Carrickmacross GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority		Associated surface water bodies	Associated terrestrial ecosystems	Area (km^2)
06 Monaghan Co.Co. Meath Co.Co Louth Co. Co.		***Rivers***: Longfield, Lagan, Proules, Glyde. ***Lakes***: Drumharriff, Moylan, Castle, Creevy, Capragh, Aphuca, Corrcuiloge, Corcin, Spring, Monally, Naglack, Fea, Tullyallen, Drumboory, Raffan's, Killark, Bursk, Annahean, Derry, Moynagh.	None identified (O'Riain, 2004)	85
Topography		This is an N-S elongated GWB extending from north of Carrickmacross to Nobber in County Meath (Figure 1). The GWB is surrounded by different aquifer types; lower permeability to the north, east and south and non karstic rocks to the west. Drumlins are common in the north of the GWB but become less frequent in the south, which has a more gently sloping topography. General elevation range from 60 mAOD in the south to c.250 mAOD in the north. The main surface water flow direction is eastwards across the GWB, to eventually discharge into Dundalk Bay.		
Geology and Aquifers	**Aquifer type(s)**	**Rk^d**: Regionally important karst aquifer dominated by diffuse flow, is sole aquifer is this GWB.		
	Main aquifer lithologies	The GWB comprises Dinantian Pure Bedded Limestones. Refer to Table 1 for details.		
	Key structures.	The rocks in the northern and central areas of the GWB are generally dipping to the west are dipping by 10-15°. In the south, the rocks are dipping by c.5° to the east.		
	Key properties	There are 15 well yields recorded within this GWB ranging from 109-1730 m^3/d (averaging c.520 m^3/d). Of these, 8 well have specific capacities: 29, 36, 37, 52, 55, 63, 82 and 364 $m^3/d/m$. The data highlight the variability of yields and transmissivities, and indicate that high abstractions are achievable. Approximately 30 (mainly karst) springs have been recorded in the GWB. Although there is little additional data about the springs, it is noted that the discharge from the Carrickmacross Public Supply Spring (1300 m^3/d) drops during dry times. This *may* suggest that the storativity of the aquifer is low, however, without further information no definite conclusion can be drawn. In the region of 100 karst features have been recorded in the Monaghan portion of this GWB: 11 caves, 18 swallow holes, 7 turloughs, 26 springs and 37 enclosed depressions. There are possibly more unrecorded features. The available groundwater levels (c.380 from 110 locations) range from 0-54 m below ground level. Just under 50% of these are less than 10 m below, and an additional 25% of <15 m below ground. Only 3 levels are greater than 30 m below ground. Some of the longer term record exhibit water level changes of up to 6 m. The data are inadequate to calculate groundwater gradients although these are often expected to be low as the aquifer can have high a transmissivity. Overall, flow directions are generally to the east. *(Pure Bedded Limestones Aquifer Chapter)*		
	Thickness	In the pure limestones, most groundwater is thought to flow in an epikarstic layer 2-3 m thick, and in a zone of interconnected, solutionally-enlarged fissures and conduits that extends approximately 30 m below this. There will also be a zone of isolated, poorly connected fissures – typically less than 150 m bgl. Seven deeper water strikes were recorded in four boreholes, ranging between 42-78 m below ground. These, and the deeper measured water levels, indicate that flow does occur in the deeper portion of the aquifer.		
Overlying Strata	**Lithologies**	Till is the predominant subsoil in this GWB (74%), with small proportions of peat (7%). Approximately 7% of the GWB is recorded as rock outcrop/shallow subsoil.		
	Thickness	From the available outcrop and depth to bedrock data, subsoil cover is thin (<3 m) in the central western area and in zones in the north of the GWB. The data suggests that thicker deposits (>3 m) occur in the central eastern and also in the central northern portion. The thickest deposits (>10 m) appear to be limited to the southern tongue and then northern tip.		
	% area aquifer near surface	*[Information will be added at a later date]*		
	Vulnerability	Vulnerability ranges from Extreme where subsoil deposits are thin (central western area; zones in the central northern area) to Moderate (central eastern area; central northern zones) and Low (south and very north), over the thicker deposits, including drumlin deposits.		
Recharge	**Main recharge mechanisms**	Both point and diffuse recharge occur in this GWB. Diffuse recharge occurs via rainfall percolating through thin subsoil and outcrops. Point recharge to the underlying aquifer occurs via swallow holes, caves and dolines. Although recharge along 'losing' sections of streams is also associated with this particular type of aquifer, to date none have been recorded in this GWB. The low stream density in this GWB, as compared to the surrounding GWBs, suggests a high proportion of aquifer recharge, which is often associated with karstified rocks.		
	Est. recharge rates	*[Information will be added at a later date]*		

Discharge	**Important springs and high yielding wells**	Sources: Carrickmacross PWS, Co. Monaghan (spring - 1320 m^3/d) Springs: see Sources above. Excellent wells: Spring Lake (1727 m^3/d), Drummond Etra (1000 m^3/d), Naffarty (969 m^3/d), Tullvaragh Lower (894 m^3/d), Barleyhill (850 m^3/d), Monanny (545 m^3/d), Kilmactrasna (477 m^3/d). Good wells: Ardagh (272 m^3/d), Leonscarve (261 m^3/d), Mullaghmore (218 m^3/d), Spiddal (175 m^3/d), Magheraboy (109 m^3/d – 2), Lattylanigan (109 m^3/d), Carrickmacross (109 m^3/d).
	Main discharge mechanisms	The main groundwater discharges are to the limited number of streams and rivers, and the lakes (e.g. Moylan Lough) and springs found within the body. At present, 26 karst springs have been recorded, and 6 springs are noted as being used for abstraction - two of which have a discharge of >1000 m^3/d.
	Hydrochemical Signature	***National classification:*** Dinantian Pure Bedded Limestones Calcareous. Generally Ca-HCO_3 signature. Due to possible dissolution of evaporite minerals in the Monaghan-Cavan-Leitrim area,Na/K/Mg-HCO_3 and Ca-SO_4 signatures may also occur. 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) *(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)*
Groundwater Flow Paths		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 diffusely karstified aquifer. Approximately 50% of the available groundwater levels are 0-10 mbgl (75% <15 mbgl) suggesting that shallow groundwater flow is prevalent, although 3 recorded water levels are deeper than 30 mbgl and 7 deeper water strikes have also been recorded, suggesting a component of deeper groundwater flow is to be expected. Continuous water tables that reflect topography are considered to exist in more diffusely karstified aquifer as the flow regimes are likely to be hydraulically connected. However the degree of interconnect depends on the frequency of fissures, faults, and joints. 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 although are likely to be shorter in discharge areas (c.100-300 m). Flow is also likely to be rapid through karst aquifers, as exemplified by tracer tests undertaken in the Annahaia townland, which recorded minimum groundwater velocities of 60 m/hr (Swartz *et al*, 2002). Overall, groundwater flow will be eastwards, towards the Upper Lough Erne, but the karstified nature of the pure limestone means that locally groundwater flow directions can be highly variable.
Groundwater & surface water interactions		In karstified areas, there is a high degree of interconnection between groundwater and surface water e.g. Spring Lough and Moyland Lough are thought to be groundwater fed (Swartz *et al*, 2002). 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.

Conceptual model

- The main surface water flow direction is eastwards, eventually discharging in Dundalk Bay.
- The GWB is bounded on all sides but differing aquifer types: lower permeability to the north, east and south, and non-karstic to the west. Drumlins occurs in the north of the GWB but become less frequent in the south, which is generally more rolling.
- The sole rock type in this GWB is a karstified limestone that is dominated by diffuse groundwater flow (aquifer category **Rk^d**).
- Most of the unconfined groundwater flux is likely to be 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 are also likely to occur along permeable fault or fracture zones, which is suggested by the number of deeper water strikes.
- Estimated transmissivity values and well yields are variable, reflecting zones of higher and lower permeability in the pure limestones. High groundwater flow velocities have been recorded in this GWB.
- 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 is discharge areas (100-300 m).
- In the limestone aquifer, recharge occurs by:
  - diffuse means – via outcrops and through thin subsoil, and
  - additional point mechanisms; 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 within the GWB. Overall, the flow direction is to the 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:** 06038 **EPA Water Level Monitoring boreholes:** None identified. **EPA Representative Monitoring points:** (MON 15), (MON 42), (MON 49), (MON 56), (MON 80).
Information Sources	Geraghty, M., Farrelly, I., Claringbold, K., Jordan, C., Meehan, R., and Hudson, M., 1997. *Geology of Monaghan-Carlingford. A geological description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 8/9, Monaghan-Carlingford*. Geraghty, M. (ed.). Geological Survey of Ireland. 60 p. McConnell, B., Philcox, M. and Geraghty, M., 2001. *Geology of Meath: A geological description to accompany the bedrock geology 1:100,000 scale map series, Sheet 13, Meath*. With contributions from J. Morris, W. Cox, G. Wright, and R. Meehan. Geological Survey of Ireland. 77 p. O' Riain, 2004. *Water Dependent Ecosystems and Subtypes (Draft)*. Compass Informatics in association with National Parks and Wildlife (DEHLG). WFD support projects. Swartz, M and Daly, D. (2002) *County Monaghan Groundwater Protection Scheme Report*. Main Report. Final Report to Monaghan County Council. Geological Survey of Ireland Woods, L., Meehan, R. and Wright, G. R., 1998. *County Meath Groundwater Protection Scheme*. Main report. Final report to Meath County Council. Geological Survey of Ireland. 54 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.

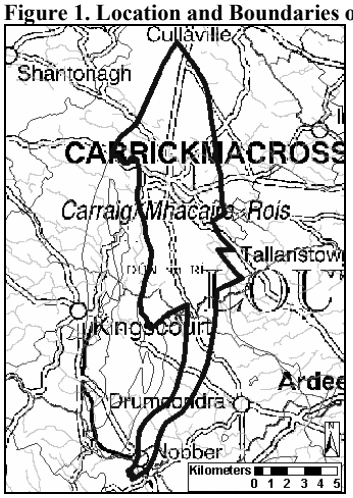

Table 1. List of Rock units in Carrickmacross GWB

Rock unit name	Code	Description	Rock unit group	**Aquifer Classification**	% Area
Milverton Group (undifferentiated)	CDMLV	Micrite, crinoidal grainstone/packstone	Dinantian Pure Bedded Limestones	Rk	100%