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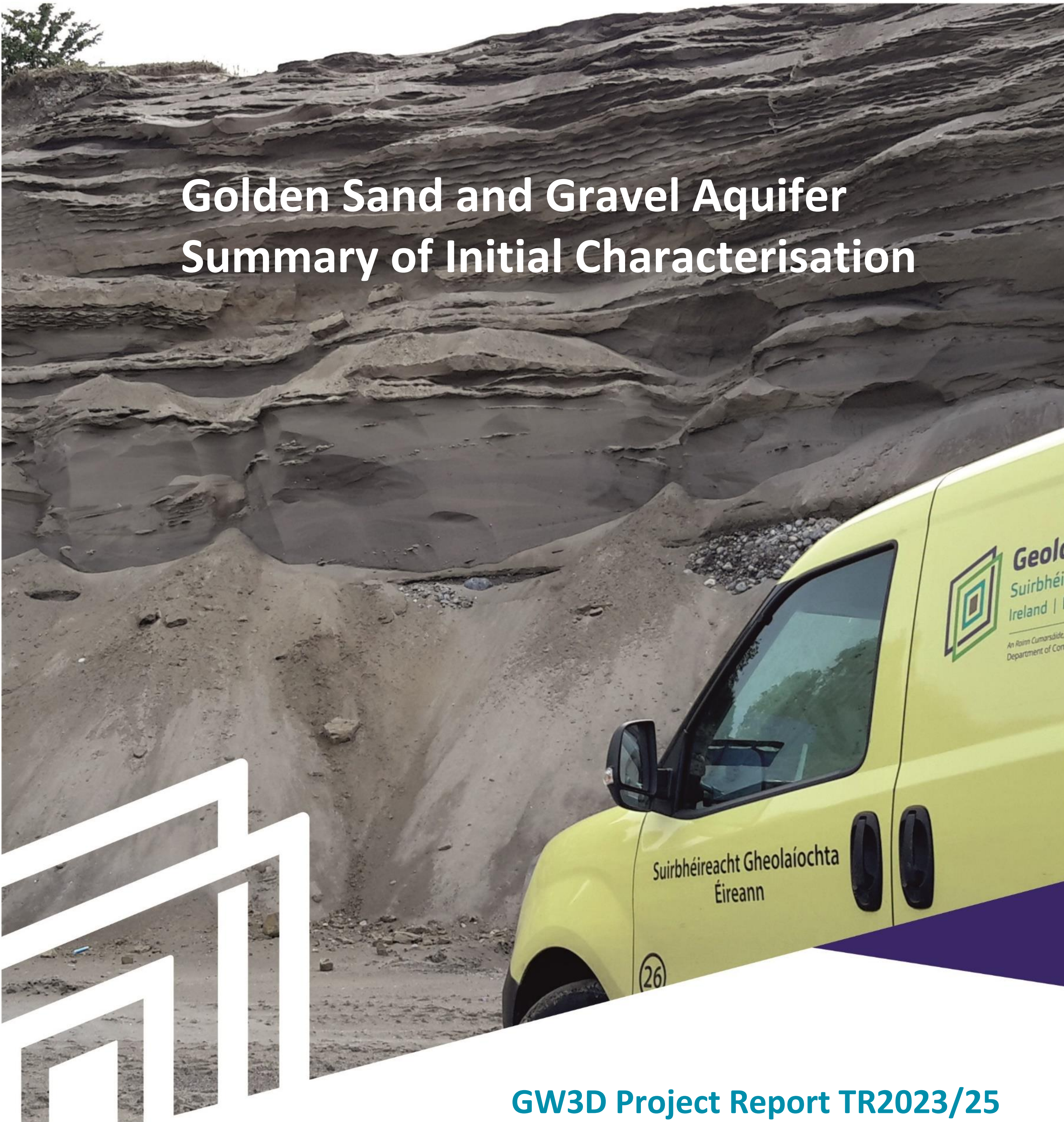
Golden Sand and Gravel Aquifer
Summary of Initial Characterisation



GW3D Project Report TR2023/25
February 2023

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

Golden 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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Golden 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 Tipperary County Council	**Rivers:** Multeen River, River Suir **Streams:** Several unnamed streams **Lakes:** None	Lower River Suir SAC	3.1

Topography		The Golden sand and gravel body extends either side of the village of Golden along the River Suir in County Tipperary, as well as along a tributary meltwater channel now occupied by the Multeen River. The sands and gravels form glaciofluvial terraces either side of the Multeen and Suir rivers (GSI, 2023b). Elevation range from 60 m AOD in the south to 70 m AOD in the north. The strip of sands and gravels are bounded on either side by till and bedrock outcrop/subcrop at slightly higher elevations.
Geology and Aquifers	**Aquifer categories**	The Golden sand and gravel deposit is confirmed as 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	Glaciofluvial sands and gravels derived chiefly from limestones (GLs) and Alluvium (A) (GSI, 2023b).
	Key structures	Borehole logs (GSI, 2023a) from within the area of the sand and gravel body show the variability of the subsurface material, which consists largely of sands and gravels, with occasional low permeability horizons. The underlying bedrock aquifer types vary considerable across the lateral extent of the sand and gravel aquifer; therefore it is difficult to determine their exact inter-relationships. These underlying rock units are Dinantian Pure Bedded Limestones and Dinantian Upper Impure Limestones. The Dinantian Pure Bedded Limestone falls under two aquifer categories; in the north these rocks are classified as a Regionally Important Aquifer - Karstified (diffuse) **(Rkd)** and in the south the rocks are Locally Important Aquifer – Karstified **(Lk)**. The Dinantian Upper Impure Limestone is a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones **(Ll)** (GSI, 2006).
	Key properties	There are no hydrogeological testing data available for materials within this aquifer body, but borehole logging data indicate that coarse material predominates (GSI, 2023a). It is therefore expected that permeability and storativity are high. In the absence of permeability test data, gravels with a fines content of less than approximately 8% are generally considered to have sufficient permeability for aquifer development (O'Suilleabhain, 2000). The productivity of the aquifer is proven by the presence of a disused public supply spring discharging from the aquifer just north of Golden, at Springmount (GSI, 2023a). This is an 'intermediate' spring in terms of flow, with a yield of 1,820 m^3/day. Generally, groundwater is considered to be unconfined within the aquifer body. The data are inadequate to calculate groundwater gradients, but these are expected to be relatively flat, in the order of 0.001, typical of sand and gravel aquifers.
	Thickness	The deepest recorded thickness of sand and gravel was recorded at the bridge in Golden, where sands and gravels reached 17 m in thickness, with a saturated thickness of 15 m. From analysis of borehole data (GSI, 2023a), the range in thicknesses varies from 7 m to >17 m over the area of the aquifer body.
Overlying Strata	**Lithologies**	Along the course of the main rivers, alluvial sediments have been deposited above the sand and gravel (GSI, 2023b).
	Thickness	The overlying alluvial sediments are not expected to be greater than 3 m thick.
	% area aquifer near surface	Approximately 30% of the area of the sand and gravel body has sands and gravels just below the surface.

	Vulnerability	Sand and gravel aquifers are classified 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 in the Golden sand and gravel body range from 1 m to 3.5 m below ground level. 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'. Extreme vulnerability consequently occurs over 35% of the aquifer area.
Recharge	**Main recharge mechanisms**	Diffuse recharge occurs *via* 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 (Hunter Williams et al., 2011). Typically the proportion of recharge that infiltrates to ground water in sand and gravel is around 85% (Hunter Williams et al., 2011). Where the water table lies below the river stage it is likely that some water may pass into the aquifer. Some rejected recharge from the surrounding higher ground on either side of the main river channel will also increase the amount of available recharge to the aquifer.
	Est. recharge rates	The rainfall in the area of the Golden sand and gravel deposit is 1,013 mm/yr (Walsh, 2012), and the estimated recharge rate to the aquifer from direct recharge is 220 mm/yr. The minimum direct groundwater throughput in the aquifer is consequently estimated to be only 251 m^3/d, but with rejected recharge the throughput increases to an approximate potential 4,575 m^3/d.
Discharge	**Large springs and large known abstractions (m^3/d)**	The public spring source at Springmount, abstracting groundwater from a clean sand and gravel deposit, yields 1,820 m^3/day (Daly *et al*., 2001).
	Main discharge mechanisms	The main discharge mechanisms are baseflow discharge to rivers and streams flowing through the aquifer body, with some discharge via springs. Where the water table is sufficiently close to the surface such that the riverbed elevation is lower than it, the aquifer will contribute groundwater to the baseflow of the river.
	Hydrochemical Signature	There are only a few analyses for the Springmount source (Daly *et al.,* 2001). The maximum admissible concentration (MAC) for bacteria and nitrate was exceeded on two occasions from nine samples. There is one sample which shows concentrations of lead (Pb) above the MAC, but further sampling is necessary to determine whether this may be indicating an issue (Daly *et al.,* 2001). Hydrochemical analysis of a groundwater sample from Springmount taken by South Tipperary County Council in May 1993 is shown in the table below.

Colour	**Odour**	**pH**	**Electrical conductivity @ 20**	**Dry Residue**	**Suspended Solids**
5	1	7.2	673	409	0
Total Hardness (as $CaCO_3$)	**Calcium**	**Magnesium**	**Sodium**	**Potassium**	**Carbonate**
361	123	13	6.7	0.9	0
Methyl orange alkalinity (as $CaCO_3$)	**Sulphate**	**Chloride**	**Nitrate as NO_3**	**Iron (total)**	**Manganese**
365	<1	23	24.8	<0.005	0.005
Zinc	**Copper**	**Lead**	**Aluminium**	**Nitrate as nitrogen**	**Nitrite as nitrogen**
<0.005	0.001	0.01	0.02	5.6	0.001
Ammonia as nitrogen	**Ortho-phosphorus**	**Sulphide**	**Total coliforms**	**Faecal Coliforms**	
0.01	0.002	0	0	0	

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, due to their restricted areal extent. This is expected to be the case at Golden, given the setting and geometry of the deposit.
Groundwater & Surface water interactions	Groundwater is expected to discharge to the springs, streams and rivers. Hydraulic connection between the groundwater and surface water is expected to be high due to the general relatively shallow positioning of the water table and the high permeability of the sand and gravel aquifer.
Conceptual model	• The sand and gravel aquifer is comprised of sands and gravels deposited along meltwater channels as the glaciofluvial terraces of the Multeen River and River Suir systems (GSI, 2023b). • The glaciofluvial sands and gravels are derived chiefly from limestones (GLs; GSI, 2023b). • The underlying bedrock aquifers beneath the sands and gravels include a Regionally Important Aquifer - Karstified (diffuse) **(Rkd)**, a Locally Important Aquifer – Karstified **(Lk)** and a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones **(Ll)** (GSI, 2006). • Sand and gravel deposits reach up to at least 17 m at their thickest. • Across approximately 35 % of the aquifer area, groundwater levels are <3 m bgl, meaning consequent 'Extreme' groundwater vulnerability. • Diffuse recharge occurs *via* rainfall percolating through the unsaturated sands and gravels. • The length of the flow paths is expected to be in the order of several hundred metres at maximum. • The data are inadequate to calculate groundwater gradients, but these are expected to be generally greater than 0.001. • Groundwater discharges to the Springfield spring, the Multeen River,the River Suir. And to some short, small tributary streams. • The minimum direct groundwater throughput in the aquifer is estimated to be only 251 m^3/d, but with rejected recharge the throughput increases to an approximate potential 4,575 m^3/d.
Attachments	Figure 1: Location and extent Figure 2: Cross sections Figure 3: Groundwater vulnerability Figure 4: Piper diagram
Instrumentation	**Hydrometric gauges:** 16005 AUGHNAGROSS (Water Level and Flow) 16006 BALLINACLOGH (Water Level and Flow) **National Water Monitoring Stations:** **River:** RS16M021000 Ballinaclogh Br RS16M080500 Aughnagross Br RS16M021100 Ballygriffin Br RS16S100100 Springs at Springmount Hse. (WS Abstr.) RS16S021500 Golden Br RS16S021510 Downstream Cashel WWTP **Groundwater:** None present
Information Sources	• Daly, D., Keegan, M., Wright, G., Flynn E. (2001). County Tipperary (South Riding) Groundwater Protection Scheme Main Report. Geological Survey of Ireland and Tipperary (South Riding) County Council. • 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

Information Sources (contd.)	• Hunter Williams, N., Misstear, B., Daly, G., Johnston, P., Lee, M., Cooney, P., Hickey, C., (2011) National Groundwater Recharge Map for Ireland. Geological Survey Ireland and Department of Civil, Structural and Environmental Engineering, Trinity College Dublin. • 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.
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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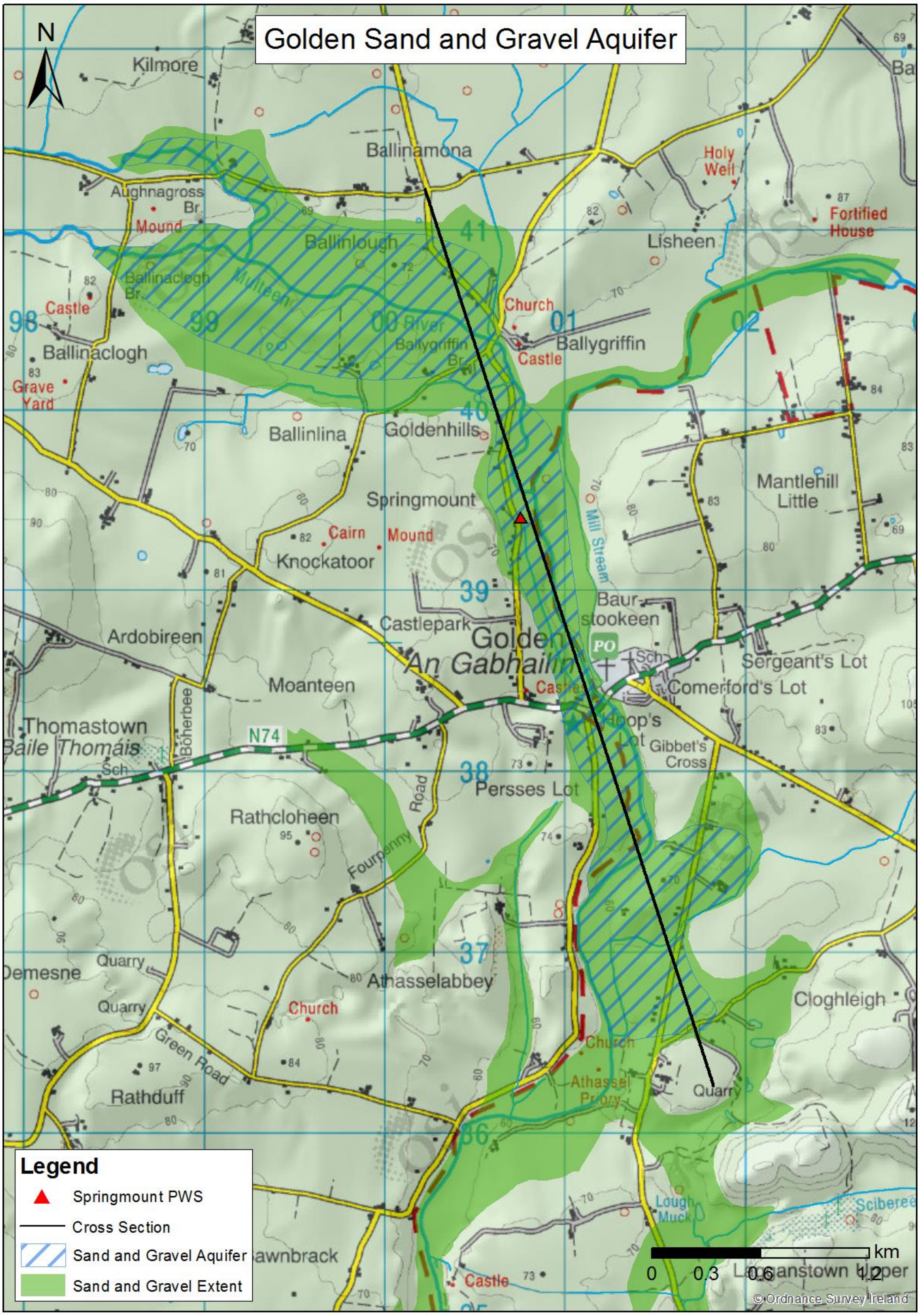

Figure 1: Golden Sand and Gravel Aquifer extent with cross section location.

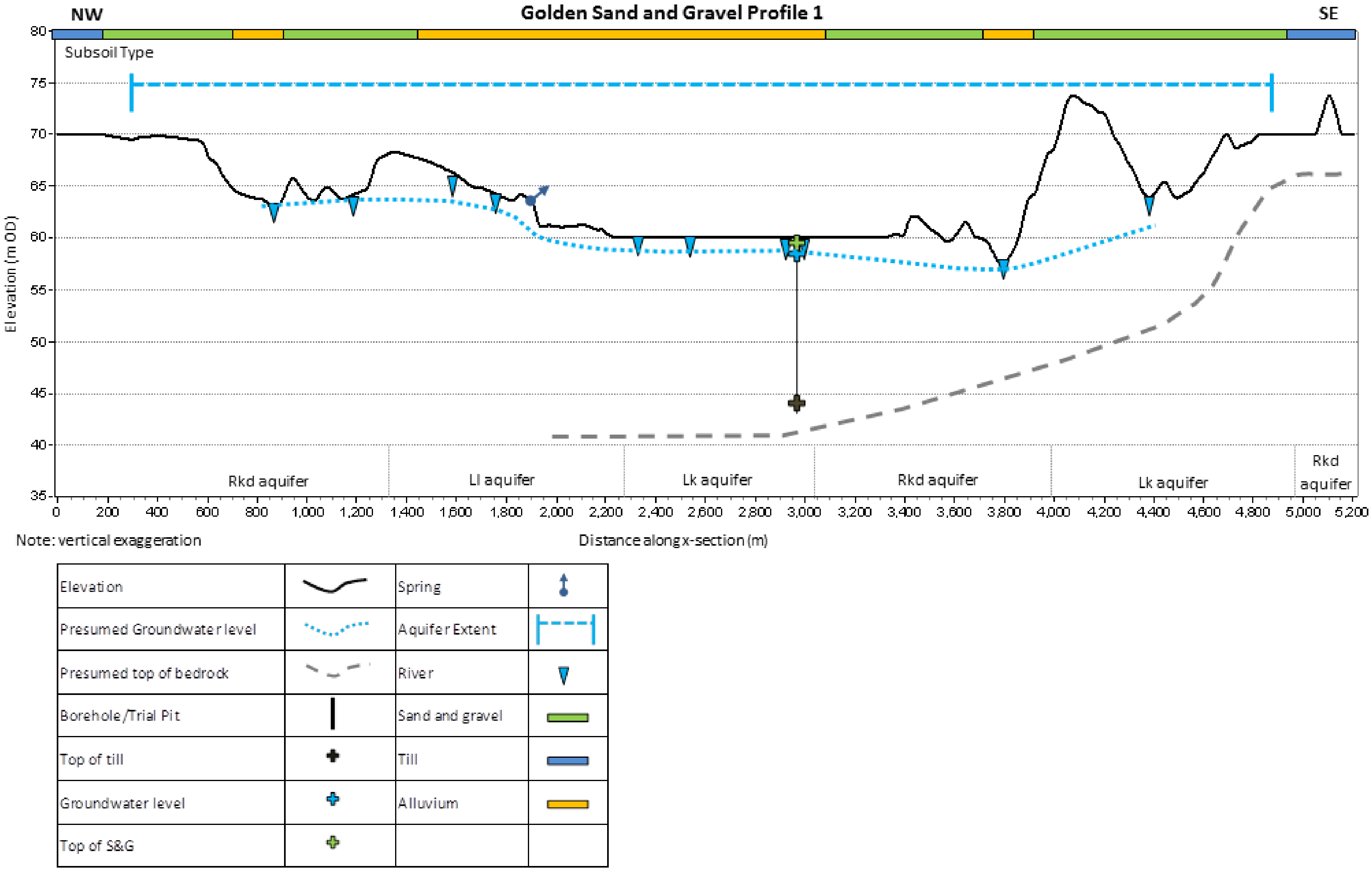

Figure 2: Cross section through the Golden Sand and Gravel Aquifer.

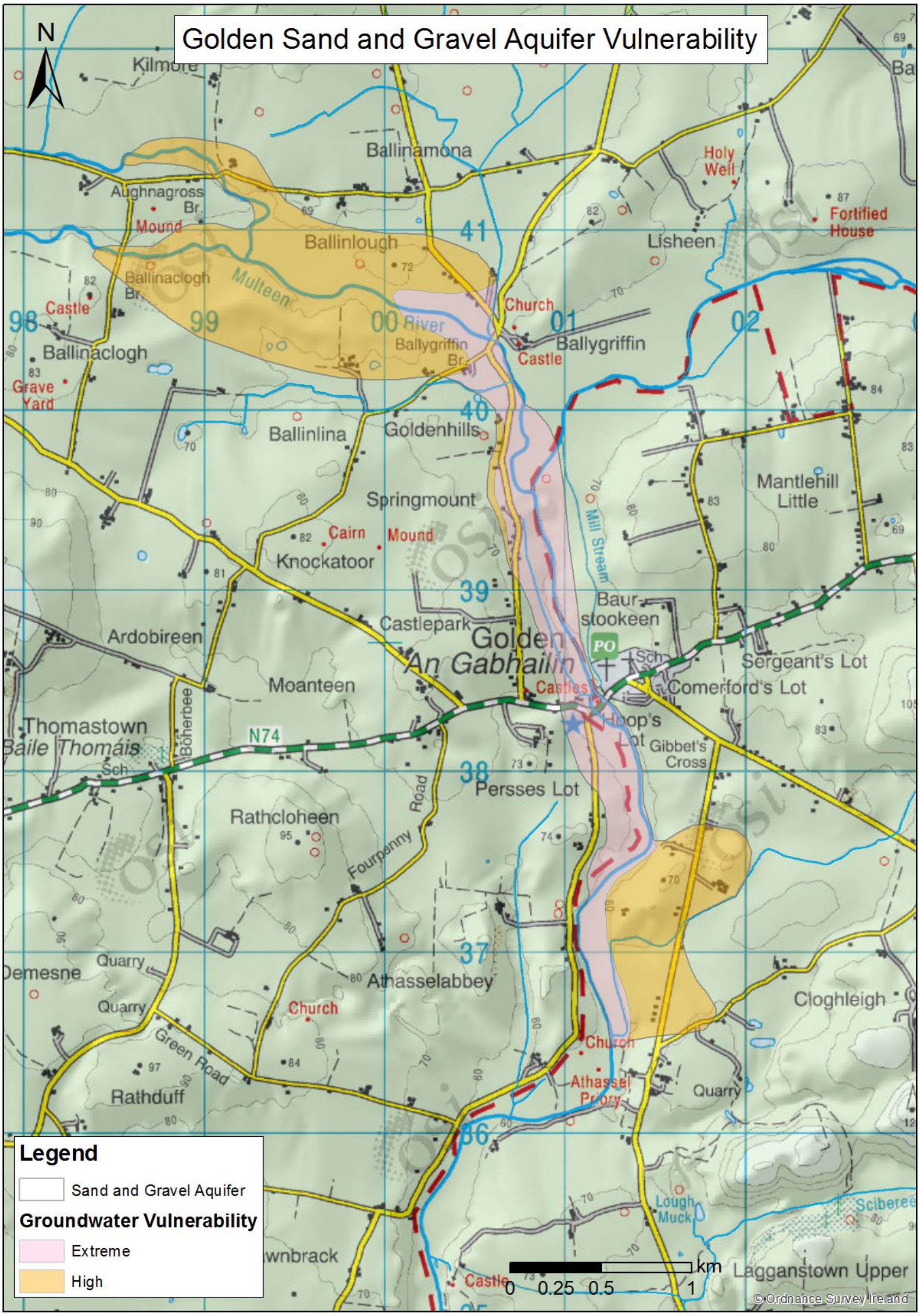

Figure 3: Groundwater vulnerability across the Golden Sand and Gravel Aquifer.

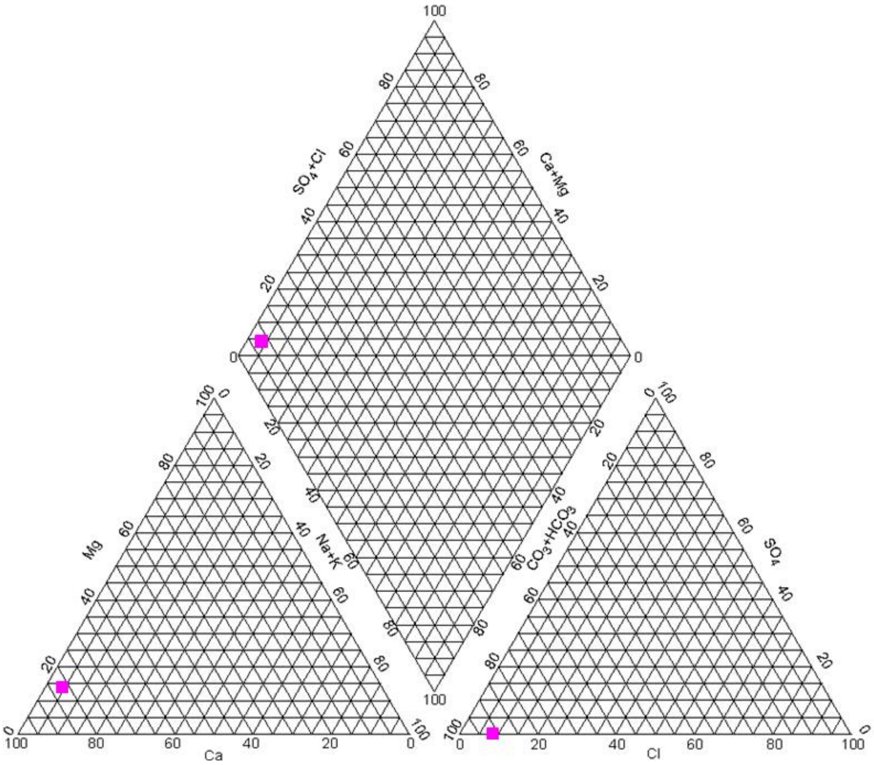

Figure 4. Piper Diagram of analysed groundwater from the Golden Sand and Gravel Aquifer, suggesting a calcium bicarbonate signature.