**Glenaniff GWB: Summary of Initial Characterisation.**

| Hydrometric Area<br>Local Authority | | Associated surface water bodies | Associated terrestrial ecosystems | Area ($km^2$) |
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| Hydrometric Area 36<br><br>Leitrim Co. Co. | | ***Rivers:*** Glenaniff, Ballagh.<br>***Streams:***103 unnamed streams.<br>***Lakes:*** Arroo, Horse, Adunny, Meenagraun, Sandy. | Arroo Mountain (O'Riain, 2004) | 48 |
| **Topography** | | Situated to the south of Lough Mevlin (Figure 1), this irregularly shaped GWB is bounded by lower permeability rocks to the north and west, and by topographic divides to the south (Hydrometric Area 35) and east. The landscape comprises upland areas along the northern and southern boundaries, split by the NW-SE aligned Glenaniff River valley. Elevations ranging from c.100 mAOD in the valley to c.480 mAOD along the south-western boundary. Surface streams flow downslope towards the central Glenaniff River, which flows in a south-easterly direction, out of the GWB to eventually discharge into Lough Melvin | | |
| **Geology and Aquifers** | **Aquifer type(s)** | **$Rk^c$**: Regionally important karst aquifer dominated by conduit flow, is the main aquifer is this GWB (75%), which is mapped on the lower slopes. The upland areas are capped by **Lm**: Locally important aquifer which is generally moderately productive (c.15%), which is surrounded by a thin band of **Ll**: Locally important aquifer which is moderately productive only in local zones. | | |
| | **Main aquifer lithologies** | The GWB mainly comprises three rock groups of Dinantian age: Pure Bedded Limestones (75.53%) Sandstones over the upland caps (13.3%) and an intervening band of Mixed Sandstones Shales and Limestones (10.45%). A small area of Dinantian Upper Impure Limestones (0.53%) lies along the south eastern boundary. Refer to Table 1 for full details. | | |
| | **Key structures.** | The rocks generally dip to the south by c.5°. | | |
| | **Key properties** | No abstraction/discharge data are available for this GWB however, highly karstified aquifers are often associated with extremely variable transmissivity values, borehole yields and spring yields. Spring yields can also be very large. Recharge can be rapid and a large proportion of the flow can occur through conduits, sometimes at extremely high velocities (e.g 100s m/hr). Accordingly, highly karstified rocks are often associated with low storativity.<br>A number of karst features have been recorded in the body: 12 caves, 3 springs and 4 swallow holes. These are principally located along the boundary between the Pure Bedded Limestones and Mixed Sandstones, Shales and Limestones. The number and location indicate that the aquifer is highly karstified – as surface water flow downslope off the lower permeability Sandstones and Impure Limestones and onto the Pure Bedded Limestones, point recharge to the karstified aquifer can rapidly occur through some of these features. A high degree of karstification is also indicated by the noticeable lower drainage density over this aquifer when compared to the adjacent non karst GWBs.<br>Groundwater gradients cannot be calculated although localised flow directions are likely to be towards the valley area in the centre of the GWB.<br>*(Pure Bedded Limestones Aquifer Chapter*) | | |
| | **Thickness** | In the pure limestones, most groundwater flows in an epikarstic layer a couple of metres thick and in a zone of interconnected solutionally-enlarged fissures and conduits that extends approximately 30 m below this. Most groundwater flux in the Sandstones (Lm aquifer) is also likely to be in uppermost top 30 m (c.3 m broken, weathered material underlain by interconnected fissuring), although there will also be a zone of isolated, poorly connected fissures – typically less than 150 m bgl – in all of the rock types.<br>In the lower permeability Mixed Sandstones, Shales and Limestones, there is a lower potential for deeper flows and the more interconnected fissure zones is also likely to be shallower –c.10-30 m in thickness. | | |
| **Overlying Strata** | **Lithologies** | *Data not available.* | | |
| | **Thickness** | Although available data are limited, the distribution of outcrops and steeper topography suggest that the subsoil in this GWB is relatively thin i.e. mainly less that 3 m thick. Although they may be thicker in the valley, they are generally unlikely to be greater than 10 m thick. | | |
| | **% area aquifer near surface** | *[Information will be added at a later date]* | | |
| | **Vulnerability** | Although vulnerability data are not available, vulnerability is *likely* to be Extreme over the higher areas, where subsoil is thinner. | | |
| **Recharge** | **Main recharge mechanisms** | Both point and diffuse recharge occur in this GWB. Diffuse recharge occurs via rainfall percolating through thin subsoil and outcrops over all of the aquifer types. In the pure limestones, point recharge to the underlying aquifer occurs via swallow holes and caves mapped along the boundary of the lower permeability aquifers, and any unrecorded dolines. Although recharge along 'losing' sections of streams is also associated with this particular type of karst aquifer, to date none have been recorded in this GWB. The steeper slopes in the body will promote runoff, however, the permeability nature of both the pure limestones and the sandstones are expected to results in a high proportion of recharge occurring. This is also indicated by the low stream density. | | |

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| | **Est. recharge rates** | *[Information will be added at a later date]* |
| **Discharge** | **Important springs and high yielding wells** | Sources: None identified.<br>Springs: None identified.<br>Excellent Wells: None identified.<br>Good Wells: None identified. |
| | **Main discharge mechanisms** | The main groundwater discharges are to the streams, rivers – especially the Glenaniff River – and any large springs found within the body. Discharge is likely to occur along the valley and lower slopes rather than in the higher zones. Given the permeable nature associated with karst aquifers, the baseflow proportion of the total streamflow is expected to be high. |
| | **Hydrochemical Signature** | ***National classification:*** Dinantian Pure and Impure Limestones<br>Calcareous. Generally Ca-$HCO_3$ signature.<br>Alkalinity (mg/l as $CaCO_3$): range of 10-990; mean of 283 (2454 data points)<br>Total Hardness (mg/l): range of 10-1940; mean of 339 (2146 data points)<br>Conductivity ($\mu$S/cm): range of 76-2999; mean of 691 (2663 data points)<br>***National classification:*** Dinantian Sandstones<br>Calcareous. Generally Ca-$HCO_3$ signature.<br>Alkalinity (mg/l as $CaCO_3$): range of 5-524; mean of 153 (65 'non limestone subsoils' data points)<br>Total Hardness (mg/l): range of 5-502; mean of 162 (67 'non limestone subsoils' data points)<br>Conductivity ($\mu$S/cm): range of 39-1184; mean of 408 (69 'non limestone subsoils' data points)<br>*(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)* |
| **Groundwater Flow Paths** | | As these rocks are generally devoid of inter-granular permeability, groundwater flows through fissures, faults, joints and bedding planes. In pure bedded limestones, these openings are frequently enlarged by karstification resulting in significantly enhanced rock permeability. Karstification can be also accentuated along structural features such as fold axes and faults. An epikarst layer in the upper few metres of the rock is likely to be present on top of the karstified aquifer. Shallow groundwater flow is likely to be dominant, although a component of deep groundwater flow would be expected.<br>Groundwater flow through karst areas is frequently extremely complex and difficult to predict. Although minimal hydrogeological investigation has been undertaken in this particular region, karst aquifers that are dominated by conduit flow are generally capable of rapidly transmitting large volumes of groundwater, which is frequently localised. Flow velocities are known to be variable, both temporally and spatially, with groundwater flows often exhibiting a rapid response to rainfall events, giving rise to 'spikey' hydrographs and springs with highly variable discharge. Rapid, localised flow through conduits often results in the aquifer having low storativity. Groundwater flow through discrete conduits may range from a) a relatively discontinuous water table, to b) actual flow directions deviating from the expected (i.e. perpendicular to the assumed water table contours), and in extreme cases c) flow across surface catchment divides/ beneath surface channels. This, however, depends on the frequency of faults, fissures and joints, and has not been established for this GWB.<br>Groundwater flow is thought to be mainly unconfined. In the karstified aquifers, groundwater flow is regional scale – flow path lengths of several kilometres are not unusual although are likely to be shorter in discharge areas (c.100-300 m), such as along the Glenaniff River. This is also likely be the case for the Sandstones although shorter flow paths are associated with the Mixed Sandstones, Shales and Limestones/ Impure Limestones. Overall, groundwater flow is likely to be towards the River Glenaniff in the centre of the GWB. However, the karstified nature of the pure limestone means that locally, groundwater flow directions can be highly variable. |
| **Groundwater & surface water interactions** | | There is a high degree of interconnection between groundwater and surface water in the karstified limestone is highlighted by the pattern of swallow holes and caves along the boundary with lower permeability rocks. The presence of dolines, caves, turloughs, springs, and 'losing' and 'gaining' streams also provide a direct route between surface water and groundwater systems. This rapid interchange between surface water and groundwater is often reflected in their similar water quality as contamination is also rapidly transported between the two systems. |

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| **Conceptual model** | • Northern and western boundaries represent changes in the aquifer type. Topographic divides provide the southern and eastern boundaries. The topography extends from a lower-lying valley to more mountainous upland areas.<br>• The main rock type in this GWB is a karstified limestone that is dominated by conduit groundwater flow (**Rk$^{c}$**). Smaller proportions of the body are underlain by sandstones, which are also considered to be characterised by a productive fracture flow system (**Lm**), and by Mixed Sandstones, Shales and Limestone (**Ll**).<br>• Most of the unconfined groundwater flux is in the uppermost 30 m of the aquifers. This occurs through a few metres (c.3 m) of broken, weathered bedrock and an underlying zones of interconnected joints, fissures, fractures and faults. In the pure limestones, the upper weathered zone is likely to equate to an epikarst layer and the underling joints, fissures, fractures and faults will be karstified (solutionally enlarged). Deeper groundwater flow may occur along permeable fault or fracture zones although is likely to occur to a lesser extent in the Ll aquifers.<br>• Transmissivity values and well yields are likely to be variable, reflecting zones of higher and lower permeability. In the pure limestones, there is the potential for high flow velocities of large quantities of groundwater through conduits, coupled with low storativity, resulting in rapid flow/discharge responses to rainfall.<br>• In general, the degree of interconnection in karstic systems is high and they support regional scale flow systems. Long flow paths (kilometres in length) can be expected although are likely to be shorter in discharge areas (100-300 m). Similar flow path lengths would be expected in the sandstones.<br>• Recharge occurs by:<br>  • diffuse means in all rock types – via outcrops and through thin subsoil – especially on the higher areas/slopes, and<br>  • additional point mechanisms in the karstified limestones; through the recorded swallow holes and caves along the boundary with lower permeability rocks, as well as any dolines, and along lengths of losing streams. Recharge is mainly associated with areas of thinner subsoil i.e. areas of extreme vulnerability.<br>• Due to the combination of point recharge and rapid flow through solutionally enlarged joint/fissure/fracture zones, there is minimal potential for contaminant attenuation in the limestone aquifer.<br>• The main discharges are to the rivers (predominantly the Glenaniff River) and springs within the GWB. Overall, the flow direction is towards the Glenaniff River, which runs through the centre of the GWB.<br>• There is a high degree of interaction between surface water and groundwater in this GWB. |
| **Attachments** | Figure 1. Table 1. |
| **Instrumentation** | **Stream gauges:** None identified.<br>**EPA Water Level Monitoring boreholes:** None identified.<br>**EPA Representative Monitoring points:** None identified. |
| **Information Sources** | MacDermot, C.V. Long C.B. and Harney S.J (1996) *Geology of Sligo-Leitrim: A geological description of Sligo, Leitrim and adjoining parts of Cavan, Fermanagh, Mayo and Roscommon, to accompany bedrock geology 1:100,000 scale map, Sheet 7, Sligo - Leitrim*. With contributions from K. Carlingbold, G. Stanley, D. Daly and R. Meehan. Geological Survey of Ireland, 100pp.<br>O' Riain, 2004. *Water Dependent Ecosystems and Subtypes (Draft)*. Compass Informatics in association with National Parks and Wildlife (DEHLG). WFD support projects. |
| **Disclaimer** | Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae |

**Figure 1. Location and Boundaries of GWB.**

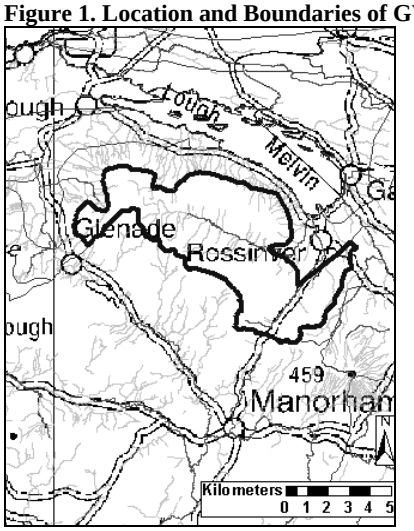

**Table 1. List of Rock units in Glenaniff GWB**

| **Rock Unit Name** | Code | Description | Rock Unit Group | **Aquifer Class.** | % Area |
|---|---|---|---|---|---|
| Dartry Limestone Formation | DA | Dark fine-grained cherty limestone | Dinantian Pure Bedded Limestones | Rkc | 75.30% |
| Glenade Sandstone Formation | GD | Pale orthoquartzitic sandstone | Dinantian Sandstones | Lm | 13.27% |
| Meenymore Formation | ME | Shale, laminated carbonate, evaporite | Dinantian Mixed Sandstones, Shales and Limestones | Ll | 10.45% |
| Glencar Limestone Formation | GC | Dark fine limestone & calcareous shale | Dinantian Upper Impure Limestones | Ll | 0.53% |
| Ballyshannon Limestone Formation | BS | Pale grey calcarenite limestone | Dinantian Pure Bedded Limestones | Rkc | 0.23% |
| Bundoran Shale Formation | BN | Dark shale, minor fine-grained limestone | Dinantian Shales and Limestones | Ll | 0.18% |
| Mullaghmore Sandstone Formation | MU | Sandstone, siltstone & shale | Dinantian Sandstones | Lm | 0.03% |