Chapter 7 Soils and Geology

7.0 Introduction

Assessments have been undertaken of the likely significant environmental impacts on the geological environment associated with the proposed National Paediatric Hospital Project. The proposed integrated National Paediatric Hospital Project, as described in full in Chapter 2 of the Environmental Impact Statement (EIS), comprises the following:

- within – or associated with – the main project site on the campus of St. James's Hospital, Dublin 8:
    - a new children's hospital and associated Family Accommodation Unit, sited in the west of the campus;
    - a new Children's Research and Innovation Centre sited along James's Street;
    - associated works to boundaries, roads, entrances, parking areas, hard and soft landscaping etc. within the application site boundary; and
    - a temporary construction compound, directly associated with the above developments at St. James's Hospital Campus, at Davitt Road, Drimnagh, Dublin 12.
- a new children's hospital satellite centre at Tallaght Hospital, Dublin 24; and
- a new children's hospital satellite centre at Connolly Hospital, Blanchardstown, Dublin 15.

This Chapter provides a description of the existing soils and geology environments for each of the project sites, and a statement of the likely soils and geology impacts associated with both the construction and operation phases of the National Paediatric Hospital Project. Mitigation measures are proposed in the form of ameliorative, remedial and reductive measures and residual impacts are described.

Assessments for each site are detailed in this Chapter with relevant technical information included in Appendices:

- Appendix 7.1 Phase I/II Environmental Site Assessment Report, O'Connor Sutton Cronin & Associates (new children's hospital, Family Accommodation Unit and Children's Innovation and Research Centre sites within St. James's Hospital Campus).
- Appendix 7.2 Site Investigation Report, Roughan O'Donovan (new children's hospital, Family Accommodation Unit and Children's Innovation and Research Centre sites within St. James's Hospital Campus).
- Appendix 7.3 Site Investigation Report, Davitt Road, URS.
- Appendix 7.4 Ground Investigation Report, new children's hospital satellite centres at Tallaght and Connolly Hospitals, Causeway Geotech Ltd.

7.1 St. James's Hospital

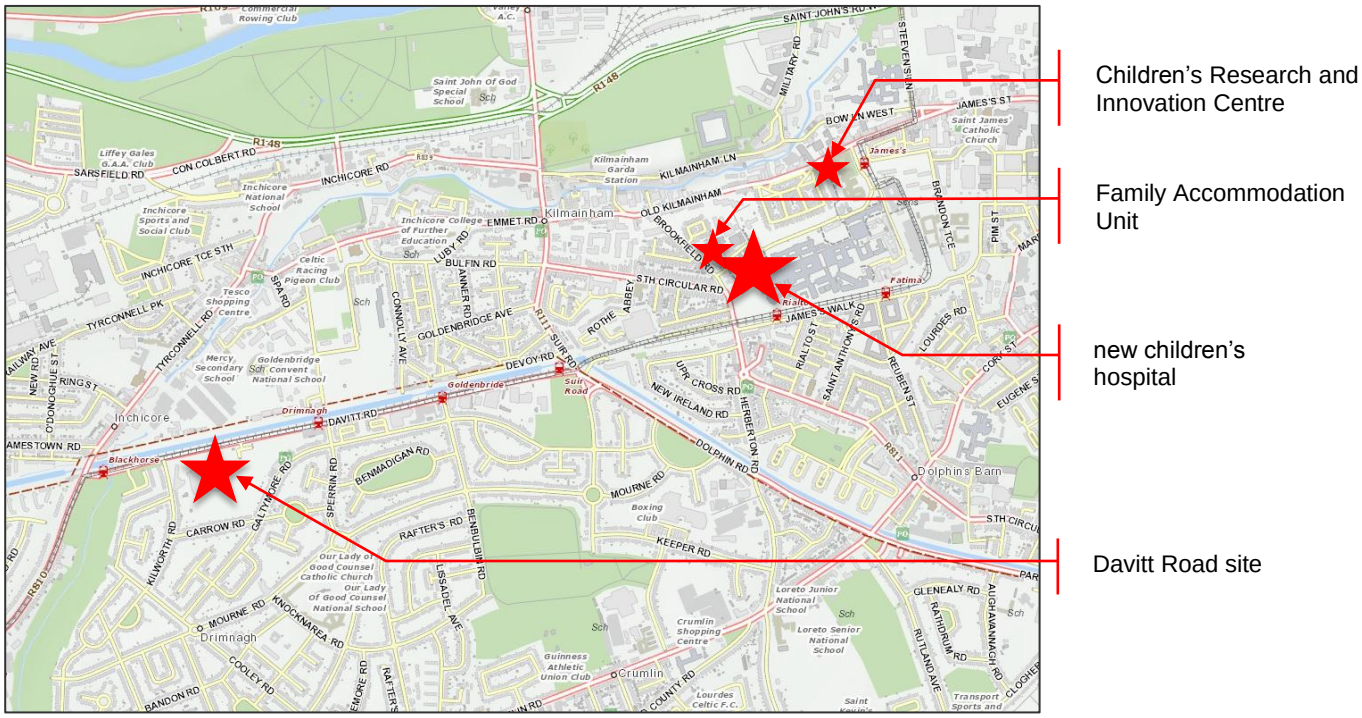
7.1.1 Introduction

Assessments of the likely significant environmental impacts on the geological environment regarding the proposed National Paediatric Hospital Project development at the St. James's Hospital campus and Davitt Road developments (as illustrated on Figure 7.1), have been undertaken for the purposes of this EIS.

The St. James's Hospital campus development includes; the new children's hospital site and Family Accommodation Unit located in the west of the St. James's Hospital campus and the Children's Research and Innovation Centre site, located near the James's Street entrance of St. James's Hospital campus adjacent to the Trinity Centre. The Davitt Road site is located remote from the project site and will be used as a construction compound (see Chapter 2 for full description). The study area for the purposes of the soils and geology chapter of the EIS extends beyond the site boundaries and includes potential receptors within a 2km radius of the project sites.

The new children's hospital includes a basement of two/three levels over the extent of the development site and the Children's Research and Innovation Centre building includes a single storey basement over the extent of the building footprint. The basement of the Family Accommodation Unit will be contained within the extent of the new children's hospital's basement. These structures have the potential to impact/interact with the local soil and geology environment.

Figure 7.1: Site Locations



The bulk of Section 7.1 deals with the potential impacts associated with the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre site.

7.1.1.1 Davitt Road

The Davitt Road site (former Unilever site) is intended as a temporary construction compound which will be made available to the contractor during the construction works. It will be used as a store for dry materials (steel, cladding, precast concrete etc.) and potentially as a staging area for the works. There are no groundworks required with the possible exception of some minor site clearance and tidy up (e.g. moving soil bund within site). It is not proposed to remove any soil or subsoil material from the site. The proposed Davitt Road site activities have low potential for impact/interaction with the geological environment.

7.1.2 Methodology

7.1.2.1 Guidelines

The Assessment has been carried out generally in accordance with the following guidelines:

- *Guidelines on Information to be contained in Environmental Impact Statements* (Environmental Protection Agency, 2002);
- *Advice Notes on Current Practice in the preparation of Environmental Impact Statements* (Environmental Protection Agency, 2003);
- *Guidelines for the preparation of Soils Geology and Hydrogeology Chapters of Environmental Impact Statements* (Institute of Geologists of Ireland, 2013);
- *Geology in Environmental Impact Statements*, A Guide (Institute of Geologists of Ireland, 2002);
- *Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*. (National Roads Authority (NRA), 2009).
- *Control of Water Pollution from Construction Sites* (Construction Industry Research and Information Association, 2001); and
- *Environmental Handbook for Building and Civil Engineering Projects* (Construction Industry Research and Information Association, 2000).

7.1.2.2 Approach

The assessment followed a phased approach as outlined the Institute of Geologists of Ireland Guidelines (Institute of Geologists of Ireland Guideline, 2013).

Phase 1: Initial Assessment

An initial assessment was carried out which; defined the project in terms of location, type and scale; established the baseline conditions; established the type of soil/geological environment; established the activities associated with the project and; initial assessment and impact determination.

These objectives were achieved by way of a geological desk study and baseline data collection. A list of sources for the desk study together with relevant Legislation are included in the Section 7.1.10 and the desk study is presented in further detail in the Phase I/II Environmental Site Assessment Report included in Appendix 7.1.

Additional information has been compiled through consultation and feedback from stakeholders, the Design Team and St. James's Hospital site staff (current and former).

The information sources were utilised to establish the baseline conditions for the site and all available information was compiled into a preliminary Conceptual Site Model (CSM). The CSM is based on the accepted Source-Pathway-Receptor model for assessing environmental impacts. The CSM went through iterative reviews and was updated with site specific data obtained through site investigations and studies.

Phase 2: Direct and Indirect Site Investigations and Studies

A number of phases of site investigations have been carried out on the project site since 2014.

Site Investigation 1 – Geotechnical

Geotechnical Investigations and Reports were undertaken by Roughan O'Donovan Consulting Engineers with Causeway Geotech Ltd. in 2014. Causeway Geotech Ltd. carried out site investigations between June and August 2014 which consisted of the following works:

- Geophysical Survey consisting 16 profiles of seismic refraction and multichannel analysis of surface waves (MASW) carried out by Minerex Geophysics.
- 19 No. cable percussion boreholes ("100" Series Boreholes) carried out including inspection pits for the avoidance of services, in-situ SPT testing, bulk, disturbed, undisturbed and environmental sampling.
- 19 No. rotary follow-on boreholes using Geobor-S techniques. These were drilled down through the overburden soils and extended by a minimum of 5m length into competent rock.
- 7 No. standpipes and 5 No. piezometers were installed as part of the works.
- 1 No. Hand Dug Pit and 13 No. Trial Pits were excavated at the site. Bulk and environmental samples were obtained from some locations for laboratory soil classification and contamination analyses. Trial pit depths varied from 0.4 to 3.0m bgl.
- Slit trenches for utilities clearance at 5 No. borehole locations.
- Indirect CBR testing at between 0.5m and 0.75m bgl using a Dynamic Cone Penetrometer (DCP) at 10 No. trial pit locations.
- Variable head permeability tests at 7 No. locations.
- Water level monitoring in July, August and December 2014.
- Water sampling and analysis in December 2014.

Factual reports were prepared by Causeway Geotech Ltd. (Report No. 14-240 - Revision A04 dated May 2015) and Minerex Geophysics (Report Ref 5805f-005). An interpretation report was prepared by Roughan O'Donovan (Ground Investigation Report). The reports from this phase of work are included in Appendix 7.2.

Site Investigation 2 – Geoenvironmental

Following the Initial Assessment a further phase of work was commissioned with the aim to refine the CSM and address any information gaps for the site. The site investigation works were carried out by Causeway Geotech Ltd. under the direction of O'Connor Sutton Cronin & Associates. The works generally followed BS10175:2011+A1:2013 Code of Practice – Investigation of potentially contaminated sites and included:

- Drilling (light percussion with some follow on rotary percussion) of 24 no. boreholes ("200" Series Boreholes) in the superficial deposits targeting shallow made ground and underlying natural soils. Undisturbed samples were obtained (up to 4mbgl) to target potential contamination hotspots using a dual capability light percussions/air rotary rig;

- Borehole drilling (Geobor-S rotary core) in the overburden providing undisturbed samples to allow characterisation of the overburden and laboratory testing of cores for permeability;

- Laboratory testing of overburden (made ground and natural soil) to analyse the characteristics/classification of the overburden at the St. James's Hospital campus specifically the sites for the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre. Analysis results were screened using relevant criteria including the Waste Acceptance Criteria (as per the Landfill Directive) and the hazardous waste assessment tool HazWasteOnline.

- Monitoring well installations within the made ground and overburden. All monitoring wells were topographically surveyed to ordnance datum.

- Installation of monitoring equipment including vibrating wire (VW) piezometers and water level pressure transducers to obtain and log water pressure measurements at key elevations across the site.

- Field testing and monitoring programme including in-situ permeability tests in the overburden, ground gas monitoring, water level monitoring, water sampling for laboratory analysis.

Additional investigative works consisting of excavation of inspection/slit trenches were carried out to investigate utilities, archaeology and ground conditions under the instruction of other Design Team members. Environmental samples were obtained from some of these locations and the laboratory analysis results and field observations have been incorporated in the geoenvironmental investigation.

A factual report was prepared by Causeway Geotech Ltd. (Ref: 15-250-A03) and an interpretive report was prepared by O'Connor Sutton Cronin in the form of a Phase I/II Environmental Site Assessment Report (Ref: N187-ESA-A01). These reports are included in Appendix 7.1 of the EIS.

Site Investigation 3 – Hydrogeological

In order to further characterise the bedrock geology and hydrogeology regime in terms of groundwater levels and estimated yields; a bedrock drilling and testing programme was commissioned. The works were carried out by Meehan's Drilling under the direction of O'Connor Sutton Cronin & Associates and Arup and included:

- Drilling and installation of 2 no. production type wells (FS01/15 and FS02/15) of circa 73m and 95m depth by Dual Rotary method;

- Drilling and installation of 5 no. monitoring wells (MW 1-5) into bedrock to depths of 18 to 30m below ground level (bgl) by Dual Rotary method;

- Collection of groundwater level information and installation of water level monitoring transducers;

- Collection of groundwater samples and laboratory analysis to establish baseline groundwater quality;

- Geophysical logging of boreholes including calliper, CCTV, natural gamma, resistivity and fluid logging;

- Hydrogeological yield testing.

A follow on monitoring programme was carried out to collect variations in groundwater levels over time. These works are reported in Appendix 7.1 and 8.1 and are discussed in detail in Chapter 8, Hydrogeology and Hydrology.

Site Investigation 4 – Environmental Site Assessment, Davitt Road Site

Geo-environmental investigation and quantitative risk assessment was carried out on the Davitt Road site by URS in November 2014 (Report Ref 47092767). The assessment included a desktop review, environmental site investigation (trial pits, installation of groundwater monitoring wells, soil and water sampling and analysis), generic qualitative risk assessment and preliminary soil waste classification. This report is included in Appendix 7.3 of the EIS.

Refinement of the Conceptual Site Model

Throughout the detailed site investigations and studies the CSM was continually updated, tested and refined with new site specific information. The outcome of this refinement is presented in this Chapter and the associated figures and technical reports.

Detailed Assessment and Impact Determination

A Detailed Assessment and Impact Determination was carried out which incorporates the full range of site investigations and studies, the refined CSM and a full assessment of any potential impacts.

The approach adopted is as per the Institute of Geologists of Ireland Guidelines (Institute of Geologists of Ireland, 2013) and each potential impact of the St. James's National Paediatric Hospital Project sites have been described in terms of Quality, Significance and Duration. The classification of impacts in this Chapter follows the definitions provided in the Glossary of Impacts contained in the Environmental Protection Agency Guidelines (Environmental Protection Agency, 2002) and Advice Note (Environmental Protection Agency, 2003).

The Institute of Geologists of Ireland Guidelines have summarised the glossary of impacts and Table 7.1 reproduces the glossary of impacts as contained in the guidance document.

Table 7.1: Impact Classification Terminology

Impact Characteristic	Term	Description
Quality	Positive	A change which improves the quality of the environment
	Neutral	A change which does not affect the quality of the environment.
	Negative	A change which reduces the quality of the environment.
Significance	Imperceptible	An impact capable of measurement but without noticeable consequences.
	Slight	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities.
	Moderate	An impact that alters the character of the environment in a manner consistent with existing and emerging trends.
	Significant	An impact which by its character, magnitude, duration or intensity alters a sensitive aspect if the environment.
	Profound	An impact which obliterates sensitive characteristics.
Duration	Short-term	Impact lasting one to seven years.
	Medium-term	Impact lasting seven to fifteen years.
	Long-term	Impact lasting fifteen to sixty years.
	Permanent	Impact lasting over sixty years.
	Temporary	Impact lasting for one year or less.
Type	Cumulative	The addition of many small impacts to create one large, more significant impact.
	'Do Nothing'	The environment as it would be in the future should no development of any kind be carried out.
	Indeterminable	When full consequences of a change in the environment cannot be described.
	Irreversible	When the character, distinctiveness, diversity, or reproductive

Impact Characteristic	Term	Description
		capacity of an environment is permanently lost.
	Residual	Degree of environmental change that will occur after the proposed mitigation measures have taken effect.
	Synergistic	Where the resultant impact is of greater significance that the sum of its constituents
	'Worst Case'	The impact arising from a development in the case where the mitigation measures may substantially fail

Additional guidance and EIS definitions are contained in National Roads Authority Guidelines (National Roads Authority, 2009). These guidelines provide useful matrices outlining how additional assessment criteria based on the importance of a feature to be protected and the magnitude of the potential impact. This approach has been adopted where appropriate.

Each potential geological impact for the proposed development, including the new children's hospital, Family Accommodation Unit, Children's Research and Innovation Centre and Davitt Road sites, and the associated activities, have been described in terms of quality, significance and duration. Where the initial impact determination concluded that the level of potential impact is capable of measureable and noticeable consequences, it is carried into the next assessment phase.

Phase 3: Mitigation, Residual and Final Impact Assessment

Phase 3 builds on the outcome of the initial assessment and detailed site assessments, by identifying mitigation measures to address the identified impacts. Mitigation measures which have been built into the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre designs have also been considered in this process.

The development including all identified mitigation measures (assumed implemented) is then subject to impact assessment, to identify any residual impacts.

The final impact assessment presented in this Chapter incorporates the outputs from the detailed assessment and impact determination, mitigation measures and residual impact assessment.

Phase 4: Completion of the EIS Section

The final phase of work was the completion of this EIS Section with associated figures and appendices. The format follows the Environmental Protection Agency guidance note and the National Paediatric Hospital Project Design team template.

7.1.2.3 Assumptions and Limitations

The description of existing conditions is based on the available desk study and ground investigation information as outlined in Section 7.1.10. Given the live and sensitive nature of the operational hospital site, the site investigations could not be completed over the entire project site due to the presence of existing services, utilities and buildings some of which contain sensitive areas where patients are currently residing. Geological conditions have been inferred in areas were investigations were not possible and the geology is considered typical and uniform across the development site. The contamination assessment focused on identified hotspot areas where possible and soil classification has been designated on a 25m generally and a 10m grid in suspected hotspot areas.

7.1.3 Receiving Environment

7.1.3.1 Introduction

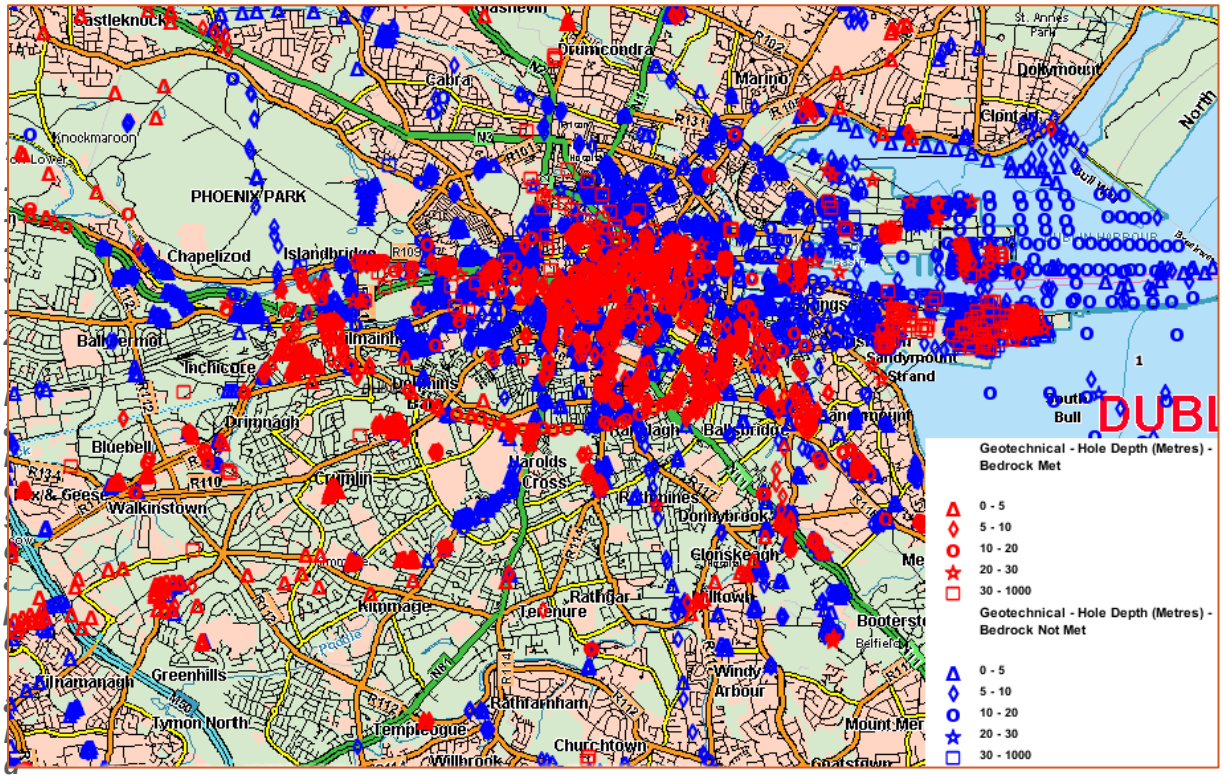
The receiving environment is discussed in terms of; geomorphology; superficial and solid geology; made ground and contamination. Further information on contamination is included in Chapter 10 – Waste, with further information on Hydrogeology included in Chapter 8.

The receiving environment for the Davitt Road site is outlined in the Environmental Site Assessment Report (Appendix 7.3) and a summary of the site setting and contamination status is included in Section 7.1.3.9.

This Section and the accompanying figures can be considered as the geoenvironmental CSM of a section of the St. James's Hospital Campus site, where the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre are proposed.

The site is within the most extensively investigated and studied region of the country and a wealth of geoenvironmental data sources are available (see Figure 7.2 for SI Locations). The geology of the Dublin region, including the properties and characteristics of the soil, subsoil and bedrock have been well studied and there are a number of case histories available for subsurface development/structures in the area (Looby & Long, 2007; Long et al, 2012).

Figure 7.2: Site Investigation Locations, Dublin (Geological Survey of Ireland Database)



7.1.3.2 Topography

The regional topography of Dublin City is generally flat being on a low lying coastal plain, and flood plain of the River Liffey. The regional highpoints are the Dublin Mountains, elev. 540 meters above Ordnance Datum (mOD), located circa 8km to the south of the city and the hills to the north-west, elev. 230mOD. To the west of the site the elevation increases gradually to merge with the midlands plain while to the east land within the city falls towards Dublin Bay and the Irish Sea. The topography of the inner city is dominated by the River Liffey which flows through the middle of the city centre.

A detailed topographical survey has been carried out for the site and has informed the EIS and the design. The site topography is generally level at c.21.m to 19.5m mOD over the entire new children's hospital and Family Accommodation Unit sites and plan extent. The site topography at the proposed Children's Research and Innovation Centre site is flat with ground level at c. 20 to 20.5mOD.

Towards the north of the new children's hospital and Family Accommodation Unit sites, the land falls steeply towards the Energy Centre and Mount Brown/Old Kilmainham Road at a level of c.7.5m OD. Beyond Mount Brown is the River Camac (tributary of River Liffey) at circa 7mOD. The confluence of the River Camac and the River Liffey is less that 1km north of the new children's hospital and Family Accommodation Unit sites at Heuston Railway Station (elev. c. 2mOD). The River Liffey is tidal and is considered as Transitional water up to Islandbridge. Further details on these rivers and hydrology are included in Chapter 8.

The proposed new children's hospital and Family Accommodation Unit sites comprise various buildings and parking areas associated with St. James's Hospital including: Hospital 7, Car Parks, Chapel, and various brick and prefabricated type buildings which house a variety of clinical and service offices. The proposed Children's Research and Innovation Centre site is currently in use as

a car park associated with the Trinity Research Centre. Further details of the existing site are included in Chapters 2, 15 and 16.

The site is within an area of urban, residential development with housing located to the north, west and south of the site. The Red Line Luas bounds the site to the south where it follows a disused arm of the Grand Canal. The track level is a local low point (c. 18.5mOD) as it goes under Rialto Bridge before steadily rising to c.20.5m when it reaches the gable end of Hospital 7 in the south of the site. The main St. James's Hospital Campus is to the east. The St. James's Hospital Energy Centre bounds the north of the project site.

The site is currently accessed through the Rialto Gate and the proposed new accesses will remain off the South Circular Road/Brookfield Road with a second service and carpark access in the north of the site off Mount Brown/Old Kilmainham Road along the side of the Energy Centre.

7.1.3.3 Areas of Geological Interest & Historic Land-use

Areas of Geological Interest

The Geological Survey of Ireland (GSI) Geological Heritage database notes that there was a historic lead mine in Kilmainham. Following consultation with the GSI it is understood that the exact location of this site is unknown and it is unlikely to be at the project site.

The GSI have conducted an audit of geological heritage sites in Dublin City which has identified three sites in the vicinity of St James's. These include:

1. Guinness Wells: This site comprises two borehole wells dug within the Guinness Brewery complex. For historical, technical and cultural importance, the wells within Dublin City are unusual. This is a County Geological Site (CGS) under the IGH16 Hydrogeology theme.

2. Phoenix Park: This site forms an extensive, 707 hectare natural landscape within the confines of Dublin City. The complexity of the site in terms of its glacial form and the manipulation of this is unusual. This is a CGS recommended as a Geological Natural Heritage Area (NHA) under the IGH7 Quaternary, IGH14 Fluvial & Lacustrine and IGH16 Hydrogeology themes.

3. River Poddle: A river which flows northwards through Dublin City; most of its course is diverted underground .The site is important owing to the channelisation and in the lore associated with the Poddle. This is a County Geological Site (CGS) under the IGH14 Fluvial & Lacustrine theme.

The Guinness Wells and River Poddle are discussed further in Chapter 8 Hydrogeology and Hydrology. The Pheonix Park site is situated remote from the project site and is not considered as a receptor for soils and geological impacts.

Historic Land Use

The available historic maps and aerial images have been reviewed and the main features are summarised in Table 7.2.

Table 7.2: Historic Land-use

Source	Use	Description
1995 (Aerial image)	Hospital	Site layout appears largely the same as the current layout with the exception of the Trinity Centre and the Mercer's Institute for Successful Aging which appears to be under construction and the and H&M buildings.
1948	Hospital	Hospital shown on project site for first time.
1935	Work house	Site developed called Dublin Union Workhouses and Corporation Lands to the north. Church shown in southwest of site.
25" B&W (1897-1913)	Agricultural land/Work House	Kilmainham Sheds (Union Workhouse) is located in the southwest corner of the site. The City Workhouse site has expanded and now includes a hospital and convent.
1885	Agricultural Land with new workhouse in	New "Ancillary Workhouse" shown in southwest corner of project site. The remainder of the site is under agricultural use. Water

Source	Use	Description
	southwest corner	feature shown in southeast corner.
6" Colour (1829-41)	Agricultural Land	Historic map series show the project site was under pasture (Garden Hill) with the Dublin Union Workhouse in the northeast. A water feature is visible in the southeast corner of the site which may have been a water source for the agricultural land or workhouse and was possibly fed/associated with the Canal.
1783 Waton's Almnac	Agriculture with Work House to northeast of site	Workhouse (South Dublin Workhouse) in the vicinity of the Trinity Centre site. Also area called "Cut Throat Lane" to side of workhouse entering into the site.

The proposed new children's hospital and Family Accommodation Unit site was predominantly under pasture until the late 1800's. From c.1870 a number of buildings were developed which were associated with the Workhouse/Foundling Hospital which occupied the eastern portion of the St. James's Hospital campus. Hospital 7 and the Chapel were first developed in c.1900 and together with Garden Hill House in the north of the proposed site, are the only original buildings remaining on-site. Other associated development occurred on the site since 1900 however these structures were either temporary wooden constructions or have since been demolished. Further details on site development are included in Chapter 16 –Architectural Heritage.

There is a burial ground noted at the eastern side of the St. James's Hospital campus which is removed from the proposed development site.

A number of former manmade water courses were present in the surrounding area including the Grand Canal directly to the south. This section of the canal closed in the mid-1970s and in the early 2000s the Red Line Luas was developed where the canal used to be. Also associated with the former canal arm are Grand Canal Docks/Harbour/Basin to the east of the St. James's Hospital campus (now Grand Canal Place) and the City Basin which is mapped along the eastern boundary of the St. James's Hospital campus. The historic 6" map records a water feature in the southeast corner of the site which may have been an agricultural water source associated with the site and Canal. From a review of historic maps is believed that the water feature was infilled in the late 1800s/early 1900s.

7.1.3.4 Regional Soils

The general lithological/geological sequence of the overburden within the Dublin area comprises the following units:

Table 7.3: Superficial Deposits in Dublin Region

Superficial Deposits
Made Ground
Estuarine/alluvial clays and silts
Estuarine/alluvial gravels and sands
Glaciomarine clays, silts and sands
Glacial Till (drift)
Glacial gravels and sands

Made ground, concrete and tarmac covers the majority of central Dublin as a result of development through the years. As the city has developed large parts of the tidal areas along the natural shoreline and along the course of the River Liffey and its tributaries have been reclaimed and modified. The majority of central Dublin has had some anthropogenic influence with made ground covering almost all of the city centre.

The dominant subsoil type in the region is glacial deposits comprising Limestone Till which is known as Dublin Boulder Clay. This till resulted from glaciations which covered the region during the Plesitocene and Quaternary periods. It is known that the ice thickness in Dublin was c. 1km. The grinding action of this ice sheet as it eroded the underlying limestone and shale, together with the loading effect resulted in the formation of a very dense/hard low-permeability deposit with pockets or lenses of course gravel (Long et al, 2012). The lenses are generally less than 2m wide and less than 0.5m thick. They are generally self-draining within 24hrs and have poor interconnectivity.

Local withdrawal and recedence of the ice sheet led to the formation of fluvioglacial sediments (gravel and sand lenses) and glaciomarine sediments (stiff/firm laminated clays, silts and sands). The glacial deposits can exhibit significant lateral and vertical variations in grain size distribution over short distances.

Following the glaciations, sea levels rose and raised beach deposits and terrace gravel sediments were deposited around the River Liffey estuary. Alluvial sediments were deposited along the rivers and into the River Liffey, estuary and Dublin Bay. Young estuarine sediments were formed along the old shoreline and within the River Liffey estuary (Farrell & Wall 1990).

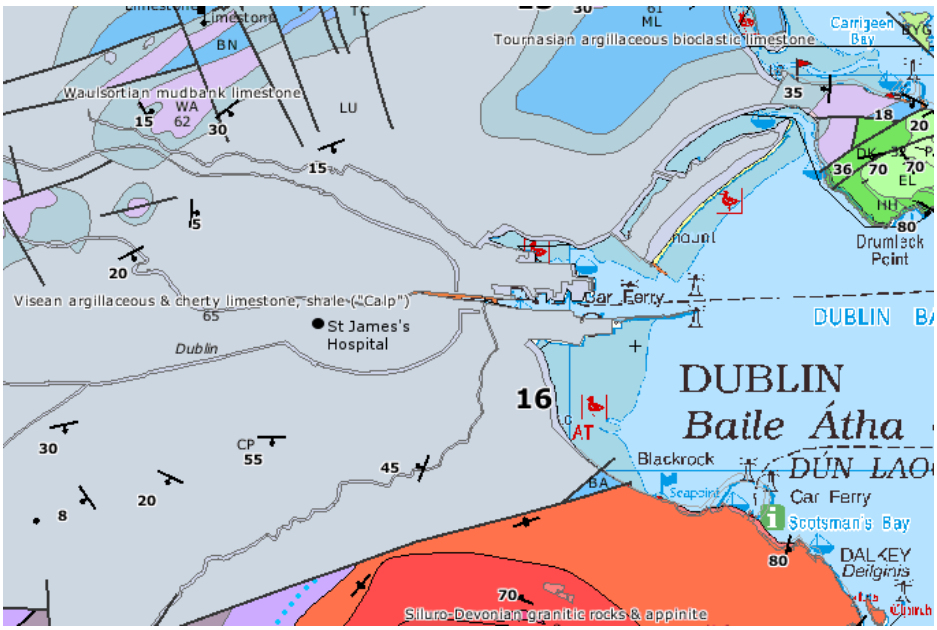
The Dublin Boulder Clay has been extensively studied and there are many publications describing its properties. Additionally there are numerous examples of deep excavations (up to 25m) and constructions within the Dublin Boulder Clay (e.g. Dublin Port Tunnel, Trinity College Library and Leinster House). Data and case history from these site has shown that the behaviour of the walls in Dublin Boulder are very ridged due to the inherent natural strength and stiffness of the material and the slow dissipation of excavation-induced depressed pore pressure or suctions (Long et al, 2012).

The recent construction of the Dublin Port Tunnel has allowed extensive study of the Dublin Boulder Clay and four distinct formations within the clay have been identified namely; the upper brown boulder clay (UBrBC), the upper black boulder clay (UBkBC), the lower brown boulder clay (LBrBC) and the lower black boulder clay (LBkBC) (Skipper at al. 2005). The upper two units are the most commonly encountered in excavations and hence are the most important from the point of view of retaining structures and basements.

7.1.3.5 Regional Geology

The bedrock of the greater Dublin region consists of Dinantian Upper Impure Limestone which is part of the Lucan Formation. The limestone is colloquially known as Calp and is estimated to be up to 800m thick. The homogenous sequence has been described as dark grey to black limestone and shale. The homogenous sequence consists of dark grey massive limestones, shaley limestones and massive mudstones. The average bed thickness is less than 1 metre, but these normally thin-bedded lithologies can reach thicknesses of 2m or more. The regional geology mapped by the GSI is illustrated on Figure 7.3.

Figure 7.3: Regional Bedrock Geology (GSI)



It is conjectured that Lucan Formation in the Dublin area contains minor synclinal and anticlinal folds with a north east south west strike. Two sets of localised faults are presented on the geological map in the north and northwest of the Dublin area with a northwest south east or east north east - west south west strike.

The Calp is almost completely obscured across central Dublin under the Dublin Boulder Clay. An outcrop is recorded on the GSI database just to the south of the St. James's Hospital campus in the form of a historic clay pit and is described as *"Thinly bedded black clayey limestone with soft black shale partings and thin calcite veins under 6ft of boulder loam"*.

7.1.3.6 Hydrogeology

The Lucan Formation is classified by the GSI as a locally important aquifer which is moderately productive in local zones only. The limestone is impermeable with fracture flow dominating. The majority of flow is in the upper weathered bedrock and is common within fractures and fissures at depths of up to 50mbgl.

Regional groundwater flow is towards Dublin Bay and the Irish Sea to the east with a minor component towards and influenced by the River Liffey.

Regional and local hydrogeology is discussed in detail in Chapter 8 and in the reports which accompany the EIS (Appendix 7.1, 7.2 and 8.1).

7.1.3.7 Local Soils

The site-specific site investigations have proven the made ground, Dublin Boulder Clay and Lucan formation. Extensive testing and characterisation of the boulder clay in terms of geotechnical properties was carried out during the 2014 investigations and assessments (see Appendix 7.2). A summary of the soils encountered is detailed in Table 7.4.

Table 7.4: Site Soils Summary

Typical Depth Proven (mbgl)	Geological Unit/Strata	Consistency/Density/Strength (EN ISO 14688-2 & EN ISO 14689-1)	Typical information	General Geotechnical Description
0 - 3.6	Made Ground	Varies	N=9 to 27 CBR=1.0% to 15.0%	Topsoil, tarmac, concrete overlying gravel fill/hardcore or sandy gravelly CLAY with low cobble content, occasional pieces of cinders, brick and/or concrete
1.4 - 2.7	Dublin Boulder Clay 1 (Upper Brown)	Soft, Soft to firm, Firm/Low to Medium	N=5 to 22 CBR=1.6% to 27%	Brown or light brown sandy gravelly CLAY
2.7 - 5.5	Dublin Boulder Clay 2 (Upper Black)	Stiff to very stiff / Very high to extremely high	N=31 to 50 (refusal)	Grey/dark grey and black sandy gravelly CLAY with occasional low cobble and boulder contents
5.5 - 19.3	Dublin Boulder Clay 3 (Lower Black)	Stiff to very stiff or hard / Very high to extremely high	N=46 to 98 (refusal)	Dark brownish grey or greyish brown and black sandy gravelly CLAY. Cobble content varies low to high. Boulder content varies rate to high.
9.5-14.8	Gravels (in north of site)	Dense to very dense	N=44 to 60 (refusal)	Clayey sandy GRAVEL with low cobble content.
10.8 – 19.3	Calp Limestone bedrock	Medium strong to strong	N/A	Thinly to medium bedded, fine to medium grained LIMESTONE, partially weathered, occasionally distinctly weathered, interbedded with very thin beds of extremely weak to weak MUDSTONE. Occasional to frequent calcite veining.

Made Ground

During the site investigations made ground was encountered at an average thickness of c. 1.5m across the new children's hospital and Family Accommodation Unit sites and up to 6m in a small area in the northeast of the site in an area where the ground level drops away steeply and so may have required greater infilling to maintain levels.

The material consisted of a gravelly fill (mixture of gravels, sands, silts and clays) with some minor elements of waste material including red brick, concrete, timber, cinder, plastic, glass and other mixed materials. The majority of the site is covered in tarmacked or paved areas including parking and roads or buildings. There are very few green areas within the existing site.

The made ground has been sampled and characterised to ensure appropriate management and disposal during excavation. This is discussed in further details in Section 7.1.3.9 below and in Chapter 10 - Waste.

Dublin Boulder Clay

In general the site subsoil consists of very stiff dark grey to black or brown sandy gravelly clay with occasional cobbles and rare boulders. The sand is fine to coarse. The gravel is subrounded to

subangular fine to coarse and cobbles are subrounded to subangular. The boulder clay thickness across the plateau area is generally around 10-15m. In the vicinity of the northern boundary of the proposed new children's hospital and Family Accommodation Unit, near Mount Brown Road the Dublin Boulder Clay is recorded to be 5-7m thick.

Occasional gravel or sand and gravel lenses are proven in the Dublin Boulder Clay described generally as dark grey subrounded to subangular fine to coarse gravel are present on the St. James's Hospital Campus. The thickness of the gravel or sand and gravel lenses varies from 0.1m to 5.30m. The gravel lenses are more common in the northern part of the new children's hospital site. No significant water was encountered in these lenses (discussed further in Chapter 8). Boulders of between 100mm and 40mm were encountered during coring.

Three of the Dublin Bolder Clay formations were encountered during the site investigations namely; upper brown (UBrBC) to c.3.7mbgl, upper black (UBkBC) from c.2.om to 6.6m bgl and lower black (LBkBC) below UBkBC extending down to rock. The lower and upper black bounder clays can be difficult to distinguish and can be considered in general to have similar characteristics and behaviour.

The strength and stiffness of the Dublin Boulder Clay increased considerably with depth. The particle size distribution (PSD) grading curves for the soils were typical of Dublin Boulder Clay studies carried out previously (see reference Section 7.1.10). The gravel content of the boulder clay is high across the site which will increase its strength parameters. The high gravel content has not impacted on measured permeability which remains low at 10^{-7} to 10^{-10} m/s. Further details on hydrogeological properties are included in Chapter 8.

Regarding excavatability of the soil (and upper bedrock) and the sheer strengths anticipated to be involved in this, it has been assessed that a combination of easy ripping and hard digging will be required. Further detail on geotechnical properties are included in Appendix 7.2 and in the Construction Methodology report which accompanies the EIS.

7.1.3.8 Local (Bedrock) Geology

Within the site the bedrock is completely covered by an extensive blanket of boulder clay and made ground. The borehole drilling programme and geophysical survey have indicated a depth to rock of between 10 and 18m bgl (10 - 0mOD). The depth to rock is shallower in the north of the site where the ground level falls away steeply from plateau to Mount Brown Road.

Based on the rock cores recovered during the 2014 site investigation, the Lucan Formation is recorded as medium to strong and thin to medium bedded dark grey fine to medium grained limestone. The strength of the limestone increases with depth.

Borehole logs from the 100 series cored boreholes indicate that the weathered Lucan Formation on the site is approximately 0.8-2.5 m thick. The weathered zone was noted during the drilling of MW01- MW05 and FS01/15 and FS02/15 by an increase in drilling rate suggesting that the rock is relatively softer. Calcite veins are occasionally to frequently present. In some borehole the limestone is interbedded with widely spaced, very thin beds of weak dark grey mudstone or brown sandy gravelly clay.

Geophysical surveys were undertaken in deeper bedrock wells. Downhole CCTV survey showed fractures within the boreholes, most of which appear to be very tight to partially open and sub-horizontal in orientation. Fractures were encountered at 36mbgl approximately 0.2 m in length with an aperture of approximately 0.02 m. Occasional sub-horizontal and sub-vertical thin calcite veins and minor pyrite beds are also visible.

The natural gamma signal obtained during the geophysics survey for the Lucan Formation in the deep borehole in the south of the site (FS02) is marked by a fluctuating signal of highs and low which probably reflects the shaley and clay mineral rich interbeds. The resistivity log was undertaken to locate any significant changes in lithology or fracture zone in the Lucan Formation. In general the resistivity signal is seen to increase where the gamma signal decreases. This infers that the higher resistivity strata are low in clay mineral which in the Lucan Formation is likely to comprise the limestone. In general the resistivity signal and the gamma signal demonstrate the highly variable and interbedded nature of the Lucan Formation comprising many medium to thick beds (0.2m to 2m) of limestone and mudstone or muddy limestone.

7.1.3.9 Assessment of Soil Contamination

Environmental Site Assessments were carried out at the new children's hospital, Family Accommodation Unit, Children's Research and Innovation Centre and Davitt Road sites. The assessments included site investigation, sampling and analysis work to characterise the soil quality

and investigate potential contamination at the site (see Section 7.1.2.2 for work undertaken). Results for the soil characterisation were combined with detailed volume estimations using 3D modelling to estimate the quantities of material which will require excavation and offsite recovery, reuse or disposal. Further details are included in Chapter 10, Waste. Details of the site investigations and results are contained in the relevant site investigation reports contaminated in Appendices 7.1, 7.2 and 7.3.

New children's hospital, Family Accommodation Unit & Children's Research and Innovation Centre sites

Samples were obtained of made ground and underlying natural clays across the sites and chemical analysis was carried out for a range of parameters. As all of the made ground is to be removed during the construction of the basements for the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre buildings, no human health risk assessment was carried out. Instead the material was classified for waste management purposes through a combination of waste acceptance criteria (WAC) testing and total pollutant content testing.

Site investigation locations were chosen to cover as much of the site as possible, considering it is a live hospital with access limitations (see Section 7.1.2.3). Targeted investigations were also used focusing on potential contamination hotspots which were highlighted in the Phase I Environmental Site Assessment (Appendix 7.1).

In general the site was found to be free from significant contamination. Some slightly elevated levels of metals (antimony) and polycyclic aromatic hydrocarbons (PAHs) were reported for a number of samples. It is likely that these contaminants are associated with the fill material/made ground which covers the site. This material has been classified according to the Landfill Directive and will be managed and disposed of in compliance with the Waste Management Act (see Chapter 10 for further details).

One confirmed hot spot was identified in the southern part of the site within the staff car park. The area is adjacent to the old Rialto gate (decommissioned) and is understood to have been the site of a pump house which was connected to the sites water supply in the late-1800s to mid-1900s. The area was found to be contaminated with heavy fraction hydrocarbons which were probably used to lubricate the pumps and the contaminants resulted from spills which occurred over the relatively long lifetime of the pump house. Any risk from this contamination will be removed once the material is removed as part of the construction phase. Risk to construction workers and management of the material will be managed under the outline Construction Management Plan which is submitted as part of this EIS and further details are included in Chapter 10 for appropriate disposal options.

A potential hotspot was identified in the area known as Hospital 7 courtyard. This area has multiple services and is in a patient sensitive area so the potential for investigation was limited. Samples from one location reported elevated pH levels. The cause of the elevated pH are unclear and it is recommended that further testing and characterisation takes place in this area during the construction phase.

Davitt Road site

The Davitt Road site was formerly occupied by Unilever and was used for the storage and production of foodstuffs and pharmaceutical goods. The site has not been operational since 2007 and it all the Unilever site buildings have been demolished down to slab level. The western portion of the wider site was occupied by Blindcraft Blinds which is also now discontinued.

The site investigation completed for the site indicated mild hydrocarbon contamination in soil at one location (off site to the west) and in water at one location on site. Elevated concentrations of PAHs were encountered in a small number of soil samples which exceeded the Stage 2 generic assessment criteria (GAC). The assessment report concludes that the contamination encountered does not pose a significant risk to site users and the environment and overall the site was found to be in good condition for a brownfield site with a history of industrial use.

7.1.3.10 Radon

According to the Environmental Protection Agency (now incorporating the Radiological Protection Institute of Ireland) the majority of Dublin City is classified as being a Low Radon Area where is it estimated that only 1-5% of dwellings will exceed the Reference Level of 200 Bq/m^3.

7.1.3.11 Summary and Type of Geological Environment

Based on the regional and site specific information available, a schematic cross section of site area has been created and is shown on Figure 7.4 and a close up section of the new children's hospital site with proposed basement levels is shown on Figure 7.5.

A summary of the site geology as illustrated on the cross sections is outlined thus:

- Made ground comprising gravelly fill with minor C&D type waste components with an average thickness of c. 1.5m covers the site.
- Made ground is largely uncontaminated with the exception of some small isolated hotspots.
- The boulder clay deposits which were encountered on site are typical of those found in the Dublin area and they are continuous across the site.
- The gravel content within the boulder clay is higher in pockets with some thin gravel lenses encountered in a number of boreholes.
- The top of rock was found at elevations of c.10.5mOD in the south of the site to 0 mOD in the north.

The type of Geological Environment as per the Institute of Geologists of Ireland Guidelines is Type A - Passive geological /hydrogeological environments.

Figure 7.4: Geological Cross Section

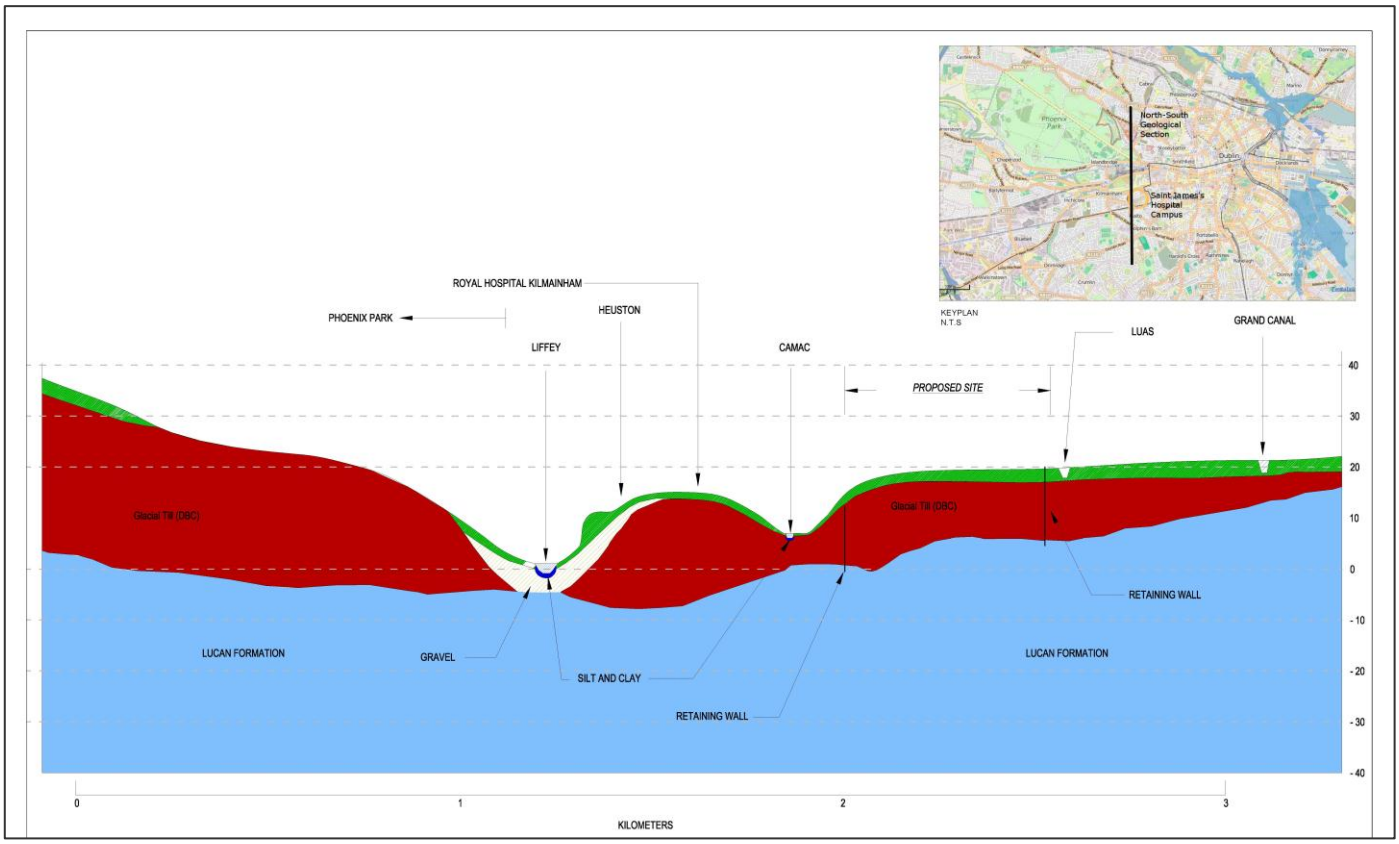
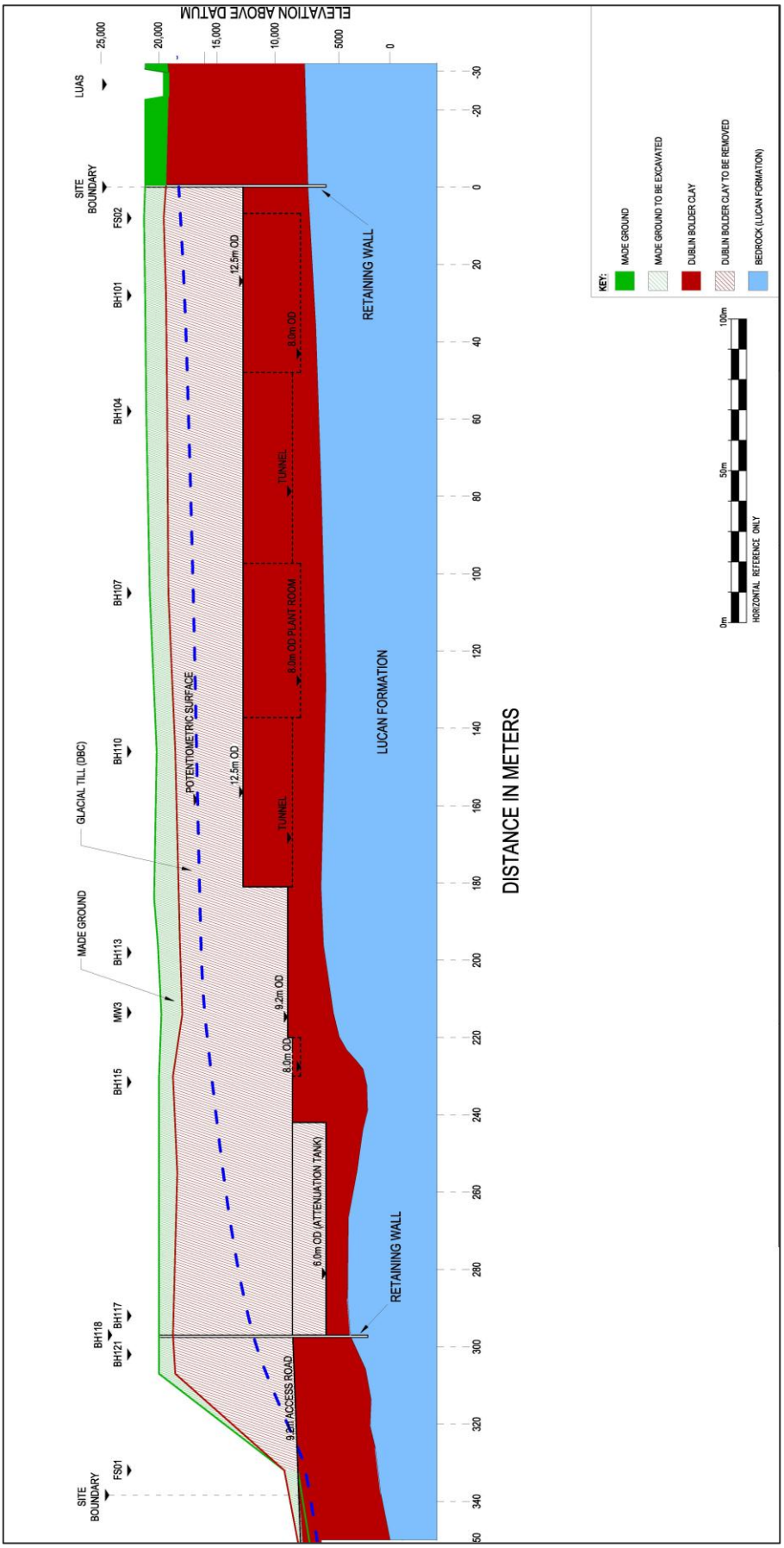


Figure 7.5: Site Cross Section



7.1.4 Characteristics of the Proposed Development

There are a number of elements associated with both the construction and operation of the proposed development which had the potential to impact on the environment with respect to soils and geology.

The activities associated with the project which have the potential for impact as detailed in Table 7.5.

Table 7.5: Site Activities

Phase	Activity	Description
Construction	Enabling Works	Demolition of existing buildings and foundations, diversion and decommissioning of existing utilities and removal of hard surfacing from the site (new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre).
	Earthworks: Excavation of Superficial Deposits	Removal of significant volumes (c. 413,000m3 in total) of overburden (above and below water table) to allow subsurface structures including a large basement at the main new children's hospital complex, associated services (inc. the Drimnagh Sewer, trench excavations, services) and a smaller basement at Children's Research and Innovation Centre.
	Earthworks: Excavation of Bedrock	Removal of a small volume (c.1,250m3 in total) of bedrock in some isolated areas in the south of the site to allow basement construction. Excavation of rock will be a maximum of c.1m deep into rock and will likely constitute the upper weathered zone only.
	Lowering the Water Table	Lowering of water table through drainage (excavation) and active pumping when excavation close to bedrock to reduce amount of groundwater entering the excavation. Considered in Chapter 8 Hydrogeology.
	Storage of hazardous Material	Fuel and chemical storage during construction both at the St. James's Hospital Campus site and the Davitt Road construction compound. As part of the construction the existing 200,000l fuel store which service the Energy Centre for back power generation are to be temporarily relocated above ground and the existing storage area is to be demolished.
	Infilling	A degree of fill will be required during the works which will include the importation of concrete and aggregate fill.
Construction and operation	Construction of sub-surface structures	Construction of a perimeter secant pile wall around the new children's hospital and the Family Accommodation Unit sites to a depth of circa 20m bgl and the Children's Research and Innovation Centre to a depth of c. 8 – 10m bgl. Construction of hydrostatic ground anchors associated with the basement and secant pile wall.
	Construction of sub-surface structures	Construction of a large basement (c.30,000m^2) of up to 2/3 levels at the new children's hospital and Family Accommodation Unit sites and a smaller single storey basement (c. 1,300m^2) at the Children's Research and Innovation Centre site.
	Infilling	A degree of fill will be required during the works which will include the importation of concrete and fill material.
Operation	Drainage Works	Altering of groundwater table by drainage, dry moat construction, basement construction and perimeter secant pile wall.
	Storage of hazardous Material	Fuel, chemical and radioactive material storage during operation. A new 400,000l oil store is to be constructed to serve the St. James's Hospital Campus via the Energy Centre. A smaller 3,000l oil storage facility will be constructed to serve the Children's Research and Innovation Centre site. There will be additional areas for chemical and general and clinical waste storage required for the sites (see Chapter 10 Waste for further information).
	Lowering the Water Table	Potential pumping from groundwater wells over an extended period to supply or partially supply the water requirements for the site (under consideration - see Chapter 8)

The activities which can have potential impacts on the soil and geological environment are generally also connected with potential impacts on the groundwater and surface water environment. These activities and impacts are detailed in Chapter 8 Hydrogeology and Hydrology.

As outlined in Table 7.5, the Construction Phase holds the greatest number of activities which could potentially impact on the geological environment. These activities primarily pertain to the basements and retaining walls which are proposed for the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre sites.

The construction phase is anticipated to take approx. four years to complete for the new children's hospital and Family Accommodation Unit . An outline of the works is as follows:

- Site Clearance, Demolitions and Enabling Works
- Services and utility diversions
- Construction of secant pile wall
- Excavation of Basement
- Construction of Basement
- Construction of Superstructure
- Completion of services and external landscaped areas

The construction of the Children's Research and Innovation Centre building will be relatively short taking c. 12-15 months to complete. The Design and the Outline Construction Management Plan have been formulated to minimise potential impacts on the soil and geology environment and further details are available with regard to this matter in Chapter 15 - Archaeological Heritage of the EIS.

7.1.5 Potential Impact of the Proposed Development

In line with EIS guidance, each potential impact for the development should be described in terms of its quality, significance and duration.

The potential impacts, mitigation measures and resulting residual impacts have been combined in a detailed assessment table presented in Section 7.1.7.

7.1.5.1 Construction Phase

The potential soils and geology impacts during the construction phase are presented in Table 7.6 and are outlined below.

These impacts also relate to and interact with other chapters within the EIS specifically:

- Chapter 5, Human Beings
- Chapter 6, Traffic and Transportation
- Chapter 8, Hydrogeology and Hydrology
- Chapter 9, Flora and Fauna
- Chapter 10, Waste Management
- Chapter 11, Noise and Vibration
- Chapter 15, Archaeology
- Chapter 12, Air Quality & Climate
- Chapter 17, Material Assets

Specific interactions are listed below, further detail is provided in the relevant chapters and in Chapter 18 Interaction of the Foregoing.

Interactions – General Points

- Excavated and stripped soil can be disturbed and eroded by site vehicles during the construction. Rainfall and wind can also impact on non-vegetated/uncovered areas within the excavation or where soil is stockpiled. This can lead to run-off with high suspended solid content which can impact on water bodies including the River Camac, River Liffey and Dublin Bay. The potential risk from this indirect impact to water bodies and/or habitats from contaminated water would depend on the magnitude and duration of any water quality impact.

- There is a potential for dust from excavations or stockpiles to impact on air quality/human beings and there are site-specific risks associated with soil-borne micro-flora (Aspergillums) which are addressed in Chapter 12.

- Construction phase dewatering will be required to excavate the basement and to maintain dry working conditions in the excavation (particularly when getting close to the bedrock). Pumped water will require discharge offsite. This is discussed further in Chapter 8 Hydrogeology and Hydrology.

- Noise and vibration will be generated through the construction phase particularly during pilling and excavation work. Given that no significant rock excavation is required it is anticipated that conventional excavation techniques (i.e. hard ripping) will suffice. Noise and vibration impacts are considered in detail in Chapter 11, Noise and Vibration.

- The removal of boulder clay from the ground could, without the adoption of appropriate control measures, lead to some ground movement in the immediate surrounds of the excavation with an associated risk of settlement and damage to buildings in the immediate area. To address this, the secant pile retaining wall has been designed based on site specific information to reduce the risk of any settlement to within acceptable levels. The details of the retaining wall design are included in the outline Construction Management Plan which accompanies this EIS.

- The basement construction will require the diversion of existing services including a public sewer (the Drimnagh Sewer) as well as services for the St. James's Hospital campus. This is discussed further in Chapter 17, Material Assets.

- A number of areas of archaeological interest have been identified within the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre sites. These areas will be excavated during the works. This is discussed further in Chapter 15, Archaeology.

7.1.5.2 Operational Phase

During the operational phase of the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre sites there will be very limited to no potential impact on the geology of the area.

The main potential impacts relate to potential spills or leaks of any deleterious material associated with the operation of the site. These impacts are detailed in Table 7.7. The potential impacts of the basement construction on the local hydrogeological regime are presented in Chapter 8.

7.1.5.3 'Do Nothing' Scenario

In the case where the National Paediatric Hospital Project was not to be developed there would be no resulting additional impacts on the soils or geology in the area of the St. James's Hospital Campus. As St. James's Hospital is currently operating on the campus, the same potential operational impacts listed in Table 7.6 and 7.7 could, without the remedial measures, occur (with the exception of the risks associated with the basement construction) and would have the potential to impact on the soil and geology of the area. This includes any existing risks associated with the soil contamination identified at the relevant project sites (see Section 7.1.3.9).

7.1.6 Ameliorative, Remedial or Reductive Measures

This section describes a range of recommendations and mitigation measures designed to avoid, reduce or offset any potential adverse impacts identified.

7.1.6.1 Construction Phase

In order to reduce the impacts on the soils and geology environment a number of mitigation measures will be adopted as part of the construction works on site. The measures will address the main activities of potential impact which include:

- Control of soil excavation and export from the St. James's Hospital campus;

- Sources of fill and aggregates for the St. James's Hospital campus developments;

- Fuel and chemical handling, transport and storage;

- Control of water during construction.

Control of Soil Excavation and Export from St. James's Hospital Campus

Made ground, subsoil and small volumes of bedrock will be excavated to facilitate the formation of the basement levels, ramp access, construction of a utility tunnel and modifications to the Drimnagh Sewer. Soil stripping, earthworks and stockpiling of soil will be carried out during the works. Stockpiles have the potential to cause negative impacts on air and water quality. The effects of soil stripping and stockpiling will be mitigated against through the implementation of an appropriate earthworks handling protocol during construction. It is anticipated that any stockpiles will be formed within the boundary of the excavation and retaining wall and there will be no direct link or pathway from this area to any surface water body. It is anticipated that only local/low level of stockpiling will occur as the bulk of the material will be excavated straight into trucks for transport offsite.

Dust suppression measures (e.g. damping down during dry periods), vehicle wheel washes, road sweeping and generally housekeeping will ensure that the surrounding environment is free of nuisance dust and dirt on roads.

Contaminated Material and Export from St. James's Hospital Campus

Site investigations have established that some localised contamination of the made ground/subsoils has occurred. If these materials are not correctly identified, segregated, classified and appropriately handled, there may be inappropriate handling and reuse of the material off-site which could impact negatively on site human beings (on-site and off-site) as well as water and soil environments.

A Watching Brief and Discovery Procedure for potential contaminated material will be prepared and adopted by the main contractor prior to work commencing on site. These documents should detail how potentially contaminated material will be dealt with during the excavation phase. All potentially contaminated material is to be either; left in situ and characterised by a competent professional through laboratory testing, or; segregated and stockpiled in a contained manner and characterised by a competent professional through laboratory testing.

The excavation of materials in the upper most strata i.e. the made ground and top of natural clays will require careful and methodical excavation.

The soil classification for the site has concluded that a range of material are present which require appropriate handling both during excavation and transport. The soil classification may be refined where the Contractor sees fit to confirm or reduce the volumes of material which may require special handling or disposal. The control of material will be carried out in accordance with the Waste Management Act and a soil management plan shall be authored by the works Contractor.

Sources of Fill and Aggregates

All fill and aggregate for the project will be sourced from reputable suppliers as per the project Contract and Procurement Procedures. All suppliers will be vetted for:

- Aggregate compliance certificates/declarations of conformity for the classes of material specified for the project;
- Environmental Management status;
- Regulatory and Legal Compliance status of the Company.

Fuel and Chemical Handling

The following mitigation measures will be taken at the St James's Hospital Campus construction site and the Davitt Road compound in order to prevent any spillages to ground of fuels and prevent any resulting soil and/or groundwater quality impacts:

- The temporary relocation of the existing 200,000l fuel store for St. James's Hospital will be carried out in a controlled manner and the new temporary bund will be designed and maintained in accordance with best practice and standards (BS 5410 and BS799-5);
- Designation of a bunded refuelling areas on the site (and at the Davitt Road site if required);
- Provision of spill kit facilities across the site;
- Where mobile fuel bowsers are used the following measures will be taken:
    - Any flexible pipe, tap or valve will be fitted with a lock and will be secured when not in use;

- The pump or valve will be fitted with a lock and will be secured when not in use;
- All bowsers to carry a spill kit and operatives must have spill response training;
- Portable generators or similar fuel containing equipment will be placed on suitable drip trays.

In the case of drummed fuel or other potentially polluting substances which may be used during construction the following measures will be adopted:

- Secure storage of all containers that contain potential polluting substances in a dedicated internally bunded chemical storage cabinet unit or inside a concrete bunded areas;
- Clear labelling of containers so that appropriate remedial measures can be taken in the event of a spillage;
- All drums to be quality approved and manufactured to a recognised standard;
- If drums are to be moved around the site they should be done so secured and on spill pallets;
- Drums to be loaded and unloaded by competent and trained personnel using appropriate equipment.

The aforementioned list of measures is non-exhaustive and are included in the outline Construction Management Plan that is submitted with this EIS.

Outline Construction Management Plan

An outline Construction Management Plan has been prepared and accompanies the EIS submission.

The outline Construction Management Plan outlines the construction strategy (referred to in Section 7.1.) and presents an outline construction delivery sequence supported by projected construction methodologies/techniques that may be adopted during the construction of the project. The outline Construction Management Plan is a live document and is to be further developed by the Main Contractor in consultation with Dublin City Council and the Planning Authority (as required). This document will include mitigation measures to reduce any potential impacts from the construction phase.

In advance of work starting on site the works Contractor will update the outline Construction Management Plan taking into account their approach and any additional requirements of the Design Team or Planning Regulator. The Contractor will also prepare a Construction Management Plan and Environmental Plan. The outline Construction Management Plan sets out the overarching vision of how the construction of the project will be management in a safe and organised manner by the Contractor with the oversight of the National Paediatric Hospital Development Board (NPHDB). As outlined above the outline Construction Management Plan is a live document and it will go through a number of iterations before works commence and during the works. It will set out requirements and standards which must be met during the construction stage and will included the relevant mitigation measures outlined in the EIS and any subsequent conditions relevant to the project.

Control of Water during Construction

The control of water during construction is discussed in detail in Chapter 8.

7.1.6.2 Operational Phase

During the operational phase of the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre at St. James's Hospital campus, there is limited potential for site operations to impact on the geology of the area.

The primary source of potential operational impacts relates to the storage and handling of deleterious substances. Improper handling or storage could result in contamination of the surrounding areas.

All new oil storage facilities will be designed and maintained in accordance with best practice and standards (BS 5410 and BS799-5). All waste storage areas will be designed to afford adequate containment for any liquid or solid waste. These measures combined with best practice will prevent any contamination of surrounding soil/bedrock.

Davitt Road

The Davitt Road Construction Compound will be reinstated once construction on the St. James's Hospital campus is complete and it is not therefore necessary to consider the operational impacts on Davitt Road as part of this assessment.

7.1.6.3 'Do Nothing' Scenario

If it is the case that the proposed St. James's Hospital Campus was not developed and the Davitt Road site was not used as a construction compound, there will not be any soil and geology mitigation measures required.

7.1.7 Predicted Impact of Proposed Development

The predicted residual impacts of the proposed development are outlined in the detailed assessment Tables 7.6 and 7.7.

7.1.7.1 Construction Phase

The predicted impacts of the construction phase are described in Table 7.6 in terms of quality, significance and duration. The relevant mitigation measures are detailed and the residual impacts are determined which take account of the mitigation measures.

The primary residual impact from the construction phase is the removal of soil and rock (minimal rock volumes) to facilitate the basement construction and the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre sites. This impact is unavoidable given the nature, requirement and design of the proposed development.

7.1.7.2 Operational Phase

The predicted impacts of the operational phase are described in Table 7.7 in terms of quality, significance and duration. The relevant mitigation measures are detailed and the residual impacts are determined which take account of the mitigation measures.

During the operational phase of the National Paediatric Hospital Project there will be no residual impact on the geology of the area associated with the new children's hospital, Family Accommodation Unit and Children's Research and Innovation Centre sites.

The potential impacts relate to the storage and handling of potentially deleterious substances. Mitigation measures including properly designed and maintained storage infrastructure and areas combined with good housekeeping practices will remove any risk of contamination to the local geological environment.

The Davitt Road Construction Compound will be reinstated once construction on the St. James's Hospital campus is complete and it is not therefore necessary to consider the operational impacts on Davitt Road as part of this assessment.

7.1.7.3 'Do Nothing' Scenario

In the case where the National Paediatric Hospital Project was not to be developed there would be no resulting additional impacts on the soils or geology in the area of the St. James's Hospital Campus. As St. James's Hospital is currently operating on the campus, the same potential operational impacts listed in Table 7.6 and 7.7 could, without the remedial measures, occur (with the exception of the risks associated with the basement construction) and would have the potential to impact on the soil and geology of the area. This includes any existing risks associated with the soil contamination identified at the relevant project sites (see Section 7.1.3.9).

Table 7.6 - Construction Phase Impact Assessment Summary - Soils and Geology

Constraint		Location			Impact Assessment					
Activity/Source	Construction Strategy	NCH and FAU Sites	CRIC Site	Davitt Rd Site	Impact Description	Quality	Significance	Duration	Mitigation	Residual Impact
Earthworks	• Site Clearance • Basement Excavation • Installation of perimeter secant pile wall • Basement Construction • Construction of hydrostatic ground anchors	x	x		Excavation of Made Ground (contaminated and non-inert material) and disposal off site	Positive	Slight	Long-term	Material is Categorised according to the Landfill Directive and will be sent to appropriately licensed facilities for treatment/disposal. Controlled excavation of contaminated material to be managed under the outline Construction Management Plan and Construction Strategy which accompany the EIS.	Slight Positive
		x	x		Excavation of Natural Soils and Subsoil for basements, retaining walls, service tunnels, drainage etc.	Negative	Moderate	Permanent	The minimum amount of space to construct the project has been designed for. Embedded retaining walls will be used to ensure that excavated volumes are kept to a minimum. Material will be reused on site where possible. Vibration and settlement monitoring to be conducted during the construction phase.	Moderate Negative
		x			Excavation of Limestone Bedrock for basement construction	Negative	Slight	Permanent	A small volume of limestone bedrock will require excavation in an isolated area in the south of the site. The excavation will be primarily limited to the Dublin Boulder Clay. The excavation of rock will be kept to a minimum and is likely to be limited to the upper weathered zone only.	Imperceptible
		x	x		Excavation of material and installation of retaining walls can generate noise and vibration	Negative	Moderate - Significant	Short-term	Appropriate techniques shall be adopted to comply with the requirements of statutory bodies in terms of noise and vibration. Further detail is included in Chapter 11, Noise and Vibration.	Slight Negative

		x	x		Reuse of suitable material off site	Positive	Slight	Long-term	Spoil generated on site is a resource and shall be re-used offsite where possible in line with relevant Waste and Planning Legislation. Art. 27 declarations will be made to the Environmental Protection Agency where required to classify the material as a by-product where required. For further information see Chapter 10 Waste.	Slight Positive
		x			Soil erosion causing airborne dust and aspergillums risk	Negative	Moderate - Significant	Short-term	Specific mitigation measures to protect sensitive receptors (patients) from airborne dust and microflora are included in Chapter 12.	Imperceptible
		x	x	x	Soil erosion causing airborne dust and/or nuisance dust on public roads	Negative	Slight	Short-term	Dust suppression measures will be implemented to minimise dust generation during extended dry periods. Dust monitoring will be conducted through the excavation period. Vehicle wheel wash facilities will be installed at site exits and a road sweeping programme will be implemented.	Imperceptible
		x	x		A degree of fill will be required during the works which will included imported fill and aggregates	Negative	Slight - Moderate	Long-term	Contract and Procurement Procedures will ensure that all aggregates required for the construction are sourced from reputable suppliers. Declarations of conformity/compliance certificates will be required to ensure all aggregates supplied meet the specified engineering specifications.	Imperceptible

Lowering Water Table	• Basement Excavation• Installation of Retaining Walls• Basement Construction	x	x		Lowering of Water Table by removal of soil and subsoil and active pumping which could contribute to settlement	Neutral	-	Short-term	The shallow water table in the vicinity of the site will be maintained by the construction of the retaining wall. Drainage measures have been incorporated to replicate pathways for shallow water to migrate around the site in the long term to prevent any altering of the equilibrium water table. Some localised pumping of groundwater will also be required to prevent ingress from the underlying bedrock. The majority of neighbouring structures are likely to be founded on the thick and highly competent boulder clay deposits. Structural surveys have been completed in surrounding properties and the retaining wall and neighbouring sites will be monitored during the works. Further details are contained in Chapter 8 Hydrology and Hydrogeology and the outline Construction Management Plan.	Imperceptible
Storage of potentially polluting materials	• Site Clearance • Basement Excavation • Installation of Retaining Walls • Basement Construction	x	x	x	Potential leak or spillage from construction related liquids on site or the temporary fuel tank associated with St. James's Hospital	Negative	Significant	Short-term	Good housekeeping on all project sites and proper handling, storage and disposal of any potentially polluting substances can prevent soil and/or water contamination. Designated and bunded storage areas will be maintained. Further details are included in the outline Construction Management Plan.	Imperceptible

NOTE: "NCH and FAU Sites" refers to the site of the new children's hospital and Family Accommodation Unit

Table 7.7 - Operational Phase Impact Assessment Summary

Activity/Source	Location			Impact Assessment						
	NCH and FAU Sites	CRIC Site	Davitt Rd Site	Impact Description	Quality	Significance	Duration	Type	Mitigation	Residual Impact
Storage of potentially polluting materials	x	x		Potential leak or spillage from fuel oil during the operation of the new children's hospital or Children's Research and Innovation Centre sites	Negative	Significant	Short-term	Indeterminable	With appropriate design and construction no specific operational measures are required outside the normal requirements for the storage of bulk fuel. Containment structures will be designed and maintained in accordance with best practice and standards (BS 5410 and BS 799-5)	Imperceptible

NOTE: "NCH and FAU Sites" refers to the site of the new children's hospital and Family Accommodation Unit

7.1.8 Monitoring

The requirement and recommendation for monitoring related to the soil and geological environments are as follows:

- Watching Brief and Discovery Strategy for any potentially contaminated material to ensure adequate classification and disposal;
- Monitoring of the retaining wall including inclinometers, tilt-meters and water movements either seepages or through control points;
- Monitoring of neighbouring structures for the effects of any vibrations / movements/ settlements arising from the excavation works based on condition surveys of adjacent buildings prior to works;
- Regular inspection of on-site fuel storage facilities to ensure environmental 'best-practices' are being employed during construction.

Monitoring of interrelated impacts such as; noise and vibration levels; groundwater levels; dust emissions etc. are dealt with in their respective EIS Chapters. Further details are also included in the outline Construction Management Plan which accompanies the EIS.

7.1.9 Reinstatement

Following completion of the construction phase, it is proposed to reinstate the Davitt Road site to near its current condition. The future use of the site is currently unknown and it is an area of mixed residential and commercial use. The adjoining site has been granted planning to be redeveloped as the Ambulance Base (Reg. Ref. 2309/15).

The URS site investigation report concluded that the site is generally in good condition for a brownfield site with a history of industrial use. It is anticipated that following its use as a construction compound and providing that the recommended mitigation measures related to the storage of deleterious materials outlined in this Chapter are implemented, the site will remain in the general good condition described in the URS report. This report can act as a baseline for any future site investigations if required.

The new children's hospital, Family Accommodation Unit and the Children's Research and Innovation Centre have a 100 year design life and in the event that it is discontinued with a view to reinstatement this would likely require a new planning permission and potentially an assessment of impacts.

7.1.10 References and Relevant Legislation Does

The following sources were used for the geology desk study with regards to the St. James's Hospital Campus and Davitt Road sites:

- Córas Iompair Éireann, DART Underground Environmental Impact Statement (2010).
- Environmental Protection Agency Envision Data Viewer: http://gis.epa.ie/Envision
- Farrell, E.R., and Wall D. (1990). Soils of Dublin, Institution of Engineers of Ireland, 115, 78-9.
- Geological Survey of Ireland Geotechnical Data Viewer http://spatial.dcenr.gov.ie/GeologicalSurvey/GeoTechnicalViewer/index.html
- Geological Survey of Ireland National Groundwater Viewer http://spatial.dcenr.gov.ie/GeologicalSurvey/Groundwater/index.html
- Geological Survey of Ireland General Data Viewer http://spatial.dcenr.gov.ie/imf/imf.jsp?site=GSI_Simple
- Geological Survey of Ireland GeoUrban Data Viewer http://spatial.dcenr.gov.ie/imf/imf.jsp?site=GeoUrban
- Geological Survey of Ireland Quaternary Geology map of Dublin.
- Geological Survey of Ireland Geotechnical Database (Reports No 790, 791, 2497, 6783 and 6939).
- Looby, M. & Long, M. Deep Excavations in Dublin, Recent Developments. Paper first presented to a meeting of the Geotechnical Society of Ireland at Engineers Ireland, 22 Clyde Rd, Dublin 4, on 11th December 2007.

- Long, M., Brangan, C., Menkiti, C., Looby, M. & Casey, P. 2012. Retaining walls in Dublin Boulder Clay, Ireland. Proceedings of the ICE – Geotechnical Engineering [Online], 165. Available: http://www.icevirtuallibrary.com/content/article/10.1680/geng.9.0091.
- Long, M. & Menkiti, C.O (2007). Geotechnical Properties of Dublin Boulder Clay. Geotechnique, No. 7, 595-611.
- Long, M. & Murphy, B. (2003). Difficulties with Ground ANPHorages in Hard Rock in Dublin, Ireland. Geotechnical & Geological Engineering, 21, 87-111.
- McConnell, B. and Philcox, M., (1994). Geology of Kildare-Wicklow: A geological description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 16, Kildare-Wicklow. Geological Survey of Ireland.
- Skipper, J., Follett, B., Menkiti, C.O., Long, M. & Clark-Hughes, J. (2005). The engineering geology and characterisation of Dublin Boulder Clay, QJEGH, 38, 171-187.

In addition to the general relevant sources listed the following site specific information sources were reviewed as part of the baseline data collection:

- Arup Consulting Engineers. Feasibility Study for a Portable supply for the new children's hospital, 2015 (Appendix 8.1 of the EIS)
- Causeway Geotech Ltd.-National Paediatric Hospital Project, Dublin-Ground Investigation Contract.
- Roughan & O'Donovan National Paediatric Hospital Project Ground Investigation Report-Interpretive Report.
- Minerex Geophysics Limited Report Ref. 5805f-005
- O'Connor Sutton Cronin & Associates Civil/Structural Engineer's Reports.
- O'Connor Sutton Cronin & Associates Environmental Site Assessment Report (Appendix 7.1).
- URS Environmental Site Assessment Report Davitt Road (Appendix 7.3)

7.2 Tallaght Hospital

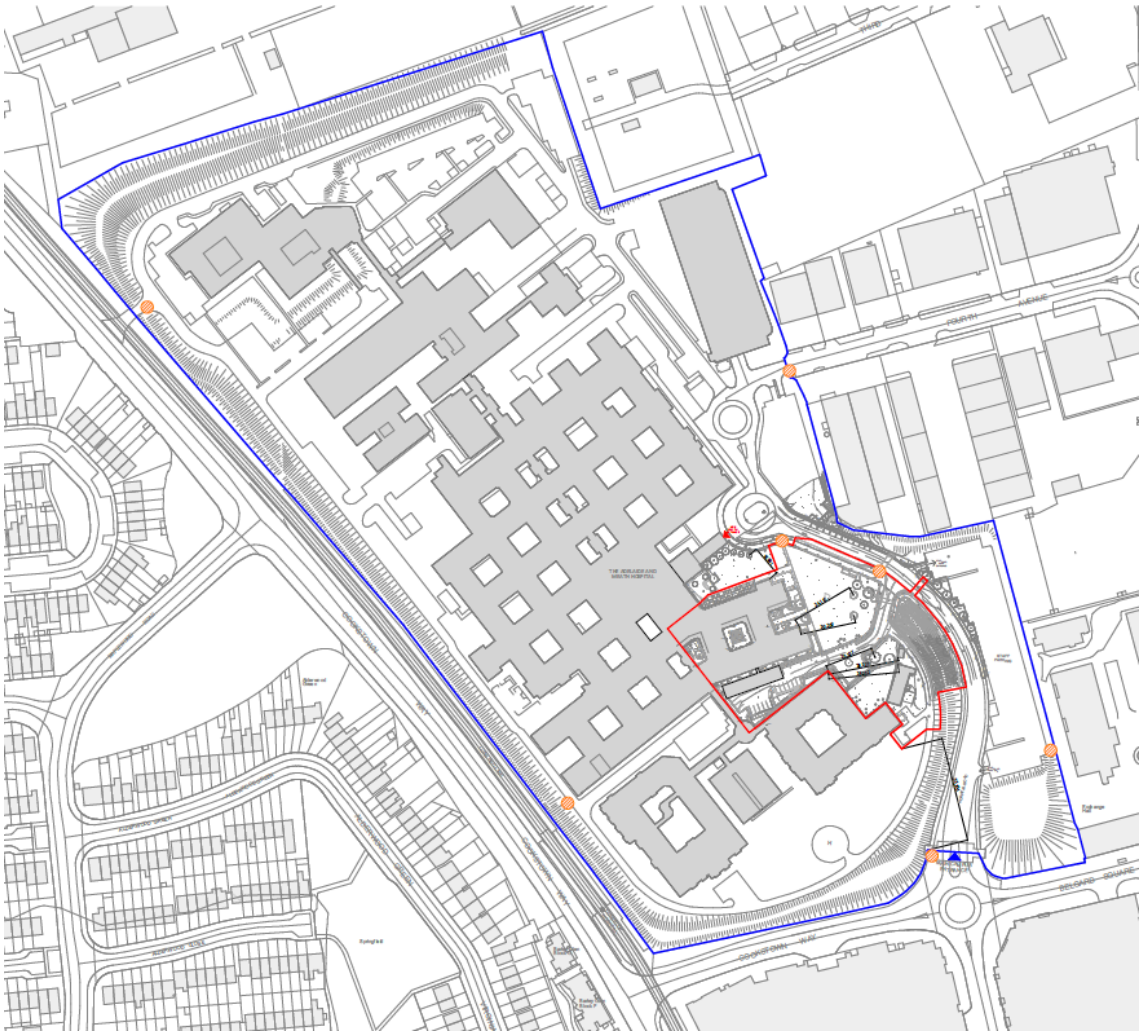
7.2.1 Introduction

The potential impacts and mitigation measures on soils, geology and hydrogeology for the construction and post development activities for the proposed children's hospital satellite centre at Tallaght Hospital are set out in the following sections.

It should be noted that generally a building of this size and nature would not normally require an EIS to be prepared for it. However, as the children's hospital satellite centres are an integral part of the National Paediatric Hospital Project the following information has been provided for completeness. The children's hospital satellite centre will have less than 5% of the floor area of the main development at the St James Hospital campus and is, therefore, of a much smaller scale and complexity. This has resulted in some differences in the methodology and presentation of the children's hospital satellite centre impacts and mitigation measures set out below.

The proposed development is located on the existing Tallaght Hospital campus in Dublin 24 (See figure 7.6 on the following page).

Figure 7.6: Site Location Map



7.2.2 Methodology

The assessment of the potential impact of the activity of soils and geology was carried out according to best practice and the methodology specified in the following guidance documents.

- *Guidelines on the Information to be Contained in Environmental Impact Statements* (Environmental Protection Agency ,2002)
- *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements* (Environmental Protection Agency, 2003);
- *Guidelines for the Preparation of Soils, Geology and hydrogeology Chapters of Environmental Impact Statements* (Institute of Geologists of Ireland 2013);

Data compilation of available information was completed at the initial stages of the project. Information has been compiled from the following sources:

- As built information from earlier developments at the site, provided by the client;
- Relevant data from the Geotechnical Survey of Ireland (GSI);
- A walkover survey of the entire site;
- Findings of a Preliminary Ground Investigation (boreholes, rotary drill holes and trial pits) at the proposed site;

- Site Investigation, National Paediatric Hospital Project, Dublin - Satellite Centres, Ground Investigation Contract, Causeway Geotech Ltd, Ref. 14-973;

- In-situ and laboratory test data.

The GSI Geotechnical Database was consulted to determine the likely overburden, bedrock material and depth to bedrock at the site. Previous investigations were performed at the site and are covered in Report Nos. 716, 4994 and 6940 in the GSI Geotechnical Database.

The preliminary ground investigation for the proposed new children's hospital satellite centre at Tallaght Hospital was carried out by Causeway Geotech Ltd. The investigation was required to determine the soil, bedrock and groundwater conditions at the site. A total of 2 No. boreholes and 2 No. trial pits have been carried out at the proposed site.

An additional phase of Ground Investigation is taking place at the site at present. Its objectives are to obtain additional information at the site, including further assessment of material to be excavated and its constituents, as well as confirmation of the soils profile. This information will inform the construction process and allow the mitigation measures to be more efficiently implemented.

7.2.3 Receiving Environment

This section provides information on existing local and the regional geological environment, with details of available site investigation data including subsoil information and bedrock geology.

Ground conditions, encountered during the preliminary ground investigation at the new children's hospital satellite centre site at Tallaght Hospital can be summarised as follows:

- 0- 0.4m Topsoil;
- 0.4 – 1.2m Firm to stiff sandy gravelly CLAY, generally comprising made ground;
- 1.2 – 4.5m Stiff to very stiff sandy gravelly CLAY;
- 4.5 – 7.0m Gravelly to very gravelly clayey to very clayey SAND;
- 7.0 – 17.5m Stiff to very stiff sandy gravelly CLAY.

The soils distribution across the site is provided on the Teagasc Soils Map. The proposed development is indicated to be underlain by made ground. Dublin Boulder Clay is present beneath these made ground deposits.

Made ground was encountered in HP301 and HP 302, located adjacent to the existing hospital at a recorded depth of 1.2 and 1.6m, where these trial pits terminated. HP302 recorded fragments of concrete and brick present in the fill material placed during construction of the existing Tallaght hospital. For further details please refer to Appendix 7.4.

The two trial pits recorded water strikes in the made ground at depths of 0.91 and 1.0m bgl.

Geological maps from the GSI were reviewed to obtain an overview of the bedrock geology at the site. The GSI Bedrock Geology Map shows that the geology in the wider site area consists of Calp Limestone, described as dark grey argillaceous limestone and cherty limestone and shale. Bedrock was not encountered during the site investigation. The anticipated depth to bedrock at the site is 17.5m.

7.2.4 Characteristics of the Proposed Development

This section provides information on the characteristics of the proposed children's hospital satellite centre at Tallaght Hospital with regard to soil and geology activities. Chapter 2 provides a more detailed description of the proposed development.

The site will be levelled for the proposed development. This will involve removal of topsoil and overburden in some areas. Material will also be excavated for the construction of the proposed foundations. The proposed foundations will be founded on lean mix concrete placed into a suitable bearing stratum. Material will also be excavated to allow for the construction of the new roadways associated with the proposed hospital.

Where feasible, excavated material will be re-used for landscaping purposes.

7.2.5 Potential Impact of the Proposed Development

An analysis of the potential impacts of the proposed children's hospital satellite centre at Tallaght Hospital on the soils and geology environment during the construction and operation is outlined in this section.

7.2.5.1 Construction Phase

The proposed development will involve the excavation of material for foundations, disturbance of topsoil and subsoil to enable the levelling of the site, deliveries of imported engineering fill, crushed stone, concrete, reinforcement and other construction materials.

Excavation and infilling of soil will be required for levelling of the site to render it suitable for construction. It is estimated that approximately 1,000m3 of material will require excavation during construction. It is estimated that a minimal amount of this material is likely to be reusable as

landscape fill and that a substantial quantity of material is likely to require transport to a landfill facility. Should contaminated soil/ water be encountered, it will be required to be removed by a licensed waste contractor. It is estimated that approximately 400 m3 of hardcore material will be imported.

During construction of the development, there is a potential risk of accidental pollution incidences from spillage or leakage of oils from construction machinery. Accidental spillages may result in contamination of soils and groundwater underlying the site should contaminants migrate through the subsoils and impact underlying groundwater. Concrete is highly alkaline and any spillage which migrates though the subsoil would be detrimental to groundwater quality. Please refer to Chapter 8 for hydrology and hydrogeology impacts.

7.2.5.2 Operational Phase

As the proposed development is located at an urbanised site, next to the existing Tallaght Hospital, there is likely to be negligible impacts during the operational phase of the proposed children's hospital satellite centre at Tallaght Hospital.

7.2.5.3 'Do Nothing' Scenario

If the proposed development does not proceed, the site will remain as a landscaped area with the existing Tallaght Hospital structures located nearby.

7.2.6 Ameliorative, Remedial or Reductive Measures

The design of the children's hospital satellite centre and Tallaght Hospital has taken account of the potential impacts of the development on the soils and geological environment local to the area where construction will take place. Measures have been incorporated in the design to mitigate the potential effects on the surrounding soils and geology. These measures seek to avoid or minimise potential effects through the implementation of best practice construction methods.

7.2.6.1 Construction Phase

Construction works will require removal of soil at foundation locations and where levelling of the site is required it is estimated that a minimal amount of this material is likely to be reusable as landscape fill. This is because only minimal landscape areas have been identified, where excavated material could be placed.

All excavated materials will be assessed for signs of possible contamination such as staining or strong odours. Should any unusual staining or odour be noticed, samples of this soil will be analysed for the presence of possible contaminants in order to ensure that historical pollution of the soil has not occurred at the proposed children's hospital satellite centre site at Tallaght Hospital. Should it be determined that any of the soil excavated is contaminated, this will be managed according to best practice and disposed of accordingly by a licensed waste disposal contractor. It should be noted that the ground investigation previously carried out has not identified an contaminants in the existing soils. The current phase of ground investigation aims to identify any further contamination at the site in areas not originally tested and this will further inform the construction process and allow the appropriate mitigation measures to be implemented more efficiently.

Potentially contaminated groundwater and polluted surface water generated during construction activities will not be discharged directly to ground or surface drainage.

To reduce any impact on the underlying subsurface strata from material spillages, all oils, solvents and paints used during construction will be stored within temporary storage areas. Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles, will take place in a designated area (or where possible off the site) which will be away from nearby surface water drains.

7.2.6.2 Operational Phase

There will be no impacts on the surrounding soils and geology during the operational phase of the development.

7.2.6.3 'Do Nothing' Scenario

There will be no impacts on the surrounding soils and geology if the development does not proceed.

7.2.7 Predicted Impact of Proposed Development

This section describes the predicted impact of the proposed development following the implementation of the mitigation measures.

7.2.7.1 Construction Phase

There are no predicted significant impacts arising from the proposed construction of the new satellite centre at Tallaght Hospital. The remedial measures indicated in Section 7.2.6.1 above, will ensure that the soils and geology environment is not adversely impacted during construction operations. We would note that a similar table to table 7.6 above has not been presented here due to the much smaller scale of the satellite centre.

7.2.7.2 Operational Phase

There are no predicted significant impacts arising from the proposed operation of the new satellite centre at Tallaght Hospital.

7.2.7.3 'Do Nothing' Phase

There are no predicted impacts arising if the construction of the new satellite centre at Tallaght Hospital does not proceed.

7.2.8 Monitoring

Monitoring during construction will consist of the following:

- Normal quality control inspection of the works during excavation of materials down to acceptable bearing stratum;
- Adherence to the outline Construction Management Plan;
- All excavations will be visually assessed for signs of possible contamination such as staining or strong odours;
- Review of any water encountered during excavation.

7.2.9 Reinstatement

Any temporary construction compounds will be completely removed from the site following the end of the construction phase. Reinstatement at completion of the works will involve restoring areas to their original condition, where practical, leaving the area in an acceptable and clean condition, removing all deleterious materials that may have been deposited during construction works.

7.3 Connolly Hospital

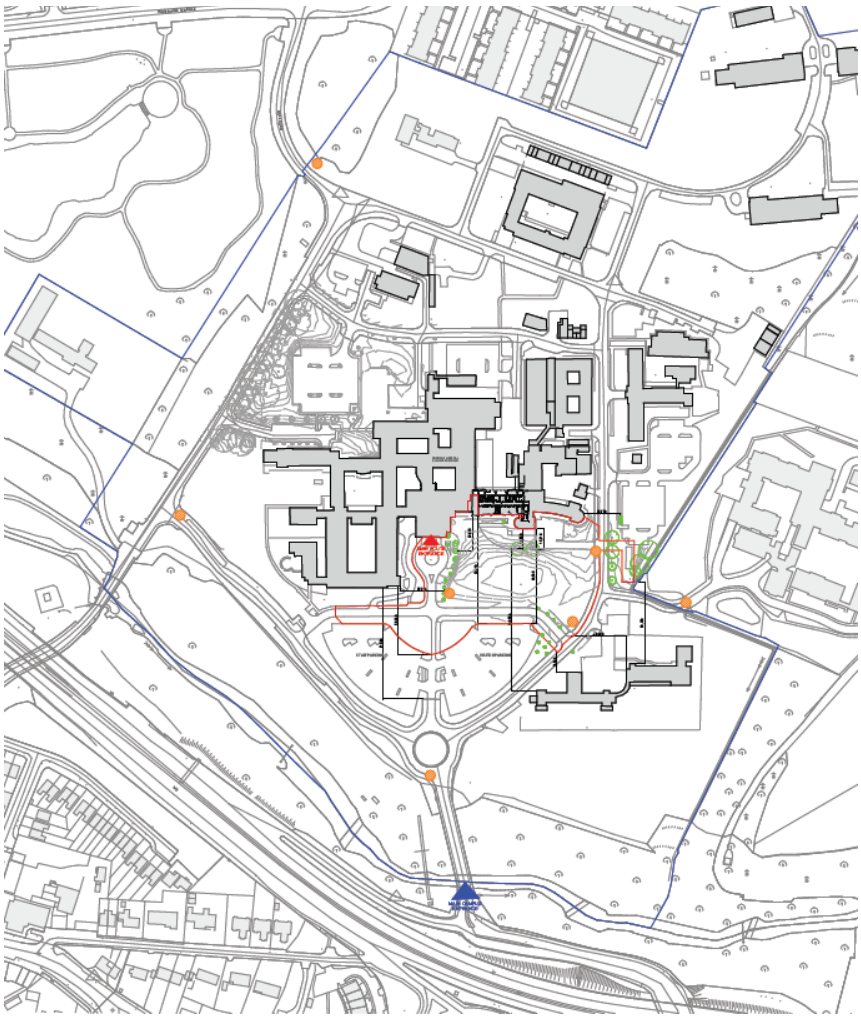
7.3.1 Introduction

The potential impacts and mitigation measures on soils, geology and hydrogeology for the construction and post development activities for the proposed new children's hospital satellite centre at Connolly Hospital are set out in the following sections.

It should be noted that generally a building of this size and nature would not normally require an EIS to be prepared for it. However, as the children's hospital satellite centres are an integral part of the National Paediatric Hospital Project the following information has been provided for completeness. The children's hospital satellite centre will have less than 5% of the floor area of the main development at the St James Hospital campus and is, therefore, of a much smaller scale and complexity. This has resulted in some differences in the methodology and presentation of the children's hospital satellite centre impacts and mitigation measures set out below.

The proposed development is located on the existing Connolly Hospital campus in Dublin 15 (See figure 7.7 below).

Figure 7.7: Site Location Map



7.3.2 Methodology

The assessment of the potential impact of the activity of soils and geology was carried out according to best practice and the methodology specified in the following guidance documents.

- *Guidelines on the Information to be Contained in Environmental Impact Statements* (Environmental Protection Agency ,2002)
- *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements* (Environmental Protection Agency, 2003);
- *Guidelines for the Preparation of Soils, Geology and hydrogeology Chapters of Environmental Impact Statements* (Institute of Geologists of Ireland 2013);

Data compilation of available information was completed at the initial stages of the project. Information has been compiled from the following sources:

- As built information from earlier developments at the site, provided by the client;
- Relevant data from the Geotechnical Survey of Ireland (GSI);
- A walkover survey of the entire site;
- Site Investigation, National Paediatric Hospital Project - Satellite Centres, Ground Investigation Contract, Causeway Geotech Ltd, Ref. 14-973;
- Findings of a Preliminary Ground Investigation (boreholes, rotary drill holes and trial pits) at the proposed site;
- In-situ and laboratory test data.

The GSI Geotechnical Database was consulted to determine the likely overburden, bedrock material and depth to bedrock at the site. Previous investigations were performed at the site and are covered in Report Nos. 532 and 4534 in the GSI Geotechnical Database.

The Preliminary Ground Investigation for the proposed development was designed by Roughan & O'Donovan and carried out by Causeway Geotech Ltd. The investigation was required to determine the soil, bedrock and groundwater conditions at the proposed new children's hospital satellite centre at Connolly Hospital. A total of 2 No. boreholes and 2 No. trial pits have been carried out at the proposed new children's hospital satellite centre at Connolly Hospital.

An additional phase of ground investigation is taking place at the site at present. Its objectives are to obtain additional information at the site, including further assessment of material to be excavated and its constituents, as well as confirmation of the soils profile to ensure a lean design process.

7.3.3 Receiving Environment

This section provides information on existing local and the regional geological environment, with details of available site investigation data including subsoil information and bedrock geology.

Ground conditions at the site, encountered during the preliminary ground investigation can be summarised as follows:

- 0- 0.2m Topsoil;
- 0.2 – 2.0m Made Ground / Firm to very stiff sandy gravelly CLAY;
- 2.0 – 10.0m Limestone bedrock.

The soils distribution across the site is provided on the Teagasc Soils Map. The proposed development is indicated to be underlain by glacial till derived from limestone and fluvioglacial sands and gravels with rock outcrop also present also at the surface.

Geological maps from the GSI were reviewed to obtain an overview of the bedrock geology at the site. The GSI Bedrock Geology Map shows that the geology in the wider site area consists of Calp Limestone, described as dark grey argillaceous limestone and cherty limestone and shale. Limestone bedrock was encountered at the site between 1m and 3m bgl. For further details please refer to Appendix 7.4.

7.3.4 Characteristics of the Proposed Development

This section provides information on the characteristics of the proposed development with regard to soil and geology activities. Chapter 2 provides a more general description of the proposed development.

At the proposed new children's hospital satellite centre at Connolly Hospital, ground levels slope gradually downwards from north to south across the abovementioned site. It is proposed that excavated material from the north of the proposed new children's hospital satellite centre site at Connolly Hospital will be reused at the southern section of the site to provide a level surface for the proposed construction. Material will also be excavated for the construction of the proposed foundations. The proposed foundations will be founded on lean mix concrete placed into a suitable bearing stratum. Material will also be excavated to allow for the construction of the new roadways associated with the proposed building.

Where feasible, excavated material will be re-used for landscaping purposes.

7.3.5 Potential Impact of the Proposed Development

An analysis of the potential impacts of the proposed new children's hospital satellite centre at Connolly Hospital on the soils and geology environment during the construction and operation is outlined in this section.

7.3.5.1 Construction Phase

The proposed development will involve the excavation of material for foundations, disturbance of topsoil and subsoil to enable the levelling of the site, deliveries of imported engineering fill, crushed stone, concrete, reinforcement and other construction materials.

Excavation and infilling of soil will be required for levelling of the site to render it suitable for construction. It is estimated that approximately 4,000m3 of material will require excavation during construction. It is estimated that a minimal amount of this material is likely to be reusable as landscape fill and that a substantial quantity of material is likely to require transport to a landfill facility. Should contaminated soil/ water be encountered, it will be required to be removed by a licensed waste contractor. It is estimated that approximately 7,000 m3 of fill material will be imported.

During construction of the development, there is a potential risk of accidental pollution incidences from spillage or leakage of oils from construction machinery. Accidental spillages may result in contamination of soils and groundwater underlying the site should contaminants migrate through the subsoils and impact underlying groundwater. Concrete is highly alkaline and any spillage which migrates though the subsoil would be detrimental to groundwater quality. Please refer to Chapter 8 for further details.

7.3.5.2 Operational Phase

As the proposed development is located at an urbanised site, next to the existing Connolly Hospital, there is likely to be negligible impacts on the surrounding area during the operational phase.

7.3.5.3 'Do Nothing' Scenario

If the proposed development does not proceed, the site will remain as a landscape area with the existing Connolly Hospital structures located nearby.

7.3.6 Ameliorative, Remedial or Reductive Measures

The design of the proposed new children's hospital satellite centre at Connolly Hospital has taken account of the potential impacts of the development on the soils and geology environment local to the area where construction will take place. Measures have been incorporated in the design to mitigate the potential effects on the surrounding soils and geology. These measures seek to avoid or minimise potential effects through the implementation of best practice construction methods.

7.3.6.1 Construction Phase

Construction works will require removal of soil at foundation locations and where levelling of the site is required. It is estimated that a minimal amount of this material is likely to be reusable as landscape fill. This is because only minimal landscape areas have been identified, where excavated material could be placed.

All excavated materials will be assessed for signs of possible contamination such as staining or strong odours. Should any unusual staining or odour be noticed, samples of this soil will be analysed for the presence of possible contaminants in order to ensure that historical pollution of the soil has not occurred at the proposed new children's hospital satellite centre at Connolly Hospital. Should it be determined that any of the soil excavated is contaminated, this will be managed according to best practice and disposed of accordingly by a licensed waste disposal contractor.

To reduce any impact on the underlying subsurface strata from material spillages, all oils, solvents and paints used during construction will be stored within temporary storage areas. Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles, will take place in a designated area (or where possible off the site) which will be away from nearby surface water drains.

7.3.6.2 Operational Phase

As there will be no impact on soils and geology in the operational phase of the development, no measures are proposed.

7.3.6.3 'Do Nothing' Scenario

As there will be no impact on soils and geology if the development does not proceed, no measures are proposed.

7.3.7 Predicted Impact of Proposed Development

This section describes the predicted impact of the proposed new children's hospital satellite centre at Connolly Hospital development following the implementation of the mitigation measures.

7.3.7.1 Construction Phase

There are no predicted significant soils and geology impacts arising from the proposed construction of the new children's hospital satellite centre at Connolly Hospital. The remedial measures indicated in Section 7.3.6.1 above, will ensure that the soils and geology e.g. environment is not adversely impacted during construction operations.

7.3.7.2 Operational Phase

There are no predicted significant impacts for soils and geology arising from the proposed operation of the new children's hospital satellite centre at Connolly Hospital.

7.3.7.3 'Do Nothing' Scenario

If the proposed development does not proceed, the site will remain as a landscape area with the existing Connolly Hospital structures located nearby.

7.3.8 Monitoring

Monitoring during construction will consist of the following:

- Normal quality control inspection of the works during excavation of materials down to acceptable bearing stratum;
- Adherence to the outline Construction Management Plan;
- All excavations will be visually assessed for signs of possible contamination such as staining or strong odours;
- Review of any water encountered during excavation.

7.3.9 Reinstatement

Any temporary construction compounds will be completely removed from the site following the end of the construction phase. Reinstatement at completion of the works will involve restoring areas to their original condition, where practical, leaving the area in an acceptable and clean condition, removing all deleterious materials that may have been deposited during construction works.