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Broadford Sand and Gravel Aquifer Summary of Initial Characterisation



GW3D Project Report TR2023/02
January 2023

Broadford Sand and Gravel Aquifer Description January 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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Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km ²)
27 – Shannon Estuary North Clare County Council		Rivers: Broadford River, Glenomra River Streams: Gortnagonnella Stream, Ardskeagh Stream, Crean Stream, Barbane Stream, O'Shea's Acres Stream, several unnamed streams Lakes: None	Doon Lough NHA	3.51
Topography	The Broadford sand and gravel aquifer is located at the northern end of the Glenomra Valley, around the village of Broadford (Figure 1). The aquifer extends along the Broadford River valley floor, for a length of approx. 6 km. The deposit is significantly hummocky, and is found at elevations between 23 m and 79 m AOD. The highest elevations are present on the eastern side of the aquifer and high mountain ridges flank either side of the body here, with Seefin risings to 296 m AOD on the southern side, and the Slieve Bearnagh range rising to 335 m AOD at the north.			
Geology and Aquifers	Aquifer categories	There are nine geotechnical data points available from within, and adjacent, to the sand and gravel body. The aquifer is considered to be unconfined and exceeds the groundwater throughput threshold of 1,000 m ³ /d, with rejected recharge contributing significantly to the throughput. Based on its areal extent, inferred thickness, inferred saturated thickness, groundwater throughput and position in the landscape the deposit is classified as Locally Important Sand and Gravel Aquifer (Lg) (DELG/EPA/GSI, 1999; GSI, 2017).		
	Main aquifer lithologies	Hummocky, glaciofluvial sands and gravels derived chiefly from Lower Palaeozoic and Devonian sandstones (GLPDSs).		
	Key structures	In general, exposure is poor within this sand and gravel aquifer, with no good profiles of sand and gravel seen in either of the two small, disused pits within the body.		
	Key properties	Groundwater level data is relatively abundant from within the area of the aquifer, with eight groundwater level data points available, three of which were collected during fieldwork for this project. Desk study data suggests that at least 5 m depth of saturated sand and gravel is present in three boreholes, with 6.8 m depth of GRAVEL identified at Broadford Village (GSI, 2023; Figure 2). Particle size distribution analysis is available from samples taken from the borehole at Broadford Village, and samples at 3 m and 6 m depth below ground level, both have less than 5% fines (GSI, 2023). Using these data, along with water levels from streams and rivers, it has been inferred that approx. 26% of the aquifer area has greater than 5m depth of saturated sand and gravel. In general, sand and gravel aquifers consist of unconsolidated coarse grained material, usually containing less than 8% fines (Ó'Súilleabháin, 2000).		
	Thickness	The thickness of the deposits varies throughout the aquifer, and proven depth to bedrock ranges from 4.3 m to 24.4 m below ground level at Cloongaheen West and Cloongaheen East Townlands respectively. Two boreholes along the base of the valley have records of subsoils which are greater than 10 m thick. In general, the thicknesses are expected to be greater than 10 m throughout the aquifer, except along the base mountain slopes on both the northern and southern fringes of the body.		
Overlying Strata	Lithologies	Approximately 40% of the aquifer is overlain with cutover raised peat and/or alluvium, with sand and gravel assumed beneath.		
	Thickness	The thickness of the cutover raised peat has been measured at 0.4 m at Doon Townland, and the thickness of the alluvium has been measured at 2.9 m at Coolagh Townland (GSI, 2023). The thickness of these overlying strata is expected to be less than 3 m throughout the remainder of their area.		
	% area aquifer near surface	Approximately 60% of the sand and gravel aquifer is at the surface, with the remainder beneath the overlying strata.		



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	Vulnerability	The groundwater vulnerability of the sand and gravel is 'Extreme' where the water table is inferred to be < 3 m from the surface; this accounts for 52% of the aquifer area. In all other areas where the water table is at depths > 3 m, the vulnerability is classed as 'High' (48% of the aquifer area, Figure 3).
Recharge	Main recharge mechanisms	Diffuse recharge occurs <i>via</i> rainfall percolating through the unsaturated sand and gravel. Due to the high permeability of sand and gravel, a high proportion of the available recharge will percolate down to the water table. In the areas of the aquifer covered by overlying strata, a much lower proportion of the available recharge will percolate downwards. Rejected recharge from the surrounding Poor Bedrock Aquifer (PI) at higher elevations increases the groundwater throughput in the aquifer.
	Est. recharge rates	The annual average rainfall for the aquifer is 1,321 mm (Walsh, 2012), thus providing an estimated diffuse groundwater recharge of 420 mm/yr. The minimum direct groundwater throughput in the aquifer is estimated to be 1,061 m ³ /d, which increases to a potential 8,868 m ³ /d when rejected recharge is included.
Discharge	Large springs and large known abstractions (m³/d)	There are no known large springs or abstractions from this aquifer, though some small springs and rises are seen in the eastern end of the aquifer body on the OSI 6 inch raster map (1830s -1930s).
	Main discharge mechanisms	Groundwater is expected to discharge into the Broadford and Glenomra Rivers and their tributaries. Some small lowlying springs are also seen on OSI 6 inch raster map (1830s -1930s), at Barbane and Gortnagonnella Townlands.
	Hydrochemical Signature	There are no data readily available to assess the hydrochemistry of this aquifer, but the groundwater is likely to have a calcium bicarbonate (CaHCO ₃) signature.
Groundwater Flow Paths		The length of flow paths depend on the extent of the sand and gravel deposit. Based on the geomorphology of the sand and gravel aquifer and the pattern of streams within it, the flow paths are not expected to exceed a few hundred metres.
Groundwater & Surface water interactions		Groundwater has been seen to discharge <i>via</i> lowlying springs at Barbane and Gortnagonnella Townlands and therefore connectivity between groundwater and surface water is high.
Conceptual model	- The deposit is significantly hummocky, and is found at elevations between 23 m and 79 m AOD, and follows the path of the Broadford and Glenomra Rivers within the base of the Glenomra Valley. - Sand and gravel thicknesses are proven to be at least 7 m at Coolagh Townland (GSI, 2023), along the path of the Broadford River. - Particle size distribution analysis of samples taken from a borehole in Broadford Village (GSI, 2023) identifies less than 5% fines at 3 m and 6 m depths below ground level. - Approximately 26% of the aquifer is inferred to have a depth of saturated sand and gravel greater than 5 m. The remainder of the aquifer is inferred to have a saturated thickness less than this. - Approximately 40% of the aquifer area is overlain with cutover raised peat and/or alluvium; with sand and gravel assumed beneath. - An area of 3.36 km² of rejected recharge from the surrounding Poor Bedrock Aquifer (PI) contributes significant groundwater recharge into the aquifer body. - The minimum direct groundwater throughput in the aquifer is estimated to be 1,061 m³/d, which increases to a potential 8,868 m³/d when rejected recharge is included.	
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 RS27B020700 (Broadford) RS27B020600 (Near Graffa Bridge) None present



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Information Sources	• DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey Ireland. • EPA 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 (2023). Geological Survey Ireland, Internal geotechnical borehole databases. • NPWS viewer. http://webgis.npws.ie/npwsviewer/ • Ó'Súilleabháin, 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. • Walsh, S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin.
Disclaimer	Note that all calculation 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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Broadford Sand and Gravel Aquifer

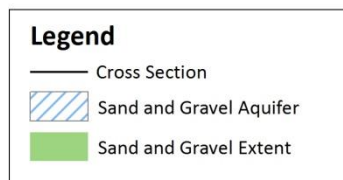
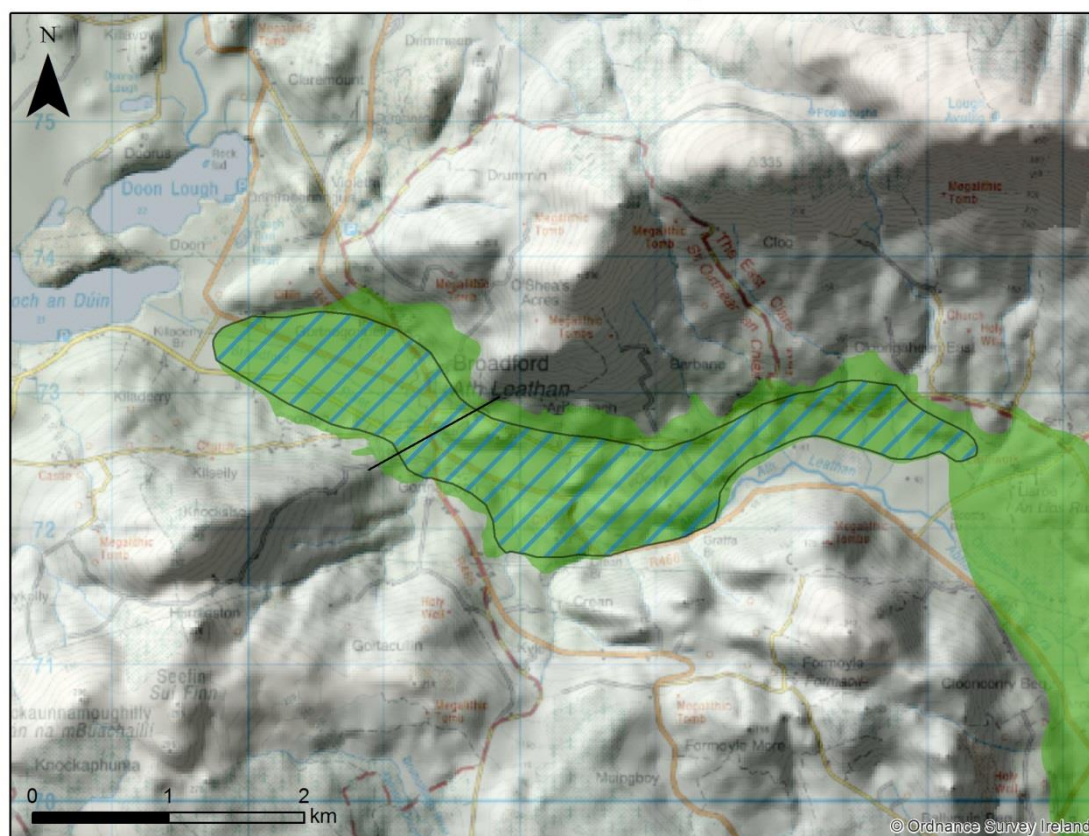


Figure 1: Broadford Sand and Gravel Aquifer extent with cross section location.

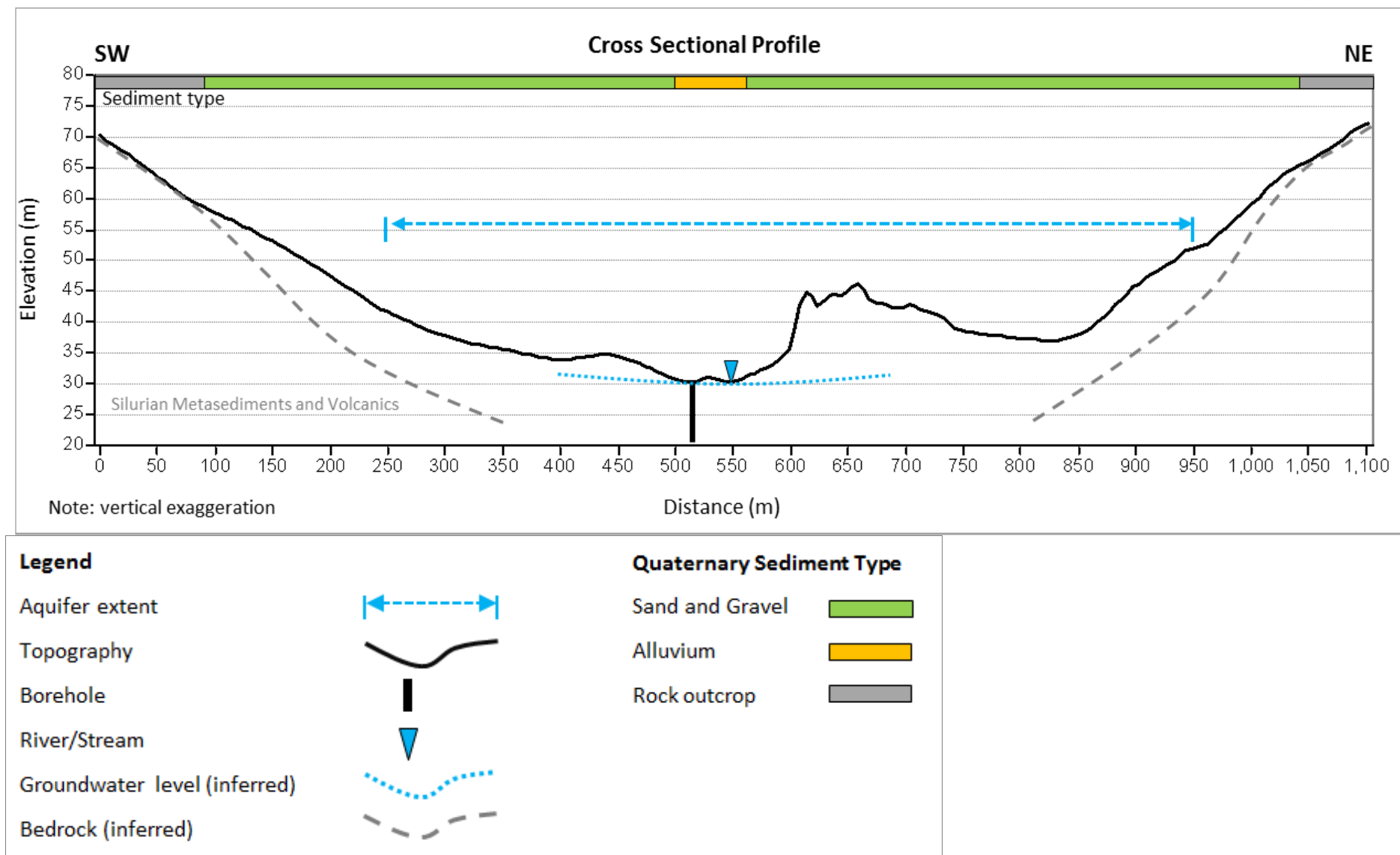


Figure 2: Cross section through the Broadford Sand and Gravel Aquifer body.

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Broadford Sand and Gravel Aquifer Vulnerability

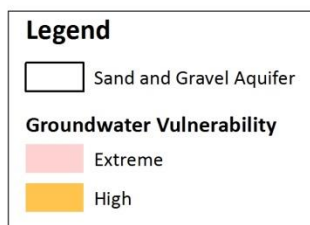
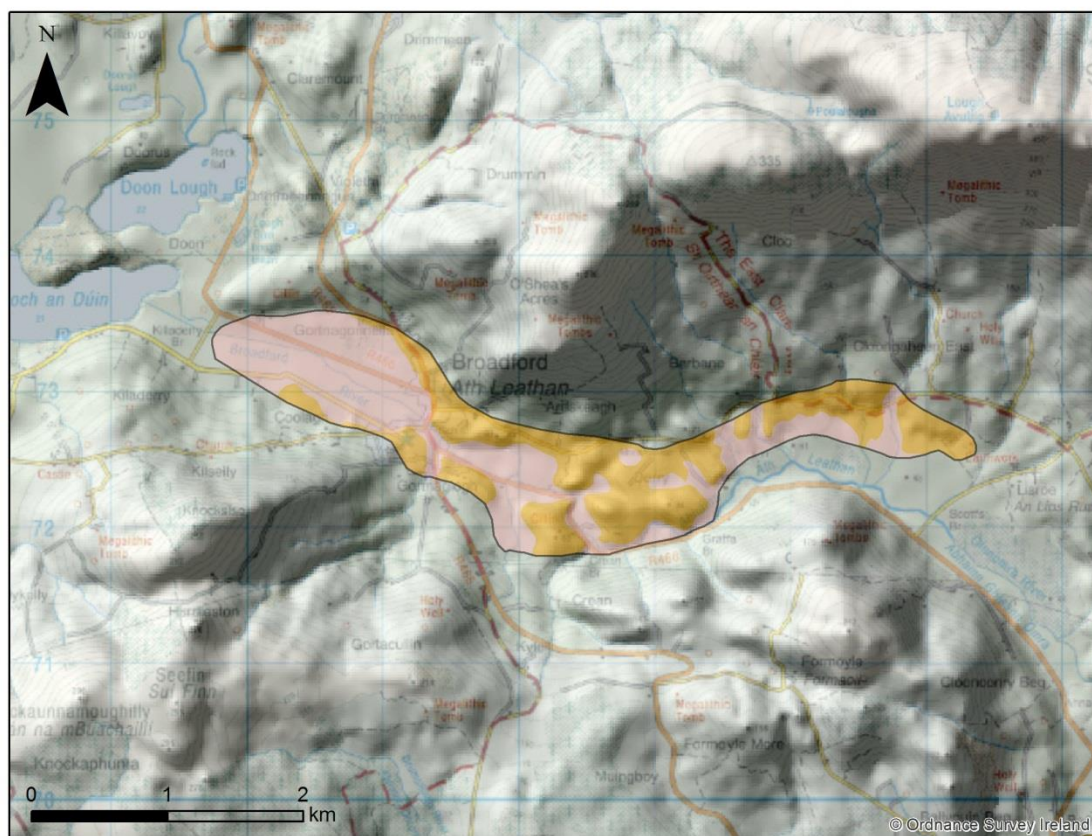


Figure 3: Groundwater vulnerability across the Broadford Sand and Gravel Aquifer.