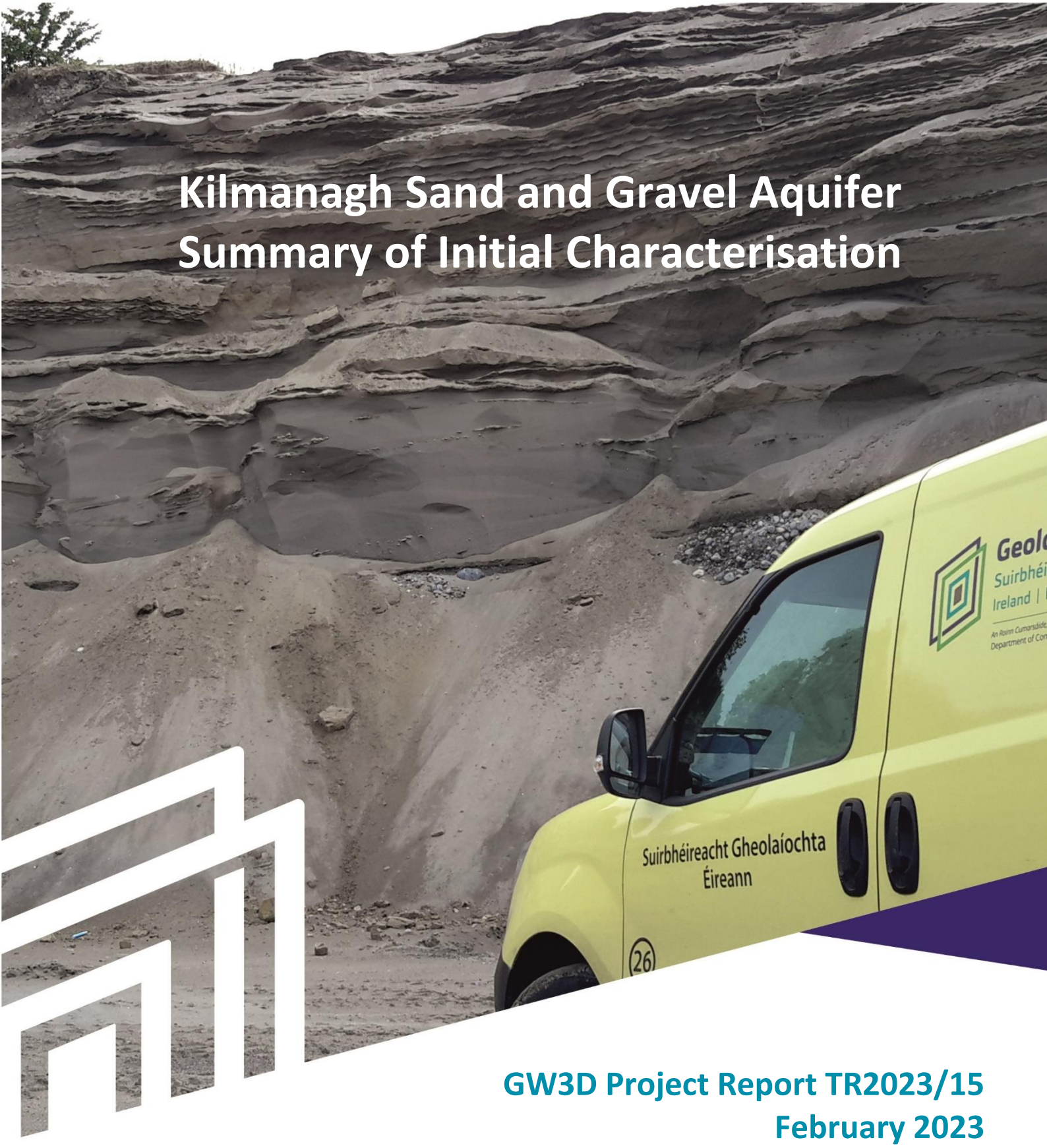
Rialtas na hÉireann
Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann



Kilmanagh Sand and Gravel Aquifer
Summary of Initial Characterisation

GW3D Project Report TR2023/15
February 2023

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

Kilmanagh 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

Kilmanagh Sand and Gravel Aquifer Description February 2023

Kilmanagh Sand and Gravel Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
15 – Nore Kilkenny County Council	**Rivers:** Tullaroan Stream, Killeen River, Graigue River, Kilmanagh River, Munster River, Whitehouse River, King's River **Streams:** Several unnamed streams **Lakes:** None	River Barrow and River Nore SAC	19.0

Topography	The Kilmanagh sand and gravel aquifer is situated in a wide valley setting between Tullaroan and Callan, in west County Kilkenny, at elevations between 70 m and 140 m AOD (Figure 1). The general topography of the aquifer is predominantly 'flat to gently undulating glacial sediments' in the north, and 'hummocky glaciofluvial sediments' further south (GSI, 2023a). The northern half of the aquifer is narrow and elongate, between Tullaroan and Kilmanagh, where bedrock-cored ridges on either side of the valley rise to high elevations up to 292 m AOD and topographically constrain the lateral extent of the aquifer. South of Kilmanagh, the aquifer body opens out and encompasses a much wider area, without the high, flanking, bedrock-cored ridges having constrained the depositional setting of the glaciofluvial sands and gravels. Away from the main river channels, the natural land drainage is moderate to good to the north of Kilmanagh, but very poor in the south.	
Geology and Aquifers	**Aquifer categories**	The body encompasses the junction of two lowlying, central valleys, as well as the offshoot valleys, both of this have glaciofluvial sands and gravels and wide belts of alluvium at surface. Either side of this central area some areas mapped as glacial till at surface, but with glaciofluvial sands and gravels at depth. There are data available from 31 borehole records, some of which have detailed logs of subsoil stratigraphy across the body. The exact composition of the subsoils in many of these boreholes is unproven, but it is expected than sand and gravel is present below the mapped areas of glacial till within the aquifer boundary. There is approx. 29% of the aquifer which is unconfined, with the remainder of the area confined beneath the glacial till. Based on its areal extent, inferred thickness, saturated thickness, groundwater throughput and position in the landscape the deposit is classified as **Regionally Important Sand and Gravel Aquifer (Rg)** (DELG/EPA/GSI, 1999; GSI, 2017).
	Main aquifer lithologies	Hummocky glaciofluvial sand and gravel sediments derived chiefly from limestones (GLs). These lie beneath a capping layer of glacial till derived chiefly from Namurian sandstones and shales (TNSSs), and a small area of till derived chiefly from limestones (TLs) further north. Alluvium overlies the sands and gravels through the central spine of the deposit.
	Key structures	In general, exposure is poor within this sand and gravel body, and no deep exposures showing the internal structure of the sand and gravel were noted during fieldwork.
	Key properties	There were 26 water level data points measured during fieldwork in the area of the sand and gravel aquifer; these data have allowed for inferences to be made on water levels throughout the body. The aquifer body is unconfined in the north where the aquifer is effectively a bedrock channel clogged with glaciofluvial sands and gravels, overlain by alluvium, and is confined in the south, where till overlies and interfingers siwht the sands and gravels. Using the point data from field work, along with desk study data, it has been inferred that approx. 45% of the aquifer area has a depth of saturated sand and gravel greater than 5 m, and much of this is confined. The dolomite is thought to contribute groundwater to the sands and gravels near the junction of the Munster and Kings Rivers near Callan (Naughton 1978), as the presence of warm springs in this area suggests that some recharge is also provided by the dolomite aquifer below the confined portion. Transmissivity has been estimated to be between 200 and 250 m^2/d, with a porosity of 0.1 to 0.25 (GSI, 2007). In general, sand and gravel aquifers consist of unconsolidated coarse grained material, usually containing less than 8% fines (Ó'Súilleabháin, 2000).

	Thickness	Two desk study boreholes have measured the thickness of the overlying glacial till at 5 m and 6.4 m in Oldtown and Kilmanagh Townlands, with thicknesses of sand and gravel at 10.5 m and 6.5 m beneath the till in both boreholes (GSI, 2023b). There are 15 borehole records which show depth to bedrock at greater than 15 m below ground level (GSI, 2023b). None of the 31 borehole records have depth to bedrock recorded at less than 10 m within the boundary of the area delineated as sand and gravel aquifer.
Overlying Strata	**Lithologies**	Approximately 15% of the aquifer is overlain with alluvial deposits, lake sediments and / or cutover raised peat, with sand and gravel assumed beneath. A further 56% of the aquifer area is covered with glacial tills derived chiefly from Namurian sandstones and shales, with till derived chiefly from limestone in a small pocket at the northern end of the aquifer.
	Thickness	The alluvial deposits, lake sediments and cutover raised peat are inferred to be less than 3 m thick. The depth of glacial till has been measured at two point localities, at 5 m and 6.4 m in Oldtown and Kilmanagh Townlands respectively (GS1, 2023b). The exact thickness of the glacial till throughout the remainder of the area of the aquifer is unknown.
	% area aquifer near surface	Approximately 29% of the sand and gravel aquifer is at the surface, with the remainder beneath the alluvial deposits, lake sediments, cutover raised peat and/or glacial till.
	Vulnerability	The groundwater vulnerability of the sand and gravel is 'Extreme' where they are confined and / or the water table is inferred to be < 3 m from the surface; this accounts for 83% of the aquifer area. In all other areas where the water table is at a depth > 3 m and the sands and gravels are unconfined, the vulnerability is classed as 'High' (17% of the area, Figure 3).
Recharge	**Main recharge mechanisms**	Diffuse recharge occurs *via* rainfall percolating through the unsaturated sands and gravels where these occur at surface in the northern end of the aquifer body (and where it is unconfined). In these localities, due to the high permeability of the sand and gravel, a high proportion of the available recharge will percolate down to the water table. As well as this, the Kilmanagh River recharges the unconfined portion of the aquifer at times of a lower water table (Naughton, 1978), and the river actually dries out in certain years upstream of Kilmanagh. In the areas where glacial till is the overlying stratum, in is estimated that approx. 30% of the available recharge will reach the groundwater table. Rejected recharge is also conceptualised as contributing to the sand and gravel body from overland or near surface flow from the surrounding ridges, as well as lateral flow in the transition zone from the surrounding ridges underlain by Poor Bedrock Aquifers **(Pl)** at the northern end of the aquifer body. This relationship is expected to be complex though as in areas further south, where overland or near surface flow from higher surrounding land may not reach the sands and gravels as owing to overlying, confining till, less recharge will infiltrate. To complicate matters even further, groundwater upwells from the dolomite bedrock aquifer in this southern portion also (Naughton, 1978; Daly, 1982).
	Est. recharge rates	The annual average rainfall for the aquifer is 987 mm (Walsh, 2012), thus providing an estimated diffuse groundwater recharge of 255 mm/yr. The minimum direct groundwater throughput in the aquifer itself is consequently estimated to be 7,300 m^3/d, which increases to a minimum potential 16,375 m^3/d when rejected recharge from the surrounding ridges that contribute is included.
Discharge	**Large springs and large known abstractions (m^3/d)**	Callan Public Water Supply spring has an estimated total flow from the sands and gravels of 1,440 m^3/day, of which approx. 600 m^3/day is used by the water supply) (EPA, 2021). Ballycallan Muintir Group Water Scheme is known to abstract groundwater from a borehole at Kilmanagh. The abstraction rate is estimated at 165 m^3/d; however, the groundwater in the sand and gravel aquifer is cased out of the borehole (Whelan, 2018). Tullaroan Group Water Scheme abstracts groundwater from a borehole at Tullaroan. The abstraction rate here is estimated at 105 m^3/d.

	Large springs and large known abstractions (m^3/d, contd.)	Several warm springs near junction of the Munster and Kings Rivers have an estimated combined flow rate of 1,000 m^3/day (Naughton, 1978). There are a number of smaller springs and rises marked on the OSI 6 inch raster map (1830s – 1930s), with the discharge rates from these springs unknown. Some of these are in the till areas overlying the sands and gravels, and soe of these issue from the sands and gravels themselves.
	Hydrochemical Signature	The groundwaters of this sand and gravel body are "Hard" and have an average EC of around 650 µS/cm (GSI, 2007). The chemical signature is regarded as calcium-bicarbonate (Ca/HCO_3, Whelan 2018) and it is therefore likely that the gravels are mostly calcareous. The electrical conductivity of one of the lowlying springs at Earlsland was measured during fieldwork, as 828 µS/cm.
Groundwater Flow Paths		The length of flow paths depend on the extent of the sand and gravel deposit. In general, regionally important sand and gravel aquifers are expected to have relatively long flow paths *i.e*. perhaps up to several kilometres. At Kilmanagh however, no annual trends are apparent (see Figure 4). Occasional sharp drops in groundwater flow have been observed, coinciding with periods when the Kilmanagh River has dried-up. This suggests that, in most summers, river recharge supports groundwater levels in the unconfined portion of the sand and gravel body.
Groundwater & Surface water interactions		Groundwater has been seen to discharge *via* lowlying springs throughout the area of the aquifer, therefore connectivity between groundwater and surface water is high.
Conceptual model		• This north-south oriented sand and gravel aquifer is situated between Tullaroan and Callan at elevations between 70 m and 140 m AOD. • Just 29% of the sand and gravel aquifer is at the surface, with glacial till derived from sandstones and shales capping large areas of the aquifer body. • Therefore the majority of the aquifer is considered as confined, particularly in the south; in the north, the aquifer is considered unconfined as the sands and gravels and alluvium comprising the aquifer are just below the ground surface. • Two desk study boreholes have measured the thickness of the overlying glacial till at 5 m and 6.4 m, in Oldtown and Kilmanagh Townlands, with thicknesses of sand and gravel of 10.5 m and 6.5 m beneath the till (GSI, 2019b). • Approximately 55% of the aquifer area has 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. • Transmissivity has been estimated to be between 200 and 250 m^2/d (GSI, 2007). • Direct recharge of rainfall occurs mainly in the northern, unconfined portion of the aquifer body, but an area of just over 8 km^2 of rejected recharge from the flanking ridges comprising Poor Bedrock Aquifer **(Pl)** either side of this zone, also contributes recharge to the aquifer. • In the summer months at least, river recharge from the Kilmanagh River also contributes to this northern portion's recharge. • Recharge mechanisms are more restricted and more complex further south, where the aquifer is confined and interfingers with both capping and interfingering, low permeability till units. • The presence of warm springs in this area suggests that some recharge is also provided by the dolomite aquifer below the confined portion. • Groundwater flows through the sand and gravel body move southwards from the unconfined portion, with some discharging back into the Kilmanagh River, and some passing into the confined portion. • Discharge mainly occurs to the series of small springs that lie close to the junction of the Munster and Kings Rivers, but some discharge is also expected directly to the Kilmanagh River (in the unconfined portion) and the Kings River (in the confined portion). • The minimum direct groundwater throughput in the aquifer itself is consequently estimated to be 7,300 m^3/d, which increases to a minimum potential 16,375 m^3/d when rejected recharge from the surrounding ridges is included.

Attachments	Figure 1: Location and extent Figure 2: Cross section Figure 3: Groundwater vulnerability Figure 4: Well hydrograph	
Instrumentation	**Hydrometric gauges:** **National Water Monitoring Stations;** **River:** **Groundwater:**	15024 (Ballyline) 15047 (Kilmanagh) RS15K020480 (King's) RS15M030700 (u/s King's River confluence) RS15T020450 (u/s Munster R confluence) RS15T020400 (Tullaroan Stream) RS15T020320 (d/s Kilmanagh. WWTP) RS15T020310 (u/s Kilmanagh. WWTP) RS15T020300 (Tullaroan Stream) RS15T020250 (Bridge at Oldtown) RS15T020200 (Bridge 0.5km d/s Tullaroan) RS15T020100 (Tullaroan Stream) GWIE_SE_G_08315000013 (Oldtown) Lakyle Cross (KIK115 - S385465) Kilmanagh 18/92 and 19/93 (both GSI boreholes)
Information Sources	• Buckley R. and Fitzsimons V. (2002). County Kilkenny Groundwater Protection Scheme. Geological Survey Ireland, 98 pp. • Daly, E.P. (1994). Groundwater Resources of the Nore River Basin. Geological Survey of Ireland Internal Report, Groundwater Section, GSI. • 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/ • EPA (2021). Drinking Water Supply Audit Report, Callan Public Water Supply. Report on behalf of Irish Water, 14 pp. • GSI (2002). County Kilkenny Groundwater Protection Scheme, Volume II: Source Protection Zones. • GSI (2007). Geological Survey Ireland, Kilmanagh Gravels GWB: Summary of Initial Characterisation. • 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: Quaternary Geomorphology Map. https://www.gsi.ie/en-ie/data-and-maps/Pages • GSI (2023b). Geological Survey Ireland, Internal groundwater databases. • Naughton, M.M. (1978). A Hydrogeological Study of the Upper Kilmanagh River Basin, Republic of Ireland. Unpublished (Research) MSc Thesis. University of Alabama. • 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. • Whelan, A. (2018). Establishment of Groundwater Zones of Contribution, Ballycallan Muintir Group Water Scheme, Co. Kilkenny. Report by IE Consulting for National Federation of Group Water Schemes and Geological Survey Ireland.	

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.

Kilmanagh Sand and Gravel Aquifer

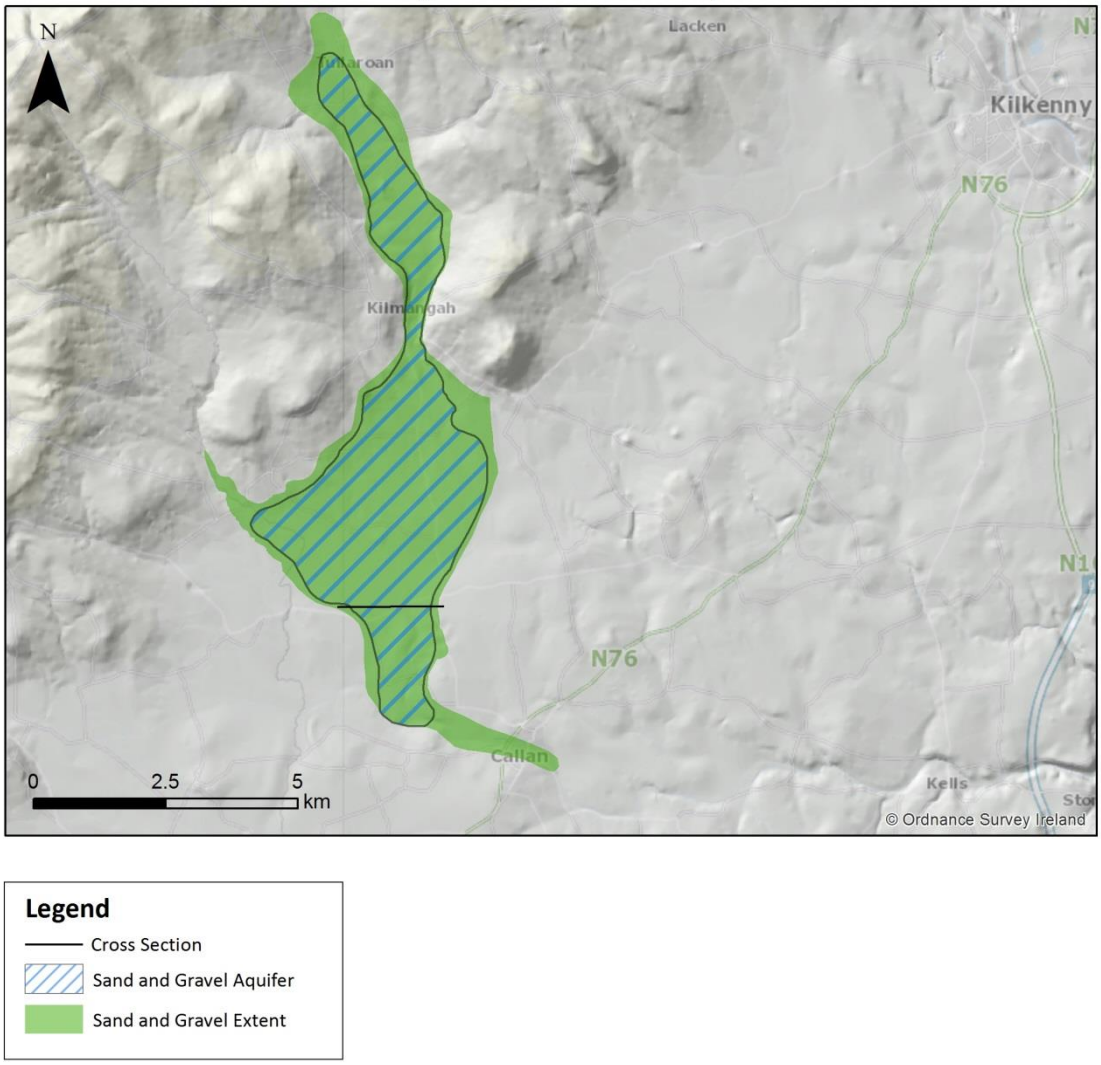


Figure 1: Kilmanagh Sand and Gravel Aquifer extent with cross section location.

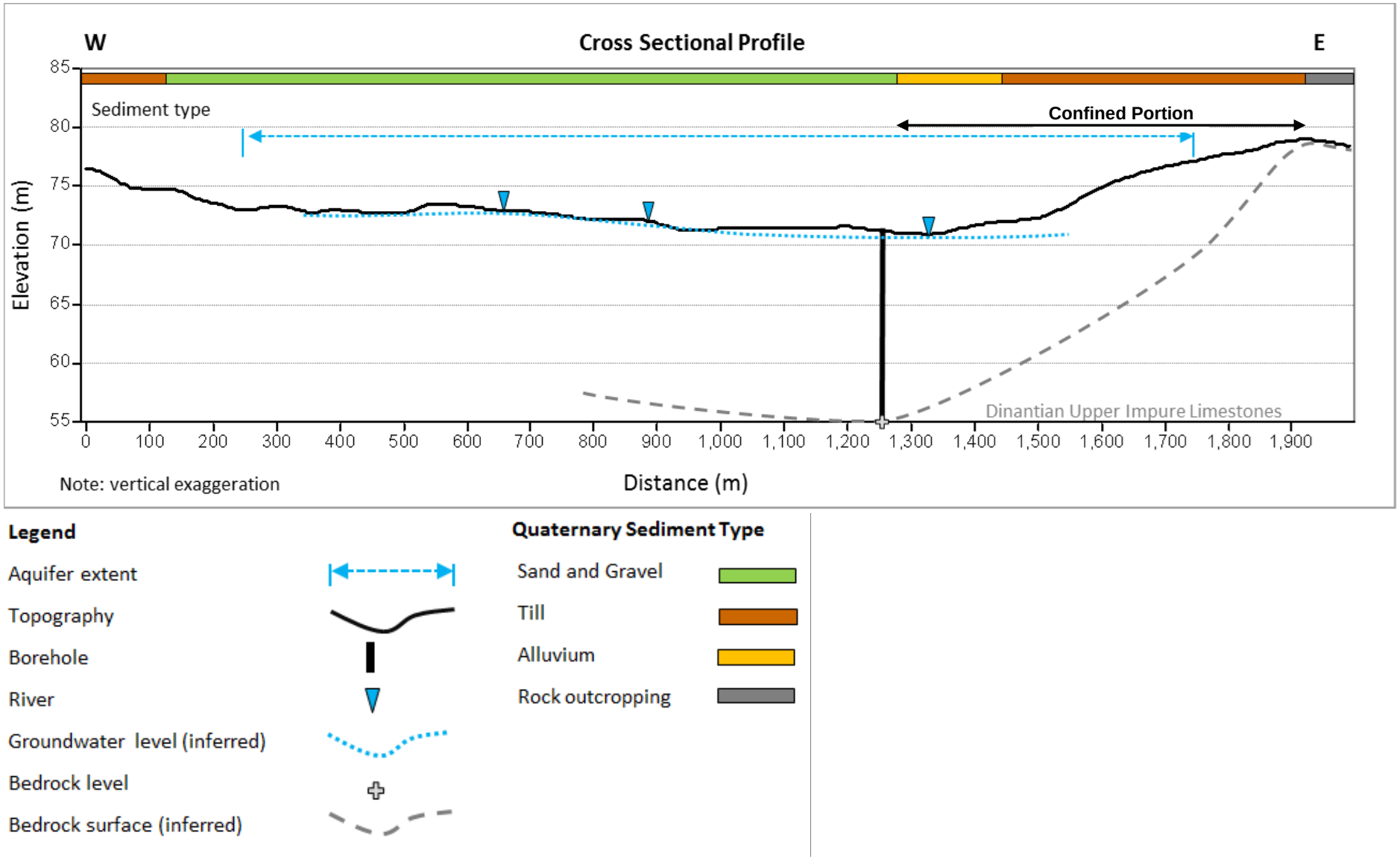


Figure 2: Cross section through the Kilmanagh Sand and Gravel Aquifer body.

Kilmanagh Sand and Gravel Aquifer Vulnerability

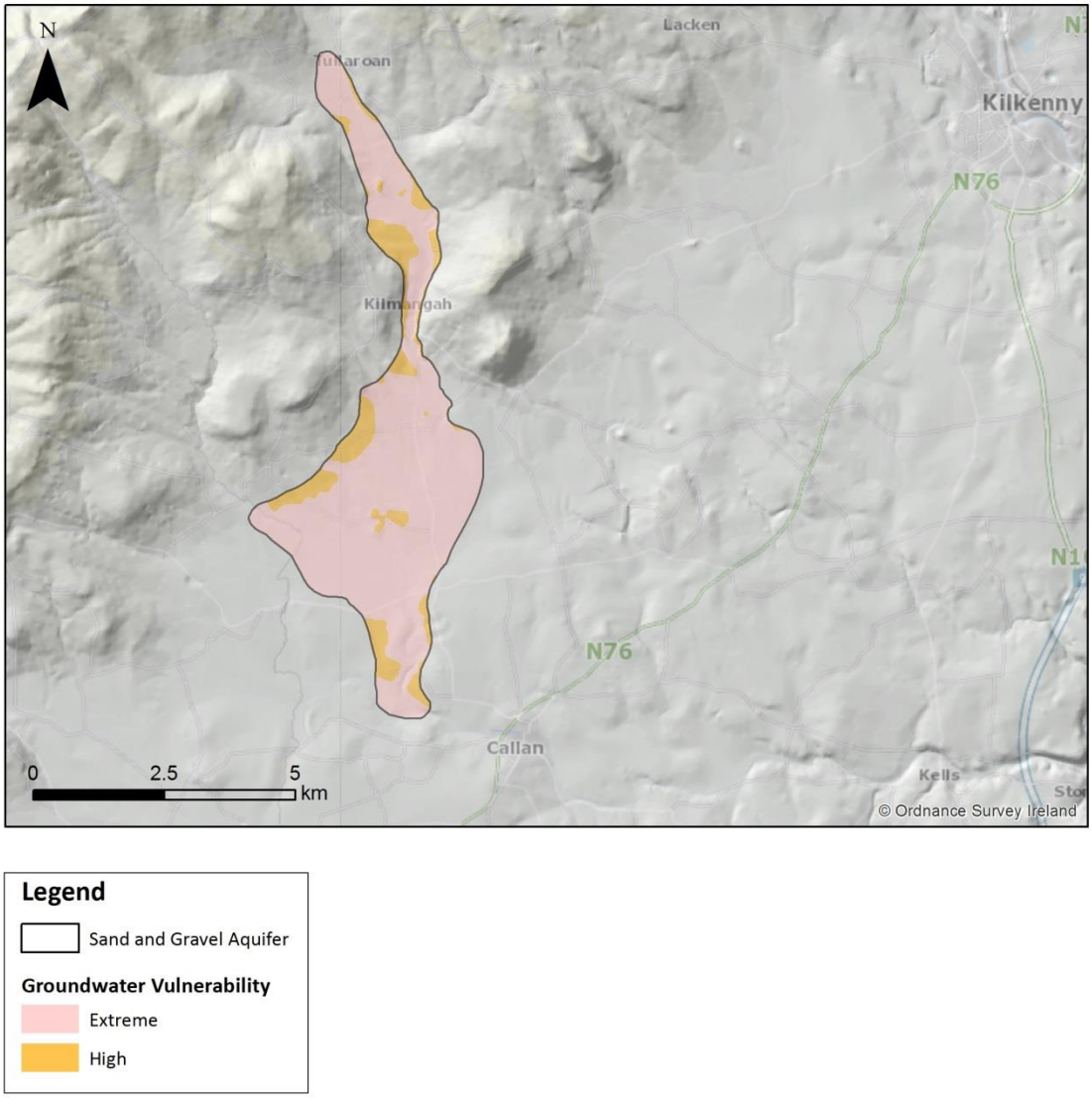


Figure 3: Groundwater vulnerability across the Kilmanagh Sand and Gravel Aquifer.

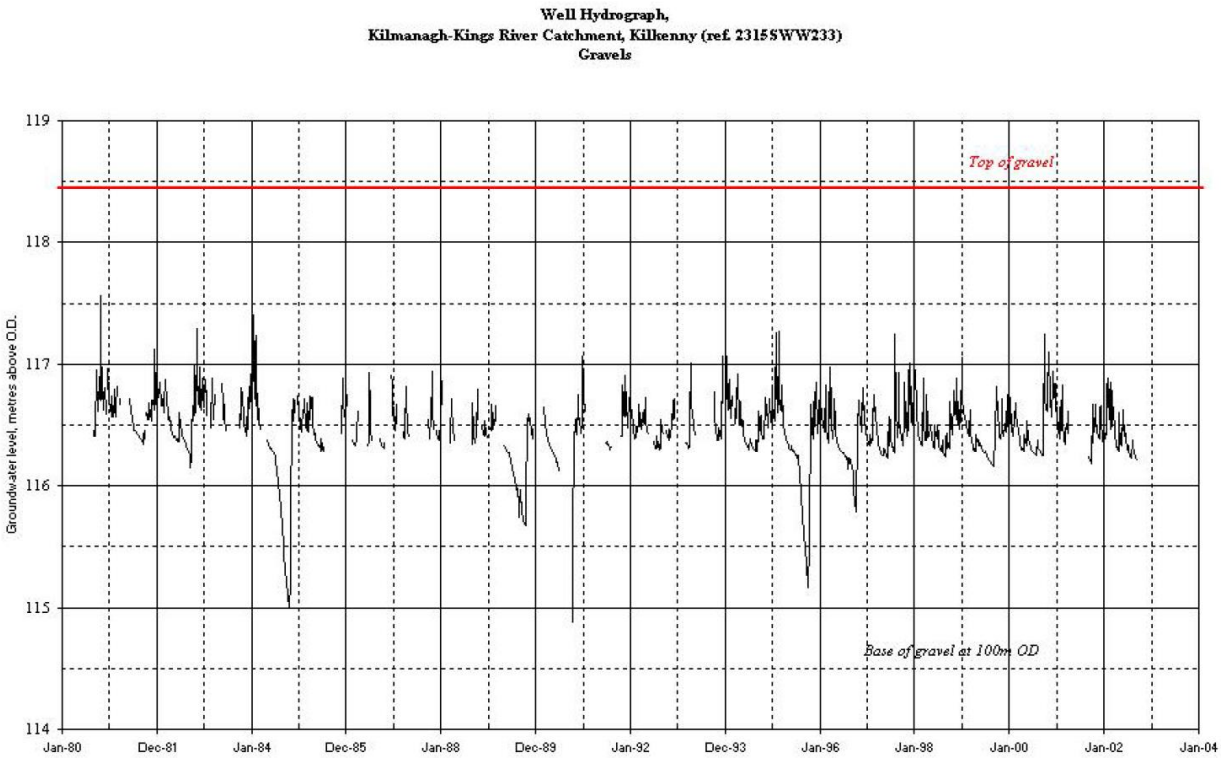


Figure 4: Well Hydrograph for the Kilmanagh Sands and Gravels.