ARUP

Ruirside Developments Ltd

Parkgate Street Blocks B1 & C

Basement Impact Assessment

Reference: PGATE-ARUP-ZZ-XX-RP-CG-0001

Issue 02 | 3 December 2024

Job number 265381-00

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Document Verification

Project title	Parkgate Street Redevelopment
Document title	Basement Impact Assessment
Job number	265381-00
Document ref	PGATE-ARUP-ZZ-XX-RP-CG-0001
File reference	

Revision	**Date**	**Filename**	20241129_265381-00_ParkgateBIA_29.11.2024		
Issue 01	02 December 2024	**Description**	Draft issue for information		
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Issue 02	03 December 2024	**Filename**	20241129_265381-00_ParkgateBIA_29.11.2024		
		Description	Issued for planning		
			Prepared by	**Checked by**	**Approved by**
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		Filename			
		Description			
			Prepared by	**Checked by**	**Approved by**
		Name			
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Issue Document Verification with Document ☑

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Executive Summary (Non - Technical)

This report presents the findings of the Basement Impact Assessment for the proposed development at 42A Parkgate Street, Dublin 8 (Hickey's site). The assessment evaluates baseline conditions, construction methodologies, and potential impacts on surrounding structures and sensitive receptors.

Baseline Conditions

Site Context:

The site has a commercial and industrial history and is surrounded by heritage-listed structures. Neighbouring buildings are located close to the western boundary wall, while other structures and services are positioned away from the proposed basements.

Ground and Groundwater Conditions:

The site consists of, from surface downward:

- Made Ground
- Fine-Grained Alluvium
- Fluvioglacial Sands and Gravels
- Limestone Bedrock.

The Fluvioglacial Sands and Gravels form a high-permeability aquifer, connected to the Limestone Bedrock aquifer. Groundwater levels are tidally influenced, with levels ranging between 1.45mOD and 0.38mOD in the sands and gravels, and 0.91mOD to 0.12mOD in the bedrock.

Proposed Development and Construction

The development includes single-level basements for Blocks B1 and C, constructed via open excavation with an assumed 1:2 slope angle (Vertical: Horizontal).

The basements will extend below peak groundwater levels. Additionally, the excavations may penetrate into the gravel aquifer in localised areas and even if they don't dewatering of the gravel aquifer will be required to reduce risk of basal heave occurring at base of Fine-Grained Alluvium necessitating localised dewatering. This will involve sump pumping, with treated water discharged into the storm drainage network or the River Liffey under appropriate permits.

Impact Assessment Findings

Negligible impact expected as implemented mitigation measures and the distance of key receptors from the zone of influence ensure minimal impact on surrounding assets and sensitive receptors.

Mitigation Measures

The proposed mitigation measures for the construction stage include:

- Tender documents that define performance and execution requirements
- Installation of an instrumentation and monitoring scheme to record actual site behaviour to compare against predictions
- Pre-defined corrective actions will be implemented if monitored data indicates more adverse conditions than predicted, ensuring movements remain within acceptable limits.

The proposed basement construction for Block B1 and Block C is concluded to have negligible impact on surrounding existing assets and sensitive receptors. Continuous monitoring and responsive corrective actions will ensure the integrity and safety of surrounding structures throughout the construction process.

1. Introduction

1.1 Background

Dublin City Council (DCC) have issued a Dublin City Development Plan (DDCDP) for 2022 to 2028[1] and it came into effect on 14th December 2022. A Basement Impact Assessment (BIA) is required for all developments which include basement levels (Chapter 15, Table 15-1, Thresholds for Planning Applications).

Planning permission was granted in 2020 (ABP Ref. 306569-20) at the site for 321 no. Build-to-Rent (BTR) residential units, ancillary residents' amenity facilities, commercial office space, retail space and café/restaurant accommodated in 5no. blocks ranging from 8 to 13 storeys over ancillary basement area, and all associated and ancillary conservation, landscaping and site development works (with amendments to car parking, basement and undercroft approved by the Board under s.146B (ABP 311507-21 refers), this permission is due to wither in 2025. In the eastern apex of the site, permission was also ultimately granted for a 30-storey Block A tower in 2021 under ABP Ref. 310567-21 which comprises 198 residential units resulting in an overall number of 519 units accommodated on site. A further application for the change of use for Block B2 from commercial office space to 40 number residential units was granted permission in 2023 under DCC Reg. Ref. LRD6042/23.

The planning application, for which this Basement Impact Assessment report forms part of, seeks a new permission for Block B1 and Block C ranging in height from 8 to 13 storeys with basement and undercroft, and including: 316no. apartments (178no. 1-bed units and 138no. 2-bed units). These blocks remain largely as per the previously consented development, with amendments made to comply with Dublin City Council Development Pan 2022-2028. The proposed development, for the purposes of this report, is considered in the context of the application site in its entirety, comprising the proposed development (i.e. revised Blocks B1 & C) and the same associated demolition, conservation, site works, landscape and boundary works, and development previously permitted under 306569-20 (as amended). It is further considered in the context of ABP Ref. 310567-21 as amended by DCC Reg. Ref. LRD6042/23 (Block A and B2). This will collectively be referred to as "the development".

The design is currently at Scheme Design Stage, in accordance with EI/ACEI plan of work[2], which is typical for the level of design undertaken preplanning and is considered appropriate to fulfil the requirements of a BIA. The Detailed Design Stage will be undertaken post planning and will be in accordance with Eurocode design standards and relevant local design standards and codes of practice.

1.2 Scope of this report

A BIA has been prepared as part of the planning application for this project, to address the requirements contained within Appendix 9 (titled 'Basement Development Guidance') of the DCC.

The report presents the baseline conditions and key hazards associated with the proposed development (Section 2). An impact assessment (Section 4) on the key hazards identified is undertaken. This has allowed any residual impacts associated with the proposed basement to be either eliminated or reduced to 'as low a reasonably practicable' using a number of industry standard mitigation measures (Section 5).

[1] https://www.dublincity.ie/residential/planning/strategic-planning/dublin-city-development-plan/development-plan-2022-2028

[2] Engineer's Ireland and the Association of Consulting Engineer of Ireland (2000). Conditions of Engagement Agreement SE 9101

1.3 Methodology

The methodology involves establishing baseline conditions using available information, identifying key hazards (Section 2), and presenting the proposed basement construction methodology (Section 3). An assessment of the construction's impact on the existing environment follows (Section 4), along with recommended measures to mitigate and manage these impacts during construction and the working life of the development (Section 5).

1.4 Sources of information

The following particular sources of information have been used in the compilation of this report:

- Dublin City Development Plan for 2022 to 2028[3]
- Geological Survey of Ireland (GSI) (www.gsi.ie)
- Environmental Protection Agency (EPA) Map Viewer (https://gis.epa.ie/EPAMap)
- Aerial images and mapping:
  - Ordnance Survey of Ireland (http://map.geohive.ie/mapviewer.html)
  - Bing maps (www.bing.com/maps) aerial photography and mapping (licensed)
  - Google maps (www.google.com/maps) aerial photography online mapping
  - Teagasc (www.teagasc.ie).
- The Irish Meteorological Service (https://www.met.ie/)
- Kealy S et al (2021). Characterisation of gravel deposits in the pre-glacial channel
- Site Specific Reports
- "Site Investigation Report (2003)" by IGSL
- "Geotechnical and Environmental Assessment Report (2006)" by Arup
- Drawing No. 11531, Topographic survey, Parkgate House Parkgate Street Dublin 8 (2018) by Precision Surveys
- "Geotechnical and Geo-Environmental Site Investigation (2019) GII Ground Investigation Report (2019)" by Ground Investigations Ireland Ltd.

1.5 Limitations

This BIA has been completed to information available at the time of writing. No assessment of impacts arising due to unknown future developments surrounding the site has been considered. Historical information and previous ground investigations from 2003 and 2019 were available at the time of writing, which were deemed appropriate information to undertake this assessment.

1.6 Authors Qualifications

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[3] https://www.dublincity.ie/sites/default/files/2021-12/volume-1-draft-dublin-city-development-plan-2022-2028-low-res.pdf

2. Baseline Conditions

2.1 Site description and topography

The subject site is a brownfield site located at 42A Parkgate Street, see Figure 1A and Figure 1B (Irish Transverse Mercator co-ordinates 713638E, 734398N). The site is triangular in shape, and is bounded by the River Liffey to the south, commercial and residential buildings to the west, and Parkgate Street to the north. Based on a 2018 topographic survey by Precision Surveys (referenced in Section 1.4), the ground elevation of the site ranges approximately between +5.5mOD (metres above Ordnance Datum Malin) and +3.3mOD, with the lowest elevations at the southwest of the site, sloping up towards the northeast.

2.2 Current site use

The site is currently not used or occupied.

2.3 Adjacent structures and basements

The proposed site is surrounded by several commercial and residential structures. Table 1 provides details of the structures both within and outside the project planning boundary and presents their locations relative to the site.

Figure 2 illustrates the approximate basement outline with the adjacent structures from Table 1.

Table 1 Summary of adjacent structures and buildings

Ref	Address	Building/ Structure Type[2]	Year of Construction	Proximity to Proposed Basement[2]	Basement[2]	Construction Type[2]
1	Parkgate Business Centre, Parkgate Street	Four-storey building	1999[2]	Approximately 5m to the northwest of Block C basement	Yes (approx. +2.75mOD)	Concrete / Masonry
2	Parkgate Place Apartments, Parkgate Street	Five-storey building	2003[2]	Approximately 1m to 3m west of Block C basement, with nearest distance to the southwest of basement. An existing boundary wall and concrete steps are between existing structure and proposed basement	Yes (unknown FFL)	Reinforced concrete
3	Phoenix Iron Works, Parkgate Street*	Two-storey building	1810 – 1830[1]	Approximately 10m to the northwest of Block B1 basement. Structure due to be demolished in advance of construction of proposed basements	N/A	Brick / Masonry
4	Phoenix Iron Works, Parkgate Street	Gates/ railings/ walls	1810 – 1830[1]	Approximately 10m to the north of Block B1 basement	N/A	Brick / Masonry
5	Parkgate Street	Electricity substation	1800-1900[1]	Approximately 30m to the east of Block B1 basement	N/A	Brick / Masonry
6	Phoenix Iron Works, Parkgate Street (river wall)	Gates/ railings/ walls	1810 – 1830[1]	Immediately adjacent to the south of the Block C basement and approximately 5m to the south of Block B1 basement	N/A	Brick / Masonry

Ref	Address	Building/ Structure Type[2]	Year of Construction	Proximity to Proposed Basement[2]	Basement[2]	Construction Type[2]
7	Boundary wall	Wall	Unknown	Immediately adjacent of Block C basement	N/A	Concrete / Masonry

*Planned to be demolished prior to basement construction

1. Details from the National Inventory of Architectural Heritage[4]
2. Estimated from aerial imagery (Google Maps)[5]

2.4 Adjacent services and infrastructure

There is an ESB low to medium voltage underground cable (4X120C) within the area of the proposed basement (Block B1 and C), which is planned to be demolished prior to construction of proposed basements.

Other services, such as drainage and gas lines, are located outside of the basement area, along Parkgate Street. Figure 4A, 4B and 4C show the locations of these services relative to the site boundary.

2.5 Site history

The site history is summarized in Table 2.

Historical maps, which form the basis for summary in Table 2, are presented in Figures 5A to 5H.

Table 2 Summary of Site History

Date	Site History
Early 1800s	2-5m of fill was used to raise the levels across the site above the River Liffey floodplains.
1800s-1890 (approximate)	Phoenix and Royal Iron Works
c.1820	Construction of the Phoenix Iron Works manager's house located the in the north-west of the site.
c.1895	Construction of the electricity sub-station east of the site.
1900 - 1910	Woollen worsted manufacturing by The Knightsbridge Mills
1910 - 1920	Site left vacant under the ownership of Phoenix and Royal Iron Works
1920 - 1930	Government Stores
1930 – 1970s	Printing works
Mid 1970s - Present	Hickey's Fabrics warehouse.

2.6 Heritage and archaeology

Table 3 provides the locations listed on the National Inventory of Architecture Heritage. The reference numbers in Table 3 refer to the reference numbers in Table 1. For the plan view of the locations, see Figure 2. The Phoenix Iron Works, Parkgate Street (Reference 3 in Table 3) is planned to be demolished prior to construction of proposed basements.

Table 3 National Inventory of Architecture Heritage

Ref:	Address	Building Type	Proximity to Proposed Basement	Reg No.	Rating
3	Phoenix Iron Works, Parkgate Street	Two-storey building	Approximately 10m to the west	50060347	Regional - Architectural, Social
4	Phoenix Iron Works, Parkgate Street	Gates/railings/walls	Approximately 10m to the north	50060346	Regional - Architectural

[4] National Inventory of Architectural Heritage (https://www.buildingsofireland.ie/)

[5] Google maps (www.google.com/maps)

Ref:	Address	Building Type	Proximity to Proposed Basement	Reg No.	Rating
5	Parkgate Street	Electricity substation	Approximately 10m to the east	50060350	Regional – Architectural, Technical
6	Phoenix Iron Works, Parkgate Street	Gates/railings/walls	Immediately adjacent to the south of the basement	50060349	Regional - Architectural

2.7 Ground conditions

2.7.1 Geological setting

According to GSI[6], the typical geology of Dublin city is overburden, that generally comprises Made Ground, overlying alluvial sediments and/or glacial drift deposits, underlain by Limestone bedrock. Figure 6 is the general soil map of Ireland published by Teagasc[7], which shows the site extent to be underlain by urban soils or Made Ground. Figure 7 shows the GSI quaternary geology map along with the site extents. According to the GSI the site is underlain by River Alluvium.

Drift is a general term applied to all materials (clay, silt, sand, boulders) transported by a glacier and deposited directly as till by or from melting within the ice, or as fluvioglacial deposits by running water emanating from the glacier. During the Pleistocene epoch of the Quaternary (the most recent geological time period), two glaciations covered the Dublin region.

These glaciations gave rise to the deposition of the till strata known as the Dublin Boulder Clay and were presumably not continuous. Local withdrawal and re-advance of the ice sheet led to the formation of fluvioglacial sediments (gravel and sand deposits) and glaciomarine sediments (stiff/firm laminated clays, silts, and sands). The glacial deposits can exhibit significant lateral and vertical variations in grain size distributions over short distances.

The site is underlain by a buried fluvio-glacial channel. This feature is infilled mostly with water bearing fluvio-glacial gravels of variable consistency. The pre-glacial channel likely represents the original course of the river Liffey (Kealy et al., 2021[8]).

The GSI 1:100,000 scale Bedrock Geology Map in Figure 8 indicates the majority of greater Dublin area, including the site, is underlain by argillaceous Limestone and Shale (colloquially known as Calp) of the Lucan Formation. No bedrock structures were noted on the 1:100,000 GSI bedrock geology map. Figure 9 shows the GSI depth to bedrock map which state that the top of rock to be approximately 5 to 10m below ground level.

Figure 10 shows the EPA Radon map, which indicates that the site is classified as having a low risk of radon gas intrusion (1 in 20 buildings in the area are likely to have high radon levels)[9].

Based on the geological setting, the expected ground stratigraphy consists of Made Ground overlying Alluvium and/or Fluvioglacial Sediments, which lie over Limestone bedrock.

2.7.2 Ground Investigations

Table 4 summarises the scope of the ground investigations on the site. The ground conditions observed during the investigations align with those described in the Geological Setting. Figure 11A and 11B show the exploratory hole locations plan for the ground investigations conducted on site.

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6 Geological Survey of Ireland (GSI) (www.gsi.ie)

7 Teagasc (www.teagasc.ie)

8 Kealy S et al (2021). Characterisation of gravel deposits in the pre-glacial channel

9 Environmental Protection Agency (EPA) (https://gis.epa.ie/EPAMap);

Table 4 Available ground investigation reports

Project Title	GI Contractor	Year	Proximity to site	Summary of Field Works	Summary of lab testing
Hickeys Fabric & Co. LTD.	IGSL	March 2003	Within the site boundary	4 no. cable percussive boreholes 4 no. cable percussive boreholes with rotary follow on 16 no. window sample boreholes 6 no. groundwater monitoring installations	Particle Size Distribution and Sedimentation Moisture Content Atterberg Limits Shear Box Uniaxial Compressive Strength (UCS) Point Load Organic Content pH and SO^3
Hickeys 43 Parkgate Place	Ground Investigations Ireland Ltd.	June 2019	Within the site boundary	4 no. cable percussive boreholes with rotary follow on 4 no. rotary core boreholes 5 no. foundation inspection pits 1 no. slit trench 18 no. window sample 10 no. groundwater monitoring installations 2 no. permeability tests 3 no. gas monitoring caps Geophysical Survey	Particle Size Distribution and Sedimentation Moisture Content Atterberg Limits Uniaxial Compressive Strength (UCS) Point Load Organic Content Chloride Content pH and Sulphate

2.7.3 Ground model

Based on information presented in Sections 2.7.1 and 2.7.2, the ground model for the site is a downward sequence of Made Ground, fine grained Alluvium, Fluvioglacial Sands & Gravels and Limestone Bedrock. provides an estimated ground model based on the available information presented previously.

Table 5 Summary of encountered ground conditions

Stratum	Description	Top level (mOD)	Base level (mOD)	Thickness (m)
Made Ground	Clayey GRAVEL or gravelly sandy CLAY with anthropogenic inclusions (ceramic, plastic, red brick etc)*	Ground level	0.29 to 2.65	1.8 to 5.0
Fine grained Alluvium	Soft to firm brown gravelly sandy silty CLAY with occasional shell fragments or soft grey SILT	0.29 to 2.44	-0.91 to 2.24	0 to 3.0
Fluvioglacial Sands and Gravels	Loose to very dense brown/black sandy clayey GRAVEL or brown gravelly clayey SAND	1.87 to -3.32	-1.74 to -3.19	1.2 to 3.7
Clay**	Firm grey sandy gravelly CLAY with occasional cobbles	-0.68 to -1.9	-2.7	0 to 0.8
Bedrock	Limestone	-1.74 to -4.25 (6.4 to 8.5mBGL)	Unproven	Unproven

* Made ground is heterogeneous in nature. This description is based on the previous site investigations on site at specific locations, and the composition of made ground may vary elsewhere on site.

**Clay layer overlaying bedrock encountered in two exploratory holes only, which may be a discrete layer.

2.8

2.8 Hydrogeological Setting

2.8.1 Hydrology

This section addresses rainfall and surface water bodies in the area. It does not cover any aspect of drainage or surface flooding. This is covered in the separate site-specific Flood Risk Assessment submitted to support the planning application for the proposed development

The nearest rain gauge to the site is Merrion Square (Gauge No. 3923), approximately 1.5km to the south of the Site, which reports an average annual rainfall of 723mm over the past 10 years[10]. The land-use in the surrounding area consists predominantly of commercial and industrial buildings which have associated drainage systems to re-direct surface runoff. It is assumed that the majority of rainfall from the surrounding area does not naturally infiltrate into the subsoil beneath the site.

The site is located in the vicinity of the River Liffey which flows immediately to the south of the proposed development. The Liffey is classified in this area as a Transitional Water Body (Liffey Estuary Upper IE_EA_090_0400) under the Water Framework Directive (WFD).

2.8.2 Aquifers

The proposed development is underlain by fluvioglacial sands and gravels which is classified by GSI as a Locally Important Gravel Aquifer (Lg). The classification of the fluvioglacial sands and gravels as an important Gravel Aquifer was amended in 2021 by the GSI.

The limestone bedrock (referred to as the Lucan formation) is classified by GSI as a Locally Important Aquifer Bedrock, which is moderately productive only in local zones and which is part of the Dinantian Upper Impure Limestones Hydro-stratigraphic Rock Unit Group.

The key hydrogeological conditions from publicly available GSI resources are summarised in Table 6. The Groundwater Aquifer map is presented in Figure 12, Vulnerability map in Figure 13 and Groundwater Recharge map in Figure 14.

Table 6 Hydrogeological conditions

Condition	Comment
Sand and Gravel Aquifer	The GSI aquifer map identifies that the area is a locally important gravel aquifer (Lg). Due to the hydraulic connection with the River Liffey, which is brackish in this area, groundwater in the GSIaquifer may have high salinity close to the river.
Bedrock Aquifer	The GSI Bedrock Aquifer map identifies the area as being underlain by a limestone aquifer is classified as being a locally important aquifer, which is moderately productive only in local zones (Ll).
Abstraction Wells	There are no abstraction wells on site or in the immediate vicinity of the site. There is a groundwater abstraction for industrial purposes from the “Cooperage Well” at the Diageo site south of the River Liffey.
Groundwater Vulnerability	Vulnerability refers to the ease by which anthropogenic contaminants can infiltrate to the underlying groundwater in a vertical or sub-vertical manner. According to the GSI database, the groundwater vulnerability of the bedrock aquifer under the site is Low in the northern side of the site to moderate vulnerability in the southern half of the site. The GSI define the vulnerability of gravel aquifers as high with the exception of cases where the water table is within 3m of ground surface when the vulnerability is extreme. Due to the variability of the groundwater levels and depth to the gravel aquifer, the site specific vulnerability is considered as High to Extreme.
Groundwater Recharge	The GSI recharge map indicates that the average rainfall recharge at the site is approximately 60mm/year. Leakage from water supply mains can contribute significantly to shallow groundwater within the Made Ground in Dublin City.
Subsoil Permeability	The GSI classify the area as having a glacial till subsoil as low permeability. On site testing of the gravel aquifer has confirmed this is a high permeability subsoil.

[10] The Irish Meteorological Service (https://www.met.ie/)

2.8.3 Groundwater levels

Previously two ground investigations were carried out on the site, in 2003 and 2019. During the 2019 ground investigation, groundwater levels were recorded in both the historical boreholes installed in 2003 and in the boreholes installed in 2019.

Groundwater levels were manually measured on four occasions in May and June 2019 and in a total of 13 installations. Table 7 summarizes the groundwater installations, the response zones strata and the groundwater level measurements taken in 2019. The average of the groundwater levels is 0.65mOD. It should have noted that there is no indication of groundwater levels within the made ground layer.

Table 7 Summary of the groundwater installations

Location ID	Response Zone/ Aquifer Screened	Installation	Average Groundwater level (mOD)*
BH01	Sand and Gravel	2003	0.29
BH02	Sand and Gravel	2003	0.24
BH05	Sand and Gravel	2003	0.74
BH06	Sand and Gravel	2003	0.24
WS06	Sand and Gravel	2003	1.57
WS12	Sand and Gravel	2003	0.55
WS13	Sand and Gravel	2003	0.65
BH101	Sand and Gravel	2019	0.40
BH102	Limestone	2019	0.39
BH103	Sand and Gravel	2019	0.83
BH104	Limestone	2019	1.00
BH105	Limestone	2019	1.11
BH106	Sand and Gravel	2019	0.65
BH107	Limestone	2019	0.56

*Measurements taken in May and June of 2019.

Table 8 shows a summary of the maximum, minimum and average (mOD) of groundwater levels recorded from the sand and gravel and bedrock aquifer.

Table 8 Summary of the groundwater levels recorded in sand and gravel and limestone aquifers

Response Zone/ Aquifer Screened	Groundwater Level Maximum (mOD)	Groundwater Level Minimum (mOD)	Average Groundwater level (mOD)*
Sand and Gravel	1.57	0.03	0.35
Limestone	1.19	-0.14	0.82

Logger Data

Groundwater level loggers were installed and monitored for a period of one month, between August and September 2019 in a total of four installations that were completed in the 2019 Ground Investigation (BH101, BH102, BH103 and BH106). The readings on the level loggers were taken every five minutes.

The groundwater level in both the natural sand and gravel aquifer and in the limestone bedrock aquifer varied with the tide influence during the monitoring period. During this monitoring period the tide level monitored from the Dublin Port Station recorded values ranging from -1.89mOD (recorded on 14/08/2019) to +2.13mOD (recorded on 31/08/2019), while the average of tide levels was +0.102mOD.

Analysing a period of seven days of data from the BH106 and comparing this with the tide level from the Dublin Port, it was noted that on both monitoring installations the levels ranged 1m. The records showed that the groundwater level ranged from -0.30mOD and +1.38mOD on the BH106 and that tide levels ranged from -1.89mOD and +0.89mOD on the Dublin Port.

While in the data from tide level the peak of maximum and minimum records varied during a week, the peak of maximum and minim records varied during two days on the BH106.

The tide levels at Dublin Port gauge[11] recorded during this monitoring period included a peak of 2.13mOD and a 98% percentile of 1.84mOD. The groundwater levels over this period peak at 1.45mOD, highlighting the attenuation of the tidal range due to storage (buffering) within the gravel aquifer. Reviewing the tidal data from this monitoring period to Nov 2024 the peak tide level observed for Dublin Port was 2.55mOD, i.e. 0.42m higher than that observed during the groundwater logger monitoring period. However, the 98th percentile over the 2019-2024 period was 1.76mOD, which is 0.08m lower than that observed during the monitoring period.

Only in extreme events might the levels temporarily be higher but due to the buffering within the aquifer the magnitude will be less than observed in the tidal peak. Therefore, the groundwater levels observed during the monitoring period in 2019 are considered representative of typical tidal fluctuations for the River Liffey and include periods amongst the highest levels.

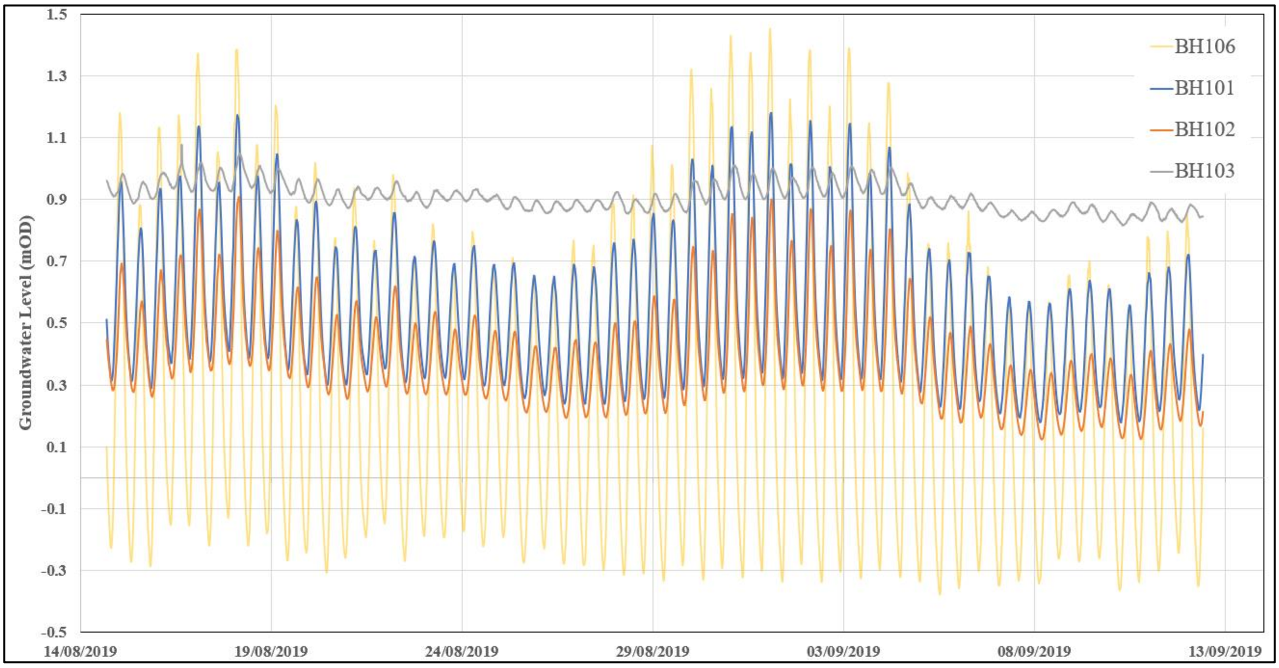

Chart 1 Groundwater Level (mOD) variation recorded by the level loggers during August and September 2019

Table 9 presents a summary of these records, including the maximum, minimum and average (mOD) groundwater levels in each of the installations.

Table 9 Summary of the groundwater levels monitored by level loggers in 2019

Location ID	Response Zone/ Aquifer Screened	Groundwater Level Maximum (mOD)	Groundwater Level Minimum (mOD)	Average Groundwater level (mOD)
BH101	Sand and Gravel	1.18	0.18	0.40
BH102	Limestone Bedrock	0.91	0.12	0.39
BH103	Sand and Gravel	1.08	0.82	0.91
BH106	Sand and Gravel	1.45	-0.38	0.26

This shows the groundwater levels monitored by level loggers ranged between 1.45mOD and -0.38mOD in sand and gravel aquifers and between 0.91mOD and 0.12mOD in limestone aquifers. The average in sand and gravel aquifers is 0.53mOD while the average in limestone bedrock aquifer, that was recorded in only one borehole, is 0.39mOD. Chart 1 shows the chart from the groundwater level data recorded in 2019.

[11] Tidal Observations (IMOS) | Marine Institute

BH106 in the south-centre of the site had the maximum variation in groundwater level as it was closest to the River Liffey and so was impacted by the tidal variation most. Groundwater levels in BH103, located in the north-centre of the site and furthest away from the river, varied the least but was still influenced slightly by tidal variation.

The compilation of these results showed that the groundwater flow across the site is in a north-west to south-east direction toward the river during low tide and in a south-east to north-west direction at high tide. The gravel aquifer is considered to be in hydraulic continuity with the River Liffey.

Summary of Groundwater and Gravel Levels at Basement Locations

Table 10 presents a summary of these installations in the vicinity of Block B1, including the average groundwater level (mOD) and the top of gravel strata (mOD). It should be noted that BH5, BH7, WS16, BH101 and BH102 are the ones located closer to the Block B1 Basement. Details are also presented on Section 1 (Figure 6).

Table 10 Summary of the installation details located nearby/within the Block B1 Basement Location

Location ID	Response Zone/ Aquifer Screened	Installation	Average Groundwater level (mOD)*	Top of gravels (mOD)	Final Depth (mbgl)
BH5	Sand and Gravel	2003	0.74	-0.16	6.50
BH7	NA	2003	NA	No gravels recorded	1.00
WS2	NA	2003	NA	1.55	4.00
WS7	NA	2003	NA	-0.47	5.00
WS8	NA	2003	NA	No gravels recorded	2.00
WS10	NA	2003	NA	No gravels recorded	4.00
WS15	NA	2003	NA	0.52	4.00
WS16	NA	2003	NA	No gravels recorded	5.00
WS106	NA	2019	NA	No gravels recorded	4.00
BH101	Sand and Gravel	2019	0.40	0.51	12.60
BH102	Limestone	2019	0.39	-1.15	15.50
BH103	Sand and Gravel	2019	0.83	1.06	15.10
BH106	Sand and Gravel	2019	0.65	-0.45	12.70
BH107	Limestone	2019	0.56	No gravels recorded	12.00

*NA: Not applicable.

Table 11 presents a summary of these installations in the vicinity of the Block C basement, including the average groundwater level (mOD) and the top of gravel strata (mOD). It should be noted that BH1, BH2, BH5, WS101 and BH101 the ones located closest to the Block C basement. Details are also presented on Section 2 (Figure 6).

Table 11 Summary of the installation details located nearby/within the Block C Basement Location

Location ID	Response Zone/ Aquifer Screened	Installation	Average Groundwater level (mOD)*	Top of gravels (mOD)	Final Depth (mbgl)
BH1	Sand and Gravel	2003	0.29	0.30	6.00
BH2	Sand and Gravel	2003	0.24	0.68	7.00
BH5	Sand and Gravel	2003	0.74	-0.16	6.50
BH6	Sand and Gravel	2003	0.24	1.10	6.00
WS1	NA	2003	NA	1.33	5.00
WS2	NA	2003	NA	1.55	4.00
WS3	NA	2003	NA	1.41	4.00

Location ID	Response Zone/ Aquifer Screened	Installation	Average Groundwater level (mOD)*	Top of gravels (mOD)	Final Depth (mbgl)
WS101	NA	2019	NA	No gravels recorded	4.00
WS104	NA	2019	NA	No gravels recorded	2.80
BH101	Sand and Gravel	2019	0.40	0.51	12.60

*NA: Not applicable.

2.8.4 Groundwater Quality

Groundwater samples were previously collected as part of the 2003 and 2019 ground investigations. This was carried out in a total of four installations (BH1, BH2, BH5 and BH7) in 2003 and in a total of five installations (BH101, BH103, BH104, BH106 and BH107) in 2019.

A Geoenvironmental Detailed Site Assessment was completed for the site by Arup in 2019. This included the development of Generic Assessment Criteria (GAC) for the purposes of a Generic Quantitative Risk Assessment (GQRA).

The 2003 results highlighted recorded exceedances of the GAC at BH1 for mineral oil, which may be associated to diesel, turpentine, and fuel oil. However, the groundwater analysis results from 2019 showed no detections of hydrocarbons or exceedance of GACs.

A summary of the groundwater analysis results completed in 2019 is presented in Table 12. The GAC exceedances at BH101 include Arsenic, Barium, Iron, Magnesium, Manganese, Potassium, Sodium, Sulphate, Chloride, Ammoniacal Nitrogen, Electrical Conductivity and Total Dissolved Solids (TDS).

These results presented in the 2019 Ground Investigation also showed exceedances in Arsenic, Iron, Manganese, Potassium and Ammoniacal Nitrogen for BH103 which is located at the northern (upgradient) boundary of the site. From these parameters, Manganese, Potassium and Ammoniacal Nitrogen were also elevated in BH106 and BH107.

BH101 is located in the southwest of the site, near the quay wall. The 2019 Ground Investigation report that this location is next to the generator building and down gradient from the UST (underground storage tanks) identified on site.

Elevated concentrations of electrical conductivity, chloride, sodium and TDS are presumed to be due to tidal influence and ingress of brackish water from the River Liffey which is classified as a transitional water body at the site.

The absence the hydrocarbons in 2019 is considered to be related to the cessation of activities and removal of oil storage tanks from the site. The tidal ingress and egress of groundwater may essentially have flushed through any previously detected contamination from the 2003 ground investigation.

Table 12 Groundwater Analysis results from the 2019 ground investigation

2019 Groundwater Analysis Results				BH101	BH103	BH104	BH106	BH107				
Parameter	Units	LOD	GAC	08/05/2019	08/05/2019	08/05/2019	08/05/2019	08/05/2019	No. Exceedances	Max	Median	Min
Dissolved Arsenic	ug/l	<0.9	7.5	<LOD	10.6	<LOD	<LOD	<LOD	1	10.60	10.60	10.60
Dissolved Barium	ug/l	<1.8	100	155.1	66.6	11.4	17.5	42.5	1	155.10	42.50	11.40
Total Dissolved Iron	ug/l	<4.7	200	1840	1335	17.1	4.7	160.6	2	1840.00	160.60	4.70
Dissolved Magnesium	mg/l	<0.1	50	188.2	14.1	4.3	28.9	26.1	1	188.20	26.10	4.30
Dissolved Manganese	ug/l	<1.5	50	1637	617.3	24.5	635.7	322.5	4	1637.00	617.30	24.50
Dissolved Potassium	mg/l	<0.1	5	54.3	14.1	2.6	17.7	16.9	4	54.30	16.90	2.60
Dissolved Sodium	mg/l	<0.1	150	1518	24.6	17.2	110.6	53.2	1	1518.00	53.20	17.20
Sulphate as SO4	mg/l	<0.5	187.5	363.5	21.5	44	97.5	133.4	1	363.50	97.50	21.50
Chloride	mg/l	<0.3	187.5	2668.9	31.7	31.7	159.7	43.6	1	2668.90	43.60	31.70
Ammoniacal Nitrogen as N	mg/l	<0.03	0.175	0.24	6.88	0.03	0.58	0.29	4	6.88	0.29	0.03
Electrical Conductivity @25C	uS/cm	<2	1875	8635	735	330	1210	898	1	8635.00	898.00	330.00
Total Dissolved Solids	mg/l	<35	1000	5008	448	213	678	584	1	5008.00	584.00	213.00
Total Organic Carbon	mg/l	<2	No abnormal change	<2	<2	6	<2	<2	None	-	-	-
EPH (C8-C40)	ug/l	<10	10	<10	<10	<10	<10	<10	None	-	-	-
C8-C40 Mineral Oil	ug/l	<10	10	<10	<10	<10	<10	<10	None	-	-	-
Mineral Oil (ug/l)	ug/l	<10	10	<10	<10	<10	<10	<10	None	-	-	-
Toluene (ug/l)	ug/l	<5	525	<5	<5	<5	<5	<5	None	-	-	-
Beneze (ug/l)	ug/l	<5	0.75	<5	<5	<5	<5	<5	None	-	-	-
Ethylbenzene (ug/l)	ug/l	<5	10	<5	<5	<5	<5	<5	None	-	-	-
Total Xylene (ug/l)	ug/l	<5	10	<5	<5	<5	<5	<5	None	-	-	-

2.8.5 Hydrogeological Conceptual Site Model (CSM)

Based on the ground conditions on the site, the hydro-stratigraphy is summarised below in Table 13.

Table 13 Conceptual site model summary (Groundwater)

Groundwater Bodies	Characteristics	Groundwater Level Maximum (mOD)	Groundwater Level Minimum (mOD)	Hydrostratigraphy
Made Ground	Continuous but highly variable stratum	No encountered during previous GI	No encountered during previous GI	Moderately permeable and unconfined, possible perched water
Fluvioglacial Sands and Gravels	Continuous stratum of high permeability	1.45	-0.38	High permeability aquifer (Gravel - Lg aquifer)
Limestone Bedrock	Groundwater flows are predominantly along fissures by fracture flow	0.91	0.12	Underlying bedrock aquifer (Limestone - Ll aquifer, which is moderately productive only in local zones)

The sand and gravel aquifer is considered to be in direct hydraulic continuity with the underlying limestone bedrock aquifer and the River Liffey. The quay wall is assumed to be permeable and not significantly limit groundwater flow. The groundwater flow direction is considered, on average, to be from north to south across the site but will vary with tidal levels with river water flowing into the gravels during high tide.

Figure 6 presents two cross sections, one from north-south, crossing Block B1 Basement (Section 1) and one from east-west, crossing Block C Basement (Section 2). The sections also highlight the gravel strata and the average groundwater level on these areas.

On the Section 1, the average groundwater level considering the two boreholes crossed (BH101 and BH5) is 0.57mOD. On the Section 2, the average groundwater level considering the three boreholes crossed (BH1, BH101 and BH5) is 0.39mOD.

Groundwater quality at the site is influenced by historic land use activities, the urban setting and the tidal influence by the River Liffey. The most recent groundwater sampling in 2019 has shown brackish groundwater and some elevated concentrations for ammonia, iron, manganese and potassium, which could be associated with leakage from urban foul drainage networks as they are detected at the up and down gradient locations at the site.

2.9 Potential for subsurface contamination

The 2019 Geoenvironmental Detailed Site Assessment included a GQRA with the development of GACs for soil quality screening. The GACs are values which have been calculated for typical soils in certain proposed end uses to determine the concentration above which there would be an unacceptable risk to human health or the environment. The samples recovered during the ground investigation were screened against the GACs for a residential end use without plant uptake. In addition, the samples were screened for the presence of asbestos fibres. There is no calculated GAC for Asbestos.

Asbestos fibres were detected at concentrations at <0.1% in a number of locations across the site (8/73). Exceedances of the GACS were detected in 10/73 samples, with 3 samples containing exceedances of both the GACS and containing Asbestos <0.1%.

The GQRA concluded that some soils were shown to reflect the industrial history of the site and contain the following elevated parameters:

- Arseni
- Arsenic
- Lead
- Benzo[a] anthracene

- Benzo[a] pyrene
- Dibenzo[ah] anthracene.

Arsenic and lead are metals and the remaining three compounds (Benzo[a] anthracene, Benzo[a] pyrene and Dibenzo[ah] anthracene) are PolyAromatic Hydrocarbons.

Ground gas was not noted in concentrations or at flow rates so as to pose a potential risk.

Therefore, soils showing exceedances of the GACs and/or containing Asbestos are automatically ruled out for reuse and will require disposal offsite. Locations which did not have any evidence of parameters elevated above the GACs or containing asbestos would be suitable for retention and reuse on site as long as the proposed end use did not change.

The assessment concluded some of the overburden material due to be excavated to facilitate the construction of the basement may be suitable for re-use as an engineered fill within the development. These soils would be subject to verification testing prior to reuse.

Materials which were identified as unsuitable for reuse, through their properties or the absence of opportunity for reuse, were identified as requiring removal off-site to a suitable facility.

In the pre-commencement phase of the project, prior to construction, the appointed contractor will have to prepare their Construction and Demolition Waste Management Plan for submission to DCC. This standard document requires, among other items, that the contractor identifies the waste materials arising from the construction, including the excavated soils, and identifies the disposal category and receiving facility for these materials.

2.10 Key hazards

Table 14 presents the key geohazards identified in the baseline conditions.

Table 14 Key geohazards

Hazard	Observation / Cause	Risk Exposure	Mitigation Measures
Ground movements	The excavation for proposed basement will lead to stress change in ground within zone of influence of works surrounding the site which will lead to ground movements that could impact third-party receptors. Existing sensitive third-party receptors to ground movement surrounding the site, e.g., NIAH structures, historic boundary wall, adjacent Parkgate apartments and business centre buildings and basements, underground services.	Ground movements due to excavation and/or dewatering could damage and thus negatively impact the surrounding receptors, requiring the client to make good the damage.	Impact on surrounding receptors due to ground movement is controlled via following steps: 1. Good knowledge of the location and condition of the existing services (and other sensitive receptors) surrounding the site. 2. Appropriate design and specification of temporary works and construction sequence to ensure ground movements as result of excavation are kept to a minimum. 3. Appropriate instrumentation and monitoring scheme employed during construction with corrective action executed should measured behaviour be less favourable than predicted.
Groundwater Levels and Flow	Dewatering during construction is required due to hydraulic conductivity properties of the fluvioglacial sands and gravels added to the hydraulic connection with the River Liffey.	In the permanent case the presence of the basement may impact existing groundwater flow.	Impact of dewatering is controlled via following steps: 1. Selection of appropriate dewatering system during construction. 2. Continuous monitoring of groundwater levels. Potential impact of basement on existing groundwater flow considered as part of this document
Contamination associated with Made Ground	Historical site development, presence of Made Ground (i.e., uncontrolled fill) within the near surface material at the site.	Material due for excavation is: a. Unsuitable for classification as by-product material and b. Must be disposed off-site as a waste and is categorised as non-hazardous or hazardous waste under the Waste Acceptance Criteria. Material present may be contaminated and pose a health and safety risk during construction. There are potential pathways for contamination on site including the made ground, gravel aquifer and groundwater flow. Dewatering during construction results in ground movements or mobilises plume of contaminated material.	Impact of contamination associated with Made Ground is controlled via following steps: 1. Minimise excavation of Made Ground material. 2. Issue factual GI information as part of tender package 3. Selection of appropriate protection measures of the gravel aquifer during temporary works and construction.

3. Proposed Basement Construction Methodology

3.1 Overall construction methodology

It is proposed that Block B1 and Block C will each include a single level basement. The construction methodology for the basement will comprise open excavation and possible temporary works for the western boundary wall and the river wall on the southern site boundary. These temporary works may include underpinning of existing western boundary wall and / or temporary propping of both boundary walls during basement construction. Cross-sections presenting the proposed works and expected ground conditions are provided in Figures 16 and 17. The plan layout of the cross-sections are provided in Figure 15.

3.1.1 Block B1

The Block B1 basement will be constructed by an open excavation with a stable sloping embankment. The slope angle will be determined by the Contractor as part of their temporary works design, but based on information presented in Section 2.7.3 a slope of 1:2 (Vertical: Horizontal) is assumed. The FFL of the Block B1 basement is +1.8mOD and the maximum excavation level is +0.6mOD at the pile cap locations. The area of the pile caps represents approximately 60% of the total basement area. Therefore, it is assumed that the majority of the excavation will be taken down to +0.6mOD. Given that the existing ground level within the basement area is between approximately +3.0mOD to +5.5mOD, the depth of excavation will be approximately 2.4m to 4.9m below existing ground level.

The average elevation of the top of the gravel strata from boreholes located close or within the Block B1 Basement location, is +0.18mOD while the average of the groundwater levels within the gravel aquifer in this part of the site is +0.70mOD. However, the range of the top of the gravel strata in the existing GI information indicates that the excavation formation level for the proposed Block B1 basement will be close to the strata boundary between the fine grained Alluvium and the water bearing Fluvioglacial Sands and Gravels (see Figure 16). Therefore, it is expected that the excavation will intersect both layers. It is likely a portion of the excavation formation level will be within the fine grained Alluvium and the remaining portion will extend into the Fluvioglacial Sands and Gravels.

A sensitive receptor proximal to Block B1 is the river wall along the southern site boundary. Block B1 will be approximately 5.3m from the river wall. The river wall is presently connected to the existing warehouse building, which will be demolished in advance to accommodate the proposed development. The river wall will be temporarily supported during the demolition of the adjacent warehouse building, before a permanent support structure is constructed. The demolition of the adjacent warehouse building will be conducted prior to the basement excavation, and it is intended to keep the temporary supports in place during the basement excavation.

The depth of the Block B1 excavations (+0.6mOD) are higher than the average depth of the top of the gravel aquifer, the top of which is at +0.18mOD. However, it is possible that local variations in the top of gravel aquifer could results in the aquifer being encountered within the excavation in places.

Groundwater will also be encountered in the Fine Grained Alluvium overlying the gravels, however as these are lower permeability strata the volume of dewatering required is expected to be limited and can be managed with standard localised sump pumping across the excavation.

Even if the gravels are not directly intercepted by the excavation it may be necessary to locally depressurise or dewater the gravels to prevent groundwater breaking through thinner layers of alluvium at the base of the excavation (aka base heave of the Alluvium), particularly at high tide. This could be achieved passively with weep holes intersecting the gravel or with localised sump pumping.

It is not expected to be viable to discharge the resulting water to ground via injection boreholes as the gravel and limestone aquifers are fully saturated, particularly at high tide. It is recommended that the groundwater is therefore provided the necessary treatment and discharged directly into the River Liffey or the storm water network in the area under a discharge permit from DCC. The inflow rates are expected to be low and will therefore have a negligible influence on the river water quality.

An indicative outline construction sequence for the Block B1 basement is as follows:

- Erection of temporary supports for the river wall during demolition of the adjacent warehouse building, which will be retained during the basement excavation
- A comprehensive instrumentation and monitoring (I&M) system will be installed on the river wall to monitor ground movement and groundwater levels before basement excavation and during the works
- Excavations within the basement will commence with excavated materials removed off site and appropriately disposed. Dewatering within the excavations will also occur
- Upon completion of the excavation, the sub-structure will be constructed. The temporary supports for the river wall will be decommissioned, and the permanent support structure for the southern boundary wall installed.

3.1.2 Block C

The Block C basement will be constructed by an open excavation with a stable sloping embankment. The slope angle will be determined by the Contractor as part of their temporary works design, but based on information presented in Section 2.7.3 a slope of 1:2 (Vertical: Horizontal) is assumed.

The FFL of the Block C basement is +2.6mOD and the maximum excavation level is +1.4mOD at the pile cap locations. The area of the pile caps represents approximately 60% of the total basement area. However, the piles will be offset from the western perimeter of the basement by 2.8m, which will limit the excavation depth in front of the western boundary wall. It is assumed that the majority of the excavation will be taken down to maximum excavation level of +1.4mOD, except for the aforementioned western perimeter. Given that the existing ground level within the basement area is between approximately +3.3mOD to +3.6mOD, the depth of excavation for the majority of the basement will be approximately 1.9m to 2.2m below existing ground level. The depth of excavation in front of the western boundary wall is 1.2m to 1.5m below existing ground level.

The existing GI information indicates that the Block C basement will likely be founded in the Made Ground and Fine grained Alluvium (see Figure 17).

Sensitive receptors proximal to Block C are the river wall to the south, the western boundary wall, and the Parkgate Place apartments west of the site boundary. It is intended to retain the boundary wall. Temporary propping and underpinning of the boundary wall may be required to be installed prior to basement excavation. As discussed in Section 3.1.1, the river wall will have temporary supports during the basement excavation.

The average of the top elevation of the gravel aquifer close or within the Block C Basement location is +0.89mOD and the average groundwater level for the gravel aquifer +0.29mOD. The maximum depth of basement excavations for Block C (+1.4mOD) do not therefore extend into the gravel aquifer and therefore dewatering of the aquifer is possibly not required. There may be some intermittent localised dewatering of the Made Ground and Alluvium required during high tide but the average groundwater level in this area is also below the base of the excavation.

The requirement to locally depressurise the gravel aquifer in Block C is less likely as there will be a greater thickness of Alluvium material overlying the gravels compared to Block B1. However, it is possible that variations in the geology on site could result in gravels being shallower and local depressurisation/dewatering will be required to resist basal heave in the fine grained Alluvium.

Similar to Block B1 it is expected the limited dewatering required can be achieved with standard localised sump pumps and discharges following appropriate treatment to the storm network or directly to the River Liffey under appropriate permit from DCC.

An indicative outline construction sequence for the Block C basement is as follows:

- Erection of temporary supports for the river wall during demolition of the adjacent warehouse building, which will remain in place during the basement excavation

- Investigative works to establish underside of western boundary wall adjacent to proposed Block C basement. Underpinning of western boundary wall, if required, to allow follow on basement excavation
- Erection of temporary props for retention of the western boundary wall, should they be required as part of temporary works design
- A comprehensive I&M system will be installed on the river wall, western boundary wall, and the Parkgate Apartments building west of basement to monitor ground movement and groundwater levels during the works
- Excavation of proposed basement. Excavated materials will be removed off site and appropriately disposed. Dewatering within the excavation if required
- Upon completion of the excavation, the substructure will be constructed. The temporary props for the boundary wall will be removed. The temporary supports for the river wall will be decommissioned, and the permanent support structure for the river wall installed.

4. Impact Assessment

4.1 Ground movement impact assessment

4.1.1 Background

To understand the potential impact from the construction of the proposed basement on adjacent buildings, utilities and other sensitive receptors within the zone of influence of the basement, a ground movement assessment is undertaken.

4.1.2 Methodology

A staged ground movement impact assessment has been undertaken assuming the following:

- The extents of the proposed excavation are based on:
  - The footprint of the proposed basement
  - An assumed temporary excavation slope of 1 vertical:2 horizontal (1V:2H) extending from the base of the excavation.
- Ground displacement at the crest of the open excavation is assumed to be $\leqslant$ 10mm as the slope is stable
- Displacements < 10mm are considered to result in negligible impact to existing assets
- The excavation extents are taken as the zone of influence of the works
- Only assets within this zone of influence are assessed further for potential impacts.

For assets within the zone of influence, appropriate mitigation measures are identified to minimise negative impacts.

4.1.2.1 Block B1

As stated in Section 3.1.1, the basement will be constructed by an open excavation with an estimated sloping embankment of 1:2. Figure 18 shows the estimated excavation slope crest for Block B1. This excavation crest line represents the zone of influence The excavation will be approximately 2.0m from the northern site boundary, approximately 30.0m from the western site boundary where the boundary wall is located, and approximately 22.0m from the existing ESB substation east of the excavation, which will be retained during construction. Existing services and infrastructure lie outside zone of influence of works.

Figure 18 shows that the crest of the excavation will be abutting the river wall. Based on topographical survey information and proposed works it is estimated that the maximum depth of excavation at the wall will be < 1.5m. As mentioned in Section 3.1.1, the river wall will have temporary supports during the excavation. Therefore, it is assumed the basement excavation will have negligible impact on the river wall.

In summary, the proposed works for Block B1 are expected to have negligible impact on surrounding existing assets, given the implemented mitigation measures and the distance of key receptors from the zone of influence.

4.1.2.2 Block C

As stated in Section 3.1.2, the basement will be constructed by an open excavation with an estimated sloping embankment of 1:2. Figure 18 shows the crest of the excavation for Block C. The excavation will be abutting the river wall to the south and the western boundary wall. The basement is greater than 50m away from the northern site boundary and the ESB substation to the east. Existing services and infrastructure lie outside zone of influence of works. Figure 18 shows that the crest of the excavation will be abutting the river wall to the south and tight against the western boundary wall.

Based on topographical survey information and proposed works it is estimated that the maximum depth of excavation at the wall will be < 1.5m. As mentioned in Section 3.1.2, the river wall will have temporary supports during the excavation. Therefore, it is assumed the basement excavation will have negligible impact on the river wall.

The proposed temporary stability works of the western boundary wall (props and underpinning) is assumed to result in negligible impact of the western boundary wall.

Based on topographical survey information the distance between the western site boundary and the Parkgate Place Apartments building west of the site is approximately 1.2m to 3.0m, with the closest distance near the southwest corner of the site. As shown in Figure 17, the proposed depth of excavation adjacent to the western boundary wall is 1.2m to 1.5m below existing ground level. While the details of the foundations for the Parkgate Place Apartments building are unknown it is assumed there founding level is deeper than the proposed depth of excavation adjacent to the western boundary wall. Therefore, it is assumed the proposed works will result in negligible impact of the Parkgate Place Apartments.

In summary the proposed excavation for Block C is anticipated to have negligible impact on existing assets, given the established zone of influence and the planned retention measures.

4.2 Groundwater impact assessment

4.2.1 Construction Phase

The excavations levels for Block B1 and Block C Basement, which are +0.6mOD and +1.4mOD, respectively. The depth of excavation is higher than the average top of the gravel aquifer at either location (+0.18mOD and +0.89mOD, respectively), however it may be the case that localised areas of shallower gravels are intercepted.

The average groundwater level Block B1 (+0.70mOD) is above the base of the excavation. Therefore, it is expected continued dewatering will be required at this location, however it will mainly be from the lower permeability alluvium and therefore inflow volumes are expected to be low and the zone of influence is not likely to extend beyond the site. Localised depressurisation/dewatering may be required where the gravel aquifer is encountered at a shallower elevation.

The average groundwater level at Block C (+0.29mOD) is well below the excavation level but intermittent dewatering may be required during high tides. Similar to Block B1, the dewatered strata will be the lower permeability alluvium and therefore inflow volumes are expected to be low and the zone of influence is not likely to extend beyond the site.

It is not proposed to drill dewatering wells into the gravel aquifer and complete site wide dewatering for basement excavation. As the drawdown required is limited and intermittent it is not expected to develop a significant cone of depression in the water table. The dewatering will cease once sufficient structure to resist hydrostatic pressures is completed.

The GQRA has identified contaminated soil underlying the site and elevated groundwater concentrations for some water quality parameters. Therefore, any dewatering from the site will require suitable treatment prior to discharge. Soil sampling and screening is required before and during construction to ensure unsuitable soil material is disposed of off-site to an appropriate facility. Some excavated soils may be suitable for reuse on site.

4.2.2 Operation Phase

Based on the available information presented in Section 2 The basements for the proposed development are unlikely to extend significantly into the gravel aquifer and therefore there is minimal permanent impact on groundwater levels within the aquifer anticipated during the operation phase of the project.

Groundwater monitoring from site indicates the overlying Alluvium and Made Ground may be partially saturated at high tide. The potential impact on groundwater as a result of the basements is therefore considered to be limited as the ongoing tidal fluctuations will also drain these strata at low tide which will prevent any persistent change in the water table within these lower permeability strata.

4.3 Hydrology/flood impact assessment

Reference shall be made to the Site Specific Flood Risk Assessment regarding the flood impact assessment for the proposed works.

4.4 Other construction related impacts

4.4.1 Material management

The ground conditions, based on existing information, indicates that the presence of Made Ground (comprising gravel, clay, ceramic plastic, red brick) over natural soils over limestone bedrock.

Reference shall be made to the outline Construction and Demolition Waste Management Plan in relation to the management of excavated materials on the site.

4.4.2 Construction Management Plan

An outline Construction Management Plan report reference has been prepared as part of planning, which also addresses section Appendix 9.4.4 of the DDCDP.

5. Mitigation Measures

5.1 Design Stage

5.1.1 Ground investigation strategy

A detailed, project specific ground investigation has been carried out. This information will be utilised throughout the remaining phases of the project.

5.1.2 Consultation

The following parties will be consulted on particular requirements for the proposed works as the project progresses:

- Third party landowners adjacent to the site to understand asset’s location and condition
- Dublin City Council regarding licences for discharging groundwater off site.

5.1.3 Basement design

A planning stage design has been completed and is documented in this report. Going forward a tender design will be completed, which will refine and detail the currently proposed planning stage design. The design intent of the proposed basements will remain consistent as the project progresses, i.e., do not extend currently proposed excavation depth to minimise the following:

- Volume of excavated material that will require disposal off site
- Volume of dewatering during construction
- Ground movements caused by excavation and dewatering.

This design intent will limit the impact of proposed works on existing sensitive receptors and assets.

The following specifications will be developed for the project. These documents will form part of the tender package for the proposed works and the construction contract:

1. Particular earthworks specification: this document will set out the requirements during the construction phase in relation to any excavations, slope formation, filling and dewatering for the project. In particular minimum criteria for earthwork formations, acceptable materials, material and groundwater disposal will be specified.
2. Particular instrumentation and monitoring specification; a minimum scheme design instrumentation and monitoring regime will be set out in this document. The detailed design of this regime will be completed by the Contractor, with the Engineers agreement, prior to its installation and implementation on site. This will include the requirement for a set of trigger values (based on a traffic light system) with appropriate hold points and contingency measures to be developed by the Contractor, in advance of commencement of construction, as part of their temporary works design.

5.2 Construction Stage

5.2.1 Condition survey

Surveys to understand the current conditions of sensitive receptors (i.e.: the river wall, the western boundary wall, and the Parkgate Place Apartments building) will be completed in advance of works commencing.

5.2.2 Instrumentation and monitoring

A comprehensive I&M scheme will be undertaken as part of the construction contract to confirm the ground response during the basement construction, specifically for the sensitive receptors within zone of influence of works, i.e., the river wall, the western boundary wall, and the Parkgate Place Apartments building. This measured data will be compared and contrasted to predicted behaviour. Should the measured data be less favourable than predicted, pre-defined actions will be executed during construction to maintain movements within acceptable limits.

Groundwater monitoring within the Alluvium and underlying gravel aquifer in the vicinity of the basements will be completed to monitor the influence of dewatering outside the excavations.

5.2.3 Groundwater management

The depth of excavation will be closely monitored to ensure there is no unnecessary over dig into the gravel aquifer which could lead to additional dewatering requirements, particularly during high tide.

If localised areas of gravel at a higher elevation, than has been identified during the ground investigation, are present these can be locally depressurised/dewatered to maintain the groundwater level below the base of the excavation. Depressurisation could be achieved with passive weep holes which would minimise the volume of water discharged and the zone of influence within the gravel aquifer. This requirement will be determined at detailed design stage.

The water abstracted during the dewatering process will be monitored and sampled to ensure that there is no contamination mobilised. If there is any contamination detected in the groundwater, then the abstracted water will be treated on site. Settlement treatment may be required on-site if fine grained soils are mobilised.

5.2.4 Groundwater Quality / Contamination

Care will be taken to ensure that there are appropriate materials management procedures during construction to ensure that there is no cross-contamination of impacted material into the sand and gravel aquifer.

5.2.5 Materials management

Reference shall be made to the outline Construction and Demolition Waste Management Plan in relation to the management of excavated materials on the site.

5.3 Key hazard mitigation

Section 2.10 presented the key geohazards identified in the baseline conditions. In addition to the above, Table 15 presents specific mitigation measures associated to those hazards.

Table 15 Identified geohazard mitigation

Hazard	Mitigation Measures
Ground Movement	Design stage Impact on sensitive receptors assessed and documented in this report. Construction stage During construction a comprehensive instrumentation and monitoring scheme will be employed to monitor ground movements and movements of sensitive receptors. The instrumentation will record factual data and this data will be compared and contrasted to predicted behaviour. Should the measured data be less favourable than predicted, pre-defined actions will be executed during construction to maintain movements within acceptable limits.
Groundwater Levels and flow	Construction Stage Excavations should not extend deeper than necessary and not extend into the gravel aquifer. Where this is unavoidable localised dewatering/depressurisation will be completed as required. Groundwater monitoring within the gravel and alluvium strata will be completed around the basements to observe the extent of drawdown impacts. Groundwater will be discharged either to the storm water network or direct to the River Liffey as it is not viable to recharge back into the saturated gravel aquifer.
Soil and Groundwater Contamination	Construction Stage Additional soil sampling and screening required in line with normal industry practice and sample density/frequency to determine the appropriate reuse/disposal options. Appropriate treatment of groundwater dewatering will be provided in advance of discharge to meet DCC permit requirements.

6. Conclusions

Baseline conditions for the site and its surrounding environment have been assessed and the key findings are:

- The site, located in Dublin 1, has an industrial and commercial history. It is surrounded by several historic heritage listed structures. Additionally, there are neighbouring buildings close to the western site boundary wall. All other existing services and structures that will remain in place post project enabling works, are located away from the proposed basements
- An assessment of the ground conditions has indicated a ground model of a downward sequence of Made Ground, Fine grained Alluvium, Fluvioglacial Sands and Gravels and Limestone Bedrock

- The Fluvioglacial Sand and Gravels is classified as a high permeability locally important aquifer and is assumed to be within hydrological connectivity with the underlying Limestone Bedrock aquifer. Groundwater levels in the Sand and Gravels aquifer are tidally influenced and range between 1.45mOD and 0.38mOD. Groundwater levels in the Limestone Bedrock aquifer are estimated to lie between 0.91mOD and 0.12mOD
- The key geohazards for the site identified are related to ground movement, groundwater conditions, and contamination associated with the Made Ground.

The proposed development for Block B1 and Block C will each include a single level basement. The basements will be constructed by an open excavation with a stable sloping embankment. The slope angle will be determined by the Contractor as part of their temporary works design, but based on the baseline conditions for the site a slope angle of 1:2 (Vertical: Horizontal) is assumed. Dewatering may be required during excavation works to:

- Stop basal heave from occurring at fine grained Alluvium / Fluvioglacial Sands and Gravels strata interface
- Keep excavation dry if excavation intersects Fluvioglacial Sand and Gravel stratum
- The volumes to be dewatered are expected to be low due to the limited and temporary (tidal) nature of the drawdown required. The resulting water will be appropriately treated to facilitate discharge to the storm drainage network or directly to the River Liffey under DCC permit.

Details of the proposed basement construction have been considered and an impact assessment has been carried out. The key findings of the impact assessment are:

- The proposed basement works are expected to have negligible impact on surrounding existing assets, given the implemented mitigation measures and the distance of key receptors from the zone of influence.

The key mitigation measures include a set of tender documents that:

- Set out construction stage performance and execution requirements
- Set out instrumentation and monitoring requirements to record factual data. This data will be compared and contrasted to predicted behaviour. Should the measured data be less favourable than predicted, pre-defined actions will be executed during construction to maintain movements within acceptable limits
- Based on the current design and analysis, the proposed works are expected to have negligible impact on existing assets and sensitive receptors. Should measured behaviour during construction be less favourable than predicted corrective action shall be executed to ensure impact on existing sensitive receptors remains negligible.

Appendix A

Basement Impact Assessment – Submission Checklist

A.1 BIA Checklist

The following checklist has been extracted from the Dublin City Development Plan (DDCDP). Additional items have been added based on particular requirements set out within the DDCDP.

Table A1 Basement Impact Assessment Submission Checklist

Ref:	Item:	BIA Report Location:	Comments:
1	Description of proposed development.	Section 1.1 and Section 2	Also refer to Planning Drawings.
2	Plan showing boundary of development including any land required temporarily during construction.	Section 1.1 and Section 2	Also refer to Planning Drawings.
3	Plan, maps and photographs to show the location of basement relative to surrounding structures.	Section 2.3 and Appendix B	Further details provided within the Planning Drawings.
4	Plans, maps and or photographs to show topography of surrounding area with any nearby watercourses/ waterbodies including consideration of the relevant maps on the SFRA (Vol 7).	Section 2.1 and 2.8, Appendix B	-
5	Plans and sections to show foundation details of adjacent structures (reference to pre-condition reports).	Section 2.3, Appendix B	Condition survey will be undertaken post planning as is consistent with current industry practice in Dublin
6	Plans and sections to show layout and dimensions of proposed basement and all proposed foundation details.	Section 2.3, 3 and Appendix B	Further details provided within the Planning Drawings. Foundation details may be updated relative to current scheme during detailed design stage.
7	Modelling evaluation of baseline groundwater levels and flows.	Section 2.8	-
8	Modelling and evaluation of groundwater levels and flows during construction and following construction of basement.	Section 3.1 and 4.2	Modelling excluded due to anticipated small volume of extraction during construction and negligible impact on existing conditions post construction.
9	Programme of enabling works and construction and restoration.	N/A refer to project construction management plan.	-
10	Identification of potential risks to land stability (including surrounding structures and infrastructure and groundwater flooding.	Section 4	-
11	Assessment of potential risks on neighbouring properties and surface groundwater.	Section 4.2	-
12	Identification of significant adverse impacts.	Section 4	-
13	Ground Investigation Report and Conceptual Site Model including: • Desktop study exploratory hole record • Results from monitoring the local groundwater regime • Confirmation of baseline conditions • Factual site investigation report.	Section 2, Appendix B	-
14	Ground movement assessment.	Section 4.1	-
15	Plans, drawings, reports to show extent of affected area.	Section 4.1 and Appendix B	-

Ref:	Item:	BIA Report Location:	Comments:
16	Construction Sequence Methodology (CSM) referring to site investigation and containing basement, floor and roof plan, sections, sequence of construction and temporary works.	Section 3	-
17	Proposals for monitoring during and post construction (groundwater movement and levels, ground movement, vibration with comparisons to baseline) – limits to be advised in BIA and monitored. Any breaches should be reported to DCC E&T.	Section 5	-
18	Consideration of potential impacts to protected structures, conservation areas and archaeology where relevant.	Section 5	-
19	Consideration of potential impacts to biodiversity and amenity.	Section 4.4	-
20	Construction Management Plan	Section 4.4.2	Refer to project construction management plan, prepared under separate cover.
21	Impact assessment and specific mitigation measures to reduce or offset significant adverse impacts with comparisons to baseline study.	Section 4 and 5	-
22	Provision for monitoring post construction (post-condition surveys, groundwater levels/flows etc.).	Section 5.2	-
23	Non-technical summary of full report.	Executive Summary (Non-technical).	-

Appendix B

Figures