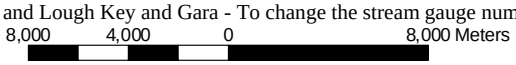
Curlew Mountains Southeast: Summary of Initial Characterisation.

OUTSTANDING ISSUES – the volcanic rocks within the Keadew Formation/Basalts and other volcanic rocks –Andesitic Lava. Is the pure basis of being Andesitic Lava enough to merit Lm classification. The extent of groundwater interaction between Curlew GWB and Lough Key and Gara - To change the stream gauge numbers from the Feature ID number



Curlew Mountains Southeast: Summary of Initial Characterisation.

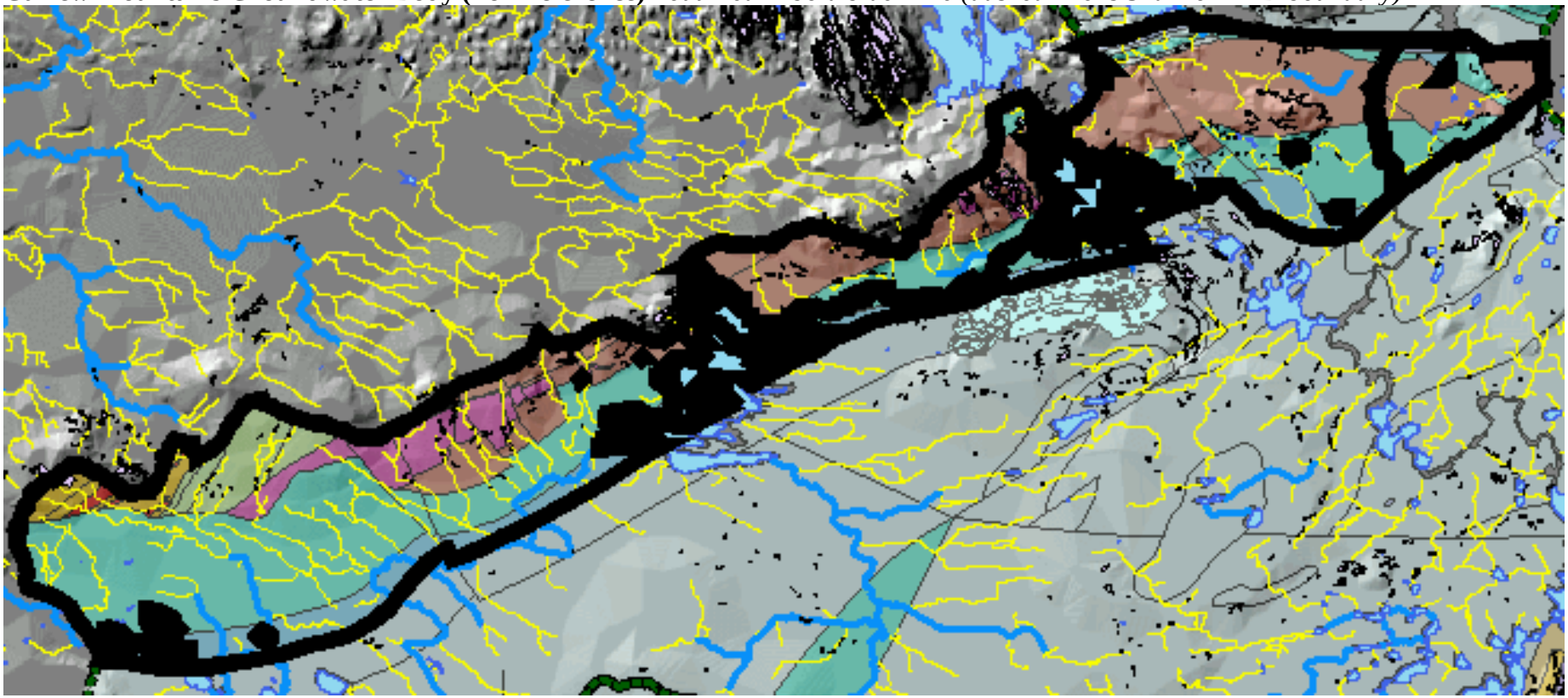
Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
26 – Shannon Upper Roscommon, Mayo, Sligo, Leitrim Co. Co.'s.	Rivers: Annaderryboy, Black, Lung, Boyle, Shannon, Feorish. Streams: Kiltaclare Lissydaly Loughs: Key, Gara, Nanoge, Roe, Adreen, Black, Urlaur and Loughaveenagh.	Lough Gower (000523); Urlaur Lakes (001571); Tullaghanrock Bog (002013); Lough Gara (000587); Corrigeenroe Marsh (000596),	285

Topography	The body occupies a broadly northeast-southwest elongated area running along the southeastern side of the Curlew Mountains. The elevation is highest along the groundwater body boundary in the Curlew Mountains, which are primarily underlain by Devonian Old Red Sandstone, rising to a top elevation of 250 mAOD. The ground elevation decreases to the southeast, towards more low lying regions where ground elevations are typically 70-90 mAOD These low lying regions are underlain by Dinantian Mixed Sandstones, Shales and Limestones (Boyle Sandstone) and Dinantian Impure Limestones (Kilbryan Limestone). In the east of the body, around Lough Key and south of Lough Allen near the rivers Feorish, Shannon and Boyle, ground elevations are less than 40-60 mAOD. Numerous small streams flow south and southeastwards off the Curlew Mountains feeding into the Lung and Boyle rivers which flow along the southeastern edge of the body. The Boyle river connects the large lakes of Lough Gara and Lough Key which occur within the body. At the eastern end of the body the River Shannon flows south from Lough Allen.	
Geology and Aquifers	Aquifer categories	**Ll**: Locally important bedrock aquifer that is moderately productive only in local zones; **Pl:** Poor aquifer which is generally unproductive expcept for local zones; **Lm:** Locally important aquifer which is generally moderately productive. A small isolated area of north east of Lough Key ($1.5km^2$) has an aquifer classification of: **Rk^c** Regionally important karstified aquifer dominated by conduit flow.
	Main aquifer lithologies	Devonian Old Red Sandstones; Dinantian Mixed Sandstones, Shales and Limestones; Dinantian Lower Impure Limestones; Dinantian Shales and Limestones; Dinantian Pure Unbedded Limestones; Silurian Metasediments and Volcanics; Ordovician Volcanics and some very small isolated areas of Granites & other Igneous Intrusive rocks and Dinantian Pure Bedded Limestones.
	Key structures	The Curlews Fault, a major northeast-southwest trending fault which forms the northern margin of the Curlew Mountians Inlier, runs through some areas in the north of the body. The Woodbrook Fault, another major fault roughly parallel to the Curlew Fault, runs along part of the southeastern margin of this body. The Curlew Mountains are crosscut by a series of minor northwest-southeast faults. Deformations associated with these major faults may have resulted in secondary faulting and jointing, locally increasing the permeability of the rock units in this body.
	Key properties	No data on hydrogeological properties specific to this groundwater body are available. Transmissivities ranging from 2-76m^2/d have been recorded in the Boyle Sandstone (Dinantian Mixed Sandstones, Shales and Limestones) with a median value expected to be in the lower end of the range. Typical transmissivities in the Dinantian Lower Impure Limestones are usually in the range from 5-10 m^2/d. Typical transmissivities for the other aquifer lithologies in this groundwater body are expected to be in a similarly low range. The rock units in this groundwater body are not considered to be major aquifers, although there may be local enhancement of permeability due to structural deformation. The storativity of these rocks will be low. The Volcanic rocks that are locally developed within the Keadew Formation could have a higher permeability as has been seen in other Basalts and Volcanic rocks in other parts of Ireland. However due to lack of data relating to exact nature of these units and their hydrogeology, they are included within the Curlew Mountains GWB.
	Thickness	In general, the effective thickness of this aquifer is likely to be about 15 m, comprising a weathered zone of a few metres and a connected fracture zone of up to 10 m below this, although deeper flow can occur in areas which have undergone a higher degree of structural deformation and faulting.
Overlying Strata	Lithologies	*[Information to be added at a later date]*
	Thickness	*[Information to be added at a later date]*
	% area aquifer near surface	*[Information to be added at a later date]*
	Vulnerability	Areas of Extreme vulnerability occur primarily along the northwestern side of the body on the higher ground and south of Lough Key. Areas of High vulnerability occur throughout the body with a significant area in the vicinity of Lough Key. Areas of Low vulnerability become more common moving south into the low-lying areas away from the Curlew Mountains.
Recharge	Main recharge mechanisms	Most recharge is likely to occur in the upland areas in the Curlew Mountains where the subsoil is thinnest. A large number of streams run off the upland areas indicating that the bedrock is of relatively low permeability and much of the potential recharge is rejected. Recharge is of a diffuse nature.
	Est. recharge rates	*[Information to be added at a later date]*
Discharge	Springs and large known abstractions (m^3/d)	Glann GWS (Glentavraun) MAY14 (20 m^3/d)– EPA list of groundwater sources (March 2002). Lyonstown GWS (Rosc. Co.Co.) – supplies two houses – GSI Well Database *[More information to be added at a later date]*

	Main discharge mechanisms	Discharge will occur to the rivers and streams that cross the groundwater body, the rivers Lung and Boyle which flow along the southeastern edge of the groundwater body, and the River Shannon in the east of the body, as well as to Lough Gara and Lough Key. As the rock units in this body are of relatively low permeability baseflow will be generally low. These may also be some small discharge to adjacent regionally important aquifers.
	Hydrochemical Signature	No relevant hydrochemical data are available in this GWB for assessment. In general in Old Red Sandstone and Silurian rocks, groundwaters have moderate hardness, alkalinity and conductivity although the hydrochemistry of the Silurain Metasediments can be quite variable. The groundwater has a calcium-bicarbonate signature. The Old Red Sandstone, Silurian rocks and Ordovician Metatsediments are **siliceous.** The Dinantian Mixed Sandstones, Shales and Limestones and the Dinantian Lower Impure Limestones have a calcium-bicarbonate signature. In the Dinantian Lower Impure Limestones hard to very hard groundwaters (typically ranging between 380–450 mg/l) with high electrical conductivities (650–800 µS/cm) are often observed. Iron and manganese concentrations frequently fluctuate between zero and more than the EU Drinking Water Directive maximum admissible concentrations (MACs). Hydrogen sulphide can often reach unacceptable levels (E.P. Daly, 1982). These components come from the muddy parts of these rock units and reflect both the characteristics of the rock-forming materials and the relatively slow speed of groundwater movement through the fractures in the rock allowing low dissolved oxygen conditions to develop. These Dinantian rocks are **calcareous.**
Groundwater Flow Paths		These rocks are devoid of intergranular permeability; groundwater flow occurs in faults fractures and joints. Due to the low permeability of the rocks in this groundwater body, groundwater flow will be of a local nature. Groundwater flow paths will be short, in general between 30 and 300 m, with groundwater discharging to streams and rivers and locally to Lough Key and Lough Gara in the centre of the body. Groundwater flow will be concentrated in a thin zone at the top of the rock. The low permeability rocks of this groundwater body act as a barrier to flow of groundwater from the Pure Bedded Limestones to the south of the body. Overall, general flow directions will be in a southerly direction away from the mountains towards the more lowlying areas and the rivers Lung and Boyle, and Lough Gara and Lough Key. In the small area of the groundwater body south of the rivers Lung and Boyle overall flow will be northwards towards the river. In the east of the body overall flow direction will be westwards towards the River Shannon. The Dinantian Lower Impure Limestone (Kilbryan Limestone) south of Lough Key is considered to act as a barrier to groundwater flow from the south from the adjoining Pure Bedded Limestones (Carrick on Shannon GWB). Groundwater tracing carried out as part of the Rockingham Spring (Boyle-Ardcarn WSS) Source Protection Report indicates that the low permeability Kilbryan Limestone is likely to be forcing the groundwater in the Pure Bedded Limestones (Oakport Limestone) to move in a south-west to north-east direction, rather than from south to north as suggested by the topography, thus preventing groundwater flow directly towards Lough Key.
Groundwater & Surface water interactions		The rock units in this body are of low permeability and baseflow to rivers and streams is likely to be relatively low.
Conceptual model		• This roughly rectangular northeast-southwest trending groundwater body is bounded to the north, west and east by topographic highs which form the surface water catchment of the Shannon RBD. Part of the northern boundary is formed by the contact with the Pure Bedded Limestones of the Skean Meeglan GWB, while the southern boundary is formed by the contact with the Pure Bedded Limestones of the Carrick on Shannon GWB. The body includes both the upland slopes of the Curlew Mountains and more low-lying areas in the vicinity of Lough Gara and Lough Key. • The groundwater body is composed primarily of low permeability rocks, although localized zones of enhanced permeability do occur in the vicinity of fault zones. Small isolated areas of higher permeability rocks occur within the groundwater body. • Groundwater flow will be concentrated in fractured and weathered zones and in the vicinity of fault zones. • Recharge will occur diffusely though the subsoils and via outcrops, primarily in the upland areas where the suboil is thinnest. The high drainage density in the uplands suggests that a high percentage of potential recharge is rejected. • Groundwater within the body is generally unconfined. Most flow will occur near the surface of the rock. In general, the effective thickness of the aquifer is likely to be not more than 15 m, comprising a weathered zone of a few metres and a connected fracture zone below this. However deeper inflows can occur .Due to the low permeability nature of the rocks in this groundwater body, groundwater flow will be of a local nature. Flow path lengths will be relatively short, and in general are between 30 and 300 m. Local flow directions are controlled by local topography. Overall, groundwater flow within the body will be in a southerly direction away from the mountains towards the low-lying areas, the rivers Lung and Boyle, and Lough Gara and Lough Key. In the east of the body overall flow direction will be towards the River Shannon. • Groundwater discharges to the streams crossing the aquifer, and locally to Lough Gara and Lough Key.
Attachments		None
Instrumentation		Staff Gauge:, Stream gauges: 26108 (Boyle River, Boyle Abbey Bridge); 1155 (Boyle River, Tinacarra); 1208 (L.Gara, Cuppanagh Bridge); 1219 (Lough Gara, Lomcloon); 1238 (Stream, Shannon Side); 1156 (Lung River, Banada); 1157 (Lung River, Banada Bridge), 1286 (Lissydaly Stream, Sonvolaun), 1204 (Lough Nanoge, Nanoge), 1203 (Lough Urlaur, Urlaur Abbey); 26078 (Lough Key, Drumcormick). EPA Water Level Monitoring boreholes: None EPA Representative Monitoring boreholes: None

Information Sources	Lee, M. & Daly D. (2003) *County Roscommon Groundwater Protection Scheme*. Main Report. Roscommon County Council & Geological Survey of Ireland, 54pp. Lee, M. & Kelly C. (2003). Boyle-Ardcarn Water Supply Scheme – Rockingham Spring Source Protection Report. Main Report. Roscommon County Council & Geological Survey of Ireland. 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.* With contributions from K. Carlingbold, G. Stanley, D. Daly and R. Meehan. Geological Survey of Ireland, 100pp. Daly, E.P. (1982) *The Groundwater Resources of the Southeast Industrial Development Region.* Unpublished report, Geological Survey of Ireland, 102 pp. Aquifer Chapters:Devonian Old Red Sandstones, Dinantian Mixed Sandstones, Shales and Limestones, Dinantian Shales and Limestones, Dinantian Pure Unbedded Limestones, Dinantian Lower Impure Limestones, Silurian Metasediments and Volcanics, Ordovician Volcanics, Granites & other Igneous Intrusive rocks, Basalts & other Volcanic rocks
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Curlew Mountains Groundwater Body (For Reference) - *outlined in bold black line (dashed line is Shannon RBD boundary)*



List of Rock units in Curlew Mountains Groundwater Body

Rock unit name and code	Description	Rock unit group
Keadew Formation (KW)	Sandstone & think mudstone	Devonian Old Red Sandstones
Moygara Formation(MG)	Red conglomerate & pebbly sandstone	Devonian Old Red Sandstones
Boyle Sandstone Formation (BO)	Sandstone, siltstone, black mudstone	Dinantian Mixed Sandstones Shales and Limestones
Kilbryan Limestone Formation (KL)	Dark nodular calcarenite & shale	Dinantian Lower Impure Limestones
Greyfield Formation (GF)	Sandstone/limestone breccia, micrite	Dinantian Mixed Sandstones Shales and Limestones
Cloonnamna Formation (CF)	Fossiliferous fine-grained sandstone	Silurian Metasediments and Volcanics
Silurian (undifferentiated)	Grey-green sandstone,siltstone	Silurian Metasediments and Volcanics
Cloonierin Formation (Cl)	Grey sandstone	Silurian Metasediments and Volcanics
Glen School Formation (GS)	Coarse-grained purple sandstone	Silurian Metasediments and Volcanics
Tawnyinagh Formation (Ty)	Tuff & minor chert	Ordovician Volcanics
Carracastle Formation	Intermediate volcanic breccia, tuff	Ordovician Volcanics
Horan Formation (HR)	Basalt, siltstone, chert	Ordovician Volcanics
Feldspar or Quartz Porphy	Feldspar/quartz porphyry	Granites & other Igneous Intrusive rocks
Brockagh Member (KWbk)	Andesitic lava	Basalts and other volcanic rocks
Sheegorey Member (KWsh)	Andesitic pyroclastics, tuff, mudstone	Basalts and other volcanic rocks
Lisgorman Shale Formation (LG)	Thin-bedded calcareous shale, limestone	Dinantian Shales and Limestones
Mudbank Limestones (mk)	Massive grey micritic limestone	Dinantian Pure Unbedded Limestones
Bricklieve Limestone Formation & Mudbank limestone (mkBK)	Bioclastic cherty limestone	Dinantian Pure Unbedded Limestones

NOTES ON GWB DESCRIPTION

NOTES

Lough Gower (MA523); Urlaur Lakes (MA1571); Tullaghanrock Bog (RO2013); Lough Gara (RO587); Corrigeenroe Marsh (RO596),
Curlew Mountains Fault

Keadew/Basalt – approx 15km2

Key properties	Transmissivity values for the rock units in this groundwater body are rare. Typical values for Dinantian Lower Impure Limestones (eg Kilbryan Limestone) range from 5-50 m^2/d, for Dinantian Mixed Sandstones, Shales and Limestones (eg Boyle Sandstone) range from 2-25 m^2/d, for Devonian Old Red Sandstones from 2-100 m^2/d , for Dinantian Pure Unbedded Limestones such as the mudbank limestones from 10-50 m^2/d, for Silurian Metasediments and Volcanics from 20-180 m^2/d. The rock units in this groundwater body are not considered to be major aquifers although there may be local enhancement of permeability due to structural deformation.
Thickness	The Devonian Old Red Sandstones (Keadew and Moygara Formations) are of significant thickness within this groundwater body. The Boyle Sandstone is 130 m thick in the Lough Key area. The Kilbryan Limestone is almost 100m thick near Boyle, Co. Roscommon.

Main aquifer lithologies	Kilbryan Limestone Formation (KL) – Dark nodular calcarenite & shale; Boyle Sandstone Formation (BO) – Sandstone, siltstone, black mudstone; Keadew Formation (KW) – Sandstone & think mudstone; Moygara Formation (MG) – Red conglomerate & pebbly sandstone Mudbank Limestones (mk) – Massive grey micritic limestone; Bricklieve Limestone Formation & Mudbank limestone (mkBK) – Bioclastic cherty limestone; Lisgorman Shale Formation (LG) – Thin-bedded calcareous shale, limestone; Greyfield Formation (GF) – Sandstone/limestone breccia, micrite Cloonnamna Formation (CF) – Fossiliferous fine-grained sandstone; Silurian (undifferentiated) – Grey-green sandstone,siltstone ; Cloonierin Formation (Cl) –Grey sandstone ; Glen School Formation (GS) – Coarse-grained purple sandstone ; Tawnyinagh Formation (Ty) – Tuff & minor chert; Carracastle Formation – Intermediate volcanic breccia, tuff ; Horan Formation (HR) – Basalt, siltstone, chert ; Feldspar or Quartz Porphy – Feldspar/quartz porphyry Brockagh Member (KWbk) – Andesitic lava (Bas); Sheegorey Member (KWsh) – Andesitic pyroclastics, tuff, mudstone Small area of Oakport Limestone Formation (OK) – Dark crinoidal calcarenites and shales

DETAILS

AQUIFER LITHOLOGIES

cg
Pl
– (Sil)
– (Sil)
– (Sil)
– (Sil)
Pl
– (Ord Volc)
– (Ord Volc)
Horan Formation (HR) – Basalt, siltstone, chert (Ord Volc)
Pl
Feldspar or Quartz Porphy – Feldspar/quartz porphyry (Gran & igne)
Lm
Brockagh Member (KWbk) – Andesitic lava (Bas)
Sheegorey Member (KWsh) – Andesitic pyroclastics, tuff, mudstone (Bas)
Ll
Lisgorman Shale Formation (LG) – Thin-bedded calcareous shale, limestone (Din S&Lmst)
Ll
Mudbank Limestones (mk) – Massive grey micritic limestone (Din Pure Unbedded)
Bricklieve Limestone Formation & Mudbank limestone (mkBK) – Bioclastic cherty limestone (Din Pure Unb)

Associated Surface Water Ecosystems
Annaderryboy, Black River, Lissydaly Stream, Kiltaclare Stream, Lung River (Shannon Upr 155a/166 155Lung), Boyle River,(Shannon Upr 155a/160 155Boyle), River Shannon (Shannon Upr 155a/128 upper main channel), Feorish (Ballyfarnon) River (Shannon Upr 155a/143 155Feorish)

Gauges: no gauges with DWF data in GWB.