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Culliagh Beg Sand and Gravel Aquifer Summary of Initial Characterisation



GW3D Project Report TR2023/36
March 2023

Culliagh Beg Sand and Gravel Aquifer Description March 2023

This sand and gravel report forms part of a series representing the output of a body of work undertaken to re-evaluate previously mapped sand and gravel aquifers and to identify new sand and gravel aquifers. This study resulted in the refinement of existing sand and gravel aquifer mapped extents, the modification of some sand and gravel aquifer categories, and the removal of some previously mapped sand and gravel aquifers, as well as identification of new aquifers. In addition to mapping the extent and depths of the sand and gravel aquifers, the investigations consider the hydraulic properties.

The study, undertaken as part of the GW3D project (2015-2019), comprised three parts:

1) Desk study and fieldwork preparation

Sand and gravel bodies above a minimum size criterion were extracted from the GSI Quaternary Sediments 1:50,000 map. Where it was known that the surface expression of the sands and gravels was only a small portion of the subsurface body, such areas were retained. This process left several hundred sand and gravel bodies remaining as a starting point for field work.

2) Fieldwork including mapping and data collection

Field work included a visit to each of the areas which had the potential to be (at least) a Locally Important Sand and Gravel Aquifer owing to its area. In such areas, gravel pits and sand pits were visited and depth and type of sediment recorded, other exposures into the subsurface were visited and logged, wells (whether Public Supply, Group Scheme or private farm or domestic) were dipped and any information on depths recorded, and data was collected where geological and hydrogeological data existed for the area.

3) Data collation, analysis and reporting.

All field data, and information from earlier reports and studies, were compiled and analysed. Where a sand and gravel body had qualifying aquifer properties (either 10 m depth sand and gravel, or 5 m depth saturated sediments), these areas were digitised in a GIS. The aquifer area was then ascertained and drawn up. Such areas formed the basic building blocks for the sand and gravel aquifer map, which included details on the aquifer name, area, aquifer resource value (Rg or Lg), confidence level, county, and any important aspects to note for each body.

The updated mapped sand and gravel aquifers are found on the Geological Survey Ireland site <https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx#Aquifers>

The GW3D Mapping Team involved in the current revision of delineated sand and gravel aquifers were:

Geological Survey Ireland staff:

- Dr. Sophie O'Connor, Groundwater Programme / Land Mapping Unit
- Dr. Sarah Blake, Groundwater Programme

Consultant support:

- Dr. Robbie Meehan, Talamh Ireland
- Coran Kelly, Tobin Consulting Engineers
- Damien Doherty, independent Consultant Geologist/ Tobin Consulting Engineers
- Natalie Duncan, independent Consultant Geologist
- Sara Raymond, independent Consultant Geologist
- James McAteer, Gavin and Doherty Geosolutions



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Culliagh Beg Sand and Gravel Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km ²)
30 - Corrib 32 - Erriff - Clew Bay Galway County Council		Rivers: Joyce's River Streams: Several unnamed streams Lakes: None	None	0.23
Topography	The sand and gravel deposits around Culliagh Beg straddle the watershed between the Joyce's and Lahill Rivers in the Maumturk Mountains, approximately 2 km to 3 km southeast of Leenaun, and extend southwards into the Joyce's River valley. The aquifer body is located within a relatively wide section of the valley floor in the townland of Culliagh Beg (Figure 1). The elevations of the land surface of the sands and gravels range from 50 m to 100 m AOD. The sediments comprise hummocky sands and gravels, and it is considered that the sand and gravels continue beneath the blanket peat which bounds them at their lower perimeter.			
Geology and Aquifers	Aquifer categories	There are hummocky ridges of sands and gravels extending intermittently through the valley southeast of Leenaun, either side of the Joyce's River (Thomas and Chiverell, 2005). The delineated aquifer body contains two of these ridges, which are both considered to have sorted sediments >10 m deep within. Exposures of up to 1.7 m depth into sorted sands and gravels exist in the locality, and a trial hole assessment from the locality shows at least 1.8 m depth to bedrock c. 50 m from the river. Further north, but outside the area delineated as part of this aquifer body, exposures of deep sands and gravels are more common. Proxy groundwater levels were obtained from the stream and river levels, with the assumption that groundwater discharges into these. It is considered that the groundwater level throughout the majority of the sand and gravel body is close to the surface. Based on likely geometry and extent, this deposit is classified as a Locally Important Sand and Gravel Aquifer (Lg) (GSI, 2017). The ssnds and gravels overlie bedrock of Ordovician Metasediments, which is a Poor Bedrock Aquifer (PI) (DELG/EPA/GSI, 1999; GSI, 2017).		
	Main aquifer lithologies	Glaciofluvial sands and gravels derived chiefly from metamorphic rocks (GMp; GSI, 2023b).		
	Key structures	Exposures in the western portion of the body show rounded to subrounded, poorly sorted sands and gravels. In the north, exposures of coarse sands and subangular to subrounded gravels are evident. The exposures show little bedding, most probably due to the limited depth of exposure in their faces.		
	Key properties	There are no known data from this sand and gravel body on yields, permeabilities or transmissivities. Sand and gravel aquifers generally consist of unconsolidated coarse grained material, usually containing less than 8% fines (Ó'Súilleabháin, 2000). Typically transmissivity ranges from 200 – 1500 m ² /d (Kelly et al., 2015). Specific yield is expected to be high (10%). Groundwater is considered to be unconfined within the aquifer at Culliagh Beg. The data are inadequate to calculate groundwater gradients, but these are expected to be relatively flat, in the order of 0.001, and typical of sand and gravel aquifers.		
	Thickness	The Culliagh Beg body contains two sand and gravel ridges, which host sorted sediments considered to be >10 m deep from geomorphological analysis. Exposures of up to 0.7 m depth of sands and gravels exist in the locality. A trial hole assessment c. 50 m from the Joyce's River shows at least 1.8 m depth to bedrock. Further north, outside the area delineated as part of this aquifer, but within the same sand and gravel body, depths of exposed sands and gravels are interpreted as much deeper.		
Overlying Strata	Lithologies	Glaciofluvial sands and gravels, with relatively large portions covered by blanket peat.		
	Thickness	Exposures show <3 m depth of overlying blanket peat, where present.		
	% area aquifer near surface	Approximately 34% of the aquifer area has sands and gravels just below the surface.		
	Vulnerability	The groundwater vulnerability of the sand and gravel aquifer is 'Extreme' where the water table is <3 m from the surface, whereas in all other areas where the water table is >3 m from surface, the vulnerability is classed as 'High'. Extreme vulnerability occurs over approximately 82% of the aquifer area at Culliagh Beg.		



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Recharge	Main recharge mechanisms	Diffuse recharge occurs <i>via</i> rainfall percolating through the unsaturated sands and gravels. Due to the high permeability of sand and gravel, a high proportion of the available recharge will percolate down to the water table where sands and gravels are at surface. The rates of recharge will be significantly less where blanket peat overlies these. A significant amount of rejected recharge enters the aquifer from the adjacent mountains at Munterowen West and Munterowen East.
	Est. recharge rates	Recharge to the aquifer is estimated at 518 mm/yr, based on an average annual rainfall of 2,633 mm/yr (Walsh, 2012). This gives a minimum direct throughput of only 83 m ³ /d, which rises to a potential 1,606 m ³ /d when rejected recharge is included. It must be noted that there is likely to be an element of seasonal variability associated with this.
Discharge	Large springs and large known abstractions (m ³ /d)	There are no known large springs or abstractions from this aquifer body.
	Main discharge mechanisms	Groundwater discharges <i>via</i> seeps and springs, as well as directly to the Joyce's River and adjacent small streams.
	Hydrochemical Signature	There are no data readily available to assess the hydrochemistry of this aquifer, but given the bedrock and subsoils geology of the area, it is expected that the hydrochemical signature is of calcium magnesium bicarbonate (CaMg HCO ₃).
Groundwater Flow Paths		The length of flow paths depend on the size of the sand and gravel deposit. In general, locally important sand and gravel aquifers are expected to have relatively short flow paths, i.e., up to several hundred metres. This is also expected to be the case at Culliagh Beg, given the topography of the area and the stream pattern.
Groundwater & Surface water interactions		Groundwater is expected to discharge to the streams and rivers, and hydraulic connection between the groundwater in the aquifer and the adjacent streams and rivers is expected to be high.
Conceptual model	- The Culliagh Beg Sand and Gravel Aquifer consists of glaciofluvial sands and gravels, made up of hummocky sands and gravels derived chiefly from metamorphic rocks (Gmp). - The deposits are situated within the Joyce's River valley to the south of Leenaun, at elevations between 50 m and 100 m AOD, and they onlap onto mountains to their west. - The aquifer is covered with relatively extensive belts of blanket peat, which covers approximately 66% of the area of the aquifer body. - The subsoils overlie bedrock of Ordovician Metasediments, which is classified as a Poor Bedrock Aquifer (PI). - The aquifer is inferred to be greater than 10 m thick over much of its extent, with c. 26% of the aquifer estimated as having ≥5 m depth sand and gravel saturation. - Across approximately 82% of the aquifer area, groundwater levels are <3 m below ground level. - The length of groundwater flow paths is expected to be in the order of a few hundred metres. - Groundwater discharges <i>via</i> seeps and springs to Joyce's River and to several unnamed streams. - Diffuse recharge occurs <i>via</i> rainfall percolating through the unsaturated sands and gravels. Recharge to the aquifer is estimated as 518 mm/yr. - This gives a minimum direct throughput of 83 m³/d, which rises to a potential 1,606 m³/d when rejected recharge is included. It must be noted that there is likely to be an element of seasonal variability associated with this.	
Attachments	Figure 1: Location and extent Figure 2: Cross section Figure 3: Groundwater vulnerability	
Instrumentation	Hydrometric gauges: National Water Monitoring Stations; River: Groundwater:	None present RS31C430010 15 m d/s bridge None present

Cullagh Beg Sand and Gravel Aquifer Description March 2023

Information Sources	• DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland. • EPA (2023). Environmental Protection Agency Map Viewer. https://gis.epa.ie/EPAMaps. • GSI (2017). A description of Irish aquifer categories. 3 pp. Available from: https://www.gsi.ie/documents/GSI%20Aquifer%20Category%20Descriptions.pdf • GSI (2023a). Geological Survey Ireland internal groundwater database. • GSI (2023b). Geological Survey Ireland Map Viewer. https://www.gsi.ie/en-ie/data-and-maps • Kelly, C., Hunter Williams, T., Misstear, B.M. and Motherway, K. (2015). Irish Aquifer Properties – A reference manual and guide. Prepared on behalf of the Geological Survey of Ireland and the Environmental Protection Agency. 110 pp. • NPWS (2023). National Parks and Wildlife Service Map Viewer. http://webgis.npws.ie/npwsvviewer • Ó'Suilleabháin, C. (2000). Assessing the boundary between high and moderately permeable subsoils. Unpublished MSc., University of Dublin. Department of Civil, Structural and Environmental Engineering, Trinity College Dublin. • Thomas, G. and Chiverrell, R. (2005). Leenaun. In: Coxon, P. (Ed.) <i>The Quaternary of Central Western Ireland</i>. Field Guide, Quaternary Research Association, London. pp. 172-178. • Walsh, S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin.
Disclaimer	Note that all calculations and interpretations presented in this report represent estimations and assumptions based on the information sources described above and established hydrogeological formulae. Figures 1, 2 and 3 are used for illustrative purposes only.

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Culliagh Beg Sand and Gravel Aquifer

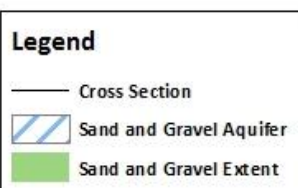
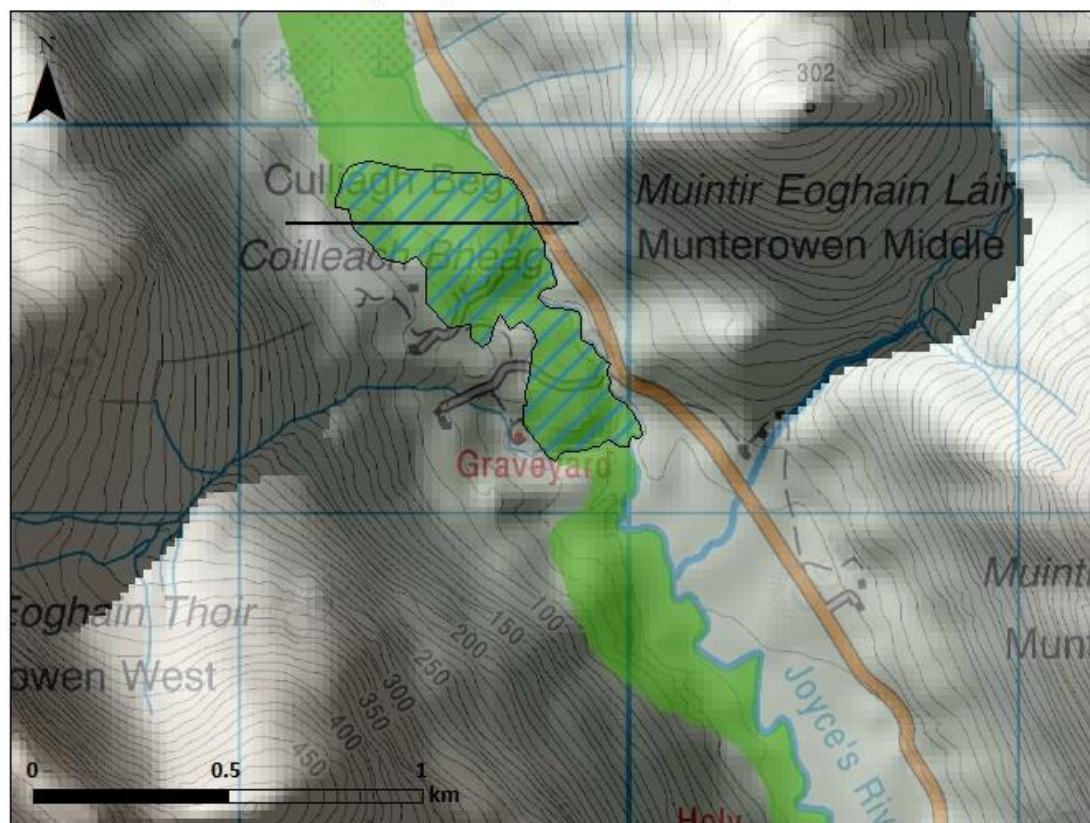
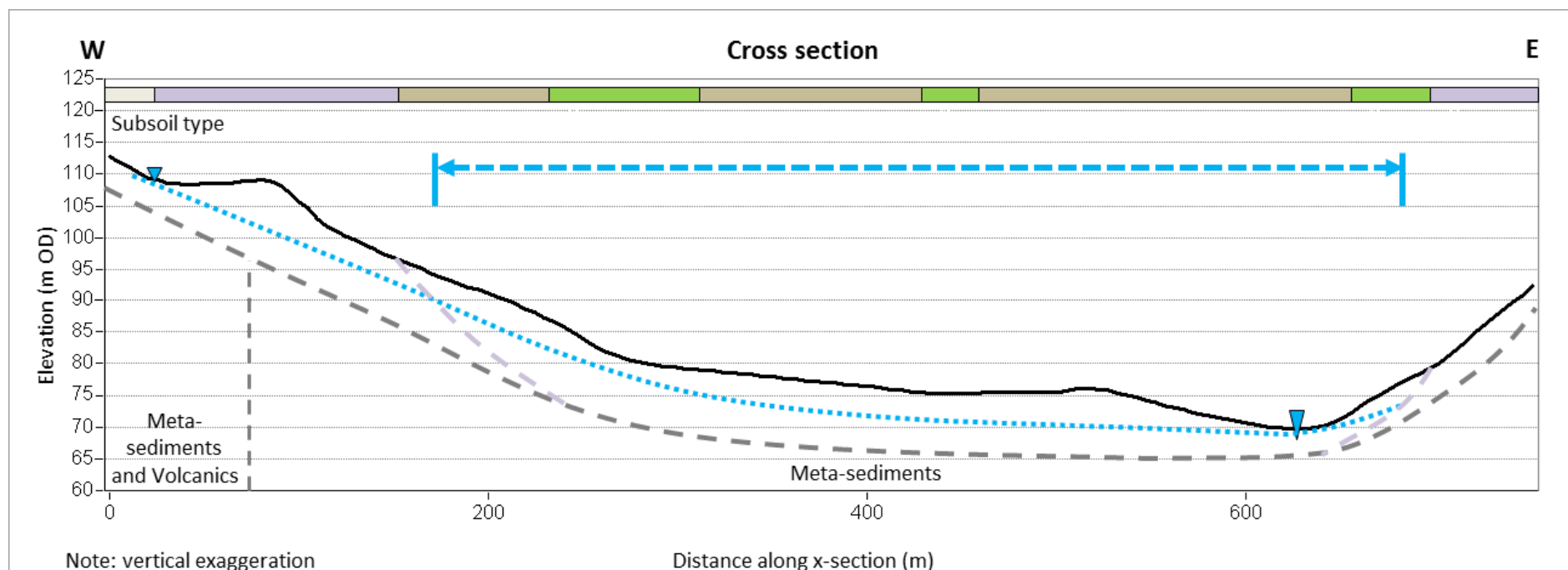


Figure 1: Culliagh Beg Sand and Gravel Aquifer extent with cross section location.

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LEGEND			
Feature		Subsoil Type	
Topography		Sands and gravels	
Groundwater level		Esker	
Top of bedrock		Windblown sands	
Borehole/Trial Pit		Till	
Dug well		Peat	
S&G exposure		Rock outcrop	
Active quarry		Alluvium	
Freshwater lake		Lake sediments	
GW Ponding		Top of S&G	
River		Top of till	
Stream/drainage channel		Karst Feature	
Spring		Spring	
Aquifer envelope		Turlough	

Figure 2: Cross section through the Culliagh Beg Sand and Gravel Aquifer body.

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Culliagh Beg Sand and Gravel Aquifer Vulnerability

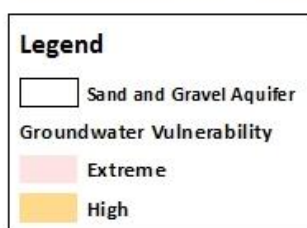
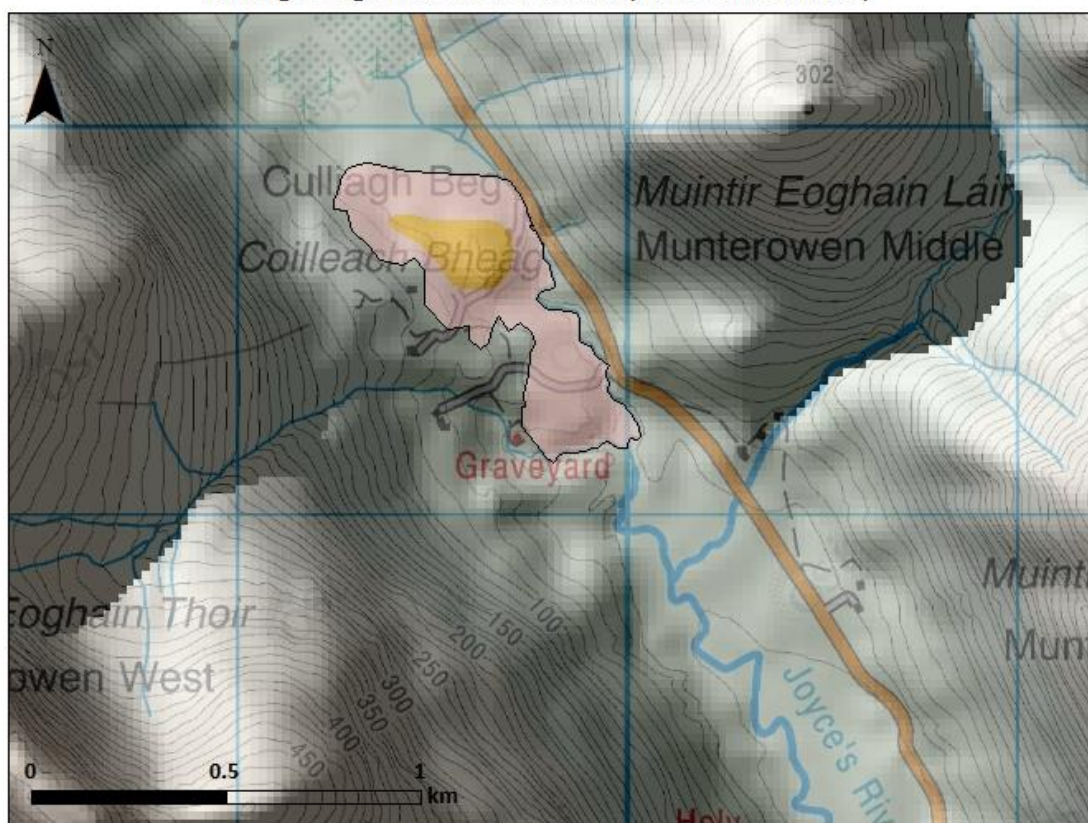


Figure 3: Groundwater vulnerability across the Culliagh Beg Sand and Gravel Aquifer.