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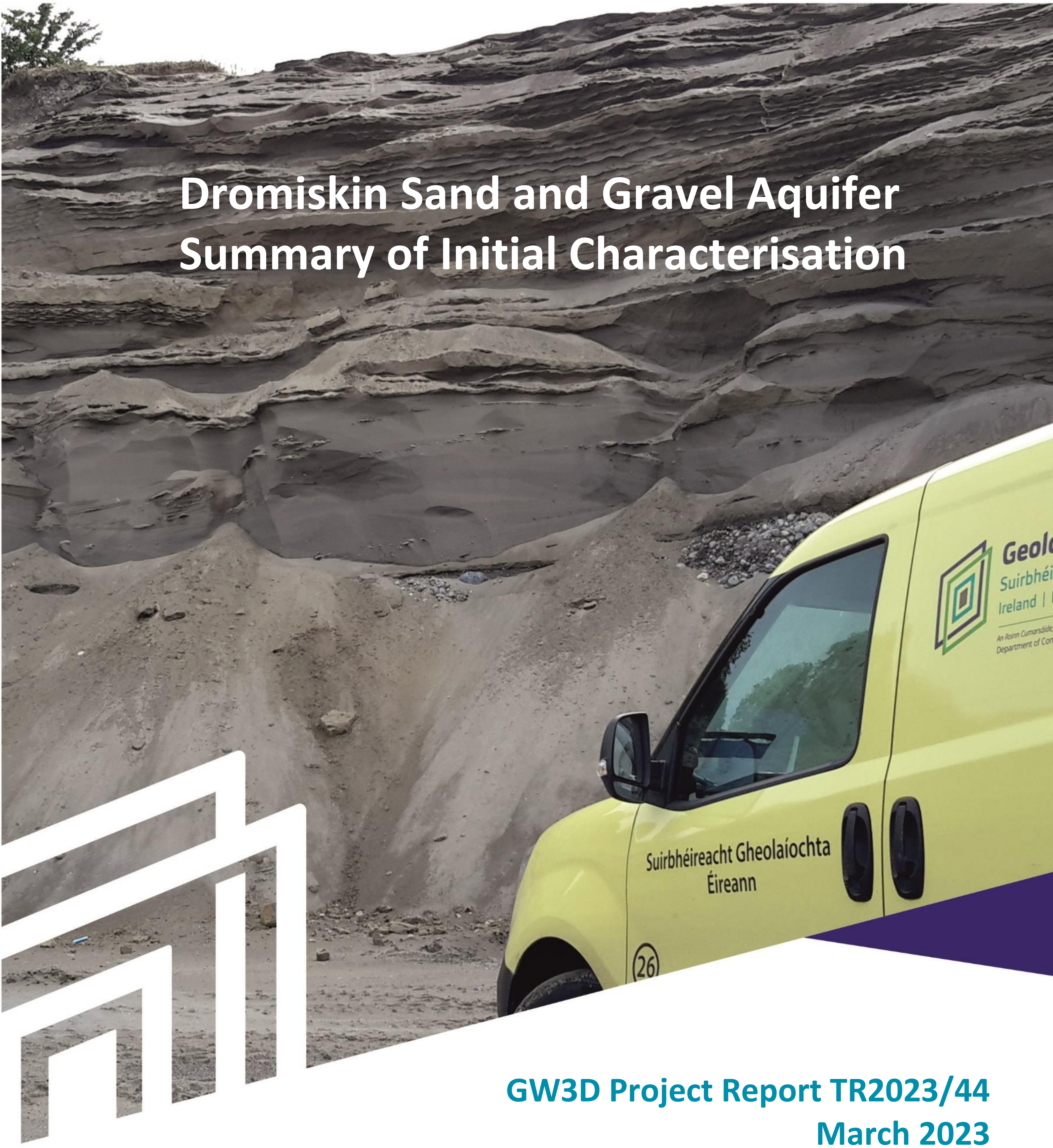
Dromiskin Sand and Gravel Aquifer Summary of Initial Characterisation



GW3D Project Report TR2023/44
March 2023

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

Dromiskin 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

GROUNDWATER3D

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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:** Fane River **Streams:** Several unnamed streams **Lakes:** Several unnamed ponds	Dundalk Bay SPA Dundalk Bay SAC Dundalk Bay pNHA	9.1

Topography	The Dromiskin sand and gravel aquifer is located north of Dromiskin village and south of the Fane River, includes the townlands of Commons, Mooretown, and part of Milltown. The deposit is gently undulating and is situated in a flat, low-lying, coastal area, where elevations do not exceed 10 m AOD. The majority of the area comprises, long, narrow, north-south oriented, dry swales of only a few decimetres amplitude; these are raised beaches deposited when sea levels were lower at the end of the last Ice Age (McCabe, 2008). Surrounding the sands and gravels are Irish Sea Till and alluvial deposits. To the east, along the coast, salt marshes occur. The Fane River flows from west to east along the northernmost boundary of the body.	
Geology and Aquifers	**Aquifer categories**	The Dromiskin sand and gravel deposit 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 sand and gravel deposit comprises a series of narrow, raised beaches oriented sub-parallel to the existing coastline (GSI, 2023a). These deposits are described as being composed predominantly of fine-grained beach sand deposits, which are interbedded with some gravels (An Forás Forbartha and GSI, 1982). The Mid Louth Regional Water Supply report indicates that the alluvium along the Fane River is gravelly in places and it may be connected to the aquifer body.
	Key structures	This deposit is composed in the majority of well sorted sands and poorly sorted gravels and boulder layers (An Forás Forbartha and GSI, 1982; GSI, 2023c). The presence of less permeable layers in the deposit, even if thin, can create perched water tables locally. The underlying bedrock is of greywacke (GSI, 2023a) which classified as a 'Poor' Aquifer (GSI, 2023a). The gravel deposit is in direct contact with bedrock intermittently, as low permeability till deposits which have been seen beneath the gravel in some boreholes (An Forás Forbartha and GSI, 1982) are discontinuous.
	Key properties	The aquifer consists of layers of well sorted sands, as well as some poorly sorted gravels and boulder layers, where the permeability varies considerably. Geotechnical investigations by Site Investigations Ltd. for the Dunleer to Dundalk M1 Motorway Project (which crosses 2.5 km lateral distance along the western edge of the aquifer) show that sands and gravels are not the dominant subsoil component of the aquifer along its' western boundary. The sediments recovered from boreholes included silt (53%), sands and gravels (35%) and clay (12%) (percentages based all layers recorded from 20 borehole logs, see Cross Section 2). Where clay and silt overlie sands and gravels, the aquifer is locally confined. Drilling undertaken by NUIG in 2016 in the central portion of the delineated aquifer body found that the GRAVEL is confined by overlying low permeability deposits. At this location a saturated COBBLE layer is overlain by 5 m depth of SILT/CLAY and CLAY. Within 3 - 4 hours after cessation of drilling, the water level rose from 11 m bgl to 3 m bgl. Borehole logs indicate bedrock is closer to the surface at the northern, southern and western boundaries of the body. Yields recorded in this aquifer are variable, from 'Moderate' to 'Excellent' (An Forás Forbartha and GSI, 1982; GSI, 2023b; Dunnes Drillers, 2016). The NERDO report of 1982 estimates that specific yield is 0.1 within this aquifer body, and groundwater storage was estimated as 12 m^3 x 10^6. This was calculated using an average saturated thickness 10 m, an area of 12 km^2, and a specific yield of 0.1. The re-delineation of the aquifer area as part of the this current 'GW3D' Project revises this storage estimate down to 9 m^3 x 10^6.

	Key properties (continued)	Daly and O'Connell (2013) reported "likely saline influence in to the marine gravels, possibly extending for approximately 750 m inland". This was confirmed in the northeastern portion of the aquifer during fieldwork, where "salty water" was reported by a farmer in a farm borehole well, only 400 m from the coastline (GW3D Fieldwork, 2016). There is also potentially a further area of saltwater intrusion extending 2 km inland from the coast towards 'The Commons' (Daly and O'Connell, 2013). According to notes on the 6 inch series historical geological map, 'The Commons' is an area of reclaimed land which comprises "small hillocks and gently undulating sand and gravel".
Overlying Strata	**Lithologies**	Mostly sands and gravels at surface, with relatively small portions of overlying alluvium or clay.
	Thickness	Where alluvium and/or clay occur, they are generally less than 3 m thick.
	% area aquifer near surface	Almost the entirety of the aquifer is just below the surface (>90% areally).
	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 range from 1 m to 3 m below ground level throughout the area of the aquifer body at Dromiskin. In areas where the water table is less than 3 m below ground level the aquifer vulnerability is mapped as 'Extreme'; this therefore covers the entirety of the area of the Dromiskin sand and gravel aquifer.
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 (DELG/EPA/GSI, 1999). Typically, the proportion of recharge that infiltrates to groundwater 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 locally, and prevent recharge of the true water table there. Depending on the relationship between the water table and river stage, the Fane River may also recharge the northern portion of the aquifer.
	Est. recharge rates	The estimated recharge rate to the aquifer from direct recharge is 260 mm/yr, from a rainfall estimate of 780 mm (Walsh, 2012). The minimum direct groundwater throughput in the aquifer is consequently estimated to be 3,686 m^3/d.
Discharge	**Large springs and large known abstractions (m^3/d)**	Drilling records supplied by Dunnes Drillers (2016) indicate that estimated yields from this aquifer can reach up to 545 m^3/day. Estimated yields through the aquifer body vary from 'Moderate' to 'Excellent'.
	Main discharge mechanisms	The groundwater is thought to discharge the Fane River and a number of unnamed streams, as well as at the coast and, in some cases, along dug ditches within the area of the sorted deposits during winter. A limited amount of groundwater from the aquifer will also recharge the underlying 'Poor' bedrock aquifer.
	Hydrochemical Signature	There is no set of complete hydrochemical analyses readily available for this aquifer. The conductivity of the groundwater was measured by NUIG (2016) while drilling in the body, and inflows between 5 m and 6 m bgl had a conductivity of 1,000 µS/cm, with salinity measured as 488 ppm. The confined groundwater encountered in this borehole, at 11.8 m bgl, had a conductivity of 1,150 µS/cm.

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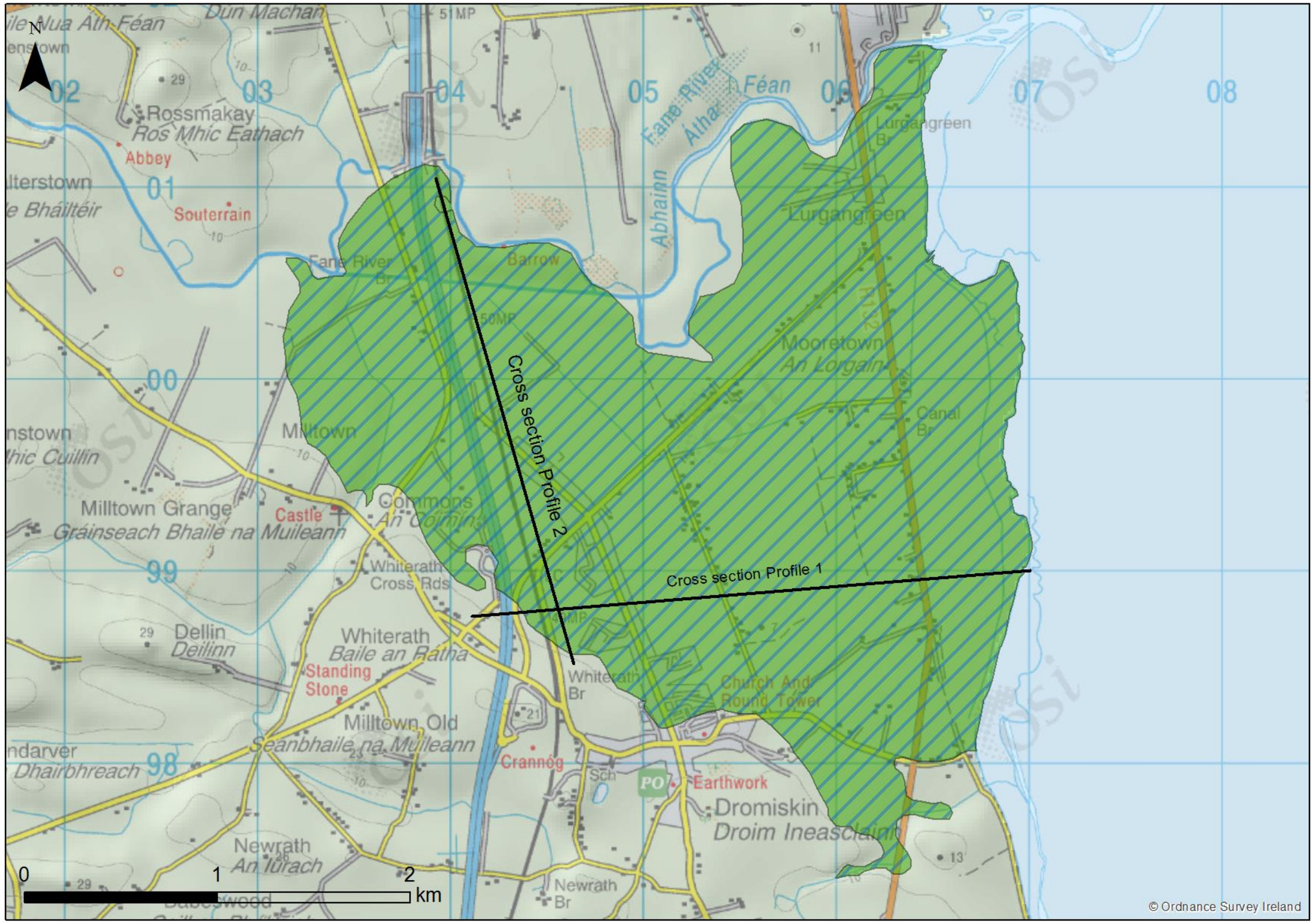
Groundwater Flow Paths	In general, locally important sand and gravel aquifers are expected to have relatively short flow paths, due to the restricted lateral extent of the aquifer. Water enters the aquifer as diffuse recharge from rainfall, and discharges to the Fane River, the unnamed streams and ditches within the deposits, as well as along the coast. The principal groundwater flow direction is thought to be from west to east through the southern half of the body, but northwards towards the Fane River in the northern portion.
Groundwater & Surface water interactions	Due to the shallow nature of the water table hydraulic connection between groundwater and surface water is expected to be high. The Fane River may act as both a discharge zone and recharge zone for the sand and gravel aquifer depending on the river stage. Tidal influence along the Fane River reaches 1.5 km inland (EPA mapviewer, 2023), and if the Fane River is recharging the aquifer along this reach, saltwater intrusion may occur.
Conceptual model	• The Dromiskin sand and gravel aquifer is a sand-dominated, marine beach deposit. • The boundaries of this aquifer are limited by the inland extent of the beach sands. • The Mid Louth Regional Water Supply report indicates that the alluvium along the Fane River is gravelly in places and it may be connected to the aquifer body. • The sand and gravel layers are interbedded with less permeable horizons, and these discontinuous layers of clay and silt form local confining units within portions of the aquifer. Clay and silt layers reduce the permeability of the aquifer, and the interconnectivity between sand and gravel layers. These finer sediments may also restrict recharge to some degree to the deeper sands and gravels. • Well yields in this area vary between 'Moderate' and 'Excellent'. • The water table is generally between 2 m to 3 m below ground level throughout the delineated area of the aquifer. • Recharge occurs by the infiltration of direct rainfall through the beach sands. • The underlying bedrock is a 'Poor Bedrock Aquifer' (GSI 2023a) so a limited amount of interaction between the sand and gravel aquifer with the bedrock aquifer is expected, as the bedrock aquifer can only accept a limited amount of recharge. This means that groundwater is retained in within the sand and gravel above the bedrock. • There is thought to be saltwater intrusion along the coastline at the eastern end of the aquifer, and towards 'The Commons', 2 km inland (Daly and O'Connell, 2013). This is probably due to the lowlying nature of the aquifer and the surrounding area (Daly and O'Connell, 2013). The depth to bedrock may also be a factor in the extent of the saltwater intrusion. At the coast, the bedrock is quite deep below the surface; sea water can more easily intrude into permeable sand and gravel material (Daly and O'Connell, 2013). The reclamation of 'The Commons' land from the sea makes a saltwater influence in this area more likely. • The minimum direct groundwater throughput in the aquifer is consequently estimated to be 3,686 m^3/d.
Attachments	Figure 1: Location and extent Figure 2: Cross sections Figure 3: Groundwater vulnerability

Instrumentation	**Hydrometric gauges:**	None present
	National Water Monitoring Stations;	
	River:	RS06F011000 (FANE – Lurgangreen Br) RS06F010970 (u/s ambient TPEFF2100D0264SW001) TW21006033FE1001 (d/s ambient TPEFF2100D0264SW001) RS06F010950 (FANE - Br d/s Stephenstown Br) RS06K210970 (KILLINCOOLE - 1st Br u/s from Fane R conf.)
	Groundwater:	None present

Information Sources	• An Foras Forbatha and Geological Survey Office (1982). Groundwater Resources in the N.E.(R.D.O). Region. March 1982. Volumes 1 to 3. • Daly, E. and O'Connell, Y. (2013). Groundwater and Land Resources in Tellus Border Coastal Zones: Final Report. Geological Survey of Northern Ireland and Geological Survey of Ireland Open File Report. 65pp. • DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland. • Dunnes Drilling Services Ltd. (2016). *Personal Communication*. • EPA (2023). EPA mapviewer. 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. • GSI (2023c). Geological Survey Ireland. Internal Geotechnical Database. • Hunter-Williams, N., Misstear, B., Daly, G., Johnson, P., Lee, M., Cooney, P. and Hickey, C. (2011). National Groundwater Recharge Map for Ireland. Geological Survey Ireland and Department of Civil, Structural and Environmental Engineering, Trinity College Dublin. • McCabe, A.M (2008). Glacial Geology and Geomorphology: The Landscapes of Ireland Dunedin Academic Press, Edinburgh. • Mid-Louth Regional Water Supply Study: Groundwater Resources. Document Ref: 72_DG_03. August 2002. Submitted by Atkins. • Murphy, O. (2012). County Louth Groundwater Protection Scheme. Report to Louth County Council. Geological Survey of Ireland. • NPWS map viewer. http://webgis.npws.ie/npwsviewer/ • Ó' Riain, G. (2004). Water Dependent Ecosystems and Subtypes Draft Report. WFD Support Projects. Compass Informatics in association with National Wildlife and Parks Service (DEHLG). • 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 of Ireland, 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.

Dromiskin Sand and Gravel Aquifer



Legend

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

Figure 1. Dromiskin Sand and Gravel Aquifer extent with cross section locations.

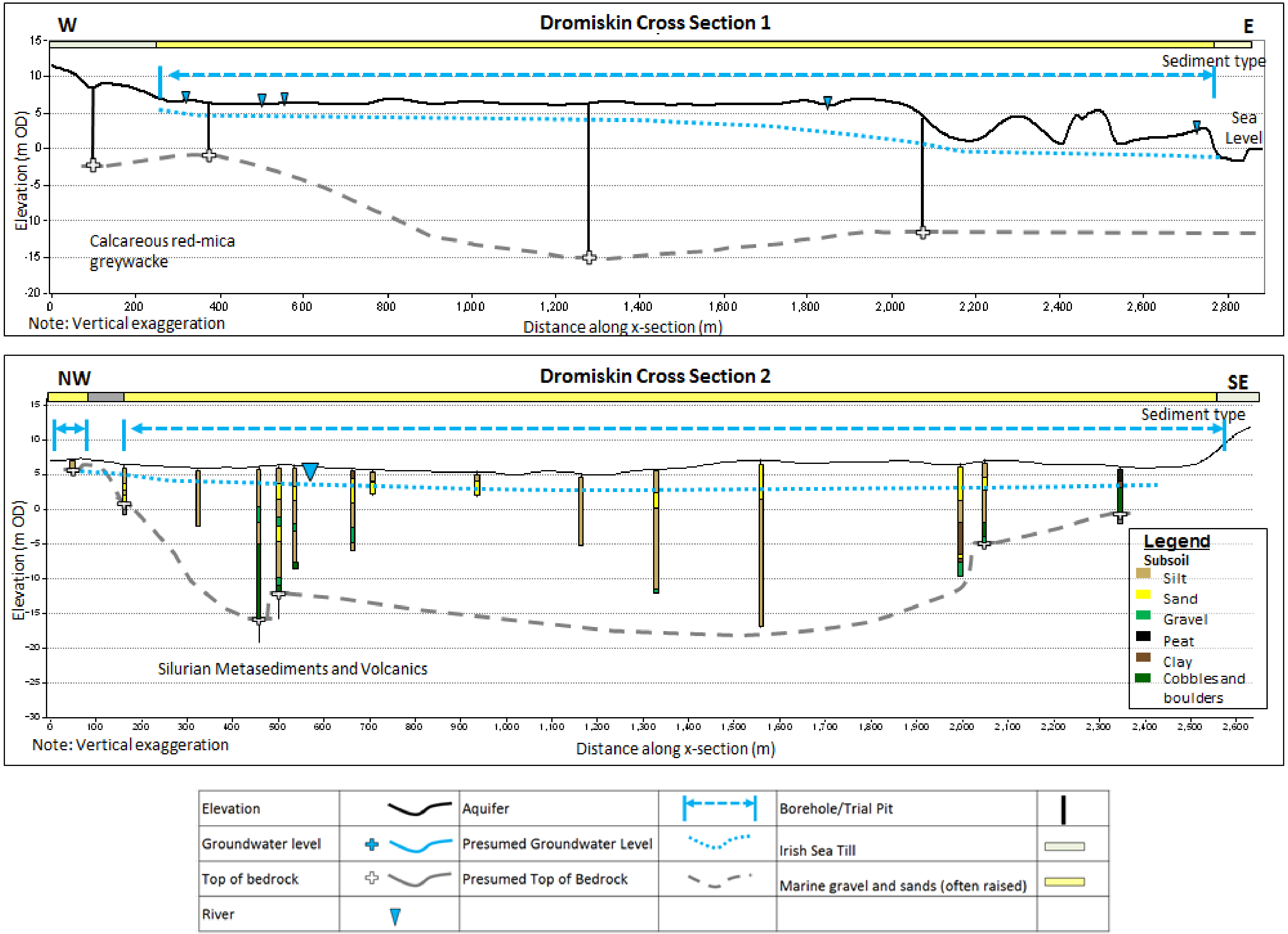


Figure 2. Cross sections through the Dromiskin Sand and Gravel Aquifer body.

Dromiskin Sand and Gravel Aquifer

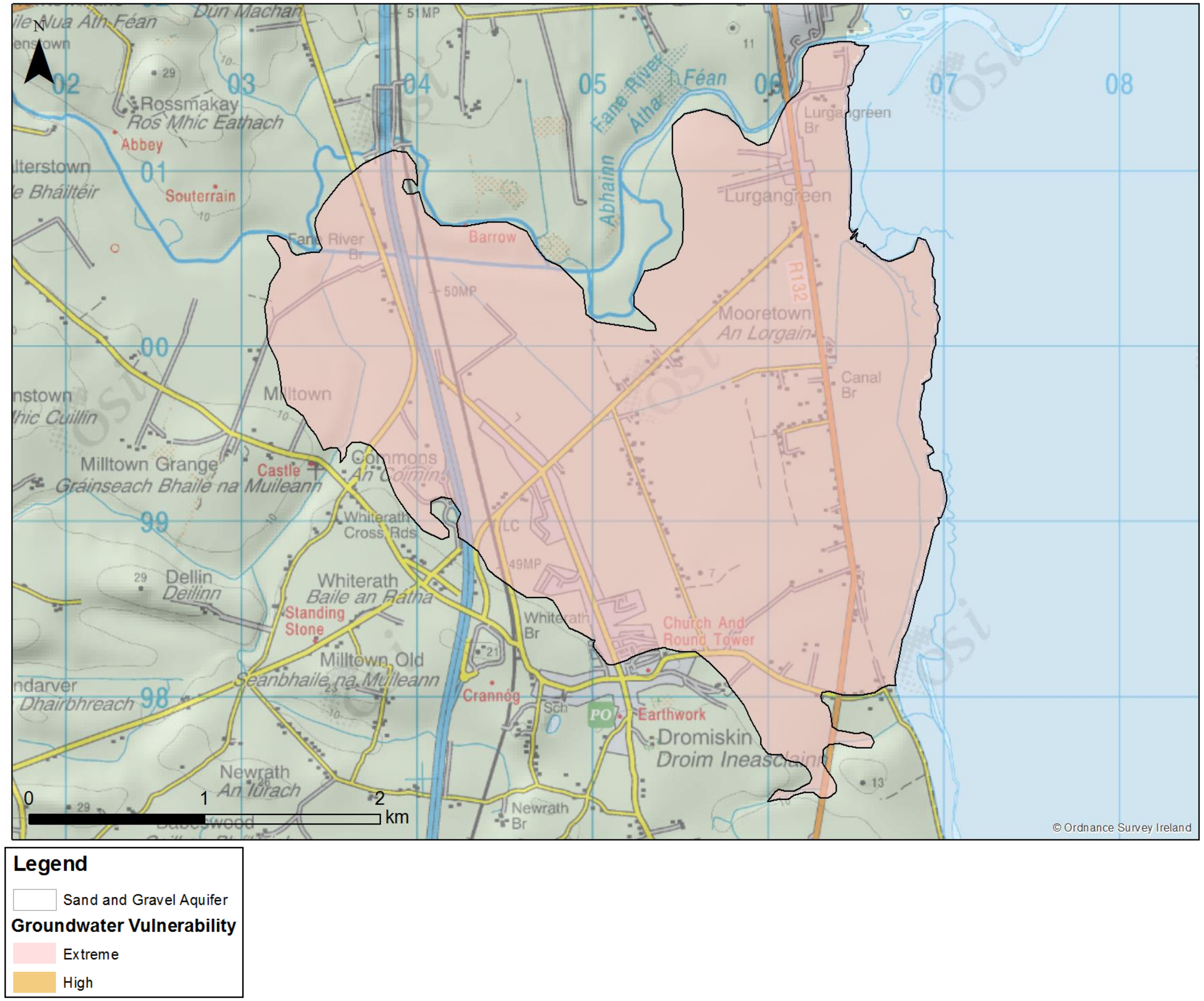


Figure 3. Groundwater vulnerability across the Dromiskin Sand and Gravel Aquifer.