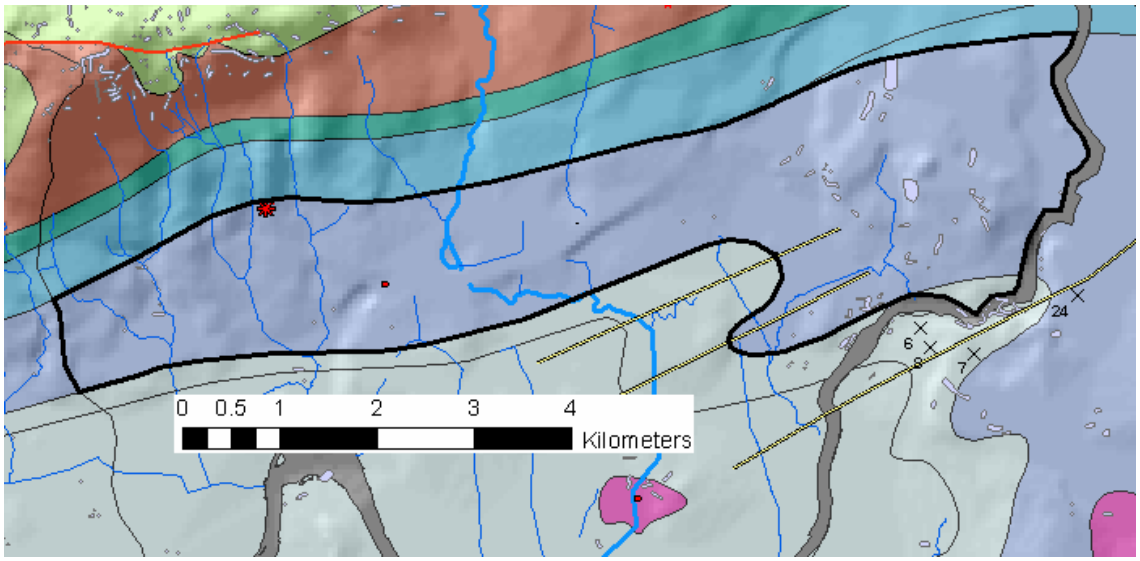
Ardnacrusha GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
25 - Blackwater/ Lower Shannon catchment Clare Co. Co.	Rivers: Shannon, Blackwater.	Knockalisheen Marsh (002001)	18

Topography	This small and narrow GWB is elongated in an ENE-WSW direction, and is about 10.5 km long by 1.5 km wide. In general, the ground is 10–20 mAOD, and flat-lying to gently undulating. Ground elevation within the GWB ranges from 20 mAOD along the river to just over 60 mAOD. The highest ground occurs along the northern margin of the GWB, and in the east of the GWB, on isolated higher ground. Drainage density is low in the east of the GWB, but higher in the west since more streams and rivers are flowing southwards off the low transmissivity Lough Graney GWB onto this area of the GWB. Elevation contours show that the River Shannon once flowed across this GWB.	
Geology and Aquifers	Aquifer categories	The GWB comprises an **Rk^d**: Regionally important karstified aquifer dominated by diffuse flow. A small area (< 1 km^2) of **Lm:** Locally important aquifer which is generally moderately productive occurs in the SE of the GWB.
	Main aquifer lithologies	Dinantian Pure Unbedded Limestones predominate in this GWB. There is a very small area (< 1 km^2) of Pure Bedded Limestone in the SE of the GWB.
	Key structures	The rocks of this GWB occur on the northern limb of a syncline. Bedding dips generally southwards at low angles of approximately 20^o. There are minor folds mapped in the eastern part of the GWB. Fractures and joints may be more open on the axis of the minor anticlines.
	Key properties	Transmissivities in diffusely karstified aquifers are in the range 20–2000 m^2/d. In this area of the country, the median value will probably be towards the lower-middle end of the range. At Croom and Fedamore WSs in the nearby Fedamore GWB (in Co. Limerick), transmissivities are 120 m^2/d [estimate range 95–145 m^2/d] and 34 m^2/d [estimate range 23–41 m^2/d], respectively. Groundwater gradients within the karstic aquifer are low, ranging from approximately 0.005 to 0.01. Storativity in this aquifer is low (effective porosity ~1.5-2.5%). *(data sources: Rock Unit Group Aquifer Chapters, Clare GWPS, Limerick GWPS and Source Reports, see references; estimates from maps)*
	Thickness	The Dinantian Pure Unbedded Limestones attain maximum thicknesses of more than 1200 m. However, most groundwater flows in an epikarstic layer a few metres thick and in a zone of interconnected solutionally-enlarged fissures and conduits extending about 30 m below this. Deeper groundwater flows can occur along fault zones. On Aughinish island, on the south side of the Shannon Estuary, there are very deep (~ 60 mbsl) conduits that relate to an ancient baselevel. There may be such conduits in this area, but they are not known; field work would be required to confirm their presence or otherwise. A borehole in the east of the GWB with a low yield and big drawdown had inflows at 29, 79 and 97 mbgl. A nearby borehole with a similarly low yield and large drawdown had inflows at 88 and 116 mbgl.
Overlying Strata	Lithologies	*[Information to be added at a later date]*
	Thickness	There are few data available for this area. Rock outcrops in patches in the eastern part of the GWB. In this area, subsoils appear to be on the order of 3-8 m thick. Nearby (~ 2 km SW), at the junction with the Limerick City North GWB, subsoils are in the range 10-20 m.
	% area aquifer near surface	*[Information to be added at a later date]*
	Vulnerability	In the east of the GWB and along the southern margin, groundwater vulnerability is mainly High, with smaller areas of Extreme vulnerability around areas of outcropping rock and karst features. In the western part of the area along the northern margin of the GWB, vulnerability is Low. In the SW, vulnerability is Moderate.
Recharge	Main recharge mechanisms	Diffuse recharge will occur over most of the GWB via rainfall soaking through the subsoil and directly to the aquifer via outcrop. The epikarst redistributes diffuse recharge in the subsurface. Surface water running-off the low transmissivity Lough Graney GWB upslope to the north is likely to sink into the aquifer of this GWB, thereby recharging at points or along linear river stretches. There is one known sinkhole in the GWB – this will receive point recharge. The lack of surface drainage in elevated parts of this GWB indicates that potential recharge readily percolates into the groundwater system. However, in low-lying areas with a high water table in this highly transmissive aquifer, there will be some rejected recharge, i.e. a proportion of the effective rainfall is rejected due to lack of storage space in the aquifer.
	Est. recharge rates	*[Information to be added at a later date]*

Discharge	Important springs and high yielding wells (m^3/d)	There are no High yielding springs (>2,160 m^3/d), or Excellent (>400 m^3/d) or Good (100 m^3/d < yield < 400 m^3/d) yielding wells known in this GWB. Parteen WS abstracts 80 m^3/d (EPA database), but its yield is not known. (NB – according to the EPA database, there is also a Parteen WS source in the adjacent Limerick City North GWB.)
	Main discharge mechanisms	The main discharges are to the streams and rivers crossing the body. Some streams emerge at springs at the base of slopes.
	Hydrochemical Signature	There are no data available to assess this GWB. The hydrochemistry of groundwaters from the nearby Fedamore GWB indicates Very Hard (370–430 mg/l as $CaCO_3$), calcium-bicarbonate type waters with high alkalinities (330–380 mg/l as $CaCO_3$) and electrical conductivities, and neutral pHs. Conductivities range between 720–900+ μS/cm. In general, background chloride concentrations will be higher than in the Midlands, due to proximity to the sea. In the limestones in the Fergus catchment, problems with *E. coli.*, iron, colour and turbidity are reported (Coxon and Drew, 1998). The sandstones and overlying peat to the north of this GWB could be a potential origin of suspended matter.
Groundwater Flow Paths		These rocks are devoid of intergranular permeability; groundwater flows through a diffuse network of solutionally-enlarged fissures and small conduits, and along faults. Dissolutional enlargement of joint, fracture and fault planes is the major mechanism that has created permeability. Groundwater is likely to flow in two main hydrogeological regimes: (1) an upper, shallow, highly karstified weathered zone, known as the epikarst, in which groundwater moves quickly, through solutionally enlarged conduits, in rapid response to recharge; (2) a deeper zone, where a dispersed slow groundwater flow component in smaller fractures and joints outside the main conduit systems. In some areas, the aquifer may be highly karstified, with groundwater flowing through interconnected, solutionally enlarged conduits and cave systems. These localised high permeability zones can give rise to rapid groundwater velocities. The GWB is mostly unconfined. However, in the NW of the GWB, where groundwater vulnerability is Low, the aquifer is potentially confined. It is considered that, in unconfined areas, the rivers and streams are in hydraulic continuity with the aquifer. Therefore, they represent the water table elevation. Near streams and rivers, water levels should be within 2 m of ground level. In relatively elevated areas between rivers, the water table may be considerably deeper, giving significant unsaturated zones. The water table is likely to generally follow the topography. Groundwater flow paths in this GWB are generally long, and can be up to several km's long. Groundwater may also discharge locally to surface water features or springs, however, if the topography is variable. In discharge zones, flow paths will be shorter, around 100–300 m. Local groundwater flow will be from the higher ground between surface water bodies to the rivers and streams. Regional groundwater flow will be in an E-W orientation, flowing to the River Blackwater that crosses the centre of the GWB, or to the River Shannon that forms the eastern margin of the GWB. The path that the River Shannon historically took crosses the GWB in the centre and east. Its former path is obvious from ground morphology. It is likely that this site of former drainage concentration has affected the distribution of karstification, and hence permeability, in the subsurface. The epikarst is thought to be relatively modern, being formed after the last ice age, while the deeper karst is likely to be a remnant of not only recent solution, but also glacial and pre-glacial solution. The groundwater flow regimes will be hydraulically connected, with the degree of interconnection depending on the faults and joints associated with the structural deformation. Groundwater flux is thought to be concentrated in the top 30 m or so of the aquifer. Heavy rainfall can cause temporary high water levels in the shallow epikarst zones, and pulses of recharge can displace material which is normally relatively undisturbed. In the east of the GWB, groundwater levels may respond quickly to rainfall events due to the general absence of subsoil cover. Bacteria are a common problem in karst areas as groundwater travel times are so short and vulnerability generally extreme. The fluctuations in colour and bacteria and, occasionally, iron, are all typical of a karst environment with a rapid 'flashy' response to rainfall events and short residence times.
Groundwater & Surface water interactions		There is an effective hydraulic interconnection between groundwater and surface water in the karst limestone. Groundwater is discharged to the surface as baseflow to streams and rivers crossing the groundwater body. Groundwater is most likely recharged near the northern boundary of the GWB by surface water flowing off the low transmissivity Lough Graney. There are streams coming off Lough Graney GWB that sink into the karst limestone of this GWB. Springs feeding streams occur at the base of slopes in this GWB. At Knockalisheen Marsh (NHA 002001) in the SW of the GWB, grassland slopes gradually to a wetland area, which then drains into the River Shannon. Much of the northern part of the site is unimproved pasture, while the lower parts near the river are extremely wet and consist of wet grassland and fen communities, which are very species rich.

Conceptual model	• The terrain in this GWB is low-lying and gently undulating. Ground elevation increases northwards and is also higher in the east. It is bounded to the east by the River Shannon. The northern boundary is formed by the contact with the lower transmissivity rocks of the Lough Graney GWB. The southern/ SE boundary is formed by the contact with the Pure Bedded Limestones of the Limerick City North GWB. The western boundary is coincident with a surface water and implied groundwater divide. • The GWB comprises diffusely karstified limestones in which groundwater is transmitted through a network of small conduits and fissures, and an epikarstic zone. The fault and fracture network and bedding-parallel pressure solution planes have been enlarged by dissolution, resulting in a highly transmissive aquifer with rapid groundwater flow in which the more permeable zones have specific orientations. The aquifer has low storativity. • It is possible that, as the site of former drainage concentration, the former path of the River Shannon that crosses the centre of the GWB has affected the distribution of karstification, and hence permeability, in the subsurface. • Recharge occurs diffusely through the subsoils or at rock outcrop. Linear or point recharge may occur along losing river stretches where streams cross onto this GWB from the low transmissivity GWB to the north. Potential recharge may be rejected in areas where the water table is very close to the surface. • Groundwater in this body is expected to show a rapid response to recharge, with rapid groundwater velocities. • Groundwater flux in this aquifer will be concentrated in an approximately 30 m zone at the top of the bedrock. This zone comprises an epikarstic layer of a few metres, below which is a network of diffuse solutionally-enlarged joints and small conduits, fractures and faults. Deeper groundwater flow can occur along permeable fault zones or deeper fractures. The volume of flow may be significantly less in these deeper systems, as evidenced by the poor yields and drawdown characteristics of boreholes in which inflows were measured at around 75-115 mbgl. • Most of the GWB is unconfined. Only in the NW of the GWB do the subsoils attain sufficient thicknesses to potentially confine the aquifer. Near rivers and streams, the water table is close to the surface. Beneath higher ground, significant unsaturated zones may exist. Water table fluctuations in discharge areas will be relatively low (on the order of 2-3 m) whereas, in recharge zones, the water table elevation may vary considerably (up to 10 m). • Groundwater discharges to the rivers and streams crossing the GWB, and to the River Shannon. The regional groundwater flow direction is probably E-W, being determined by the geometry of the aquifer and the drainage pattern. There is a groundwater divide in the GWB, with groundwater flowing to the River Blackwater in the centre of the GWB, or to the Shannon in the east of the GWB. Local groundwater flow directions are determined by topography and local drainage patterns. Flow path lengths are generally long (up to several km's). In discharge zones, flow paths will be much shorter, at around 100–300 m. • Rivers may be both losing and gaining, depending upon the location within the system, and also upon the time of year. In late summer, rivers may be losing, but gaining in the rest of the year. Streams in the north of the GWB are sinking. Streams emerge at the base of slopes.
Attachments	None.
Instrumentation	Stream gauges: 25055.
Information Sources	Deakin, J. and Daly, D. (2000) *County Clare Groundwater Protection Scheme.* Geological Survey of Ireland Report to Clare Co. Co., 67 pp. Deakin, J., Daly, D. and Coxon, C. (1998) *County Limerick Groundwater Protection Scheme*. Geological Survey of Ireland Report to Limerick Co. Co., 72 pp. Deakin, J. (1995) *Croom WS – Groundwater Source Protection Zones*. Geological Survey of Ireland Report to Limerick Co. Co., 6 pp. Deakin, J. (1995) *Fedamore WS – Groundwater Source Protection Zones*. Geological Survey of Ireland Report to Limerick Co. Co., 6 pp. Aquifer chapters: Dinantian Pure Unbedded Limestones.
Disclaimer	Note that all calculations and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae



Rock units in GWB

Rock unit name and code	Description	Rock unit group
Waulsortian Limestones (WA)	Massive unbedded lime-mudstone	Dinantian Pure Unbedded Limestones