Lough Swilly West 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.		***Rivers :*** Bullaba, Corkey, Corravaddy Burn, Dooballagh Burn, Drumhallagh, Glashagh Upper, Glashagh Lower, Glaskeelan, Glenalla, Glenvar, Leannan, Lurgy, Swilly, Tehabber, Owenwee, Lownagh. ***Streams:*** Leslie Hill, 1665 unnamed streams ***Lakes:*** Cannon, Carn, Carrick, Claggan, Cloncarney, Clonkillymore, Clonkillybeg, Columbkille, Cottain, Doon, Garnahalowey, Gartan, Gibbons, Gort, Gorteen, Irvine, Knockalla, Long, Goragh, Hanane, Acrappan, Acrobane, Agannon, Akibban, Anny, Askerry, Avroughdal, Aweel, Beg, Coney, Darragh, Deele, Doira, Doo, Fern, Fullarton, Inseach, Meeltoge, Mnafin, Nacally, Nafinn, Nafirm, Nakey, Nambradden, Napuckan, Nascally, Rogan, Magheradrumman, Pollett/Cloghmore, Sproule's, The Bog, Thorn.	Meentygrannagh Bog, Cloghernagore Bog and Glenveagh National Park and Lough Swilly (O'Riain, 2004)	557
Topography		This GWB (Figure 1) comprises the eastern portion of the Fanad Peninsula, and east of the Glenveagh National Park. Southern and western boundaries are topographic divides (Hydrometric Areas 01 and 38). The eastern boundary is constrained by circuitous coastline and the south-eastern boundary comprises a differing aquifer type. The topography ranges from low-lying, flat areas along the coast (<10 mAOD) to more mountainous, upland zones ~ over 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 predominantly flows to the east, to discharge into Lough Swilly.		
Geology and Aquifers	**Aquifer type(s)**	The GWB is dominated by **Pl:** Poor aquifer which is generally unproductive except for local zones (95%), with an area of **Pu:** Poor aquifer, generally unproductive, occurring in SSW-NNE trending bands east of the Glendowan Mountains (<15 km^2). One main, although small, area of **Ll:** Locally important aquifer, moderately productive only in local zones, is present, as well as several narrow bands adjacent to the Pu aquifers (2.5%).		
	Main aquifer lithologies	Precambrian Quartzites, Gneisses & Schists is the main rock group in this GWB (88.44%), with a sizeable area of Granites & Other Igneous Intrusive Rocks (9.1%) along the south-western boundary (c.60 km^2 under the Glendowan Mountains). There are also small areas of Precambrian Marbles (2.12%) and a pocket of Devonian Old Red Sandstones is also present (0.34%, < 2km^2). Refer to Table 1 for more details.		
	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 .		

	Key properties	Yields from the 8 available wells range from 2-1090 m^3/d, although 5 have <35 m^3/d. Specific capacities of 0.05 and 545 $m^3/d/m$ have been recorded, which represents the national range for this rock group. The national average is 45 $m^3/d/m$ for 20 wells. Although there are no transmissivity data for the GWB, they are likely to be low for all rock types, with the possibility of higher values in faulted zones, especially in the coarser-grained rocks (quartzites, gneisses and granites). Typical specific dry weather flows for this rock group in Donegal are low (0.41-1.1 $l/s/km^2$ at 5 stations), indicating that this aquifer does not make a significant baseflow contribution to streamflow. Storativity is also expected to be low. Although the Precambrian Marbles group is also categorised as a poorly productive aquifer, it is considered to be slightly more productive (Ll) than the Quartzites, Gneisses and Schists group (Pl/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 m^3/d with an average of 202 m^3/d (15 wells). Transmissivity values of 11 and 12 m^2/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 $m^3/d/m$). The same rocks also supply the Culdaff WSS (East Inishowen GWB): yield of 523 m^3/d, transmissivity of c.110 m^2/d, and specific capacity of 126 $m^3/d/m$. Karstification may also occur in these rocks e.g. the Pollnapaste Cave, west Donegal (Parkes *et al*, 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 Pl/Pu aquifers, transmissivity and storativity values are still thought to be relatively low. All of the 62 available groundwater levels are less than 10 m below ground level (70% <3 mbgl). Although levels are inadequate to calculate groundwater gradients, these are expected to be relatively steep. N.B. Additional data are available for the Termon rock unit in the Letterkenny area. However, it is possible that these data also reflect the overlying productive gravel deposits. They are therefore excluded from this assessment (refer to Donegal GWPS). *(Precambrian Aquifer Chapter; Donegal GWPS; Culdaff WSS Source Report; Magherabeg/Veagh WSS Source Report*)
	Thickness	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. Only marginally deeper water strikes are noted (5 strikes of 19-36 mbgl in 4 wells.
Overlying Strata	**Lithologies**	The GWB is predominantly covered by till (52%), with less proportions of peat (26%). Approximately 17% of the GWB is recorded as outcrop/shallow rock.
	Thickness	Subsoil is absent or thin over much of the GWB, especially in the northern and western areas. Thicker deposits (>3 m) are limited to the lower lying areas, especially along river valleys, with the thickest deposits of >10 m limited to the centre of valleys.
	% area aquifer near surface	*[Information will be added at a later date]*
	Vulnerability	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, the vulnerability ranges from High to Moderate, with occasional small areas of Low that are associated with thicker pockets of peat.
Recharge	**Main recharge mechanisms**	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 relatively high stream density is likely to be influenced by the low permeability rocks.
	Est. recharge rates	*[Information will be added at a later date]*
Discharge	**Springs and large known abstractions**	Sources: Possible future Letterkenny Supply (overlain by productive gravel deposits). Drum (109 m^3/d). Springs: None identified. Excellent wells: Corderry (1090 m^3/d). Good wells: Ray (218 m^3/d), see Sources above.
	Main discharge mechanisms	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.
	Hydrochemical Signature	***National classification:*** Precambrian Quartzites, Gneisses and Schists Non-calcareous with bi-modal alkalinity distribution although the higher range is possibly caused by thin marble bands and overlying limestone subsoil. Alkalinity (mg/l as $CaCO_3$): range of 14-400; mean of 168 (41 'non limestone subsoils' data points) Total Hardness (mg/l): range of 46-412; mean of 200 (39 'non limestone subsoils' data points) Conductivity (μS/cm): range of 160-752; mean of 446 (45 'non limestone subsoils' data points) *(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)*

Groundwater Flow Paths	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. All of the 62 groundwater levels available are <10 m below ground level, with 70% <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 and streams. Water strikes very marginally deeper than the estimated interconnected fissure zone suggest a limited component of deep groundwater flow, however shallow groundwater flow is dominant. Overall, groundwater flow is eastwards, towards Lough Swilly.
Groundwater & surface water interactions	Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater - surface water interactions occur. Baseflow to rivers and streams is relatively low.
Conceptual model	• Western and southern GWB boundaries are topographic divides (Hydrometric Areas 38 and 01). The eastern boundary comprise coastline, mainly along Lough Swilly, and the south-eastern boundary is marked by a differing aquifer. 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 (Ll aquifer) are likely to have slightly higher transmissivities than the Quartzites, Gneisses and Schists and Granite rock groups (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 thicker 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 eastwards towards Lough Swilly, as determined by the topography. • The future Letterkenny WSS will potentially be within this GWB, depending on whether is abstracts from the bedrock or the overlying gravels.
Attachments	Figure 1. Table 1.
Instrumentation	**Stream gauge**: 39001*, 39005, 39006, 39007, 39008, 39009, 39011, 39012, 39020, 39061, 39070, 39071, 39072. * Have Adjusted Dry Water Flow data. **EPA Water Level Monitoring boreholes:** None identified. **EPA Representative Monitoring boreholes:** (DON 13)
Information Sources	Lee M. and Fitzsimons V. (2004). *County Donegal Groundwater Protection Scheme.* Main Report. Draft Report to Donegal County Council. Geological Survey of Ireland 58pp. Lee M. and Daly D. (2004). *Magherabeg/Veagh Public Water Supply Scheme, Source Protection Zones.* Geological Survey of Ireland Report. Lee M. and Daly D. (2004). *Culdaff Water Supply Scheme, Source Protection Zones*. Geological Survey of Ireland Report. Long, C.B. & McConnell B.J. (1997) Geology of North Donegal: *A geological description to accompany bedrock geology 1:100,000 scale map, Sheet 1 and part of Sheet 2, North Donegal.* With contributions from P. O'Connor, K. Claringbold, C. Cronin and R. Meehan. Geological Survey of Ireland. 87pp Minerex Environmental Ltd (2000). *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*. MEL Report Ref:- 1009-828 (Final).doc. O' Riain, G. 2004. *Water Dependent Ecosystems and Subtypes (Draft)*. Compass Informatics in association with National Parks and Wildlife (DEHLG). WFD support projects. Parkes, M., Johnston, D., Simms, M.J. and John G. Kelly (1999). *Geological guidance of speleogenesis in marble of the Dalradian Supergroup, County Donegal, Ireland.* Cave and Karst Science Vol. 26. No3. December 1999. Transactions of the British Cave Research Association.
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.

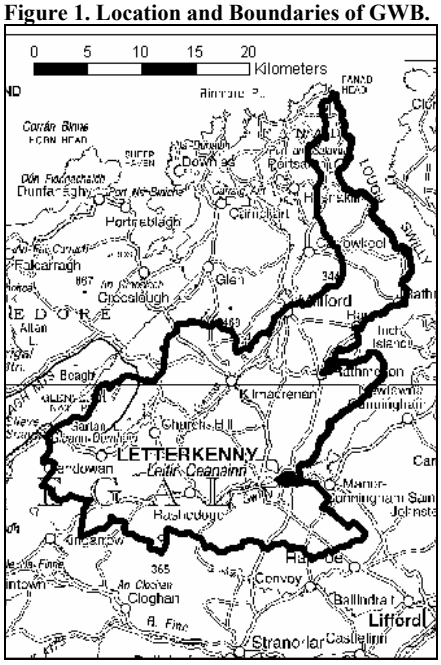

Table 1. List of rock units in Lough Swilly West GWB

Rock Unit Name	Code	Description	Rock Unit Group	**Aquifer Class.**	% Area
Termon Formation	TE	Banded semi-pelitic & psammitic schist	Precambrian Quartzites, Gneisses & Schists	Pl	47.95%
Upper Crana Quartzite Formation	UC	Psammitic schist with pebbly grit beds	Precambrian Quartzites, Gneisses & Schists	Pl	12.88%
Lower Crana Quartzite Formation	LC	Psammitic schist, some marble beds	Precambrian Quartzites, Gneisses & Schists	Pl	12.06%
Main Donegal Granite	MdGr	Coarse biotite granite & granodiorite	Granites & other Igneous Intrusive rocks	Pl	9.04%
Slieve Tooey Quartzite Formation	ST	Whitish quartzite with pebble beds	Precambrian Quartzites, Gneisses & Schists	Pl	6.14%
Killeter Quartzite Formation	KT	Slightly impure quartzite	Precambrian Quartzites, Gneisses & Schists	Pl	2.55%
Sessiagh-Clonmass Formation	SC	Quartzite, dolomitic marble & schist	Precambrian Quartzites, Gneisses & Schists	Pl	2.11%
Metadolerite	Md	Hornblendic and sometimes schistose	Precambrian Quartzites, Gneisses & Schists	Pl	2.00%
Aghyaran & Killygordon Limestone Formtns	DG	Marble, quartzite, psammite; graphitic	Precambrian Marbles	Ll	1.54%
Lower Falcarragh Pelite Formation	LF	Grey carbonaceous pelitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	1.18%
Upper Falcarragh Pelite Formation	UF	Pelitic, semi-pelitic, psammitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	1.02%
Falcarragh Limestone Formation	FL	Blue-grey banded marble, pelite partings	Precambrian Marbles	Ll	0.36%
Glencolumbkille Pelite Formation	GP	Black graphitic pelitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	0.34%
Ballymastocker Formation	BA	Red conglomerate & arkosic sandstone	Devonian Old Red Sandstones	Ll	0.34%
Culdaff Limestone Formation	CU	Grey graphitic marble & pelitic schist	Precambrian Marbles	Ll	0.12%
Cranford Limestone Formation	CR	Quartzite breccia & marble	Precambrian Marbles	Pl	0.09%
Port Askaig Formation	PA	Diamictite, schist & quartzite	Precambrian Quartzites, Gneisses & Schists	Pu	0.07%
Appinite suite	Ap	undifferentiated	Granites & other Igneous Intrusive rocks	Pl	0.06%
Ards Quartzite Formation	AQ	Whitish quarztite with pebble beds	Precambrian Quartzites, Gneisses & Schists	Pl	0.06%
Knockletteragh Member	TEkg	Pebbly grits	Precambrian Quartzites, Gneisses & Schists	Pl	0.05%
Port Askaig Formation	PA	Diamictite, schist & quartzite	Precambrian Quartzites, Gneisses & Schists	Pu	0.03%