

East Inishowen GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water bodies	Associated terrestrial ecosystems	Area (km ²)
Hydrometric Area 40 Donegal Co. Co.	<p>Rivers: Ballyboe, Ballyhallan, Bredagh, Cabry, Clonmany, Cloontagh, Culdaff, Donagh, Drung, Glenagannon, Keenagh, Long Glen, Roosky, Straid.</p> <p>Lakes: Carrickabraghy, Fad, Craignacally, Callybear, Nastackan, Drumlea, Effish, Black, Naminn, Inn, Bo.</p> <p>Streams: Portaleen, Malin, Lough Nastackan stream .790 - unnamed streams</p>	Magheradrumman Bog and North Inishowen Coast (O' Riain, 2004).	507
Topography	Covering north and east Inishowen, this GWB is predominantly bounded by coastline (Figure 1). The west and south-western boundaries are topographic divides (Hydrometric Area 39). The topography includes lower-lying, flatter areas (e.g. between Doagh Island and Culdaff Bay) as well as more mountainous, upland zones that are characteristic of southern and western regions. The highest elevations are between 500-600 mAOD along the north-western boundary. Surface water flow is both northwards and south-eastwards towards the coast.		
Geology and Aquifers	Aquifer type(s)	The majority of the GWB comprises PI: Poor aquifer which is generally unproductive except for local zones (>90%). Trending SW-NE across the centre of the GWB is a band of Pu: Poor aquifer, generally unproductive (7%). Adjacent to the northern edge of the Pu aquifer, is a narrow band of LI: Locally important aquifer, moderately productive only in local zones. There is also a small area of LI aquifer to the south of the GWB.	
	Main aquifer lithologies	Precambrian Quartzites, Gneisses & Schists dominate this GWB (96%) with small areas of i) Dinantian Mixed Sandstones, Shales and Limestones to the south (1.5%), ii) Granites & Other Igneous Intrusive Rocks in the northwest corner (<1%), and iii) thin bands of Precambrian Marbles trending SW-NE across the centre of the GWB (1.25%). Refer to Table 1 for details.	
	Key structures.	The rocks are dipping to the SW, possibly as much as 40-50°. The Trawbreaga Bay and Glentogher Faults trend NNW-WWE through the centre/western area and the Leannan Fault, being orientated SW-NE, passes through the north-western and northern points of this GWB. Smaller scale structural features include the adjacent anticline and syncline folds in the Culdaff area.	
	Key properties	<p>The available yield data for the PI/Pu rocks (9 wells) range from 4.5-330 m³/d, averaging 90 m³/d. Two specific capacity values are also available: 33 and 1100 m³/d/m – the second is from an artesian well. Although there are no transmissivity data for the GWB, they are likely to be low, with the possibility of higher values 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 this aquifer does not make a significant baseflow contribution to streamflow. Storativity is also expected to be low.</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). Marbles data in this particular GWB are only available for the Culdaff WSS: yield of 523 m³/d, transmissivity of c.110 m²/d, and specific capacity of 126 m³/d/m. 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). 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.</p> <p>80% of the available groundwater levels (23) are 0-5 m below ground level. Although the data are inadequate to calculate groundwater gradients, these are expected to be greater than 0.01.</p> <p><i>(Precambrian Aquifer Chapter; Donegal GWPS; Culdaff WSS Source Report; Magherabeg/Veagh WSS Source Report)</i></p>	
Thickness	Most groundwater flux is likely 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 41, 45 and 70 m bgl in 3 PI/Pu boreholes (low yields), and at 42 and 64 m bgl in the Culdaff WSS borehole – LI aquifer.		
Overlying Strata	Lithologies	The GWB is predominantly covered by till and peat (40% and 35% respectively), with just under 10% recorded as rock outcrop/shallow rock. Approximately 3% of the area is recorded as sand/gravel.	
	Thickness	Subsoil is absent or thin over much of the GWB, especially on the higher areas. Thicker deposits (>3 m) are found in the central and southern regions with small areas of thick deposits (>10 m) along the north coast and Trawbreaga Bay. The thick deposits mainly comprise sand and gravel.	
	% area aquifer near surface	[Information will be added at a later date]	

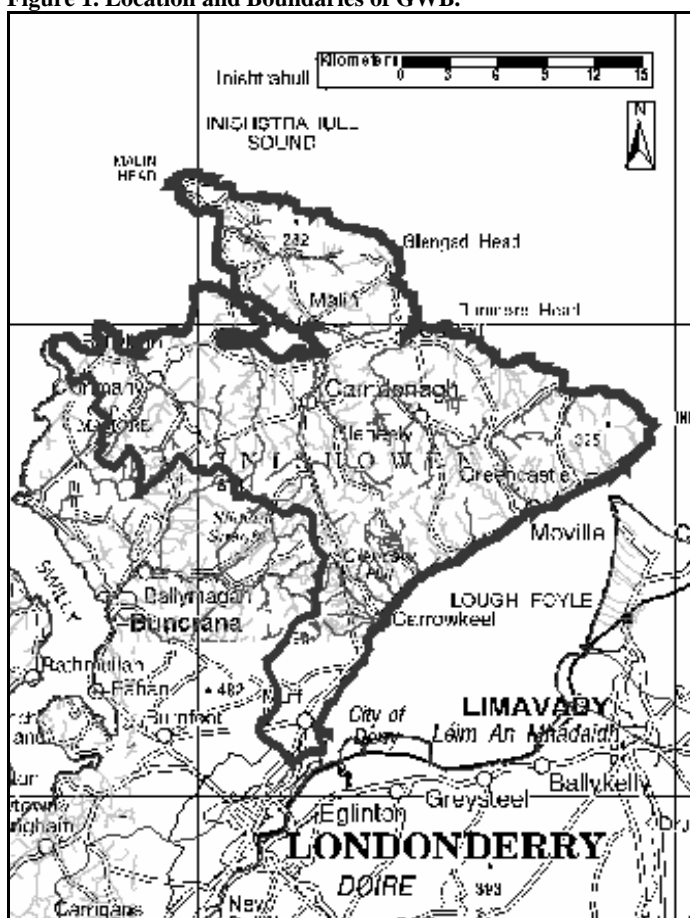
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	Vulnerability	From the Donegal GWPS, vulnerability ranges from Extreme over the higher and some of the coastal areas, to Moderate in the lower lying areas where subsoil is thicker. Sand and gravel deposits, which are generally the deepest, are categorised as High. Small areas of Low vulnerability 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 subsoil deposits (thicker peat) 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 lower permeability rocks.
	Est. recharge rates	<i>[Information will be added at a later date]</i>
Discharge	Important springs and high yielding wells	Sources: Culdaff PWS (523 m ³ /d); Precambrian Marbles (LI). Gleneely PWS; Oort (546 m ³ /d); overlying gravels may influence productivity. Springs: Ballyliffin (1090 m ³ /d) Excellent Wells: Culdaff WSS (see above). Gleneely PWS (see above) Good Wells: Urbarreagh (330 m ³ /d), Ballylosky (109 m ³ /d, 163 m ³ /d), Whitecastle (110 m ³ /d), Cooly (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) <i>(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)</i>
	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. In the Marbles, the permeability of the fracture/fault zones may be enhanced by some degree of karstification. Available groundwater levels are 0-10 m below ground level (80% <5 mbgl). Flow paths are likely to be short (30-300 m) with groundwater discharging rapidly to nearby streams and small springs. Water strikes deeper than the estimated interconnected fissure zone suggest a component of deep groundwater flow, however shallow groundwater flow is dominant. Groundwater flow directions are expected to follow topography – overall, in northerly or easterly directions.
	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		<ul style="list-style-type: none"> Coastline bounds the GWB to the north, east and southeast. Western and south-western boundaries are topographic divides. The terrain is characteristically hilly to mountainous, although the central areas includes a low-lying, flatter areas. The GWB is composed primarily of low transmissivity rocks, although the Marbles (LI aquifer) are likely to have slightly higher transmissivities than the Quartzites, Gneisses and Schists (PI/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 c.10m thick; 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 deep peat and the low permeability bedrock. Therefore, most of the effective rainfall is not expected to recharge the aquifer. 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 directions are expected to be to the north and east, as determined by the topography. The Culdaff PWS source protection area is located within this GWB.
Attachments		Figure 1. Figure2. Table 1.
Instrumentation		Stream gauges: 40001, 40002, 40003, 40004, 40005, 40006, 40007, 40060, 40070, 40071, 40072. EPA Water Level Monitoring boreholes: (DON 036), (DON 037), (DON 038). EPA Representative Monitoring points: (DON 04), (DON 14), DON 36), (DON 42).

1st Draft East Inishowen GWB Description – July 2004

Information Sources	<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>Lee M. and Daly D. (2004). <i>Culdaff Public Water Supply Scheme Source Protection Zones</i>. Draft Report to Donegal County Council. Geological Survey of Ireland 13pp.</p> <p>Lee M. and Daly D. (2004). <i>Magherabeg/Veagh Public Water Supply Scheme Source Protection Zones</i>. Draft Report to Donegal County Council. Geological Survey of Ireland 13pp.</p> <p>Long, C.B. & McConnell B.J. (1997) <i>Geology of North Donegal: A geological description to accompany bedrock geology 1:100,000 scale map, Sheet 1 and part of Sheet2, North Donegal</i>. With contributions from P. O'Connor, K. Claringbold, C. Cronin and R. Meehan. Geological Survey of Ireland. 87pp</p> <p>O' Riain, 2004. <i>Water Dependent Ecosystems and Subtypes (Draft)</i>. Compass Informatics in association with National Parks and Wildlife (DEHLG). WFD support projects.</p> <p>Parkes, M., Johnston, D., Simms, M.J. and John G. Kelly (1999). <i>Geological guidance of speleogenesis in marble of the Dalradian Supergroup, County Donegal, Ireland</i>. Cave and Karst Science Vol. 26. No3. December 1999. Transactions of the British Cave Research Association.</p>
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.

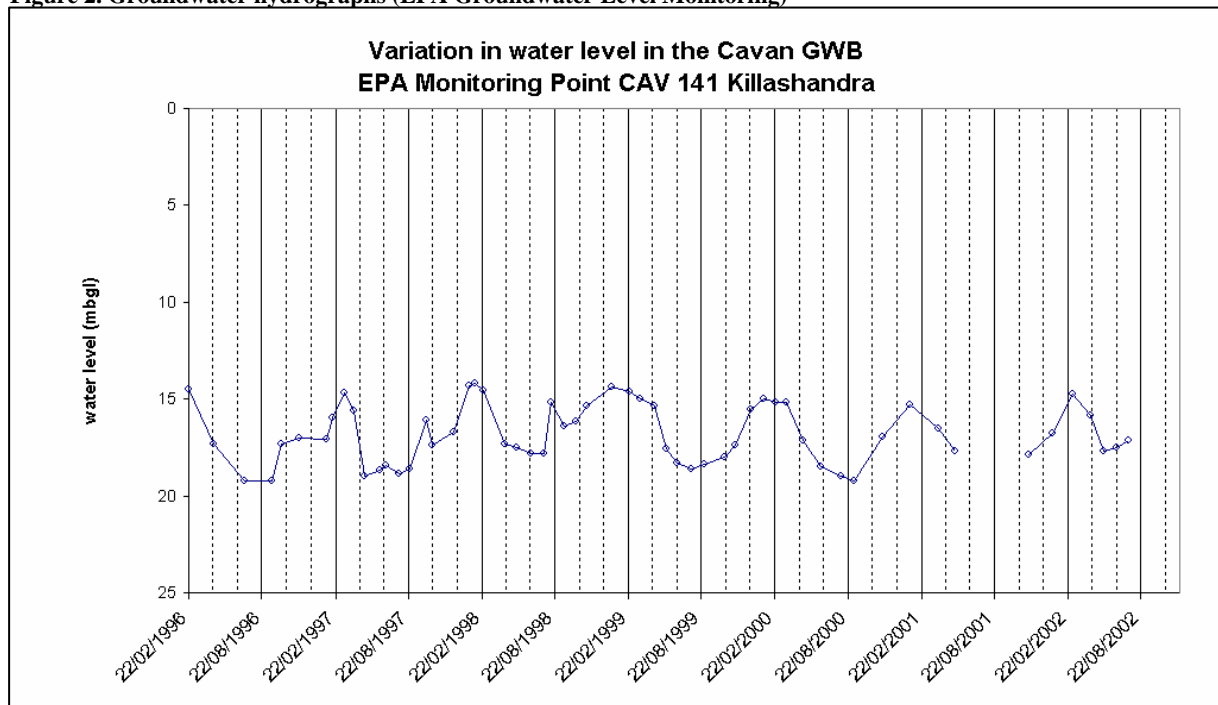


1st Draft East Inishowen GWB Description – July 2004

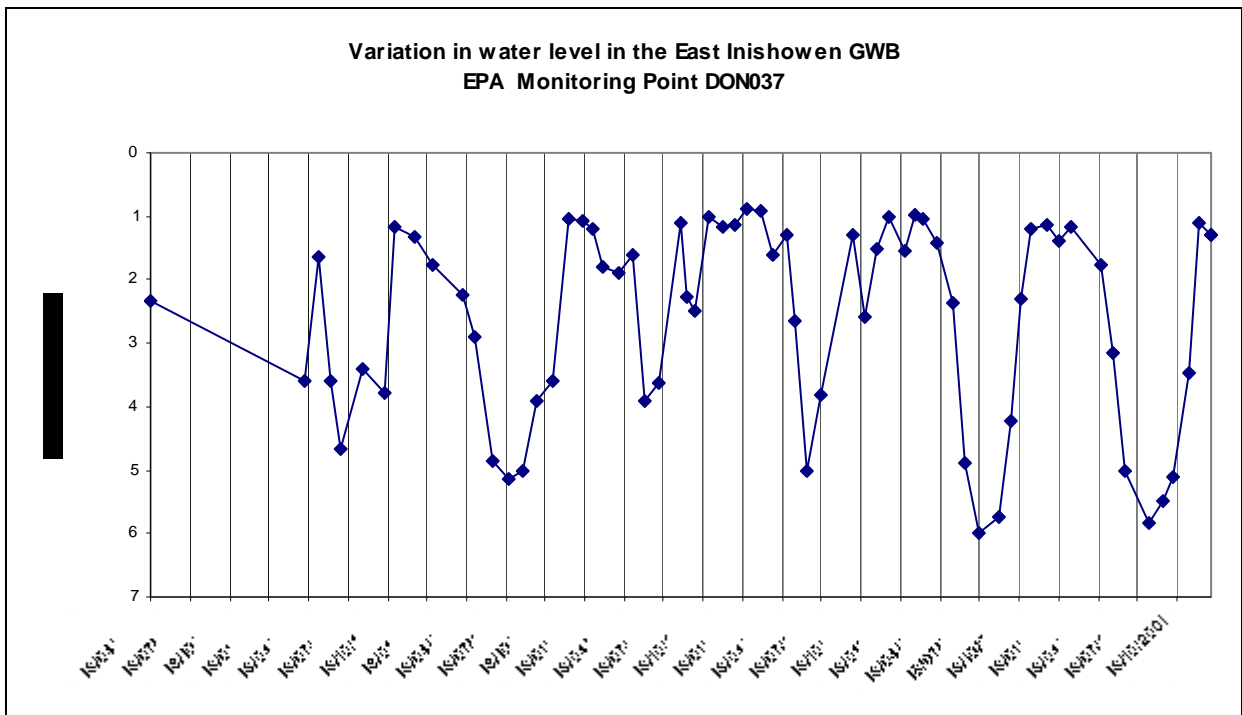
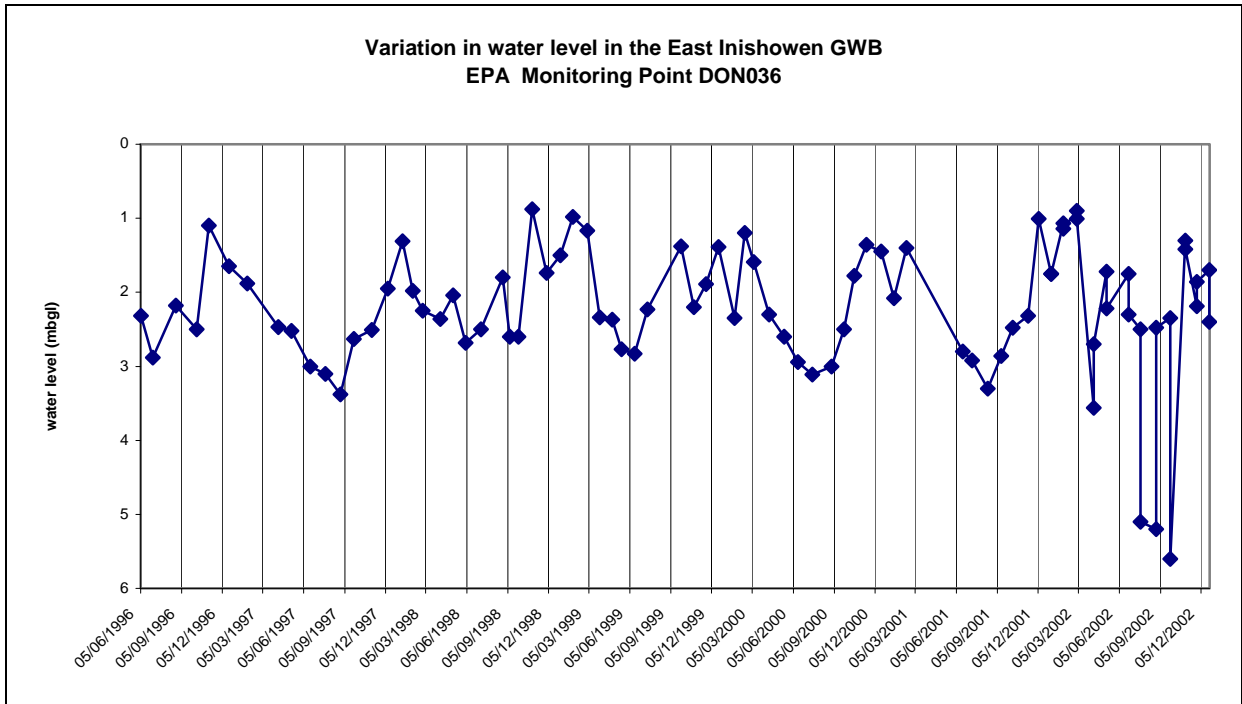
Table 1. List of Rock units in East Inishowen GWB

Rock Unit Name	Code	Description	Rock Unit Group	Aquifer Class.	% Area
Inishowen Head Grits and Phyllites Form.	IH	Psammitic and pelitic schist with grit	Precambrian Quartzites, Gneisses & Schists	PI	22.22%
Termon Formation	TE	Banded semi-pelitic & psammitic schist	Precambrian Quartzites, Gneisses & Schists	PI	18.31%
Fahan Grit Formation	FG	Pale grey grit with psammitic schist	Precambrian Quartzites, Gneisses & Schists	PI	11.39%
Slieve Tooley Quartzite Formation	ST	Whitish quartzite with pebble beds	Precambrian Quartzites, Gneisses & Schists	PI	10.04%
Upper Crana Quartzite Formation	UC	Psammitic schist with pebbly grit beds	Precambrian Quartzites, Gneisses & Schists	PI	8.61%
Lower Crana Quartzite Formation	LC	Psammitic schist, some marble beds	Precambrian Quartzites, Gneisses & Schists	PI	7.16%
Fahan Slate Formation	FS	Dark pelitic & psammitic schist	Precambrian Quartzites, Gneisses & Schists	Pu	6.66%
Lough Foyle Succession	LFS	Schist and grit with thin marble units	Precambrian Quartzites, Gneisses & Schists	PI	5.22%
Cloghan Green Beds Member	FGcg	Graded grit with green epidotic grit	Precambrian Quartzites, Gneisses & Schists	PI	4.14%
Culmore Formation	CM	Sandstone with quartz pebbles, mudstone	Dinantian Mixed Sandstones, Shales and Limestones	LI	1.51%
Metadolerite	Md	Hornblendic and sometimes schistose	Precambrian Quartzites, Gneisses & Schists	PI	1.50%
Culdaff Limestone Formation	CU	Grey graphitic marble & pelitic schist	Precambrian Marbles	LI	1.25%
Greencastle Green Beds Formation	GR	Green epidotic grit & green schist	Precambrian Quartzites, Gneisses & Schists	PI	1.08%
Tullagh Point Granite	Tu	Coarse granodiorite to monzogranite	Granites & other Igneous Intrusive rocks	PI	0.92%

Figure 2. Groundwater hydrographs (EPA Groundwater Level Monitoring)



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