

Tievebaun GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water bodies	Associated terrestrial ecosystems	Area (km ²)
Hydrometric Area 36 Leitrim Co. Co. Sligo Co. Co.	<i>Rivers:</i> None <i>Streams:</i> 17 unnamed streams <i>Lakes:</i> None	Ben Bulben, Gleniff and Glenade Complex (O’Riain, 2004)	10
Topography	This is an approximately triangular-shaped, upland GWB covering Tievebaun Mountain and the northern flanks of Truskmore (Figure 1). The southern boundary comprise a topographic divide (Hydrometric Area 35), with the remaining boundaries consisting of lower permeability rocks. Being an essentially upland GWB, the landscape is steep, with elevations ranging from 360 to 610 mAOD on Tievebaun, and 640 mAOD on Truskmore. The surface flow radiates downslope although very few channels are mapped.		
Geology and Aquifers	Aquifer type(s)	Rk^c: Regionally important karst aquifer dominated by conduit flow, covers the majority of the GWB (80%). The areas are capped by Lm: Locally important aquifer which is generally moderately productive (11%), 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 (79.57%), Sandstones over the upland caps (11.29%) and an intervening band of Mixed Sandstones Shales and Limestones (9.14%). Refer to Table 1 for full details.	
	Key structures	The rocks are generally dipping towards Tievebaun peak by 10-40°.	
	Key properties	<p>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.</p> <p>No karst data are available although the c.20 features were recorded in the nearby Glenaniff GWB, which comprises the same rocks in a similar sequence. The location of these features indicate that the aquifer is highly karstified. This is likely to be case for the Tievebaun GWB, especially as there is very low drainage density over the rocks, suggesting that water rapidly recharges the aquifer, which is characteristic of karst rocks.</p> <p>Groundwater gradients cannot be calculated although flow directions are likely to radiate downslope to the north, west and east within the GWB. Regional flow is generally northwards, to eventually discharge into Donegal Bay.</p> <p><i>(Pure Bedded Limestones Aquifer Chapter)</i></p>	
	Thickness	<p>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.</p> <p>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.</p>	
Overlying Strata	Lithologies	No data are available for 60% of this GWB (NI and Leitrim). However, of the remaining area, till is the predominant subsoil (c.70%), with a small proportion of peat (12%).	
	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 than 3 m thick.	
	% area aquifer near surface	<i>[Information will be added at a later date]</i>	
	Vulnerability	Although vulnerability data are not available, vulnerability is <i>likely</i> to be Extreme over the majority of the GWB, based on the assumption that the subsoil is generally 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 any swallow holes, caves and 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 over the majority of the body. This is also indicated by the low stream density.	
	Est. recharge rates	<i>[Information will be added at a later date]</i>	

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Discharge	Important springs and high yielding wells	Sources: None identified. Springs: None identified. Excellent Wells: None identified. Good Wells: None identified.
	Main discharge mechanisms	Any groundwater discharges are to the streams, rivers and any springs found within the body. However, given the permeable nature of the aquifers and the topographic location of this GWB, there are likely to be minimal discharges within the GWB itself. Instead, a large proportion of groundwater moving down-gradient through the permeable limestone is more likely to discharge to surface water once it encounters the lower permeability aquifers of the Rossinver GWB. This assessment of discharge is indicated by the surface drainage pattern; the majority of rivers/streams in the area start at the boundary between the Tievebaun and Rossinver GWBs.
	Hydrochemical Signature	<i>National classification:</i> Dinantian Pure and Impure Limestones Calcareous. Generally Ca-HCO ₃ signature. Alkalinity (mg/l as CaCO ₃): range of 10-990; mean of 283 (2454 data points) Total Hardness (mg/l): range of 10-1940; mean of 339 (2146 data points) Conductivity (µS/cm): range of 76-2999; mean of 691 (2663 data points) <i>National classification:</i> Dinantian Sandstones Calcareous. Generally Ca-HCO ₃ signature. Alkalinity (mg/l as CaCO ₃): range of 5-524; mean of 153 (65 'non limestone subsoils' data points) Total Hardness (mg/l): range of 5-502; mean of 162 (67 'non limestone subsoils' data points) Conductivity (µS/cm): range of 39-1184; mean of 408 (69 'non limestone subsoils' data points) <i>(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)</i>
Groundwater Flow Paths	<p>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.</p> <p>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.</p> <p>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, which would span the width of the GWB. Long flow paths are also likely to occur in the Sandstones although shorter flow paths are associated with the Mixed Sandstones, Shales and Limestones/ Impure Limestones (c.100-300 m). Overall, groundwater flow is likely to radiate out from the summits in the GWB. However, the karstified nature of the pure limestone means that locally, groundwater flow directions can be highly variable.</p>	
Groundwater & surface water interactions	<p>There is a high degree of interconnection between groundwater and surface water in karstified limestone areas such as in this GWB. Any unrecorded swallow holes, dolines, caves, turloughs, springs, and 'losing' and 'gaining' streams all 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.</p>	

Conceptual model	<ul style="list-style-type: none"> • Northern, western and eastern boundaries comprise lower permeability aquifers. A topographic divide provide the southern boundary. Essentially constituting an upland area, the topography is generally mountainous. • The main rock type in this GWB (c.80%) is a karstified limestone that is dominated by conduit groundwater flow (Rk^c). Approximately 10% of the area is underlain by sandstones, which are also considered to be characterised by a productive fracture flow system (Lm). The Sandstones are ringed by Mixed Sandstones, Shales and Limestone (LI). • 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. • Transmissivity values and well/spring 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. • 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. • Recharge occurs by: <ul style="list-style-type: none"> • diffuse means in all rock types – via outcrops and through thin subsoil, and • additional point mechanisms in the karstified limestones; swallow holes, dolines, caves and along lengths of losing streams – mainly occurring where subsoils are thin i.e. areas of extreme vulnerability. • 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. • The main discharges are to the rivers and springs, principally at the boundary of the GWB, where the groundwater moving through the karstified aquifer encounters the lower permeability aquifers of the Rossinver GWB. The flow radiates out from the centre of the GWB to the west, north and east, as determined by the topography. • 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. EPA Water Level Monitoring boreholes: None identified. EPA Representative Monitoring points: None identified.
Information Sources	MacDermot, C.V. Long C.B. and Harney S.J (1996) <i>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</i> . With contributions from K. Carlingbold, G. Stanley, D. Daly and R. Meehan. Geological Survey of Ireland, 100pp. O' Riain, 2004. <i>Water Dependent Ecosystems and Subtypes (Draft)</i> . 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

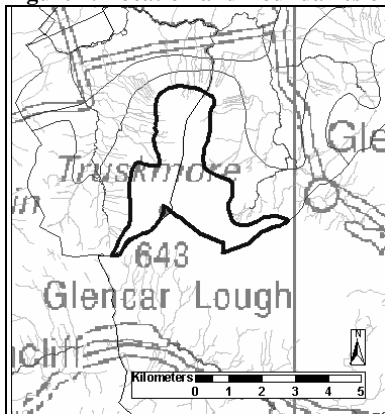


Table 1. List of Rock units in Tievebaun GWB

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	79.57%
Glenade Sandstone Formation	GD	Pale orthoquartzitic sandstone	Dinantian Sandstones	Lm	11.29%
Meenymore Formation	ME	Shale, laminated carbonate, evaporite	Dinantian Mixed Sandstones, Shales and Limestones	LI	9.14%