Grange East GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
35 Sligo Co. Co.	Rivers: Grange, Carney, Doonowney. Lakes: None	Bunduff Lough and Machair (000625), Cummeen Strand / Drumcliff Bay (000627).	39

Topography	The GWB occupies an area on Lissadell Peninsula, along the northern headland of Sligo Bay, stretching from Mullaghmore to Drumcliff Bay. Elevations range from sea level to 50 mAOD. It is bounded to the north and south by the coastline. It is bounded to the east and west by the Grange West and the Drumcliff GWB's. Figure 1 shows the location and boundaries. The GWB is principally drained by tributaries of the Grange river.	
Geology and Aquifers	**Aquifer categories**	**Rk^c:** Regionally important karstified aquifer dominated by conduit flow. The 'c' signifies conduit flow. **Lm:** Locally important aquifer, generally moderately productive.
	Main aquifer lithologies	Dinantian Pure Bedded Limestones dominate two thirds of the GWB. The northern end of the GWB is occupied by Dinantian Sandstones. Table 1 gives the rock units present.
	Key structures	The GWB is located in the Rosses Point-Cuilcagh-Manorhamilton Fault Zone. A NNE-SSW fault bounds the GWB to the west. The beds are dipping at 5^o, mainly to the east.
	Key properties	There are no hydrogeological data available for the GWB. In the Dinantian Pure Bedded Limestones transmissivities are expected to be variable, ranging from 1 to greater than 2000 m^2/d. Storativity is likely to be low - approximately 0.01-0.02. In the area occupied by the Dinantian Sandstones, good yields are expected, based on boreholes drilled by the GSI in the Dinantian Sandstones in the vicinity of Sligo Town (Daly, 1975). Transmissivity is in the order of 100-150 m^2/d in the sandstones. In the vicinity of faults, transmissivity may be higher. Storativity in the sandstones is expected to be in the order of 2%. Groundwater velocities are expected to be rapid in the Dinantian Pure Bedded Limestones. Groundwater gradients are expected to be greater than 0.0005 across the GWB.
	Thickness	Within the limestones, most groundwater flow is likely to be 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. Within the sandstones, most groundwater flux is likely to be in the upper part of the aquifer, comprising three broad zones: a zone comprising a broken and weathered zone typically less than 3 m thick; a zone of interconnected fissuring up to 40 m thick; and a zone of isolated poorly connected fissuring typically less than 150 m.
Overlying Strata	**Lithologies**	Till is the dominant subsoil over most of the GWB, however there are extensive areas of cutover peat, particularly to the northeast of Grange. Along the northern part of the GWB bordered by the coastline there are extensive areas of windblown deposits. The presence of peat is unusual over karstified limestones and may be due to low permeability till.
	Thickness	Depth to bedrock data are sparse. Thicknesses of greater than 10 m are recorded in boreholes on either side of this GWB. Two rock outcrops are present and bedrock is close to surface to the north of Grange according to annotation on the original 6 inch sheets (GSI Archival data). It is likely that thickness is greater in the southern half of the GWB.
	% area aquifer near surface	*[Information to be added at a later date]*
	Vulnerability	*[Information to be added at a later date]*
Recharge	**Main recharge mechanisms**	Diffuse recharge occurs via rainfall percolating through permeable subsoil and rock outcrops. There is no evidence for point recharge occurring, however there may be unrecorded karst features via which point recharge may be occurring in the limestones.
	Est. recharge rates	*[Information to be added at a later date]*
Discharge	**Large springs and high yielding wells (m^3/d)**	None identified
	Main discharge mechanisms	The main discharges are to small springs, streams, rivers and to the coast.

	Hydrochemical Signature	There are no data available, however, the groundwater is expected to have a $CaHCO_3$ signature. Alkalinity, electrical conductivity and hardness are expected to be high. Water sampling carried out in the limestones in the vicinity of Carrowmore, Sligo report the following values in six samples (Higgins, 1987). Brackish water is likely close to the coast. Alkalinity (mg/l as $CaCO_3$): 113-163. Total Hardness (mg/l): 302-430. Conductivity (μS/cm): 580-725. Chloride (mg/l): 24-35. The quality of the water from the Mullaghmore Sandstone is liable to be high in iron (Aldwell, 1981). The results of a water sample take from a GSI investigation borehole near Sligo town (Daly 1975) are shown below.

Total Hardness (mg/l CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Total Alkalinity (mg/l CaCO3)	Sulphate (mg/l)	Chloride (mg/l)	EC(µS/cm)	Iron (mg/l)	Manganese (mg/l)
44	25	19			328	140	35		28.0	nil

Groundwater Flow Paths	Groundwater flow is expected to be concentrated in fractured and weathered zones and in the vicinity of fault zones within the sandstones. Flow paths can be expected to be relatively long, and are likely to be up to 2000 m. Groundwater flow directions are expected to follow topography, generally toward the coast. The Dinantian Limestones are generally devoid of intergranular permeability. Groundwater flows through fissures, faults, joints and bedding planes. In pure bedded limestones these openings are enlarged by karstification which significantly enhances the permeability of the rock. Karstification can be accentuated along structural features such as fold axes and faults. Groundwater flow through karst areas is extremely complex and difficult to predict. As flow pathways are often determined by discrete conduits, actual flow directions will not necessarily be perpendicular to the assumed water table contours. Flow velocities can be rapid and variable, both spatially and temporally. Flow path lengths can be up to a several kilometres in length, however, due to the relatively small size of the GWB, it is likely that flow paths will be shorter than other large karst GWB's. Overall groundwater flow will be towards the sea, but the karstified nature of the bedrock means that locally, groundwater flow directions can be highly variable.
Groundwater & Surface water interactions	Generally, there is a high degree of interconnection between groundwater and surface water in karstified limestone areas. Any contamination of surface water is rapidly transported into the groundwater system, and vice versa. Groundwater will contribute baseflow to the streams and rivers.

Conceptual model	• The GWB occupies an area on Lissadell Peninsula, along the northern headland of Sligo Bay, stretching from Mullaghmore to Drumcliff Bay. Elevations range from sea level to 50 mAOD. • It is bounded to the north and south by the coastline. It is bounded to the east and west by the Grange West and the Drumcliff GWB's. The GWB is principally drained by tributaries of the Grange river. • The GWB is comprised of Dinantian Pure Bedded Limestones and Dinantian Sandstones. • Transmissivities are expected to be variable, ranging from 1 to greater than 2000 m^2/d in the limestones. Storativity is likely to in the range of 1-2%. Transmissivity is in the order of 100-150 m^2/d in the sandstones. Transmissivities are likely to be higher in the vicinity of fault zones. • Most groundwater flux is likely to be in the upper part of the aquifer. • Till is the dominant subsoil type. • Recharge occurs via diffuse mechanisms. Point recharge to the underlying aquifer may be occurring via as yet unrecorded karst features. • The main discharges are to small springs, streams, rivers and to the sea along the coastline. • The groundwater is expected to have a calcium bicarbonate signature. • There is a high degree of interconnection between groundwater and surface water.
Attachments	Table 1 and Figure 1.
Instrumentation	**Stream gauge:** 35009, 35027. **EPA Water Level Monitoring boreholes:** None **EPA Representative Monitoring points:** None

Information Sources	Aldwell, C. R. (1981) *The Geology and Mineral Resources of Co. Sligo with special emphasis on Groundwater and its protection*. Lecture by C.R. Aldwell of Geological Survey of Ireland to Institute of Engineers of Ireland. Sligo – March 16th, 1981. Daly, E. (1975) ***Report on the groundwater potential of the area around Sligo town.*** Geological Survey of Ireland. Higgins, T. (1987) *An Assessment of the Impact of Human activity on groundwater quality in the Carrowmore area of County Sligo.* BSc thesis. Sligo Regional Technical College. MacDermot, C.V. Long C.B. and Harney S.J (1996) Geology of Sligo-Leitrim: *A geological description of Sligo, Leitrim and adjoining parts of Cavan, Fermanagh, Mayo and Roscommon, to accompany bedrock geology 1:100,000 scale map, Sheet 7, Sligo - Leitrim.* Geological Survey of Ireland, Dinantian Sandstones and Dinantian Pure Bedded Limestone Aquifer Chapters. Unpublished.
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae.

Table 1. List of Rock units in GWB

Rock unit name and code	Description	Rock unit group	Aquifer Classification
Dartry Limestone Formation (DA)	Dark fine-grained cherty limestone	Dinantian Pure Bedded Limestones	Rkc
Ballyshannon Limestone Formation (BS)	Pale grey calcarenite limestone	Dinantian Pure Bedded Limestones	Rkc
Mullaghmore Sandstone Formation (MU)	Sandstone, siltstone & shale	Dinantian Sandstones	Lm

Figure 1 Location and boundaries of GWB.