Tallow GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
18 Waterford and Cork Co. Cos	**Rivers:** Bride, Flesk, Ballynaparka, Goish, Curraheen, Glenaboy	Blackwater River and Estuary (000072)	79.7

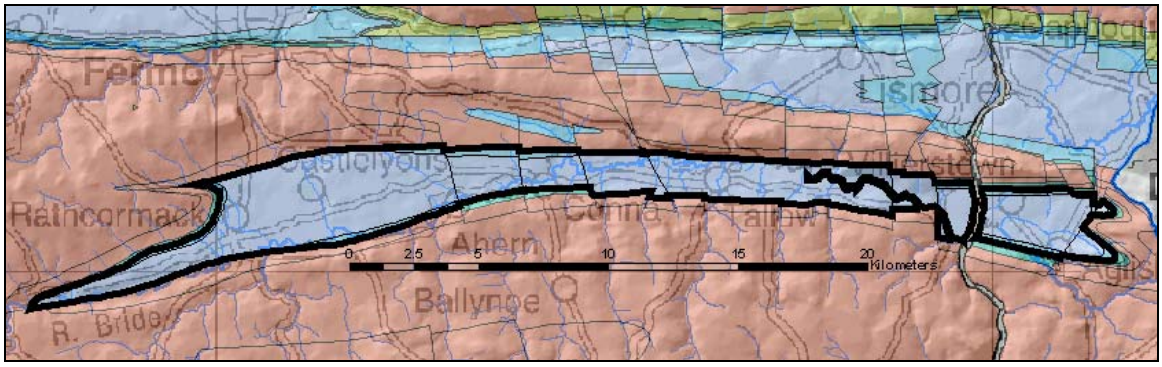
Topography	This GWB occupies the floor of an elongate east-west trending valley (Bride Valley) in east Cork. The valley is bounded to the north and south by parallel east-west trending ridges. The valley floor is generally flat to gently undulating. Ground elevations range from 0–100 m OD. Elevations fall towards the main Blackwater channel in the east. The ready weathering & erosion of the thin shaly limestones which occur at the margins of the body is thought to be responsible for the topographic lows along the edges of the valley.	
Geology and Aquifers	**Aquifer categories**	The main aquifer category in this GWB is: **Rkd**: Regionally important karstified aquifer dominated by diffuse flow (90%). A narrow area (8 km^2 in total) around the margins of the body has an aquifer category of: **Ll:** Locally important aquifer, moderately productive only in local zones (10%)
	Main aquifer lithologies	The main aquifer lithology in this GWB is Dinantian Pure Unbedded Limestones (Waulsortian Limestone Formation) (90%). A narrow area (8 km^2 in total) around the margins of the body is composed of Dinantian Lower Impure Limestones (10%).
	Key structures	During the Variscan Orogeny (mountain building episode), rocks in the South Munster region were compressed from the south into a series of folds on east west axes. Subsequent erosion stripped the more soluble Carboniferous Limestones from the fold crests or ridges (anticlines) exposing the harder, more resistant sandstones underneath. The Carboniferous Limestones were preserved in the fold troughs (synclines) which today line elongate east-west trending valleys separated by the intervening sandstone ridges. Extensive fracturing and faulting accompanied the folding of the rocks. The ridges and valleys are cut by series of shear faults trending approximately north-south and a series of 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, commonly spaced at intervals of about 0.5 to 2 metres (Wright, 1979) which are very evident in exposures in quarries and caves in East Cork.
	Key properties	The pure unbedded limestones of the South Munster region are highly productive. Faults and joints were enlarged by karstification as groundwater moved through the limestones. These limestones are characterised by karst features. Within this GWB only a few are known – for instance, around the village of Castlelyons, and in the townland of Aghern West, where a sink-to-rising tracer test in 1979 gave a high apparent velocity of about 2300 m/d. Several other features are suggested by markings on O.S. 6" sheets, and many more are probably obscured by subsoils. Transmissivity in the pure unbedded limestones can range up to a few thousand m^2/d. Pumping tests in the same rock type in the Cloyne GWB to this south of this body 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). In the impure limestones, transmissivities are lower; they will generally be in the range 5-20 m^2/d but may be higher where karstification has occurred.
	Thickness	The Dinantian Pure Unbedded Limestones (Waulsortian Limestone) are at least 600m thick in the Cork Syncline (Sleeman & Pracht 1994). Most groundwater flow probably occurs 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 also occur. Boreholes have intersected major zones of fissuring at depth in Waulsortian Limestone at Cloyne, Co Cork (Cloyne GWB), at about 41m below ground level, i.e. 20m below O.D, and at Ringaskiddy (Carrigaline GWB), where major water inflows occur down to 40m below O.D (Wright 1979). In the past sea level is estimated to have been approximately 50-60m below present day O.D., the level to which the now infilled channel of the River Lee was eroded (Farrington 1959) enabling karstification at depth. Today this region is an example of a drowned karst terrain. In the Impure Limestones at the margins of this GWB, most groundwater flow occurs in an upper weathered layer of a few metres and a zone of interconnected fissures often not extending more than 15 m from the top of the rock, although occasional deep inflows associated with major faults can be encountered. Impure limestones are also much less susceptible to karstification.
Overlying Strata	**Lithologies**	*Subsoil Types identified in Tallow GWB by Teagasc Parent Material Mapping (Draft): Alluvium (A); Sandstone sands and gravels (Devonian) (GDSs); Karstified limestone bedrock at surface (KaRck); Made Ground (Made); Rock outcrop and rock close to surface (Rck); Till – Devonian Sandstone Till (TDSs), Limestone Till (TLs).* This GWB is primarily covered by glacial till, with substantial areas of alluvium along the Bride River. By analogy with tills in South Cork, the permeability of the till deposits is probably mainly 'moderate'.

	Thickness	Depth-to-bedrock data are sparse. There are some areas within this GWB with outcrop or where subsoils are likely to be <3m, particularly around Castlelyons, Bridebridge, and Aghern. The underlying pure unbedded limestone in this valley is highly karstified and likely to have a very irregular bedrock surface. Subsoil depths in these areas can therefore be highly variable within short distances.
	% area aquifer near surface	
	Vulnerability	As noted above, depth-to-bedrock data are sparse. Permeability of the till is likely to be moderate, by analogy with till permeabilities in South Cork (Kelly D, Leader U, Wright G, 2002), but drilling near Conna WS also found much of the till to have a sandy texture and a high permeability. Vulnerability has been mapped only in a small area (~1 km^2) around the Conna WSS borehole (Kelly, 2000), where vulnerability is mostly Extreme or High, with a small area of Moderate vulnerability. Over the GWB as a whole this pattern is likely to persist.
Recharge	**Main recharge mechanisms**	The sandstone ridges to the north and south of this GWB (Glenville GWB), provide abundant runoff which supplies recharge to the limestone aquifer in the valley. A small volume of groundwater may cross as through-flow from the sandstones into this GWB. In the GWB itself both point and diffuse recharge will occur. Swallow holes and collapse features provide the means for point recharge to the karstified aquifer. Diffuse recharge will occur over the entire GWB via rainfall percolating through the subsoil. The lack of surface drainage in several parts of this GWB indicates that potential recharge readily percolates into the groundwater system. The generally 'moderate' permeability subsoils will generally not restrict percolation of recharge. However, variability in subsoil depths due to the underlying karstified limestone means that even in areas with lower permeability subsoil, opportunities for recharge to areas of shallower limestone can still occur.
	Est. recharge rates	
Discharge	**Large springs and high yielding wells (m^3/d)**	*Note: The following data need to be checked and updated by RBD Project Consultants.* Data from GSI Well Database: Excellent BHs: Castlevons Co-op (1818 m^3/d) Knockmourne (1823 m^3/d)-private well Good BHs: Conna Village WS (270 m^3/d) Additional data from EPA Groundwater Sources List: Also: Aghern Spring (High Spring)
	Main discharge mechanisms	Groundwater discharges to springs within the GWB and to the rivers and streams crossing the GWB. Rivers overlying the limestones in the South Munster Synclines have relatively high dry weather flows representing contributions from the underlying aquifer.
	Hydrochemical Signature	Hydrochemical data are scarce. Hydrochemical analyses from Conna WS show the water is moderately hard to hard (222-303 mg/l as $CaCO_3$), with electrical conductivity 494-636 µS/cm, and a hydrochemical signature of calcium bicarbonate type. These values are typical of groundwater from limestone rocks, but 'softer' than analyses for some other areas in North Cork. This is probably due to the input of groundwater from the sandstone and siltstone rock units to the south of the borehole. Nitrate concentrations at Conna WS range 18-53 mg l^{-1} (15 samples; 1993-1999), averaging 40 mg l^{-1}, and with an increasing trend. The data appear to show higher values in summer, lower values in winter, possibly caused by winter recharge diluting the concentrations. It suggests either (a) the aquifer is generally high in NO_3, and winter rain dilutes the concentration or (b) summer applications of fertiliser and slurry push the concentrations upward. Chloride concentrations at Conna WS range 14-25 mg/l (8 samples; 1993-1999), average 22 mg/l, and Potassium 1.9-5.8 mg/l. Limited data from De Bruin (1979) from a spring near Brideebridge show an EC of 420 µS/cm, Chloride of 23.6 mg/l, but a lower nitrate level (19.1 mg/l).

Groundwater Flow Paths	These rocks are devoid of intergranular permeability. Groundwater flow occurs in the many faults and joints, enlarged by karstification. Past depression of the sea level enabled karstification at depth, which further enhanced 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). Well hydrographs in limestone aquifers elsewhere in Cork show annual fluctuation of water levels of about 3-5 metres. Groundwater in this GWB is generally unconfined. The highly permeable aquifer supports a local scale flow system. Groundwater flow paths may be over a kilometre long, but are limited by the narrowness of the limestone valley. Regional groundwater flow is towards the Blackwater River.
Groundwater & Surface water interactions	The nature of the karstic system can lead to rapid interchanges of water between surface and underground. Swallow holes and caves receive surface water, and groundwater is discharged to surface as springs or as baseflow to rivers crossing the groundwater body.
Conceptual model	• This GWB occupies the floor of an elongate east-west trending valley in east Cork. The body is generally flat to gently undulating (10-100 m OD). • The GWB is bounded to the north and south by the contact with the low permeability sandstones and mudstones. • The GWB is composed mainly of diffusely karstified, highly permeable pure limestones with a narrow underlying layer of less permeable impure limestone around the margins of the body. To the north and south of the body are ridges of low permeability sandstones. • 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 are common 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 flows through the many 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 this body is unconfined. The water table is generally less than 10 metres below the surface with an average annual fluctuation up to 6 metres. Groundwater gradients are very flat in the permeable limestones (0.001-0.002). The highly permeable aquifer can support regional scale flow systems. Groundwater flow paths are limited by the small extent of the GWB, and may be even shorter where the water table is very close to the surface. Overall groundwater flow is to the Bride River and its tributaries. • Recharge to this GWB is both point and diffuse. The ridges to the north and south of this GWB provide runoff which supplies recharge to the limestone aquifer in the valley. Swallow holes, collapse features and sinking streams provide the means for point recharge to the karstified aquifer. Diffuse recharge will occur over the entire GWB via rainfall percolating through the subsoil. The lack of surface drainage in much of this GWB indicates that potential recharge readily percolates into the groundwater system. Some areas of low permeability subsoil in the east of the body may restrict percolation of recharge in areas where they are present in sufficient thickness. A relatively small volume of groundwater may cross as through-flow into this GWB from the adjacent low transmissivity GWBs. • Some areas of Extreme Vulnerability exist within this GWB. In a highly karstified aquifer such as this GWB the underlying limestone will have a very irregular surface. Subsoil depths in this GWB can therefore be highly variable within short distances. • There may be a high degree of interaction between surface water and groundwater in this GWB. Swallow holes and caves receive surface water, and groundwater is discharged to surface as springs or as baseflow to rivers crossing the groundwater body.
Attachments	
Instrumentation	**Stream gauges:** 18001*, 18033 * Adjusted Dry Water Flow available. **EPA Water Level Monitoring boreholes:** Conna (CON 30), Waterford Co-op, Conna (CON 156), (CON 157) **EPA Representative Monitoring points:** Conna WSS (CON 28)

Information Sources	Kelly D, Leader U, Wright G (2002) *South Cork Groundwater Protection Scheme*. Report to Cork County Council (South). Geological Survey of Ireland. De Bruin RH (1979) *A Hydrogeological Survey in a Part of the River Bride Catchment.* Unpublished thesis, Free University, Amsterdam. Farrington A (1959). The Lee Basin Part one: glaciation. Proc. R. Ir. Acad. 60B (3), 135-166. Kelly C (2000) Conna Water Supply Scheme (village bore): Groundwater Source Protection Zones. Report to Cork County Council (Northern Division). Geological Survey of Ireland. Sleeman AG, Pracht M (1994) *Geology of South Cork. A geological description of South Cork to accompany the Bedrock Geology 1:100,000 Map Series, Sheet 25*. Geological Survey of Ireland, 59pp Wright G, Gately C (2002) *Whitegate Regional WaterSupply Scheme (Dower Springs)*. Groundwater Source Protection Zones. Geological Survey of Ireland Report, 19pp. Wright GR (1979) Groundwater in the South Munster Synclines. In: Hydrogeology in Ireland, Proceedings of a Hydrogeological Meeting and associated Field Trips held in the Republic of Ireland from 22 to 27 May, 1979. Published by the Irish National Committee of the International Hydrological Programme.
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae.

Tallow GWB (For reference only)



List of Rock units in Tallow GWB

Rock unit name and code	Description	Rock unit group	Aquifer Classification
Waulsortian Limestones (WA)	Massive unbedded lime-mudstone	Dinantian Pure Unbedded Limestones	Rk^d
Ballysteen Formation (BA)	Fossiliferous dark-grey muddy limestone	Dinantian Lower Impure Limestones	Ll