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Culliagh More Sand and Gravel Aquifer Summary of Initial Characterisation



GW3D Project Report TR2023/35
March 2023

Culliagh More 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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Culliagh More Sand and Gravel Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km ²)
32 – Erriff - Clew Bay Galway County Council		Rivers: Lahill River Streams: Several unnamed streams Lakes: None	Maumturk Mountains SAC Maumturk Mountains pNHA Maumtrasna Mountain Complex pNHA	0.24
Topography	The Culliagh More sand and gravel deposits begin at Leenaun village at the head of Killary Harbour, and extend southeastwards along the Maam Valley, between the Maumturk and Maumtrasna Mountains. The delineated area of aquifer is set within these deposits, located within a wider section of the valley floor in the townland of Culliagh More, directly north of a col. This col separates the Culliagh More aquifer, at the northeast, from the Culliagh Beg aquifer, at the southwest. The sediments comprise hummocky, delta and outwash plain sands and gravels, which are extensively described in Coxon (2005). There is evidence that the sands and gravels continue beneath the blanket peat, especially along the valley floor (Coxon, 2005). The elevation of the sands and gravels surface within the Culliagh More aquifer body range from 60 m to 85 m AOD. The Lahill River rises from the aquifer and meets mountain streams before flowing northwards, entering Killary Harbour at Leenaun.			
	Geology and Aquifers	Aquifer categories	The aquifer body consists of an outwash plain incised by the Lahill River. Field observations in the area show that there are intermittent terraces of sands and gravels extending through the length of the valley, either side of the river (Thomas and Chiverell, 2005). Exposures of up to 1 m depth sands and gravels can be observed within the area of delineated aquifer body. A trial hole assessment shows >0.5 m depth of gravels beneath c. 1 m depth of clay deposits at Culliagh More. Bedrock outcrops can be observed within the river bed, c. 200 m downstream of the delineated aquifer area. Based on cross sections and associated topographic analysis, it is considered that a large proportion of the sand and gravel deposits have >10 m depth. Groundwater levels were obtained from the stream and river levels, with the assumption that groundwater discharges into these. A trial hole assessment c. 35 m from the river shows a groundwater level of 1.6 m BGL. Based on likely geometry and extent, this deposit is classified as a Locally Important Sand and Gravel Aquifer (Lg) (GSI, 2017), and overlies bedrock of Ordovician Metasediments, which is a poor bedrock aquifer (PI) (GSI, 2017).	
		Main aquifer lithologies	Glaciofluvial sands and gravels derived chiefly from Lower Palaeozoic sandstones and shales (GLPSS; GSI, 2023b).	
		Key structures	Exposures within the sands and gravels show rounded, poorly sorted materials. No exposures showed any bedding, possibly due to the limited height of the exposed faces.	
		Key properties	There are no known data in this aquifer on yields, permeabilities or transmissivities. Sand and gravel aquifers generally consist of unconsolidated, coarse-grained material, usually containing less than 8% fines (Ó'Súilleabháin, 2000). Typically transmissivity ranges from 200 – 1500 m ² /d (Kelly et al., 2015). Specific yield is expected to be high (10%). Groundwater is considered to be unconfined within the aquifer at Culliagh More. 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	Exposures of up to 1 m depth of sands and gravels can be observed within the delineated aquifer body. A trial hole assessment, undertaken as part of a planning application, shows >0.5 m of sorted gravels beneath c. 1 m of clay deposits. Bedrock outcrops can be observed within the river bed, c. 200 m downstream of this locality. From cross sections and geomorphological analysis, it is considered that c. 30% of the aquifer of the aquifer has greater than 10 m depth of sands and gravels. The deepest sands and gravels, at the northwestern end of the deposit and close to Leenaun, are not included as part of the delineated aquifer body as they are unsaturated and their base slopes northwestwards, down-valley.	
Overlying		Lithologies	Sands and gravels at surface, with relatively large portions covered by blanket peat (83% of the delineated aquifer area).	
		Thickness	Exposures show <3 m depth of overlying blanket peat, where present.	



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	% area aquifer near surface	Approximately 17% of the area of the delineated aquifer is just below the surface; the remainder is buried beneath peat.
	Vulnerability	The groundwater vulnerability of the sands and gravels aquifer is 'Extreme' wherever the water table is <3 m from the surface, whereas in all other areas where the water table is at >3 m depth from surface, the vulnerability is classed as 'High'. Extreme vulnerability occurs over approximately 95% of the delineated aquifer area at Culliagh More.
Recharge	Main recharge mechanisms	Diffuse recharge occurs <i>via</i> rainfall percolating through the unsaturated sands and gravels. Due to the high permeability of sand and gravel, a high proportion of the available recharge will percolate down to the water table where these materials are at surface. A significant amount of rejected recharge enters the aquifer from the flanking mountains at Munterowen West, and at Culliagh More.
	Est. recharge rates	Recharge to the aquifer is estimated at 415 mm/yr, which is quite low owing to the fact that much of the body is covered by peat. The figure is based on an average annual rainfall of 2,741 mm/yr (Walsh, 2012). This gives a minimum direct throughput of 83 m ³ /d, which rises to a potential 1,387 m ³ /d when rejected recharge is included. It must be noted that there is likely to be an element of seasonal variability associated with this.
Discharge	Large springs and large known abstractions (m³/d)	There are no known large springs or abstractions from this aquifer body.
	Main discharge mechanisms	Groundwater is expected to discharge <i>via</i> some small lowlying springs as seen on OSI 6 inch raster map (1830s – 1930s) in Culliagh More Townland. Groundwater also discharges directly to the Lahill River, and to other small streams.
	Hydrochemical Signature	There are no data readily available to assess the hydrochemistry of this aquifer, but given the bedrock and subsoils geology of the area, it is expected that the hydrochemical signature is of calcium magnesium bicarbonate (CaMg HCO ₃).
Groundwater Flow Paths		The length of flow paths depend on the size of the sand and gravel deposit. In general, locally important sand and gravel aquifers are expected to have relatively short flow paths, <i>i.e.</i> up to several hundred metres. Given the geometry of the sands and gravels at Culliagh More, the maximum flow path length will be no more than approximately 200 m.
Groundwater & Surface water interactions		Groundwater is expected to discharge to the streams and springs, as specified above. Hydraulic connection between the groundwater in the aquifer and the adjacent streams is therefore expected to be high.
Conceptual model	- The Culliagh More sand and gravel aquifer consists of glaciofluvial outwash plain sediments, with the sands and gravels derived chiefly from Lower Palaeozoic sandstones and shales (GLPSsS). - The deposits are situated within the Maam Valley to the southeast of Leenaun, at elevations between 60 m and 85 m AOD. - The subsoils overlie bedrock of Ordovician Metasediments, which is a poor bedrock aquifer (PI). - The aquifer is covered with large portions of blanket peat, covering approximately 83% of the delineated aquifer area. - The sands and gravels within the aquifer are inferred to be greater than 10 m thick over much of their extent, with c. 30% of the aquifer estimated as having ≥5 m depth sand and gravel saturation. - Across approximately 95% of the delineated aquifer area, groundwater levels are <3 m BGL. - Diffuse recharge occurs <i>via</i> rainfall percolating through the unsaturated sands and gravels. Recharge to the aquifer is estimated as 415 mm/yr. - This gives a minimum direct throughput of 83 m³/d, which rises to a potential 1,387 m³/d when rejected recharge is included. It must be noted that there is likely to be an element of seasonal variability associated with this. - The length of the flow paths in this sand and gravel aquifer is expected to be in the order of several hundred metres, but given the geometry of the sands and gravels at Culliagh More, the maximum flow path length will be about 200 m. - Groundwater discharges <i>via</i> seeps and springs to the Lahill River, as well as to several unnamed streams.	



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Attachments	Figure 1: Location and extent Figure 2: Cross section Figure 3: Groundwater vulnerability
Instrumentation	Hydrometric gauges: None present National Water Monitoring Stations; River: None present Groundwater: None present
Information Sources	- Coxon, P. (Ed.) (2005). The Quaternary of Central Western Ireland: Field Guide, Quaternary Research Association, London. - 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 - Kelly, C., Hunter Williams, T., Misstear, B.M. and Motherway, K. (2015). Irish Aquifer Properties – A reference manual and guide. Prepared on behalf of the Geological Survey of Ireland and the Environmental Protection Agency. 110 pp. - NPWS (2023). National Parks and Wildlife Service Map Viewer. http://webgis.npws.ie/npwsvviewer - 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. - Thomas, G. and Chiverrell, R. (2005). Leenaun. In: Coxon, P. (Ed.) <i>The Quaternary of Central Western Ireland</i>. Field Guide, Quaternary Research Association, London. pp. 172-178. - Walsh, S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin.
Disclaimer	Note that all calculations 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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Culliagh More Sand and Gravel Aquifer

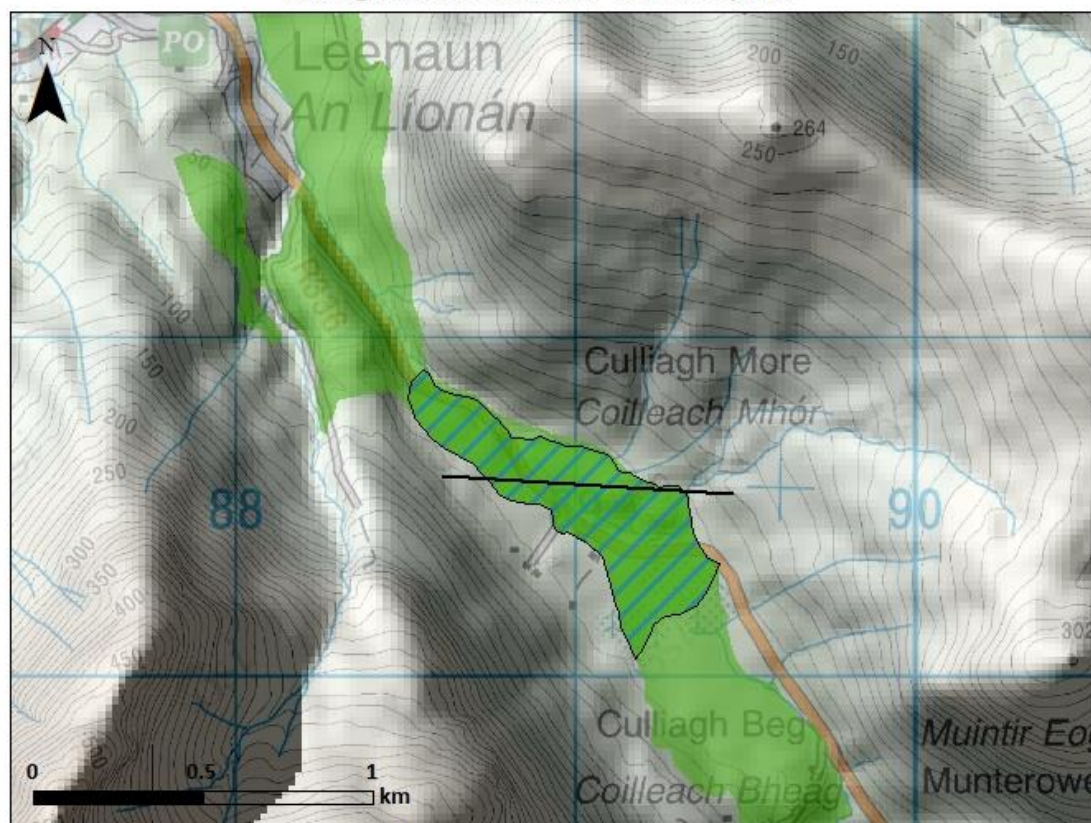
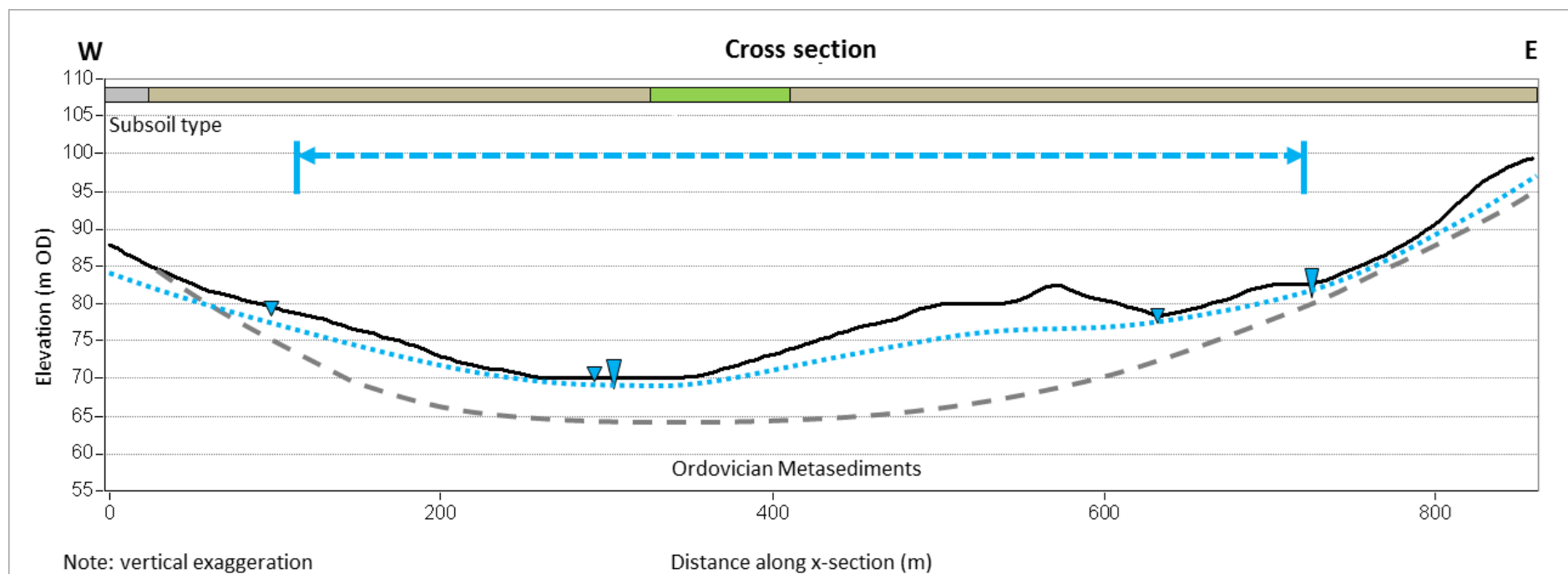


Figure 1: Culliagh More Sand and Gravel Aquifer extent with cross section location.

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LEGEND			
Feature		Subsoil Type	
Topography		Sands and gravels	
Groundwater level		Esker	
Top of bedrock		Windblown sands	
Borehole/Trial Pit		Till	
Dug well		Peat	
S&G exposure		Rock outcrop	
Active quarry		Alluvium	
Freshwater lake		Lake sediments	
GW Ponding		Top of S&G	
River		Top of till	
Stream/drainage channel		Karst Feature	
Spring		Spring	
Aquifer envelope		Turlough	

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

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Culliagh More Sand and Gravel Aquifer Vulnerability

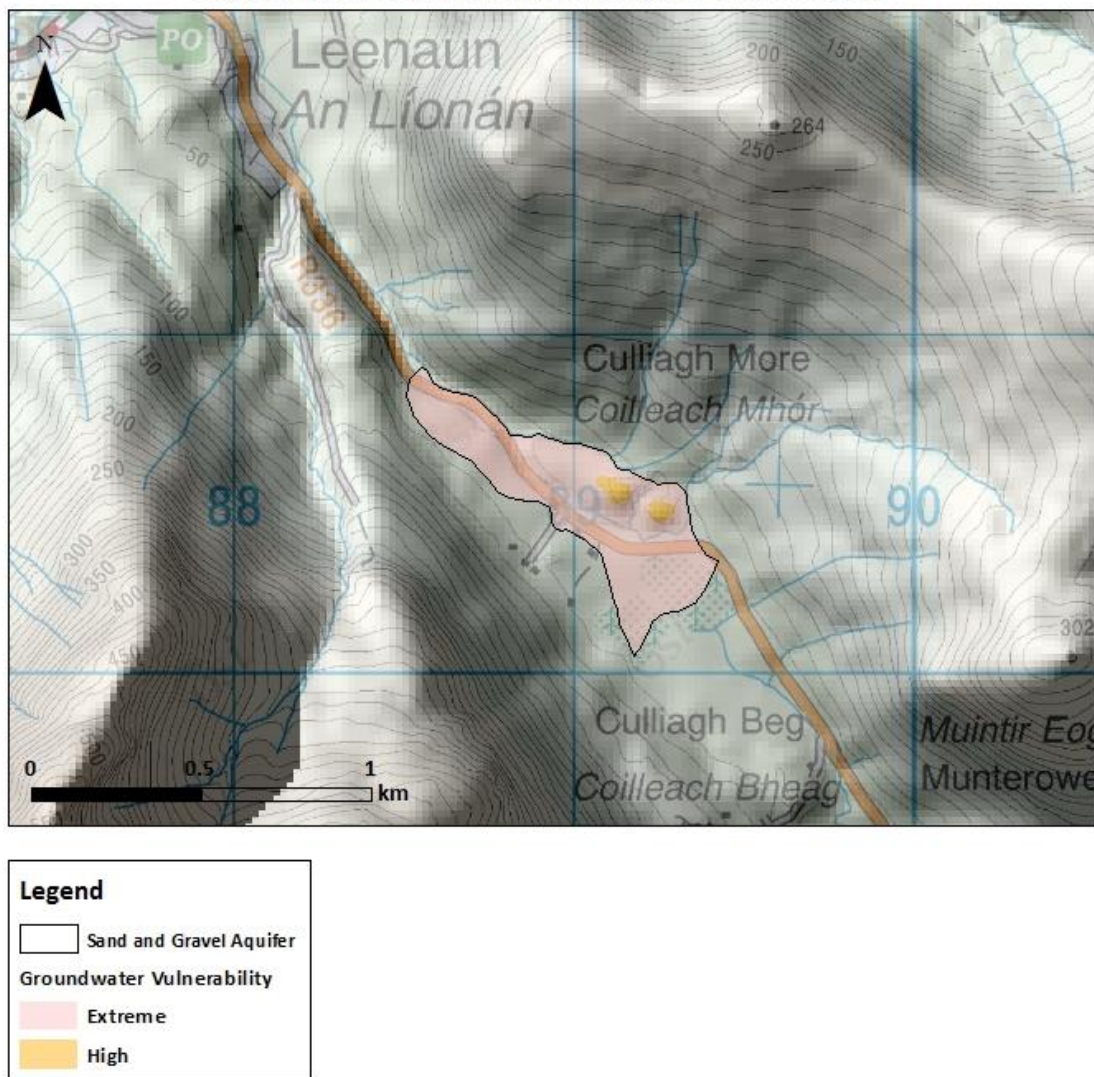


Figure 3: Groundwater vulnerability across the Culliagh More Sand and Gravel Aquifer.