7. WATER: HYDROGEOLOGY & HYDROLOGY

7.1 Introduction

The following Environmental Impact Assessment Report (EIAR) section has been prepared by Colin O'Reilly PhD, of Envirologic Ltd on behalf of Barrett Mahony Consulting Engineers. This section should be read in conjunction with EIAR Section: Soils & Geology.

7.1.1 Methodology

The aims of this EIAR Section are to:

- Conduct a review to establish baseline conditions relevant to the hydrological and hydrogeological environment within the site boundary, and the local surrounding environs;
- Assess the potential impacts to the hydrological and hydrogeological environment, which can reasonably be expected to occur as a result of the proposed development;
- Implement suitable mitigation measures to address identified adverse impacts.

Documents consulted during the preparation of this EIAR Section are listed in the References section. This report has been compiled taking cognisance of:

- Guidelines for the preparation of soils, geology and hydrogeology chapters of environmental impact statement. Institute of Geologists of Ireland (2013);
- Revised guidelines on the information to be contained in Environmental Impact Statements. Environmental Protection Agency (2015).
- Draft Guidelines on the information to be contained in environmental impact assessment reports. Environmental Protection Agency (2017).

A site walkover survey was performed on 2nd September 2016.

7.2 Receiving Environment

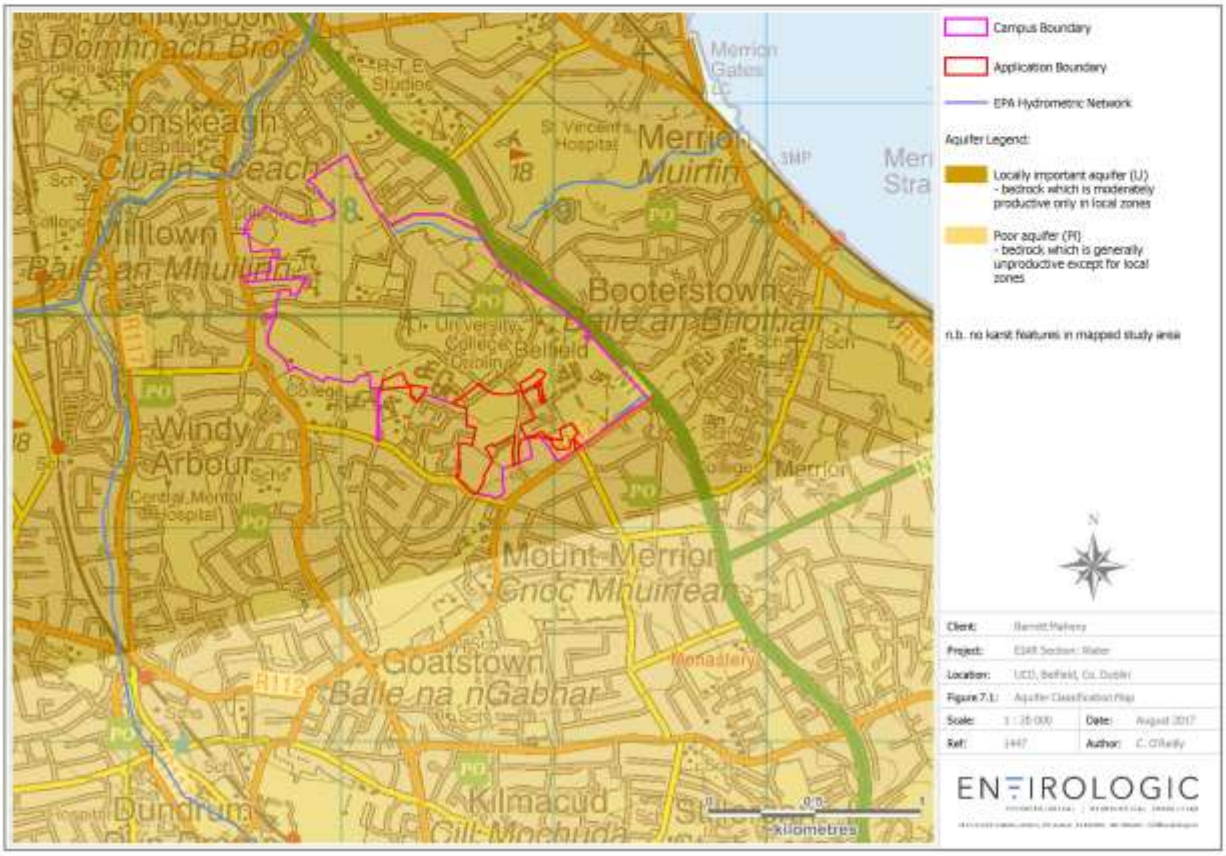
7.2.1 Soils & Geology

The soils, quaternary deposits and bedrock geology were discussed with accompanying figures in the EIAR Section: Soils & Geology. In summary, the soils are thick and exhibit generally moderate drainage with some local variation. The subsoils are a thick, low permeability till, typical of Dublin boulder clay. These are underlain by an impure limestone bedrock formation.

7.2.2 Aquifer Classification

Figure 7.1 shows that the GSI classifies Calp limestone as a locally important aquifer, which is moderately productive only in local zones (LI). These aquifers have a limited and relatively poorly connected network of fractures, fissures and joints, giving a low fissure permeability which tends to decrease further with depth. A shallow zone of higher permeability may exist within the top few metres of more fractured/weathered rock, and higher permeability may also exist along fault zones. These zones may be able to provide larger 'locally important' supplies of water. In general, the lack of connection between the limited fissures results in relatively poor aquifer storage and flow paths that may only extend a few hundred metres. Due to the low permeability and poor storage capacity, the aquifer has a low recharge acceptance. Some recharge in the upper, more fractured/weathered zone is likely to flow along the relatively short flow paths and rapidly discharge to streams, small springs and seeps.

Figure 7.1 Aquifer Classification Map



The Calp limestones are impure and hence not prone to karstification.

The site lies within the Dublin Groundwater Body (GSI, 2004), which reports that permeabilities in Calp limestone are likely to be low (1 – 10 m2 d-1), decreasing with depth. Dublin City is essentially a cement cap which prevents the area from receiving recharge. As such the area of the groundwater body beneath Dublin City will have different recharge processes than typically observed elsewhere in Ireland. Recharge to the aquifer may occur on greenfield areas such as parks, squares and gardens. Conservatively it is estimated that 10% of the city area is available for recharge. Some recharge occurs from leaking sewers, mains and storm drains though this is unquantified.

7.3.3 Vulnerability

The vulnerability categories, and methods for determination, are presented in Groundwater Protection Schemes (1999). The guidelines state that 'as all groundwater is hydrologically connected to the land surface, it is the effectiveness of this connection that determines the relative vulnerability to contamination. Groundwater that readily and quickly receives water (and contaminants) from the land surface is considered to be more vulnerable than groundwater that receives water (and contaminants) more slowly and in lower quantities. The travel time, attenuation capacity and quantity of contaminants are a function of the following natural geological and hydrogeological attributes of any area:

1) the subsoils that overlie the groundwater;
2) the type of recharge - whether point or diffuse;
3) the thickness of the unsaturated zone through which the contaminant moves.

The GSI have classified groundwater vulnerability across Belfield campus, including the application site, as 'Low' (Figure 7.2). This infers that depth of low permeability overburden is greater than 10 m (Table 7.1). This has been confirmed by site investigation in Area 1. Site investigation in Area 2 showed some localised sands and gravels and groundwater may have a higher vulnerability rating in this part of the site.

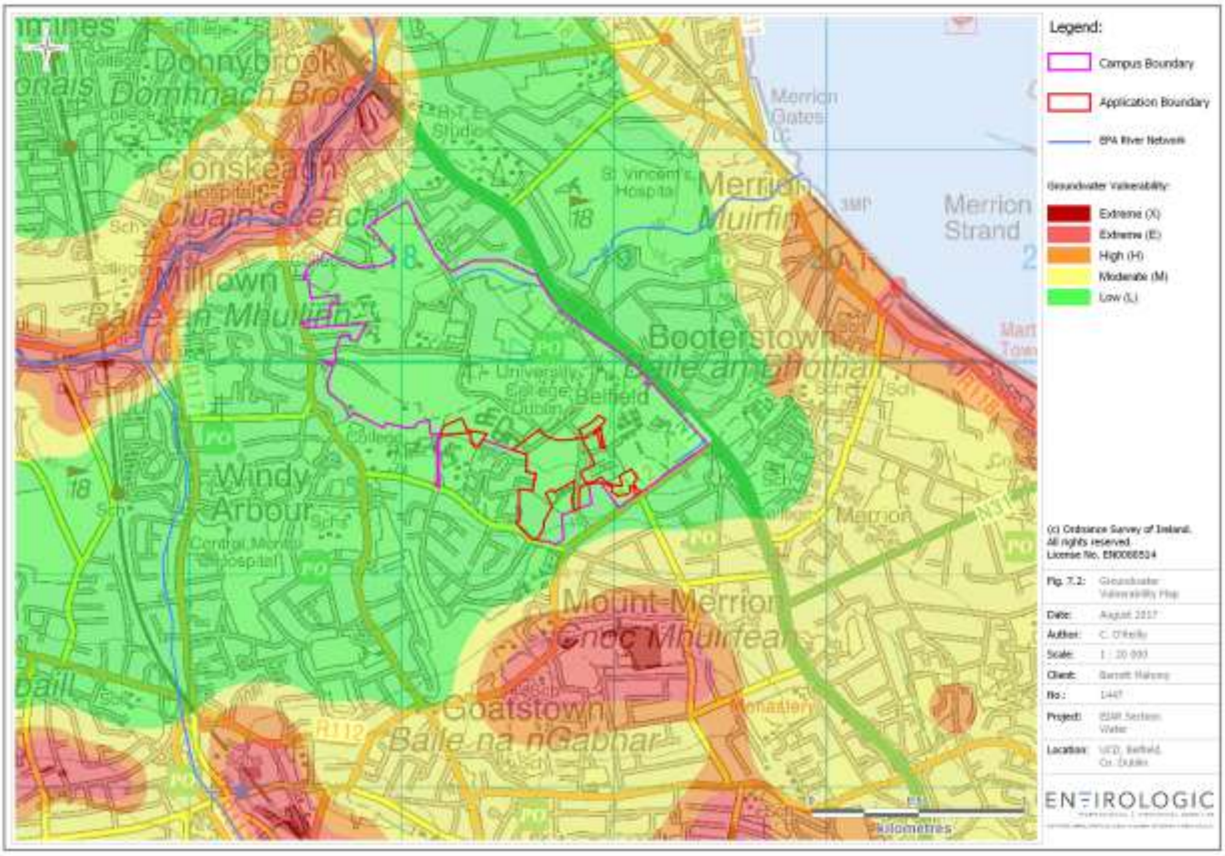
Table 7.1 Vulnerability Mapping Criteria (DELF/EPA/GSI, 1999)

Subsoil Thickness	Hydrogeological Requirements				
	Diffuse Recharge			Point Recharge	Unsaturated Zone
	Subsoil Permeability & Type				
	High permeability (sand & gravel)	Moderate permeability (sandy subsoil)	Low permeability (clayey subsoil, clay, peat)	(Swallow holes, losing streams)	(sand & gravel aquifers *only*)
0-3m	Extreme	Extreme	Extreme	Extreme (30m radius)	Extreme
3-5m	High	High	High	N/A	High
5-10m	High	High	Moderate	N/A	High
>10m	High	Moderate	Low	N/A	High

Notes: (i) N/A = not applicable

(ii) Permeability classifications relate to the material characteristics as described by the subsoil description and classification method

Figure 7.2 Groundwater Vulnerability Map



7.2.4 Source Protection

The site does not lie within a groundwater source protection area as mapped by the GSI or EPA. The closest source protection area to the site is 19 km southwest at Kilteel which is deemed too far to be at risk of impact.

7.2.5 Climatic Data

Monthly gridded rainfall data was sourced from Met Éireann (Walsh, 2012) and is presented in Table 7.2.

Table 7.2 Long term mean monthly rainfall data (mm) (Walsh, 2012)

J	F	M	A	M	J	J	A	S	O	N	D	Annual
70	52	58	53	61	60	50	64	60	82	81	77	768

The closest synoptic station to the site is at Casement Aerodrome, 14 km to the west, where average potential evapotranspiration (PE) is 510 mm yr-1. This value is used as a best estimate of the site PE. Actual evapotranspiration (AE) is estimated by multiplying PE by 0.95, to allow for the reduction in evapotranspiration during periods when a soil moisture deficit is present (Water Framework Directive, 2004). Actual evapotranspiration is therefore 484.5 mm yr-1 (0.95 PE).

The Effective Rainfall (ER) for the site is determined from:

ER = AAR – AE
= 768 mm yr^{-1} – 484.5 mm yr^{-1}
ER = 283.5 mm yr^{-1}

The application area 12.19ha. Hence, the volume of water from precipitation that is available for runoff or recharged directly is given by:

Site area runoff-recharge:

= area x ER
= 121,883 m^2 x 0.2835 m y^{-1}
= 34,553 m^3 yr^{-1} (91 m^3 d^{-1})

7.2.6 Recharge

Recharge coefficients can be utilized to estimate the proportion of water infiltrating to bedrock, against that moving laterally as shallow subsurface flow and surface overland flow. The recharge coefficient applicable to Low vulnerability and low permeability subsoil is 20% (Hunter Williams et al., 2013). The volume of groundwater recharge generated by precipitation falling within the site area can thus be estimated as:

Annual Recharge = (area x ER) x recharge coefficient
= 34,553 m^3 y^{-1} x 0.2
= 6,910 m^3 yr^{-1}

Areas covered in concrete are likely to have a reduced recharge coefficient closer to 10%.

7.2.7 Designated Areas

Designated areas of hydrogeological importance within 15 km of the site are presented in Table 7.3. The Elm Park Stream flows into South Dublin Bay SAC and Rockabill to Dalkey Island SAC. These are considered to be the primary designated areas at risk of potential impact from site activities.

Table 7.3 Designated Areas of Hydrogeological Importance

Designation	Area	Distance from Site
SAC	South Dublin Bay	1.3 km east
	Wicklow Mountains	8.2 km south
	North Dublin Bay	5.5 km north
	Rockabill to Dalkey Island	8.2 km east
SPA	South Dublin Bay & River Tolka Estuary	1.3 km east
	North Bull Island	5.2 km north
	Wicklow Mountains	8.2 km south
Proposed NHA	South Dublin Bay	1.3 km east
	North Dublin Bay	5.5 km north
	Grand Canal	4.3 km north
	Royal Canal	5 km north
	Dodder Valley	7.3 km west
	Fitzsimon's Wood	3.5 km south

	Dalkey Coastal Zone & Killiney Hill	5.8 km east
	Dingle Glen	7.1 km south
	Ballybetagh Bog	8.4 km south
	Glenasmole Valley	10.8 km southwest
	Lugmore Glen	12.7 km southwest
	Liffey Valley	10.4 km northwest

7.2.8 Surface Hydrology

An assessment of surface hydrology in the area is necessary to identify potential surface water receptors at risk of impact, in terms of flow and quality.

7.2.8.1 Surface Water Catchment

It is important to consider the surface water catchment, and any other potential upgradient sources of contamination to local surface watercourses, and the fate of any potential contaminants downstream. Where accessible, local streams were surveyed on 02/09/16 (Figures 7.3 and 7.4) using RTK VRS technique and referencing Malin Head as elevation datum. These levels, along with topographical contours, were used to define local surface water catchments, as shown in Figure 7.3.

The primary watercourse in the area is the River Dodder which rises in the Dublin Mountains. This flows in a northeast direction, parallel to the western campus boundary, before discharging to the sea at Ringsend. Only a minor proportion of Belfield campus lies within the Dodder catchment. The application site is not within the Dodder catchment.

The majority of Belfield campus, and the entire application site, is within the catchment of a first order stream that rises in Goatstown, and is referred to as the Elm Park Stream. This enters the Belfield campus at its southern boundary, behind the Belgrove residences, and is culverted through the centre of the campus via a 1200 mm by 2400 mm concrete culvert. This stream continues underneath the N11 just north of the main campus entrance before returning to an open channel through Elm Park Golf Course, and outfalling to the sea at Merrion. The surface water catchment to the Elm Park Stream at its outfall to the sea is estimated as being 5 km^2. It should be noted that natural catchment areas in heavily urbanised areas may have been altered by stormwater drainage networks.

Figure 7.3 Catchment Map

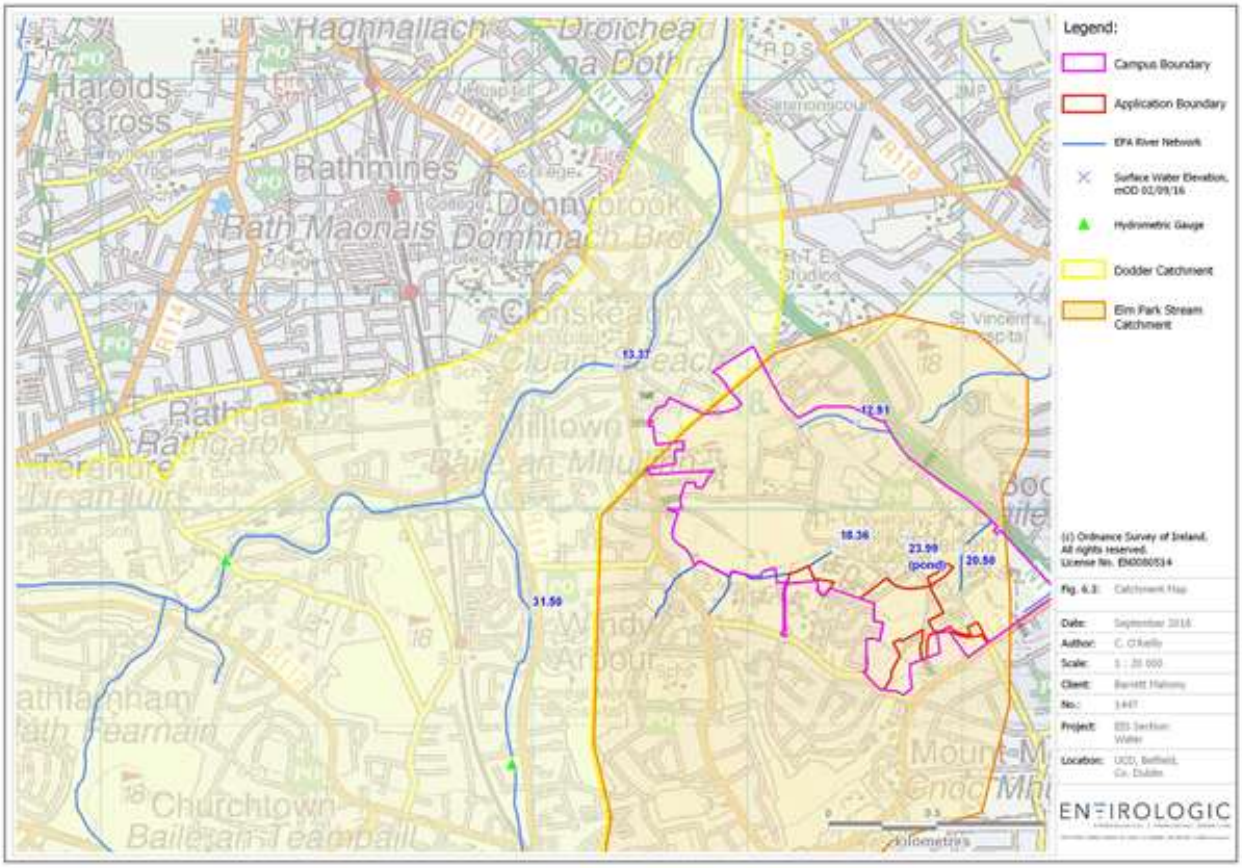
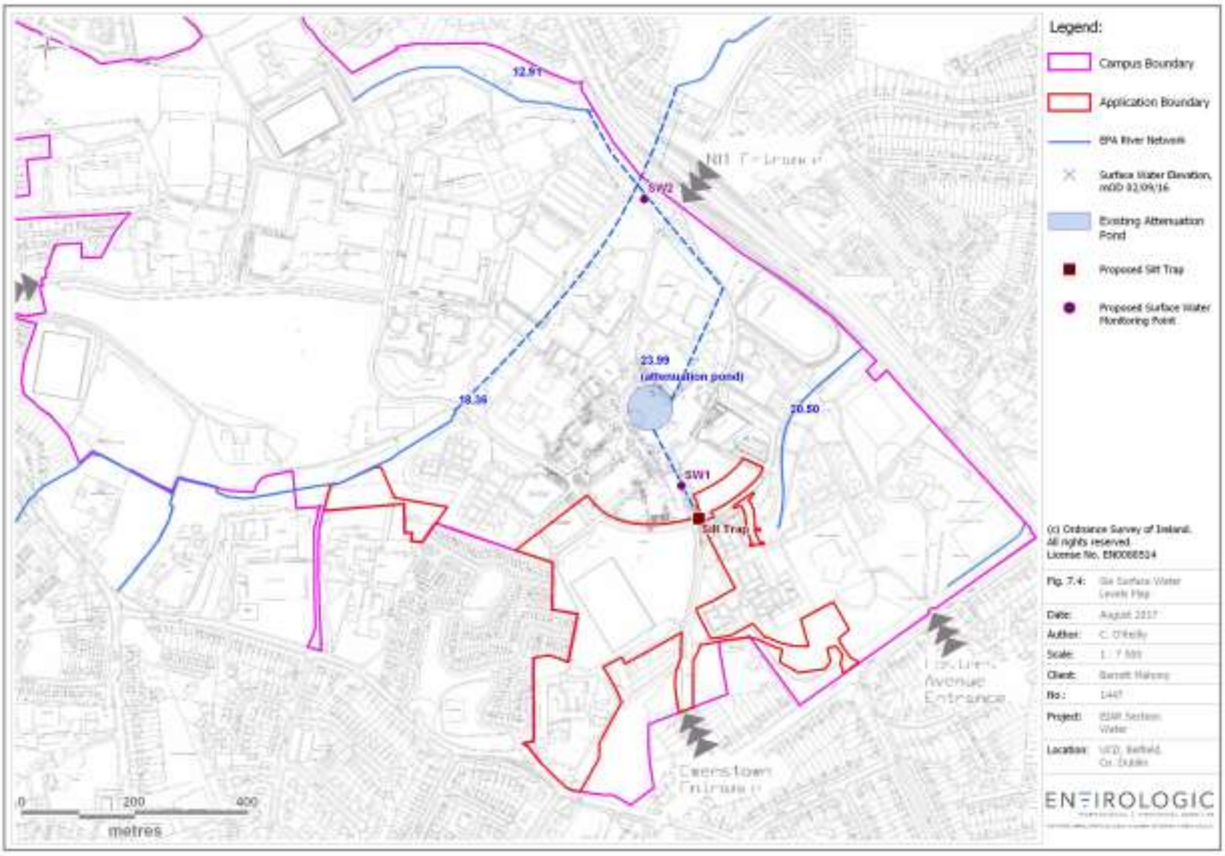


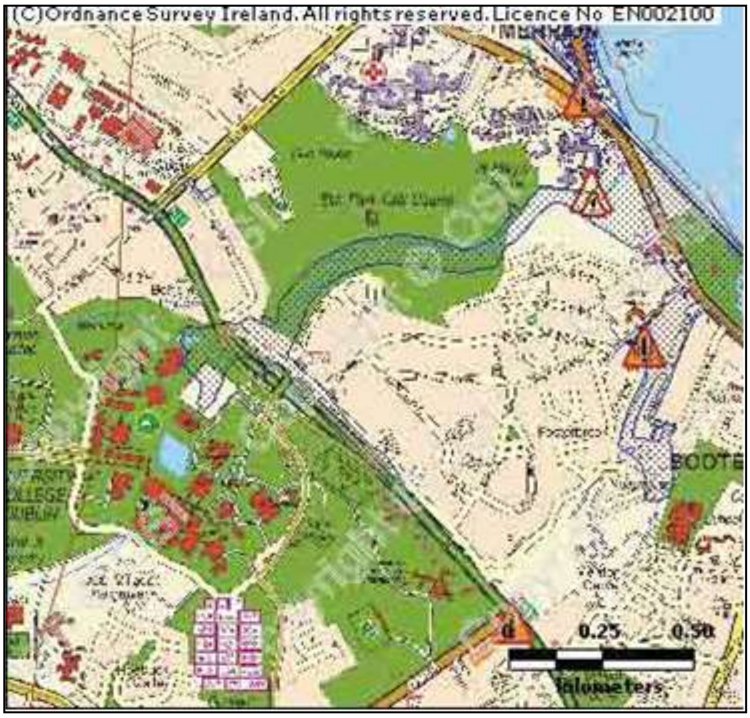
Figure 7.4 Site Surface Water Levels Map



7.2.8.2 Flood Risk

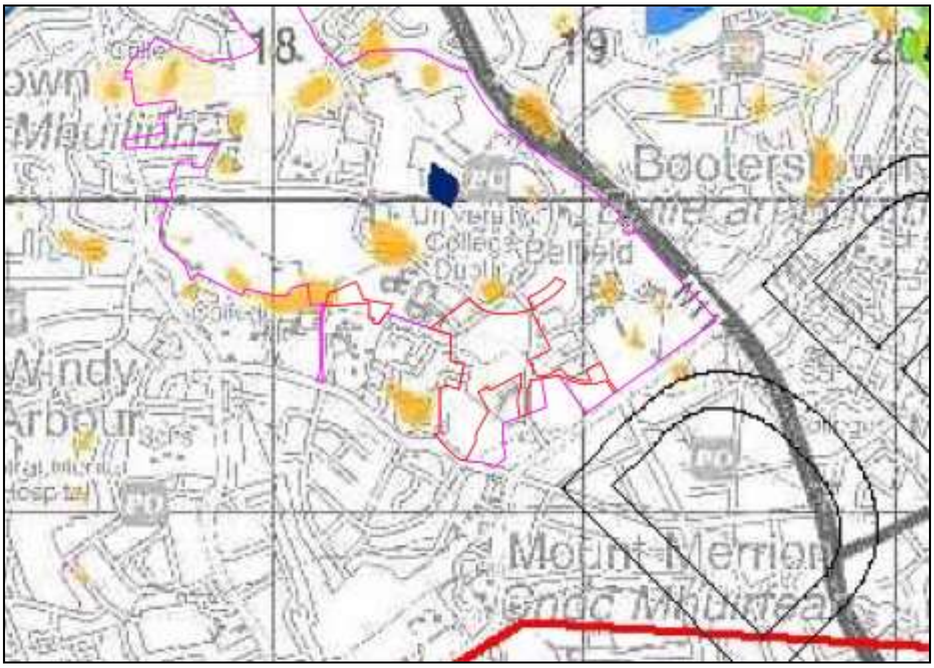
Reference was made to the OPW Floodmaps which shows that the nearest recorded flood event to the site is 1.4 km to the northeast at Merrion (see Fig. 7.5 below). This refers to a flood event in 1963 when high stream flows coincided with extreme high tides. The polygon shows the flood extents during this event flanked the open section of the stream through the golf course, backing up to the main campus entrance. The OPW data states 'the local authority who provided this flood information wishes to point out that a number of defence assets were put in place since one or more of the flood events described by this item.' There is no reported flooding at this location since 1963. The application site is shown not to be within an area of benefitting lands.

Figure 7.5 OPW Flood Maps as taken on 13th September 2016



The pFRA maps (map no. 238) show that the site is not at risk of fluvial or pluvial flooding (Fig. 7.6).

Figure 7.6 Application boundary superimposed on pFRA maps



The site is not included in the Eastern CFRAM maps or Dodder CFRAM maps.

The Irish Coastal Protection Strategy Study (OPW, 2013) shows the site to be unaffected by coastal flooding. 1 in 1000 year extreme high tide at Merrion is between 3.25 mOD (current) and 4.25 mOD (future worst case scenario).

A hydrometric gauge is in place on the Dodder River at Waldron's Bridge, 1.7 km southwest of the site. This shows that water levels surveyed on 2nd September 2016 represent approximate baseflow conditions. Gauge data also shows maximum flow over the last twenty years is in the order of 46 $m^3 s^{-1}$, corresponding to a peak level of 28.95 mOD Malin.

A hydrometric gauge is in place on the Slang River at Frankfort Close, 1.7 km southwest of the site. This shows maximum flow over the last twenty years is in the order of 2.6 $m^3 s^{-1}$, corresponding to a peak level of 38.65 mOD Malin.

7.2.8.3 Surface Water Quality

There is no upgradient catchment to the site from which to obtain surface water samples that would represent baseline surface water quality.

There are no EPA biological water quality monitoring sites on the Elm Park Stream. The EPA monitoring points on the Dodder are in a different catchment to the application and therefore not considered in further detail.

7.2.9 Hydrogeology

Understanding of the groundwater resource in the area is required to assess the potential impact to local groundwater receptors. There will be no abstraction of groundwater as part of the proposed development. There will be no direct or indirect discharge of treated stormwater to ground via unlined attenuation areas.

7.2.9.1 Groundwater Levels

The GSI database shows two wells downgradient of the site at the following approximate locations:

- Elm Park Golf Course. This is an 84 m deep borehole of 150 mm diameter installed in 1987. Bedrock was encountered at 15 m below ground. The recorded yield is 96 $m^3 d^{-1}$, which exhibited a drawdown of 14 m during a 48 hour pumping test. It is assumed that this is used for irrigation purposes.
- St Vincent's Hospital. This is a 12.4 m deep borehole installed in 1996. Bedrock was encountered at 10.2 m below ground. No hydrogeological details are on the GSI record.

During the 2016 IGSL site investigation groundwater seepages were observed in several of the boreholes (BH01. BH03, BH04). Slightly higher inflows were noted at the base of the sand lens in BH06. This is likely to be water resting on lower permeability subsoil or weathered bedrock.

Groundwater levels in standpipes were monitored over two site visits. Results of monitoring are shown in Table 7.4. These boreholes did not penetrate bedrock and as such these results are assumed to represent a perched water table in the stiff boulder clay.

Table 7.4 Groundwater levels in overburden monitoring wells

Borehole	Groundwater level, 21/01/16, mbgl	Groundwater level, 08/02/16, mbgl
BH1	1.10	0.95
BH4	2.30	2.15
RC3	0.90	0.75

7.2.9.2 Overburden Permeability

During the site investigation infiltration tests were carried out on the overburden to explore the feasilbity of utilising soakaways or infiltration trenches to dispose of surface water.

The following permeabilities were returned (refer to Figure 6.3 for trial pit locations):

- TP01 = 0.00074 m min^{-1} = 1 x 10^{-5} m s^{-1}
- TP02 = 0.00047 m min^{-1} = 8 x 10^{-6} m s^{-1}
- TP04 = 0.00056 m min^{-1} = 9 x 10^{-6} m s^{-1}

Subsoil permeabilities were considered too low to be suitable for disposal of surface water. These permeabilities are representative of the upper subsoil strata. Permeabilities are likely to decrease significantly with increasing depth, as the boulder clay becomes more compact and stiff. Dublin boulder clay is significantly stiffer than other well-characterised tills and has a mean permeability of 1 x 10^{-9} m s^{-1} (Long and Menkiti, 2007).

7.2.9.3 Groundwater Flow Direction

Assuming it follows local topography, i.e. towards the Irish Sea, then groundwater flow direction beneath the site is from southwest to northeast.

Given the thick, low permeability subsoils it is likely that there will be perched water tables. Perched groundwater flow direction is likely to be towards local streams, and therefore perpendicular to the regional groundwater flow direction. Under these conditions groundwater in the bedrock aquifer is likely to be confined.

7.2.9.4 Groundwater Quality

There is no historic groundwater quality data available which relates to the application site or surrounding area. The current status of the Dublin Groundwater Body is 'expected to achieve good status.'

Given the lack of groundwater receptors in the area, the thick layer of low permeability subsoils protecting the bedrock aquifer, and the nature of the proposed development, it was not deemed necessary to install groundwater monitoring boreholes to provide baseline groundwater quality data, or to serve as compliance points to monitor groundwater quality during the construction and operational phases.

7.3 Characteristics of the Proposal

The characteristics of the proposed development with regard to the hydrological and hydrogeological environment are outlined below. The characteristics pertain to both construction and operational activities.

7.3.1 Potable Water

Potable Water will be sourced from the existing campus supply fed off the 100mm water main on the N11 and supplemented by a new connection from the 200mm water main on Foster's avenue.

7.3.2 Domestic Wastewater

Student residences and other buildings containing toilet facilities will be connected to the foul mains sewer that runs through Belfield campus. Domestic wastewater is subsequently transferred to an existing Irish Water mains sewer.

7.3.3 Surface Water Runoff

Precipitation currently landing within the application site falls on:

- Hardstanding: roofed areas of buildings, roadways, footpaths;
- Permeable areas: playing pitches, temporary surface car parks.

That precipitation which falls on hardstanding areas passes to the campus stormwater drainage network, before passing to the DLRCC mains storm water network. Some of this water currently passes through existing underground attenuation devices (Roebuck Residences).

During construction and operational phases of the proposed development all surface water landing on hardstanding surfaces in the application site (to include Roebuck Residences) will be diverted towards an existing attenuation pond between the Engineering Building and Sutherland Law Building.

The attenuation pond was designed with the proposed development in mind and has sufficient extra capacity available. The area of hardstanding draining to the pond post-construction will be 6.8 ha. The outflow from the lake will be restricted to pre-development greenfield runoff rates of 45.2 $l\ s^{-1}$, controlled using a hydrobrake. The pond is capable of storing the excess runoff generated from this hardstanding area during a 1 in 100 year storm event (Barrett Mahony, 2016).

Where suitable footpaths shall be constructed from permeable paving. However, given the limited permeability of the underlying subsoil it is envisaged that though some rainwater will be stored as interception, the excess will enter the stormwater network.

The new Little Sisters and Sutherland School of Law car park surfaces will consist of permeable, coarse stone car spaces. The aisles will be finished in DBM draining to the permeable car spaces either side so no run-off will enter the stormwater network.

The existing overflow from the attenuation pond is to a 225mm diameter pipe. This will be redirected to a 375mm diameter pipe, that subsequently connects to a 600mm diameter pipe on the campus network.

This subsequently flows into a 750 mm/ 900 mm / 975 mm diameter concrete pipe which runs southeast to northwest along the southern side of the Stillorgan Road. West of the campus entrance this culvert outfalls to the culverted section of the Elm Park Stream that passes through the centre of the campus via a 2400 mm concrete box culvert.

7.3.4 Hydrocarbon Interceptor

There will be no refuelling of vehicles on the site during the operational phase. Machinery used during the construction phase will preferably be refuelled off-site. Where refuelling needs to be carried out on site this shall take place on a designated hardstanding area within the site compound. Runoff from this designated refuelling area will pass through an appropriately sized hydrocarbon interceptor prior to being diverted to the existing attenuation pond.

7.3.5 Silt Interceptor

A silt trap will be installed to treat runoff from the construction site. It will be sized to treat runoff from active construction areas.

The silt trap will be installed at the northeastern corner of the application site, treating water before it enters the attenuation pond (see Figure 7.4).

The attenuation pond will provide a residence time for further clarification of stormwater prior to it entering the Elm Park Stream and comfortably provides "Treatment Storage" as per SUDS requirements for the operational phase.

Surface water leaving both the silt trap and attenuation pond will be monitored on a regular basis to ensure both devices are efficiently removing sediment.

7.3.6 Basement Dewatering

During the construction phase minor dewatering may be required to provide dry working conditions during basement construction. Due to the low permeability subsoils it is envisaged that this will primarily be rainwater. The lowest working floor is predicted to be 4 m below ground level, and based on site investigation data bedrock will not be encountered. Based upon the low subsoils permeabilities it is not envisaged that sheet piling will be required to stem groundwater flows entering the basement construction area.

Rainwater falling in the basement area during construction phase will drain to a minor sump from which water will be pumped to the silt trap, and subsequently discharged to the attenuation pond. A perimeter french drain will prevent surface runoff from entering the basement construction area.

During the operational phase rainwater will not enter the basement. A minor sump will be installed as a mitigation measure to collect minor inflows from entrance ramp, condensation, etc. This collected water will be pumped to the Foul Sewer, via an appropriately sized hydrocarbon interceptor.

7.3.7 Discharges to Groundwater

There will be no discharges to ground during the construction or operational phases.

7.3.7 Use of Natural Resources

Water will be used off-site in the processing of raw material (bedrock, gravel, sand) and production of precast concrete, readymix concrete, readymix mortar, blocks and bricks. Mains water will be used during the construction and operational phases as outlined above.

7.4 Potential Impacts

The procedure for determination of potential impacts on the receiving water environment was to identify potential receptors within the site boundary and surrounding environment and use the information gathered during the desk study and site walkover to assess the degree to which these receptors will be impacted upon. Impacts are discussed in terms of quality, significance, duration and type. The impact definitions and criteria are further detailed in EPA Guidelines (EPA, 2015).

In accordance with the NRA Guidelines the site is deemed to be an attribute of 'Low' importance. Although it is classified as a locally important aquifer it supplies potable water to less than 50 homes, and is of significance or value on a local scale only. The ultimate fate of stormwater is the Elm Park Stream which is considered to be an attribute of 'Medium' important given that it discharges to South Dublin Bay SAC.

The potential impacts from the construction and operational phases of the proposed development are summarized in Table 7.5, using the headings discussed under the criteria for determination of impacts (Tables 7.A.1, 7.A.2, 7.A.3).

The key activities during the construction phase will involve the excavation of material for foundations and basement car park, deliveries of imported engineering fill, crushed stone, concrete, reinforcement and other construction materials. Other construction activities will include site storage of cementituous material such as mortar, temporary oils and fuels. The primary impacts arising from such activities are:

- Increased runoff;
- Increased sediment load in runoff and subsequent deposition in local watercourses;
- Contamination of local watercourses with hydrocarbons, cementituous material.

7.4.1 Cumulative Impacts

When considered in tandem with other existing developments in the area, the proposed development will result in further removal of greenfield areas and replacement with hardstanding. This will result in a cumulative reduction in recharge to the groundwater aquifer. The effect of this is considered negligible given the lack of groundwater users in the area. The increase in hardstanding will also increase surface water runoff generated on the campus. Flow control devices have been installed to restrict runoff to pre-development greenfield runoff rates so there should be no cumulative increase in flood risk to the Elm Park Stream. Stormwater in excess of the greenfield runoff rate shall be retained on campus.

All stormwater leaving the application site during the construction phase and operational phase will pass through silt interceptors. Hydrocarbon interceptors will treat runoff where there is a potential source of hydrocarbons. Hence there should be no cumulative impact to receiving surface water quality (surface water and groundwater).

The proposed development will result in a cumulative increase in potable water demand and foul water discharge. Infrastructural requirements for such increases are subject to agreement with Irish Water and Dún-Laoghaire Rathdown County Council. Irish Water's Pre-Connection Enquiry Feedback states that the development is feasible without upgrade of the Public system.

7.4.2 Unplanned Events

Consideration has been given to environmental impacts associated with unplanned events such as accidents, floods, etc . Section 7.3.8.2 has shown that the risk of flooding on site is negligible.

Heavy rainfall events during the construction phase may give rise to increased risk of sediment loss. Suspended sediment control measures have been designed to cater for high intensity rainall events. Several independent mitigation measures will be implemented for entrapment of mobilised sediment to compensate for surcharging of any one of these control measures. Adequate attenuation will be incorporated into the surface water runoff system during construction and operational phases to mitigate against flood flows.

7.4.3 Do-Nothing Scenario

The do-nothing scenario means that runoff from greenfield areas (e.g. playing pitches) will be at greenfield runoff rates. Runoff from hardstanding areas within the application site, such as Roebuck Residences, currently passes though an attenuation device prior to entering the surface water network.

Table 7.5 Summary of Potential Impacts

Activity	Attribute	Character of Potential Impact	Importance of Attribute (refer to Table 6A.1)	Magnitude of Potential Impact (refer to Table 6A.2)	Term	Significance of Potential Impact (refer to Table 6A.3)
Construction Phase						
Removal of vegetation during the construction phase	Receiving stream	Silt-laden runoff from exposed subsoil. The increased silt content in runoff has potential to degrade local surface water quality.	Medium	Moderate	Short-term	Moderate
Stockpiling of topsoil/subsoil	Receiving stream	Silt-laden runoff from stockpiles. The increased silt content in runoff has potential to degrade local surface water quality.	Medium	Moderate	Temporary	Moderate
Storage of hydrocarbons; leakages from machinery; spillages during refuelling	Receiving stream/ aquifer	Runoff/recharge during the construction phase may contain hydrocarbons.	Low (aquifer)/Medium (stream)	Moderate	Short-term	Moderate
Spillages of cementituous material, washdown of concrete trucks	Receiving stream/ aquifer	Runoff during the construction phase may contain cementituous material.	Low (aquifer)/Medium (stream)	Moderate	Short-term	Moderate
Removal of overburden	Aquifer	Increase in vulnerability of underlying aqufier	Low	Small	Permanent	Imperceptible
Foul water	Receiving stream/ aquifer	Lack of sanitary facilities prior to connection with mains sewer being established	Low (aquifer)/Medium (stream)	Moderate	Temporary	Moderate
Interception of upgradient surface and subsurface drains entering site	Receiving stream	Contamination of upgradient runoff entering site	Medium	Small	Long-term	Slight

Contamination of groundwater	Aquifer	Impact to downgradient groundwater receptors	Low	Small	Temporary	Imperceptible
Operational Phase of Proposed Development						
Increased runoff rates from hardstanding and roofed areas	Receiving stream	Increase in flood risk to local watercourses	Medium	Small	Long-term	Slight
Hardstanding installation	Aquifer	Reduction in recharge to groundwater	Low	Negligible	Permanent	Imperceptible
Reduction of subsoil depth	Aquifer	Increase in groundwater vulnerability	Low	Small	Permanent	Imperceptible
Contamination of groundwater	Aquifer	Impact to downgradient groundwater receptors	Low	Small	Long-term	Imperceptible

7.5 Mitigation Measures

The principal objectives of the mitigation measures are:

- Plan and design water pollution, erosion and sediment controls;
- Minimise erosion and potential for soiled water to be generated by minimizing site runoff volumes and the area of exposed ground;
- Prevent natural, clean runoff entering the works area;
- Provide appropriate control and containment measures on site;
- Install drainage and runoff controls before starting site clearance and earthworks;
- Prevent any direct discharges from the construction site into the Elm Park Stream through on-site treatment and overland flow treatment.

The significant potential impacts identified in Table 7.5 are resolved under the mitigation measures set out under Table 7.6.

Table 7.6 Summary of mitigation measures

Activity	Attribute	Character of Potential Impact	Mitigation Measure	Predicted Impact
Construction Phase				
Removal of vegetation during the construction phase	Receiving stream	Silt-laden runoff from exposed subsoil. The increased silt content in runoff has potential to degrade local surface water quality.	Excavations will remain open for as little time as possible before the placement of fill. This will minimise potential for runoff from exposed soil/subsoil. Topsoil stripping be will be restricted to the minimum area required for efficient earthworks operation. Silt traps will be placed in the receiving drainage network to minimise silt loss. Maintain a vegetated margin of at least 10 m around the working area where possible.	Imperceptible
Stockpiling of topsoil/subsoil	Receiving stream	Silt-laden runoff from stockpiles. The increased silt content in runoff has potential to degrade local surface water quality.	Maximise distance of stockpiles from gullies and drainage channels. Excavations will remain open for as little time as possible before the placement of fill. This will minimise potential for water ingress into excavations. Silt traps will be placed in the recieving drainage network to minimise silt loss. Weather conditions shall be taken into account when planning construction activities to minimise risk of runoff from the site. Maintain a vegetated margin of at least 10 m around the working area where possible. A manhole between the pond and the Elm Park Stream will serve as a sampling chamber (see Figure 7.4) for the construction phase.	Imperceptible
Storage of hydrocarbons; leakages from machinery; spillages during refuelling	Receiving stream/ aquifer	Runoff/recharge during the construction phase may contain hydrocarbons.	Potentially contaminating substances will be stored in designated areas that are isolated from gullies or open channels. Hazardous wastes such as waste oil, chemicals and preservatives will be stored in sealed containers. Fuelling, lubrication and storage areas will be in a designated area, not within 30 m of surface waters. All waste containers will be stored within a secondary containment system (e.g. a bund for static tanks or a drip tray for mobile stores and drums). The bunds will be capable of storing 110% of tank capacity, plus a minimum 30 mm rainwater allowance where the bund is uncovered. Where more than one tank is stored, the bund must be capable of holding 110% of the largest tank or 25% above the aggregate capacity. Drip trays used for drum storage must be capable of holding at least 25% of the drum capacity. Regular monitoring of water levels within drip trays and bunds due to rainfall	Imperceptible

			will be undertaken to ensure sufficient capacity is maintained at all times. There will be no storage of fuels on site. Refuelling shall be by mobile bunded bowser at a designated area, i.e. ste compound, or where possible off-site. An adequate supply of spill kits and hydrocarbon absorbent packs shall be stored in this area.	
Spillages of cementituous material, washdown of concrete trucks	Receiving stream/ aquifer	Runoff during the construction phase may contain cementituous material.	All ready-mixed concrete shall be delivered to site by truck. A suitable risk assessment for wet concreting shalll be completed prior to works being carried out. Washdown and washout of concrete trucks, with the exception of the chute, will take place at an appropriate facility off-site. There will be no hosing into surface drains or gullies of spills of concrete, cement, grout or similar materials. Such spills shall be contained immediately and runoff prevented from entering the drainage network. Given the significant amount of concrete to be laid on site, if the concrete contractor insists that trucks are washed out on site, then washings from such shall pass through a temporary settlement tank with pH correction.	Imperceptible
Removal of overburden	Aquifer	Increase in vulnerability of underlying aqufier	Removal of subsoil to facilitate basement installation may increase vulnerability from Low to Moderate. Given that the excavated area will be covered in hardstanding, which reduces recharge even further, there is no decrease to groundwater protection. Based on site investigation data it is not envisaged that bedrock will be encountered.	Neutral
Foul water	Receiving stream/ aquifer	Lack of sanitary facilities prior to connection with mains sewer being established	Permanent sanitary facilities, including connection to mains foul sewer, are available.	Neutral
Interception of upgradient surface and subsurface drains entering site	Receiving stream	Contamination of upgradient runoff entering site	Cut-off drains shall be provided to intercept clean runoff water and divert away from the site work areas. Small overflow dams and geotextile silt barriers shall be installed in any perimeter channels within the construction site.	Neutral
Contamination of groundwater	Aquifer	Impact to downgradient groundwater receptors	Site runoff during construction phase will be diverted to surface water drainage network, following treatment. There will be no direct or indirect discharges to ground.	Imperceptible
Operational Phase				
Increased runoff rates	Receiving stream	Runoff from hardstanding and roofed areas	Sustainable Urban Drainage Systems (SuDS) shall be implemented to control all runoff leaving the site at pre-development greenfield runoff rates. Refer to Section 13 of EIAR for further details.	Neutral

Runoff contaminated with hydrocarbons	Receiving stream/ Aquifer		There will be no bulk storage of fuels on site. All runoff generated on basement car parks will discharge to the foul sewer.	Neutral
Silt-laden runoff	Receiving stream	Suspended solids having a negative impact on riverine habitats	All runoff generated on hardstanding (excluding roofed area) will pass through the on-site pond. The pond provides adequate residence time for settlement of suspended solids.	Neutral
Removal of subsoil	Aquifer	Increase in groundwater vulnerability	Any areas from which subsoil is removed will be subsequently covered in hardstanding which further reduces recharge. There is no decrease to groundwater protection.	Neutral
Contamination of groundwater	Aquifer	Impact to downgradient groundwater receptors	Hardstanding will prevent diffuse recharge across the site. There will be no direct discharges to ground.	Neutral

7.6 Residual Impacts

Based upon the remediation measures outlined in the EIAR the predicted residual impacts on the hydrological and hydrogeological environment during the construction phase will be a short-term imperceptible impact. The implementation of mitigation measures will ensure that the predicted impacts on the hydrological and hydrogeological environment do not occur during the operational phase and that the residual impact will be of a long-term imperceptible significance.

7.6.1 Monitoring

A project-specific Construction and Environmental Management Plan (CEMP) is to be established and maintained by the contractors during the construction and operational phases of the proposed development. The Plan will cover all potentially polluting activities and include an emergency response procedure. All personnel working on the site shall be trained in the implementation of the procedures. As a minimum, the manual will be formulated in consideration of the standard best international practice including but not limited to:

- CIRIA, 2011. Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors;
- CIRIA, 2005. Environmental Good Practice on Site (C650);
- BPGCS005. Oil Storage Guidelines;
- CIRIA, 2007. The SuDS Manual (C697);
- Environment Agency, 2004. UK Pollution Prevention Guidelines (PPG).

Any installations recommended under mitigation measures should be inspected on a daily basis by a designated person. Topography slopes generally from south to north and during the construction phase site runoff will be directed towards the drainage network at the northern site boundary. Site runoff during the operational phase shall be directed towards the attenuation pond, as described previously.

Two compliance points shall facilitate monitoring of site runoff during the construction phase and to ensure there is no degradation of surface water quality in the Elm Park Stream or South Dublin Bay SAC. The compliance/monitoring points are:

1) SW1 = Between outlet of silt trap and attenuation pond;

2) SW2 = Between outlet of attenuation pond and Elm Park Stream.

Parameters for analysis are presented in Table 7.7, with Surface Water Regulations threshold values also indicated. Sampling interval will be agreed with local authority.

Table 7.7 Proposed Surface Water Monitoring Parameters

Parameter	Units	Surface Water Regs (SI 272 2009)	Surface Water Regs (1989)
pH		5.5 – 9.0	
Conductivity	µS cm^{-1}	1000	
Alkalinity	mg/l HCO_3		
BOD	mg/l		
COD	mg/l		
Suspended solids	mg/l		50 (A1 waters)
Ammonia	mg/l N	0.14	
Nitrate	mg/l NO_3	50	
Total Nitrogen	mg/l N		
Total Phosphorus	mg/l P	0.035 – 0.07	
Sulphate	mg/l SO_4	200	
Chloride	mg/l Cl	250	
Boron	mg/l B	0.025	
Cadmium	mg/l Ca		
Copper	mg/l Cu	0.005	
Iron	mg/l Fe		
Lead	mg/l Pb	0.072	
Magnesium	mg/l Mg		
Manganese	µg/l Mn		
Mercury	µg/l Hg		
Nickel	µg/l Ni	0.02	
Sodium	mg/l Na		
Zinc	µg/l Zn	8	
Fractionated Hydrocarbons	µg/l		
Total coliforms	mpn/100ml	5,000	
Faecal coliforms	mpn/100ml	1,000	

7.6.2 End of Use

There is no planned timeline for the longevity of the proposed development. At end of use stage the buildings would most likely be demolished. Demolition will give rise to increase loss of sediment matter to watercourses. The demolition protocol will ensure mitigation measures for entrapment of sediment.

7.7 Conclusions & Summary

In the context of surface water the primary impacts are to surface water quality, due to contamination with hydrocarbons and building materials such as concrete, and transport of silt from the site. A number of temporary mitigation measures will be implemented to prevent any negative impact to surface water quality during construction phase. Permanent mitigation measures, primarily silt interception by the existing lake and hydrocarbon interceptors for the basement car park will protect water quality during the lifetime of the proposed development. A stormwater attenuation device shall control stormwater flows from the site at pre-development greenfield runoff rates, and this will protect against any potential increase in flood risk due to the introduction of hardstanding. Attenuated stormwater will be diverted to the Elm Park Stream.

The potential risk to groundwater is less due to the protective coverage provided by a thick layer of low permeability overburden. As this is removed for site development the protection to the underlying aquifer is temporarily reduced. Mitigation measures will protect against any impact to groundwater quality. Hardstanding will be installed on any areas where subsoil has been disturbed, thereby protecting the underlying aquifer. Foul water is to be discharged to a mains sewer network.

Potential impacts to the hydrological and hydrogeological environment have been assessed, and appropriate mitigation measures have been presented. There are no likely significant impacts on the hydrological or hydrogeological environment associated with the proposed development of the site. It is not anticipated that any impacts will arise following the implementation of the mitigation measures outlined in the EIAR.

7.8 References

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Appendix 7.A: Impact Definitions