Lough Swilly East 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 :*** Aghaweel, Burnfoot, Cashelnacor, Crana, Glashagh- Crana, Mill, Owenboy, Owenerk, Owennasop, Skeoge. ***Streams:*** 536 unnamed streams ***Lakes:*** Crunlough, Fad, Mamore, Shivnagh, Doo, Anvrickabrack, Mill Pond, Mintraghs.	North Inishowen Coast and Lough Swilly (O'Riain, 2004)	376
Topography		This GWB (Figure 1) comprises west Inishowen. The eastern and southern boundaries are topographic divides (Hydrometric Areas 01 and 40). The western boundary is constrained by circuitous coastline (Lough Swilly) and the south-western boundary represents a change in aquifer type. The topography ranges from low-lying, flat areas along the coast (<10 mAOD) and to the south of the body, to more mountainous, upland zones ~ over 600 mAOD along the eastern boundary (Slieve Snaght). Surface water flows to the west 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 (82%), with an area of **Pu:** Poor aquifer, generally unproductive – c.50 km^2 of SW-NE bands trending across the middle of the GWB. Two areas of **Ll:** Locally important aquifer, moderately productive only in local zones, are present in the body (c.7 and 5 km^2), as well as a narrow band adjacent to the Pu aquifer.		
	Main aquifer lithologies	Precambrian Quartzites, Gneisses & Schists is the main rock group in this GWB (95.88%), with small areas of Precambrian Marbles (3.65%), and a small area of Granites and other Igneous Intrusive rocks is also present (0.43%) in the north west. 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 5 available Precambrian Quartzites, Gneisses and Schists (Pl/Pu) wells range from 5-2200 m^3/d. The highest yield is considered to be anomalous for this area (*pers. comm.* P. Dullea, drilling contractor) and 3 wells have <30 m^3/d. Specific capacities of 0.45 and 440 $m^3/d/m$ have been recorded, the higher value of which corresponds to the highest yielding well. 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 5 available groundwater levels are 0-15 m below ground level, with 4 <3 mbgl. Although levels are inadequate to calculate groundwater gradients, these are expected to be relatively steep. *(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. Deeper water strikes are noted at 40, 46 and 63 mbgl in 3 wells.		
Overlying Strata	**Lithologies**	The GWB is mainly covered by till (41%) and peat (34%), with approximately 12% recorded as outcrop/shallow rock.		
	Thickness	Subsoil is absent or thin over much of the GWB, especially the higher ground in the northern and central areas. Thicker deposits (>3 m) are more common in the flatter areas and river valleys, with the thickest deposits of >10 m occurring in the south of the GWB and in 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 and in the southern area, 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: Fahan PWS (spring – 45 m^3/d). Springs: see above. Excellent wells: Lismoghry (2200 m^3/d). Good wells: Ballynakilly (110 m^3/d).
	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. Of the few available groundwater levels (5), 5 are <5 m below ground level. 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 deeper than the estimated interconnected fissure zone suggest a component of deep groundwater flow, however shallow groundwater flow is dominant. Overall, groundwater flow is westwards, 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		• Southern and eastern GWB boundaries are topographic divides (Hydrometric Areas 01 and 40). The western boundary comprise coastline (Lough Swilly) and the south-western boundary represents a change in aquifer type. The terrain is characteristically hilly to mountainous, incised by large valleys and with low-lying, flatter areas along to the south. • 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 (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 westwards towards Lough Swilly, as determined by the topography.
Attachments		Figure 1. Table 1.
Instrumentation		**Stream gauge**: 39002, 39003, 39004, 39010, 39013, 39015, 39016, 39021. **EPA Water Level Monitoring boreholes:** None identified. **EPA Representative Monitoring boreholes:** None identified.

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.

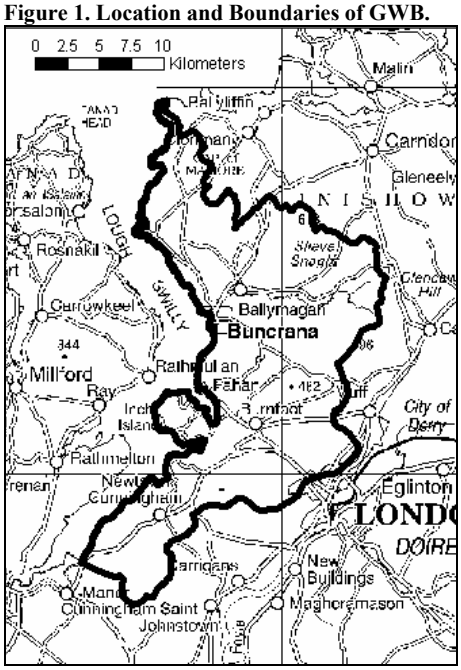

Table 1. List of rock units in Lough Swilly East GWB

Rock Unit Name	Code	Description	Rock Unit Group	Aquifer Class.	% Area
Lough Foyle Succession	LFS	Schist and grit with thin marble units	Precambrian Quartzites, Gneisses & Schists	Pl	35.87%
Fahan Slate Formation	FS	Dark pelitic & psammitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	14.18%
Fahan Grit Formation	FG	Pale grey grit with psammitic schist	Precambrian Quartzites, Gneisses & Schists	Pl	12.43%
Lower Crana Quartzite Formation	LC	Psammitic schist, some marble beds	Precambrian Quartzites, Gneisses & Schists	Pl	9.92%
Termon Formation	TE	Banded semi-pelitic & psammitic schist	Precambrian Quartzites, Gneisses & Schists	Pl	8.79%
Upper Crana Quartzite Formation	UC	Psammitic schist with pebbly grit beds	Precambrian Quartzites, Gneisses & Schists	Pl	6.90%
Slieve Tooey Quartzite Formation	ST	Whitish quartzite with pebble beds	Precambrian Quartzites, Gneisses & Schists	Pl	6.64%
Culdaff Limestone Formation	CU	Grey graphitic marble & pelitic schist	Precambrian Marbles	Ll	3.68%
Metadolerite	Md	Hornblendic and sometimes schistose	Precambrian Quartzites, Gneisses & Schists	Pl	1.15%
Tullagh Point Granite	Tu	Coarse granodiorite to monzogranite	Granites & other Igneous Intrusive rocks	Pl	0.43%