

Lough Swilly GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water bodies	Associated terrestrial ecosystems	Area (km ²)
Hydrometric Area 39 Donegal Co. Co.	<p>Rivers : Aghaweel, Bullaba, Burnfoot, Camowen, Cashelnacor, Caslough, Corkey, Crana, Deelee, Dooballagh Burn, Drumhallagh, Drumbarney Stream, Evishbreedy, Glashagh- Crana, Glashagh Upper, Glashagh Lower, Glaskeelan, Glenalla, Glenvar, Leannan, Lurgy, Mill, Owenboy, Owenerk, Owennasop, Swilly, Sharagore, Slievemain, Tehabber, Burnfoot, Skeoge, Owenwee, Lownagh, Corravaddy Burn.</p> <p>Streams: Leslie Hill, Drumbarney, 2245 unnamed streams</p> <p>Lakes: Cannon, Carn, Carrick, Claggan, Cloncarney, Clonkillymore, Clonkillybeg, Columbkille, Cottain, Crunlough, Doon, Garnahallowey, Gartan, Gibbons, Gort, Gorteen, Irvine, Knockalla, Long, Fad, Goragh, Hanane, Mamore, Shivnagh, Acrappan, Acrobane, Agannon, Akibban, Anny, Askerry, Avroughdal, Aweel, Beg, Coney, Darragh, Deelee, Doira, Doo, Fern, Fullarton, Inseach, Meeltoge, Mnafin, Nacally, Nafinn, Nafirm, Nakey, Nambradden, Napuckan, Nascally, Rogan, Anvrackabrack, Magheradrumman, Mill Pond, Mintraghs, Pollett/Cloghmore, Sproule's, The Bog, Thorn.</p>	Meentygrannagh Bog, North Inishowen Coast, Cloghernagore Bog and Glenveagh National Park and Lough Swilly (O'Riain, 2004)	932
Topography	This GWB discharges surface water and groundwater into Lough Swilly i.e. west Inishowen, east Fanad Peninsula, and east of the Glenveagh National Park. The eastern, southern and western boundaries are surface water divides (Hydrometric Areas 40, 01 and 38). The northern boundary is constrained by circuitous coastline. The topography ranges from low-lying, flat areas along the coast (<10 mAOD) to more mountainous, upland zones ~ over 600 mAOD along the eastern boundary (Slieve Snaght, Inishowen), and 500 mAOD along the western boundary (Glendowan Mountains). The intervening area comprises lower-lying valleys between rock-cored hills, with occasional areas of drumlins in the valleys. Surface water flows to the east, north and west to discharge into Lough Swilly.		
Geology and Aquifers	Aquifer type(s)	The GWB is dominated by P1 : Poor aquifer which is generally unproductive except for local zones (%), with two areas of Pu : Poor aquifer, generally unproductive – c.50 km ² of SW-NE trending bands in west Inishowen and a SSW-NNE trending band east of the Glendowan Mountains (c.15 km ²). Three areas of L1 : Locally important aquifer, moderately productive only in local zones, are present in the body (7.5, 6.5 and 4.7 km ²), as well as several narrow band adjacent to the Pu aquifers.	
Geology and Aquifers	Main aquifer lithologies	Precambrian Quartzites, Gneisses & Schists is the main rock group in this GWB (91.45%), with a sizeable area of Granites & Other Igneous Intrusive Rocks (5.59%) along the south-western boundary (c.60 km ² under the Glendowan Mountains). There are also 4 small areas of Precambrian Marbles (2.75%), a pocket of Devonian Old Red Sandstones is also present (0.2%, < 2km ²). Refer to Table 1 for more details.	
Geology and Aquifers	Key structures	The rocks in this part of Donegal have been significantly deformed, resulting in a large number of approximately SW-NE faults (e.g. Leannan and Belshade Faults) and the rock succession dipping between 40-80° to the SW. There are also a number of anticline and syncline folds, the largest of which extend from the middle of the Inishowen Peninsula to north of Letterkenny Town .	

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	<p>Key properties</p> <p>Yields from the 13 available Precambrian Quartzites, Gneisses and Schists (PI/Pu) wells range from 2-2200 m³/d. The highest yield is considered to be anomalous for this area (<i>pers. comm.</i> P. Dullea, drilling contractor) and 8 wells have <35 m³/d. Specific capacities of 0.05, 0.45, 440 and 545 m³/d/m have been recorded, which represents the national range for this rock group. The national average is 45 m³/d/m for 20 wells. There are no transmissivity data for the GWB although a value of 10 m²/d has been obtained for the coarser-grained Precambrian PI/Pu rocks in south Donegal. In general, transmissivities in these rocks are likely to be low although higher values may be achieved in faulted zones, especially in the coarser-grained rocks (quartzites and gneisses). Typical specific dry weather flows for this rock group in Donegal are low (0.41-1.1 l/s/km² at 5 stations), indicating that these aquifers have low storativity (expected to be c.0.5%).</p> <p>Although the Precambrian Marbles group is also categorised as a poorly productive aquifer, it is considered to be slightly more productive (LI) than the Quartzites, Gneisses and Schists group (PI/Pu). No data are available for the Marbles in this particular GWB however, additional information is available from other parts of County Donegal. Yields in the Raphoe and Manor Cunningham GWBs range from 2-1090 m³/d with an average of 202 m³/d (15 wells). Transmissivity values of 11 and 12 m²/d have been calculated for the Magherabeg/Veagh WSS (Manor Cunningham GWB), and 7 specific capacity values are available: 0.1, 0.4, 0.8, 4, 31, 82 and 165 m³/d/m. The same rocks also supply the Culdaff WSS: yield of 523 m³/d, transmissivity of c.110 m²/d, and specific capacity of 126 m³/d/m. Karstification may also occur in these rocks e.g. the Pollnapaste Cave, west Donegal (Parkes <i>et al</i>, 2000), and a 'fractured cavity' recorded in the Culdaff WSS borehole log, which possibly reflects some degree of solution. Overall, the data highlight that yields and transmissivities (calculated and implied) are variable and that there are productive zones in these rocks that may have been enhanced by karstification. Although better than the PI/Pu aquifers, transmissivity and storativity values are still thought to be relatively low i.e. <20 m²/d and <1% respectively.</p> <p>95% of the x available groundwater levels are 0-5 m below ground level. Although levels are inadequate to calculate groundwater gradients, these are expected to be greater than 0.01.</p> <p>N.B. Additional data are available for the Termon rock unit in the Letterkenny area. However, these data possibly also reflect the overlying productive gravel deposits. They are therefore excluded from this assessment (refer to Donegal GWPS).</p> <p><i>(Precambrian Aquifer Chapter; Donegal GWPS; Pettigo WSS Source Protection Report; Culdaff WSS Source Report; Magherabeg/Veagh WSS Source Report)</i></p>
	<p>Thickness</p> <p>Most groundwater flux is expected to be in the uppermost part of the aquifer comprising a broken and weathered zone typically less than 3 m thick, a zone of interconnected fissuring c.10 m thick, and a zone of isolated poorly connected fissuring typically less than 150 m. Deeper water strikes are noted at between 19-63 mbgl in 7 wells.</p>
Overlying Strata	<p>Lithologies</p> <p><i>Jen</i></p>
	<p>Thickness</p> <p>Subsoil is absent or thin over much of the GWB, especially in the northern and western areas. Thicker deposits (>3 m) are more common in the Inishowen area with the deposits of >10 m limited to the centre of river valleys.</p>
	<p>% area aquifer near surface</p> <p>< 3 m (<i>consultants</i>)</p>
	<p>Vulnerability</p> <p>From the Donegal GWPS, the majority of this GWB is classified as Extremely vulnerability, due to the high percentage of thin subsoil. Where subsoils are thicker, such as in the valleys and in the eastern area, the vulnerability ranges from High to Moderate, with occasional small areas of Low that are associated with thicker pockets of peat.</p>
Recharge	<p>Main recharge mechanisms</p> <p>Diffuse recharge occurs via rainfall percolating through the subsoil and rock outcrops. Due to the low permeability of some thicker peat subsoil deposits and the aquifers, a high proportion of the effective rainfall will quickly discharge to the streams in the GWB. In addition, the steep slopes in the mountainous areas promote surface runoff. The stream density is approximately x km/km², reflecting the high proportion of surface runoff.</p>
	<p>Est. recharge rates</p> <p><i>[Information will be added at a later date]</i></p>
Discharge	<p>Springs and large known abstractions</p> <p>Sources: Future Letterkenny Supply (overlain by productive gravel deposits). Fahan public supply 45m³/d, William Mc Mahon- no abstraction data, Rathmelton WS – no abstraction data. Excellent wells: Corderry – 1090 m³/d, Lismoghry – 2200 m³/d, Sallahagrane - 1000 m³/d, Sallahagrane - 785 m³/d, Ballymacool - 559 m³/d. Good wells: Drum – 109 m³/d, Ray – 218 m³/d, Ballynakilly – 110 m³/d.</p>
	<p>Main discharge mechanisms</p> <p>The main discharges are to the rivers and streams crossing the GWB, reflecting short groundwater flow paths. Small springs and seeps are likely to issue at the stream heads and along their course. Seepages will develop on the coastal cliff faces.</p>

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Hydrochemical Signature	<p>National classification: Precambrian Quartzites, Gneisses and Schists</p> <p>Non-calcareous with bi-modal alkalinity distribution although the higher range is possibly caused by thin marble bands and overlying limestone subsoil.</p> <p>Alkalinity (mg/l as CaCO₃): range of 14-400; mean of 168 (41 ‘non limestone subsoils’ data points)</p> <p>Total Hardness (mg/l): range of 46-412; mean of 200 (39 ‘non limestone subsoils’ data points)</p> <p>Conductivity (μS/cm): range of 160-752; mean of 446 (45 ‘non limestone subsoils’ data points)</p> <p><i>(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)</i></p>
Groundwater Flow Paths	<p>In the absence of inter-granular permeability, groundwater flow is expected to be concentrated in upper fractured and weathered zones and in the vicinity of fault zones. Of the 81 groundwater levels available, 80 are <10 m below ground level, with 75% <3 mbgl. In the Marbles, the permeability of the fracture/fault zones may be enhanced by some degree of karstification. Unconfined groundwater flow paths are short (30-300 m), with groundwater generally following the topography and then discharging rapidly to seeps, small springs, streams and lakes. Water strikes deeper than the estimated interconnected fissure zone suggest a component of deep groundwater flow, however shallow groundwater flow is dominant. Overall, groundwater flow is towards Lough Swilly.</p>
Groundwater & surface water interactions	<p>Due to the shallow groundwater flow in this aquifer the groundwater and surface waters are closely linked. The aquifer discharges readily to the overlying (gaining) streams and peat. Almost half the GWB is covered by ecosystems that are (Connemara Bog Complex / The Twelve Pins - Garraun Complex / Mweelrea-Sheffry-Errif Complex) dependent on groundwater.</p> <p>Some of the NHAs within the GWB are likely to be groundwater-dependent to some extent (which ones? Paul Mills disk). Therefore over-abstraction in these areas could have a detrimental effect on some of these habitat, although closer investigation is required to determine the nature of this dependency. Last bit from ERBD-Bailieborough.</p>
Conceptual model	<ul style="list-style-type: none"> • Western, southern and eastern GWB boundaries are surface water catchment divides (Hydrometric Areas 40, 38 and 01). The northern boundary comprise coastline, mainly along Lough Swilly. The terrain is characteristically hilly to mountainous, incised by large valleys and with low-lying, flatter areas along the coast. Drumlin feature in some of the valleys. • The GWB is composed primarily of low transmissivity rocks, although the Marbles (L1 aquifer) are likely to have slightly higher transmissivities than the Quartzites, Gneisses and Schists (Pl/Pu). • Most of the groundwater flux is likely to be in the uppermost part of the aquifer comprising: a broken and weathered zone typically less than 3m thick; a zone of interconnected fissuring less than c.10m; and a zone of isolated fissuring typically less than 150m. Karstification may have enlarged the fractures/faults in the Marbles. • Recharge occurs diffusely through the subsoil and rock outcrops, although is limited by any peat and the low permeability bedrock. Therefore, most of the effective rainfall is not expected to recharge the aquifers. • Flow paths are likely to be short (30-300 m) with groundwater discharging rapidly to the streams crossing the aquifer, and to small springs and seeps. Overall, the flow direction is towards Lough Swilly, as determined by the topography. • The source protection area for the future Letterkenny WSS will be within this GWB. • NHAs?
Attachments	?
Instrumentation	<p>Stream gauge: 39001*, 39002, 39003*, 39004, 39005, 39006, 39007, 39008, 39009, 39010, 39011, 39012, 39013, 39015, 39016, 39020, 39021, 39061, 39070, 39071, 39072.</p> <p>* Have Adjusted Dry Water Flow data.</p> <p>EPA Water Level Monitoring boreholes: None</p> <p>EPA Representative Monitoring boreholes: (DON 13)</p>
Information Sources	<p>Long, C.B. & McConnell B.J. (1997) Geology of North Donegal: <i>A geological description to accompany bedrock geology 1:100,000 scale map, Sheet 1 and part of Sheet 2, North Donegal</i>. With contributions from P. O’Connor, K. Claringbold, C. Cronin and R. Meehan. Geological Survey of Ireland. 87pp</p> <p>Lee M. and Fitzsimons V. (2004). <i>County Donegal Groundwater Protection Scheme</i>. Main Report. Draft Report to Donegal County Council. Geological Survey of Ireland 58pp.</p> <p>Minerex Environmental Ltd (2000). <i>Letterkenny Water Supply – No. 2 Augmentation Scheme. Groundwater resource development in Glen Swilly. Data Review, Geophysics, Core Logging, Replacement Well Drilling, Pumping Tests & Reporting. Fieldwork July – November 2000</i>. MEL Report Ref:- 1009-828 (Final).doc.</p> <p>Lee M. and Daly D. (2004). <i>Pettigo Public Water Supply Scheme Source Protection Zones</i>. Draft Report to Donegal County Council. Geological Survey of Ireland XXpp. Not written yet</p>
Disclaimer	<p>Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae</p>

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Table 1. List of rock units in Lough Swilly GWB

Rock Unit Name	Code	Description	Rock Unit Group	Aquifer Class.	% Area
Termon Formation	TE	Banded semi-pelitic & psammitic schist	Precambrian Quartzites, Gneisses & Schists	PI	32.11%
Lough Foyle Succession	LFS	Schist and grit with thin marble units	Precambrian Quartzites, Gneisses & Schists	PI	14.51%
Lower Crana Quartzite Formation	LC	Psammitic schist, some marble beds	Precambrian Quartzites, Gneisses & Schists	PI	11.19%
Upper Crana Quartzite Formation	UC	Psammitic schist with pebbly grit beds	Precambrian Quartzites, Gneisses & Schists	PI	10.46%
Slieve Tooley Quartzite Formation	ST	Whitish quartzite with pebble beds	Precambrian Quartzites, Gneisses & Schists	PI	6.34%
Fahan Slate Formation	FS	Dark pelitic & psammitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	5.73%
Main Donegal Granite	MdGr	Coarse biotite granite & granodiorite	Granites & other Igneous Intrusive rocks	PI	5.38%
Fahan Grit Formation	FG	Pale grey grit with psammitic schist	Precambrian Quartzites, Gneisses & Schists	PI	5.03%
Metadolerite	Md	Hornblendic and sometimes schistose	Precambrian Quartzites, Gneisses & Schists	PI	1.66%
Culdaff Limestone Formation	CU	Grey graphitic marble & pelitic schist	Precambrian Marbles	LI	1.56%
Killeter Quartzite Formation	KT	Slightly impure quartzite	Precambrian Quartzites, Gneisses & Schists	PI	1.52%
Sessiagh-Clonmass Formation	SC	Quartzite, dolomitic marble & schist	Precambrian Quartzites, Gneisses & Schists	PI	1.26%
Aghyaran & Killygordon Limestone Formations	DG	Marble, quartzite, psammite; graphitic	Precambrian Marbles	LI	0.92%
Lower Falcarragh Pelite Formation	LF	Grey carbonaceous pelitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	0.70%
Upper Falcarragh Pelite Formation	UF	Pelitic, semi-pelitic, psammitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	0.61%
Falcarragh Limestone Formation	FL	Blue-grey banded marble, pelite partings	Precambrian Marbles	LI	0.22%
Glencolumbkille Pelite Formation	GP	Black graphitic pelitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	0.20%
Ballymastocker Formation	BA	Red conglomerate & arkosic sandstone	Devonian Old Red Sandstones	LI	0.20%
Tullagh Point Granite	Tu	Coarse granodiorite to monzogranite	Granites & other Igneous Intrusive rocks	PI	0.18%
Cranford Limestone Formation	CR	Quartzite breccia & marble	Precambrian Marbles	PI	0.05%
Port Askaig Formation	PA	Diamictite, schist & quartzite	Precambrian Quartzites, Gneisses & Schists	Pu	0.04%
Appinite suite	Ap	undifferentiated	Granites & other Igneous Intrusive rocks	PI	0.04%
Ards Quartzite Formation	AQ	Whitish quartzite with pebble beds	Precambrian Quartzites, Gneisses & Schists	PI	0.03%
Knockletteragh Member	TEkg	Pebbly grits	Precambrian Quartzites, Gneisses & Schists	PI	0.03%
Port Askaig Formation	PA	Diamictite, schist & quartzite	Precambrian Quartzites, Gneisses & Schists	Pu	0.02%