Whitegate GWB: Summary of Initial Characterisation.

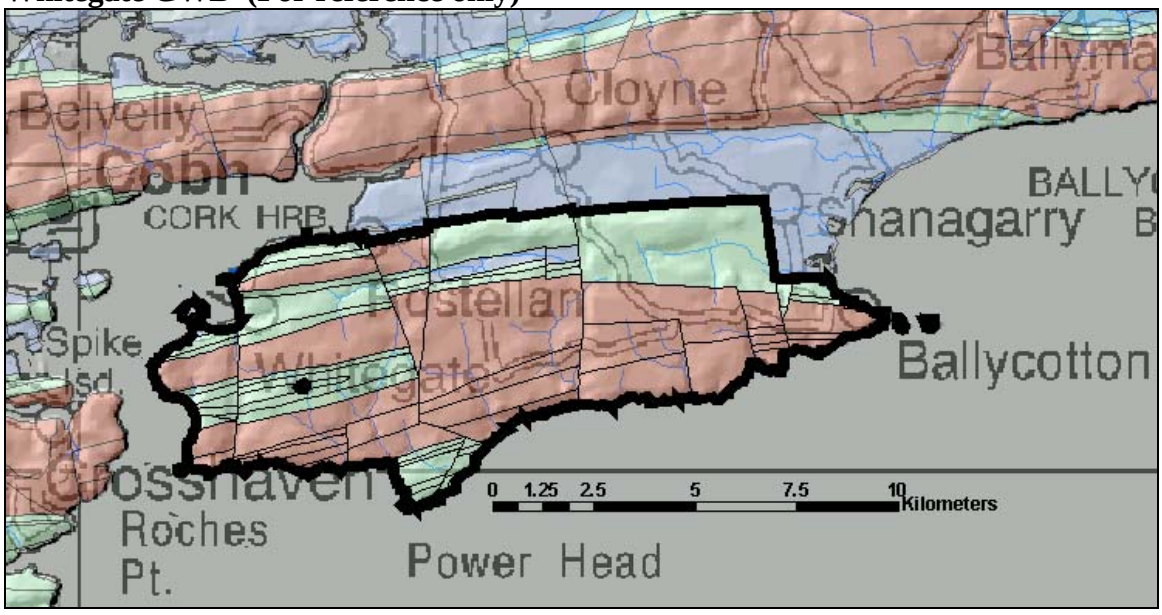
Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
19 Cork Co. Co.	**Rivers:**.None **Lakes:** None **Stream:** Carrigacrump	(001408) Carrigacrump Caves	78.9

Topography	Ground elevations range from 10-80 m OD. The hills to the south of Cloyne reach almost 90 m OD, while the ridge south of Carrigacrump reaches about 72 m OD. These ridges represent the remnants of an old erosion surface (possibly Cretaceous age) gradually falling towards a former coastline. The Carrigacrump valley bottom elevation falls from about 30 m OD at its upper end (Ballyfin townland) to 5.2 m OD at its lower end (by Titeskin Church). A single stream, rising in Ballyfin, drains the valley, then turns northwest to join the Whitewell stream and reach the sea at Rostellan.	
Geology and Aquifers	**Aquifer categories**	**Ll:** Locally important aquifer, moderately productive only in local zones (98%) **Rk^{d}*/Pending Classification**: * This area is karstified but is not regionally important due to its small size (< 2 km^2) – a new classification code to represent such areas is pending. (2%)
	Main aquifer lithologies	Devonian Old Red Sandstones (59%), Dinantian Mudstones and Sandstones (Cork Group) (39%), Dinantian Pure Unbedded Limestones (2%).
	Key structures	The widespread faulting and folding associated with the Variscan Orogeny in the south of Ireland has given rise to zones of enhanced permeability in the mudstones and sandstones. These can occur close to faults and fold axes, but such zones are generally local. The rocks are folded into anticlines and synclines, with approximately East-West axes. The rocks are also broken by a strong system of steeply-dipping cross faults running approximately NNW-SSE, roughly at right angles to the fold axes. The faulting has generally resulted in moving the rocks on the east side of each fault a little way to the south (i.e. they are dextral wrench faults). There are also other faults roughly parallel to the fold axes. This GWB encompasses the Carrigacrump Syncline, which contains a small area of karstified limestone. The Carrigacrump area is mapped as a fault-bounded trough ('graben').
	Key properties	The Devonian ORS and Dinantian Mudstones & Sandstones (Cork Group) of this GWB are generally considered to be a relatively low permeability rock except where zones of higher permeability have been created by folding and faulting. Coarse grained rocks such as the sandstones and conglomerates have a greater tendency to contain a fissure permeability and will have higher permeabilities than the fine grained mudstones and siltstones. In general, the aquifer transmissivities will be in the range 2-20 m^2/d. However, 'Excellent' yielding wells (>400 m^3/d) are known in some of the units – these yields are usually associated with boreholes in fault zones. Aquifer storativity will be low in all rock units. Groundwater gradients are likely to be in the range 0.01 to 0.04. This GWB includes a small area (1.2km^2) of Dinantian Pure Unbedded Limestones (Waulsortian Limestone) in the Carrigacrump Syncline in the north of the body. Karst features are prominent (Carrigacrump Quarry Caves & Ballyfin Cave). These limestones are highly productive in the neighbouring karstic Cloyne GWB where pumping tests in boreholes at Cloyne (Cloyne-Aghada WSS) gave a range of transmissivity of 200 to over 2000 m^2/day (Wright 2002). Boreholes in the limestones in this GWB showed a very high transmissivity but the aquifer is limited in size and the cone of depression is constrained by the width of the aquifer, and drawdown increases during pumping. A groundwater gradient of (0.0005 – 0.001) would be expected in the limestones.
	Thickness	The Dinantian Mudstones and Sandstones (Cork Group) and Devonian Old Red Sandstone units in this GWB form sequences which can be several kilometres thick (Sleeman & Pracht, 1994). Most groundwater flow in this GWB is expected to occur within the top 15 m of the aquifer, in the layer that comprises a weathered zone of a few metres and a connected fractured zone below this. The limestone in the Carrigacrump Syncline may be over 100m deep. 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. There is evidence of major zones of fissuring at depth in similar limestones in the Cloyne GWB.
Overlying Strata	**Lithologies**	This GWB is primarily overlain by glacial till, mostly of 'moderate' permeability. However in a low-lying area in the northeast of the body is a small area of 'low' permeability till. There are many areas of rock outcrop or shallow rock. Small areas of sand and gravel and alluvium also occur. *Subsoil Types identified in Whitegate GWB by Teagasc Parent Material Mapping (Draft): Alluvium (A); Limestone sands and gravels (Carboniferous) (GLs); Marine sands and gravels (MGs); Made Ground (Made); Rock outcrop and rock close to surface (Rck); Till – Devonian Sandstone Till (TDSs), Limestone Till (TLs).*

	Thickness	Most of the GWB has < 3 m subsoil. Rock outcrop and shallow rock are common. Deeper subsoils are encountered in a more low-lying area in the north east of the body (5-24 m). In the Carrigacrump Syncline subsoil thickness is very variable over short distances due to the highly karstified nature of the underlying limestone which results in a very irregular bedrock surface. Depth to bedrock of 18 m is recorded within 300 m of rock outcrop and is thought to represent infilled cavities in the karstified limestone. ?Jurassic Clays have been recorded in such cavities near Cloyne.
	% area aquifer near surface	
	Vulnerability	The South Cork Groundwater Protection Scheme includes this GWB. Most of the body is of Extreme Vulnerability, with some areas of High Vulnerability. One area in the northeast of the body has Moderate Vulnerability and a small isolated area of Low Vulnerability are also recorded.
Recharge	**Main recharge mechanisms**	Diffuse recharge will occur via rainfall percolating through the subsoil or areas of outcropping rock. The proportion of the effective rainfall that will recharge the aquifer is determined by the permeability of the soil and subsoil, and by the slope. The predominantly shallow 'moderate' permeability till will allow easy percolation of recharge however the area of 'low' permeability till in the northeast of the body may restrict percolation of recharge to the underlying aquifer.
	Est. recharge rates	
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 GSI Well Database: Devonian ORS: Finure BH (545 m^3/d), Cork Group:-Irish Refining (326 m^3/d), Kilmacahill (109 m^3/d) Dinantian Pure Unbedded Limestone: Farrannamanagh (1860 m^3/d)
	Main discharge mechanisms	The main discharges are to the streams flowing across the GWB and to small springs and seeps. Streams flowing off this body to the north provide recharge to the limestone aquifer in the Cloyne GWB. Groundwater will also discharge at the coast.
	Hydrochemical Signature	This GWB is underlain by non-carbonate rock units, which include Old Red Sandstone rocks, as well as the sandstones and mudstones of the Cork Group. Alkalinity ranges 14-310 mg/l (as $CaCO_3$) and hardness ranges 43-224 mg/l (moderately soft to moderately hard). The Old Red Sandstone formations largely contain calcium bicarbonate type water. Conductivities in these units are relatively low, ranging 125-600 µS/cm, with an average of 312 µS/cm. Conductivities in the Cork Group rocks are quite similar with an average of 381 µS/cm and a range from 160 to 433 µS/cm. In general, high iron (Fe) and manganese (Mn) concentrations can occur in groundwater derived from ORS, due to the dissolution of Fe and Mn from the sandstone/shale where reducing conditions occur. It has been demonstrated that at low pumping rates water does not reside long enough in the well for oxidation to occur, thereby resulting in elevated Fe and Mn in small domestic supplies (Applin *et al*, 1989). No EPA monitoring data are currently available for this GWB. Background chloride concentrations in all aquifers will be higher than in the Midlands, due to the proximity to the sea. Where the influence of sea water incursion is responsible for high chloride levels pumping rates in such areas may need to be kept below a level with could cause sea water to be drawn into the boreholes.
Groundwater Flow Paths		The Devonian ORS and Dinantian Mudstones & Sandstones of this GWB have no intergranular permeability; groundwater flow occurs in fractures and faults; in-filling of fractures is to be expected. The permeability of individual fractures and the degree of interconnection will be generally low, with fracturing confined to local zones. Permeability is highest in the upper few metres but generally decreases rapidly with depth. In general, groundwater flow is concentrated in the upper 15 m of the aquifer, although deeper inflows from along fault zones or connected fractures can be encountered. Significant yields can be obtained where boreholes are drilled into known fault zones. In these rocks groundwater flow paths are expected to be relatively short, typically from 30-300 m, with groundwater discharging to small springs, or to the streams that traverse the aquifer. Flow directions are expected to approximately follow the local surface water catchments. Groundwater is generally unconfined in this groundwater body. Groundwater flow within the isolated area of karstified Dinantain Pure Unbedded Limestones will occur in an upper shallow highly karstified weathered zone and in fractures and faults that have been enlarged by karstification.
Groundwater & Surface water interactions		Groundwater in the Devonian ORS and Dinantian Mudstones & Sandstones (Cork Groups) will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater - surface water interactions occur. Baseflow to rivers and streams is likely to be relatively low. In the small area of limestone in the Carrigacrump Syncline there will be rapid interchanges of water between surface and underground in the karstic system where the subsoil cover is thin.

Conceptual model	• The groundwater body is bounded to the south and west by the coast, and to the north by the contact with the karstic limestones of the Cloyne GWB. • The topography of this body is ….. • The groundwater body primarily comprises Devonian ORS and Dinantian Mudstones & Sandstones (Cork Group) which have low transmissivity and storativity, although localised zones of enhanced permeability occur along fault zones. Flow occurs along fractures, joints and faults. Flows in the aquifer are generally concentrated in a thin zone at the top of the rock, although deeper groundwater flows along faults and major fractures. • Diffuse recharge occurs across the GWB through the subsoils and rock outcrops. • The water table can vary from a few metres up to more than 10 m below ground surface, depending upon topography. Groundwater is generally unconfined. Flow path lengths are generally short, ranging from 30-300 m. Local groundwater flow directions are controlled by local topography. • Groundwater discharges to the numerous streams and rivers crossing the aquifer and to small springs and seeps. • There is a small (1.2 km^2) isolated area of Dinantian Pure Unbedded Limestones within this GWB, which are diffusely karstified, highly permeable pure limestones similar to those that occur in the Cloyne GWB to the north. Groundwater flow in this small area will occur in a shallow highly karstified weathered zone of a few metres thick and in deeper interconnected, solutionally enlarged conduits.
Attachments	None
Instrumentation	**Stream gauges:** 19026 **EPA Water Level Monitoring boreholes:** None **GSI Water Level Monitoring boreholes: Farrannamanagh and Carrigacrump** **EPA Representative Monitoring points:** None
Information Sources	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 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. Wright GR (2002) *Cloyne/Aghada Water Supply Scheme.* Groundwater Source Protection Zones. Geological Survey of Ireland report, 15pp.
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Whitegate GWB (For reference only)



List of Rock units in Whitegate GWB

Rock unit name and code	Description	Rock unit group	Aquifer Classification
Courtmacsherry Formation (CY)	Calcareous mudstone with limestone	Dinantian Mudstones and Sandstones	Ll
Pigs Cove Member (KNpc)	Sand-lensed mudstone	Dinantian Mudstones	Ll

		and Sandstones	
Cuskinny Member (KNcu)	Flaser-bedded sandstone and mudstone	Dinantian Mudstones and Sandstones	Ll
Old Head Sandstone Formation (OH)	Flaser-bedded sandstone and minor mudstone	Dinantian Mudstones and Sandstones	Ll
Waulsortian Limestone (WA)	Massive unbedded fine-grained limestone	Dinantian Pure Unbedded Limestones	Pending Classification (Rk^{d}*)
Gyleen Formation (GY)	Sandstone with mudstone and siltstone	Devonian Old Red Sandstones	Ll
Ballyknock Member (GYbn)	Green sandstone, siltstone and mudstone	Devonian Old Red Sandstones	Ll
Ballytrasna Formation (BS)	Purple mudstone with some sandstone	Devonian Old Red Sandstones	Ll