Knockatallon GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
Hydrometric Area 03 Monaghan Co. Co. N.I.	***Rivers:*** Maghery, Mountain Water, Scotstown. ***Streams:*** 50 unnamed streams. ***Lakes***: Killy, Meenish, Antraicer, Anportan, Brandan, Gulluane, Sallagh, Naheery.	None identified (O'Riain, 2004)	54

Topography		This SW-NE aligned generally rectangular GWB (Figure 1) is bordered by less productive aquifers to the north and south, faults to the east, and a topographic divide to the west (Hydrometric Area 36). Located on the south-eastern flank of Slieve Beagh in north Co. Monaghan, elevations increase from 100 mAOD in the valley along the southeastern border to 350 mAOD in the northwest, creating a hilly-mountainous terrain. Surface water flows to the southeast.
Geology and Aquifers	**Aquifer categories**	This GWB is split into two aquifer types of that have the same alignment as the GWB. The units are **Lm:** Locally important aquifer which is generally moderately productive, underling approximately a third of the body to the north, and **Rf:** Regionally important fissured aquifer, in the central and southern areas of the body. It is noted that the Rf aquifers comprise Dinantian Mixed Sandstones, Shales and Limestones, and Pure Bedded Limetone rock group. Pure Bedded Limestones are frequently classified as **Rk** (Regionally important karstified aquifers) however, in this instance they are considered to have a higher proportion of shale, which is thought to significant reduce the potential for karstification, although still facilitates a high degree of fissure flow.
	Main aquifer lithologies	This GWB is split into three, roughly equal rock groups. All of the rocks are of Dinantian Age: Sandstones are located to the north, Mixed Sandstones, Shales and Limestones are in the centre of the GWB, and Pure Bedded Limetones are located to the south. Refer to Table 1 for details.
	Key structures	The main structural features of this GWB area the two N-S/SE aligned faults that constitute the eastern and part of the western boundaries. The displacement and movement in this region has resulted in the rocks generally dipping to the east by 15-20°.
	Key properties	There are 19 well yields recorded within this GWB ranging from 159-6546 m^3/d (averaging c.1100 m^3/d). Of these, 3 wells have specific capacities: 10, 300 and 500 $m^3/d/m$. Transmissivity values range from 35-65 m^2/d from 6 pumping/observation wells (Kelly, 2001). The data highlight that reasonably high yields and transmissivities are achievable. However, 17 of these wells are associated with the Tydavnet GWS and are clustered in the south (Mixed Sandstones, Shales and Limestones; Pure Bedded Limetones) and are therefore not necessarily representative of the Dinantian Sandstones in the north. The lithology of Sandstone means that they are generally associated with higher fissure permeability with the potential to have relatively high transmissivity values – c.>50 m^2/d, which may be higher in the vicinity of faults (c.100-150 m^2/d). Assessment of the Tydavnet GWS well field indicates that the central and southern portions of the GWB are confined by a lower shale-dominated aquifer beneath, and a thick, low permeability subsoil above. This will effects its recharge potential and storativity, which has been estimated as between $0.95x10^{-5}$ and $5.5x10^{-5}$ (Kelly, 2001). This is significantly lower than the storativity associated with the unconfined Sandstones. This work also indicated that over-abstraction has occurred in this aquifer, due to its confined nature in the area of the GWS (Kelly, 2001). It is noted that this GWB includes both Rf and Lm aquifers, which are both considered to have significant fissure flow systems, and therefore it is anticipated that groundwater flow will occur across their boundary. However, as no data are available for the Lm (Dinantian Sandstone) aquifer, the degree of connectivity between the two is unknown. This uncertainty has further implications with regard to the area recharging the Tydavnet GWS/over-abstracted, confined Rf aquifer. Presently, groundwater recharge research is investigating this particular groundwater system (Brown *et al*, on-going), which may help to further characterise this GWB. Generally, the overall flow directions are expected to follow topography i.e. to the southeast. *(Monaghn GWPS; MSc thesis – R Kelly; Dinantian Aquifer Chapters; Recharge research – L. Brown et al.*)
	Thickness	Most groundwater flux in all rock groups is expected to be in the uppermost part of the aquifer. This is thought to comprising a broken and weathered zone typically less than 3 m thick, a zone of interconnected fissuring, and a zone of isolated poorly connected fissuring typically less than 150 m. Given the lithology of the Sandstone, and the available data for the remaining rocks, the zone of interconnected fissuring is likely to extend to between 30-40 m thick. Deeper flows are supported by the 21 water strikes recorded in 13 boreholes, which range from 27-79 m below ground. Depending on the shale content of the limestones, the upper broken/weathered interconnected zones may have some degree of karstification in these rocks.

Overlying Strata	**Lithologies**	Till is the predominant subsoil recorded in this GWB, covering approximately 64%. There is also a smaller proportion of peat (29%).
	Thickness	From the available outcrop and topographic information, the subsoil is characteristically thick (>10 m) in the southern and central areas. The subsoil becomes thinner (<3 m thick) and sporadically absent at higher elevations to the north of the GWB.
	% area aquifer near surface	*[Information will be added at a later date]*
	Vulnerability	Vulnerability ranges from Extreme where subsoil deposits are thin or absent along the northern boundary, to Low where the low permeability deposits are thicker. Areas of High and Moderate vulnerability flank the Extremely vulnerable areas.
FsRecharge	**Main recharge mechanisms**	Diffuse recharge occurs via rainfall percolating through the thinner subsoil and rock outcrops i.e. especially in the northern portion of the GWB. However, in the central and southern areas the thick, low permeability subsoil will only allow a fraction of the effective rainfall to filter through and recharge the aquifer. The majority of the rainfall will discharge to the streams in the GWB. In addition, any steeper slopes will promote surface runoff.
	Est. recharge rates	*[Information will be added at a later date]*
Discharge	**Large springs and high yielding wells (m^3/d)**	Sources: Tydavnet GWS (production and trial wells): 6546 m^3/d, 1960 m^3/d, 1300 m^3/d, 1200 m^3/d, 1090 m^3/d (3), 982 m^3/d, 750 m^3/d, 665 m^3/d, 600 m^3/d, 500 m^3/d (2); 339 m^3/d, 200 m^3/d, 150 m^3/d. Springs: None identified. Excellent Well: See Sources above. Toneystackan 500 m^3/d; Bragan 665 m^3/d, 648 m^3/d. Good Wells: See Sources above.
	Main discharge mechanisms	Apart from being pumped out of the aquifer, the main groundwater discharges are to the streams, rivers, lakes and springs within the GWB, as well as to the adjacent faults (east and west boundaries). Where groundwater is unconfined (northern portion), the baseflow proportion of the total streamflow is expected to be higher than for the adjacent Pu/Pl/Ll GWB, due to the generally higher transmissivities associated with this aquifer. The discharge to surface water is likely to be limited/negligible where the thicker low permeability subsoil provides a confining layer in the central and southern areas of the GWB. However, a number of springs are recorded in the southern part of the GWB. This may be due to groundwater that is flowing down-gradient encountering the lower permeability Tydavnet GWB, at which point some of the groundwater may be forced up to the surface.
	Hydrochemical Signature	***National classification:*** Dinantian Sandstones Calcareous. Generally Ca-HCO_3 signature. Alkalinity (mg/l as $CaCO_3$): range of 5-524; mean of 153 (65 'non limestone subsoils' data points) Total Hardness (mg/l): range of 5-502; mean of 162 (67 'non limestone subsoils' data points) Conductivity (μS/cm): range of 39-1184; mean of 408 (69 'non limestone subsoils' data points) ***National classification:*** Dinantian rocks (excluding Sandstones) 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		In the absence of inter-granular permeability, groundwater flow is expected to be concentrated in fractured and weathered zones and in the vicinity of fault zones. Groundwater flow is thought to be generally of a regional scale. Where unconfined, long flow path lengths (up to 2000 m) would be expected in the Sandstones and Pure Bedded Limestones. Although shorter flow paths are frequently associated with the remaining Dinantian rocks (c.30-300 m), the higher degree of fracturing in this instance suggest that paths may be of a similar magnitude to the other rocks. Generally, groundwater travel times in the confined zone are relatively slow and flow path lengths may be considerably longer than in the unconfined zone. Groundwater flow directions are expected to follow topography i.e. down-gradient to the southeast.
Groundwater & Surface water interactions		Groundwater will contribute baseflow to the streams and rivers flowing across this GWB, especially in the north where the aquifer is unconfined. Where the groundwater is confined, there will be limited interaction between surface and groundwater. The springs recorded in the southern area are possibly a results of groundwater being forced up to the surface as it encounters the lower permeability aquifers of the Tydavnet GWB along its flow path.

Conceptual model	• The GWB is bounded by lower permeability aquifers to the north and south. Faults form the eastern boundary and the western comprises a topographic divide. Being located on the south-eastern flank of Slieve Beagh, the topography ranges from steep to hilly, with elevations between 100-350 mAOD. • All of the rocks in this GWB are of Dinantian age. Sandstones (Lm aquifer category) are mapped to the north, Pure Bedded Limestone (Rf category) are located in the south and Mixed Sandstones, Shales and Limestones (Rf category) are in the central area. All rock groups are considered to have the potential for relatively high fissure permeability and good transmissivities. The 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.30-40 m thick, and a zone of isolated fissuring typically less than 150m. • Groundwater flow in the northern portion of the GWB (mainly Sandstones) is unconfined whereas the central and southern aquifers (Pure Bedded Limestone; Mixed Sandstones, Shales and Limestones) are confined between a underlying shale bedrock and an overlying thick, low permeability subsoil. • Estimated transmissivity values for the Pure Bedded Limestone and Mixed Sandstones, Shales and Limestones range from 35-65m^3/d/m and are thought to be similar for the Sandstones (no data available). Storativity of the confined aquifer is estimated as $0.95x10^{-5}$ to $5.5x10^{-5}$, although is thought to be significantly higher in the unconfined Sandstones. • The unconfined aquifer are thought to be able to support regional scale flow systems, with flow paths up to 2000 m with groundwater discharging to the rivers/streams crossing the aquifer, and to small springs and seeps. Flow paths in the remaining confined aquifer may be considerably longer with considerable less interaction with the surface water. • Recharge will occur diffusely through the subsoil and rock outcrops although is significantly limited by the thicker low permeability subsoil in the central and southern areas. Most of the effective rainfall over the unconfined Sandstones expected to recharge the aquifer. This is not likely to be the case over the confined aquifer. • The main discharges are to the streams, rivers, lakes and springs within the GWB and the bounding faults. The interaction between groundwater and surface water, and therefore discharges to surface water, are thought to be limited by the confining layer of subsoil in central and southern areas. Overall, the flow direction is likely to be to the southeast, as determined by the topography.
Attachments	Figure 1. Table 1.
Instrumentation	**Stream gauges: N**one identified. **EPA Water Level Monitoring boreholes:** (MON 120), (MON 133), (MON 134), (MON 147), (MON 152) **EPA Representative Monitoring points: (**MON 11), (MON 13)
Information Sources	Brown L., Wijnen J., and Misstear B., (on-going). *2002-W-MS/16:Recharge and Groundwater Vulnerability*. ERTDI Programme 2000 – 2006. Phase 3: Water Framework Directive (WFD). 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. Kelly R., (2001). *An investigation into groundwater resources in the Knockatallon area of northwest Monaghan*. Unpublished MSc. Thesis, Civil Engineering Department, Queen's University, Belfast. O' Riain, G. 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.
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.

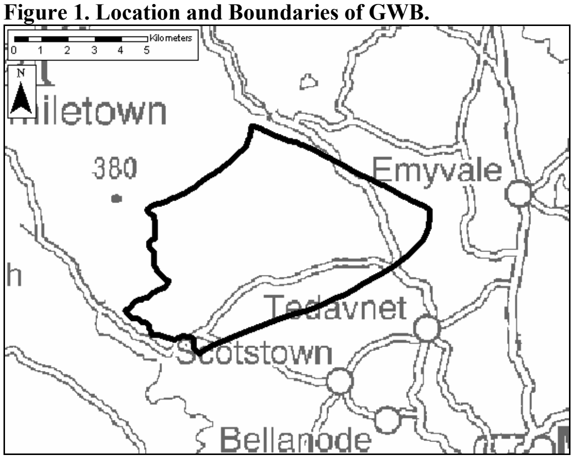

Table 1. List of Rock units in GWB

Rock Unit Name	Code	Description	Rock Unit Group	**Aquifer Class.**	% Area
Dartry Limestone Formation	DA	Dark fine-grained cherty limestone	Dinantian Pure Bedded Limestones	Rf	34.29%
Meenymore Formation	ME	Shale, laminated carbonate, evaporite	Dinantian Mixed Sandstones, Shales and Limestones	Ll	33.14%
Carnmore Sandstone Member	MEce	Pale grey sandstone	Dinantian Sandstones	Lm	32.57%