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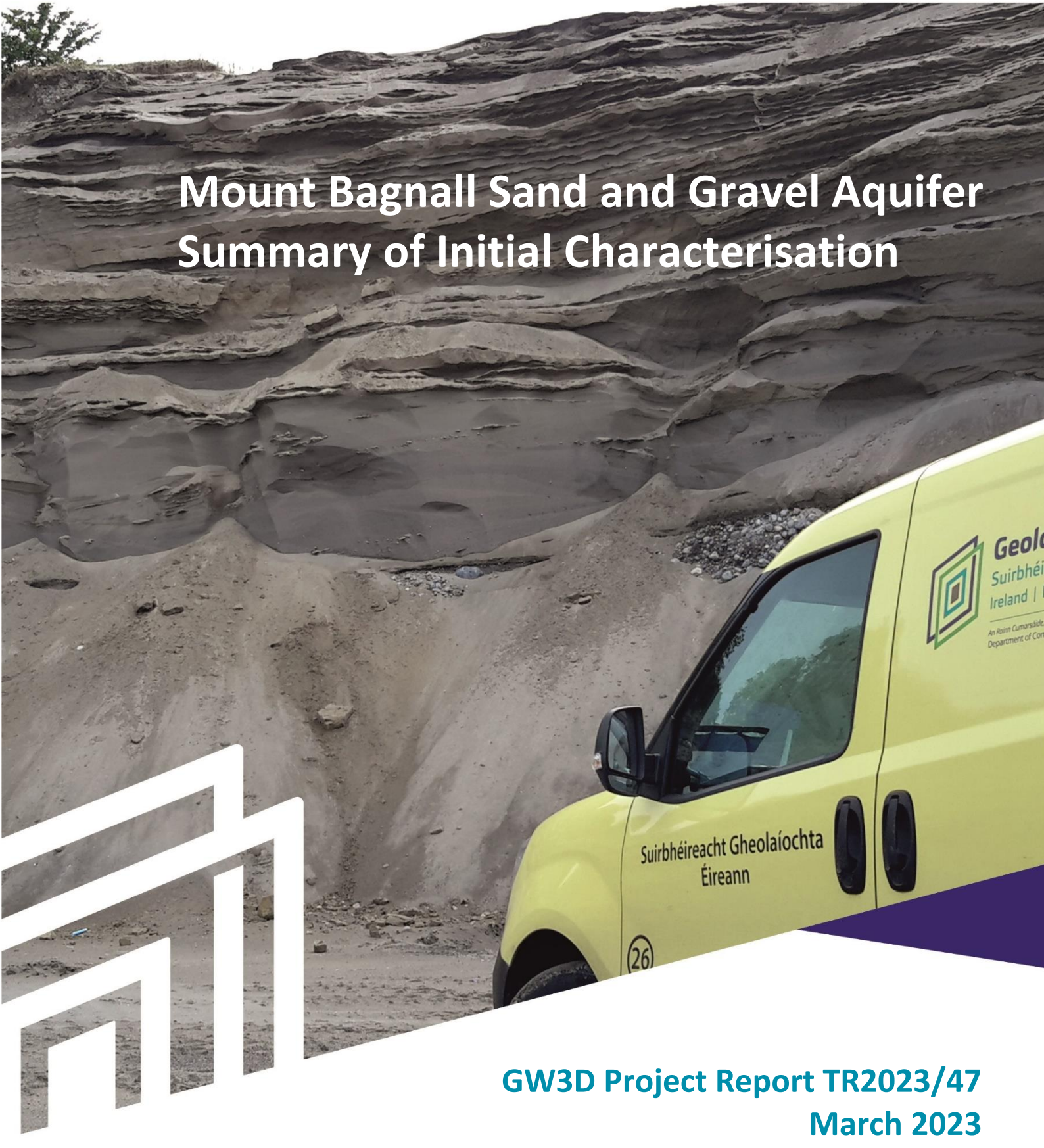

Mount Bagnall Sand and Gravel Aquifer
Summary of Initial Characterisation

GW3D Project Report TR2023/47
March 2023

Geological Survey Ireland is a division of the Department of the Environment, Climate and Communications

Mount Bagnall 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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Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
06 - Newry, Fane, Glyde and Dee Louth County Council	**Rivers:** Castletown (or Piedmont) River **Streams:** Several unnamed streams **Lakes:** Lough Anmore, Lough Anmoney, several other unnamed ponds	Dundalk Bay SAC Dundalk Bay SPA Dundalk Bay pNHA	4.5

Topography	The Mountbagnall sand and gravel aquifer is situated along the southern side of the Cooley Peninsula, northeast of Dundalk (Figure 1). To the northwest, at Slievenaglogh, bedrock outcrops through till deposits. To the south the aquifer is bounded by Dundalk Bay and the Irish Sea. Elevations across the body vary between sea level and 30 m AOD. This area has been quarried extensively, which has changed the microtopography of the deposit over time. The Castletown River flows from north to south through the eastern end of the deposit.	
Geology and Aquifers	**Aquifer categories**	The Mountbagnall sand and gravel body is confirmed to be greater than 10 m in thickness and has a saturated thickness greater than 5 m. The thickness, saturated thickness and areal extent satisfy the criteria of a **Locally Important Sand and Gravel Aquifer (Lg**) (DELG/EPA/GSI, 1999; GSI, 2017).
	Main aquifer lithologies	This aquifer is comprised of glaciofluvial sands and gravels derived chiefly from granites (GGr; GSI, 2023a).
	Key structures	The deposit is comprised of hummocky moraine (McCabe, 2008). Borehole logs (GSI, 2023b) show the variability of the subsoil material which consists largely of sands and gravels, with occasional low permeability horizons. These logs also record till deposits underlying the sands and gravels. The bedrock beneath the Quaternary subsoils is undifferentiated in terms of its exact lithology, but is dominated by limestones, and is classified as a Locally Important Aquifer (GSI, 2023a).
	Key properties	The hummocky sands and gravels are thickly bedded, as seen in pit exposures, with successions of thick, clean gravel interbedded with well sorted SAND units. Low permeability horizons are observed as occurring infrequently in pits throughout the area of the sand and gravel, and occasionally at the surface (GW3D Fieldwork, 2016). These layers may locally confine the sands and gravels. In Riverstown and Loughanmore Townlands, boreholes were drilled in 2007 for Louth County Council (Teillard, 2007). The Riverstown borehole records the presence of highly variable grain sizes in the layered subsoil, including interbedded 'cobbly sandy GRAVEL', pure 'clay' layers, 'gravelly CLAY' and 'SAND' in geotechinical logs. The Loughanmore borehole geotechnical log records the presence of 'clayey sandy GRAVEL', 'silty sandy gravelly CLAY' and 'sandy cobbly GRAVEL'. Borehole and pit logging data suggest that coarse material predominates, and therefore permeability and storativity are expected to be high. The transmissivity of the aquifer is estimated to be 1,000m^2/day, with a specific yield of 0.1 (An Forás Forbartha and GSI, 1982). The estimated annual renewable groundwater resource for the Cooley Drift area (which includes a number of other sand and gravel deposits) was calculated to be on average 30 to 75 x 10^6 m^3/year (An Forás Forbartha and GSI, 1982). This value is based on an average saturated thickness of 10 m to 30 m, and an areal extent of 30 km^2. The continual quarrying activity within the aquifer since the NERDO report was completed may have reduced the saturated thickness of the aquifer and these data may therefore no longer be valid. A revision of this calculation using the data currently available suggests that the average saturated thickness is estimated as only 10 m, with an areal extent of 4.5 km^2. This gives a revised estimation of the annual renewable groundwater resources of 4.5 x 10^6 m^3/year. In Riverstown, Teillard (2007) measured inflows from "shallow perched" water tables and estimated yields that fell into the category of 'Good' yields. In Loughanmore, Teillard (2007) encountered "dry sand and gravel" during drilling, with no significant inflows encountered in the subsoils. The static water table was measured to be 30 m bgl here, and close to bedrock. The water level in this Loughanmore borehole was measured during GW3D Fieldwork (2016) and the level was found to be much higher, at 11 m bgl. This suggests that saturated zone has deepened over time.

		The delay in inflow to the borehole may be due to the relative low permeability of the material. This highlights the variability of the aquifer material, and therefore of transmissivity and yield. Daly and O'Connell (2013), using Tellus Airborne Geophysical Survey AEM data, observed that there is evidence of 'possible saline influence into the gravels' along the Dundalk Bay coast.
	Thickness	According to the NERDO report (An Forás Forbartha and GSI, 1982) the sands and gravels are at least 20 m thick over half of their extent. The greatest thickness of sands and gravels recorded in this deposit is 36.6 m, where bedrock was not met in the borehole (GSI 2023b).
Overlying Strata	**Lithologies**	Mostly sands and gravels at surface, with relatively small portions of land within the delineated aquifer area covered by alluvium.
	Thickness	Where present the alluvium is expected to be relatively shallow (<2 m deep).
	% area aquifer near surface	Approximately 97% of the area of the sand and gravel body has sands and gravels just below the surface.
	Vulnerability	Most of the aquifer is at the surface and therefore vulnerable; consequently, pollutants can easily infiltrate the aquifer. Sand and gravel aquifers are categorised as having either 'High or 'Extreme' vulnerability (DELG/EPA/GSI, 1999), with the vulnerability classification determined by the depth to the water table from ground level. Measured water levels at Mountbagnall range from 8 m to 18 m below ground level. In areas where the water table is less than 3 m below ground level the aquifer vulnerability is mapped as 'Extreme' and where it is greater than 3 m below ground level the aquifer vulnerability is mapped as 'High'. Quarrying activities have removed the covering unsaturated sediments above the water table in many localities within this aquifer body; this therefore increases the vulnerability of these localities to 'Extreme', as the water table is interpreted as being less than 3 m from the surface. Where rivers flowing through the aquifer are thought to be in hydraulic connectivity with the groundwater, the surrounding areas are also classified also as having 'Extreme' vulnerability ratings.
Recharge	**Main recharge mechanisms**	The aquifer receives both direct and indirect recharge (An Forás Forbartha and GSI, 1982). Groundwater recharges directly as precipitation filters through the unsaturated zone. The aquifer area is also expected to receive rejected recharge from elevated areas to the north.
	Est. recharge rates	The rainfall in the area of the Mountbagnall sands and gravels is 940 mm (Walsh, 2012), and the estimated recharge rate to the aquifer from direct recharge is 295 mm/yr. The minimum direct groundwater throughput in the aquifer at Mountbagnall is consequently estimated to be 2,038 m^3/d, which rises to a minimum potential 5,107 m^3/d when rejected recharge from the Slievenaglogh and the other hills at the north is included.
Discharge	**Large springs and large known abstractions (m^3/d)**	There are no recorded large springs or abstractions from this aquifer body. However, there are a number of recorded yields which range from 21.8 (GSI, 2023b) to 380 m^3/d (Teillard, 2007). In Riverstown, Teillard (2007) measured inflows to a borehole at two gravel layers within the aquifer and found at an estimated yield of 380 m^3/d at 1.8 m bgl, but the inflow was estimated to provide a yield of 170-190 m^3/d in the same borehole at 22.86 m depth. In Loughanmore, Teillard (2007) found "no significant inflows" from the subsoil to the borehole, but untested inflow has occurred here since drilling.
	Main discharge mechanisms	The aquifer is thought to discharge along the coastline and to springs, and is considered to be in hydraulic connectivity with the undifferentiated limestone bedrock beneath.
	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 signature.
Groundwater Flow Paths		In general, locally important sand and gravel aquifers are expected to have relatively short flow paths due to the restricted lateral extent of the aquifer body; this is also likely to be the case at Mountbagnall, given the spatial extent and geometry of the sand and gravel body.
Groundwater & Surface water interactions		Hydraulic connection between the groundwater and surface water is expected to be high at discharge zones, such as along the coast and along the Castletown River, and where springs rise.

Mount Bagnall Sand and Gravel Aquifer Description March 2023

Conceptual model	• This Locally Important Sand and Gravel Aquifer has an area of 4.5 km^2 and is situated as a narrow, east-west strip along the southern portion of the Cooley Peninsula. • The hummocky sands and gravels were deposited from outwash as glaciers retreated to the northwest (An Forás Forbartha and GSI, 1982). • The boundaries of the aquifer are delimited to the north by till deposits at higher elevations, and to the south by the sea. • This is an extensive sand and gravel body which is recorded as reaching over 30 m in thickness, and the delineated aquifer is generally underlain by till deposits. Depth to bedrock is variable. • The average saturated thickness is estimated to be 10 m. The aquifer is general unconfined, but layers may be locally confined where overlying clay is present. • The dominant sediments are clean, permeable GRAVEL with sand and occasional clay layers. • Yields recorded within the aquifer vary considerably. The transmissivity of the aquifer is expected to be high. • This aquifer receives direct recharge from precipitation and indirect rejected recharge from the less permeable slopes to the north. Groundwater recharges directly as water percolated through the unsaturated zone to the water table. Groundwater is not expected to be retained in the sediment but rather to flow quickly to discharge zones along the coast; this may contribute to some of the relatively low yields recorded in this aquifer. • The groundwater gradient is interpreted as being shallow. • The abstraction of sand and gravel seems to have degraded the aquifer, as quarrying is thought to have reduced recharge to the aquifer by backfilling quarries with less permeable material, thus lowering the water table and possibly reducing yields. • The minimum direct groundwater throughput in the aquifer at Mountbagnall is estimated to be 2,038 m^3/d, which rises to a minimum potential 5,107 m^3/d when rejected recharge from the hills at the north is included.
Attachments	Figure 1: Location and extent Figure 2: Cross sections Figure 3: Groundwater vulnerability
Instrumentation	**Hydrometric gauges:** 06062 Giles Quay **National Water Monitoring Stations;** **River:** RS06B010400 BIG (LOUTH) - 0.5km d/s Riverstown Br **Groundwater:** None present
Information Sources	• An Forás Forbatha and Geological Survey Office (1982). Groundwater Resources in the N.E.(R.D.O). Region. March 1982. Volumes 1 to 3. • Daly, E.P. (1980). An Interim Report on the Cooley Peninsula Sands and Gravels. Unpublished Internal Report, Groundwater Section, Geological Survey of Ireland. • DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of 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 (2023a). Geological Survey Ireland Spatial Resources Viewer. https://www.gsi.ie/en-ie/data-and-maps/Pages • GSI (2023b). Geological Survey Ireland. Internal Groundwater Database • McCabe, A.M (2008). Glacial Geology and Geomorphology: The Landscapes of Ireland. Dunedin Academic Press, Edinburgh. • Murphy, O. (2012). County Louth Groundwater Protection Scheme. Report to Louth County Council. Geological Survey of Ireland. • NPWS viewer. http://webgis.npws.ie/npwsviewer/ • O' Riain, G. (2004). Water Dependent Ecosystems and Subtypes Draft Report. WFD Support Projects. Compass Informatics in association with National Wildlife and Parks Service (DEHLG). • Robinson, K.W. (1973). A Resistivity Survey on the Cooley Peninsula Co. Louth for the Hydrogeology section. Unpublished MSc. Thesis, Trinity College Dublin.

Information Sources (contd.)	• Teillard., B. (2007). Results of Geophysical Investigation Carried out at Loughanmore and Riverstown,Cooley Peninsula,Co. Louth. BMA GeoServices. • Walsh S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin. • Wright G.R., Aldwell C.R., Daly, D. and Daly, E.P. (1982). Groundwater resources in the Republic ofIreland, vol 6. In: European community's atlas of groundwater resources, SDG, Hannover, Germany.
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.

Mountbagnall Sand and Gravel Aquifer

Legend

- Cross Section
- Sand and Gravel Aquifer
- Sand and Gravel Extent

Figure 1. Mountbagnall Sand and Gravel Aquifer extent with cross section.

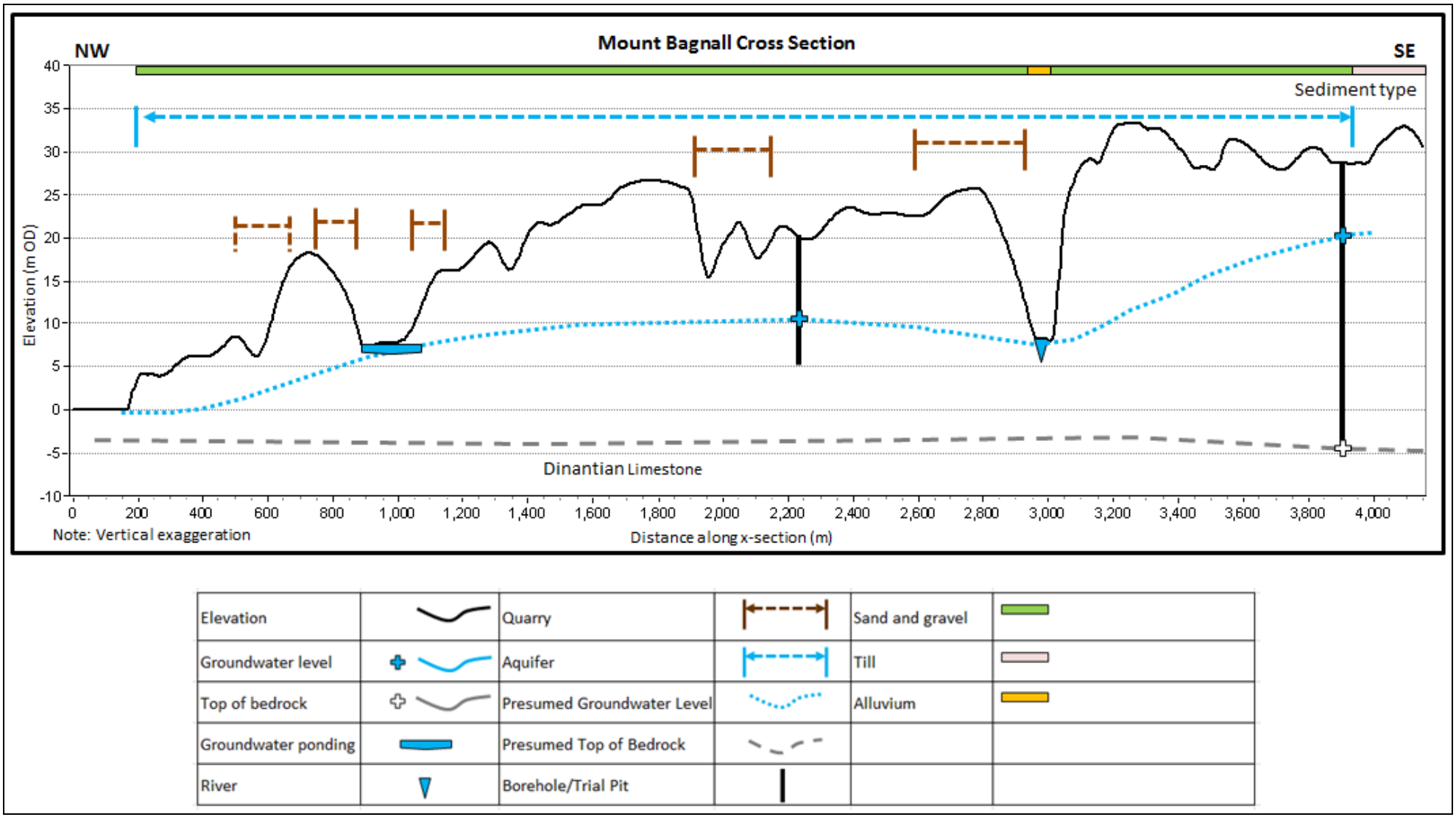

Figure 2. Cross section through the Mountbagnall Sand and Gravel Aquifer body.

Mountbagnall Sand and Gravel Aquifer Vulnerability

Figure 3. Groundwater vulnerability across the Mountbagnall Sand and Gravel Aquifer.