Limerick City North GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
25 - Shannon/ Graney catchment Clare and Limerick Co. Co's.	Rivers: Shannon, Blackwater.	Fergus Estuary and Inner Shannon, North Shore (002048), Knockalisheen Marsh (002001)	19

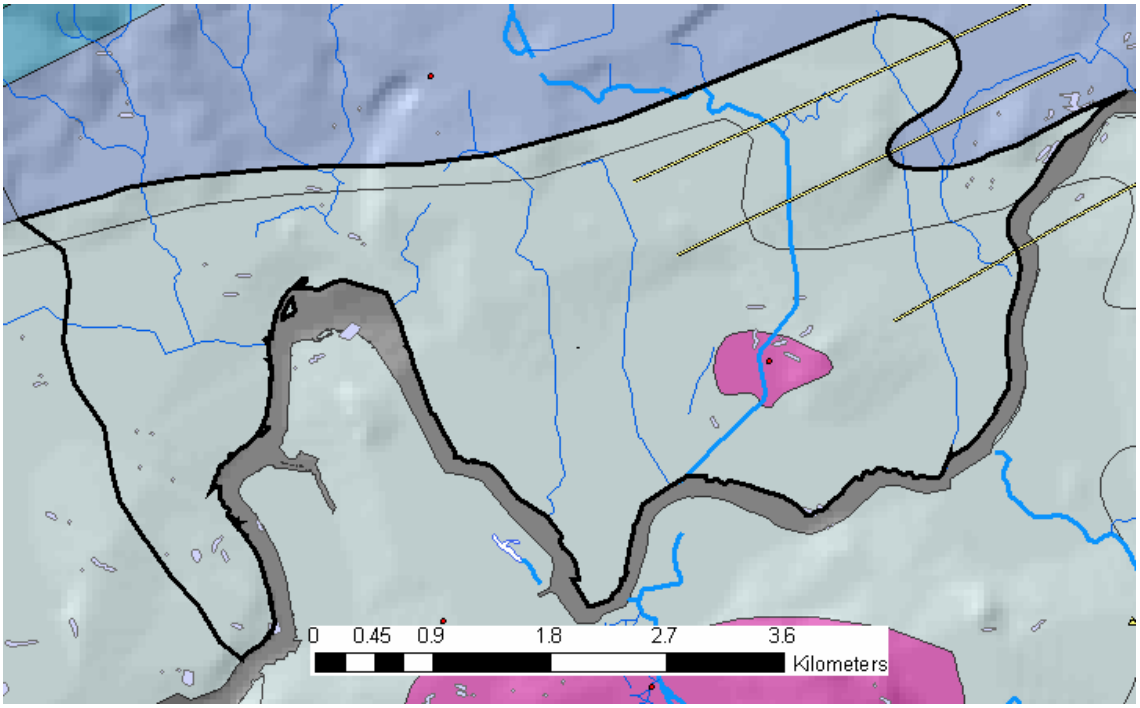
Topography	The GWB is elongated E-W. It is generally low-lying, with most of the ground in the GWB less than 20 mAOD in elevation. Slightly higher ground is found along the northern boundary, where elevations reach just over 30 mAOD. Ground elevation decreases southwards towards the River Shannon, where elevations are < 10 mAOD. Drainage density is relatively high. The mainly N-S flowing streams that drain off the karstic Ardnacrusha GWB to the north slightly incise into the bedrock.	
Geology and Aquifers	Aquifer categories	The GWB comprises **Lm:** Locally important aquifers which are generally moderately productive. The Basalts and other Volcanic rocks rock unit group is currently classified as **Lm**.
	Main aquifer lithologies	Dinantian Pure Unbedded Limestone is the major rock unit group in the GWB. There is a small area (< 0.5 km^2) of Basalts and other Volcanic rocks in the SE of the GWB.
	Key structures	The rocks of this GWB occur on the northern limb of a major ENE-WSW trending syncline, near to the core. Bedding dips generally southwards at low angles of approximately 10-15°. There are minor folds with wavelengths of about 1.5 km 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 are likely to be in the range 5-150 m^2/d, with the median value towards the lower-middle end of the range. Transmissivity in the limestone aquifer of the Pallas Grean GWB, 20 km to the SE, was estimated as 26 m^2/d. In the Volcanic rocks, transmissivities will be similar, with median values towards the lower end of the range. At Herbertstown WS in the nearby Knockroe SW GWB, transmissivity in the volcanics is about 100 m^2/d. However, there are failed wells known in this rock unit group. Because of the very low ground level gradients, groundwater gradients will be very low (~0.005-0.01) over the GWB. *(data sources: Rock Unit Group Aquifer Chapters, GWPS Reports, Source Reports, see references; estimation from maps)*
	Thickness	The Dinantian Pure Bedded Limestones vary laterally in maximum thicknesses from 150 m to up to 500 m. However, most groundwater flow is likely to take place in the top ~30 m, in the zone that comprises a weathered layer of a few metres (epikarst) and a connected fractured layer below this. Deeper groundwater flow occurs along fault zones and large fractures. In the volcanic rocks, most groundwater flux is likely to be in the top ≤ 20-30 m, in the zone comprising a weathered layer of a few metres and a connected fractured zone below this. However, more isolated water-bearing joints or faults can be intercepted at greater depths.
Overlying Strata	Lithologies	*[Information to be added at a later date]*
	Thickness	There are insufficient subsoil thickness data currently available to assess this GWB. Outcropping rock and rock close to surface occurs small patches across the GWB.
	% area aquifer near surface	*[Information to be added at a later date]*
	Vulnerability	Groundwater vulnerability over the GWB is predominantly High. Extreme vulnerability occurs in small areas near Parteen, along the western boundary of the GWB, and in the SE. There are isolated small areas of Moderate vulnerability in the centre of the GWB.
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. Sinking streams recharge the aquifer at points and probably along part of their lengths in low water table conditions. Swallow holes (one is mapped) also receive point recharge. Where the water table is very close to ground surface, recharge may be rejected. Recharge will be inhibited in paved areas, such as the urbanised areas in the SW of the GWB and around Parteen in the middle of the GWB.
	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 Ardnacrusha GWB.)
	Main discharge mechanisms	The main discharges are to the streams and rivers crossing the GWB, particularly to their lower reaches, and to the River Shannon that forms the southern and eastern boundaries of the GWB. Streams sinking in the aquifer re-emerge at springs further downslope.
	Hydrochemical Signature	No relevant hydrochemical data are available for the limestone aquifer in this GWB for assessment. By analogy with other pure limestone aquifers, the groundwater is likely to be Hard to Very Hard, with corresponding high alkalinity and conductivity, a neutral pH, and a calcium–bicarbonate signature. In general, background chloride concentrations will be higher than in the Midlands, due to proximity to the sea.

Groundwater Flow Paths	These rocks are devoid of intergranular permeability; groundwater flow occurs in fractures and faults. In the pure limestone aquifer, groundwater flows through an epikarstic layer and a zone in which fractures are more dense and open. The epikarst is thought to be relatively modern, being formed after the last ice age. The groundwater flow regimes in the epikarst and fractured zones will be hydraulically connected, with the degree of interconnection depending on the faults and joints associated with the structural deformation. Karstification with an element of conduit flow is indicated in the limestone aquifer below the epikarst by sinking streams and a swallow hole. Within the volcanic rocks, groundwater flows through the weathered zone and the connected fractured zone below this. Groundwater flows through fractures and faults and may also flow through primary structures formed when lava flows cooled causing jointing. Groundwater flux is thought to be concentrated in the top 30 m or so of the aquifers. The GWB is considered to be generally unconfined, with the rivers and streams in hydraulic continuity with the aquifer. Sinking and re-emerging streams and groundwater levels adjacent to streams that are up to 5 mbgl in summer indicate that, although there is probably an effective hydraulic connection between surface water and groundwater, surface water features do not necessarily represent the water table elevation, particularly in summer. Streams and rivers are both losing and gaining, with the direction of water flow between streams and aquifers dependent on seasonal variations in water levels. Groundwater levels are probably up to around 10-15 mbgl away from surface water bodies, depending upon ground elevation and season. The water table will generally follow the topography. In high water table conditions, local groundwater flow will be from the higher ground between surface water bodies to the rivers and streams, where it discharges. In low water table conditions, the flow direction may be reversed, with groundwater flowing away from the rivers. Regional groundwater flow directions are generally oblique to the N-S flowing streams and major river within the GWB, i.e., roughly southwards to the Shannon. Groundwater flow path lengths are on the order of 500–1500 m over the bulk of the GWB. In discharge zones, flow paths will be much shorter, at around 100–300 m.
Groundwater & Surface water interactions	There is an effective hydraulic interconnection between groundwater and surface water in the limestone aquifer. Groundwater is discharged to the surface as baseflow to streams and rivers crossing the groundwater body. Groundwater is also recharged by surface water, by sinking streams within the GWB and at a known swallow hole. The volume of water flowing from rivers to aquifers or vice versa depends on the water table elevation. Groundwater will flow into the NHA Inner River Shannon as direct baseflow, and via baseflow to the Blackwater River which flows into the Shannon. At Knockalisheen Marsh (NHA 002001) in the NW of the GWB, grassland slopes gradually into 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 the GWB is sloped gently southwards. The GWB is bounded to the south and east by the River Shannon, to the north by the contact with the highly karstified Pure Unbedded Limestones of Ardnacrusha GWB.
- The GWB is bounded to the west by a surface water catchment boundary which is an implied groundwater divide. However, a stream that the County boundary between Co.'s Clare and Limerick follows crosses the western boundary. Within the GWB, it drains eastwards into the NHA Knockalisheen Marsh.
- The GWB comprises moderately transmissive aquifers in which most groundwater flows through joints, faults and fractures. The aquifers have low storativity.
- Recharge occurs diffusely through the subsoils and at outcrop. Potential recharge may be rejected in areas where the water table is very close to the surface. Recharge will be inhibited in paved areas, such as the urbanised areas in the SW of the GWB and around Parteen in the middle of the GWB.
- Groundwater flow occurs along fractures, joints and faults in the limestones and volcanic rocks. There is likely to be an epikarstic layer at the top of the limestones, which acts to redistribute recharge in the subsurface and, in high water table conditions, is a very high transmissivity layer. A component of groundwater flow in karstic conduits is indicated by sinking streams and swallow holes. The flow regime in the volcanic aquifer is similar, excepting the epikarstic layer. Groundwater flux in the aquifers will be concentrated in a zone at the top of the bedrock that is approximately 30 m or less thick. Deeper groundwater flow can occur along permeable fault zones or deeper fractures, however.
- The aquifers in the GWB are unconfined. In their lower reaches, near rivers and streams the water table is close to the surface. However, in the upper reaches of streams and rivers, the summer water table can be several metres below the surface water levels. This, coupled with sinking and re-emerging streams indicates a high degree of interaction between surface and groundwater. Beneath higher ground, significant unsaturated zones are likely to exist. Water table fluctuations in discharge areas will be relatively low (on the order of 1-2 m) whereas under local topographic highs in the limestones, the water table elevation may vary considerably more.
- Flow path lengths are generally long (up to 1500 m). In discharge zones, flow paths will be much shorter, at around 100–300 m. On a local scale, groundwater discharges to the streams and smaller rivers crossing the aquifer. Local groundwater flow directions are determined by topography and local drainage patterns. Regional groundwater flow directions are directed towards the Shannon, i.e. mainly southwards.
- Groundwater discharges to the rivers and streams crossing the GWB, and to the Shannon at the south and east of the GWB.

Attachments	None.
Instrumentation	Stream gauges: 25312.
Information Sources	Deakin, J. (1995) *Herbertstown Public Supply, Groundwater Source Protection Zones*. Geological Survey of Ireland Report to Limerick Co. Co., 6 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. and Daly, D. (2000) *County Clare Groundwater Protection Scheme.* Geological Survey of Ireland Report to Clare Co. Co., 67 pp. Aquifer Chapters: Pure Bedded Limestones, Basalts and other Volcanic rocks.
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
Visean Limestones (Undifferentiated)		Dinantian Pure Bedded Limestones
Lough Gur Formation (LR)	Pale cherty crinoidal limestone	Dinantian Pure Bedded Limestones
Volcaniclastic Rocks (V)		Basalts and other Volcanic rocks