

Limerick City & County Council in partnership with Limerick Twenty Thirty DAC

Cleeves Riverside Quarter

Structural Report

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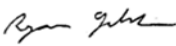
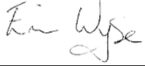
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Ove Arup & Partners Ireland Limited
Hartstonge House
Upper Hartstonge Street
Limerick
Ireland
arup.com

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		Name	Ryan Gibbons Liam Hartnett Eoin Wyse	Noel Sheridan	Noel Sheridan
		Signature	  	 	

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1. Introduction

This Structural Engineering Report has been prepared by Arup on behalf of Limerick City & County Council in partnership with Limerick Twenty Thirty DAC (LTT) as part of a planning application for the proposed Cleeves Riverside Quarter Development.

Limerick City and County Council, in partnership with Limerick Twenty Thirty DAC, intends to seek the approval of An Coimisiún Pleanála in accordance with Section 175 and 177AE of the Planning and Development Act 2000, as amended, for a mixed-use development that seeks the regeneration and adaptive reuse of a strategic brownfield site, as part of the Limerick City and County Council 'World Class Waterfront revitalisation and transformation project'.

The purpose of the report is to detail and rationalise the foundations and structural scheme proposed for the various residential buildings on the Cleeves Riverside Quarter (CRQ) site and to demonstrate that the foundations are adequate and appropriate for the soil conditions.

2. The Proposed Development

The proposed development comprises Phase II, of an overall Masterplan with four phases of development proposed. Phase II is subsequent to ongoing stabilisation and repair of the Flaxmill protected structure (Phase I). Phase III is intended to comprise an educational campus, inclusive of the adaptive reuse of the Flaxmill Building as part of that development and will be subject to a future separate application. Phase IV comprising the Shipyard site will be the final phase of development.

The proposed development provides for the (A) Demolition of a number of structures to facilitate development and (B) Construction and phased delivery of (i) buildings within the site ranging in height from 3 – 7 stories (with screened plant at roof level) including (a) 234 no. residential units; (b) 270 no. student bedspaces (PBSA) with ancillary resident services at ground floor level; (c) 256sqm of commercial floorspace; and (d) a creche; (ii) extensive public realm works, (iii) riverside canopy and heritage interpretative panels, (iv) 3 no. dedicated bat houses; (v) Mobility Hub with canopy; and (vi) all ancillary site development works including (a) water services, foul and surface water drainage and associated connections across the site and serving each development zone; (b) attenuation measures; (c) raising the level of North Circular Road; (d) car and bicycle parking; (e) public lighting; (f) telecommunication antennae and (g) all landscaping works. Consent is also sought for use of the PBSA accommodation, outside of student term time, for short-term letting purposes.

The Geotechnical investigation undertaken as part of this report examines the wider Masterplan area while the structural scheme and the assessment of the foundations considers the Phase II proposed development. See Figure 2 below outlining the proposed Phase II development.

2.1 Site Location

The site, known locally as 'Cleeves Riverside Quarter' comprises the former industrial mill complex ('Cleeves') situated on the northern side of the River Shannon, Limerick City and occupies the area between; Stonetown Terrace Road to the northeast; O'Callaghan Strand to the southeast; Condell Road (R527) to the southwest; and, Salesian Primary School and the 'Fernhill' residential estate to the northwest and west respectively - all situated in the townland of Farranshone More in Limerick City. The site is dissected by North Circular Road where it extends between Shelborne Road Lower and O'Callaghan Strand. The full extent of the planning application site is shown in Figure 1.

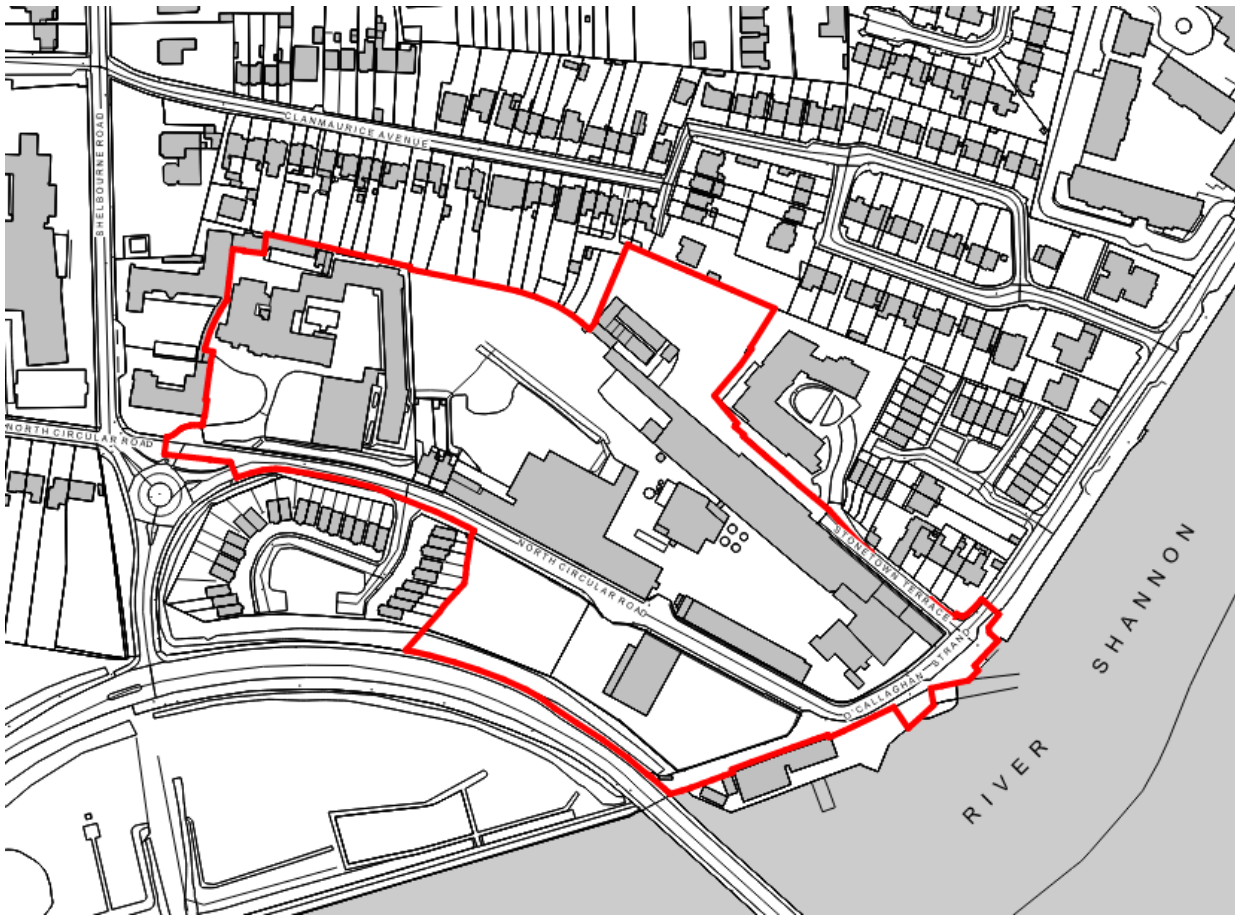


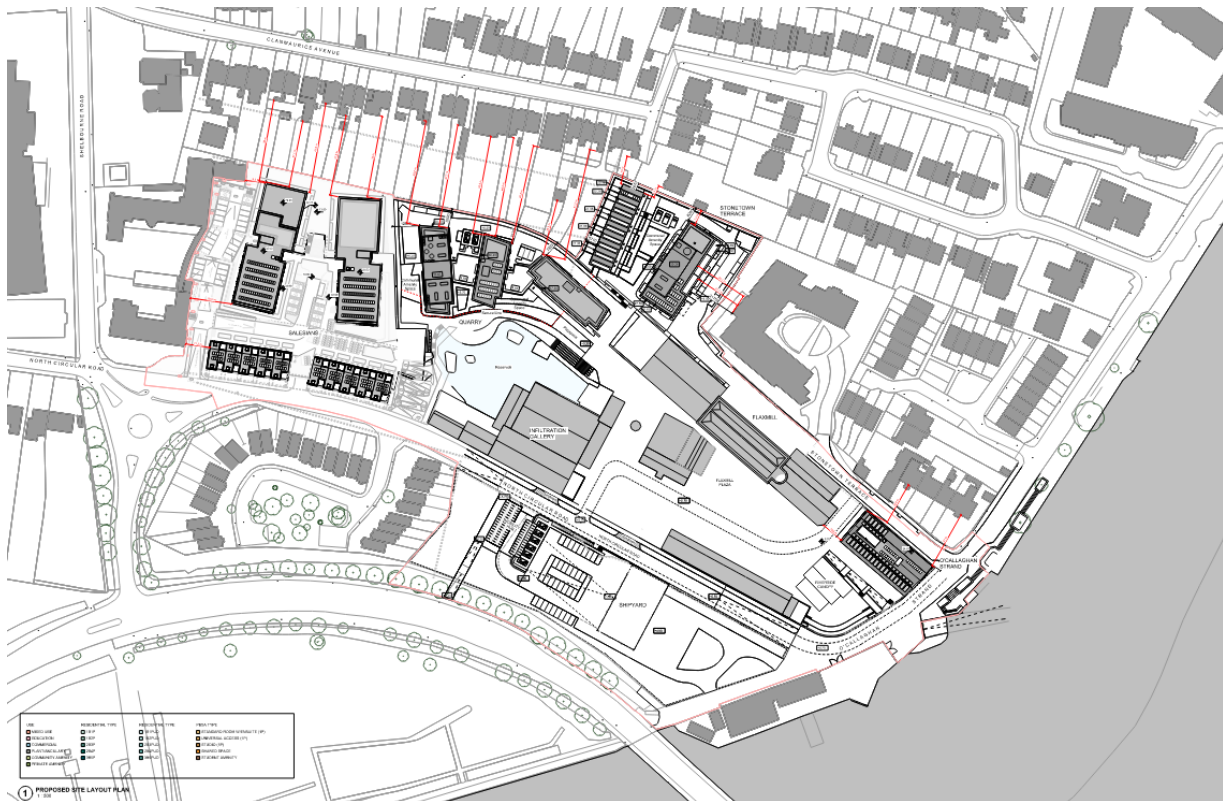
Figure 1: Application Boundary

2.2 Residential Zones

Construction of seven residential apartment buildings is proposed to take place within 4 development zones. The four 'zones' within the site range in height from 3 – 7 storeys (with screened service plant at roof level) comprising; (a) 234 no. residential units; (b) 270 no. student bedspaces with ancillary resident services at ground floor level; (c) 256sqm of commercial floorspace; and (d) a creche. The specific development details of each proposed development zone comprise the following:

- **Saleians Zone** – 1 no. building with 2 no. blocks extending to 6 and 7 storeys comprising 146 no. apartments (76 no. 1 bed; and 70 no. 2 bed); a creche; semi basement car and bicycle parking; reception area, plant rooms, and refuse storage, with screened external plant and photovoltaic panels at roof level; 20 no. 3 storey 3 bed triplex units with photovoltaic panels at roof level; and 30 no. car parking spaces for the dedicated use of the adjoining Saleians Primary School.
- **Quarry Zone** – 1 no. Purpose Built Student Accommodation (PBSA) building with 3 no. blocks extending to 6 and 7 storeys comprising 270 no. bedspaces with study rooms, shared areas, exercise room, reception area, plant rooms, refuse storage and bicycle parking all at ground floor level and screened external plant and photovoltaic panels at roof level. Provision is made for telecommunication antennae on the roof top of one block. Consent is also sought for use of the PBSA accommodation, outside of student term time, for short-term letting purposes.
- **Stonetown Terrace Zone** – 1 no. building extending to 4 - 5 storeys comprising 38 no. apartments (6 no. studios; 12 no. 1 beds; and 20 no. 2 beds) with plant rooms and refuse storage at ground level, ancillary infrastructure at basement level at northern end of the block, with screened external plant and photovoltaic panels at roof level; 9 no. 3 storey 3 bed townhouses with photovoltaic panels at roof level; and a dedicated secure bicycle storage facility.

- O’Callaghan Strand Zone – 1 no. building extending to 4 / 5 storeys comprising 21 no. apartments (9 no. 1 bed and 12 no. 2 bed) with an open roof structure accommodating communal open space, plant and photovoltaic panels; and 299qm of commercial ground floorspace intended to accommodate Class 1, Class 2 and / or Class 3 uses, with provision for car parking in the undercroft.



3. Geotechnical Investigation

3.1 Scope and objective of this work

This ground investigation summary has been prepared to inform planning and preliminary design of the Cleeves Riverside Quarter proposed development in Limerick City (hereafter referred to as the 'site'). This has been prepared based on the site-specific ground investigation undertaken from March to May 2025, and to a lesser extent the publicly available information from the Geological Survey Ireland (GSI).

This section includes a review of historical ground investigation information in the vicinity (within approximately 500m) of the site, available information in the public domain from the online databases of the GSI, Environmental Protection Agency (EPA), Táilte Éireann (previously Ordnance Survey Ireland), and site-specific ground investigation information. This summary should be read in conjunction with the following documents:

1. Desk Study
2. Cleeves Riverside Quarter, Ground Investigation – Factual Report (PGL, 2025)

This section of the report presents a summary of the Priority Geotech Limited (PGL) 2025 ground investigation and provides a preliminary ground model for the site which is used to identify potential ground related hazards which may impact on the design and construction of the proposed redevelopment of the site.

3.2 Limitations

This document has been prepared to inform planning and the preliminary design of the proposed redevelopment of the site.

Any third party using this information for any purpose other than the above does so at their own risk, and no responsibility is undertaken to any third party.

3.3 Geotechnical category

The proposed development at the site can be assigned Geotechnical Category 2 in accordance with I.S. EN 1997-1:2005 Eurocode 7: Geotechnical design – Part 1: General rules. Geotechnical Category 2 includes conventional structures and foundation types that demonstrate no exceptional risk or difficult soil or loading conditions.

Detailed designs for structures in Geotechnical Category 2 should usually include quantitative geotechnical data and analysis that all fundamental requirements are satisfied. In terms of field and laboratory testing during a ground investigation, routine procedures may be used for Geotechnical Category 2 sites. Examples of conventional structures that comply with Geotechnical Category 2 include, but are not limited to spread foundations, raft foundations, pile foundations, retaining walls, excavations, and embankments and earthworks.

3.4 Existing information

3.4.1 Site description and topography

The site is located to the west of Limerick City centre and the River Shannon. The site is brownfield consisting of disused industrial buildings constructed during the 19th and 20th centuries in the central portion of the site, the Salesian's School buildings in the western portion of the site, car parking facilities to the south, and St. Michael's Rowing Club boathouse along the eastern site boundary. There is a disused, flooded quarry pit in the centre of the site. There are a number of significant heritage structures on the site such as the original early 19th century mill, the infiltration gallery, and the chimney stack.

The original topography of the site had a slight gradient from north-west to south-east and a steeper gradient from north to south sloping towards the River Shannon. However, the original topography has been substantially altered by the historical development of the site. The lowest elevations encountered across the

site of approximately 1.5 mOD are associated with the disused quarry excavation in the centre of the site. The highest elevations are approximately 14 mOD and are encountered in the north-west of the site (former Salesian's School) and in the north of the site (Stonetown Terrace).

Additionally, there is evidence of imported material where the levels across the Stonetown Terrace portion of the site have been raised by approximately 1 to 2 m high.

3.4.2 Site history

Historically, the site has had a variety of land uses since the early 19th century. During the early- to mid-19th century, the site mostly comprised of agricultural land. There was a quarry located in the central portion of the site. By 1839, there was an active dock yard located in the southern portion of the site operated by the Limerick Ship Company.

During the 1850's, the site underwent rapid development associated with linen factory production. The flax mill, cold store, Victorian houses, and weaving complex buildings were constructed in the central portion of the site, with the addition of the chimney stack in 1860.

In the late-19th century, the site and buildings were used for a variety of purposes. During the 1870's, the site factory buildings were reopened as a flour and corn mill following a fire in the previous spinning factory.

By 1881, manufacturing of prepared coffee began in the southern dock yard site. In 1884, the Cleeves site began to process cream and skim milk. Additional ancillary buildings and structures were constructed during the late-19th and early-20th centuries associated with the condensed milk operation.

The site conditions and majority of structures remained relatively unchanged during the 20th century. The Salesian's School in the northwest of the site was established in 1924 through the purchase of existing buildings from the Cleeve family. In 1940, the St. Michael's Rowing Club workshop was constructed in the southeast of the site along the River Shannon. In 1950, additional packaging stores and storerooms were constructed associated with the cheese plant. Active use and operation on the site, including milk processing, ceased in 2011.

3.4.3 Historical Ground Investigations

The GSI geotechnical borehole database indicates that there have been two previous ground investigations undertaken in close proximity to the site. The factual information from these reports is presented below.

One of these previous ground investigations (1962) was undertaken to the northeast of the site, whereas the second historical ground investigation was undertaken to the southwest (IGSL, 2008).

The 1962 ground investigation, comprising two trial pits to a maximum depth of approximately 2 m BGL, indicated made ground / topsoil underlain by firm dark red brown boulder clay. The 2008 ground investigation, comprising four boreholes to a maximum depth of 10 m BGL, indicated made ground / topsoil underlain by mostly silts and clays with gravel lenses encountered.

Two additional site-specific ground investigation factual reports were provided to Arup by Limerick Twenty Thirty. These site-specific ground investigations included an environmental assessment in 2015 (Verde, 2015), and a geotechnical assessment in 2019 (GII, 2019). The ground conditions encountered during the previous site-specific ground investigations are presented in Table 1 below.

Table 1 Summary of ground conditions encountered during previous site-specific ground investigations (Verde, 2015, and GII, 2019).

Stratum	Stratum description	Top depth (mBGL)	Base depth (mBGL)	Thickness (m)
Made Ground – Fill material	Tarmacadam surfacing or concrete hardstanding	Ground level to 0.2	0.1 to 0.5	0.1 to 0.3
	Fill material of CLAY / SILT / SAND / GRAVEL with variable secondary constituent components	Ground level to 0.5	0.3 to 5.7	0.1 to 5.6
Fluvial sediments	Soft to stiff light brown / reddish brown sandy gravelly CLAY / silty sandy GRAVEL with occasional to many cobbles and boulders	1.0 to 2.8	1.9 to 5.0	0.1 to 3.5

Stratum	Stratum description	Top depth (mBGL)	Base depth (mBGL)	Thickness (m)
Weathered bedrock	Dark grey limestone	3.3 to 4.5	4.2 to 5.0	0.5 to 0.9
Bedrock - Limestone	Medium strong to very strong very fine to fine grained thinly laminated to medium bedded LIMESTONE. Unweathered to partially weathered. Rare calcite veins and fossils.	2.0 to 6.0	N/A	N/A

3.5 Ground conditions

The expected ground conditions for the site have been described using publicly available information from the Geological Survey Ireland (GSI) and from the previous site-specific ground investigations.

3.5.1 Overburden

The previous site-specific ground investigations indicate widespread made ground across the site. The made ground is generally composed of reworked fill material typically described as Clay / Silt / Sand / Gravel with variable secondary constituent components. Anthropogenic material was also encountered within the made ground material including red brick, concrete, plastic, and timber fragments. Ash and cinder were also encountered in minor pockets of made ground.

The made ground is underlain by fluvial sediments, as encountered during the previous site-specific ground investigations. The GSI Quaternary sediments mapping indicates that the site is underlain by urban material related to historical development of the site with neighbouring estuarine silts and clays to the south along the River Shannon. The fluvial sediments encountered across the site were typically described as soft to stiff light brown / reddish brown sandy gravelly Clay / silty sandy Gravel with occasional to many cobbles and boulders.

3.5.2 Geology

The GSI bedrock mapping (1:100k) indicates that the site and surrounding Limerick City area is underlain by Carboniferous Visean Limestones which are typically described as undifferentiated limestones. As presented in Section 3.4.3, the previous site-specific ground investigations encountered competent limestone bedrock at depths from 2 to 6mBGL, typically described as medium strong to very strong very fine to fine grained thinly laminated to medium bedded Limestone. Unweathered to partially weathered. Rare calcite veins and fossils.

The GSI karst dataset does not indicate any karst features within the site or surrounding area, however karstic features may be obscured due to urban development of the site and surrounding area. The previous site-specific ground investigations encountered minor evidence of cavities within the bedrock as well clay infilled fractures, which may indicate the possible presence of karstic features at the site.

3.6 Field and laboratory studies

3.6.1 Ground Investigation

Ground investigation works were required to inform the site-specific preliminary design and planning phase of the proposed development. Arup scoped, procured, and monitored the site-specific ground investigation, which was carried out by Priority Geotech Limited (PGL). The site-specific ground investigation, hereafter referred to as the 'PGL 2025 GI', was carried out between March and May 2025. The PGL 2025 GI Factual Report, comprised of the following:

- 15 no. Cable Percussive Boreholes with standard penetration tests (SPTs), to a depth of 5 metres Below Ground Level (m BGL)
- 15 no. Rotary Core follow-on boreholes into bedrock to depths of 10 m BGL. One additional rotary core follow-on borehole is ongoing at the time of writing (June 2025) in St. Michael's Rowing Club (BH313)

- 23 no. Trial Pits to depths of 4.5 m BGL or practical refusal
- 11 no. Groundwater monitoring installations, of which: four are located within bedrock and seven located within the overburden
- One Surface water installation within the reservoir location
- Six Slit Trenches with sampling and photographs to depths of 2.0 m BGL or refusal whichever occurs first to detect the existing services
- Seven Foundation Inspection Pits to record the foundations of the adjacent buildings
- Three groundwater level monitoring dataloggers in the bedrock installations (BH308, BH311, BH314)
- Installation of a groundwater level monitoring datalogger in the surface water installation within the reservoir
- Downhole colour (or optical if deemed necessary) televiewer survey within selected boreholes (BH301, BH302, BH303, BH304) to record spacing, dip, and azimuth of discontinuities in underlying bedrock
- Geotechnical sampling and laboratory testing
- Geo-environmental sampling and testing
- Groundwater sampling and testing (for all the installations)
- Surface water sampling and testing; and
- Factual reporting, including AGS format files (to include for laboratory test data) with investigation data.



Figure 3: As-built exploratory locations undertaken during the PGL 2025 GI.

3.6.2 Stratigraphy

The stratigraphy of ground conditions encountered in each subsection of the site is outlined below. Geological cross sections for the site are presented in Appendix A (Geological Cross Sections).

3.6.2.1 Salesian's School site

The stratigraphy of ground conditions encountered in the Salesian's School section of the proposed development is presented in Table 2 below.

Table 2 Ground conditions encountered at the Salesian's School site during the PGL 2025 GI (PGL, 2025).

Stratum	Stratum description	Top depth (mBGL)	Base depth (mBGL)	Thickness (m)
Topsoil*	Topsoil	Ground level	0.3	0.3
Made Ground – Surfacing	Tarmacadam surfacing or concrete hardstanding	Ground level	0.1 to 0.3	0.1 to 0.3 Average (0.1)
Made Ground – Fill material	(MADE GROUND) Reddish brown / brown / dark brown / grey / dark grey, slightly sandy to very sandy slightly gravelly to gravelly slightly clayey to very clayey CLAY / SAND / GRAVEL with occasional to medium cobble and boulder content and inclusions of red brick fragments, concrete, tiles, plastic timber, glass. Sand is fine to coarse. Gravel is fine to coarse and sub-angular to rounded. Cobbles are sub-angular to sub-rounded, limestone lithology, 63-200mm in diameter. Boulders are sub-angular to sub-rounded, limestone lithology, 200-400mm in diameter.	0.1 to 0.3	0.3 to 2.6	0.2 to 2.3 Average (1.1)
Subsoils – Glacial	Medium dense greyish brown to brown clayey, sandy to very sandy, gravelly CLAY / SAND / GRAVEL with low to high cobble content. Sand is fine to coarse. Gravel is fine to coarse angular to sub-rounded. Cobbles are angular to sub-rounded, limestone lithology, 63-200mm diameter.	0.3 to 1.5	0.6 to 4.2	0.3 to 2.7 Average (1.4)
Bedrock – Limestone	Strong, grey LIMESTONE. Slightly to moderately weathered. Minor clay accretion present on fracture surfaces. Small areas of brecciation.	0.7 to 4.2	N/A	N/A

*Topsoil only encountered in one exploratory location (BH301).

Topsoil is only encountered in one exploratory location (BH301) from ground level to a maximum depth of 0.3 m BGL. Made ground is extensive across the Salesian's School site. Made ground in the form of surfacing tarmacadam or concrete hardstanding is encountered at ground level to a maximum depth of 0.3 m BGL. Both the topsoil and surfacing made ground is underlain by fill material made ground. At the Salesian's School site, the fill material is encountered from 0.1 to 0.3 m BGL to a maximum depth of 2.6 m BGL, being typically described as reddish brown / brown / dark brown / grey / dark grey, slightly sandy to very sandy slightly gravelly to gravelly slightly clayey to very clayey Clay / Sand / Gravel with occasional to medium cobble and boulder content and inclusions of red brick fragments, concrete, tiles, plastic timber, glass. Sand is fine to coarse.

The extensive made ground at the Salesian's School site is underlain by glacial subsoils encountered from 0.3 to 1.5 m BGL to a maximum depth of 4.2, being typically described medium dense greyish brown to brown clayey, sandy to very sandy, gravelly Clay / Sand / Gravel with low to high cobble content. Sand is fine to coarse. Gravel is fine to coarse angular to sub-rounded. Cobbles are angular to sub-rounded, limestone lithology, 63-200mm diameter.

The glacial subsoils is underlain by bedrock lithology encountered from 0.7 to 4.2 m BGL, being typically described as Strong, grey Limestone. Slightly to moderately weathered. Minor clay accretion present on fracture surfaces. Small areas of brecciation.

3.6.2.2 Stonetown Terrace site

The stratigraphy of ground conditions encountered in the Stonetown Terrace section of the site is presented in Table 3 below.

Table 3 Ground conditions encountered at the Stonetown Terrace site during the PGL 2025 GI (PGL, 2025).

Stratum	Stratum description	Top depth (mBGL)	Base depth (mBGL)	Thickness (m)
Made Ground – Fill material	(MADE GROUND) Soft to stiff, reddish brown to dark brownish black, very clayey, silty, slightly sandy to very sandy, gravelly to very gravelly CLAY / SAND / GRAVEL with organic matter, red brick fragments, construction rubble, waste material (plastic, silicon, slate tile, wires) and low to high cobble and boulder content. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to sub-rounded. Cobbles are sub-angular to sub-rounded, limestone lithology, 63-200mm in diameter. Boulders are sub-angular, limestone lithology, 200 to >850mm in diameter.	Ground level	1.4 to 2.7	1.4 to 2.7 Average (2.1)
Subsoils – Glacial	Stiff, reddish brown, slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse and sub-angular to sub-rounded.	1.5 to 2.5	3.0 to 14.5	0.5 to 13.0
	Core runs attempted. Assumed BOULDERS, limestone lithology*	2.7	4.5	1.8
Bedrock – Limestone	Strong to very strong, fossiliferous LIMESTONE. Slightly weathered. Oxidation discolouration and minor clay infilling present on fracture surfaces.	3.0 to 14.5	N/A	N/A

*Coarse grained glacial subsoils only encountered BH307 in the Stonetown Terrace portion of the site, immediately underlain by limestone bedrock lithology.

During the Priority Geotech Limited (PGL) 2025 GI, made ground was encountered across the Stonetown Terrace site from ground level to a maximum depth of 2.7 m BGL, being typically described as soft to stiff, reddish brown to dark brownish black, very clayey, silty, slightly sandy to very sandy, gravelly to very gravelly Clay / Sand / Gravel with organic matter, red brick fragments, construction rubble, waste material (plastic, silicon, slate tile, wires) and low to high cobble and boulder content. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to sub-rounded. Cobbles are sub-angular to sub-rounded, limestone lithology, 63-200mm in diameter. Boulders are sub-angular, limestone lithology, 200 to >850mm in diameter. Anecdotal evidence indicates that Stonetown Terrace was used as a dumping site for construction and demolition waste from basement excavations of neighbouring properties.

The extensive made ground across the Stonetown Terrace site is predominantly underlain by fine grained glacial subsoils encountered during open hole drilling from 1.5 to 2.5 m BGL to a maximum depth of 14.5 m BGL, being typically described as stiff, reddish brown, slightly sandy gravelly Clay. Sand is fine to coarse. Gravel is fine to coarse and sub-angular to sub-rounded. Coarse grained glacial subsoil, typically described as Boulders, is also present in the Stonetown Terrace site being encountered in BH307 at 2.7 m BGL to a depth of 4.5 m BGL.

The fine grained and coarse-grained glacial subsoils are underlain by bedrock lithology encountered from 3.0 to 14.5 m BGL, being typically described as strong to very strong, fossiliferous Limestone. Slightly weathered. Oxidation discolouration and minor clay infilling present on fracture surfaces.

3.6.2.3 Flax Mill site (PBSA / Quarry Building)

The stratigraphy of ground conditions encountered in the Flax Mill section of the site is presented in Table 4 below.

Table 4 Ground conditions encountered at the Flax Mill site during the PGL 2025 GI (PGL, 2025).

Stratum	Stratum description	Top depth (mBGL)	Base depth (mBGL)	Thickness (m)
Made Ground – Surfacing	Tarmacadam surfacing or concrete hardstanding	Ground level to 0.2	0.1 to 0.3	0.1 to 0.3 Average (0.2)
Made Ground – Fill material	(MADE GROUND) Light brown to black, slightly clayey to very clayey, slightly sandy to very sandy, slightly gravelly to gravelly CLAY / SAND / GRAVEL with low to high cobble and boulder content with red brick fragments and waste materials (timber, glass, pottery). Sand is fine to coarse. Gravel is fine to coarse, angular to sub-rounded. Cobbles are sub-angular to sub-rounded, limestone lithology, 63-200mm in diameter. Boulders are sub-angular to sub-rounded, limestone lithology, 200-500mm in diameter.	Ground level to 0.3	0.6 to 2.9	0.6 to 2.7 Average (1.6)
Subsoils – Glacial	Greyish reddish brown to brown very silty, very sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to sub-rounded. *	1.5	3.7	2.2
	Firm to stiff, light brown to greyish brown, slightly sandy, slightly gravelly to gravelly CLAY / SILT with medium cobble and boulder content. Sand is fine to coarse. Gravel is fine to coarse angular to sub-rounded. Cobbles are sub-angular to subrounded, limestone lithology, 63-120mm in diameter.	1.8 to 2.9	2.2 to 5.1	0.2 to 3.3 Average (1.2)
Bedrock – Limestone	Strong to very strong, unweathered to moderately weathered. Slight oxidation discolouration and minor clay accretion on fracture surfaces.	2.4 to 5.1	N/A	N/A

*Coarse grained glacial subsoils only encountered in BH315 in the Flax Mill portion of the site during the PGL 2025 GI.

Made ground is extensive across the Flax Mill portion of the site. The made ground encountered during the PGL 2025 GI includes surfacing layers and underlying fill material. The surfacing layers, typically described as tarmacadam surfacing or concrete hardstanding, are encountered from ground level to 0.2 to a maximum depth of 0.3 m BGL. The underlying fill material is encountered from ground level to 0.3 m BGL to a maximum depth of 2.9 m BGL, being typically described as light brown to black, slightly clayey to very clayey, slightly sandy to very sandy, slightly gravelly to gravelly Clay / Sand / Gravel with low to high cobble and boulder content with red brick fragments and waste materials (timber, glass, pottery). Sand is fine to coarse. Gravel is fine to coarse, angular to sub-rounded. Cobbles are sub-angular to sub-rounded, limestone lithology, 63-200mm in diameter. Boulders are sub-angular to sub-rounded, limestone lithology, 200-500mm in diameter.

At the Flax Mill site, the made ground is underlain by coarse grained and fine-grained glacial subsoils. Coarse grained glacial subsoils are only encountered within the Flax Mill site at BH315 at a depth of 1.5 to 3.7 m BGL, being typically described as greyish reddish brown to brown very silty, very sandy Gravel. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to sub-rounded. The majority of the made ground across the Flax Mill site is underlain by fine grained glacial subsoils, which are encountered from 1.8 m BGL to 2.9 m BGL to a maximum depth of 5.1 m BGL, being typically described as firm to stiff, light brown to greyish brown, slightly sandy, slightly gravelly to gravelly Clay / Silt with medium cobble and boulder content. Sand is fine to coarse. Gravel is fine to coarse angular to sub-rounded. Cobbles are sub-angular to subrounded, limestone lithology, 63-120mm in diameter.

The glacial subsoils are underlain by bedrock lithology which is encountered at 2.5 to 5.1 mBGL within the Flax Mill site. The bedrock encountered is typically described as strong to very strong, unweathered to moderately weathered. Slight oxidation discolouration and minor clay accretion on fracture surfaces.

3.6.2.4 Shipyard site (O'Callaghan Strand Building)

The stratigraphy of ground conditions encountered in the Shipyard section of the site is presented in Table 5 below.

Table 5 Ground conditions encountered at the Shipyard site during the PGL 2025 GI (PGL, 2025).

Stratum	Stratum description	Top depth (mBGL)	Base depth (mBGL)	Thickness (m)
Made Ground – Surfacing	Tarmacadam surfacing or concrete hardstanding	Ground level	0.1 to 0.6	0.1 to 0.6 Average (0.2)
Made Ground – Fill material	(MADE GROUND) Brown / grey to black silty, clayey to very clayey, slightly sandy to very sandy, gravelly CALY / SAND / GRAVEL with low to high cobble content and occasional boulders with timber, red brick, mortar, metal, and concrete fragments, and ash. Sand is fine to coarse. Gravel is fine to coarse, angular to sub-rounded. Cobbles are angular to sub-rounded, limestone lithology, 63-200mm in diameter. Boulders are angular to sub-angular, limestone lithology up to 600mm in diameter.	0.1 to 0.6	0.7 to 2.5	0.6 to 2.4 Average (1.7)
Subsoils – Glacial	Soft to stiff brown to greyish black, slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is fine to coarse, angular to sub-rounded. Cobbles are sub-rounded, limestone lithology, 63-200mm in diameter.	1.0 to 7.0	1.5 to 7.5	0.2 to 2.5 Average (1.0)
	Medium dense to dense, greyish brown, slightly clayey, slightly silty to very silty, gravelly SAND / GRAVEL with high cobble content. Sand is fine to coarse. Gravel is fine to coarse, angular to sub-rounded. Cobbles are angular, limestone lithology, 63-200mm in diameter.	1.2 to 5.5	1.6 to 7.0	0.4 to 1.5 Average (0.8)
Bedrock – Limestone	Medium strong to very strong, grey to dark grey, LIMESTONE. Unweathered to highly weathered. Clay accretion present on fracture surfaces. Minor evidence of limestone dissolution.	2.4 to 7.5	N/A	N/A

Made ground is widespread across the Shipyard portion of the site. Made ground, typically described as tarmacadam surfacing or concrete hardstanding is encountered from ground level to a maximum depth of 0.6 m BGL. The surfacing made ground is underlain by made ground fill material encountered at 0.1 m BGL to 0.6 m BGL to a maximum depth of 2.5 m BGL, being typically described as brown / grey to black silty, clayey to very clayey, slightly sandy to very sandy, gravelly Caly / Sand / Gravel with low to high cobble content and occasional boulders with timber, red brick, mortar, metal, and concrete fragments, and ash. Sand is fine to coarse. Gravel is fine to coarse, angular to sub-rounded. Cobbles are angular to sub-rounded, limestone lithology, 63-200mm in diameter. Boulders are angular to sub-angular, limestone lithology up to 600mm in diameter.

The made ground is underlain by interbedded lenses of fine grained and coarse-grained glacial subsoils. The fine-grained glacial subsoils are encountered from 1.0 m BGL to 7.0 m BGL to a maximum depth of 7.5 m BGL and are typically described as soft to stiff brown to greyish black, slightly sandy slightly gravelly Clay with low cobble content. Sand is fine to coarse. Gravel is fine to coarse, angular to sub-rounded. Cobbles are sub-rounded, limestone lithology, 63-200mm in diameter. The coarse-grained glacial subsoils, encountered from 1.2 m BGL to 5.5 m BGL to a maximum depth of 7.0 m BGL, are typically described as medium dense to dense, greyish brown, slightly clayey, slightly silty to very silty, gravelly Sand / Gravel with high cobble content. Sand is fine to coarse. Gravel is fine to coarse, angular to sub-rounded. Cobbles are angular, limestone lithology, 63-200mm in diameter.

The glacial subsoils are underlain by bedrock lithology which is encountered from 2.4 m BGL to 7.5 m BGL. The bedrock encountered is typically described as medium strong to very strong, grey to dark grey,

Limestone. Unweathered to highly weathered. Clay accretion present on fracture surfaces. Minor evidence of limestone dissolution.

3.7 Groundwater installations

Groundwater monitoring installations, in the form of standpipes, were installed in 11 no. borehole location across the site. Groundwater monitoring is ongoing. Table 6 below details the groundwater monitoring results recorded to date, at the time of writing (July 2025).

Table 6 Summary of static groundwater levels.

Exploratory ID	Slotted Standpipe (m BGL)	Response Zone	Date (02/05/2025)	
			m BGL	m OD
BH301	1.5 to 3.5	Glacial subsoil - coarse	Dry	Dry
BH302	7.5 to 9.5	Bedrock	5.08	7.56
BH305	1.0 to 3.0	Made Ground / Glacial subsoil - fine	Dry	Dry
BH306	3.0 to 5.0	Bedrock	Dry	Dry
BH307	3.5 to 5.5	Bedrock	3.2	9.24
BH308*	5.5 to 7.5	Bedrock	7.29	4.37
BH309	1.0 to 3.0	Made Ground	2.75	1.35
BH310	1.5 to 3.5	Made Ground	3.05	1.28
BH311	8.5 to 10.5	Bedrock	2.18	1.45
BH312	1.5 to 3.5	Glacial subsoil - coarse	2.85	1.31
BH314	6.0 to 8.0	Bedrock	3.66	1.57

*BH308 dipped on 08/05/2025.

At the time of writing (July 2025), groundwater levels are variable across the site, ranging from 2.18 to 5.08 m BGL. Four standpipe installations were dry when dipped. The most consistent groundwater readings were recorded in the Shipyard portion of the site where groundwater was encountered between 2.18 and 3.05 m BGL (1.28 to 1.45 mOD), most likely due to the proximity of the River Shannon.

Groundwater strikes were also reported during exploratory hole excavation. A total of 15 no. groundwater strikes ranging from 2.1 to 11.5 mBGL were encountered in borehole excavations. Only two groundwater strikes were recorded within trial pit excavations at 2.4 m BGL (TP321) and 2.0 m BGL (TP317). Seepage groundwater ingress rates were recorded in the trial pits. Groundwater was generally encountered within the bedrock or at top of rock (9 no. strikes), however groundwater strikes were also encountered within the made ground (BH304, TP321), and coarse grained (BH301) and fine grained (BH305, TP317) glacial subsoils strata. Groundwater strikes were not encountered in 36 no. exploratory locations across the site. It should be noted that the ground investigation was undertaken within a period of prolonged dry weather, and so groundwater strikes do not represent the groundwater equilibrium at the site. There is also the potential for tidal influence on the groundwater regime at the site due to the proximity to the River Shannon estuary.

Groundwater level monitoring and testing is ongoing within the standpipe installations. Data loggers have been installed in 4 no. standpipe installations within the bedrock for a continuous 12 month recording period (BH308, BH311, BH314, and SW01). The data loggers will help determine tidal influence and seasonal fluctuations in the groundwater regime of the site.

Groundwater levels vary seasonally and are likely to be 0.5 to 1.0 metres higher during winter months.

3.8 Geotechnical field test results

3.8.1 Standard Penetration Tests (SPTs)

Standard Penetration Tests (SPTs) were performed within each borehole exploratory location during cable percussion and rotary follow on. A summary of the SPT measurements recorded during the PGL 2025 GI are presented in Table 7 below.

Table 7 Summary of Standard Penetration Test (SPT) N-value results.

Parameter	Symbol	Unit		Made Ground	Glacial subsoils (coarse grained)	Glacial subsoils (fine grained)
Standard Penetration Test	SPTN	Blows/ 300mm	Minimum to Maximum Mean Characteristic value (No. of samples)	7 to 50 34 26 (22)	27 to 50 48 44 (10)	16 to 50 47 43 (26)

Laboratory tests

3.8.2 Characteristic testing

A number of geotechnical characteristic laboratory tests were carried out on selected soil samples taken during the PGL 2025 GI, which included:

- 80 no. moisture contents
- 29 no. Atterberg limits (Plastic and Liquid), and
- 60 no. particle size gradings with 33 no. hydrometers.

A summary of the geotechnical characteristic laboratory testing results, along with characteristic values, are presented in Table 8 below.

Table 8 Summary of geotechnical classification laboratory test results carried out with characteristic values.

Parameter	Symbol	Unit		Made Ground	Glacial subsoils (coarse grained)	Glacial subsoils (fine grained)
Moisture content	m _c	%	Minimum to Maximum Mean Characteristic value (No. of samples)	1.1 to 35 13.2 9.8 67	7 to 15 10.7 9.4 7	8 to 41 24.3 19.1 6
Liquid limit	LL	%	Minimum to Maximum Mean Characteristic value (No. of samples)	18 to 55 31.7 26.5 24	19 to 21 20 19.8 3	48 to 65 56.5 52.3 2
Plastic limit	PL	%	Minimum to Maximum Mean Characteristic value (No. of samples)	12 to 34 21.8 18.5 22	13 to 14 13.5 13.5 2	33 to 43 38 35.5 2
Plasticity index	PI	%	Minimum to Maximum Mean Characteristic value (No. of samples)	5 to 21 11 8.9 22	6 6 6 2	15 to 22 18.5 16.8 2

3.8.3 Rock testing

Geotechnical laboratory testing was conducted on rock core samples collected during the PGL 2025 GI, which included:

- 28 no. Uniaxial Compressive Strength (UCS) tests, and;
- 56 no. Point Load tests.

A summary of the rock laboratory testing results is included in Table 9 below.

Table 9: Summary of geotechnical laboratory tests results carried out on rock samples.

Parameter	Symbol	Unit		Bedrock - Limestone
Uniaxial compressive strength	UCS	MPa	Minimum to Maximum Mean Characteristic value (No. of samples)	47.7 to 154 107 93.6 (28)
Point load test index	I _s	MPa	Minimum to Maximum Mean Characteristic value (No. of samples)	1.9 to 6.0 3.8 3.3 (56)

3.8.4 Geoenvironmental and geochemical testing

3.8.4.1 Geoenvironmental testing

As part of the PGL 2025 GI, 61 no. geo-environmental samples were tested and screened in terms of their Waste Acceptance Criteria (WAC) as defined in the Landfill Directive (2002) to categorise the samples in terms of suitable disposal locations. Table 10 provides a summary of the number of samples categorised into each of the WAC categories.

Table 10 Geo-environmental sample WAC categorisation.

Stratum	No. of samples	Soil Recovery Facility (SRF)	Inert licenced landfill	Non-hazardous licenced landfill	Non-hazardous licenced landfill (with asbestos)	Hazardous licenced landfill
Made Ground	56	0	38	1	3	14
Glacial subsoil	5	3	1	1	0	0

Based on the findings of the PGL 2025 GI and the results of the geo-environmental testing, the following can be stated:

- Due to the extensive made ground across the site, there was minimal sampling and testing of the underlying glacial subsoil material. Of the glacial subsoil samples tested, three samples are suitable for disposal to a Soil Recovery Facility in all local domains (Domain 1, Domain 2, Domain 4, and Domain 5). One glacial subsoil sample tested is suitable for disposal to an inert licenced landfill facility (BH314), and one sample is suitable for disposal to a non-hazardous licenced landfill due to elevated levels of Total Organic Carbon (TOC) (TP301).
- Trace levels of asbestos (<0.001%), in the form of Chrysotile, was encountered at three exploratory locations, all of which were located in Stonetown Terrace (BH305, BH306, and BH308).
- The majority of the made ground material tested is suitable for disposal to an inert licenced landfill.
 - One made ground sample (BH309) is suitable for disposal to a non-hazardous licenced landfill due to elevated TOC.
 - Seven of the samples tested were categorised as hazardous, with the European Waste Code (EWC) 17 05 03*, all located in the Shipyard site (BH309, BH311, TP318, TP320, TP321, and TP322). The

material tested was classified as hazardous due to elevated levels of heavy metal concentrations including Copper, Lead, and Zinc. One sample (TP321 at 0.75 m BGL) also displayed elevated levels of Polycyclic aromatic hydrocarbons (PAHs) (phenanthrene, anthracene, and fluoranthene).

- Seven other samples were classified as non-hazardous (with the EWC 17 05 04), require disposal to a hazardous licenced facility due to exceeding the limits for acceptance into a non-hazardous licenced facility.

3.8.4.2 Geochemical testing

To determine the potential for aggressive ground conditions in relation to buried concrete, chemical testing was undertaken on 18 no. soil samples. These chemical test results were assessed in accordance with I.S. EN 206:2013 +A2:2021 Concrete – Specification, performance, production, and conformity, and BRE Special Digest 1 to determine the relevant exposure class, design sulfate class, and aggressive chemical environment for concrete (ACEC) class. The results of the chemical testing are summarised in Table 11 below.

Table 11: Summary of pH and sulfate testing.

No. of samples	Minimum pH	Characteristic pH	Maximum Acid-soluble Sulfate (mg/kg)	Characteristic Acid-soluble Sulfate (mg/kg)	Maximum Water-soluble Sulfate (mg/l)	Characteristic Water-soluble Sulfate (mg/l)
Soil						
18	7.2	7.5	1300	817.5	350	190

In accordance with Table 2 of the I.S. EN 206:2013 +A2:2021 Concrete – Specification, performance, production, and conformity, the acid-soluble sulfate results demonstrate that there is negligible risk of chemical attack. We would recommend exposure class XA1. This is the least aggressive exposure class, being described as a slightly aggressive chemical environment. The sulfate levels detected were low and well below the lower threshold for Class XA1 (2,000 mg/kg).

In accordance with Table C1 of the BRE Special Digest 1:2005, the water soluble sulfate results demonstrate a resultant Design Sulfate (DS) class of DS-1. The Aggressive Chemical Environment for Concrete (ACEC) Class is AC-1. The sulfate levels detected were low and well below the threshold for the DS-1 classification (500 mg/l). The tested material on site qualifies as the least aggressive class for both Design Sulfate and Aggressive Chemical Environment for Concrete.

3.8.5 Reusability testing

Made ground described as reworked natural soils containing anthropogenic inclusions were observed across the entire Cleaves site.

Made ground which can be proven to contain less than 2% anthropogenic material can be described as equivalent to natural ground and therefore may be reused on site. If the made ground material is proven to contain less than 2% anthropogenic material, it may be suitable for reuse as Class 4 (Landscape Fill) in accordance with the TII Specification for Road Works Series 600 (hereafter referred to as 'TII Series 600'), subject to verification testing.

Excavated made ground material should be replaced with suitable engineered fill where necessary to reach the desired formation level. Non-compliant made ground, such as the hazardous made ground encountered in the Shipyard portion of the site or made ground with greater than 2% anthropogenic material, is unsuitable for reuse on site and should be disposed of off-site to a suitably licenced facility.

It is likely that the glacial subsoils present on site beneath the made ground could be suitable for reuse as either Class 2C2 (General cohesive fill) beneath pavements or Class 4 (Landscape fill) in accordance with the TII Series 600, subject to verification testing. Based regional experience, the glacial subsoil may be suitable for lime and/or cement stabilisation and, as a result, when stabilised, suitable for fill beneath ground bearing slabs. Additional ground investigation and laboratory testing would be required to confirm the volumes of materials suitable for reuse under each classification.

If substantial volumes of rock are to be excavated on site, additional ground investigation and laboratory testing would be required to determine the suitability of crushed rock for use as an aggregate on site.

3.8.6 Excavation and Backfill Volumes

A preliminary cut and fill exercise to determine volumes of excavated material and back fill required as part of the works was carried out. It was noted during the GI that made ground observed across the site typically contained >2% anthropogenic materials and would therefore not be considered suitable for reuse. Based on our observations during the GI, the made ground will require disposal off-site.

The initial ground model suggests that approximately 52% of the total excavation (~51,000 t) is expected to consist of made ground and will therefore require off-site disposal. 48% (~47,000 t) is expected to be natural ground and may be suitable for reuse.

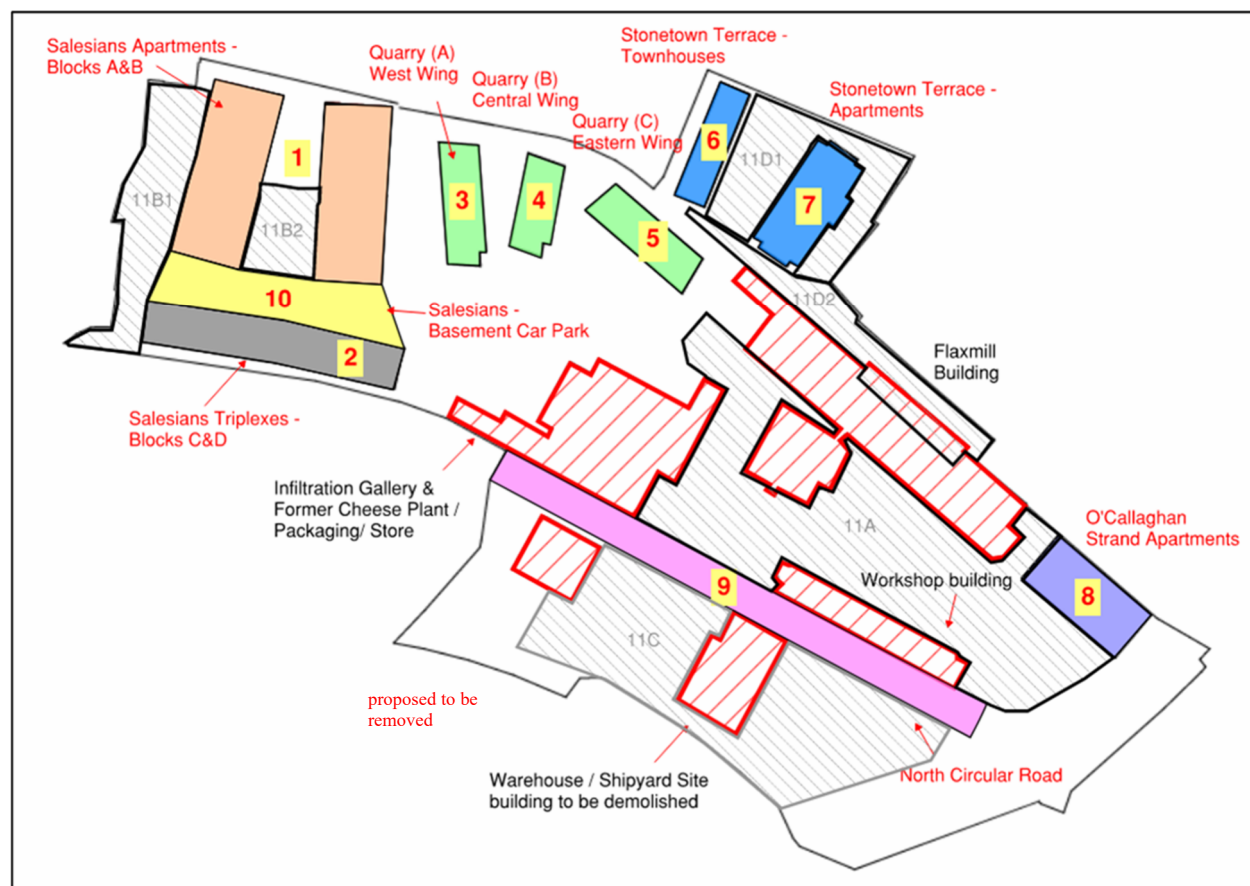


Figure 4: CRQ Zones Considered for Cut / Fill

Table 12: Estimate of Excavation Volumes (t)

ID	Zone	Volume of Made Ground (t)	Volume of Glacio-Fluvial deposits (t)	Volume of rock (t)
1	Salesians Apartments – Blocks A&B	5700	3080	10920
2	Salesians Triplexes – Blocks C & D	3040	2860	6760
3	Quarry (A) West Wing	2280	0	0

ID	Zone	Volume of Made Ground (t)	Volume of Glacio-Fluvial deposits (t)	Volume of rock (t)
4	Quarry (B) Central Wing	1900	0	0
5	Quarry (C) Eastern Wing	1900	0	0
6	Stonetown Terrace - Townhouses	1900	770	0
7	Stonetown Terrace - Apartments	3420	2600	4200
8	O'Callaghan Strand Apartments	2470	2400	130
9	North Circular Road	9880	0	0
10	Salesians - Basement Car Park	2660	3080	10400
11	Site Wide Civil / Hardstanding Areas	15,770	0	0
SUMS		50,920 (26,800 m³)	14,790 (6,750 m³)	32,410 (12,550 m³)
TOTAL		98,120 (46,100 m³)		

Theoretically, the material that can be reused is the combined volume of rock (12,550m³) and glacio-fluvial deposits (6,750m³) totals approximately 19,300m³. The site requires 13,950m³ of general fill, in addition to part of the 16,800m³ needed for the engineered slab fill. This implies that approximately 11,450 m³ (30,750 - 19,300) will need to be imported to meet the general fill requirement, along with a proportion of the material required for the slab. However, this is assuming that all of the natural ground requiring excavation from beneath the site is suitable for the proposed uses on site. Extensive testing and assessment will be required to show the suitability of the excavated materials for use.

Table 13: Estimate of Backfill Volume (t)

ID	Zone	General Fill (t)	Engineered Fill (t)
1	Salesians Apartments – Blocks A&B	200	4400
2	Salesians Triplexes – Blocks C & D	0	2000
3	Quarry (A) West Wing	2900	800
4	Quarry (B) Central Wing	2200	600

ID	Zone	General Fill (t)	Engineered Fill (t)
5	Quarry (C) Eastern Wing	1500	800
6	Stonetown Terrace - Townhouses	100	800
7	Stonetown Terrace - Apartments	4400	1200
8	O'Callaghan Strand Apartments	4400	1200
9	North Circular Road	12200	3200
10	Salesians - Basement Car Park	0	2000
11	Site Wide Civil / Hardstanding Areas	-	15800
SUMS		27,900 (13,950 m³)	32,800 (16,800 m³)
TOTAL		60,700 (30,750 m³)	

3.9 Conclusions and recommendations

The findings of the Priority Geotech Limited (PGL) 2025 GI generally agree with the assumptions and expectations of the geotechnical desktop review and correlate well with previous ground investigations in the surrounding area and at the site.

The topography of the site is variable. The northwest to southeast naturally sloping topography towards the River Shannon has been significantly altered through anthropogenic activities at the site, including quarrying, shipyard backfilling, and material stockpiling. The lowest elevations encountered across the site of approximately 1.5 mOD are associated with the disused quarry excavation in the centre of the site. The highest elevations are approximately 14 mOD and are encountered in the north-west of the site (former Salesian's School) and in the north of the site (Stonetown Terrace).

The stratigraphy of the site has been described as topsoil (one occurrence – BH301) and made ground (surfacing material) composed of bituminous surfacing and concrete hardstanding underlain by made ground (fill material) composed of historical fill material, construction and demolition waste, and reworked subsoil material with anthropogenic material. Widespread made ground deposits are typically underlain by glacial subsoils composed of coarse-grained slightly clayey to very clayey, sandy to very sandy gravel and fine-grained slightly sandy slightly gravelly to gravelly clay. Bedrock level is variable across the site, being encountered from 0.7 to 14.5 m BGL. There was minor evidence of karstic dissolution features encountered in BH311.

Groundwater standpipe installations were installed in 11 no. borehole exploratory locations. At the time of writing (June 2025), groundwater levels are variable across the site, ranging from 2.18 to 5.08 m BGL. Four standpipe installations were dry when dipped. The groundwater levels are likely to be 0.5 to 1.0 metres higher during the winter months.

Geo-environmental testing has demonstrated that there is a variable contamination risk across the site. The majority of made ground material across the site is suitable for disposal to an inert licenced landfill. However, asbestos was encountered in three samples tested from the Stonetown Terrace portion of the site which are suitable for disposal to a non-hazardous licenced landfill with asbestos. Also, hazardous material (17 05 03*) was encountered in seven locations in the Shipyard portion of the site. These hazardous samples, along with seven other made ground samples tested, require disposal to a hazardous licenced landfill. Of the five glacial subsoil samples tested, three are suitable for disposal to a Soil Recovery Facility in Domain 1, 2,

4, or 5, one sample is suitable for disposal to an inert licenced landfill, and one sample is suitable for disposal to a non-hazardous licenced facility.

The formation levels for the foundations should be chosen such that there is a reasonably consistent bearing stratum under each individual building to negate differential settlement. All made ground beneath proposed structure floor plans should be excavated. There is potential to reuse the excavated natural or equivalent to natural material on site. Should the material prove to be unsuitable for reuse, it should be disposed of to an appropriately licenced permitted facility in accordance with current waste regulations.

4. Structural Scheme

4.1 Foundations

Groundwater strikes encountered during the PGL 2025 GI and subsequent groundwater level monitoring in standpipe installations, as detailed in Section 3.7, indicate that there is a low probability for groundwater ingress into excavations across the site. Continuous groundwater level monitoring is ongoing to determine tidal and seasonal fluctuations in the groundwater regime.

Pad foundations and strip footings will be used to support columns, superstructure walls and or core walls. Lean mix upfill will be required from the underside of the pad foundations down to competent bearing stratum or rock. The formation level for the foundations will be 1m below the ground floor level of the buildings to allow sufficient space for the buildup to the ground floor slab and for services coming into the building. The figures below show typical sections through strip and pad footings. From the latest monitoring, groundwater levels recorded, range from 2.5m (Salesian Apartments) to 6.6m (Stonetown Terrace) below FFL. Groundwater levels vary seasonally and are likely to be 0.5 to 1.0 metres higher during winter months. Continuous groundwater level monitoring is ongoing with standpipe installation data loggers installed to determine tidal and seasonal fluctuations in the groundwater regime.

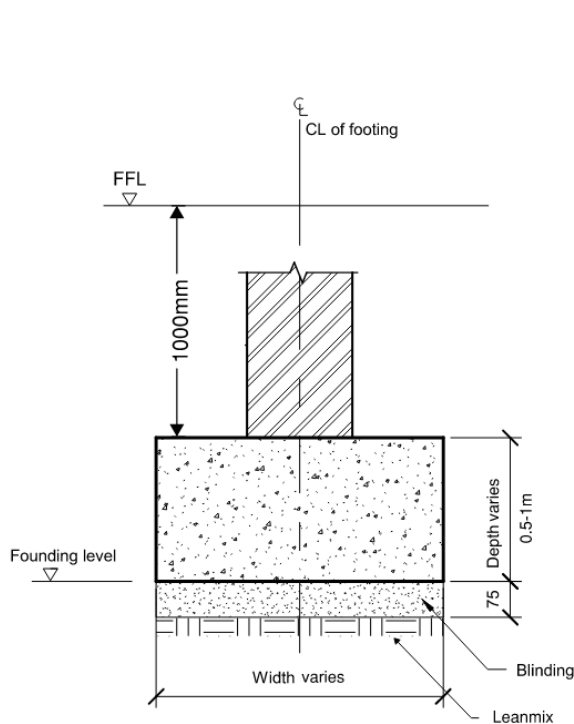


Figure 5: Strip Footing Typical Section

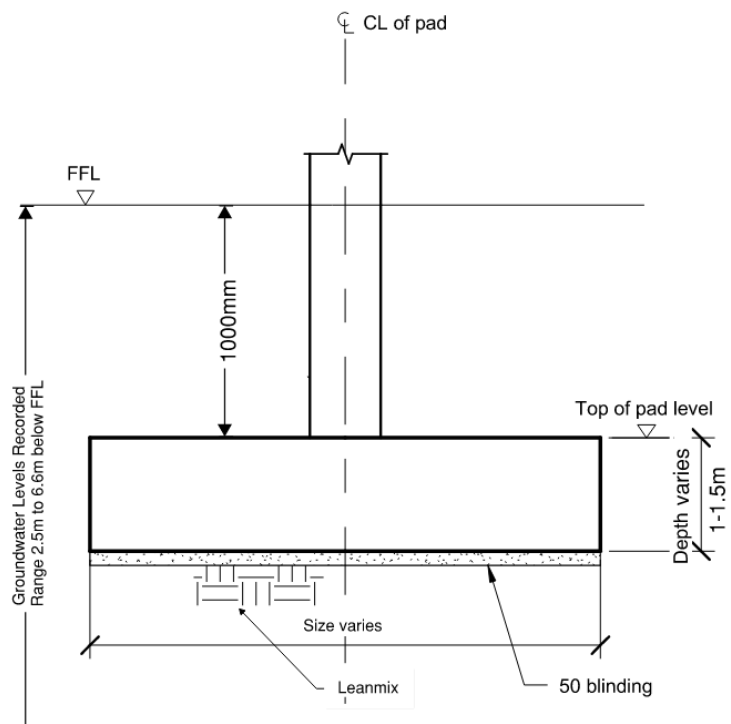


Figure 6: RC Pad Foundation Typical Section

Based on the information received from the latest ground investigation, the only building that will require a piled solution is Stonetown Terrace Apartments. Ground beams, pile caps and cores supported by bored piles are proposed for this building. See typical section through pile cap below.

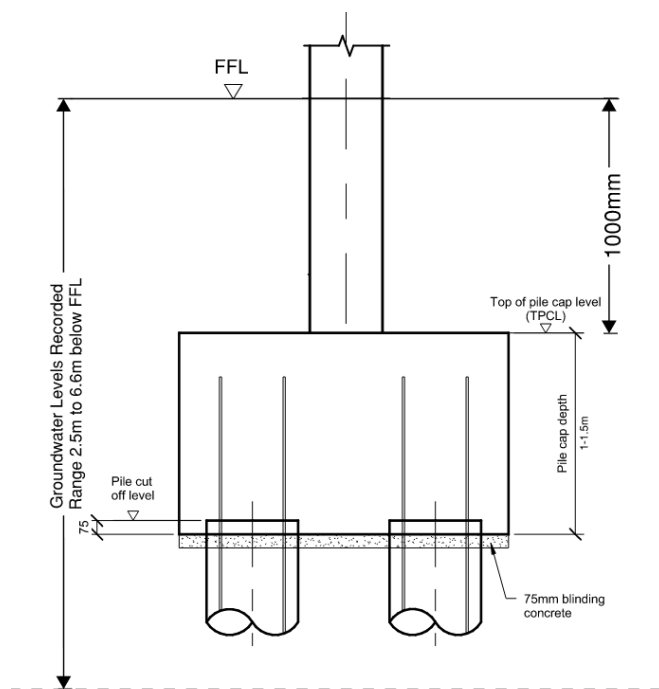


Figure 7: Pile Cap Typical Section

4.1.1 Design Assumptions

It is assumed that the made ground encountered on the site beneath the proposed structures will be excavated during construction. The made ground does not constitute a suitable bearing stratum due to the heterogeneity of this material. It is possible that made ground could be retained on site if a suspended slab and piled foundations are adopted which would lead to no structural loading on the made ground.

There is a potential for the reuse of made ground material within the site, if it can be shown to be equivalent to natural material. This is defined as the made ground being shown to contain <2% anthropogenic material.

The recommendations above are proposed based on our current expectations of the site conditions. These assumptions will be subject to the findings of confirmatory investigations.

4.1.2 Proposed Foundation Solutions

4.1.2.1 Stonetown Terrace

An assessment of the proposed structures has been undertaken based on the ground conditions encountered during the PGL 2025 GI. The stratigraphy and properties of the ground conditions encountered, indicate that piled foundations bearing in the underlying competent limestone bedrock are required for the apartment block. Ground beams, pile caps and cores supported by bored piles are proposed. Bedrock noted at a range of 11mOD to -1mOD. Piles are to be end bearing on rock, with a 0.5m embedment.

For the apartment block, a stepped raft slab to suit site levels on lean-mix blinded Clause 808 broken stone on stripped site is suitable.

From the latest groundwater monitoring standpipes, the groundwater recorded at the Stonetown Terrace site is approximately 6.6m below the FFL. Continuous groundwater level monitoring is ongoing in Stonetown Terrace with a standpipe installation data logger installed in BH308 to determine tidal and seasonal fluctuations in the groundwater regime.

4.1.2.2 Shipyard site (O'Callaghan Strand Building)

An assessment of the proposed structure has been undertaken based on the ground conditions encountered during the PGL 2025 GI. The stratigraphy and properties of the ground conditions encountered, as detailed in Section 3.6.2.4 indicate that shallow pad foundations bearing on the shallow limestone bedrock can be used under the RC columns. RC ground beams are to be used under the columns at the perimeter where the existing stone wall is to be retained. This will limit the amount of disturbance to the base of the stone wall. An RC core slab is proposed under the RC core walls.

From the latest groundwater monitoring standpipes, the groundwater recorded at the O'Callaghan Strand site is approximately 4.25m below the FFL. Continuous groundwater level monitoring is ongoing in the Shipyard site with a standpipe installation data logger installed in BH311 to determine tidal and seasonal fluctuations in the groundwater regime.

4.1.2.3 Flax Mill site (PBSA / Quarry Building)

A preliminary assessment of the proposed structures has been undertaken based on the ground conditions encountered during the PGL 2025 GI. The stratigraphy and properties of the ground conditions encountered, as detailed in Section 3.6.2.3 indicate that shallow pad foundations bearing on the shallow limestone bedrock are the suitable foundation solution for the PBSA building. An RC core slab is required under the RC core walls.

From the latest groundwater monitoring standpipes, the groundwater recorded at the PBSA site is approximately 4.1m below the FFL. Continuous groundwater level monitoring is ongoing in the Flax Mill site with a standpipe installation data logger installed in BH314 to determine tidal and seasonal fluctuations in the groundwater regime.

4.1.3 Salesian's Apartments & Triplexes

A preliminary assessment of the proposed structures has been undertaken based on the ground conditions encountered during the PGL 2025 GI. The stratigraphy and properties of the ground conditions encountered, as detailed in Section 3.6.2.1 indicate that strip footings bearing on the shallow limestone bedrock are the foundation solution for the Salesian Apartments. An RC core slab is required under the RC core walls.

For the Salesian Triplexes, a reinforced concrete raft foundation with thickenings under walls and columns is required.

From the latest groundwater monitoring standpipes, the groundwater at the Salesian Apartments site is approximately 2.5m below the FFL. At the Salesian Triplexes, no groundwater was encountered in the groundwater monitoring installation. Continuous groundwater level monitoring is ongoing with a standpipe installation data logger to determine tidal and seasonal fluctuations in the groundwater regime.

4.2 Ground Floor Structure

4.2.1 Stonetown Terrace

For the Stonetown Terrace building, an RC Suspended slab is required. The suspended slab will span between RC rising walls that are supported by RC ground beams and pilecaps.

For the townhouses a ground bearing raft slab on rigid insulation on radon membrane on compacted hardcore will be provided at ground floor with edge thickenings around the perimeter to support the loadbearing walls. Internal slab thickenings will be provided to support internal loading bearing walls. Compacted hardcore to IS888 will be required to make up levels as required to a suitable bearing stratum. Internal non-load bearing walls of lightweight construction can be supported on the ground bearing slab.

4.2.2 Shipyard site (O'Callaghan Strand Building)

For O'Callaghan Strand, a ground bearing slab on rigid insulation on radon membrane on compacted hardcore will be provided at ground floor. Compacted hardcore to IS888 will be required to make up levels as required to a suitable bearing stratum. Internal non-load bearing walls of lightweight construction can be supported on the ground bearing slab.

4.2.3 Flax Mill site (PBSA / Quarry Building)

For the PBSA Buildings, a ground bearing slab on rigid insulation on radon membrane on compacted hardcore will be provided at ground floor. Compacted hardcore to IS888 will be required to make up levels as required to a suitable bearing stratum. Internal non-load bearing walls of lightweight construction can be supported on the ground bearing slab

4.2.4 Salesian's Apartments & Triplexes

For the Salesians Apartments, a ground bearing slab on rigid insulation on radon membrane on compacted hardcore will be provided at ground floor. Compacted hardcore to IS888 will be required to make up levels as required to a suitable bearing stratum. Internal non-load bearing walls of lightweight construction can be supported on the ground bearing slab.

For the Salesians Triplexes, a reinforced concrete raft foundation with thickenings under walls and columns is required for the base of the carpark. For the roof slab of the car park area an RC slab is required supported by RC columns and an RC wall. For the triplexes not over the car park, a ground bearing slab on rigid insulation on radon membrane on compacted hardcore will be provided at ground floor. Compacted hardcore to IS888 will be required to make up levels as required to a suitable bearing stratum. Internal non-load bearing walls of lightweight construction can be supported on the ground bearing slab.

4.3 Superstructure Structural Scheme

The proposed superstructure for each building is described below.

4.3.1 Stonetown Terrace

For the Stonetown Terrace Apartments, an in-situ RC frame is to be used. This would include a flat slab with temporary propping/ back propping required to facilitate construction of the flat slab. The slab would be supported by RC columns and RC down stand Beams on the perimeter. The roof structure of the apartments will cater for the ASHP plant as well as the Green Roof / PV requirements. Stability Cores are proposed at the Lift / Staircores, with In-situ RC Walls.

For the Stonetown Terrace Townhouses, a timber frame structure is proposed. Prefabricated engineered timber frame systems will be used for the external and internal compartment walls. The floors will be made up of composite timber-steel webbed floor joists. The roof will be constructed using prefabricated timber roof trusses.

4.3.2 Shipyard site (O'Callaghan Strand Building)

For O'Callaghan Strand, an in-situ RC frame is to be used. As with Stonetown Terrace, this would include a flat slab with temporary propping/ back propping required to facilitate construction of the flat slab. The slab would be supported by RC columns and RC down stand Beams on the perimeter. At roof level, there will be an area for plant as well as a communal space. The roof structure will be made up of a series of steel portal frames. Stub columns and main portal frame beams with trimmer beams around the roof openings. A steel transfer beam is required to create a clear open space in one area of the roof.

4.3.3 Flax Mill site (PBSA / Quarry Building)

For the PBSA Buildings, an in-situ RC frame is to be used. This would include a flat slab with temporary propping/ back propping required to facilitate construction of the flat slab. The slab would be supported by RC columns and RC down stand Beams on the perimeter. The roof structure of the apartments will cater for the plant requirements. Stability Cores are proposed at the Lift / Staircores, with In-situ RC Walls.

The single storey Amenity link structures between the blocks will be stand-alone structures, with movement joints at each interface with the adjacent blocks. These will be constructed using timber. A CLT floor will be supported by Glulam beams and columns.

4.3.4 Salesian's Apartments & Triplexes

For the Salesian Apartments, a precast concrete slab and wall scheme is the most suitable option. This would include a Precast Wideslab with an In-Situ Concrete Topping. Temporary construction propping would be required due to the slab spans. The slab would be supported by precast walls. The roof structure of the apartments will cater for the ASHP plant as well as the Green Roof and Solar PV requirements. Stability Cores are proposed at the Lift / Staircores, with Precast Core Walls. Steel balconies will be cantilevered from the precast frame using a thermal break connection system.

For the Salesian Triplexes, an insitu RC frame will be used for the carpark structure. An RC slab is being proposed for the capping slab of the basement. The slab spans onto RC Beams and columns. The perimeter of the basement will be designed as a reinforced concrete retaining wall. A Stability Core is proposed at the Lift / Staircore, with a RC walls.

For the Triplexes above the basement, a timber frame structure is proposed. Prefabricated engineered timber frame systems will be used for the external and internal compartment walls. The floors will be made up of composite timber-steel webbed floor joists. The roof will be constructed using prefabricated timber roof trusses.

4.4 External Structures

4.4.1 Shipyard Canopies

The shipyard site will provide 2no. canopy structures, with bowstring roof truss structures. The trusses are proposed to be constructed in timber and will be supported by steel columns down to individual pad foundations. The steel columns will be designed as cantilevers above the ground/foundation level to provide lateral stability to the structures in both directions.

4.4.2 Riverside Canopy

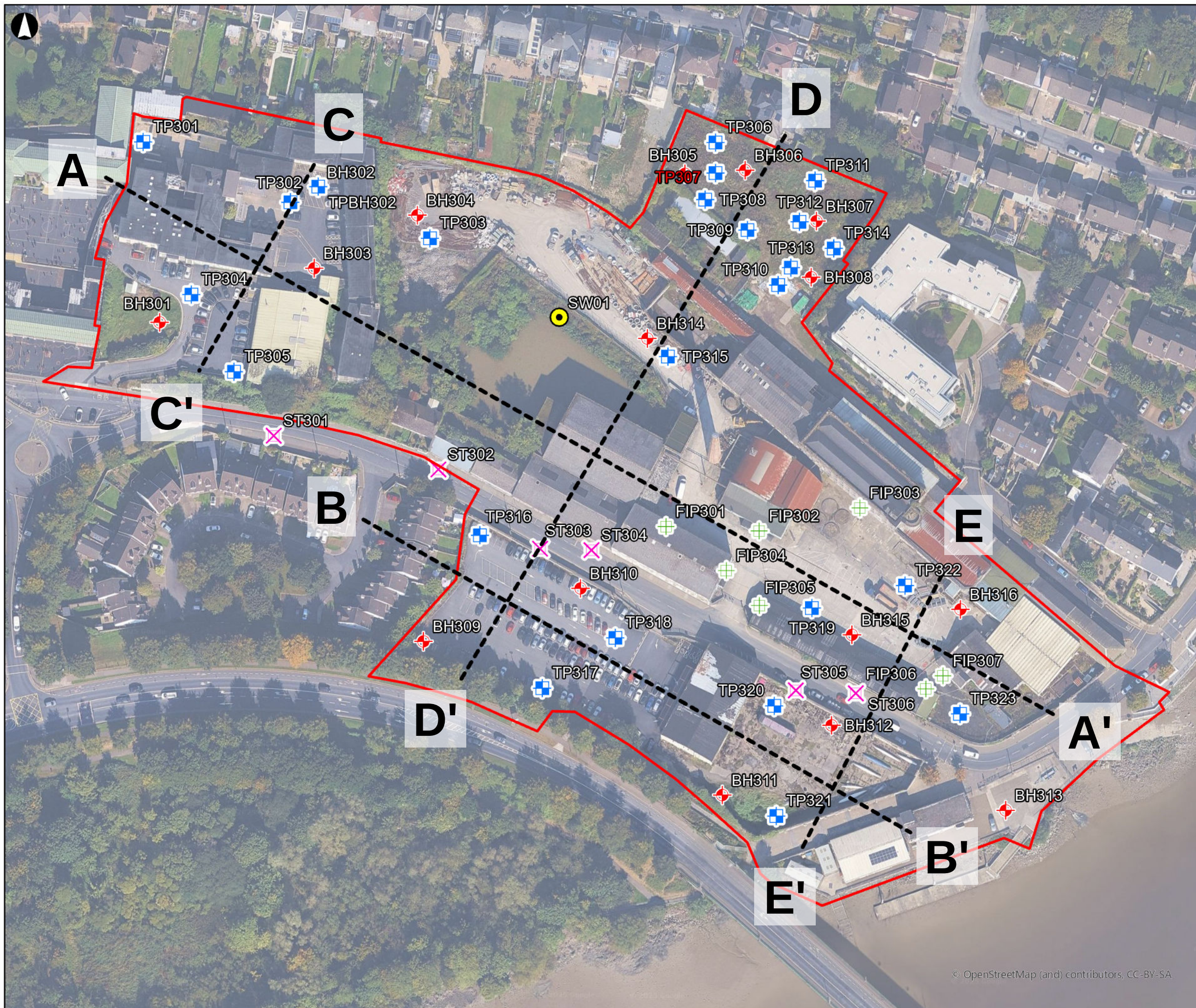
The proposed architectural intent for riverside canopy structure consists of 3no. parallel barrel-vaulted roofs which are formed using curved glulam beam sections in a structural diagrid pattern. Glulam columns are provided as the vertical structural elements, which transition to reinforced concrete stub columns below ground level. The foundation solution consists of conventional concrete pad foundations on leanmix build up from competent bearing stratum.

4.4.3 Salesians and Quarry Wall Stairs and Walkway

The proposed architectural intent requires a suspended walkway and stairs over the existing reservoir basin. The structural scheme to support the walkway will consist of pairs of RC piers supported off the reservoir bedrock. Similarly, the adjacent stair structure will require 2no. RC piers intermediately to break up the span. Beneath the top landing of the stairs is a wildlife feature to house native bats. It is proposed to cantilever out two RC beams below ground level to provide support the top of the stairs without impacting the wildlife feature.

Appendix A

Geological Cross Sections



Legend

Site Boundary

GI Exploratory Locations

- Borehole - Cable Percussion with Rotary Follow-on (BH)
- Trial Pits (TP)
- Slit Trenches (ST)
- Soakaways (SA)
- Foundation Inspection Pits (FIP)
- Surface Water (SP301)

Coordinate System:
IRENET95 Irish Transverse Mercator

Metres
0 12.5 25 50

0	2025-06-04	PC	EW		
Rev	Date	By	Chkd	Appd	Authd

ARUP

50 Ringsend Road
Dublin 4
D04 T6X0
Ireland
www.arup.com

Client

Limerick Twenty Thirty

Project Name

Cleeves Riverside Quarter

Drawing Title

Cross Section Line Locations

Scale at A3

1:1,250

Role

For Information Only

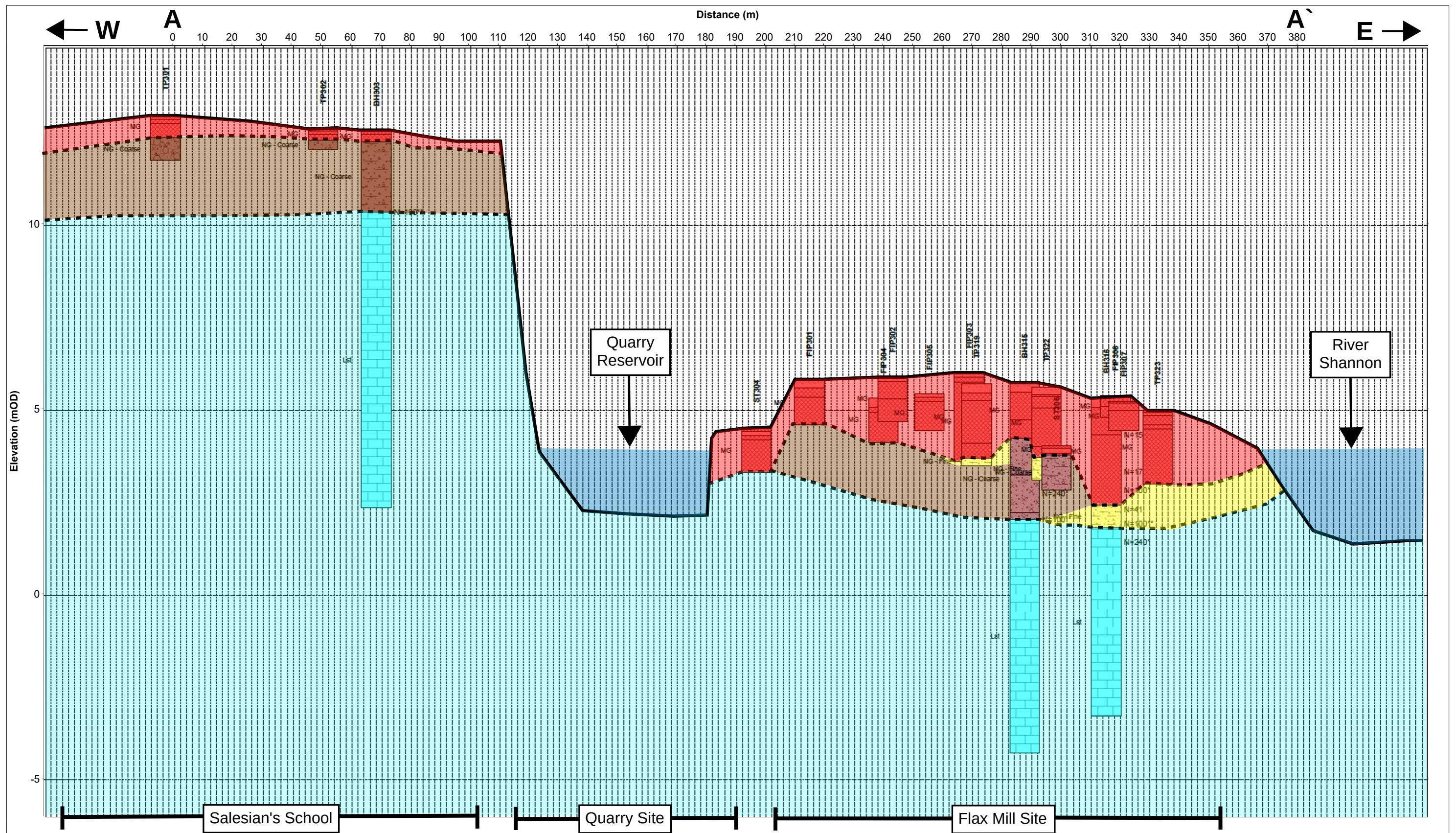
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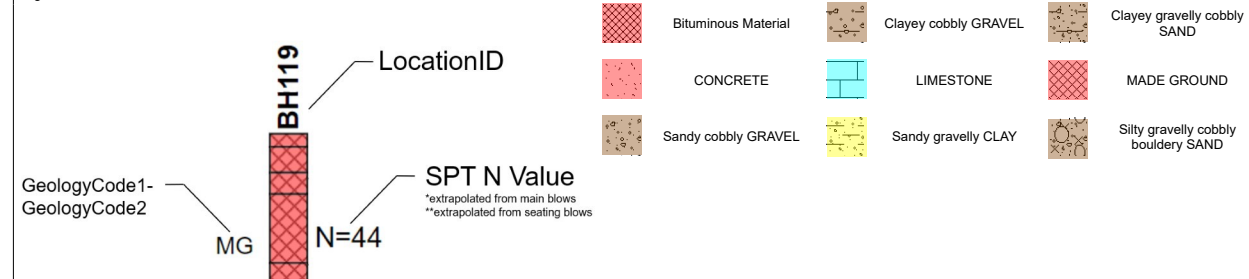
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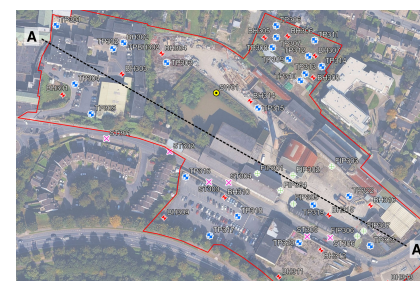
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Legend



Notes



Client

Limerick Twenty Thirty

Job Title

Cleeves Riverside Quarter

Scale

Revision

0

ARUP

Figure Title

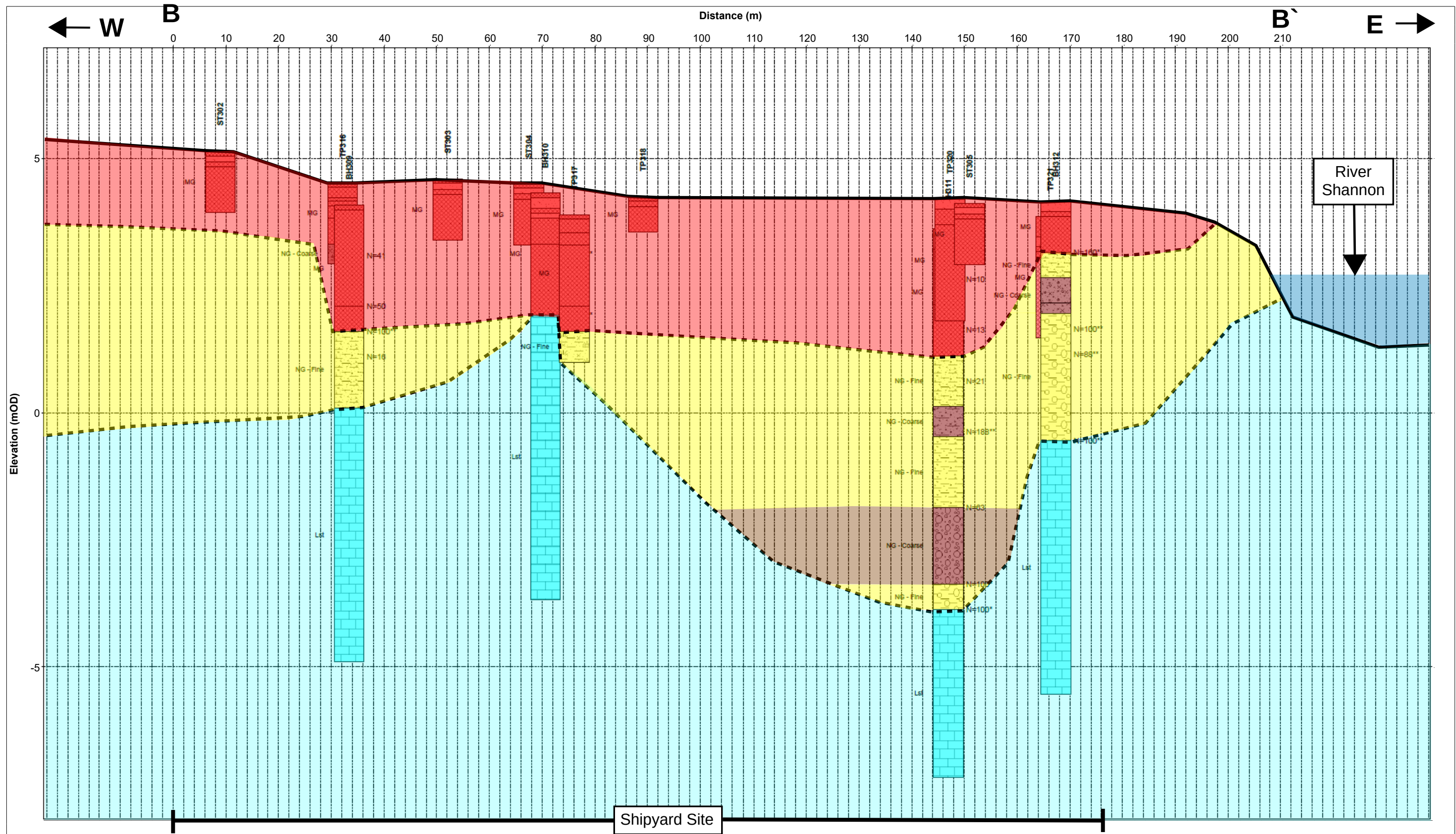
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Job No

277975-00

Figure No

02



Legend

GeologyCode1-
GeologyCode2

MG

LocationID

BH119

SPT N Value

*extrapolated from main blows
**extrapolated from seating blows

N=44

	Bituminous Material		Bouldery CLAY		Clayey sandy GRAVEL
	CONCRETE		Gravelly CLAY		Gravelly cobbly BOULDERS
	LIMESTONE		MADE GROUND		Sandy gravelly CLAY

Notes

Client

Limerick Twenty Thirty

Job Title

Cleeves Riverside Quarter

Scale

Revision

0

ARUP

Figure Title

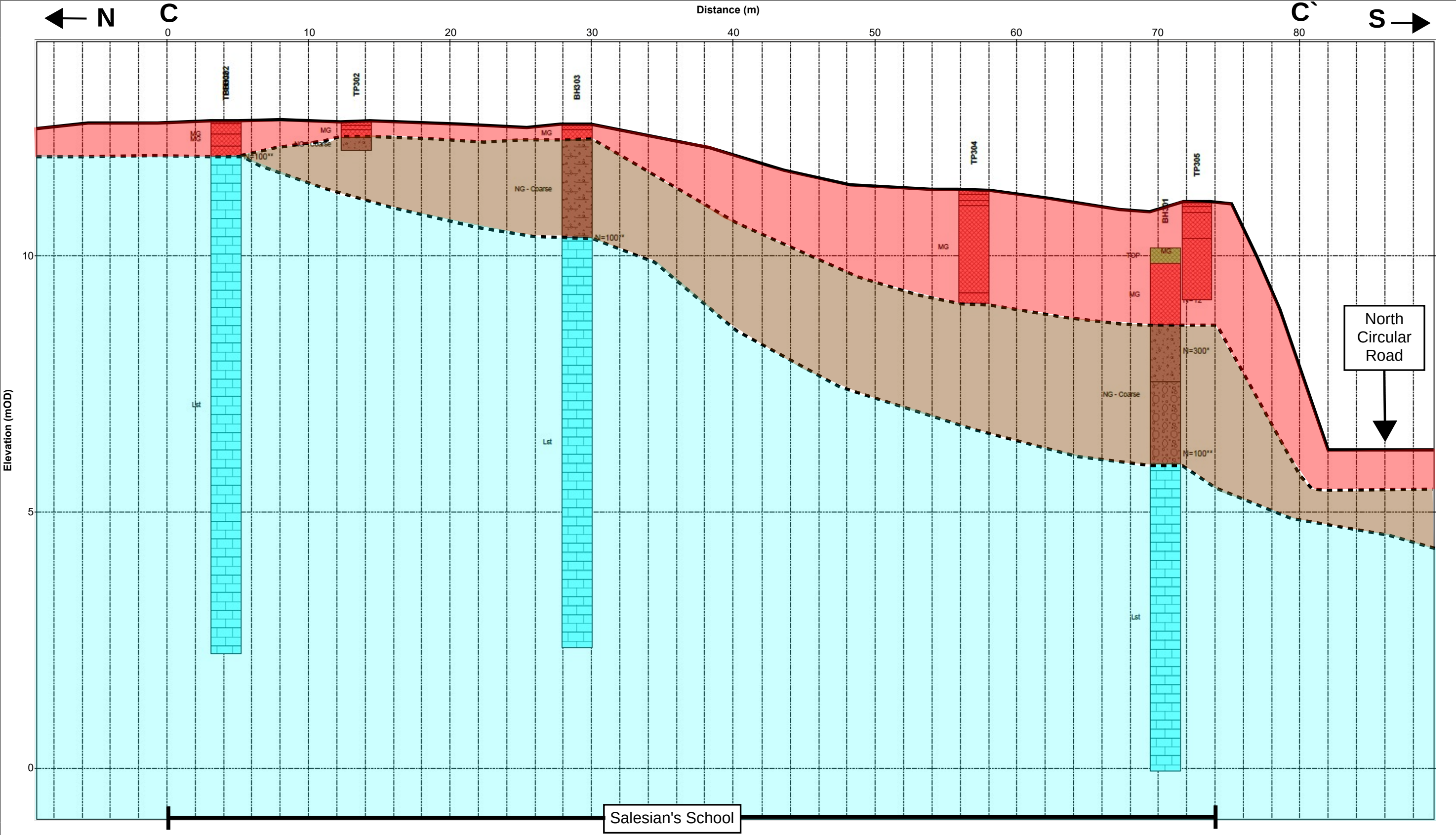
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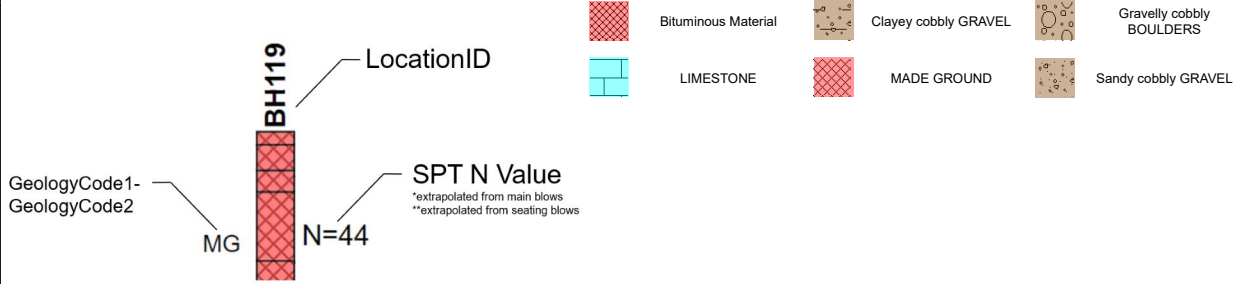
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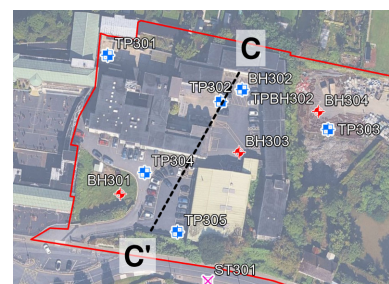
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Legend



Notes



Client
Limerick Twenty Thirty
Job Title
Cleeves Riverside Quarter

Scale

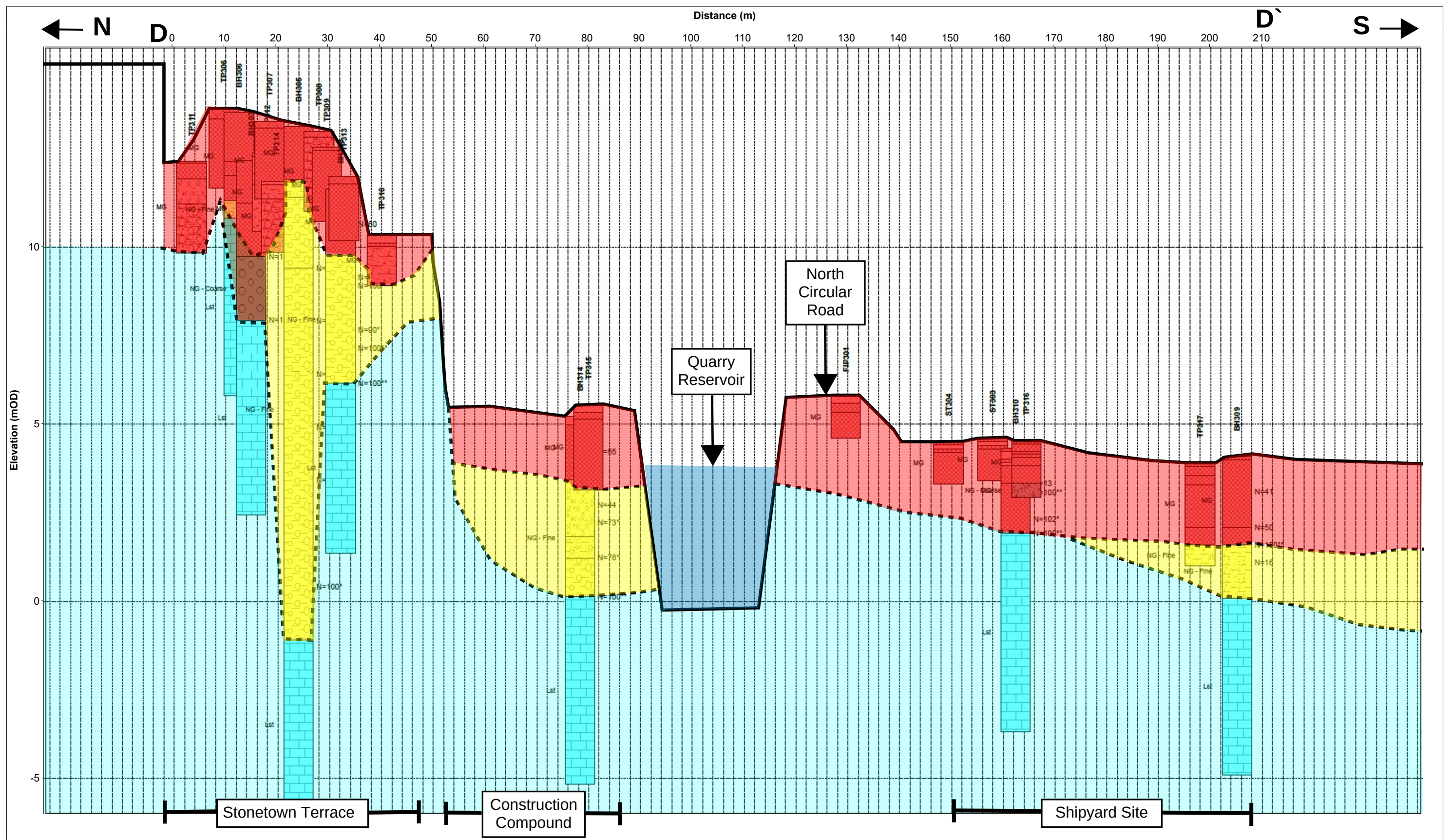
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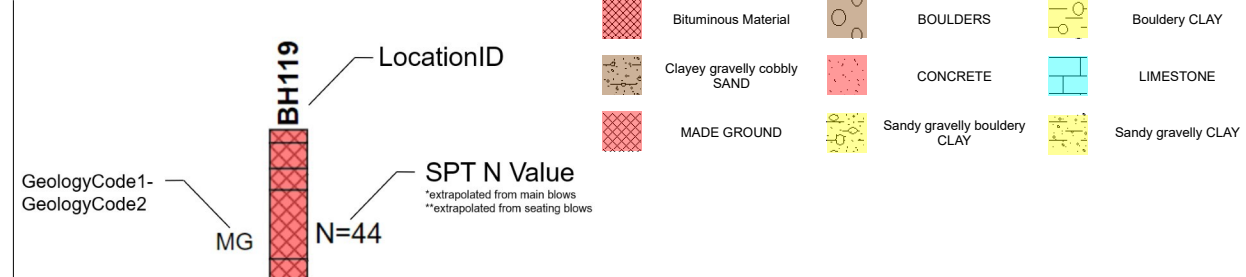
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Cross Section C - C'

Job No
277975-00

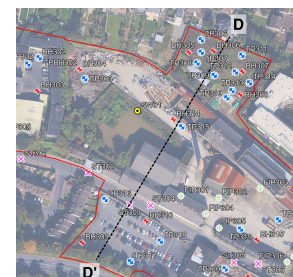
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Legend



Notes



Client

Limerick Twenty Thirty

Job Title

Cleeves Riverside Quarter

Scale

Revision

0

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Figure Title

Cross Section D - D'

Job No

277975-00

Figure No

05

