Section 10:
Soils, Water, Hydrology and Hydrogeology

10.1 INTRODUCTION

This chapter of the EIS document has been prepared by DBFL, Consulting Engineers, and addresses the drift and solid geology associated with the site. It looks at natural water bodies carrying surface water including streams, rivers and lakes (hydrology). It also looks at groundwater, shallow and deep, (hydrogeology) and where applicable estuarine waters and marine waters which may be affected by the proposed development.

10.2 STUDY METHODOLOGY

The assessment of the potential impact of the proposed development on the geology and water bodies was carried out according to the methodology specified by the EPA and the specific criteria set out in the Guidelines on Information to be Contained in an Environmental Impact Statement (EPA 2002) and the Advice Notes On Current Practice (in preparation of Environmental Impact Statements) (EPA 2003).

Information on the geology formation, groundwater and hydrogeology was assembled from the following sources;

- Site visit;
- Site investigation Report,
- Geological Survey of Ireland (GSI) online maps and databases,
- GSI Geology of Kildare-Wicklow document,
- EPA online maps and databases,

In the context of Soils and Geology, cognisance was also paid to the document produced by the Institute of Geologists of Ireland, "Geology in Environmental Impact Statements – a guide", September 2002. This document outlines the likely impacts and potential mitigation measures for geological issues by topic, although no importance criteria are given by which the impact can be graded.

In the context of water quality, to assess the existing quality of surface waters in the vicinity of the proposed site, a desk based assessment, including a review of published water quality data information for the area, was undertaken. This information was extracted from the Environmental Protection Agency Website and the extracted map is reproduced in Figure 10.2

DBFL Consultant Engineers engineering team provided design information on runoff associated with the development.

10.3 RECEIVING ENVIRONMENT

10.3.1 BACKGROUND

With regard to the receiving environment we address individually the components associated with section of the EIS namely the soils (drift geology), bedrock (solid geology), hydrology and hydrogeology for the site in turn.

10.3.2 SOILS (DRIFT GEOLOGY)

The glacial drift deposits overlying the bedrock are generally comprised of Dublin Boulder Clays. This is a lodgement till which has accumulated at the base of glaciers. The boulder clays generally consist of gravel, and occasional cobbles and boulders embedded in a stiff clay and silt matrix. Boulder clays encountered during site investigations can typically be separated into an upper brown boulder clay overlying deeper grey/black boulder clay deposits. The brown boulder clay is considered to be a weathering product of the underlying grey/black boulder clay and differs slightly from the grey/black boulder clay in character. Glacial gravels and sands can be present within the boulder clays as 'pockets' of variable lateral and vertical extent. Site Investigation reports are provided in Appendix 10.1

10.3.3 BEDROCK (SOLID GEOLOGY)

According to the bedrock maps of Kildare and Wicklow produced by the Geological Survey of Ireland and GSI online mapping service (Figure 10.1)The bedrock geology of this area is of the Lower Carboniferous period, a mostly limestone bedrock. This type of rock covers large areas of counties Dublin, Kildare and Meath.

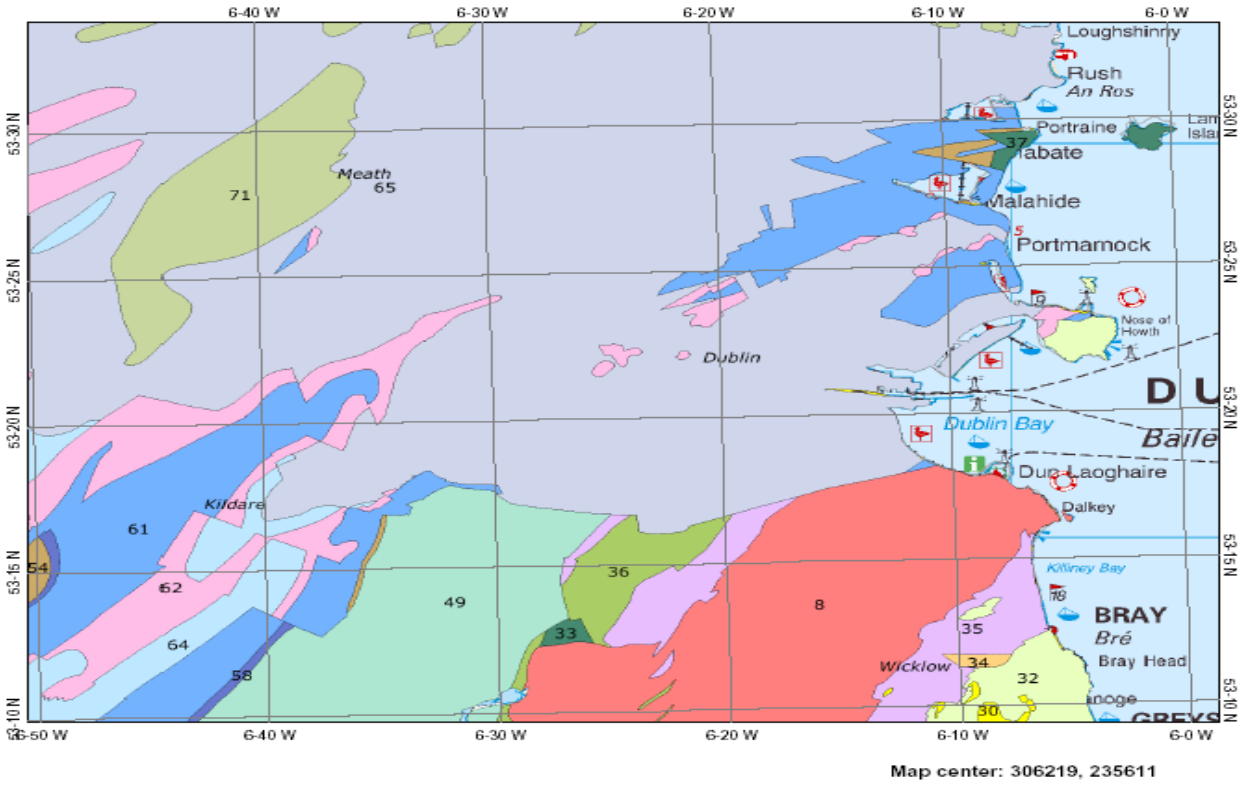

Figure 10.1: Bedrock Geology Map (Source: GSI Mapping Service)

10.3.4 HYDROLOGY (NATURAL WATER COURSES)

The nearest natural watercourse is the Liffey Estuary. The subject site falls within Hydromeric Area No. 9 (River Liffey) and is within the urban centre of Dublin and

lies over 500 metres north of the Liffey Estuary, downstream of the River Liffey, and upstream of the River Cammock junction with the estuary. The River Liffey rises at Kippure in the Wicklow Mountains, and flows from there in a great meandering arc for almost 100 kilometres, until it encounters the salt water of the tidal reach at Islandbridge. The broad sixty-kilometre plain of the Liffey lies between the Mourne Mountains to the north and the Wicklow Mountains to the south.

According to EPA online records (Figure 10.2) the water quality associated with the River Liffey upstream of the subject site is Q3-4 Moderate Status, and the River Cammock is Q2-3 Poor Status. The Liffey assessment was undertaken in 2007 200metres downstream of Chapelizod Bridge. Historical Assessments at Islandbridge: UCD Boat Club between 1971 and 1991 show the Staus as Q3. The Cammock Assessment indicated that the River had bad status Q1-2 based on readings from 1981 to 2002. A recent reading in 2008 indicated that some improvement had taken place with the quality improving to Q2-3 Poor Status.

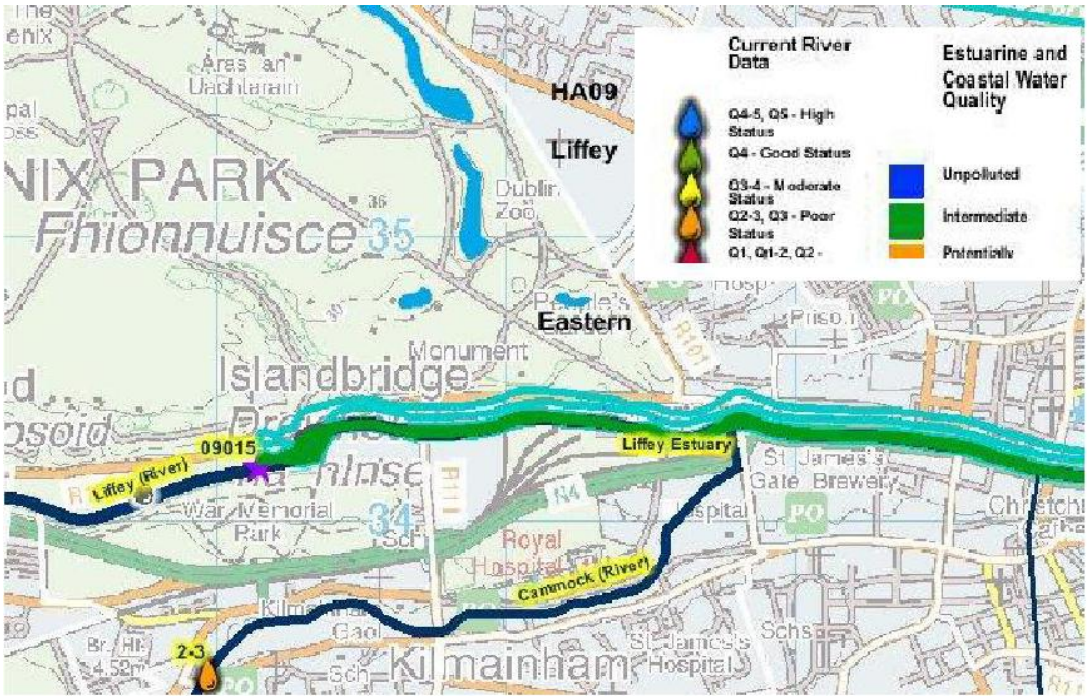

Figure 10.2 Water Framework Directive River Status (Source: EPA.)

The EPA uses the Q value system for assessing river water quality. This system describes the relationship between water quality and the macroinvertebrate community in numerical terms. Q5 waters have high diversity of macroinvertebrates and good water quality, while Q1 have little or no macroinvertebrate diversity and bad water quality. Intermediate values, Q1-2, 2-3, 3-4 etc denote transitional conditions. The presence of pollution causes changes in flora and fauna of rivers. Well documented changes occur in the macroinvertebrate community in the presence of organic pollution: Sensitive species are progressively replaced by more tolerant forms as pollution increases.

In the context of the Liffey Estuary, this is identified as being Nutrient Sensitive waters. Since 2000, Water Management in the EU has been directed by the Water Framework Directive (WFD). One of the conditions of this Directive is that Member States keep a Register of all the water bodies that must have extra controls on their quality by virtue of how the water is used by people and by wildlife. Nutrient Sensitive waters include nitrate vulnerable zones and areas designated as sensitive areas under the Urban Waste Water Treatment Directive (91/271/EEC).

Furthermore the Estuarine water quality has been defined as Intermediate as a consequence of Eutrophication (Figure 10.2). Eutrophication has long been the principle pressure on lake water quality in Ireland, but in recent years there has been increasing evidence that nutrient inputs are causing similar problems in estuarine and marine waters. Eutrophication is caused by enrichment of water by nutrients (especially phosphorous and/or nitrogen compounds) causing an accelerated growth in algae and other plant forms, which causes an undesirable disturbance to the balance of organisms present in the water, and the quality of the water. In addition, eutropied waters may experience mass growth and strandings of algal material, which typically produces very strong odours and visual impact as it degrades on beaches and shorelines.

The subject site currently discharges both surface and foul drainage to a public combined sewer and not directly to the watercourse. Direct responsibility for untreated waters entering the River Liffey from the public sewer is generally associated with its maintenance.

Flood records indicate that a severe tidal flooding incident occurred on the Liffey Estuary in 2002 (Details are provided in Appendix 10.2). While the flooding did not affect the subject site directly, it is likely that the interceptor sewer running along the North Quays would have been affected resulting in untreated waters entering the Liffey. Also, as the public sewer system is combined, overflows to the Liffey during extreme rainfall events are likely as the system makes its way to the treatment facility.

The water quality within the designated water courses will be particularly affected by the quantity and quality of surface water run-off from the contributing areas. In the context of the subject site, the area is small with surface waters either entering the local geology or the public sewerage network. An annual precipitation of up to 800mm is typical for this area.

According to the OPW flood mapping service, no flooding has occurred within 1 km of the subject site. When the search is extended out to 2.5 km, there a number of flood incidents (Details are provided in Appendix 10.2). However, the risk to the subject site would be considered very low. Therefore, in the absence of a separate Flood Risk Assessment and Management Study (FRAMS) for the Liffey at this location and based on the justification method presented in the new planning guidelines for flood risk assessment, this issue of fluvial flooding requires no further comment.

10.3.5 HYDROGEOLOGY

Groundwater can be defined as water that is stored in, or moves through, pores and cracks in sub-soils. Aquifers are rocks or deposits that contain sufficient void spaces and which are permeable enough to allow water to flow through them in significant quantities. The potential of the rock to store and transport water is governed by permeability, of which there are two types, inter-granular and fissure permeability.

Intergranular permeability is found in sediments, sands, gravels and clays. Fissure permeability is found in bedrock, where water moves through (and is stored in) cracks, fissures, planes and solution openings.

When considering groundwater it is important to consider the underlying geology, its complexity including faults, the large amounts of water and rainfall available for recharge and the overlying Quaternary deposits.

The bedrock geology of this area is of the Lower Carboniferous period, a mostly limestone bedrock. This type of rock covers large areas of counties Dublin, Kildare and Meath. Permeability in these strata is a function of the lithology, extent of dolomitisation, faulting or fracturing and degree of karstification. The geology of this area is incredibly variable, but it is usually dominated by low permeability, fine grained and argillaceous limestones and shales. The GSI bedrock aquifer map (Figure 10.3) indicates the development lands are within a "Locally Important Aquifer", and that bedrock is "Moderately Productive only in Local Zones".

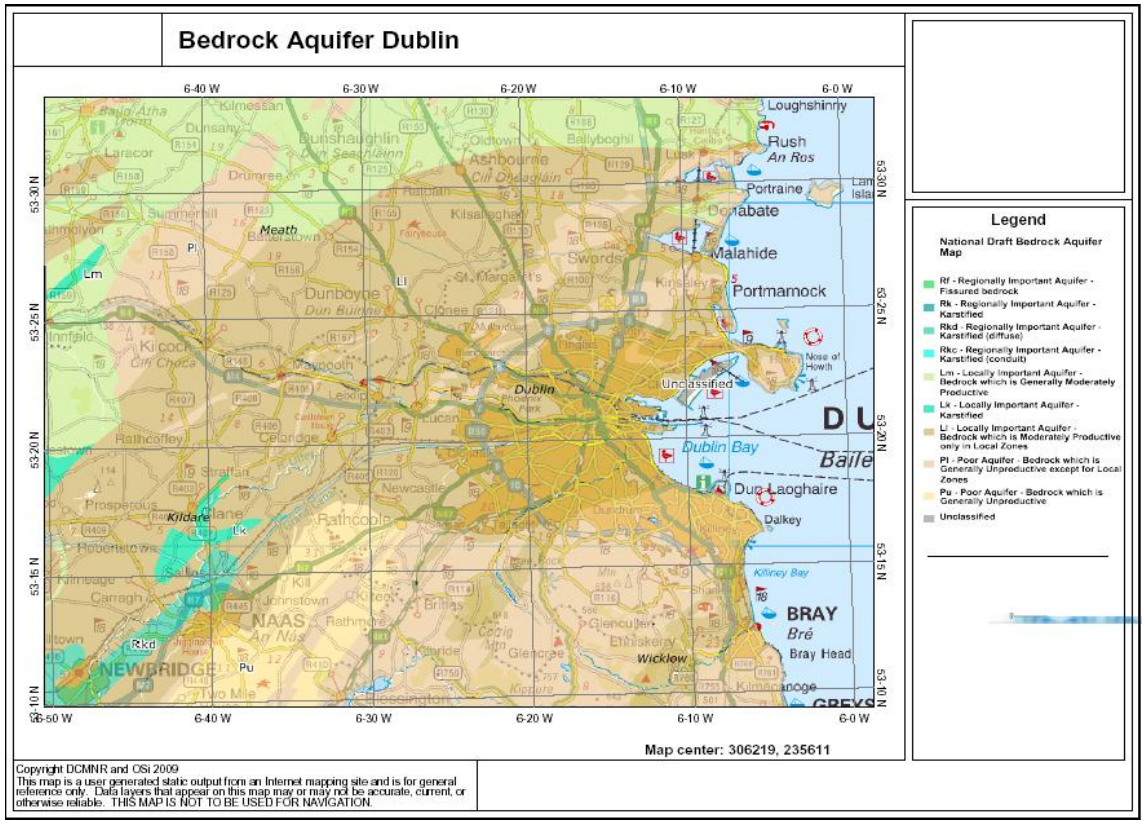

Figure 10.3 Bedrock Aquifer Map (Source GSI)

The Draft Interim Groundwater Vulnerability Map produced by GSI (Figure 10.4) as part of the Water Framework Directive programme indicates that the subject site is within an area that has a vulnerability rating of high to low with only an interim study conducted to date.

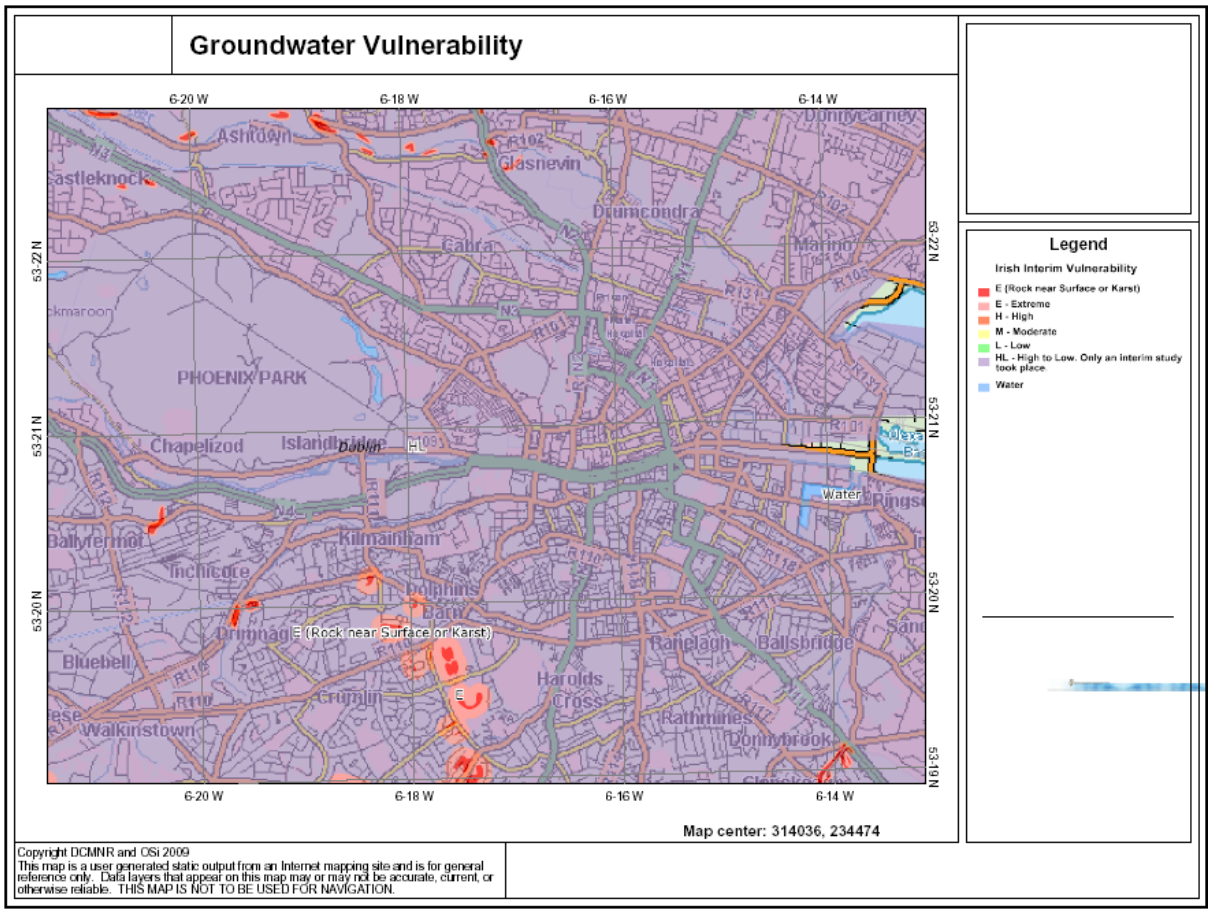

Figure 10.4 Interim Groundwater Vulnerability Map. (Source: GSI.)

As pointed out previously the drift geology for the site would be typically considered as boulder clay with limited permeability with occasional zones of gravels. This is confirmed by the typical clay make-up presented on the borehole logs. Water was encountered in some bore holes but was likely to be small pockets. Water strikes appeared at levels starting at 2 metres below ground level. This relatively shallow flow could be attributable to the base flow of the Liffey Estuary.

10.4 CHARACTERISTICS OF THE PROPOSALS

10.4.1 BACKGROUND

Consideration of the Characteristics of the Proposed Development allows for a projection of the 'level of impact' on any particular aspect of the proposed environment that could arise.

A full description of the proposed development is provided in Section 2 of this EIS document. The masterplan for the area, for both phases cumulatively, has identified the potential for 398 residential units accommodating 1810 persons, 3160 square metres of community / commercial space and an allowance of 4680 square metres for a public park. This represents an increase in the number of residents from approximately 700 (subject to current occupancy figures) compared with the masterplan proposals of 1810. This represents an increase of 259% in the context of the O'Devaney Gardens site specifically, but only represents just over 25% of an increase on the Intermediate neighbourhood population associated with the Arran Quay Area Band D and just over 6% of the wider neighbourhood area covering all Arran Quay Census areas.

The increase in development size will result in the decanting of residents to alternative accommodation or the phasing of the scheme will be undertaken to generate the new residential accommodation first and allow transfer to the new accommodation.

10.5 POTENTIAL IMPACT OF THE PROPOSED DEVELOPMENT

10.5.1 OVERVIEW

This section of the EIS looks at the potential impact of the proposed development on the soils, geology, hydrology and hydrogeology associated with the site and its surroundings.

10.5.2 SOILS & DRIFT GEOLOGY

Construction Phase

The following aspects of the proposed development have the potential to affect or interact with soils:

- Demolition of the existing buildings
- Regrading of the proposed site;
- Soil removal from the 'footprint' of the roads, car park and the site building;
- Soil disturbance in areas where the levels or drainage need to be altered; and
- Soil excavation for trenching (for buried services).

The level of significance of the impacts on the soils resource will be directly proportional to the type of interaction with the proposed development. Soil removal will permanently impact the soil resource of the areas affected. The total site area is 5.7 Ha, approx. of which after completion 30% would be retained as

green or permeable and the remaining used for car parking, residential, commercial and community based buildings all being impermeable. The latter area represents a significant, but highly localised, negative impact given the loss of the non-renewable natural resource.

Soil compaction, principally due to movement of construction traffic, is a potential impact associated with sites proposed for development, which if it occurs it can alter the drainage patterns of the soil, with subsequent implications for both soil productivity and surface water drainage.

Site preparation works will include site clearance (excavation of soil and subsoil for storage and re-use on to proposed landscaped areas to the site), construction of site and a construction compound area. The topsoil layer will be removed from the areas proposed for building construction. The excavated topsoil material will be retained on site for construction of mounds/berms and for general landscaping purposes. A cut and fill operation will be necessary to re-grade certain parts of the site. It is anticipated that the majority of the soil will remain onsite to be disposed of during landscaping or reengineered for suitable back fill material.

In the context of soil replacement materials imported to site, these will be natural stones sourced from locally available quarries. The majority of imported soil replacement materials will be granular in nature and used in the construction of road pavement foundations, drainage and utility bedding and surrounds. Materials will be brought to site and placed in their final position in the shortest possible time. Any imported material will be kept separate from the indigenous arisings from the site. All excavation to accommodate imported material will be precisely co-ordinated to ensure no surplus material is brought to site beyond the engineering requirement.

Engineered materials will also be introduced to the site including cementitious, and bituminous materials. The use of these materials as soil replacement will be limited only to optimised engineering requirements for the purposes of trafficked pavement and thoroughfare construction. The placement of these materials will typically be within the top 0.5 metres of the current surface levels. Based on the findings of the intrusive geotechnical assessment this depth is formed in made ground and not virgin material. Therefore, the impact on the local drift geology is minimal.

Operation Phase

There is no direct impact on the drift geology as a result of the operational phase.

10.5.3 SOLID GEOLOGY

Construction Phase

As the development will typically occur in the overburden to the site no geological impacts are expected to result from the proposed development on the solid geological resource.

Operation Phase

There is no direct impact on the solid geology as a result of the operational phase

10.5.4 HYDROLOGY (NATURAL WATERCOURSES)

Construction Phase

Although direct impact on the Liffey estuary 500 metres south in an urban environment is considered remote, the potential remains for contamination during the construction process from solid laden waters flowing over-ground (roads and streets) to the Estuary.

Operational Phase

While there is no direct impact on the Liffey Estuary as a result of the operational phase, the possibility exists for shallow groundwater contamination through foul or contaminated surface water discharging and meeting the base-flow for the Liffey Estuary.

10.5.5 HYDROGEOLOGY

Construction Phase

It is not envisaged that the construction works for the developments would have any direct impact on the underlying bedrock geology. However there is potential impact on the groundwater environment during construction arising from spills or leaks of fuels and oils from machinery and vehicles. Extensive earthworks will require large machines on site during the construction phase including excavators, bulldozers and trucks from which accidental spillages or leaks may have the potential to infiltrate to the locally important aquifer.

The potential likely and significant impact on hydrogeology during the construction phase is considered to be short term, temporary and low.

Operational Phase

The day-to-day activities of the completed proposed development would be unlikely to have any direct impact on the groundwater environment. The majority of the surface water will be allowed to recharge with any silts trapped by active surface systems and filtrated passively by penetration through the soil layers. The risk of spills or leaks of fuels and oils from vehicles associated with the developments may impact on the surface water system, however with the inclusion of light liquid interceptors prior to the discharge location is designed to address this.

Basements are not presented in the masterplan for this site. Therefore, the depth of foundations will be governed by ground conditions only. Given the structures are relatively small in overall height, foundations are unlikely to extend to a depth that would impact greatly on the movement of ground water.

There is therefore unlikely to be any significant impact on hydrogeology from the operation phase of the proposed development.

10.6 DO-NOTHING IMPACT

In order to provide a qualitative and equitable assessment of the proposed development, this section considers the proposed development in the context of the likely impacts upon the receiving environment should the proposed development not take place.

Form a general viewpoint; if the proposed development does not proceed there would be no additional impact on the local soils, bedrock, hydrology and hydrogeology . Nonetheless, in the context of existing infrastructure and receptors the following comments are made specifically:

- Pluvial flooding events would continue to be a risk.
- Groundwater status would remain unchanged if the current development and active drainage systems remained.
- Groundwater contamination would continue to be at risk due to ageing foul water infrastructure.
- Contamination of the Liffey Estuary would still remain a risk with the surface water contribution to the public combined sewer.

10.7 REMEDIAL OR REDUCTIVE MEASURES

Remedial and mitigation measures describe any betterment or corrective measures that are either practicable or reasonable, having regard to the potential impacts. This includes avoidance, reduction and remedy measures as set out in Section 4.7 of the Development Management Guidelines 2007 to reduce or eliminate any significant adverse impacts identified

Construction Phase

The following mitigation measures are proposed for the construction phase of the proposed development with reference to reduction of impact on solid and drift geology as well as hydrology and hydrogeology:

CONST 1: Construction works will be carried out with the least feasible disturbance of soils. All sub soils should remain on site and engineered into the design solution in order to minimise materials leaving the site

CONST 2: Basement excavations should be kept to a minimum to reduce impacts to the subsoil, topsoil and drift geology;

CONST 3: Where soil stripping/ excavation occurs the resulting excavated soil fractions will be separated into topsoil and subsoil stockpiles.

CONST 4: Temporary storage of spoil will be managed to prevent accidental release of dust and uncontrolled surface water run-off which may contain sediment and solid matter.

CONST 5: Heavy vehicle movement and construction works on exposed soils will be minimised during prolonged periods of wet weather.

CONST 6: Areas compacted due to heavy vehicle/machinery movements will be concentrated wherever possible on areas proposed for future hardstanding / impervious features i.e. roads, buildings.

CONST 7: Any soil excess to the requirements of the cut and fill operation at the site will be conveyed to an appropriately licensed or permitted facility by a licensed contractor in accordance with Local Authority/EPA guidelines. The soil volume will be kept to a minimum.

CONST 8: Dewatering measures should only be employed where necessary;

CONST 9: In the event of groundwater being encountered during the construction phase, mitigation measures will include dewatering by pumping to an appropriate treatment facility prior to discharge. Other measures would include excluding contaminating materials such as fuels and hydrocarbons from sensitive parts of the site i.e. highly vulnerable groundwater areas.

CONST 10: To minimise any possible contamination of the surface watercourses in the vicinity, which would ultimately discharge to the River Liffey, a settlement pond and interceptor trenches will be constructed along the southern boundary (lowest contour level) of the site.

CONST 11: Mitigation measures should be put in place by the contractor in relation to storage of fuels and other materials and general maintenance of the site.

CONST 12: Construction of the proposed roads infrastructure should be conducted in a controlled manner and in such a way as to prevent risk of flooding to locations downstream.

CONST 13: Surface water collecting in excavations should be directed to on-site settlement ponds, where silt removal will be facilitated prior to discharge to the further reduce the possibility of contaminants entering the local water system.

CONST 14: If concrete mixing is carried out on site, the mixing plant should be sited in a designated area with an impervious surface.

CONST 15: When it is necessary to store diesel or oil fuels on site, they should be stored in appropriate containers in bunded storage areas.

CONST 16: Any hazardous construction materials shall be stored appropriately;

CONST 17: Sewage generated during the construction phase of the project would be discharged to temporary portable toilet facilities. These units would be maintained and the waste collected therein would be disposed of using an appropriate contractor. The potential

impacts of wastewater on soil and groundwater media are therefore considered to be minimal.

Operational Phase

The following mitigation measures are proposed for the operational phase of the proposed development with reference to reduction of impact on solid and drift geology as well as hydrology and hydrogeology.

OPERAT 1: Stormwater storage structures and drainage systems should incorporate infiltration to promote the potential for ground water recharge.

OPERAT 2: Regular inspection of the hydraulic controls, gullies, catchpits and petrol interceptors will be required to prevent contamination and increased runoff from the site or contribution to the shallow hydrogeology. Warning alarms should be provided.

OPERAT 3: In order to reduce the risk of defective or leaking sewers or water supply pipework, all new pipework should be laid in accordance with the relevant standards, pressure tested and CCTV surveyed as appropriate to ascertain any possible defects.

Remedial and mitigation measures describe any betterment or corrective measures that are either practicable or reasonable, having regard to the potential impacts. This includes avoidance, reduction and remedy measures as set out in Section 4.7 of the Development Management Guidelines 2007 to reduce or eliminate any significant adverse impacts identified.

10.8 RESIDUAL IMPACT & MONITORING

The residual impact on the soils, geology, hydrology and hydrogeology linked to the site will be minimal.

Although no specific monitoring will be required as part of the proposed development it is envisaged that EPA Monitoring will continue in the area through the life of the development in respect of water quality and ground water.

10.9 INTERACTIONS

This section of the report should be read in conjunction with the site services section, specifically in regard to man-made water conduits.