CIVIL & STRUCTURAL ENGINEERING (Paul Healy)

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IN THE MATTER OF AN APPLICATION TO
AN BORD PLEANÁLA
FOR PERMISSION FOR
STRATEGIC INFRASTRUCTURE DEVELOPMENT
(THE CHILDREN'S HOSPITAL OF IRELAND)

ABP Reg. No. PL29N.PA0024

AND IN THE MATTER OF AN ORAL HEARING

Statement of Evidence of Paul Healy, O'Connor Sutton Cronin Consulting Engineers

On the Topic of Civil & Structural Engineering

1. Qualifications and Experience

1.1 I am Paul Healy, BSc(Eng), Dip.Struct.Eng, CEng., F.I.E.I., F.I.Struct.E., R.Cons.EI, Director of O'Connor Sutton Cronin (OCSC) and Project Director for this project.

1.2 My professional qualifications include :

- Honours Degree BSc(Eng), College of Technology, Bolton Street – 1985;
- Chartered Engineer, Engineering Council UK – 1991;
- Member of Association of Consulting Engineers of Ireland. – 2002;
- Fellow of the Institution of Structural Engineers – 2007;
- Fellow of the Institution of Engineers of Ireland – 2007;
- FETAC Certificate in Safety, Health & Welfare at Work – 2007.

1.3 I have over 25 years experience in structural engineering and have been responsible for the successful delivery of a wide range of structural projects in Ireland and abroad. These include hospitals, university buildings, schools, public assembly buildings, Airport Terminal Building and bridges.

1.4 I have been involved in the Structural Design of many large and complex buildings both here in Dublin and also on an international scale. I was Project Review Director for the Convention Centre along Dublin's North Quay which at its highest point is almost 50m tall, together with Lead Design Director for the proposed 35 storey hotel at the rear of the Convention Centre. I was involved on a joint venture basis with a Canadian Consulting Engineer Practice for the design of residential tower buildings in Abu Dhabi which included blocks ranging in height from 40 – 60 storeys. I was also involved in the Peer Review of a 40 storey office development in Canary Wharf, London.

1.5 Regarding specific hospital experience and building within "live" and operational hospitals, I was Structural Director for the new Connolly Hospital at Blanchardstown, numerous developments in Our Lady of Lourdes, Drogheda, and projects in Beaumont Hospital and Our Lady's Children's Hospital, Crumlin.

I have been involved with the Mater Campus since early 2000 when we were appointed under the former Children's Hospital Project. In addition to preparation of Tender documents for the Childrens Hospital, this project also involved the completion of the hostel building sandwiched between the historic buildings (No's. 30 – 38 and old Mater classical building) along Eccles Street together with a centre for Nurse education at the corner of Eccles St and Nelson St.

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2. Role in Proposed Development

I am the Project Director for OCSC responsible for the following Civil & Structural areas of the project, and the preparation of the corresponding sections of the Environmental Impact Statement (EIS):

- Civil / Structural Design of Building;
- Soils, Geology and Hydrogeology;
- Material Assets - Water, Drainage;
- Outline Construction Strategy.

Relevant chapters and sections of the EIS have been prepared by my colleagues Paul Tierney (Soils, Geology and Hydrogeology), Robert Fitzmaurice (Material Assets - Water and Drainage) and David Rehill (Outline Construction Strategy), all O'Connor Sutton Cronin staff, who are accompanying me here during the Oral Hearing.

I have prepared this Statement of Evidence in conjunction with Paul, Robert and David however, Madam Inspector, in order to comply with your earlier direction not to repeat information already submitted under the EIS, I propose to deliver today a summary of the main findings on each of the following topics together with a response to submissions made on these matters:

- Structural Design of the Building;
- Soils, Geology and Hydrogeology;
- Material Assets – Water and Drainage.

In addition and for the record, I attach full details of our complete statements in the following Appendices to this statement:

- Appendix 1 – Structural Design by myself, Paul Healy;
- Appendix 2 – Soils, Geology and Hydrogeology by Paul Tierney;
- Appendix 3 – Material Assets – Water and Drainage by Robert Fitzmaurice.

My colleague David Rehill will separately deliver his statement of evidence on Construction Strategy.

3. Characteristics of the Proposed Development – Structural Design

3.1 INTRODUCTION

The proposed building development, location, form, layout and occupancy has been previously described in detail by the Architectural witnesses. All structural designs, materials and workmanship shall comply with the relevant Eurocodes (I.S. EN Ref's), EU Standards Codes of Practice or equivalent Irish Standards or Codes of Practice.

3.2 SUPER-STRUCTURE DESIGN

The building superstructure is broadly considered as those elements extending above general ground level and in this building is considered to include levels L0 to L16 with a general building height of approximately 68.6m above Eccles Street entrance level. There is also a small area enclosing the service cores (on the north) which extends to approximately 73.6m (relative to Eccles Street).

A number of submissions raised the issue of the height of the building and its consideration as a tall building. Whilst this building, in a planning policy context and from a visual impact perspective, may be considered to be a tall or high building, in the context of Structural Engineering design, this building is not considered or categorised as a tall building. Structural design of tall buildings is more importantly characterised where the height to width slenderness ratio is high and the dominant design is highly influenced and dictated by lateral or horizontal design considerations rather than just vertical load effects. This hospital building does not fall into this category for structural design.

Floor to floor heights within the hospital superstructure typically vary between 3.8m and 4.5m depending on occupancy and need to tie in with other Adult Hospital facilities (particularly L-1, L0, L1 and L3).

The building structural grid has to respond to many competing demands and layouts at the various levels. Following a number of studies to ascertain the optimum approach, a primary structural grid of 7.8m x 7.8m was chosen. This grid allows for an efficient structural solution and can easily be accommodated by way of many structural forms including in-situ concrete frame, steel frame, composite construction and or a hybrid insitu/pre-cast concrete solution.

Based on assessment criteria as set out under 3.4.1 of my Statement in Appendix 1, the chosen structural solution to move forward with for this building is an in-situ concrete frame of reinforced concrete columns and flat slab. The flat slab floor plate solution is very versatile, works well for highly serviced buildings and can accommodate flexible layouts. Above this (Wards levels), the building grid changes to suit the individual ward room layouts and the architectural profile of the elevations.

A 3D computer Finite Element (FE) model using specialist structural design software was developed for the entire building from roof to foundation, incorporating all structural elements and proposed material properties. The 3D structural model provided us with accurate design data on vibration and dynamic performance of the building. Designed "strong points" in the form of shear core stability walls, lift / stair cores etc. strategically positioned within the building were modelled and represented to resist the applied loads. Overall, lateral behaviour and stability of the building was confirmed and found acceptable using this 3D analysis.

The structural solution is sufficiently flexible and adaptable to accommodate and keep in line with changes in hospital operational policies. The chosen structural solution has been subject to continuous testing throughout the Exemplar Design Stage, and will continue up to tender stage based on the criteria and building demands set out above, the need to future proof and provision of "soft zones" for changes in service provision and advances in clinical needs.

3.3 SUB-STRUCTURE DESIGN

The building sub-structure generally comprises those elements below ground level including foundations and those supporting the super-structure. For this building the sub-structure elements are considered to comprise the 4 levels of basement including levels L-4 to underside L0. Existing ground levels vary across the site falling generally from South West to North East. The levels on North Circular Road (NCR) are approximately 1 No. storey lower than Eccles Street. The depth of basement therefore varies relative to the existing levels but is typically 14m below the level of the existing surface car park and increasing to approximately 18m at its deepest, local to the Metro North access box area.

3.3.1 Ground Conditions

A detailed review of the ground conditions is set out under the Soils, Geology and Hydrogeology Statement contained under Section 4 to follow and Appendix 2 of this Statement.

3.3.2 Excavation and Perimeter Cut-Off Wall

The basement construction will involve the installation of a perimeter "Cut-Off" wall to the entire footprint, comprising a series of augur bored vertical interlocking piles extending down and penetrating into the impermeable very stiff glacial till (black boulder clay) to achieve a sufficient seal. For the purposes of referencing and describing this further, I will refer to this wall as a Secant Pile Wall which is the more commonly used Engineering term. The pile diameter, spacing and depth will vary around the site to suit particular prevailing conditions, boundary constraints and is envisaged between 900 to 1200mm diameter, extending down to a toe level of approximately -7.5m OD at its deepest ie, approximately 2.5m above the bedrock levels (-10m OD).

A series of 2D finite element (FE) ground analysis models were developed and analysed at critical sections around the basement perimeter including at the Mater Private Hospital (MPH), Eccles Street / Historic Listed Buildings and at the Mater Adult Hospital to the north of the proposed basement. The result from the FE analysis models concludes that in general the predicted movements are within acceptable limits, generally within *negligible / very slight* risk of the occurrence of building damage.

As the excavation proceeds and in order to prop and provide restraint to the secant wall, a series of temporary horizontal ground anchors or ties will be installed at varying levels and spacing. These temporary ground anchors are designed as pre-stressed and can be de-stressed if required as the permanent structural basement works advances and replaces the need to provide temporary lateral support. Such situations where they are envisaged to be de-stressed are in the vicinity of the running tunnels for the proposed Metro North.

The construction of the basement will require the excavation and disposal off-site of approximately 269,000m^3 of soils. No rock excavation is envisaged.

The construction of a 'water tight' secant pile box around the proposed basement will assist with the control of water infiltration and thus ensure minimum seepage entering the excavation. This is a tried and trusted practice both at a national and international level and has been successfully carried out many times within the boulder clays of Dublin. During construction, a monitoring regime will be put in place to allow the Contractor to take the necessary steps to ensure that should any water enter the dig, the differential groundwater level does not exceed approximately 1m (which is considered in line with seasonal variations).

3.3.3 Foundations and Basement Design

The prevailing ground conditions allow the use of a traditional foundation solution including a raft type stiff plate foundation to spread the applied and imposed loads. This stiff 1.0m thick concrete plate spreads the loads to a more even distribution across the footprint and limits the effects of differential settlement.

The four storey underground fully water tight concrete basement accommodates car-parking over the four levels for patients, public and staff for the use of the Children's Hospital of Ireland. On the eastern side of the basement, the design includes for the integration of an entrance to the proposed Metro North Mater stop directly off Eccles Street. The design and integration of this area has been fully developed in conjunction with the RPA and includes for access from Eccles Street down to the Metro Platform levels.

3.3.4 Car Park Access and Layout

The proposed carpark is laid out over four underground levels with the primary access/egress off Eccles Street and a second access/egress off the North Circular Road. It is intended that the car park for the Children's Hospital of Ireland will link in with and integrate with the already approved and currently under construction car park for the Mater Adult Hospital.

The total number of spaces included under the CHoI is 972. The structural grid and column spacing has been carefully set out at 7.8m in the east/west direction to allow 3 No. car park spaces per bay.

3.4 SUBMISSIONS & RESPONSES

The following persons / organisations made submissions or responded to the Board in relation to the Civil/Structural Engineering issues :

- *Mater Private Hospital (MPH)*

3.4.1 Issue:

MPH comments on elements of O'Connor Sutton Cronin Report relating to Mater Private Hospital (Volume 1).

MPH note that they do not accept the settlement mitigation measures proposed in Section 9 of OCSC report relating to Linear Accelerators and the assessment of MPH's construction joints in Appendix H.

Response:
We wish to advise the Board that we have had very recent discussions with MPH on these issues. With regard to the Linear Accelerations we have agreed monitoring positions and details as a precautionary measure. Based on our Assessment Report it is anticipated that the CHoI works will have no impact on the Linacs Bunkers. Similarly, regarding the issue of Joint C, we are in discussion with MPH and their representatives and have agreed monitoring proposals and pre-construction mitigation measures in this area.

4. Soils, Geology & Hydrogeology

4.1 INTRODUCTION

The full details of the Soils, Geology & Hydrogeology Statement are contained within Appendix 2 as attached. The following are the main issues that have been addressed in Chapter 7- Soils, Geology and Hydrogeology of the EIS:

- The excavation to allow for the installation of the four storey basement car park and its potential effect on the soils, geology and hydrogeological environments.

4.2 DESCRIPTION OF EXISTING ENVIRONMENT

- Historical Ordnance Survey of Ireland maps dating from 1847 to 1991 indicate that no significant sources of contamination were present on-site;
- Site investigations indicate that the stratigraphy's underlying the site consist of made ground, brown gravelly clay, grey black very gravely clay and sand with gravels (colloquially known as *Dublin Boulder Clays*);
- Bedrock was encountered c. 27m below ground level (bgl); and
- Site investigations indicate the presence of 2 No. distinct probable water bearing horizons. The first horizon is a gravel layer from 7 to 17m bgl (10-0mOD) that is both over and underlain by low permeable clays and the second horizon is the bedrock.

4.3 POTENTIAL IMPACTS ARISING FROM PROPOSED DEVELOPMENT

4.3.1 Construction Phase Potential Impacts

- Approximately 269,000m^3 of soil will be excavated and disposed of off-site to facilitate the installation of the basement. A soil classification report was prepared and in consultation with a number of landfills concluded, that the vast majority of the excavated material will be disposed of at inert landfill facilities. The remaining material, approximately 1250m^3 of soil (0.5% of the total volume to be excavated) may be disposed of at a non-hazardous landfill. Notwithstanding this, the site will be continuously monitored during the excavation process with further confirmatory analysis undertaken at the landfills; and
- It is not anticipated that there will be any significant potential impacts regarding the bedrock geology or hydrogeology environments;

4.3.2 Operational Phase Potential Impacts

- There will not be any significant impacts regarding the soils, geology or hydrogeology environments during the operational phase.
- No permanent ground water lowering regime is proposed for this development as the basement is designed as a water tight structure.
- 3D ground water flow model extending to a $9km^2$ study area was level oped and reported on under the Byrne Looby Hydrogeological Report contained within Appendix 7h, Vol 3 of the EIS. This report concluded that the ground water flow will remain unchanged and a potential 1m draw down in water levels within a 100m radius upstream of the development (ie, western side). There is no predicted change in water levels on the downstream (eastern) side. The 1m potential reduction in ground water level is within the seasonal variations experienced at the Mater.

4.4 MITIGATION MEASURES PROPOSED

- A construction management strategy has been prepared that addresses issues such as the storage of fuels etc.;
- Wheel wash facilities will be used to prevent mud being tracked onto the adjoining roads; and
- A "Dust Boss" system will be adopted to suppress any air borne dust.

4.5 SUBMISSIONS AND RESPONSES

No issues were raised or submitted in relation to soils, geology and hydrogeology.

5. Material Assets – Water and Drainage

5.1 INTRODUCTION

The full details of the Material Assets – Water and Drainage Statement are contained within Appendix 3 of this Statement.

Chapter 12 of the EIS sets out the proposed drainage and potable water network for the development and establishes the potential impacts and mitigation measures for the Children's Hospital of Ireland at the Mater Hospital Campus.

5.2 DESCRIPTION OF EXISTING ENVIRONMENT

5.2.1 Potable Water Supply

In order to address water supply in the area, a new 250mm diameter watermain from Dorset Street to supply the Mater Campus was recently constructed by Dublin City Council which is sufficient to provide potable water to the proposed development. A secondary source of potable water will be supplied from the existing 450mm watermain on the North Circular Road.

5.2.2 Foul Drainage Network (Combined)

The proposed site is currently served by an existing 600mm – 900mm diameter combined sewer on North Circular Road, and an ovaloid brick combined sewer varying between 900mm x 630mm and 2100mm to 930mm on Eccles Street. In addition there is an existing 300mm combined sewer crossing the site and outfalling to the existing network on Leo Street via Eccles Place to the east of the proposed development.

5.2.3 Storm Drainage Network

This area of the city is drained using the combined network and hence, there is currently no dedicated surface water line serving the development along North Circular Road or Eccles Street. All surface water runoff currently outfalls to the existing combined networks described in *Section 3.2.2. of the EIS.*

The existing hard surface car parking area of the lands subject to the planning application currently drains by gravity and outfalls with no attenuation measures in place.

5.3 POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

A list of potential impacts and proposed mitigation measures to existing water and drainage networks for both the construction and operational phases of the development have been assessed within Chapter 12 of the EIS and are set out under Sections 3.3 and 3.4 of the attached Statement contained in Appendix 3.

In summary and following the implementation of the proposed mitigation measures, there will be no significant impacts on the water and drainage networks in the Mater Campus area. In fact, during the operational phase and with the incorporation of SUDS and attenuation measures, it is predicted that the proposals will lead to a reduction in run-off during periods of high intensity rainfall.

5.4 SUBMISSIONS AND RESPONSES

5.4.1 The following persons / organisations made a submission to the Board in relation to the issue of drainage:

- Dublin City Council (DCC);
- Sinn Féin, Tallaght;
- Berkeley Environmental Awareness Group;
- Pascal Donohoe, TD.

5.4.2 Issue:

Under Item 15.0 "Planning Authority View on Conditions" of the DCC submission, we note a number of water and drainage related conditions:

Condition 15.1 Water Conditions
Response:
We wish to advise the Board that we are happy to accept the proposed Conditions as set out by DCC on this matter.

Condition 15.2 Drainage Conditions
Response:
We wish to advise the Board that we are happy to accept the proposed conditions as set out by DCC on this matter. We also further note and have been advised by DCC that the projected completion date for the Ringsend Waste Water Treatment Plant is 2015.

5.4.3 Issue:

Sustainable Urban Drainage System (SUDS). A number of submissions and respondents raised issues relating to water supply and SUDS.

Response:
In accordance with best practice and in keeping with the principles of Sustainable Urban Drainage System for this development, the proposed storm water system will incorporate a tiered approach to storm water management. The use of green roof technology and water re-use systems have been incorporated where appropriate to allow the rainwater generated from the site to be incorporated into a water management / site maintenance arrangements for use in such areas as landscape gardens, irrigation, wash down areas etc.

5.4.4 Issue:

Discharge of the foul sewage into combined sewer on North Circular Road.

The Sinn Fein submission notes as follows:
"One of the most disturbing aspects of the EIS is the acceptance of the report that the discharge of the foul sewage from the development into a combined sewer on North Circular Road. This is a practise that is inconsistent with proper management of the drainage from the site……"

Response:
We wish to advise the Board that this submission is totally incorrect. In fact discharge of foul sewage to the combined sewer system is indeed the usual and most appropriate system to discharge into in this area. We would additionally add that as noted in our statement above, under the operational phase of this development, the combined sewer in North Circular Road will be relieved of flow during periods of otherwise peak flows.

5.4.5 Issue:

Part of the development levy is ring-fenced and used for the upgrade of the local drainage network.

This issue was raised by Berkeley Environment Awareness Group and Pascal Donohoe, TD.

Response:
We wish to advise the Board that this is a matter for Dublin City Council and outside the control of the Applicant.

5.5 CONCLUSION

It is proposed to connect into the recently up graded public potable water supply network adjacent to the site. This current water supply network has sufficient capacity to adequately supply the proposed development.

In order to maintain a sustainable water supply system, the proposed scheme is to be fitted with water saving and reuse devices to reduce, as much as is practical, the quantity of water consumed.

The proposed foul system will connect into the adjacent public combined network. The proposed use of combined water saving devices will reduce the volume of effluent generated by the proposed development. The public drainage network has the capacity to adequately carry the proposed effluent volumes.

In accordance with best practice and in keeping with the principles of sustainable development, the proposed storm water system will incorporate a tiered approach to storm water management. The use of green roof technology and water reuse systems will allow the rainwater generated by the site to be incorporated into a water management/site maintenance arrangement. Furthermore, by installing a stormwater attenuation tank, extreme storm volumes experienced during intense storms will be controlled on site and allowed to enter the public system at a reduced discharge rate, thus reducing potential surcharging on the public drainage network during critical storm periods.

6. Potential Impacts Arising from the Proposed Development

I have identified and include here a high level overview and summary of the likely significant impacts resulting from the Civil / Structural Engineering aspects of the proposals. However, a more detailed assessment has been carried out in the individual chapters and Witness Statements contained with Appendices 1, 2 and 3.

6.1 CONSTRUCTION PHASE

The majority of the civil / structural engineering construction phase impacts occur as a result of the basement and sub-structure works and can broadly be considered to arise due to the following activities:

- Installation of piling for perimeter cut-off wall;
- Installation of horizontal ground anchors;
- Excavation of soil for disposal off-site;
- Traffic and traffic movements associated with the excavation;
- Control of ground water due to the excavation of soil;
- Possible settlement of existing surrounding buildings;
- Installation of anti-floatation anchors;
- Concrete works associated with concrete pours to the foundations and concrete sub-structure frame;
- Drainage related matters.

In addition, the construction of the superstructure can equally cause similar impacts associated with the concrete works, façade and fitout.

A number of potential impacts arise as a result of these activities and include inter alia:

- Noise and vibration impacts;
- Risk of possible settlement and movement impacts to surrounding buildings and services;
- Possible impacts on hydrogeology;
- Air quality and dust impacts;
- Human beings impacts;
- Traffic related impacts;
- Material assets water and drainage impacts.

The respective chapters, appended reports and statements carries out a detailed assessment for each of the potential impacts in turn and identifies as and where appropriate, mitigation measures are required to achieve compliance.

6.2 OPERATIONAL PHASE

It is not anticipated that there will be any significant impact with respect to the operational phase of the development regarding the soils, geology and hydrogeological environments.
Regarding material assets water and drainage related, the operational phase of the development shall have a positive effect on the existing drainage network in the immediate area since the applicant site is currently un-attenuated and shall reduce the potential for surcharging and flooding in the downstream catchment.

7. Mitigation Measures Proposed

7.1 CONSTRUCTION PHASE – MITIGATION MEASURES

The significant Civil / Structural Engineering mitigation measures proposed to reduce potential impacts to within acceptable criteria include :

- Mitigation at source;
- Monitoring;
- Procedural / Organisation of the works;
- Programming / Phasing of Works.

Mitigation at source includes such techniques as lowering power output, low noise / vibration equipment, specific controls on equipment (ie, pile rotary equipment), screens / barriers, enclosures and regular maintenance of equipment to maintain in good working order.

Regarding monitoring, it is proposed that a suitably qualified Independent Specialist Monitoring Consultant shall be appointed to carry out and report on monitoring outputs during the course of the CHoI works at agreed intervals and for a sufficient period of time following completion of the relevant parts of the works. A detailed schedule of monitoring will be set-up and carried out to all potentially affected areas with closer scrutiny and rigorous regime to those areas predicted to be in the slight risk of occurrence of building damage and areas where sensitive equipment and procedures are carried out. It is intended that a Community Liaison Committee will be established prior to the commencement of the development. Details of this will be set-out later in evidence under the Community Gain.

The procedural and organisation mitigation will set-out the intended approach to the works for critical activities such as commencing sufficiently far away from sensitive receptors and working in a progressive manner towards these receptors in conjunction with the results of the monitoring.

The programming and phasing mitigation includes the potential to carry out elements of the works when sensitive activities or equipment at the receptors are not in use. This may include out of normal hours working and we would refer you further to the *Outline Construction Strategy* for proposals in this regard.

The above proposed mitigation measures are set-out in the relevant EIS chapters and appendix reports.

7.2 OPERATIONAL PHASE – MITIGATION MEASURES

There are no operational phase mitigation measures envisaged relating to Civil / Structural Engineering matters.

8. Predicted Residual Impacts (ie, Post Mitigation)

8.1 CONSTRUCTION PHASE – RESIDUAL IMPACTS

In order to monitor the effectiveness of the implementation of the mitigation measures proposed in the EIS, it is proposed to carry out the following confirmatory monitoring, which may include:

- Carrying out follow-up surveys and condition / dilapidation reports on surrounding existing buildings;
- Carrying out any necessary and/or agreed repairs or remedial works to existing properties following completion of monitoring;
- Carrying out post-construction surveys on drainage works and implementation of any repairs as agreed with DCC.

8.2 Operation Phase – Residual Impacts

There are no predicted operation phase residual impacts relating to Civil / Structural Engineering matters.

PAUL HEALY
For O'Connor Sutton Cronin

APPENDIX 1

Statement of Evidence of

Paul Healy, O'Connor Sutton Cronin Consulting Engineers

On the Topic of Civil & Structural Engineering

1. Professional Qualifications & Experience

1.1 I am Paul Healy, BSc(Eng), Dip.Struct.Eng, CEng., F.I.E.I., F.I.Struct.E., R.Cons.EI,. Director of O'Connor Sutton Cronin (OCSC) and Project Director for this project.

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I have been involved with the Mater Campus since early 2000 when we were appointed under the former Children's Hospital Project. In addition to the preparation of Tender documents for the Children's Hospital, this project also involved the completion of the hostel building sandwiched between the historic buildings (No's. 30 – 38 and old Mater classical building) along Eccles Street together with a centre for Nurse education at the corner of Eccles St and Nelson St.

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2. Role In Proposed Development

I am the Project Director for OCSC responsible for the following Civil & Structural areas of the project, and the preparation of the corresponding sections of the Environmental Impact Statement (EIS) :

- Civil / Structural Design of Building;
- Soils, Geology and Hydrogeology;
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Relevant chapters and sections of the EIS have been prepared by my colleagues Paul Tierney (Soils, Geology and Hydrogeology), Robert Fitzmaurice (Material Assets - Water and Drainage) and David Rehill (Outline Construction Strategy), all O'Connor Sutton Cronin staff, who are accompanying me here during the Oral Hearing.

My colleague Tony Horan prepared all matters relating to Traffic and Transportation and Tony will separately deliver his Statement of Evidence on same.

3. Characteristics Of The Proposed Development – Structural Design

3.1 INTRODUCTION

The proposed building development, location, form, layout and occupancy has been earlier described in detail by the Architects. We seek here to set-out the Civil / Structural Engineering Design undertaken in accordance with the Exemplar Design requirements of the Brief.

3.2 CODES, STANDARDS AND LOADING

All structural designs, materials and workmanship shall comply with the relevant Eurocodes (I.S. EN Ref's), EU Standards Codes of Practice or equivalent Irish Standards or Codes of Practice. Where Eurocodes are used, the referred Irish National Annex to each respective EN shall be considered. Where no Eurocode, EU Standard or Irish Standard exists, compliances shall be obtained through relevant British or other Internationally recognised standard or Good Industry Practice.

Eurocode 1 (I.S EN 1991) Actions on Structures Parts 1-1 to 1-7, sets out the requested loading (actions) to be accommodated within the structural design. Wind loads and snow loading used for lateral and overall stability design have been based on this Eurocode, modified to take account of local ground roughness conditions.

3.3 BUILDING STRUCTURE CATEGORY

A number of submissions raised the issue of the height of the building and its consideration as a tall building, I wish to address this from a structural engineering perspective.

With reference to Eurocode 1 (I.S. EN 1991) Actions on Structures and relevant parts of the Irish Building Regulations, this building is categorised as Consequence Class 3 (CC3) as it comprises a hospital in excess of three storeys. Four classes are identified, namely Class 1, 2a, 2b and 3, Class 3 being the highest classification and therefore any hospital building with greater than three storeys will remain within this same classification.

Whilst this building, from a Dublin City Council Planning context and visual perspective extending above the general street scape may be considered tall or high rise, in the context of Structural Engineering design, this building is not considered or categorised as a tall building.

More appropriately, it can be considered within the medium or mid rise category which includes building up to 20 - 25 storeys. Structural design of tall buildings are more importantly characterised where their height to width slenderness ratios are high and the dominant design is highly influenced and dictated by lateral or horizontal design considerations rather than just vertical load effects. This hospital building does not fall into this category for structural design.

3.4 SUPER-STRUCTURE CONCEPTS

The building superstructure is broadly considered as those elements extending above general ground level and in this building is considered to include levels L0 to L16 with a general building height of approximately 68.6m above Eccles Street entrance level. There is also a small area enclosing the service cores (on the north) which extends to approximately 73.6m (relative to Eccles Street).

3.4.1 Building Form & Concept

The superstructure concept and massing of the Hospital is broadly laid out in a rectilinear / elliptical footprint and extends generally fifteen levels above an entrance level (L1) off Eccles Street. Design constraints require that levels L0, L1 and L3 horizontally tie in with the adjoining Adult Hospital building (currently under construction).

Our approach to the structural design was to evaluate a number of structural solutions suitable to respond to the demands of the building. Ease of construction, use of prefabrication offsite (to improve quality and reduce traffic impacts and programme), flexibility, programme, environmental considerations, Health and Safety, market availability and cost effectiveness are some of the main criteria by which these solutions were assessed.

The functional stacking of the hospital facilities encompasses much of the high demand and heavily services accommodation in an area defined as the "**Treatment Zone**", up to and including levels L4 thus requiring a structural solution to be robust, yet suitably adaptable and flexible to serve future needs. From Levels 6 – 9, a suite of "**Therapy Zones**" accommodating a series of really exciting and structurally challenging spaces for outpatients, in-patients and families. A dedicated plant floor at Level L5 is sandwiched within these zones. Levels 10 – 15 accommodate the wards and Education Centre with the upper reduced area at Level 16 designed to accommodate an integrated plant room.

Floor to floor heights within the hospital superstructure typically vary between 3.8m and 4.5m (with one level at 5m high) depending on occupancy and need to tie in with other Adult Hospital facilities (particularly L-1, L0, L1 and L3). L3 accommodating the theatres in both hospitals.

3.4.2 Structural Design

The building structural grid has to respond to many competing demands and layouts at the various levels. Following a number of studies to ascertain the optimum approach, a primary structural grid of 7.8m x 7.8m was chosen. This grid allows for an efficient structural solution and can easily be accommodated by way of many structural forms including in-situ concrete frame, steel frame, composite construction and or a hybrid insitu/pre-cast concrete solution.

Based on the already identified assessment criteria, the chosen structural solution to move forward with for this building is an in-situ concrete frame of reinforced concrete columns and flat slab. This frame, up to and including Level 10 is supplemented as necessary, with local enhancements / thickenings to deal with external cantilevers, heavy plant and vibration sensitive equipment at various levels. The flat slab floor plate solution is very versatile, works well for highly serviced buildings and can accommodate flexible layouts.

Above this (Wards levels), the building grid changes to suit the individual ward room layouts and the architectural profile of the elevations. A structural transfer slab is provided at the underside of L10 to allow this column transition to occur. Insitu concrete, pre-cast concrete and/or steel frame are viable solutions for the upper Ward levels. However, maintaining continuity of resources, skills and techniques used at lower levels, an insitu concrete frame is preferred.

The structural solution is sufficiently flexible and adaptable to accommodate and keep in line with changes in hospital operational policies. The chosen structural solution has been subject to continuous testing throughout the Exemplar Design Stage, and will continue up to tender stage based on the criteria and building demands set out above, the need to future proof and provision of "soft zones" for changes in service provision and advances in clinical needs.

3.5 STRUCTURAL ANALYSIS AND MODELLING

A 3D computer Finite Element (FE) model using specialist structural design software was developed of the entire building from roof to foundation, incorporating all structural elements and proposed material properties. This FE model allowed the application of the appropriate design loading and the opportunity to test and study various structural options for compliance within the design standards. The 3D structural model also provided us with accurate design data on vibration and dynamic performance of the building. Designed "strong points" in the form of shear core stability walls, lift / stair cores etc. strategically positioned within the building were modelled and represented to resist the applied loads. Overall, lateral behaviour and stability of the building was confirmed and found acceptable using this 3D analysis.

3.6 SUB-STRUCTURE CONCEPTS

The building sub-structure generally comprises those elements below ground level including foundations and those supporting the super-structure. For this building the sub-structure elements are considered to comprise the 4 levels of basement including levels L-4 to underside L0. Existing ground levels vary across the site falling generally from South West to North East. The levels on North Circular Road (NCR) are approximately 1 No. storey lower than Eccles Street. The depth of basement therefore varies relative to the existing levels but is typically 14m below the level of the existing surface car park and increasing to approximately 18m at its deepest, local to the Metro North access box area.

3.6.1 Ground Conditions

A number of Geotechnical Site Investigations have been carried out on the Mater Campus over the course of 1999 to 2010 and these are set-out and included within Appendices 7A, 7B and & 7C, Volume 3 of the EIS.

The ground conditions prevailing at the Mater Campus can be broadly summarised as follows :

- Made ground (fill material) up to 2m deep.
- Brown slightly sandy gravelly CLAY with cobbles.

- Grey black very gravelly CLAY with cobbles.
- Brown medium to coarse SAND / GRAVEL.
- Grey brown stiff to very stiff slightly sandy CLAY with cobbles.
- Calp LIMESTONE (strong to very strong) bedrock.

These conditions are typical of Glacial Tills found extensively throughout the Dublin area and are often more colloquially referred as *Dublin Boulder Clays,* either brown or black (depending on the colour and strength composition encountered). The overburden stratum of the boulder clays contains a relatively thick (10m) layer of water bearing sandy gravels. Extensive ground water monitoring has been carried out over the years at the Mater Campus and whilst the levels were noted to vary across the site and over seasonal influence, a design ground water level (equilibrium level) for the CHoI basement of 15m OD (c. 2 – 3m below existing car park levels) has been recommended.

The limestone bedrock has been confirmed on the site via a number of rotary core holes at approximately 27m below existing ground levels. This is approximately 13m below the general lowest basement L-4 level (3.2m OD) and equivalent to a level of approximately -10m OD.

3.6.2 Excavation and Perimeter Cut-Off Wall

The basement construction will involve the installation of a perimeter "Cut-Off" wall to the entire footprint, comprising a series of augur bored vertical interlocking piles extending down and penetrating into the impermeable very stiff glacial till (black boulder clay) to achieve a sufficient seal. For the purposes of referencing and describing this further, I will refer to this wall as a Secant Pile Wall which is the more commonly used Engineering term. The pile diameter, spacing and depth will vary around the site to suit particular prevailing conditions, boundary constraints and is envisaged to be between 900 to 1200mm diameter, extending down to a toe level of approximately -7.5m OD at its deepest ie, approximately 2.5m above the bedrock levels (-10m OD).

A series of 2D finite element (FE) ground analysis models were developed and analysed at critical sections around the basement perimeter including at the Mater Private Hospital (MPH), Eccles Street / Historic Listed Buildings and at the Mater Adult Hospital to the north of the proposed basement. Due to the sensitivity of very specialist equipment and procedures carried out at the MPH in close proximity to the basement excavation, a detailed assessment reported under "*Impact Assessment of Basement Construction – Construction for the Children's Hospital of Ireland on the Mater Private Hospital*" and included within Volume 1 reviews the potential impacts on the sensitive equipment and procedures.

The result from the FE analysis models concludes that in general the predicted movements are within acceptable limits, generally within *negligible / very slight* risk of the occurrence of building damage. Isolated instances of *slight* risk of occurrence of building damage were identified, particularly at the protected structures on No's. 30 – 38 Eccles Street and a particular joint (Ref. Joint C) extending over a length of approximately 8m at the MPH. Appropriate mitigation measures have been incorporated to minimise and mitigate these effects.

As the excavation proceeds and in order to prop and provide restraint to the secant wall, a series of temporary horizontal ground anchors or ties will be installed at varying levels and spacing. These ground anchors comprise a high tensile steel rod inserted into a pre-drilled hole (of the order of 150mm diameter) grouted-up to bond to and develop resistance from the surrounding ground mass. The length of anchors will vary depending on imposed loading conditions and spacing / location within the wall. Based on designs carried out to date, it is envisaged that the maximum anchor diagonal length will be in the order of 20m long inclined at an angle of some 30° - 45° off the horizontal. These temporary ground anchors are designed as pre-stressed and can be de-stressed if required as the permanent structural basement works advances and replaces the need to provide temporary lateral support. Such situations where they are envisaged to be de-stressed are in the vicinity of the running tunnels for the proposed Metro North. In this instance, an exclusion zone has been preserved following discussions with the Rail Procurement Agency (RPA).

The construction of the basement will require the excavation and disposal off-site of approximately 269,000m^3 of soils. No rock excavation is envisaged.

The construction of a 'water tight' secant pile box around the proposed basement will assist with the control of water infiltration and thus ensure minimum seepage entering the excavation. Additionally, a significant 'toe' will be formed below the basement formation level into the very impervious clays to ensure groundwater will not enter the excavation from this low level, again minimising the risk of ground water drawdown. In turn this arrangement will not significantly impact the groundwater levels in the area. This is a tried and trusted practise both at a national and international scale and has been successfully carried out many times within the boulder clays of Dublin. During construction, a monitoring regime will be put in place to allow the Contractor to take the necessary steps to ensure that should any water enter the dig, the differential groundwater level does not exceed approximately 1m (which is considered in line with seasonal variations).

3.6.3 Foundations and Basement Design

The prevailing ground conditions allow the use of a traditional foundation solution including a raft type stiff plate foundation to spread the applied and imposed loads. This foundation raft is in the order of a 1m thick concrete slab and integrates with the lowest basement car park level L-4. This stiff plate spreads the loads to a more even distribution across the footprint and limits the effects of differential settlement. In order to overcome the potential effects of buoyancy and high long term ground water pressures, anti-floatation anchors will be installed at regular spacing and anchored into the basement slab. The depth and size of these will depend on spacing's and the overall mass of the building (floor thicknesses etc.) confirmed at Detail Design Stage.

Environmental and sustainability features form an important part of this development and from a structural engineering perspective includes Geothermal Closed Loop Boreholes, for extraction of energy from the ground (without interference to ground water), the use of Ground Granulated Blastfurnace Slag (GGBS) cements which during its production process is an eco-friendly low CO_2 emission alternative to normal cements, rainwater harvesting tanks to capture rainfall for re-use and a large attenuation water tank to reduce and minimise flows to the public sewers during heavy rainfall events.

The four storey underground concrete basement accommodates carparking over the four levels for patients, public and staff for the use of the Children's Hospital of Ireland. A detailed carparking demand study and analysis has been prepared and will be presented separately by my colleague Tony Horan. It is proposed that the basement construction will be built as an integral part of the main hospital development.

On the eastern side of the basement, the design includes for the integration of an entrance to the proposed Metro North Mater stop directly off Eccles Street. The design and integration of this area has been fully developed in conjunction with the RPA and includes for access from Eccles Street down to the Metro Platform levels.

3.6.4 Car Park Access and Layout

The proposed carpark is laid out over four underground levels with the primary access/egress off Eccles Street and a second access/egress off the North Circular Road. It is intended that the car park for the Children's Hospital of Ireland will link in with and integrate with the already approved and currently under construction car park for the Mater Adult Hospital.

The total number of spaces included under the CHoI is 972. The structural grid and column spacing has been carefully set out at 7.8m in the east/west direction to allow 3 No. car park spaces per bay.

4. Potential Impacts Arising from the Proposed Development

I have identified and include here a high level overview and summary of the likely significant impacts resulting from the Civil / Structural Engineering aspects of the proposals. However, a more detailed assessment has been carried out in the individual chapters and reports contained within the EIS.

4.1 CONSTRUCTION PHASE

The majority of the structural engineering construction phase impacts occur as a result of the basement and sub-structure works and can broadly be considered to arise due to the following activities:

- Installation of piling for perimeter cut-off wall;
- Installation of horizontal ground anchors;
- Excavation of soil for disposal off-site;
- Traffic and traffic movements associated with the excavation;
- Control of ground water due to the excavation of soil;
- Possible settlement of existing surrounding buildings;
- Installation of anti-floatation anchors;
- Concrete works associated with concrete pours to the foundations and concrete sub-structure frame;
- Drainage related matters.

In addition, the construction of the concrete frame superstructure can equally cause similar impacts associated with the concrete works, façade and fitout.

A number of potential impacts arise as a result of these activities and include inter alia:

- Noise and vibration impacts;
- Risk of possible settlement and movement impacts to surrounding buildings and services;
- Possible impacts on hydrogeology;
- Air quality and dust impacts;
- Human beings impacts;
- Traffic related impacts;
- Material assets water and drainage impacts.

The respective chapters and appended reports included within the EIS carries out a detailed assessment for each of the potential impacts in turn and identifies as and where appropriate, mitigation measures are required to achieve compliance. A witness statement has been separately prepared for each of these potential impacts and will be delivered under the appropriate module of the Oral Hearing.

4.2 OPERATIONAL PHASE

It is not anticipated that there will be any significant impact with respect to the operational phase of the development regarding the soils geology and hydrogeological environments.

Regarding material assets water and drainage related, the operational phase of the development shall have a positive effect on the existing drainage network in the immediate area since the applicant site is currently un-attenuated and shall reduce the potential for surcharging and flooding in the downstream catchment.

5. Mitigation Measures Proposed

5.1 CONSTRUCTION PHASE – MITIGATION MEASURES

The significant Civil / Structural Engineering mitigation measures proposed to reduce potential impacts to within acceptable criteria include :

- Mitigation at source;
- Monitoring;
- Procedural / Organisation of the works;
- Programming / Phasing of Works.

Mitigation at source includes such techniques as lowering power output, low noise / vibration equipment, specific controls on equipment (ie, pile rotary equipment), screens / barriers, enclosures and regular maintenance of equipment to maintain in good working order.

Regarding monitoring, it is proposed that a suitably qualified Independent Specialist Monitoring Consultant shall be appointed to carry out and report on monitoring outputs during the course of the CHoI works at agreed intervals and for a sufficient period of time following completion of the relevant parts of the works. A detailed schedule of monitoring will be set-up and carried out to all potentially affected areas with closer scrutiny and rigorous regime to those areas predicted to be in the slight risk of occurrence of building damage and areas where sensitive equipment and procedures are carried out. It is intended that a Community Liaison Committee membership will include a number of members of the local community, as well as elected members of the Council, officials of the Council, and representatives of the developer. The committee will liaise with the appointed contractor who will be required to carry out monitoring during the construction phase of the project.

The procedural and organisation mitigation will set-out the intended approach to the works for critical activities such as commencing sufficiently far away from sensitive receptors and working in a progressive manner towards these receptors in conjunction with the results of the monitoring.

The programming and phasing mitigation includes the potential to carry out elements of the works when sensitive activities or equipment at the receptors are not in use. This may include out of normal hours working and we would refer you further to the *Outline Construction Strategy* for the proposals in this regard.

The above proposed mitigation measures are set-out in the relevant EIS chapters and appendix reports.

5.2 OPERATIONAL PHASE – MITIGATION MEASURES

There are no operational phase mitigation measures envisaged relating to Civil / Structural Engineering matters.

6. Predicted Residual Impacts (ie, Post Mitigation)

6.1 CONSTRUCTION PHASE – RESIDUAL IMPACTS

In order to monitor the effectiveness of the implementation of the mitigation measures proposed in the EIS, it is proposed to carry out the following confirmatory monitoring, which may include:

- Carrying out follow-up surveys and condition / dilapidation reports on surrounding existing buildings;
- Carrying out any necessary and/or agreed repairs or remedial works to existing properties following completion of monitoring;
- Carrying out post-construction surveys on drainage works and implementation of any repairs as agreed with DCC.

6.2 OPERATION PHASE – RESIDUAL IMPACTS

There are no predicted operation phase residual impacts relating to Civil / Structural Engineering matters.

7. SUBMISSIONS AND REPONSES

The following persons / organisations made submissions or responded to the Board in relation to the Civil/Structural Engineering issues :

- *Mater Private Hospital (MPH)*

7.1 ISSUE:

MPH comments on elements of O'Connor Sutton Cronin Report relating to Mater Private Hospital (Volume 1).

MPH note that they do not accept the settlement mitigation measures proposed in Section 9 of OCSC report relating to Linear Accelerators and the assessment of MPH's construction joints in Appendix H.

Response:
We wish to advise the Board that we have had very recent discussions with MPH on these issues. With regard to the Linear Accelerators we have agreed vibration and settlement impact monitoring positions and details as a precautionary measure. Based on our Assessment Report, it is anticipated that the CHoI works will have no impact on the Linacs Bunkers. Similarly, regarding the issue of Joint C, we are in discussion with MPH and their representatives and have agreed monitoring proposals and pre-construction mitigation measures in this area.

APPENDIX 2

Statement of Evidence of

Paul Tierney, O'Connor Sutton Cronin Consulting Engineers

On the Topic of Soils, Geology and Hydrogeology

1. Professional Qualifications & Experience

I, Paul Tierney, am an Environmental Geologist and hold a degree (BSc) in Earth Science from the National University of Ireland, Galway (1998) as well as a Diploma in Environmental Engineering from Trinity College Dublin (2005). I am a member of the European Federation of Geologists, the Institute of Geologists of Ireland and the International Association of Hydrogeologists.

I am a Senior Geologist with O'Connor Sutton Cronin Consulting Engineers and am responsible for the Geological and Environmental aspects on a range of projects, most notably:

- River Dargle Flood Defences, Bray;
- National Sports Campus Development, Abbotstown;
- Northside Town Centre, Coolock, Dublin 5;
- Clancy Barracks (Phased Development) and
- Research and Development Facility, Maynooth.

2. Role In Proposed Development

I was directly responsible for the following areas of the project, and the preparation of the corresponding sections of the Environmental Impact Statement [EIS]:

- Chapter 7 – Soils, Geology and Hydrogeology

3. Key Issues in Relation to Soils, Geology and Hydrogeology

3.1 INTRODUCTION

Chapter 7 of Volume 2 of EIS sets out the likely impacts on the soils, geology and hydrogeology environments regarding the proposed development of the Children's Hospital of Ireland at the Mater Hospital Campus.

The following are the main issues that have been addressed in Chapter 7 of the EIS:

- The excavation to allow for the installation of the four storey basement car park and its potential effect on the soils, geology and hydrogeological environments.

3.2 DESCRIPTION OF EXISTING ENVIRONMENT

The following describes the existing soils, geological and hydrogeological environments and historical land use at the site using information obtained from the Geological Survey of Ireland (GSI), site investigations undertaken within and in the vicinity of the proposed development and historical Ordnance Survey of Ireland maps[1]:

- Historical Ordnance Survey of Ireland maps dating from 1847 to 1991 indicate that the site was occupied by houses and gardens with some open ground in 1847. The Mater Miscericordiae Hospital is located on the current Mater Campus in 1876, with the surrounding area becoming more developed in 1890. In 1908 a laundry is recorded as being present on-site with a nursing home and a Dominican College present in 1966. A number of tanks are located on site in 1973, which are probably potable water tanks;
- Site investigations indicate that the stratigraphy's underlying the site consist of the following:
  - made ground, consisting of demolition rubble consisting of concrete, brick, ash, glass, pottery and mortar in a matrix of gravelly clay;
  - brown slightly sandy gravely clay with cobbles,
  - Grey black very gravelly clay with cobbles;
  - Brown medium to coarse sand with occasional gravels.
- The site is underlain by Calp Limestone, which is classified as comprising dark grey to black limestone and shale. Bedrock was encountered on-site at approximately 27m below ground level (bgl);
- Site investigations indicate the presence of 2 No. distinct probable water bearing horizons. The first horizon is a gravel layer from 7 to 17m bgl (10-0mOD) that is both over and underlain by low permeable clays and the second horizon is the bedrock; and

[1] Section 7.2, Volume 2, EIS.

- The GSI groundwater well database indicates the presence of only 1 No. well within 1 km of the site, which is located approximately 720m to the south east that was drilled in 1899 and its use is unknown.

3.3 POTENTIAL IMPACTS ARISING FROM PROPOSED DEVELOPMENT

3.3.1 Construction Phase Potential Impacts

- Potential contaminants such as fuel have the potential to spill, which could results in the contamination of the local soils, bedrock geology or hydrogeological environments. It is deemed that this potential impact would be relatively localised and reversible and as such may be deemed moderate;
- A review of historic information and maps indicates that no significant sources of contamination were located on the proposed development site;
- Approximately 269,000m^3 of soil will be excavated and disposed of off-site to facilitate the installation of the basement. A soil classification report was prepared and based on this report together with consultation with a number of landfills concluded that the vast majority of the excavated material will be disposed of at inert landfill facilities such as Murphys Inert Landfill, Gormanstown, Co. Meath (Waste Licence No. W151) and Murphys Inert Landfill, Hollywood Great, The Naul, Co. Dublin (Waste Licence No. W129). The Gormanstown facility has an annual capacity of 750,000 tonnes (which is now closed due to lack of demand, however can be re-opened if demand increases) and The Naul facility has an annual capacity of 500,000 tonnes, however this year to date has only accepted approximately 15,000 tonnes. As such it may be concluded that the volumes to be disposed of at the inert facilities would not pose a problem with regard to the acceptable capacities of the landfills:-

  Note: It should also be noted that at this time, it is expected that the excavation process may extend over 2 No. licence years for the facilities mentioned.

  The remaining material, approximately 1,250m^3 of soil (equivalent to c.120 truck loads or 0.5% of the total volume to be excavated) may be disposed of at a non-hazardous landfill such as Ballynagran Residual Landfill operated by Greenstar in Co. Wicklow. Further testing will be required to confirm the classification assumptions made to date, particularly for the west section of the site, (due to the presence of existing buildings) and prior to undertaking of significant construction works. Notwithstanding this the site will be continuously monitored during the excavation process with further confirmatory analysis undertaken at the landfills;
- It is not anticipated that there will be any significant potential impacts regarding the bedrock geology as the proposed excavation works will not extend to bedrock;

- It may be required to lower the water table to allow for the construction of the basement structure. The Byrne Looby Hydrogeology report[2] addresses this issue and concludes that the temporary dewatering procedure may lower the groundwater levels to a maximum of 1m in the vicinity of the excavated area, however this temporary lowering will not have a significant effect;
- The OCSC report titled "Effect of Basement Construction on Protected Structures"[3] investigated the potential for the construction works to impact on neighbouring protected structures. This concluded that a continuous monitoring programme will be implemented to ensure that any movement of the buildings will be identified and the construction activity will be sufficiently altered to minimise the impact. This can be achieved by reducing the output for the piling machine, increase the number of ground anchors to limit deflection or to grout the existing building foundations to overcome potential weak spots;
- Discussions with the Railway Procurement Agency (RPA) were held regarding the positioning of the proposed secant pile wall adjacent to the proposed tunnels for Metro North. It is noted that the recommended exclusions zones will be respected and the temporary support anchors required to resist the lateral loads on the secant pile wall will utilise systems developed for installation near tunnelling works.

3.3.2 Operational Phase Potential Impacts

- The basement has the potential to alter local groundwater levels and/or flows. As such a 3D ground water flow hydrogeological assessment was undertaken extending to a 9km study area, as presented in the Byrne Looby report contained in Appendix 7h, Vol 3 of the EIS. This concluded that there will be no change of groundwater mass balance which means that subsequent to the construction of the basement structure the volume of groundwater flowing into the study area will be the same as that flowing out of the study area, which has historically been the case. There is also no predicted change of flow to the Tolka River or the River Liffey.
- There is no predicted long term effect downstream of the basement and upstream outside 100m of the site. A groundwater level reduction of 1m was predicted to occur in the alluvial and glacial sands on the upgradient side within an approximate 100m proximity to the basement. This reduction in ground water level is within the seasonal variation experienced at this site.
- Surface water run-off from hardstanding areas will pass through a closed drainage system, which will incorporate silt traps and oil interceptors, prior to discharge into the Local authority operated sewer system.

3.4 MITIGATION MEASURES PROPOSED

3.4.1 Construction Phase

[2] Appendix 7H, Volume 3, EIS
[3] Appendix 7F, Volume 3, EIS

- A construction management strategy has been prepared that addresses issues such as the storage of fuels;
- Wheel wash facilities shall be used to clean vehicles to prevent mud being tracked onto adjoining roads. In addition to this road washing machinery shall be used, if and when required;
- Any stockpiled material will be dampened during dry periods to prevent the spreading of dust. A "Dust Boss" system will also be adopted to suppress any air borne dust. This system utilises a low powered fan to blow a fine controlled water mist over the excavation area and haul routes;
- A 'water tight' cut-off secant pile wall will be constructed around the proposed basement. This will ensure that during the temporary dewatering programme the surrounding groundwater levels will not be significantly impacted. During construction a monitoring programme will be put in place to allow the Contractor to take the necessary steps to ensure that the differential groundwater level does not exceed 1m, which is within the level of seasonal fluctuation. A significant 'toe' will be formed below the basement foundation level into the low permeability clays to prevent groundwater from entering the excavation, thus preventing drawdown of the local groundwater; and
- During the excavation programme any groundwater within the excavated area will be discharged at a controlled rate to a Local Authority operated sewer, via a settling tank and oil separator. In order to facilitate this, a Discharge Licence will be sought form the Local Authority, which will require on-going testing and monitoring of the groundwater prior to discharge to address any potential contamination issues.

3.4.2 Operational Phase

The silt traps and oil interceptors that are located on-site will be regularly monitored and maintained.

3.5 PREDICTED RESIDUAL IMPACTS (ie, POST-MITIGATION)

3.5.1 Construction Phase Impacts

Approximately 269,000m^3 of soils will be excavated and removed off-site for authorised disposal. It is not anticipated that there is any significant impact on the geology and hydrogeology due to the removal of this material.

3.5.2 Operational Phase Impacts

It is not anticipated that there will be any significant residual impact with respect to the operational phase of the development regarding the soils, geology or hydrogeological environments.

4. Submissions & Responses

No issues were raised or submitted in relation to soils, geology and hydrogeology.

APPENDIX 3

Statement of Evidence of

Robert Fitzmaurice, O'Connor Sutton Cronin Consulting Engineers

On the Topic of Material Assets – Water and Drainage Piped Services

1. Professional Qualifications & Experience

I am Robert Fitzmaurice, Chartered Civil Engineer and hold a degree (B.E Hons) in Civil & Environmental Engineering from the University of Bradford (1999) as well as a post graduate Diploma in Environmental Engineering from Trinity College Dublin (2005) and a Masters degree in Industrial Engineering from University College Dublin (2009).

I am a senior project engineer within O'Connor Sutton Cronin Consulting Engineers. In this role I was responsible for conceptual through to Planning Submission design of water/drainage related matters. My experience includes various mixed commercial and resident schemes throughout Dublin notably;

- Spencer Dock Development;
- Clancy Barracks Development;
- Heuston Square Development.

2. Role In Proposed Development

My role included responsibility for the following areas of the project, and the preparation of the corresponding sections of the Environmental Impact Statement, (EIS).

- Section 12 – Material Assets - Water and Drainage Piped Services.

3. Key Issues In Relation to Material Assets – Water and Drainage

3.1 INTRODUCTION

Chapter 12 of the EIS sets out the proposed drainage and potable water network for the development and establishes the potential impacts and remediation measures for the Children's Hospital of Ireland at the Mater Hospital Campus.

Potable Water Supply (Section 12.2.1 of the EIS)
This section of the EIS covered the proposed water demand generated from the scheme and reviews the existing public potable water infrastructure in the area.

Foul water Drainage (Section 12.2.2 of the EIS)
This section of the EIS covered the foul effluent generated from the proposed development and the capacity in the pubic drainage network.

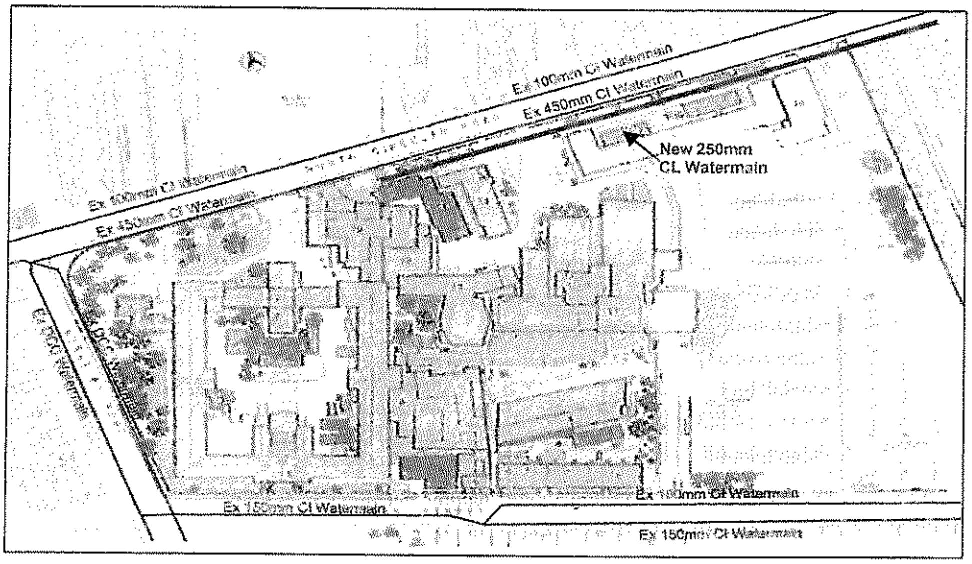
Storm water Drainage (Section 12.2.3 of the EIS)
This section of the EIS covered the proposed alterations to the existing storm regime at the site and how the proposed development will adhere to the principles

of Sustainable Urban Drainage System (S.u.D.S) in accordance with the requirements of the Local Authority. It is predicted that the current proposals will lead to a reduction in storm water runoff during periods of high intensity rainfall while allowing captured water to be re-used on site for non-clinical/potable and maintenance purposes.

3.2 DESCRIPTION OF EXISTING ENVIRONMENT

3.2.1 Potable Water Supply

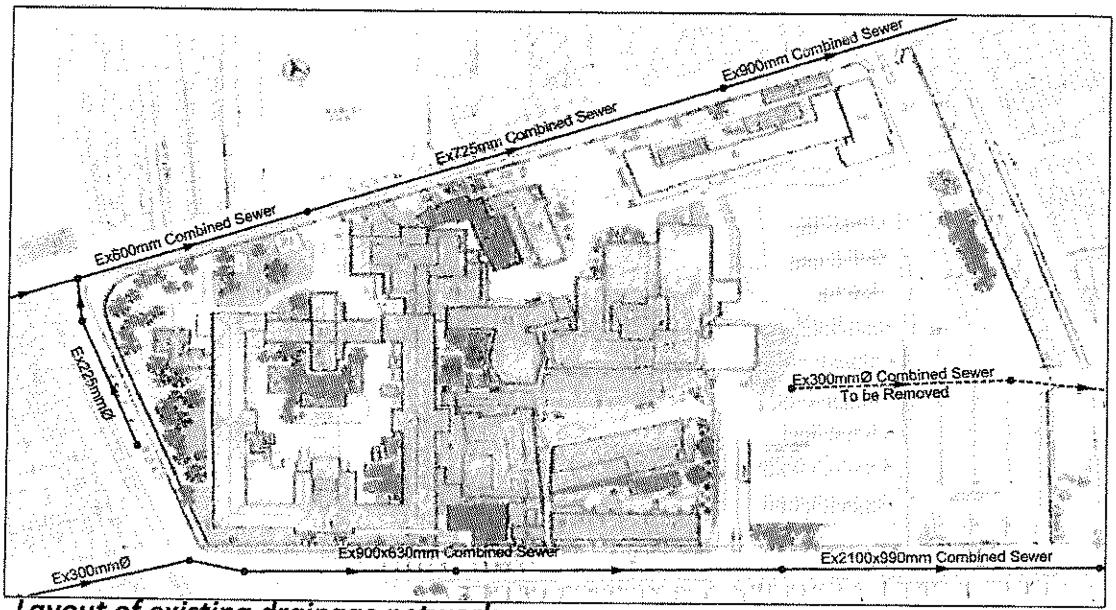
The existing "Mater Campus" is located within the jurisdiction of Dublin City Council and is served by a number of watermains. The proposed site is currently served by an existing 450mm cast iron watermain on the North Circular Road, together with a 100mm and 150mm cast iron watermains on Eccles Street, see below for Existing Watermain Layout. Following discussions with Dublin City Council Water Divisions, Senior Executive Engineer, we were advised that the existing water supply infrastructure in the vicinity of the development is currently at capacity. In order to address this, a new 250mm diameter watermain from Dorset Street to supply the Mater Campus was recently constructed by Dublin City Council which is sufficient to provide potable water to the proposed development. A secondary source of potable water will be supplied from the existing 450mm watermain on the North Circular Road. This supply provides redundancy and shall only be used in the event that the new 250mm watermain becomes incapacitated and temporarily unable to deliver potable water to the hospital.



Layout of existing potable watermains

3.2.2 Foul Drainage Network (Combined)

The proposed site is currently served by an existing 600mm – 900mm diameter combined sewer on North Circular Road, and an ovaloid brick combined sewer varying between 900mm x 630mm and 2100mm to 930mm on Eccles Street. In addition there is an existing 300mm combined sewer crossing the site and outfalling to the existing network on Leo Street via Eccles Place to the east of the proposed development, see below for Existing Drainage Layout.



Layout of existing drainage network

3.2.3 Storm Drainage Network

This area of the city is drained using the combined network and hence, there is currently no dedicated surface water line serving the development along North Circular Road or Eccles Street. All surface water runoff currently outfalls to the existing combined networks described in *Section 3.2.2. earlier.*

The existing hard surface car parking area of the lands subject to the planning application currently drains by gravity and outfalls with no attenuation measures in place to the existing combined drainage network.

3.3 POTENTIAL IMPACTS ARISING FROM THE PROPOSED DEVELOPMENT

3.3.1 Construction Phase Potential Impacts – Potable Water Supply

There could be potential for short-term negative impacts associated with the construction of the proposed development from the following:

- Accidental spills of harmful substances such as petrol or oil during the delivery and storage of harmful substance or by leakages from construction machinery;
- Increased pollutant and nutrient input due to an increase in surface runoff and removal of existing landscape;
- Increased litter distribution from construction material.

3.3.2 Operational Phase Potential Impacts - Potable Water Supply

During the operation phase, potential impacts that might be associated with the water supply to the new development include;

Impact of water demand on the adjacent public water supply network.

3.3.3 Construction Phase Potential Impacts – Foul (Combined) Drainage Network

There could be potential for short-term negative impacts associated with the construction of the proposed development from the following:

- Accidental spills of harmful substances such as petrol or oil during the delivery and storage of harmful substances or by leakages from construction machinery;
- Increased pollutant and nutrient input due to an increase in surface runoff and removal of existing landscape;
- Increased litter distribution from construction material.
- Foul sewer pipeline and manhole construction activity.
- Increased risk of blockages to sewers from construction works.
- Disturbance while connection to public drainage network is made.
- Increased temporary flow due to groundwater pumping

3.3.4 Operational Phase Potential Impacts - Foul (Combined) Drainage Network

During the operation phase, potential impacts that might be associated with the foul drainage network to the new development include;

- Potential for medical waste to be incorrectly disposed of through the foul sewer network.
- Increased volumes of effluent causing potential capacity issues within the public drainage network.

3.3.5 Construction Phase Potential Impacts – Storm water network

Whilst there is currently no dedicated public storm sewer, there could be potential for short-term negative impacts associated with the construction of the proposed development from the following:

- Accidental spills of harmful substances such as petrol or oil during the delivery and storage of harmful substance or by leakages from construction machinery;

- Increased pollutant and nutrient input due to an increase in surface runoff and removal of existing landscape;

- Increased litter distribution from construction material.

- Storm pipeline and manhole construction activity.

- Increased volumes of stormwater causing potential capacity issues within the public drainage network.

3.3.6 Operational Phase Potential Impacts – Storm Water Network

During the operation phase, potential impacts that might be associated with the surface water drainage network to the new development include;

Potential for medical waste to be incorrectly disposed of through the surface water network.

3.4 MITIGATION MEASURES PROPOSED

3.4.1 Construction Phase – Potable Water

There will be no major requirement for water supply during the construction of the proposed development until completion/occupation. Local arrangements shall be made between Dublin City Council and the contractor, to meet the contractors needs/demands. The water demand for temporary sanitary facilities will be minor and of short term nature and have no long term effect on the water supply network.

3.4.2 Operational Phase – Potable Water

Water conservation measures have been included and incorporated within the development in order to minimise the demand, which would also result in significant environmental benefits and cost savings. The following water conservation measures are incorporated into the proposed development:

- The installation of dual-flush toilet systems,

- The installation of aeration taps and other water saving devices to reduce water demand.

- 2 No. rainwater harvesting tanks shall also be incorporated into the development for all non-potable requirements throughout the operational phase. This shall reduce the volume of potable water to be drawn off the mains.

3.4.3 Construction Phase – Foul Drainage Network

During the construction phase of the proposed development there will be minimal impact on the existing foul network until completion/occupation. The contractor is to provide offline toilet and sanitary facilities during the construction phase and is to liaise with Dublin City Council for the disposal of foul from the offline facilities. There are existing 200mm and 100mm private combined sewers adjacent to the existing MMUH Ward Block building. As this building is operational, the sewers will be appropriately diverted during the construction period.

3.4.4 Operational Phase – Foul Drainage Network

The following foul drainage measures are incorporated for the proposed development:

- Grease interceptors will be provided in canteen/kitchen areas.
- Where possible the foul sewer shall be laid at a deeper level than that of the surface water sewer to eliminate the possibility of cross contamination.
- All new foul sewers shall be tested in accordance with the requirements of the local authority.
- All new foul sewers to be inspected by CCTV to identify any defects.
- Water saving devices to be utilised throughout the development to reduce foul effluent generation.

3.4.5 Construction Phase – Storm Water Network

The proposed development will have a negligible impact on the existing drainage system during construction. In order to mitigate any potential impact on the drainage network, construction of temporary detention/settlement tanks will be incorporated in consultation and agreement with the Local Authority.

3.4.6 Operational Phase – Storm Water Network

The following storm drainage measures are recommended for the proposed development:

- Where possible the foul sewer will be laid at a deeper level than that of the surface water sewer to eliminate the possibility of cross contamination.
- All new surface water sewers shall be tested in accordance with the requirements of Dublin City Council Drainage Division.

- All new surface water sewers to be inspected by CCTV surveys to identify any defects.

- The use of trapped gullies to remove silts from the surface water network.

- Installation of an attenuation tank to store rain water during a high intensity event and release flows in a controlled manner, as per levels agreed Dublin City Council.

- Overflow devices to the attenuation tanks to ensure that a 1 in 100 year storm event can be stored on site ie local ramps to podium/car parking areas.
- Installation of oil separators to reduce the potential for oil contaminating the public drainage network.

3.5 PREDICTED RESIDUAL IMPACTS (IE, POST MITIGATION)

3.5.1 Construction Phase Impacts – Potable Water

The on-site mitigation measures proposed during the construction phase will reduce to acceptable levels any interference with the public potable water supply.

3.5.2 Operational Phase Impacts – Potable Water

Water demands for the proposed development shall be met by 1 no. connection via a Bulk Water Meter (located within the site boundary) to the new 250mm diameter watermain on the North Circular Road. A back up connection shall also be constructed from the existing 450mm watermain on North Circular Road that shall only come into use should the new 250mm main become incapacitated and is unable to supply the development. All watermains to serve the proposed development shall be constructed of 110mm and 150mm PE 80/PE100 watermains.

The total estimated daily demand for water shall be approximately $420m^3$/day and has been agreed with and based on Dublin City Council Water Division historical data for hospitals in the Greater Dublin Area. This equates to a flow of 4.84 l/s and can easily be accommodated within the new 250 diameter water main.

3.5.3 Construction Phase Impacts – Foul (Combined) Drainage Network

The on-site mitigation measures proposed during the construction phase will reduce to acceptable levels any interference with the public combined drainage network.

3.5.4 Operational Phase Impacts – Foul (Combined) Drainage Network

Foul drainage generated from the Children's Hospital above the basement levels shall flow under gravity via pipes of 150mm and 200mm in diameter to Level 0

(Podium Level) and outfall by gravity to the new 300mm foul sewer within the site. This will discharge to the existing 750mm combined sewer on North Circular Road.

The low quantity of foul drainage generated from the proposed basement car park levels will be collected in pipes of 100mm and 150mm in diameter and will flow by gravity to the lowest level of the basement car park. From there it will be pumped via a foul pumping station and a 75mm diameter rising main to the groundfloor level where it will discharge to a new 300mm foul sewer and in turn into the North Circular Road combined sewer.

The total estimated daily foul sewage flows shall be 420m^3/day and is considered worst case being in excess of the standard EPA Guidelines for such hospital developments. This then equates to a flow of 4.84 l/s (DWF) and a peak flow of 29.0 l/s (6DWF). The existing 750mm combined sewer on North Circular Road has sufficient capacity to accommodate this flow.

3.5.5 Construction Phase Impacts – Storm Water Network

The on-site mitigation measures proposed during the construction phase will reduce to acceptable levels any interference with the existing public storm water (combined) drainage network.

3.5.6 Operational Phase Impacts – *Storm Water Network*

Following discussions with Dublin City Council Drainage Division, the discharge from the completed development will be limited to 2.6 l/s (2.0 l/s per hectare). The attenuation tanks (with c.800m^3 of storage provided) will be constructed to cater for excess surface water runoff from a 100 year storm event. The attenuated flow will outfall to the existing combined sewer network on North Circular Road via a 225mm storm sewer, in accordance with the Greater Dublin Regional Code of Practice.

Runoff from the basement levels will be collected via a Class 2 Petrol Interceptor before being pumped to ground floor level where it will discharge to the proposed foul sewer network.

The operational phase of the development will have a positive affect on the existing drainage networks in the immediate area as the applicant site is currently un-attenuated and shall reduce the potential for surcharging and flooding in the downstream Dublin City Council drainage networks.

4. Submissions and Responses

4.1 The following persons / organisations made a submission to the Board in relation to the issue of drainage:

- Dublin City Council (DCC);
- Sinn Féin, Tallaght;
- Berkeley Environmental Awareness Group;
- Pascal Donohoe, TD.

4.2 ISSUE:

Under Item 15.0 "Planning Authority View on Conditions" of the DCC submission, we note a number of water and drainage related conditions:

Condition 15.1 Water Conditions
Response:
We wish to advise the Board that we are happy to accept the proposed Conditions as set out by DCC on this matter.

Condition 15.2 Drainage Conditions
Response:
We wish to advise the Board that we are happy to accept the proposed conditions as set out by DCC on this matter. We also further note and have been advised by DCC that the projected completion date for the Ringsend Waste Water Treatment Plant is 2015.

4.3 ISSUE:

Sustainable Urban Drainage System (SUDS). A number of submissions and respondents raised issues relating to water supply and SUDS.

Response:
In accordance with best practice and in keeping with the principles of Sustainable Urban Drainage System for this development, the proposed storm water system will incorporate a tiered approach to storm water management. The use of green roof technology and water re-use systems have been incorporated where appropriate to allow the rainwater generated from the site to be incorporated into a water management / site maintenance arrangements for use in such areas as landscape gardens, irrigation, wash down areas etc.

4.4 ISSUE:

Discharge of the foul sewage into combined sewer on North Circular Road.

The Sinn Fein submission notes as follows:
"One of the most disturbing aspects of the EIS is the acceptance of the report that the discharge of the foul sewage from the development into a combined sewer on North

Circular Road. This is a practise that is inconsistent with proper management of the drainage from the site……"

Response:
We wish to advise the Board that this submission is totally incorrect. In fact, discharge of foul sewage to the combined sewer system is the usual and most appropriate system to discharge into. We would additionally add that as noted in our statement above, under the operational phase of this development, the combined sewer in North Circular Road will be relieved of flow during periods of otherwise peak flows.

4.5 ISSUE:

Part of the development levy is ring-fenced and used for the upgrade of the local drainage network.

This issue was raised by Berkeley Environment Awareness Group and Pascal Donohoe, TD.

Response:
We wish to advise the Board that this is a matter for Dublin City Council and outside the control of the Applicant.

5. Conclusion

Following a review of available records and liaising with Local Authority stakeholders and the design team, the proposed potable water supply and subsequent drainage arrangements have been established.

It is proposed to connect into the recently up graded public potable water supply network adjacent to the site. This current water supply network has sufficient capacity to adequately supply the proposed development.
In order to maintain a sustainable water supply system the proposed scheme is to be fitted with water saving and reuse devices to reduce, as much as is practical, the quantity of water consumed.

The proposed foul system will connect into the adjacent public combined network. The proposed use of combined water saving devices will reduce the volume of effluent generated by the proposed development. The public drainage network has the capacity to adequately carry the proposed effluent volumes.

In accordance with best practice and in keeping with the principles of sustainable development, the proposed storm water system will incorporate a tiered approach to storm water management. The use of green roof technology and water reuse systems will allow the rainwater generated by the site to be incorporated into a water management/site maintenance arrangement. Furthermore, by installing a stormwater attenuation tank, extreme storm volumes experienced during intense storms will be controlled on site and allowed to enter the public system at a reduced discharge rate, thus reducing potential surcharging of the public drainage network during critical storm periods.