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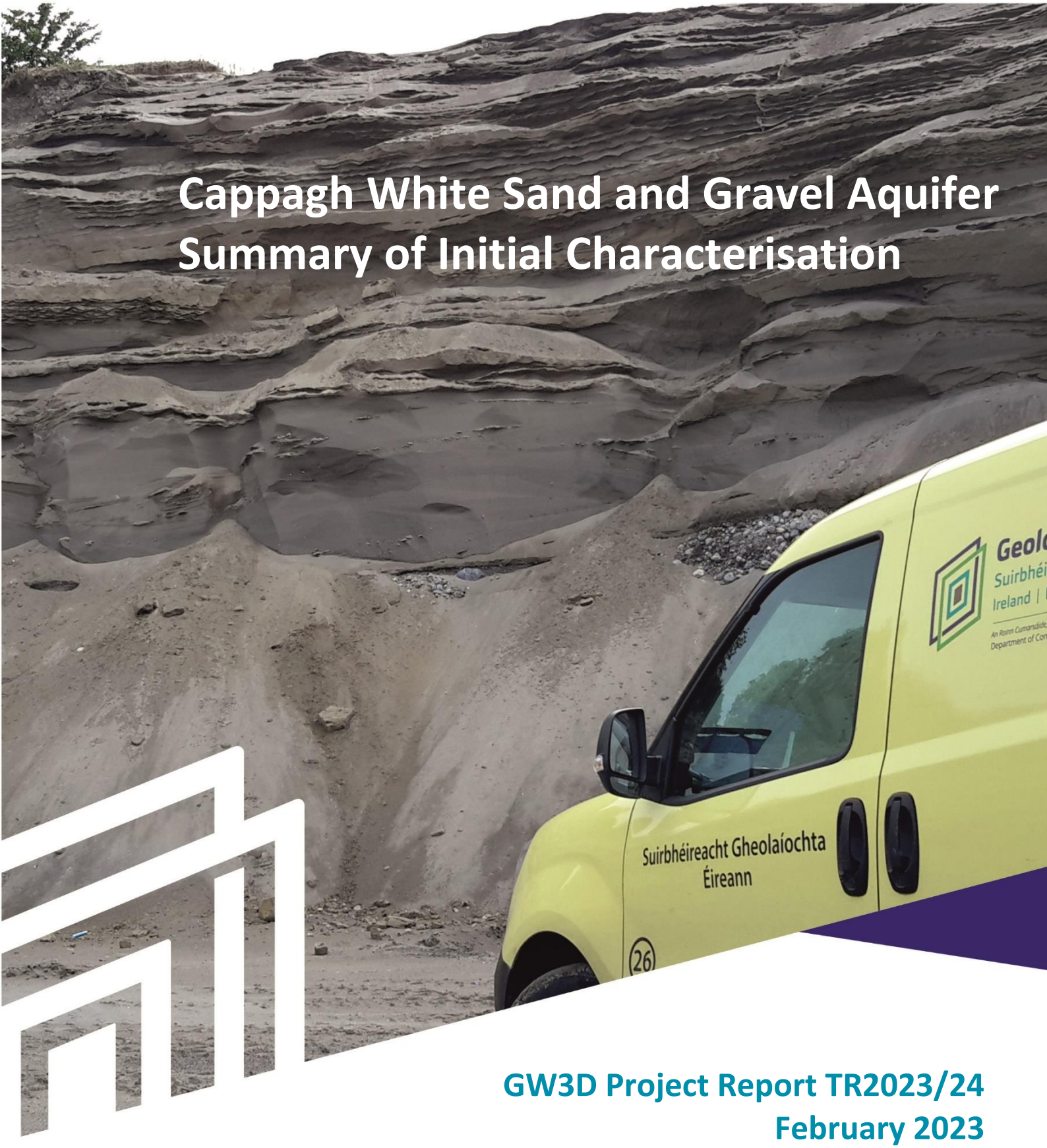

Cappagh White Sand and Gravel Aquifer
Summary of Initial Characterisation

GW3D Project Report TR2023/24
February 2023

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

Cappagh White Sand and Gravel Aquifer Description February 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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Cappagh White Sand and Gravel Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
16 – Suir 25 - Lower Shannon Tipperary County Council	**Rivers:** Glasheenyreagha River, Multeen River, Cauteen River **Streams:** Several unnamed streams **Lakes:** Several unnamed ponds	Lower River Suir SAC Ballyneill Marsh pNHA Ballydonagh Marsh pNHA Annacarty Wetlands pNHA	21.8

Topography	The Cappagh White sand and gravel deposit is a wide, hummocky expanse of glaciofluvial and glaciolacustrine sediments at the southern end of the Slieve Felim Uplands, broadly between the villages of Cappagh White, Donohill and Dundrum (Figure 1). The elevation across the aquifer area ranges between 90 m AOD and 160 m AOD, and is bounded on all sides by either till or bedrock outcrop/subcrop at higher elevations. The Multeen River flows from north to south through the centre of the deposit, and is fed by the Glasheenyreagha River in the northern portion of the body. The Cauteen River, a headwater of the Dead River, also rises in the western portion of the body and flows westwards.	
Geology and Aquifers	**Aquifer categories**	The sand and gravel deposit is confirmed to be greater than 10 m in thickness and have 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	The glaciofluvial and glaciolacustrine sands and gravels are derived chiefly from Lower Palaeozoic and Devonian sandstones (GLPDSs).
	Key structures	Borehole logs and logged quarry exposures show the variability of the aquifer material, which consists largely of GRAVEL with interbedded SAND and COBBLE beds, and occasional low permeability horizons (GSI, 2023c). The sand and gravel deposit is in direct contact with bedrock intermittently, as the till deposits beneath the sand and gravel are discontinuous (GSI, 2023c). The underlying bedrock is mostly Devonian Old Red Sandstone, but along the southern boundary Dinantian (early) Sandstones, Shales and Limestones and Dinantian Lower Impure Limestones are also present (GSI, 2023b). These bedrock units are generally Locally Important Aquifers with the Dinantian (early) Sandstones, Shales and Limestones are a Poor Aquifer (GSI, 2023b).
	Key properties	Borehole logs record that the aquifer is dominated by sand and gravel size materials, with interbedded low permeability layers throughout the deposit (GSI, 2023c). Variability in the aquifer material influences the hydrogeological behaviour of the aquifer. The aquifer is generally unconfined, but may become locally confined where lower permeability deposits overlie the gravels. Though permeability testing data are limited, productivity, borehole logging and gravel pit data indicate that coarse material predominates and that permeability and storativity are high. The Ironmills Public Water Supply (PWS) abstracts groundwater from this aquifer. Aquifer properties have been estimated here based on pumping tests undertaken at this supply. Gaston et al. (2013) reported that the pumping test analysis by Keegan (1993) indicated that the yield of the aquifer is 3,052 m^3/day, the specific capacity is estimated to be 874 m^3/day/m, the effective porosity is 0.2 to 0.3, and the transmissivity is between 714 m^2/day and 980 m^2/day (Gaston et al., 2013). The underlying bedrock aquifer is generally 'Poor' and cannot accept all available recharge. This has the effect of retaining the water within the body of the sand and gravel aquifer.
	Thickness	The deepest recorded thickness of the sand and gravel is 40 m, and the deepest recorded saturated thickness is 35 m (GSI, 2023c).
Overlying Strata	**Lithologies**	Peat, alluvium and lacustrine sediments are mapped as overlying portions of the sand and gravel body (GSI, 2023b).
	Thickness	The thickness of the peat, alluvial and lacustrine deposits is unknown, but where they occur all are expected to be no more than 3 m deep.
	% area aquifer near surface	Approximately 90 % 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 unprotected; 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 exact class determined by the depth to the water table from ground level. Measured water levels range from 0.5 m to 30 m below ground level in the Cappagh White body. In areas where the water table is less than 3 m below ground level the aquifer vulnerability is classed as 'Extreme' and where it is greater than 3 m below ground level the aquifer vulnerability is classed as 'High'.
Recharge	**Main recharge mechanisms**	The aquifer receives both direct and indirect recharge. Diffuse recharge occurs by the infiltration of rainfall through the unsaturated sands and gravels. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil, and by the slope (DELG/EPA/GSI, 1999). Typically the proportion of recharge that infiltrates to ground water in sand and gravel is around 85% (Hunter-Williams et al., 2011). The presence of less permeable layers in the deposit, even if thin, can create perched water tables and prevent recharge to the true water table.
	Est. recharge rates	The rainfall in the area of the Cappagh White sand and gravel deposit is 1,150 mm/yr (Walsh, 2012), and the estimated recharge rate to the aquifer from direct recharge is 430 mm/yr. The minimum direct groundwater throughput in the aquifer is consequently estimated to be 7,269 m^3/d, but with rejected recharge the throughput increases to an approximate potential 10,858 m^3/d.
Discharge	**Large springs and large known abstractions (m^3/d)**	Ironmills PWS is known reported to abstract 1,638 m^3/day, but can supply a yield of 3,052 m^3/day (Gaston et al., 2013).
	Main discharge mechanisms	The main discharge mechanisms are baseflow discharge to rivers, seepages at the extremities of the body and discharge via springs.
	Hydrochemical Signature	The EPA drinking water returns (2003) indicate that the groundwater has a calcium-magnesium bicarbonate hydrochemical signature ($C_4H_6CaMgO_{13}$).
Groundwater Flow Paths		Groundwater flow path length depends on the extent of the sand and gravel deposit, and also upon the spacing of internal groundwater divides and the distance between streams. In general, locally important sand and gravel aquifers are expected to have relatively short flow paths. The variability in the composition of this aquifer disrupts flow, shortening groundwater flow paths. It is assumed that generally the surface water and groundwater flow directions coincide. The principal groundwater flow direction is therefore considered to be southeastwards. There are not enough hydrogeological data to calculate precise groundwater gradients, but it is estimated that they are in the order of 0.001.
Groundwater & Surface water interactions		Hydraulic connection between the groundwater and surface water is expected to be high.
Conceptual modelConce		• The Cappagh White Locally Important Sand and Gravel Aquifer is a hummocky sand and gravel deposit, comprised of outwash sediments that were deposited by glacial meltwaters at the margins of a retreating ice-sheet. • The sands and gravels include heterogeneous and stratified mixtures of sands and gravels that are interbedded with, and that transition laterally to, finer-grained silts and clay. • From their depositional history, the coarser outwash sediments can be expected to be channelized and sinuous in a general north-south direction along the Multeen River valley. • The outwash sediments are generally underlain by glacial till and/or bedrock. • The boundaries of the aquifer are delimited for the most part by the extent of the mapped sand and gravel deposit (GSI, 2023c). • Small areas of peat, lacustrine sediments and alluvium overlie the sands and gravels in places. • The aquifer is generally unconfined although may be locally confined by low permeability sediments.

	• The underlying bedrock is a 'Poor' Bedrock Aquifer (GSI, 2023b) and therefore this is expected to retard infiltration downwards and to hold groundwater in a body in the sands and gravels above it. • This is further supported by water level records form Donohill Landfill (Tipperary County Council, 2010) where water levels in the bedrock are not comparable to those in the gravel aquifer. • The groundwater gradient is generally subdued due to the permeable nature of the deposits. • Recharge to the aquifer occurs diffusely through the unsaturated zone, and water enters the aquifer as diffuse recharge from rainfall, and discharges at ditches, the rivers and streams. • The minimum direct groundwater throughput in the aquifer is consequently estimated to be 7,269 m^3/d, but with rejected recharge the throughput increases to an approximate potential 10,858 m^3/d.
Attachments	Figure 1: Location and extent Figure 2: Cross section 1 Figure 3: Cross section 2 Figure 4: Groundwater vulnerability
Instrumentation	**Hydrometric gauges:** None present **National Water Monitoring Stations;** **River:** RS16M020650 Br just u/s Glasheenyreagha R conf RS16M020700 Multeen -- Ironmills Br. RS25C100030 CAPPAWHITE STREAM - Br E of Cappawhite RS25C100050 CAPPAWHITE STREAM - Br W of Rahyvira RS16M020780 Br SW of Annacarty RS16M020800 Multeen – Hawarden Br RS25C040100 CAUTEEN – Br N of Donohill RS16M020900 Morpeth Br **Groundwater:** GWIE_SE_G_13137000009 Ironmills WS
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 • Gaston, L., Moe, H., Meehan, R. and Deakin, J. (2013). Establishment of Groundwater Source Protection Zones: Ironmills Public Water Supply Scheme. Report to Environmental Protection Agency. • 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 • GSI (2023c). Geological Survey Ireland. Internal Bedrock Database • Hunter-Williams, N.H., Misstear, B.D.R., Daly, D. and Lee, M. (2011). Development of a national groundwater recharge map for the Republic of Ireland. Quarterly Journal of Engineering Geology and Hydrogeology, 46(4):493-506. • Keegan, M. (1993). Groundwater Vulnerability and Protection in County Tipperary (South Riding), Ireland. Unpublished M.Sc. Thesis, Sligo Regional Technical College. • NPWS (2023). National Parks and Wildlife Service Map Viewer. http://webgis.npws.ie/npwsviewer • 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. • Walsh, S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin. • Tobin Consulting Engineers (2016). Donohill Landfill, Garryshane, Donohill, Co. Tipperary; Civic Amenity Upgrade Works, Environmental Impact Assessment, Stage 1. Report for Tipperary County Council.

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. Figure 1 and Plate 1 are used for illustrative purposes only.

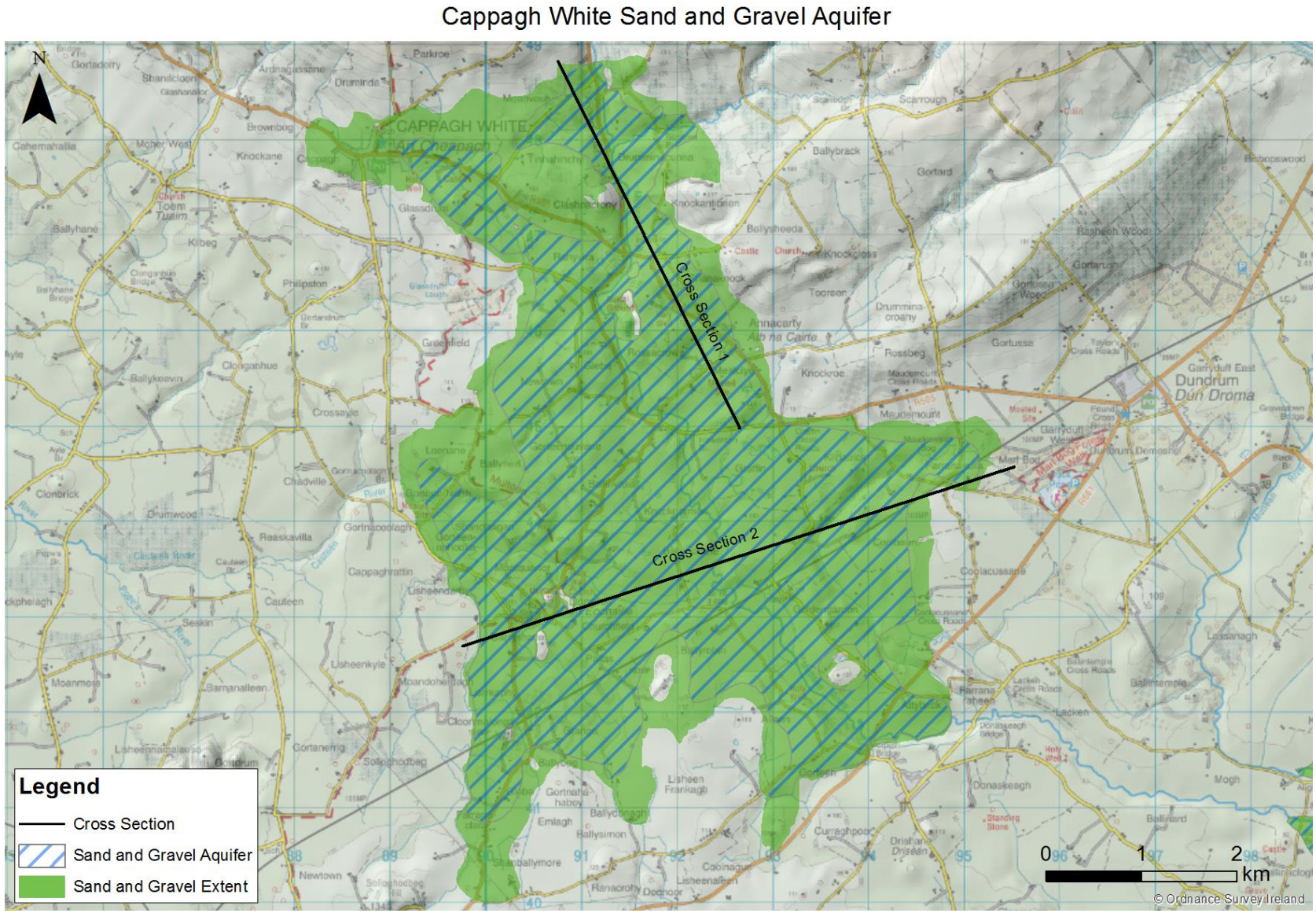
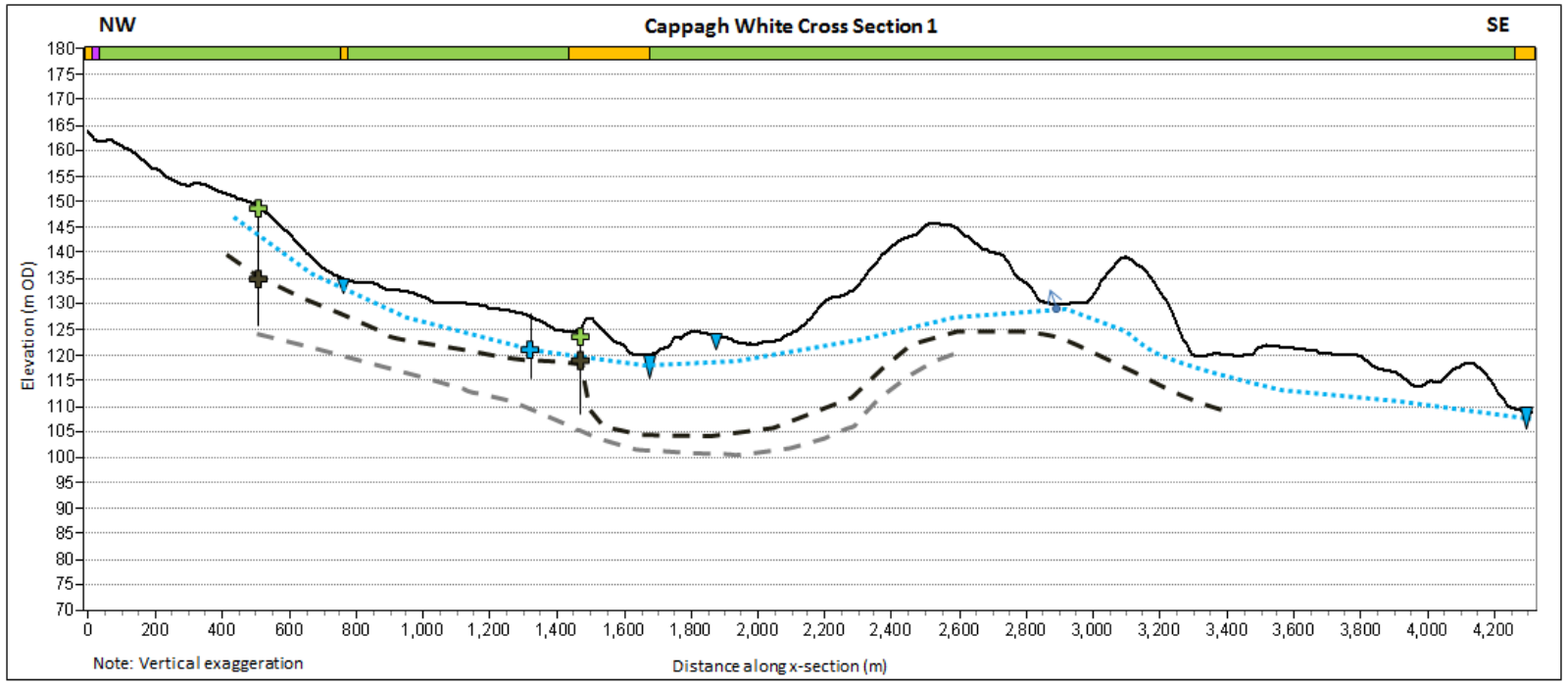
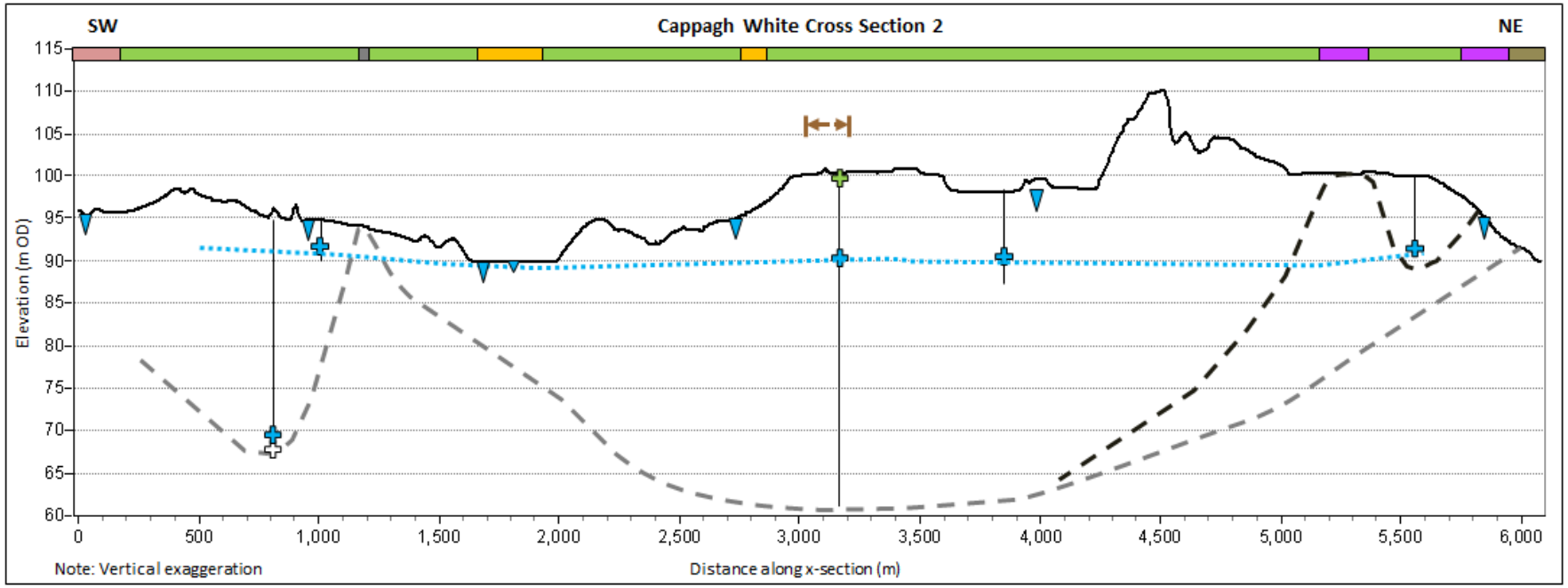


Figure 1. Cappagh White Sand and Gravel Aquifer extent with cross section location.



Groundwater level		Borehole/Trial Pit	
Top of S&G		River	
Top of till		Spring	
Top of bedrock		Sands and gravels	
Presumed Groundwater level		Till	
Presumed Top of till		Rock outcrop	
Top of bedrock		Alluvium	

Figure 2: Cross section 1 through the Cappagh White Sand and Gravel Aquifer body.



Groundwater level		River	
Top of S&G		Quarry	
Top of till		Sand and gravel	
Top of bedrock		Till	
Presumed Groundwater level		Till	
Presumed Top of till		Rock outcrop	
Top of bedrock		Alluvium	
Borehole/Trial Pit		Peat	

Figure 3: Cross section 2 through the Cappagh White Sand and Gravel Aquifer body.

Cappagh White Sand and Gravel Aquifer Vulnerability

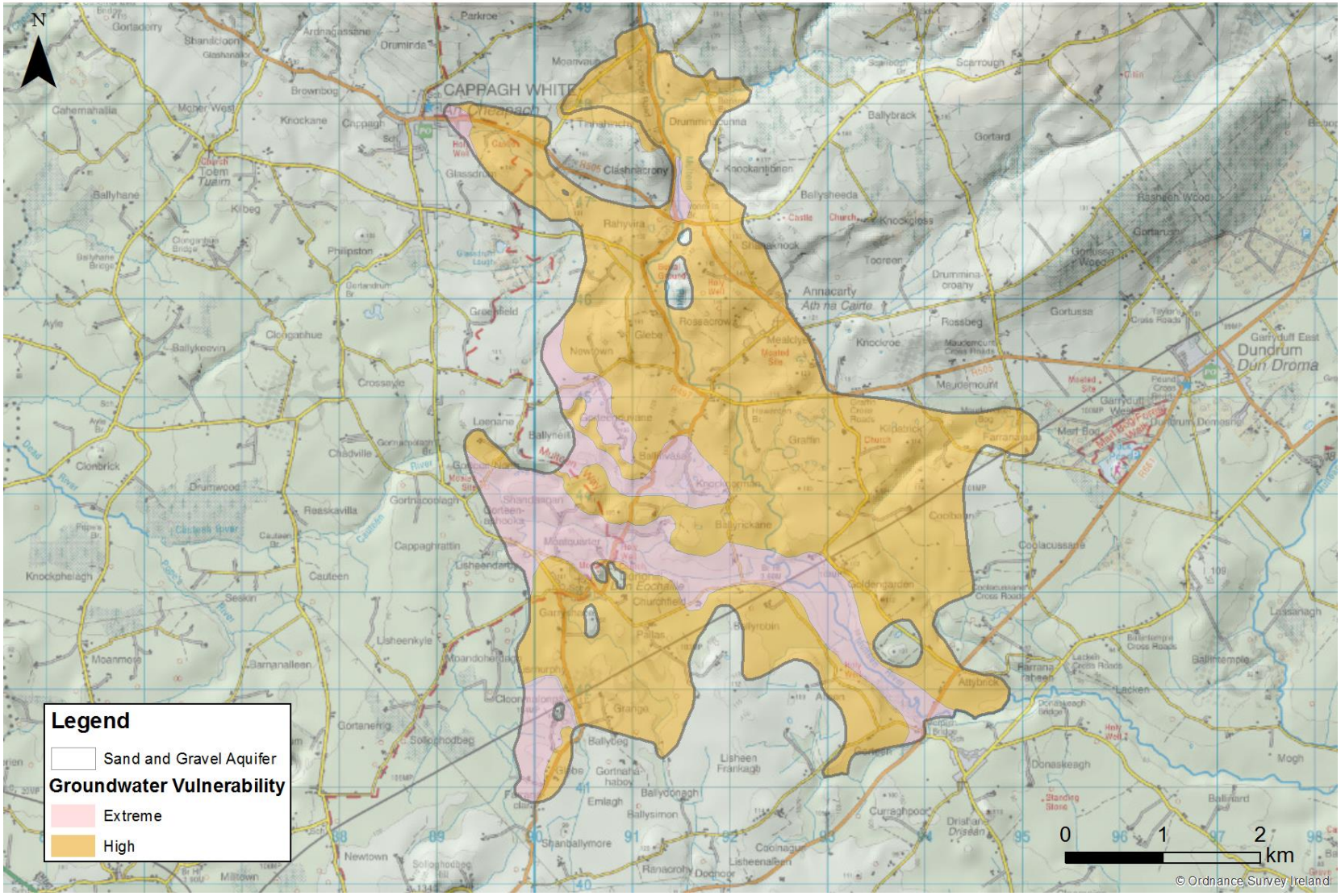


Figure 4. Groundwater vulnerability across the Cappagh White Sand and Gravel Aquifer.