380 mg/l as $CaCO_3$) and electrical conductivities, and neutral pHs. At the Tobergal source in this GWB, the hydrochemical analyses of groundwater are indicative of a calcium-magnesium-bicarbonate type water suggesting that dolomitisation may be an influential factor in the hydrogeological regime. The analyses show a hard water (259–273 mg/l ($CaCO_3$)), with moderate alkalinity (255 mg/l ($CaCO_3$)). The hardness would be more typical of the sandstones in Co. Limerick but values this low may also occur in limestones. Conductivities measured for the project are also slightly lower than is commonly found in the limestones, at approximately 540 µS/cm. The EC funded study of thermal groundwaters in Ireland showed that the spring has a temperature of 13.4–14.1°C, which is considered to be a few degrees higher than normal groundwater. This indicates that at least some of the groundwater issuing at the spring has been thermally heated and is likely therefore to be coming up from a considerable depth. |

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| **Groundwater Flow Paths** | These rocks are generally devoid of intergranular permeability; most groundwater flows through a diffuse network of solutionally-enlarged fissures and small conduits, and along faults. However, dolomitisation, by reducing the solids volume during recrystallisation, will have enhanced locally the permeability in two ways: (i) generating intergranular permeability, and (ii) collapsing into the void space and creating cavities. Dolomitisation and dissolution along structural weaknesses have caused permeability to vary significantly with depth. For example, three main production zones are indicated in the Newcastle West area: a high permeability karstified band in the upper 10–15 m of bedrock; a middle zone from 35–50 m, where north/south trending fractures, spaced at between 500 m and 800 m apart, have been preferentially dolomitised; and a lower fractured zone at a depth of over 100 m.<br>Groundwater levels are generally quite shallow and above the base of the subsoil, although significant unsaturated zones can exist. Towards the north of the GWB, where there are areas of outcropping rock and thinner subsoil, groundwater is unconfined or semi-confined by the subsoil. In this area, the water table is typically 0- 6 mbgl and, near streams and rivers, water levels are generally within 2 m of ground level. Over much of the area, the water level is above the base of the subsoil. One water level measurement of 19 mbgl was recorded in a borehole at the top of a small local high point, showing a significant unsaturated zone and indicating high aquifer transmissivity.<br>In the southern parts of the GWB, groundwater is probably confined over much of the GWB by the thick, low permeability subsoils. Water level measurements in this area are mainly from 0-6 mbgl and significantly above the base of the subsoil. Some wells are artesian. Work by Deakin (1995), Brück *et al.* (1986) and Murphy and Brück (1989) indicates that there is an upwards gradient caused by deep groundwater circulation and groundwaters flowing up faults, possibly from the Devonian Kiltorcan-type Sandstones that lie >300 m beneath the Dinantian Pure Unbedded Limestones (Waulsortian Limestones). Not all of the groundwater originates at depth, however, and abstracted and spring waters are likely to be a combination of shallow and deep groundwaters.<br>Deeper water levels of around 10-20 mbgl are recorded in the southern areas. In the very southeast of the GWB, deeper water levels coincide with the highest ground and thick subsoils, although unconfined conditions occur over small parts of this area. In three areas in the southern part of the GWB (SE of Newcastle West, SE of Tobergal, and 600 m west of the Owenskaw River), deeper water levels and unconfined conditions exist. The reason for the lower water levels is not clear as although these areas are between rivers or streams, elevation is not significant. These boreholes (21-53 m deep) may be tapping deeper conduits/ cavities or isolated fissures.<br>The piezometric surface/ water table is likely to generally follow the topography. Seasonal water level variations at the two monitoring points in this GWB are less than 1 m. This is probably because the sites are located near to the River Deel (i.e., a discharge zone). Local groundwater flow will be from the higher ground to the rivers and streams, which are considered to be in hydraulic continuity with the aquifer despite generally thick subsoils, and to the springs. Regional flow is to the east and north. Flow path lengths are likely to be considerable, up to several kilometers, although in discharge zones, flow paths will be much shorter, at around 100–300 m. At the Tobergal WS springs, the discharge curve shows smooth variation and doesn't correlate with rainfall events, but with seasonal water table fluctuation. This indicates that long flow paths and groundwater residence time is smoothing out local variations and rainfall events. |
| **Groundwater & Surface water interactions** | Over much of the GWB, groundwater is confined. However, groundwater discharges to large springs and supports river and stream flows. In the north of the GWB, groundwater is shallow and can be unconfined. Significant baseflow will be provided to the River Deel and, due to the karstic nature of the aquifer, groundwater-surface water interaction has the potential to be rapid. |
| **Conceptual model** | • The groundwater body is roughly 'ε'-shaped. It is bounded to the north, west and south by the contact with the low transmissivity rocks of the Ballylongford GWB. Most of the eastern boundary is formed by the contact with the impure limestones of the Feenagh GWB, except the northeast and southeast parts, which are surface water catchment divides. Most of the ground in this GWB is flat-lying; ground elevation decreases gently northwards and eastwards.<br>• The groundwater body is composed entirely of high transmissivity karstified and dolomitised limestones. Groundwater flows through a diffuse network of solutionally-enlarged fissures and small conduits, along major faults, and along preferentially-dolomitised zones.<br>• Recharge from rainfall occurs diffusely through the subsoils and at outcrop. Over areas where subsoils are thick and low permeability, rainfall will run off. In areas where the water table is very close to the ground surface, potential recharge may be rejected. A relatively small volume of groundwater may flow to this GWB from the adjacent Ballylongford GWB. The pure limestone aquifer is also thought to receive groundwaters that circulate from considerable depth and flow up faults, and originate in the Devonian Kiltorcan-type aquifer, which is separated from the pure limestone aquifer by low permeability impure limestones.<br>• The aquifer in this GWB is mainly confined or semi-confined. Artesian wells and springs upwelling through confining low permeability subsoils are common in the southern part of the GWB. Groundwater levels are generally quite shallow, although local unconfined conditions and significant unsaturated zones can occur.<br>• Aquifer transmissivity varies with depth. Shallow groundwater flows in a high permeability karstified band in the upper 10–15 m of bedrock. Deeper flows occur in a zone from 35–50 m, where north/south trending fractures, spaced at between 500 m and 800 m apart, have been preferentially dolomitised and in a lower fractured zone at a depth of over 100 m. Groundwater can also flow from significant depths up fault zones. Deeper groundwaters mix with shallow groundwaters, resulting in some spring waters having slightly elevated temperatures (c. 14$^{o}$C).<br>• The piezometric surface/ water table is likely to generally follow the topography. Local groundwater flow will be from the higher ground to the rivers and streams, which are considered to be in hydraulic continuity with the aquifer despite generally thick subsoils. Groundwater also discharges to springs. Regional flow is to the east and north. Flow path lengths are likely to be considerable, up to several kilometers, although in discharge zones, flow paths will be much shorter, at around 100–300 m. |

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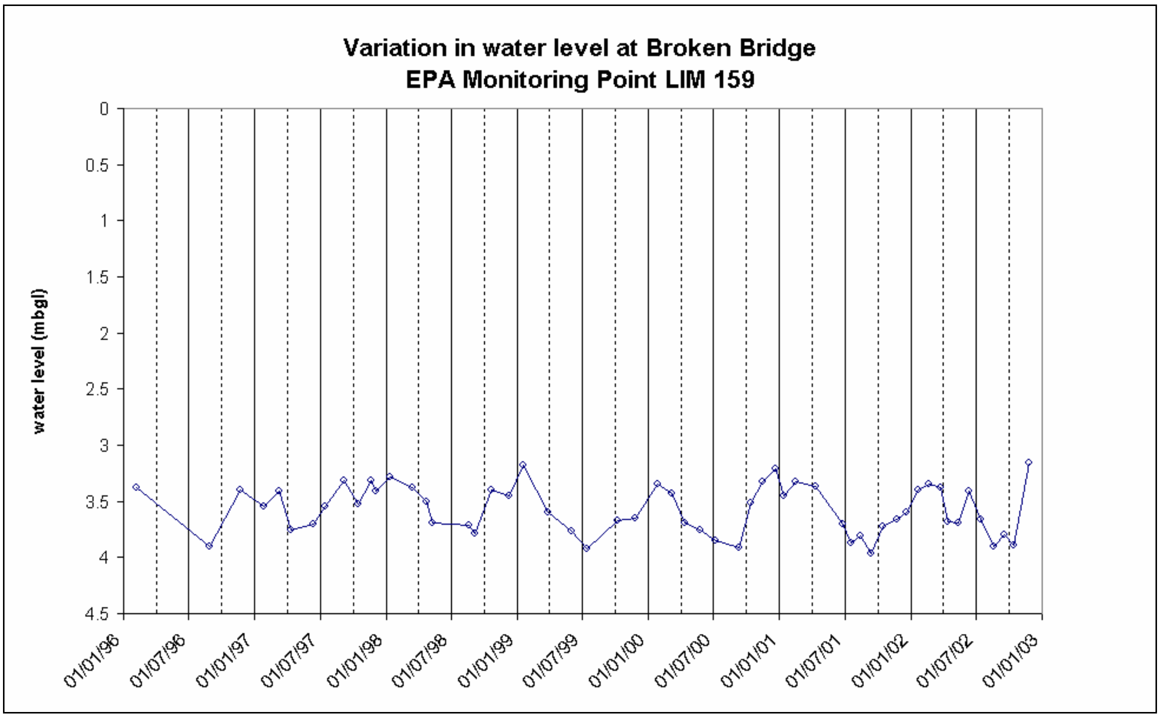
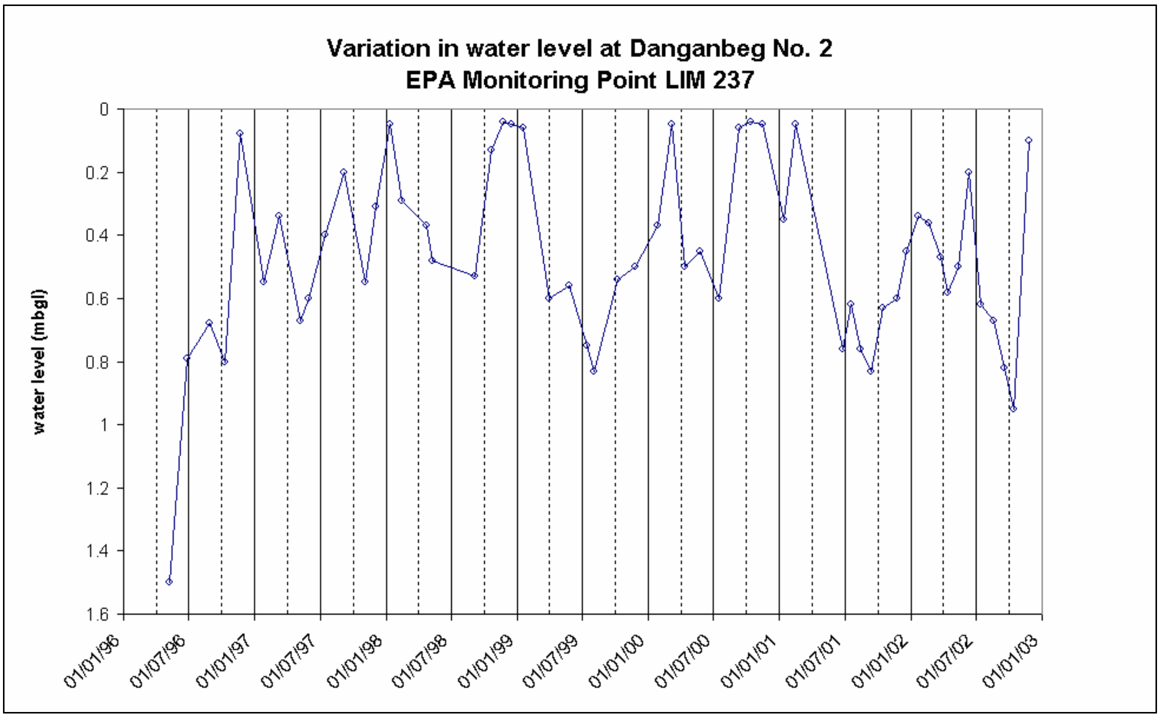
| **Attachments** | Groundwater hydrographs (Figures 1 and 2); Hydrochemical signature (Figure 3) |
| **Instrumentation** | Stream gauges: 24011*, 24012*, 24021, 24030, 24031*. *(specific dry weather flow calculated for stations marked with *)*<br>EPA Water Level Monitoring boreholes: Broken Bridge (Golden Vale – Bellville) (LIM159), Danganbeg No. 2 (LIM237).<br>EPA Representative Monitoring boreholes: South West RWS (LIM111). |
| **Information Sources** | Brück, P.M., Cooper, C.E., Duggan, K., Goold, L. and Wright, D.J. (1986) The Geology and Geochemistry of the Warm Springs of Munster. *Ir. J. Earth Sci*., Vol. 7, pp. 169-194.<br>Deakin, J., Daly, D. and Coxon, C. (1998) *County Limerick Groundwater Protection Scheme*. Geological Survey of Ireland Report to Limerick Co. Co., 72 pp.<br>Deakin, J. (1995) *Croom Public Supply – Groundwater Source Protection Zones*. Geological Survey of Ireland Report to Limerick Co. Co., 6 pp.<br>Deakin, J. (1995) *Fedamore Public Supply – Groundwater Source Protection Zones*. Geological Survey of Ireland Report to Limerick Co. Co., 6 pp.<br>Deakin, J. (1995) *Tobergal (SW Region) Public Supply – Groundwater Source Protection Zones*. Geological Survey of Ireland Report to Limerick Co. Co., 6 pp.<br>Murphy, F. X. and Brück, P. M. (1989). *An investigation of Irish Low Enthalpy Geothermal Resources with the aid of Exploratory Boreholes*. Final Report for contract No. EN3G-00660-IRL (GDF), Report No. 89/13, Dept. of Geology, UCC, pp. 150.<br>Aquifer chapters: Dinanatian Pure Unbedded Limestones. |
| **Disclaimer** | Note that all calculations and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae |

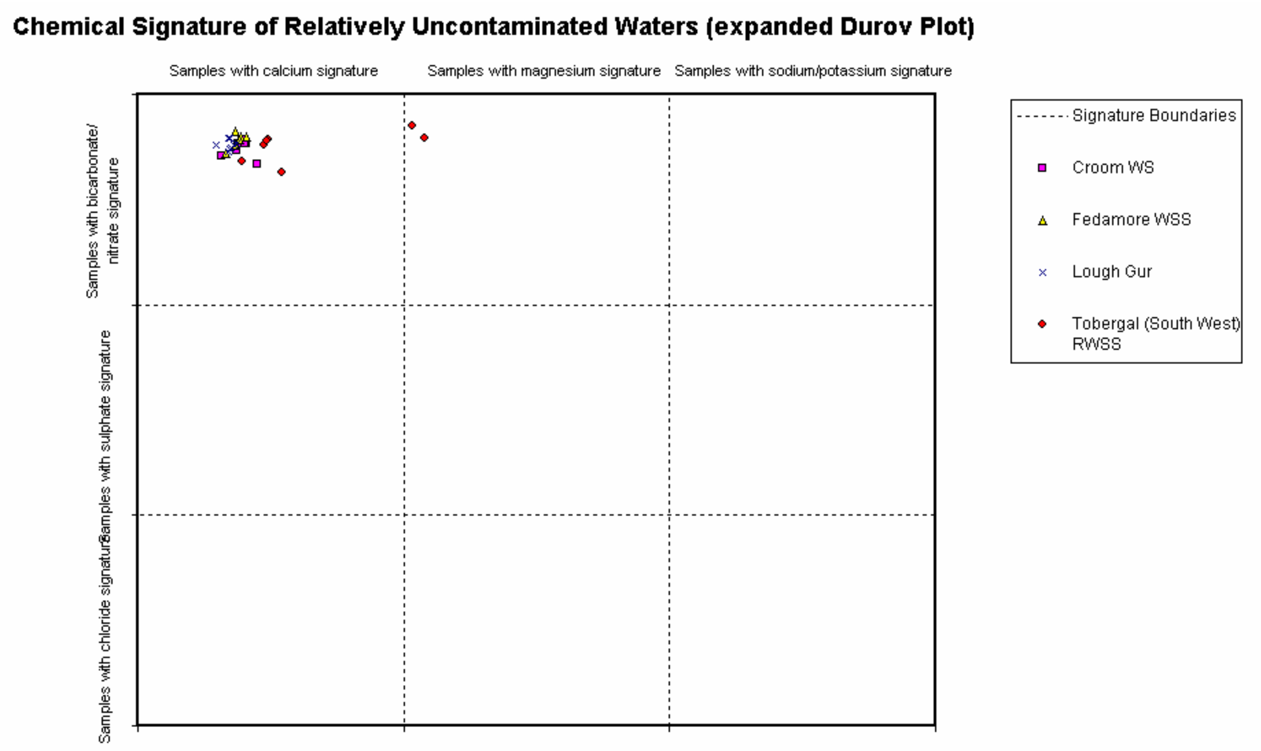
## Figure 1: Groundwater hydrograph



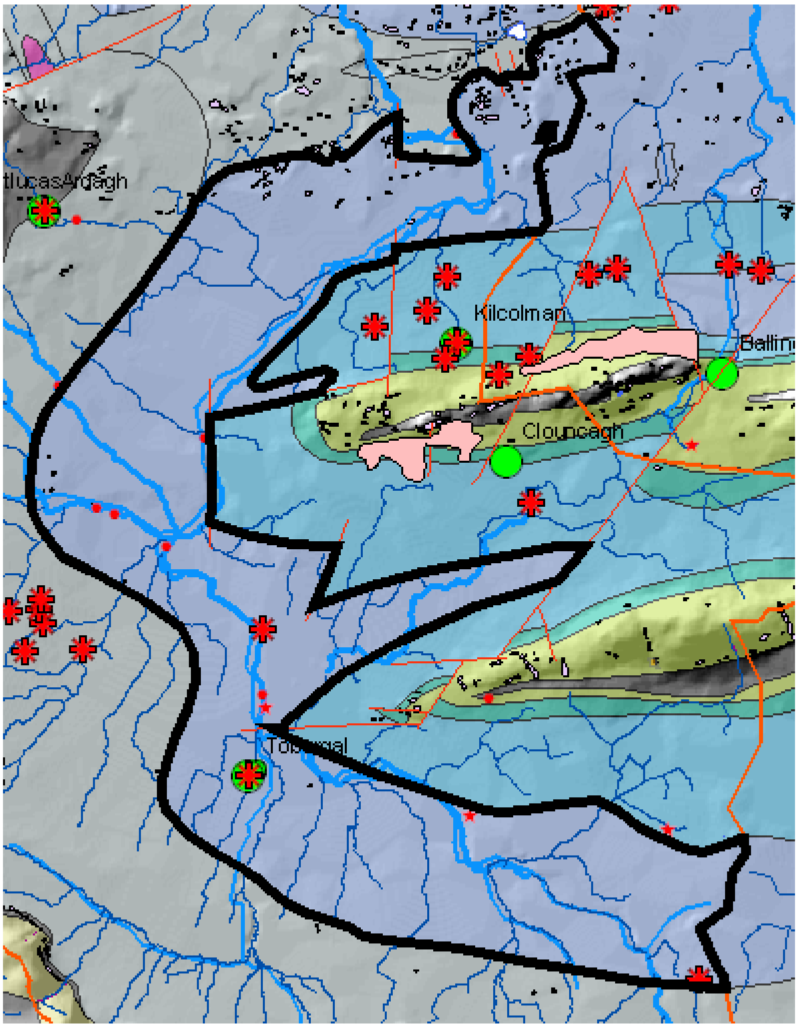
## Figure 2: Groundwater hydrograph




## Figure 3: Hydrochemical Signature




*NB: Croom, Lough Gur and Fedamore WSs are in nearby GWBs comprised of similar pure unbedded limestone aquifers. Tobergal RWS is situated within this GWB.*




**Rock units in GWB**

| Rock unit name and code | Description | Rock unit group |
|---|---|---|
| Waulsortian Limestones (WA) | | Dinantian Pure Unbedded Limestones |