Araglin GWB: Summary of Initial Characterisation.

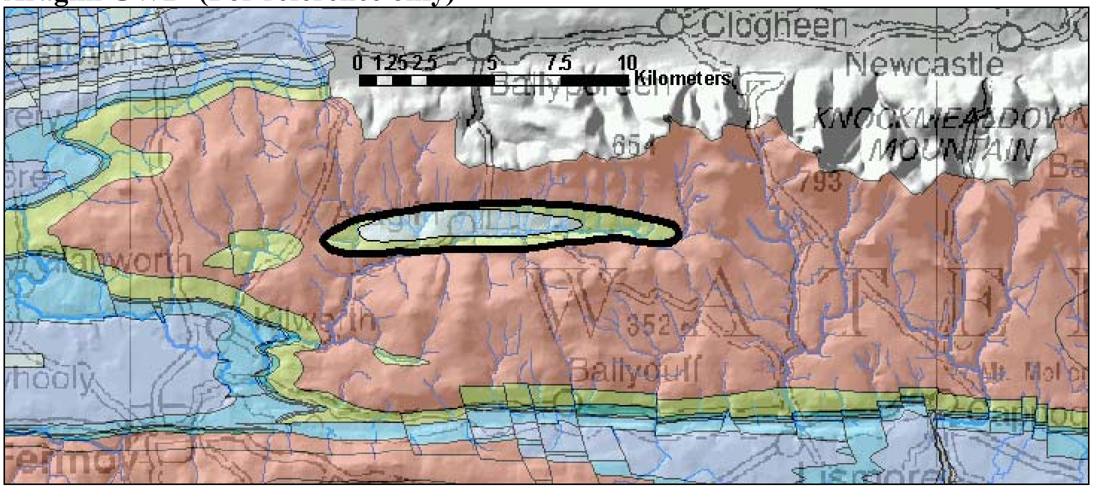
Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
18 Cork, Tipperary, Waterford Co. Cos	**Rivers:** Araglin	None currently listed	17.7

Topography		This GWB occupies a small east-west trending valley wholly surrounded by the less permeable sandstones of the Knockmealdown GWB. Minimum elevation is about 70 m OD, and maximum about 150m OD. The Araglin River exits from the GWB to the southwest at a point approximately one-third of its length from the eastern end.
Geology and Aquifers	**Aquifer categories**	**Rf:** Regionally important fissured aquifer; **Rk:** Regionally important karstified aquifer
	Main aquifer lithologies	Devonian Kiltorcan-type Sandstones (10 km^2) Dinantian Pure Unbedded Limestones (7 km^2)
	Key structures	The regional structural deformation of the Variscan Orogeny created the characteristic South Munster sandstone ridge (anticline)-limestone valley (syncline) topography. The Devonian Kiltorcan-type Sandstones of this GWB are the uppermost unit of the Devonian Old Red Sandstone succession. They usually occur on the margins of the sandstone ridges, but in this case they outcrop around a minor syncline within the main Knockmealdown ridge. The outcrop area of the Kiltorcan-type Sandstones is limited (approx. 100-500 m wide) but the sandstones dip underneath the overlying Dinantian limestone. The Dinantian Limestone is preserved in the centre of the syncline. The degree of hydraulic continuity between the sandstone and the limestone is not known, but by analogy with similar areas, it is likely that the sandstone may be confined by overlying beds of shale or shaly limestone at the bottom of the limestone succession. Extensive fracturing and faulting accompanied the folding of the rocks. The ridges and valleys are generally cut by shear faults trending approximately north-south and thrust faults with a general east-west trend. The major north-south shear faults are paralleled by a very well developed system of vertical or near-vertical north-south joints which are very evident in exposures in quarries and caves in East Cork. These joints are commonly spaced at intervals of about 0.5 to 2 metres (Wright, 1979).
	Key properties	Results of aquifer testing in Kiltorcan sandstones are variable. Generally transmissivity is expected to range from 40-100 m^2/d. Daly (1985) reports estimates of 5-1850 m^2/day, and suggests that highest values are probably associated with low-lying areas close to anticlines or faults. Daly suggests that sandstone permeabilities are in the order of 0.5 to 20 m/day, increasing up to 80 m/day in localised areas. Transmissivity will be reduced at depth, where the Kiltorcan Formation is thinner in the centre of synclines and permeability is reduced by deep burial. Borehole yields of 50-1300 m^3/d have been encountered (typical yield of 500 m^3/d) with specific capacities of 5 to 40 m^3/d/m. Storage values range from 0.01-0.1; the higher storage coefficients result from limited intergranular porosity (the sandstone is susceptible to weathering). Numerical modelling at Cappoquin suggested groundwater gradients of 0.03-0.08 (Hudson 1996). The pure unbedded limestones of South Munster are highly productive. Faults and joints were enlarged by karstification. Karst features may occur. Transmissivity in the pure unbedded limestones can range up to a few thousand m^2/d. Pumping tests in the same rock type in Cloyne GWB gave a range of transmissivity of 200 to over 2000 m^2/day, and 900 - 13,000 m^2/d for a water supply borehole near Dungarvan, Co Waterford (Dungarvan GWB, SERBD). Groundwater gradients within the pure unbedded limestones are low, around 0.001-0.002 (Wright & Gately 2002). The pure bedded limestones are also highly productive although less evidence of extensive karstification is currently recorded. Storativity is low in all aquifers.
	Thickness	Geophysical borehole logging suggests that significant water movement occurs at depths of over 60 m in the Kiltorcan Sandstones where the aquifer is unconfined. Where confined, active groundwater circulation is expected to be much more limited, but some deep flow has been inferred from mineral exploration boreholes at depths of over 200m (Daly 1985). Kiltorcan Formation is generally thinner in the centre of the synclines. The Dinantian Pure Unbedded Limestones (Waulsortian Limestone) are at least 600m thick in the Cork Syncline (Sleeman & Pracht, 1994), but in this syncline are likely to be much thinner. Most groundwater flow may occur in an epikarstic layer a couple of metres thick and in a zone of interconnected solutionally-enlarged fissures and conduits that extends approximately 30 m below this. However deeper flows can occur.
Overlying Strata	**Lithologies**	Subsoils in this GWB are predominantly Till, of probably moderate permeability (by analogy with tills in south Cork). *Subsoil Types identified in Araglin GWB by Teagasc Parent Material Mapping (Draft): Alluvium (A); Rock outcrop and rock close to surface (Rck); Till – Devonian Sandstone Till (TDSs).*
	Thickness	Thickness data are not available.

	% area aquifer near surface	
	Vulnerability	No Vulnerability map has been prepared for a GWPS. Vulnerability is probably generally High, with some significant areas of Extreme.
Recharge	**Main recharge mechanisms**	The sandstone ridges to the north and south of this GWB (GWB) provide abundant runoff which may augment recharge to the limestone/sandstone aquifers in the valley. A small volume of groundwater may cross as through-flow from the surrounding sandstones into this GWB. In the GWB itself both point and diffuse recharge may occur. Swallow holes and collapse features may provide access for point recharge to the karstified aquifer. Diffuse recharge will occur over the entire GWB via rainfall percolating through the subsoil. Groundwater in this body generally may show a rapid response to recharge.
	Est. recharge rates	*To be assessed.*
Discharge	**Large springs and high yielding wells (m^3/d)**	*Note: The following data needs to be checked and updated by RBD Project Consultants.* Data from EPA Groundwater Sources List: Mitchelstown Co-Op Bore (91 m^3/d)
	Main discharge mechanisms	Groundwater discharges to springs within the GWB and to the rivers and streams crossing the GWB.
	Hydrochemical Signature	No data are available; the following is inferred by analogy with other similar aquifers. Groundwater from the Kiltorcan-type Sandstones is mainly a calcium/magnesium bicarbonate type water although the hydrochemistry can be variable. In the recharge areas where the Quaternary deposits are absent or derived from non-Carboniferous strata the water is quite soft (<150 $CaCO_3$ mg/l). Where the aquifer is overlain by limestone-derived drift the total hardness normally ranges 150–250 mg/l $CaCO_3$. Iron and manganese levels are low although occasional high levels are recorded. Chemical analyses of groundwater from the Cappoquin WS indicate **'moderately soft'** water (71-75 mg/l $CaCO_3$) with relatively low alkalinity (39-43 mg/l $CaCO_3$). Conductivities are also relatively low (155-195 µS/cm). The groundwater in the limestone will dominated by calcium and bicarbonate ions. Hardness can range from moderately hard to very hard (200 mg/l to >400 mg/l (as $CaCO_3$). Spring waters tend to be softer as throughput is quicker and there is less time for the dissolution of minerals into the groundwater. Groundwater alkalinity is high, up to 400 mg/l (as $CaCO_3$). Alkalinity is generally less than hardness, indicating that ion exchange (where calcium or magnesium are replaced by sodium) is not significant. Electrical conductivities (EC) can also vary greatly, typically being 500-700 µS/cm. Due to the high level of interaction between groundwater and surface water in karstic aquifers, microbial pollution can travel very quickly from the surface into the groundwater system. The normal filtering and protective action of the subsoil is often bypassed in karstic aquifers due to the number of swallow holes, dolines and large areas of shallow rock.
Groundwater Flow Paths		Groundwater flow generally occurs through faults and joints, but Kiltorcan-type Sandstones are sometimes slightly friable and may have a minor component of intergranular porosity. In general groundwater flow is concentrated in the upper 30 m of the aquifer, but deeper inflows can be encountered. The aquifer is unconfined at outcrop but becomes confined as it dips beneath the Limestone in the centre of the syncline. Where confined, active groundwater circulation is expected to be much more limited, but some deep flow has been inferred from mineral exploration boreholes at depths of over 200 m (Daly 1985). The limestone has no intergranular permeability. Groundwater flow occurs in the faults and joints enlarged by karstification. Past depression of the sea level enabled karstification at depth, which further enhances the permeability of these rocks. Because of the high frequency of fissures in this region, overall groundwater flow is thought to be of a diffuse nature, although solutionally enlarged conduits and cave systems do occur. Groundwater flow occurs in an upper shallow highly karstified weathered zone in which groundwater moves quickly in rapid response to recharge. Below this is a deeper zone where there are two components to groundwater flow. Groundwater flows through interconnected, solutionally enlarged conduits and cave systems that are controlled by structural deformation. In addition there is a more dispersed slow groundwater flow component in smaller fractures and joints outside the larger conduits. The water table is generally within 10 m of the surface, except for the more elevated parts of the limestone aquifers, and the typical annual fluctuation of the water table ranges up to 6 or 7 m (Wright 1979). Groundwater in this aquifer is unconfined. Groundwater flow path lengths will be restricted by the small extent of the aquifers.
Groundwater & Surface water interactions		Based on data from other areas with similar rock type the Kiltorcan aquifer is expected to contribute a relatively high baseflow to streams and rivers directly underlain by rock. The nature of the karstic limestone leads to rapid interchanges of water between surface and underground. Swallow holes, etc. may receive surface water, and groundwater is discharged to surface as springs or as baseflow to rivers crossing the groundwater body.

Conceptual model	• This GWB occurs in a narrow synclinal valley (maximum 1800m m wide) within the Knockmealdown GWB. Ground elevations range 70-150 m OD. • The GWB is bounded all around by the contact with the lower permeability sandstones of the Knockmealdown GWB. The Kiltorcan-type Sandstones of this GWB dip both north and south and become confined beneath the Dinantian limestone. • The GWB comprises both a productive fissured sandstone (classed as a regionally important fissured aquifer) and a karstified limestone aquifer (classed as a regionally important karstified aquifer). • The Kiltorcan Sandstone may become confined beneath the overlying limestones. The extent of hydraulic continuity between the two aquifers is not known. By analogy with other areas, shales and/or shaly limestones are likely to occur between them. • The regional structural deformation that created the characteristic South Munster sandstone ridge (anticline) - limestone valley (syncline) topography was accompanied by intense fracturing and high frequency jointing (N-S jointing dominates) within the limestone synclines. Subsequent karstification of these openings has significantly enhanced the permeability of the pure limestones. Karst features such as cave systems, sinking streams, springs, swallow holes and other collapse features may occur in this GWB. Karstification is known to extend well below present sea levels, and is estimated to extend to depths of 50 to 60 m below O.D. Malin Head. • Groundwater flow generally occurs through faults and joints; however the Kiltorcan-type Sandstones are sometimes slightly friable and may have a minor component of intergranular porosity. • In general groundwater flow is concentrated in the upper 30 m of the sandstone, although deeper inflows can be encountered. Groundwater flow is influenced by topography and groundwater flow will be from the higher ground towards the valleys. • In the limestone, groundwater flows through the faults and joints formed by deformation that were subsequently enlarged by karstification. Most groundwater flow occurs in an upper shallow highly karstified weathered zone of a few metres thick in which groundwater moves quickly in rapid response to recharge. Below this is a deeper zone where there are two components to groundwater flow. Groundwater flows through interconnected, solutionally enlarged conduits and cave systems that are controlled by structural deformation (influence of N-S jointing). In addition there is a more dispersed slow groundwater flow component in smaller fractures and joints outside the larger conduits. Generally this connected fractured zone extends to about 30 mbgl in pure limestones, however in the pure bedded limestones of the South Munster region, deep inflows from major zones of fissuring have been encountered to 40-50 mbgl. • Groundwater in the limestone is unconfined. The water table is generally less than 10 metres below the surface, but may be greater in higher topographic areas, with an average annual fluctuation up to 6 metres. Groundwater gradients are very flat in the permeable limestones (0.001-0.002). Groundwater flow paths will be limited by the narrowness of the valley. Overall groundwater flow is to the rivers draining the valley, predominantly the Blackwater, and ultimately to the sea. • The GWB is recharged diffusely via rainfall percolating through the subsoil and by runoff from the Knockmealdown GWB all around. The generally 'moderate' permeability subsoils will not restrict percolation of recharge. • There are probably several areas of Extreme Vulnerability within this GWB. Elsewhere, the remainder of the body appears to be predominantly High Vulnerability. The limestone will have a very irregular bedrock surface, and subsoil depths may therefore be highly variable within short distances. • There may be a high degree of interaction between surface water and groundwater in this GWB • Based on data from other areas with similar rock type the aquifers are expected to contribute a relatively high baseflow to streams and rivers directly underlain by rock.
Attachments	
Instrumentation	**Stream gauges:** None **EPA Water Level Monitoring boreholes:** None **EPA Representative Monitoring points:** None
Information Sources	Sleeman AG, McConnell B (1995) Geology of East Cork - Waterford. A geological description of East Cork, Waterford and adjoining parts of Tipperary and Limerick, to accompany the Bedrock Geology 1:100,000 scale map series, Sheet 22, East Cork - Waterford. 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

Araglin GWB (For reference only)



List of Rock units in Araglin GWB

Rock unit name and code	Description	Rock unit group	Aquifer Classification
Dinantian Limestones (undifferentiated) (DIN)	Undifferentiated limestones	Dinantian Pure Bedded Limestones	Rf
Kiltorcan Formation (KT)	Yellow & red sandstone & green mudstone	Devonian Kiltorcan-type Sandstones	Rf