Chapter 10
Water (including Hydrology & Flood Risk)

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10. WATER (INCLUDING HYDROLOGY & FLOOD RISK)

10.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) presents the hydrological assessment of the proposed construction and operational phases of the DART+ West project (hereafter referred to as the 'proposed development'). This chapter sets out the methodology used in the assessment (Section 10.3), details the likely significant impacts associated with the construction and operational phase of the proposed development (Section 10.6), describes measures to mitigate identified significant impacts (Section 10.7) and details residual impacts post mitigation (Section 10.9).

This chapter should be read in conjunction with the following chapters, and their appendices, which present related impacts arising from the proposed development and proposed mitigation measures to ameliorate the predicted impacts:

- Chapter 4 Description of the Proposed Development.
- Chapter 5 Construction Strategy.
- Chapter 8 Biodiversity.
- Chapter 9 Land and Soils.
- Chapter 11 Hydrogeology.

10.2 Legislation, policy, and guidance

10.2.1 Legislation

This chapter has been prepared in accordance with a number of laws including inter alia the following:

- EU Directive 2011/92/EU as amended by Directive 2014/52/EU on the assessment of the effects of certain public and private projects on the environment ("the EIA Directive"), the Transport (Railway Infrastructure) Act 2001 (as amended and substituted), the European Union (Railway Orders) (Environmental Impact Assessment) (Amendment) Regulations 2021 (S.I. No. 743/2021) which give further effect to transposition of the EIA Directive by amending the Transport (Railway Infrastructure) Act 2001.
- Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for action in the field of water policy (as amended) ('EU Water Framework Directive') requires all Member States to protect and improve water quality in all waterbodies so that they achieve good ecological status by 2015 or, at the latest, by 2027. It has been given legal effect in Ireland by, *inter alia*, the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003) (as amended) and the European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009),
- It applies to rivers, lakes, groundwater, transitional and coastal waters. The Directive requires that management plans be prepared on a river basin basis and specifies a structured method for developing these plans.
- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks ('EU Floods Directive') which came into force in 2007, aims to reduce the adverse consequences of flooding on human health, the environment, cultural heritage and economic activity. The EU Floods Directive was transposed into Irish law by the European Communities (Assessment and Management of Flood Risks) Regulations 2010, (S.I. No. 122 of 2010), which were amended by*, inter alia,* the S.I. No. 470/2012 - European Union (Environmental Impact Assessment) (Flood Risk) Regulations 2012 and the European Communities (Assessment and Management of Flood Risks) (Amendment) Regulations 2015, (S.I. No. 495 of 2015).

10.2.2 Policy

Relevant policy documents that have informed this chapter include:

- Dublin City Development Plan 2016-2022.
- Draft Dublin City Development Plan 2022-2028.
- Fingal Development Plan 2017-2023.
- Draft Fingal Development Plan 2023-2029.
- Kildare County Development Plan 2017-2023.
- Draft Kildare County Development Plan 2023-2029.
- Meath County Development Plan 2021-2027.
- North Lotts and Grand Canal Dock Strategic Development Zone Planning Scheme 2014.
- Ashtown – Pelletstown Local Area Plan 2014.
- Pelletstown Local Area Plan 2014.
- Hansfield Strategic Development Zone Planning Scheme 2006.
- Kellystown Local Area Plan, January 2021.
- Barnhill Local Area Plan 2019.
- Leixlip Local Area Plan 2020-2023.
- Maynooth Local Area Plan 2013-2019.

10.2.3 Guidance

This chapter has been prepared having due regard to relevant EIA guidance documents listed in Chapter 1 and the specific policy and guidance listed below:

- Environmental Protection Agency (EPA) (2002), *Guidelines on the Information to be Contained in Environmental Impact Statement*.
- Environmental Protection Agency (EPA) (2003), *Advice Notes on Current Practice in the Preparation of Environmental Impact Statement.*
- Environmental Protection Agency (EPA) (2022), *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (EIAR).
- Transport Infrastructure Ireland (TII 2009) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.
- Transport Infrastructure Ireland (TII 2008) *Guidelines for the crossing of watercourses during the construction of National Road Schemes*.
- DoEHLG (Nov 2009) *The Planning System and Flood Risk Management – Guidelines for Planning Authorities.*

10.3 Methodology

10.3.1 Study Area

The primary study area includes lands within 250 m of the proposed development as shown in Figure 10-1 below. Consideration is also given to the surface waterbodies that are potentially hydrologically linked to the study area, this includes the Tolka and Liffey estuaries.

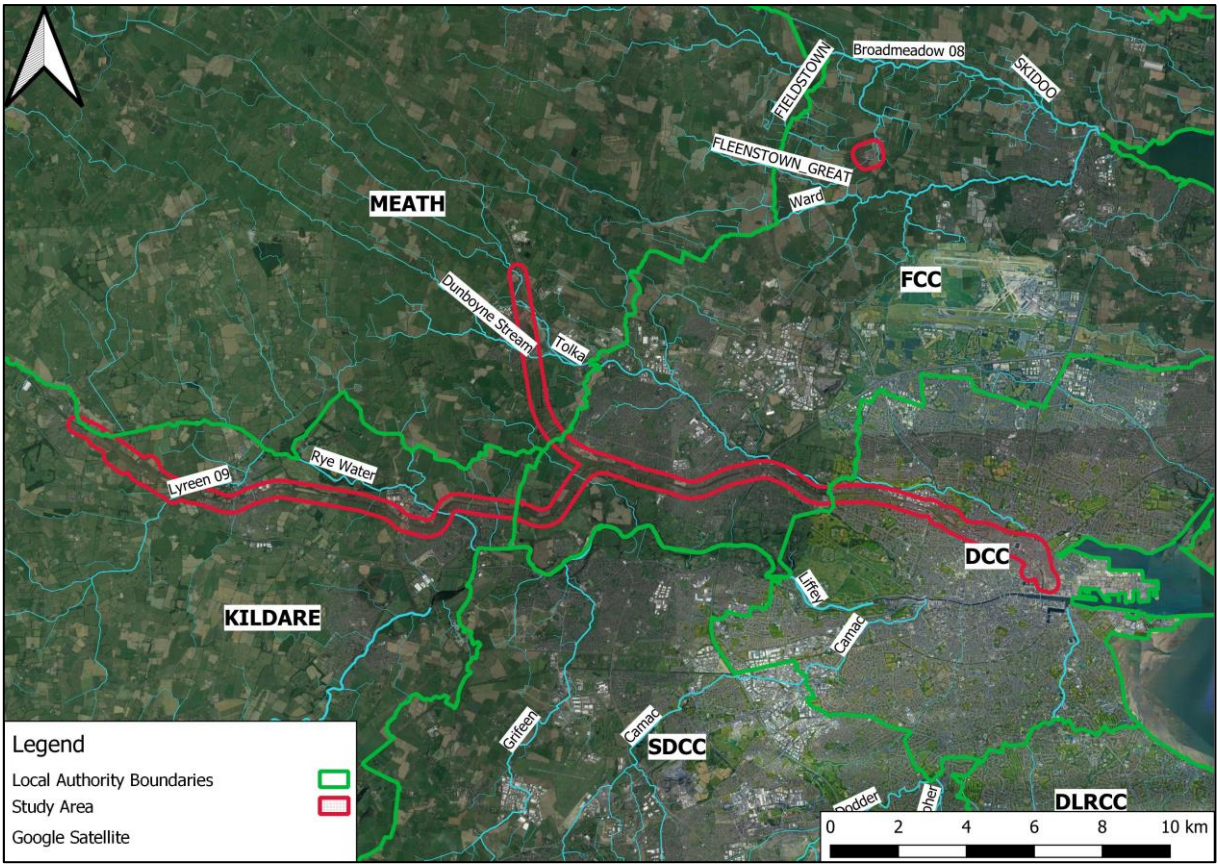

Figure 10-1 Study Area

10.3.2 Survey methodology

The hydrological impact assessment methodology is in agreement with the guidance outlined in Sections 5.6 and 5.7 of the TII '*Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, 2009'*. The impact category, duration and nature of impact have been assessed in this chapter, as per the guidelines. The range of criteria for assessing the importance of hydrological features within the study area (site boundary + 250 m) and the criteria for quantifying the magnitude of impacts follow the TII guidelines and the EPA (2022) '*Guidelines on the Information to be contained in Environmental Impact Assessment Reports*'.

The hydrological assessment includes a review of published literature available and web-based search for relevant material. Site specific topographical information and aerial photography has been reviewed to locate any potential features of hydrological interest, and these have been investigated on the ground by a walkover survey undertaken from March 2020 through to June 2021, in order to assess the significance of any likely environmental impacts.

Available topographical and hydrometric information (field and desk based) has been used to perform hydrological impact assessments of the proposed development. All watercourses and water bodies which could be affected directly (i.e., crossed or realigned/ diverted) or indirectly (i.e., generally those that lie within 250m of the proposed development) were assessed through previous site walkover visits followed up by a detailed desk study and hydrological assessment.

Water quality monitoring has been progressed to provide baseline information relating to key reaches in the vicinity of the proposed development. The monitoring is focused on the Lyreen river and tributaries and constitutes macroinvertebrate and physiochemical sampling.

A site-specific flood risk assessment has been prepared for the proposed development in line with OPW guidelines detailing the existing flood risk within the vicinity of the development and the proposed flood risk

management measures incorporated throughout the development design. Hydraulic modelling was undertaken in combination with hydrological flow estimation for key river reaches to confirm flood risk.

10.3.2.1 Field surveys

Field surveys and walkover assessments were carried out to assess the hydrological impacts of the proposed development. Detailed topographical surveys were conducted for key sections of major and minor watercourses to inform the hydraulic assessment of multiple watercourses where hydrological impacts were likely to occur. The topographic survey was complimented by high resolution LiDAR surveying of floodplains and wider catchments.

10.3.2.2 Desk study

A desk study was completed in order to obtain information on the receiving hydrological environment using the following sources:

- Teagasc – Subsoil Map.
- Aerial Photography.
- Environmental Protection Agency (EPA) Surface Water Quality.
- EPA Viewer WFD Scores for Rivers, Transitional Water Bodies and Coastal Waters.
- OPW (Office of Public Works) Preliminary Flood Risk Assessment Mapping (pFRA).
- OPW Catchment Flood Risk Assessment and Management Mapping (CFRAMs).
- OPW Flood Hazard mapping.
- Irish Coastal Wave and Water Level Modelling Study.
- Geological Survey of Ireland (GSI) Web Mapping.
- Strategic Flood Risk Assessments for Dublin City, Fingal County, County Kildare County Development plans a well as Maynooth Local Area Plan.

10.3.2.3 Consultation

Consultations were undertaken with all local authorities within the study area, Waterways Ireland, Irish Water and the Office of Public Works. Specific consultation was undertaken with Kildare County Council in May 2021 regarding the provision of compensatory storage within the vicinity of OBG23 Jackson's Bridge and the proposed depot lands.

10.3.2.4 Hydrology impact assessment methodology

Types of hydrological impact for the proposed development fall into two broad categories of quantitative and qualitative impacts.

Quantitative impacts: Hydraulic structures such as bridges, culverts, channel diversions, outfalls and flood defences can, if not appropriately designed, impact negatively on upstream water levels and downstream flows. If the conveyance area of a river is significantly reduced it may impede flow during times of floods thus causing water levels within the vicinity of the structure to be raised above what would occur in the absence of the structure and potentially increase flooding of undefended lands.

Qualitative impacts: The nature of the proposed development requires the crossing of multiple watercourses, and which poses an inherent risk of surface water contamination during the construction phase. Construction works have the potential to mobilise silts and sediments in the water column. Additionally, changes to the drainage network may convey contaminants to receiving waterbodies.

10.4 Difficulties encountered/limitations

Topographic surveys were procured at key locations throughout the study area to inform the hydraulic assessment of watercourses and associated flood risk. At the time of publication, the topographic survey of the Westmanstown stream has not been completed due to issues with access arrangements to private lands directly upstream of the culvert under the Royal Canal. Nonetheless, the hydraulic assessment has progressed based on data provided by Fingal County Council which included a topographic survey of the channel undertaken in 2017. It is our understanding that no significant changes to the channel upstream of the canal culvert have occurred since 2017. However, thus far we have been unable to confirm due to the aforementioned access issues. It is noted that that a previous restriction to flow has been removed by Iarnród Éireann at the Westmanstown stream Royal Canal culvert. This has been confirmed by topographic survey.

10.5 Receiving environment

10.5.1 Regional overview of hydrology

The majority of the proposed development is located within the Liffey and Dublin Bay WFD catchment. This catchment includes the area drained by the River Liffey and by all watercourses entering tidal water between Sea Mount and Sorrento Point, Co. Dublin, draining a total area of 1,616 km². The main urban centres within this catchment include Dublin City, Dún Laoghaire, Lucan, Clonee, Dunboyne, Leixlip, Maynooth, Kilcock, Celbridge, Newcastle, Rathcoole, Clane, Kill, Sallins, Johnstown, Naas, Newbridge, Athgarvan, Kilcullen and Blessington.

The Main Storage and Distribution Centre (MSDC) is located within the Nanny-Delvin WFD Catchment. This catchment includes the area drained by the Rivers Nanny and Delvin and by all streams entering tidal water between Mornington Point and Sea Mount, Co. Dublin, draining a total area of 711 km². The main urban centres in this catchment are Swords, Donabate, Lusk, Skerries, Balbriggan, Stamullin, Laytown, Bettystown, Duleek, Ashbourne, Ratoath and Dunshaughlin.

10.5.2 River and lake surface waterbodies

The EPA carries out water quality assessments of rivers, transitional and coastal water bodies as part of a nationwide monitoring program required as part of national commitments to the implementation of the EU Water Framework Directive. Data is collected from physio-chemical and biological surveys, sampling both river water and the benthic substrate (sediment). Sampling is carried out throughout the year and the main parameters analysed include: conductivity, pH, colour, alkalinity, hardness, dissolved oxygen, biochemical oxygen demand (BOD), ammonia, chloride, ortho-phosphate, oxidised nitrogen and temperature.

Within the Liffey and Dublin Bay catchment and Nanny-Delvin catchment the proposed development crosses 7 no. WFD Subcatchments as indicated in Figure 10-2 below. As part of the WFD implementation the EPA have characterised the surface waterbodies and key pressures within these Subcatchments. River and lake surface waterbodies are discussed below within each sub-catchment.

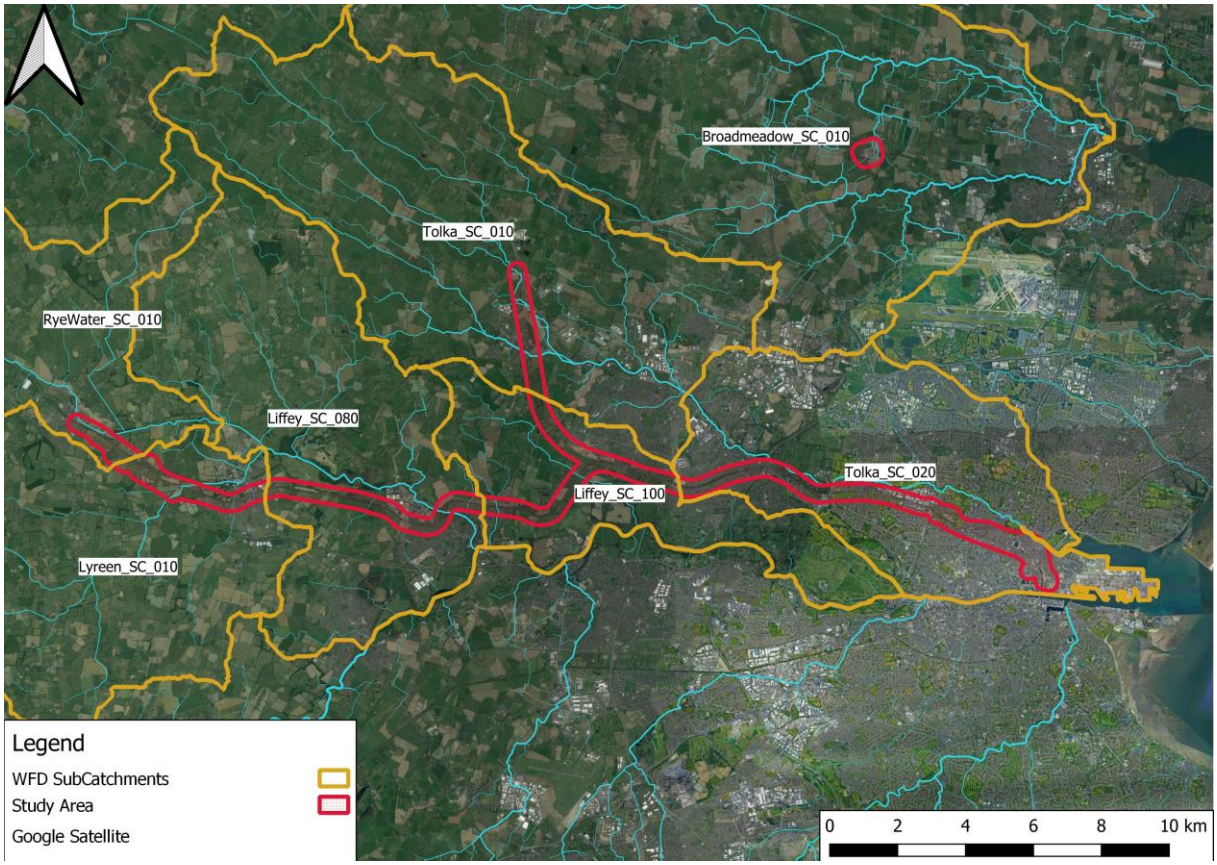

Figure 10-2 WFD Subcatchments

10.5.2.1 Tolka_SC_020

This sub-catchment primarily drains to the Tolka river and minor tributaries comprising the Bachelors, Scriblestown, Abbotstown and Ballycoolen Streams. The EPA indicate poor/moderate water quality throughout, both with regard to biology/ecology and chemistry, ecological status primarily caused by Diffuse Urban and Combined Sewer Overflows negatively impacting the Tolka and its tributaries. The most recent cycle of the WFD appraisal indicates that the majority of surface waterbodies within the catchment are "Poor" Status and are "At Risk" of not meeting their WFD objectives. The exception being the most downstream reach of the Tolka (Tolka 60) which has been given a Status of "Moderate" (though also "At Risk").

10.5.2.2 Liffey_SC_100

This sub-catchment drains to the Liffey River and tributaries of the Liffey. The southern boundary of the catchment is marked by River Liffey itself and as such the reach is likely equally influenced from the catchment south of the river. Three of the four River waterbodies are indicated to be "Moderate" Status and "At Risk" of not meeting WFD objectives. The remaining river waterbody (Liffey_160_) is identified as "Poor" Status with its risk rating currently under review. Primary pressures are indicated to be Diffuse Urban and Combined Sewer Overflows throughout the catchment.

10.5.2.3 Tolka_SC_010

This sub-catchment drains the upper reaches of the River Tolka and its tributaries. Five of the six surface waterbodies are indicated to be "At Risk" of not meeting WFD objectives with the remainder being under review. The entirety of the main channel of the Tolka (Tolka_10, 20 & 30) has been assigned a "Poor" Status including the reach east of Dunboyne which is crossed by the proposed development. Tributary reaches Pinkeen_10 and Powerstown (Dublin)_10 are also "Poor" Status while the Dunboyne Stream_10 is identified as "Moderate". Primary pressures are indicated to be Diffuse Urban and Combined Sewer Overflows throughout the catchment. Pressures, within the catchment are primarily agriculture with waste water discharges and industry playing a lesser role.

10.5.2.4 Liffey_SC_080

The catchment contains a section of the Liffey and Ryewater as well as their tributaries. All river waterbodies in this sub-catchment are "At Risk" of not meeting WFD objectives. The section of the Liffey within this catchment was assigned a "Good" Status in the most recent WFD cycle following significant improvements. North of Maynooth town the Ryewater (RYE WATER_030) is assigned a "Moderate" Status, while east of Maynooth the Ryewater (RYE WATER_040) is assigned a "Poor" Status.

Primary pressures within the subcatchment have been identified as agricultural and domestic waste water in rural areas with additional pressures from urban runoff in the built up areas.

10.5.2.5 Lyreen_SC_10

All four river waterbodies within this sub-catchment (Clonshanbo_010, Clonshanbo_020, Lyreen_010 and Lyreen_020) are "Poor" Status and "At Risk" of not meeting WFD objectives. Agriculture and septic tanks on poorly draining lands are significant pressures in addition to diffuse urban sources. This catchment appears to drain a significant section of the M4 (untreated and unattenuated) via the Lyreen River, Meadowbrook Stream and their tributaries. South of the M4 the Lyreen has been subject to drainage works with associated hydromorphological pressures.

10.5.2.6 Ryewater_SC_010

The upper reaches of the Ryewater (Ryewater_010) and the Jenkinstown (Jenkinstown stream_010) stream are both indicated as being "At Risk" of not meeting their WFD objectives. The third surface waterbody within the catchment is currently under "Review" having previously been "At Risk" of not meeting WFD objectives. All river waterbodies are identified as "Moderate" Status. Predominantly the subcatchment is agricultural with heavy wet soils, agriculture and domestic waste water are significant pressures with nutrients and sediment as an additional issue.

10.5.2.7 Broadmeadow_SC_010

Ten out of the eleven surface river waterbodies within subcatchment are indicated as being "At Risk" of not meeting their WFD objectives. The remaining waterbody is currently under "Review". Eight of the River waterbodies are identified as "Poor" Status while the remaining are "Moderate" Status. The significant pressures throughout this subcatchment are agriculture, domestic waste water, diffuse urban run-off and channelisation. Combined sewer overflows is also a pressure within Broadmeadow_010, Broadmeadow_020, Ward_020 and Ward_040.

10.5.3 Transitional waterbodies

As is the case for rivers and lakes, the impact of nutrient enrichment and the process of eutrophication is also a major concern in the tidal waters environment. The direct negative effects of excessive nutrient enrichment include increases in the frequency and duration of phytoplankton blooms and excessive growth of attached opportunistic macroalgae. The subsequent breakdown of this organic matter can lead to oxygen deficiency which in turn can result in the displacement or mortality of marine organisms. As such the effects of over enrichment can severely disrupt the normal functioning of tidal water ecosystems.

The status of individual estuarine and coastal water bodies is assessed using the EPA's Trophic Status Assessment Scheme (TSAS). This assessment is required for the Urban Waste Water Treatment Directive and Nitrates Directive. The scheme compares the compliance of individual parameters against a set of criteria indicative of trophic state (see Table 10-1). These criteria fall into three different categories which broadly capture the cause-effect relationship of the eutrophication process, namely nutrient enrichment, accelerated plant growth, and disturbance to the level of dissolved oxygen normally present.

Table 10-1 Biological river water quality classification system

Trophic Status	Pollution Status	Condition
Unpolluted	Unpolluted	Unpolluted water bodies are those which do not breach any of the criteria in any category.
Intermediate	Unpolluted	Intermediate status water bodies are those which breach one or two of the criteria.
Potentially Eutrophic	Slightly polluted	Potentially Eutrophic water bodies are those in which criteria in two of the categories are breached and the third falls within 15 per cent of the relevant threshold value.
Eutrophic	Polluted	Eutrophic water bodies are those in which criteria in each of the categories are breached, i.e., where elevated nutrient concentrations, accelerated growth of plants and undesirable water quality disturbance occur simultaneously.

The Tolka estuary was indicated to be "Potentially Eutrophic". The River Liffey estuary is split into the upper and lower estuary. The upper estuary was indicated to be Eutrophic while the lower estuary was indicated to be unpolluted as was Dublin Bay.

The EPA Catchments.ie website mapping section provides details on the assessments of the Coastal and Transitional Waterbodies in the vicinity of the proposed development. This data was reviewed as part of this assessment and a summary is given in Table 10-2.

The status of the three transitional (estuarine) waterbodies as a "Heavily Modified" water body also changes the criteria for assessment, whereby the amended criteria generally have higher tolerances for pollutants etc. WFD objectives require heavily modified (and artificial) waterbodies to achieve "Good Ecological Potential". Water quality in the catchment is mainly "at risk" from sources of pollution such as urban waste water.

Table 10-2 WFD classification of transitional and coastal waters near the proposed development (2013-2018 sampling period, EPA)

Waterbody		Code	WFD Status	Objective	Risk	Heavily Modified Waterbody
Upper Liffey Estuary	Islandbridge to Talbot Memorial Bridge	IE_EA_090_0400	Good Ecological Potential	Protect	Review	YES
Lower Liffey Estuary	Downstream of Talbot Memorial Bridge	IE_EA_090_0300	Good Ecological Potential	Protect	Review	YES
Tolka Estuary	Downstream of Drumcondra	IE_EA_090_0200	Moderate Ecological Potential	Restore	At Risk	YES
Dublin Bay	Howth Head to Dalkey	IE_EA_090_0000	Good	Protect	Not At Risk	No

10.5.4 The Royal Canal

The Royal Canal is in close proximity to the proposed development for much of its length between the Dublin Docklands area extending west past Maynooth to the depot lands in Kildare. The EPA have characterised the Royal Canal as a single waterbody within the study area known as Royal Canal Main Line (Liffey and Dublin Bay). The canal is an artificial waterbody. The canals risk status is currently under review (3rd WFD cycle) but for all monitoring periods up to the present (1st and 2nd WFD cycle) this section of the canal has achieved "Good Ecological Potential".

10.5.5 Flood risk

10.5.5.1 Fluvial & sea level rises / coastal flooding

A flood risk assessment for the proposed development has been prepared to support the proposed development (see the Site-Specific Risk Assessment (SSFRA) accompanying this RO application). Key areas with potentially elevated level of flood risk have been identified. These are discussed in the following sections:

- Docklands / Newcomen area;
- Leixlip Confey Station, flooding emanates from minor tributaries of the Rye Water River as they cross under the canal and railway.
- Barberstown (XG012) Level Crossing;
- Between Maynooth and Kilcock -River Lyreen flooding;
- Dunboyne Tolka River Valley – South of M3 Parkway

10.5.5.1.1 Docklands and Newcomen

The Docklands/Newcomen area is in close proximity to the Liffey, Tolka and Royal Canal. The Tolka and Liffey are tidally dominated at this location, as such; the most prevalent flood risk to the site is from extreme tidal inundation events or tidal events in combination with extreme fluvial events. Hydraulic modelling undertaken as part of the Irish Coastal Wave and Water Level Modelling Survey (ICWWS) indicates that the subject site is liable to flood from tidal inundation in the 0.5% AEP event. However, it should be noted that the aforementioned assessments do not account for flood defence infrastructure. As such the measures along the Tolka's estuary and works at Spencer dock are not considered. In comparison, the National Catchment-based Flood Risk Assessment and Modelling Programme (CFRAMS) (2017) flood mapping does take account of these measures and no flooding was indicated within the proposed development site in the 0.1% AEP coastal event. As per the Guidelines, the Docklands / Newcomen area is within Flood Zone A. However, when existing flood risk management measures are considered the lands are defended to the design standard 0.5%AEP coastal flood event and the 0.1%AEP event when freeboard allowances are accounted for.

Both the ICWWS and CFRAMS considered the likely effects of climate change. With the inclusion of climate change factors as per the OPW Mid-Range Future climate scenario (MRFS), both studies show that the development lands are liable to flood in the 0.5% AEP event and much of the land is liable to have flood depths of >2 m above existing ground levels. The ICWWS estimated flood levels at Spencer Dock incorporating climate change are:

- 10% AEP (+MRFS) Event = 3.36 mOD.
- 0.5% AEP (+MRFS) Event = 3.58 mOD.
- 0.1% AEP (+MRFS) Event = 3.80 mOD.

Track lowering is proposed at multiple locations in this area to accommodate the OHLE that is required for electrification of the line in addition to the provision of underground platforms at Spencer Dock Station. In future extreme events exacerbated by climate change there is potential for subject lands to be inundated from tidal flooding including the underground platforms.

10.5.5.1.2 Leixlip Confey Station

Flooding emanates from minor tributaries of the Ryewater River (the Rathleek and Sillechain streams) as they cross under the canal/railway. CFRAMS mapping indicates that the two culverts conveying the streams under the Royal Canal and railway act as a minor restriction to flow in the fluvial 0.1% AEP event. Flooding remains north of the canal in these events and does not encroach on rail infrastructure in the area. As per the Guidelines, Leixlip Confey station and the adjacent rail infrastructure are within Flood Zone C.

CFRAMS mapping indicates that when climate change is considered (MRFS), flood waters flow along the canal in an easterly direction. Confey station is protected by a >1 m wall/embankment along its length while the track extending east and west is similarly elevated. It is highly unlikely that flood waters could build up

within the canal as to inundate the rail line to the south. The information available is considered sufficient to appraise flood risk at Leixlip Confey area and further assessment is not required.

10.5.5.1.3 Barberstown Level Crossing

A 1D-2D hydraulic model of the Westmanstown stream and subject lands was developed and is detailed in the SSFRA (see the Supporting Documents accompanying this RO application). No flooding is seen to emanate from the channel in the current climate scenario up to the 0.1% AEP event. In the 0.1% AEP event flooding exits the channel upstream of the local road culvert and ponds in adjacent lands before flooding the road and re-entering the stream via parallel road drains.

In the climate change scenario, flooding is also very limited with the only minor flooding of lands north of the subject area up to the 0.1% AEP event. In the 0.1% AEP MRFS event the area north of the local road continues to flood. In addition, the lands immediately upstream of the canal culvert appear to flood with waters going out of bank for ~160 m upstream of the culvert. Nonetheless, none of the modelled scenarios were seen to affect the proposed road layout and bridge abutment proposed for the site. The model indicates that none of the proposed development footprint is within the 0.1% AEP flood extents (including climate change) and therefore the development at Barberstown is within Flood Zone C.

10.5.5.1.4 Site between Maynooth and Kilcock - River Lyreen Flooding

A 1D-2D hydraulic model of the River Lyreen and its tributaries was developed and is detailed in the SSFRA (see the Supporting Documents accompanying this RO application). Two distinct flooding locations between Maynooth and Kilcock were identified and are discussed below.

Jackson Bridge - rail track

The Lyreen River has been subject to relatively significant modifications in the vicinity of OBG23 Jackson's Bridge. These are primarily as a result of the rail, canal and motorway crossings. Consultations with landowners have also indicated that the Lyreen was dredged during the course of the motorway construction. It should also be noted that lands directly downstream of the canal culvert appear to have been a deposition area during the motorway construction, resulting in increased levels and removal of floodplain area. The aforementioned existing crossings and topography have been represented in the model.

In the current climate scenario the lands directly upstream of UBG22 flood first with flood waters spreading upstream. The culvert under the M4 also exhibits out of bank flooding that builds up south of the M4 before overtopping the road and flowing both north towards the railway and east along the motorway. Having overtopped the M4 flood waters flow overland parallel to the Lyreen. Flood waters overtop the existing rail line in ~10% AEP event and flow east along the canal. In the 0.1% AEP event, flood depths upstream of UBG22 are in excess of 1.5 m. The model indicates that a large portion of the subject area including lands within the footprint of the proposed road and rail embankments are within Flood Zone A. In the MRFS climate change scenario the flood sources, pathways and receptors are very similar to those seen in the current climate scenario with an overall increase of flood extents in all directions.

Bailey's Bridge - proposed depot

A review of topography, historic mapping and GSI data indicates that the Ballycaghan stream has been significantly altered and straightened compared to its original course. In the current climate scenario the lands upstream of the proposed depot appear to flood first along a route that may have been the historic channel corridor. Field crossings are generally undersized along this reach and are overtopped in relatively frequent events. Overall flood depths are generally low with the deepest ponding in the vicinity of Bailey bridge at a depth of 0.5 m where flood waters appear to be confined by the rail embankment to the north. This ponding is evident in Figure 10-3.

The model indicates that a large portion of the subject area including lands within the footprint of the proposed depot are within Flood Zone A. In the MRFS climate change scenario the flood sources, pathways and

receptors are very similar to those seen in the current climate scenario with an increase in flood extents further downstream towards the Ballycaghan Stream confluence with the Lyreen River.

Figure 10-3 Flooding south of Bailey's bridge November 2000

10.5.5.2 Dunboyne Tolka River Valley - South of M3 Parkway

The Tolka river valley is crossed multiple times by the railway. The area was subject to a flood alleviation scheme completed circa 2015 which upgraded many of the previous rail and road crossing of the Tolka that restricted flow. A hydraulic assessment of the completed measures was undertaken in 2019. The resultant flood extent mapping indicates that there is significant flooding of Tolka valley either side of rail line in flood events as frequent as 1 in 10 year. However, no flooding is indicated for the rail line between Bennetstown and Dunboyne including Dunboyne and the M3. A review of the flood levels and track levels indicates that in a 1 in 1000 year flood event the tracks are a minimum of 1.4 m above flood level. As per The Guidelines the rail line from Dunboyne to the M3 Parkway is considered to be within Flood Zone C. The climate change mapping for the area shows no indication flooding of the track or M3 Parkway in the 0.1% AEP + MRFS event.

10.5.5.3 Surface water

Surface water flooding occurs when the local drainage system cannot convey stormwater flows from extreme rainfall events. The rainwater does not drain away through the normal drainage pathways or infiltrate into the ground but instead ponds on or flows over the ground. Surface water flooding is unpredictable as it depends on a number of factors including ground levels, rainfall and the local drainage network.

10.5.5.3.1 Broombridge Station

As described in the OPW flood event report, flooding at Broombridge Train Station on 24th October 2011 appears to have been caused by extreme rainfall in combination with a series of blockages in the surface water drainage network and the Royal Canal. Met Eireann indicated that the 9hr storm event on the 24th of October was circa 1.3% AEP at the Phoenix Park gauge. The OPW indicates that road drainage may have become blocked or had its capacity exceeded. As there is no evidence of previous or subsequent flooding at this location the flood risk is considered low. There is no indication of coastal or fluvial contributions to flooding at this location therefore as per the Guidelines Broombridge Train Station and the adjacent rail infrastructure are within Flood Zone C.

10.5.5.3.2 Clonsilla level crossing

Flooding has been recorded in the vicinity of the Clonsilla crossing, occurring between 2000-2002. This appears to have been caused by inadequate capacity in the existing drainage network. Subsequentially, the Local Authority proposed a series of interim measures which were to be carried out in 2003. As there is no evidence of previous or subsequent flooding at this location the flood risk is considered low.

There is no indication of coastal or fluvial contributions to flooding at this location therefore as per the Guidelines Clonsilla level crossing and the adjacent rail infrastructure are within Flood Zone C.

10.5.5.3.3 Glendhu Park, Cabra, Dublin

The flooding in Glendhu Park in October 2011 appears to be caused by extreme rainfall. Nonetheless, DCC post-flooding reports indicate that the SuDS based drainage system performed well and minimal property damage occurred. Flood depths of ~0.5 m were recorded following this event. Given that the railway is >1 m above Glendhu Park and the adjoining lands and as there is no indication of historic or likely flooding impacts arising from the development at this location the flood risk is considered low. There is no indication of coastal or fluvial contributions to flooding at this location therefore as per the Guidelines Glendhu Park and the adjacent rail infrastructure are within Flood Zone C.

10.5.5.3.4 M50-N3 interchange, railway and Royal Canal cross over the M50

The railway and canal are bridged over the M50 at this location. Flooding on the 13/11/2002 appears to be solely confined to the carriageway due to the insufficient hydraulic capacity of the surface water drainage network. As there is no indication of historic or likely flooding impacts to the development at this location, this location is considered low risk. There is no indication of coastal or fluvial contributions to flooding at this location therefore as per the Guidelines the M50-N3 Interchange and the adjacent rail infrastructure are within Flood Zone C.

10.5.5.3.5 Leixlip Louisa station

Iarnród Éireann's IAMS datasets indicate historic flooding from drainage in the vicinity of the Leixlip Louisa Station. Nevertheless, there is no indication that the track was previously affected or if flooding has recurred. There is no indication of coastal or fluvial contributions to flooding at this location therefore as per the Guidelines, the Leixlip Louisa station and the adjacent rail infrastructure are within Flood Zone C.

10.5.6 Potable water supply from surface water

Leixlip Water Treatment Plant and Reservoir

Leixlip Water Treatment Plant is located ~1.4 km from the proposed development. The plant provides a significant percentage of the potable water supply to Dublin City and environs with a maximum capacity circa 255 million litres per day (though a significant proportion is understood to be reserved for manufacturing and industry). The reservoir is fed by the River Liffey and its tributaries. One such tributary drains the area of land between the proposed development and the M4.

10.5.7 Recreational and amenity waters

The EPA identify three recreational waters within Dublin Bay. These areas are outside the study area and are identified only for comprehensiveness. These are listed in Table 10-3 below.

Table 10-3 Recreational Waters

Name	EPA Current Water Quality
Dollymount Strand	Good Water Quality
Sandymount Strand	Sufficient Water Quality

Name	EPA Current Water Quality
Seapoint	Excellent Water Quality

In addition to those designated by the EPA, the Royal Canal has significant amenity value utilised for boating, rowing, swimming and fishing as well as cycling and walking along the parallel Canal towpath/greenway. The amenity value of the canal is inherently tied to its biodiversity and water quality with any degradation either likely to negatively affect amenity value.

10.6 Description of potential impacts

Strategic infrastructure projects, given their scale and nature, have significant potential for causing impact to the hydrological environment both during their construction and operation and consequently require careful planning and detailed assessment to ensure the best solution is obtained. This section will describe the potential impacts associated with the proposed development before mitigation measures are applied. Both direct and indirect impacts will be addressed for the construction and operation of the proposed development. The nature, extent and duration of the impacts will also be assessed.

The assessment of hydrological impacts for the proposed development has been based on the analysis and interpretation of the data acquired during the site-specific investigations undertaken as part of the EIA, including the biodiversity surveys, intrusive site investigation, material assets survey, topographical survey, hydraulic modelling and hydrological walkover surveys. The procedure follows the guidelines set out in the publication '*Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*', TII, 2009.

Key hydrological receptors identified in the vicinity of the proposed development include:

- European Designated Sites.
- Ecologically sensitive surface water features and catchment systems.
- Flood Risk Areas.

10.6.1 Construction Phase

Construction activities pose a significant risk to watercourses, particularly works within the channel and contaminated surface water runoff from construction activities entering the watercourse.

10.6.1.1 Impact on Water Quality

Construction activities within and alongside surface waters, can contribute to the deterioration of water quality and can physically alter the river bed and bank morphology with the potential to alter erosion and deposition rates locally and downstream. Activities (such as earthworks, sheet piling or concreting) within or close to the watercourse channels can lead to increased turbidity through re-suspension of bed sediments and release of new sediments.

The main contaminants likely to arise from construction include:

- Elevated silt/sediment loading within watercourses from construction site runoff. Runoff from landside works is likely highly variable throughout the study area due to differing infiltration surfaces e.g. railway ballast, agricultural lands and areas of existing hard standing. Elevated silt loading can lead to long-term damage to aquatic ecosystems by smothering spawning grounds and gravel beds and clogging the gills of fish. Increased silt load in receiving watercourses stunts aquatic plant growth, limits dissolved oxygen capacity and overall reduces the ecological quality with the most critical period associated with low flow conditions. Other pollutants in the watercourse can bind to silt which can lead to increased bioavailability of these pollutants.

- Spillage of concrete, grout and other cement-based products. These cement-based products are highly alkaline (releasing fine highly alkaline silt) and extremely corrosive and can result in significant impact to watercourses altering their pH, smothering the stream bed and physically damaging fish through burning and clogging of gills due to the fine silt.
- Accidental spillage of hydrocarbons from construction plant and refuelling operations at storage depots / construction compounds, which can reach watercourses.
- Faecal contamination arising from inadequate treatment of on-site toilets and washing facilities.
- The proposed underpass and aqueduct at Ashtown will require ~50 m length the Royal Canal to be dewatered to facilitate construction. Dewatering will be required with pumps and settlement tanks running 24 hours a day discharging water back into the canal and the duration needed will be approximately 1 year.
- Further instream works will be required for the proposed bridges over the Royal Canal.
- The construction of the depot will require the realignment of approximately 400 m of the Ballycaghan stream. The channel diversion will be constructed prior to the original channel being decommissioned.

In the absence of mitigation measures, the potential effects are *negative, temporary, moderate* to *significant*.

10.6.1.2 Impact on Flood Risk

There is potential for flood events to occur during the construction phase. The construction works will increase the number of people near known sources of flooding, thus increasing the potential for flood risk related impacts on human health. The risk is reduced due to the relatively predictable nature of the flooding within the study area e.g. systems are in place to monitor and warn against extreme tidal events. This has the potential to have *negative, temporary, slight* to *moderate* effects.

There is also potential for pollutants derived from construction materials to be mobilised by flood waters. Given its susceptibility to flooding and the considerable volume of earthworks required, the works required for the depot and compensatory storage areas poses the greatest risk of pollution as a result of flood events. In comparison, the second most at flood risk area, the Docklands, is effectively defended to the 1 in 1000 year coastal / fluvial event. Overall, flood events during the construction phase have the potential to have *negative, temporary, moderate to significant* effects on hydrological receptors.

10.6.1.3 Royal Canal Water Levels

Multiple sections of track lowering are proposed throughout the development to allow for the sufficient OHLE clearances. Many of these locations are in close proximity to the Royal Canal with track levels being reduced to below existing canal water levels. Excavation of the tracks adjacent the canal has the potential to allow for leakage from the canal during the construction phase. The likely effects are *negative, slight* to *moderate, temporary*.

10.6.1.4 Recreational and amenity waters

Throughout the construction phase there will be considerable disruption to the Royal Canal and its adjacent walking paths either directly through the aforementioned instream works or indirectly via noise pollution e.g. the proposed depot. The Ashtown underpass works will close a section of the canal with flow through the closed section being maintained via pipes. Recreational users of the canal will not be able to navigate this section of the canal at Ashtown for the duration of the works. The likely effects are *negative*, *moderate* to *significant, short term*.

10.6.2 Operational Impacts

Large infrastructure projects can cause permanent disturbance to river channels, floodplains, and the flood regime. Watercourse crossings and development within floodplains if not appropriately designed, create an obstacle to flow, resulting in increased flood risk and damage in the vicinity of the proposed structures. Such structures can locally alter channel morphology resulting in changes in flow velocity and water depth. These

structures can also result in localised riverbed and riverbank erosion, resulting in long-term changes to the morphology of the river channel.

10.6.2.1 Impact on Surface Water Quality

New surface water drainage networks will be provided throughout the proposed development which collect surface water run-off from the railway area and shall pass through hydrocarbon interceptors separator prior to discharge to receiving waterbodies. In addition, vegetated Sustainable Drainage Systems (SuDS) are to be incorporated in the design. This will limit the potential for impacts to the water quality of receiving waterbody and has the potential to have *positive, long term, not significant to slight* effects.

Additionally, operational phase maintenance works to bridges could result in accidental spillage of paint which will be used in the periodic repainting. In order to control this risk, the paint specified for this purpose shall not contain lead or tributyltin (TBT) or shall be otherwise approved for use near water. This has the potential to have *negative, temporary, imperceptible to slight* effects.

New foul drainage connections are to be provided to the existing public networks to Irish Water Standards. Each proposed substation, permanent compounds, the Spencer Dock station and the depot will be connected to the existing foul network. The likely effects are *neutral, long term,* and *imperceptible.*

10.6.2.2 Water Framework Directive Assessment

Any works which could affect the biological, physiochemical or hydromorphological quality of a waterbody requires an assessment in line with the WFD to demonstrate how the proposed works will not lead to a degradation status and where possible, enhance waterbody status in order to achieve the required Good status target as set out in the directive. The Sweetman -v- An Bord Pleanala & Anor [2021] IEHC 16 judgement has been reviewed in the context of the WFD and its implementation within Ireland. As of the 08/02/2022 the EPA has assigned a WFD status for all water bodies within the study area. An assessment of likely impacts to water bodies within the study area has been completed and is provided in Table 10-4 and Table 10-5 below. The assessment concludes that the proposed development will have negligible effects on waterbody status and the attainment of Good status (or good ecological potential for the Royal Canal).

Table 10-4 Water Framework Directive Assessment Summary - Rivers and Canals

Water body affected (WFD Code)	Ecological Status Or Potential	Driving element for status classification	Significant Pressures	River Basin Management Plan (RBMP) Measures	Does the proposed DART+ West development prevent the achievement of the subject watercourses WFD Objectives?
LIFFEY_160 (IE_EA_09L012040)	Poor	Extrapolated from Powerstown (Dublin)_010 (IE_EA_09P210700)	Agricultural	Actions to address Agricultural pressures are set out in Section 7.1.6 of the 2nd Cycle RBMP.	The existing rail line crosses the Sillechain stream on the northern periphery of Leixlip. No works are required to the existing culvert crossing. Works will be limited to the provision of OHLE, and associated works required for electrification. Track lowering in the vicinity of OBG13 will require amendments to the existing drainage network. A new outfall is proposed to a drainage ditch that flows through St. Catherine's Park prior to discharging to the River Liffey. Increases to flow rate and volume are envisaged to be negligible. The design of the outfall (including rip rap and check dams) will mitigate erosion within the minor channel. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
LIFFEY_180 (IE_EA_09L012350)	Moderate	Extrapolated from MORELL_040 (IE_EA_09M010300)	Urban Run Off, Urban Waste Water	Actions to address pollution from urban waste-water and urban runoff are set out in Section 7.2.3 of the 2nd Cycle RBMP.	The existing rail line crosses the Westmanstown stream ~600m south of Hansfield. No works are required to the existing culvert crossing. The adjacent Barberstown level crossing is to be closed and replaced by a bridge over the railway and Royal Canal. The site specific flood risk assessment for the proposed development has indicated that the proposed works are outside the floodplain of the adjacent Westmanstown Stream.The proposed bridge road network will drain to the Westmanstown Stream. Prior to discharge flows will be attenuated within SuDS measures. Although within the catchment of the subject waterbody, works between Coolmine and Hansfield have been reviewed and are not considered likely to have a perceptible impact on Liffey_180 given the nature of the works and limited hydrological connectivity. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures, existing drainage paths and discharge rates / volumes. The proposed development will not prevent Liffey_180 from attaining Good Status.
LYREEN_010 (IE_EA_09L020035)	Poor	Invertebrate Status or Potential	Agricultural, Domestic Waste Water, Hydromorphology, Industry - Nutrient & Organic	Actions to address Agricultural pressures are set out in section 7.1.6 of the 2nd Cycle RBMP. Actions to address Domestic Waste Water pressures are set out in Section 7.1.2 of the 2nd Cycle RBMP. Actions to address	Lyreen_10 is located upstream of the proposed works at OBG23 Jacksons Bridge. No works are proposed within the catchment of Lyreen_10. However, the area including the Lyreen south of the M4 is prone to flooding due to the existing culvert conveying the River Lyreen under the Royal Canal which has been identified as acting as a restriction to flow. The proposed works at this location consist of a new rail embankment and bridge spanning the Lyreen to provide sufficient protection to the proposed rail infrastructure in flood events. A detailed site specific flood risk assessment has been carried out for the proposed development which assessed the propose works at this location (see Supporting Documents prepared for this RO application). The assessment indicated that with the provision of compensatory

Water body affected (WFD Code)	Ecological Status Or Potential	Driving element for status classification	Significant Pressures	River Basin Management Plan (RBMP) Measures	Does the proposed DART+ West development prevent the achievement of the subject watercourses WFD Objectives?
				hydromorphology are set out in Section 7.6.2 of the 2nd Cycle RBMP.Actions to address industrial pressures are set out in Section 7.7 and 7.8 of the 2nd Cycle RBMP.	storage and flood relief culverts there would result in a negligible effect on the flood regime overall.The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures, due to the limited nature of interventions within the catchment. The proposed development will not prevent Lyreen_010 from attaining of Good Status.
LYREEN_020 (IE_EA_09L020 100)	Poor	Invertebrate Status or Potential	Agricultural, Urban Run Off	Actions to address Agricultural pressures are set out in Section 7.1.6 of the 2nd Cycle RBMP. Actions to address pollution from urban waste-water and urban runoff are set out in Section 7.2.3 of the 2nd Cycle RBMP.	Lyreen_20 comprises stretches of the Lyreen River and its tributaries such as the Ballycaghan Stream and Meadowbrook Stream in the vicinity of Maynooth town. The Rye Water Valley/Carton SAC is located immediately downstream of the Lyreen_20 east of Maynooth. The area has been identified as liable to flood as part of the site specific flood risk assessment (SSFRA), see Supporting Documents prepared for this RO application. The provision of a sufficient standard of flood protection for the proposed development requires the creation of a new offline alignment and bridge crossings of the Lyreen River and the Ballycaghan stream. The offline alignment will be on an earthen embankment raising the rail line above the Lyreen floodplain. A diverted L5041 local access road will also require a separate embankment. Flood waters displaced as part of the works will require the implementation of compensatory storage adjacent to the Lyreen River. The proposed depot is also located within the catchment of Lyreen_20. The area has been identified as liable to flood as part of the SSFRA and will require the implementation of compensatory storage adjacent to the Ballycaghan Stream. The depot construction will require 400m of Ballycaghan Stream to be realigned. A review of historic mapping and various geological data sets indicate that the stream has been subject to significant historic alterations (straightening). Currently there is minimal riparian vegetation present. The realignment of the Ballycaghan stream will be designed to closely match existing channel characteristics and includes an appropriately sized vegetated buffer. The SSFRA carried out for the proposed development assessed the impact of the proposed works on the existing flood regime at this location. The assessment indicated that with the provision of compensatory storage, flood relief culverts and appropriate bridge spans, there would be a negligible effect on the flood regime overall. During the construction phase significant earthworks will be required to construct the depot, Ballycaghan Stream diversion, embankments through the lyreen floodplain and compensatory storage areas with potential impacts to the sediment regime of adjacent and downstream watercourses. Following the implementation of the mitigation measures outlined in the Environmental Operating Plan in Appendix D of Appendix A5.1 in Volume 4 of this EIAR, there will be a negative, slight, temporary residual impact on water quality during the construction phase of the proposed development. The proposed drainage network for the depot will include SuDS measures to treat runoff quality (in addition to hydro-carbon interceptors) and manage runoff rates/volumes. The provision of compensatory storage will include the creation

Water body affected (WFD Code)	Ecological Status Or Potential	Driving element for status classification	Significant Pressures	River Basin Management Plan (RBMP) Measures	Does the proposed DART+ West development prevent the achievement of the subject watercourses WFD Objectives?
					of biodiversity enhancement measures in the form of diverse wetland mosaics. The proposed compensatory storage areas will replace existing agricultural land uses and associated pressures. During the operational phase, the impact to hydromorphology and ecological integrity of the subject reach (Lyreen and Ballycaghan) is likely positive, imperceptible to slight permanent.The Meadowbrook stream is culverted under the existing rail line immediately west of Maynooth train station. As part of the development a new outfall connection will be made to the existing culvert (UBG21A) allowing for the new sidings area to be drained. Increases to flow will be relatively minor with the proposed works subject to approval under section 50 of the Arterial Drainage Act 1945. Hydro-carbon interceptors and non-return outfalls are to be included prior to outfall. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
RYE WATER_020 (IE_EA_09R010300)	Moderate	Invertebrate Status or Potential	Agricultural - Pasture, Domestic Waste Water, Urban Waste Water	Actions to address Agricultural pressures are set out in Section 7.1.6 of the 2nd Cycle RBMP.Actions to address Domestic Waste Water pressures are set out in Section 7.1.2 of the 2nd Cycle RBMP.Actions to address pollution from urban waste-water and urban runoff are set out in Section 7.2.3 of the 2nd Cycle RBMP.	Although geographically close the Rye Water_20, the waterbody is separated from the proposed development by the Royal Canal which acts as a watershed. No water drains from the proposed development to the subject waterbody.The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
RYE WATER_040 (IE_EA_09R010600)	Poor	Invertebrate Status or Potential	Agricultural, Domestic Waste Water, Urban Run Off	Actions to address Agricultural pressures are set out in Section 7.1.6 of the 2nd Cycle RBMP.Actions to address Domestic Waste Water pressures are set out in Section 7.1.2 of the 2nd Cycle RBMP.Actions to address pollution from urban waste-water and urban runoff are set out	The majority of the length of the Rye Water within Ryewater_040 is also designated as the Rye Water Valley/Carton SAC. Works within the subject waterbodies catchment will entail alterations to multiple road bridges to ensure sufficient clearances for OHLE. Track lowering and associated drainage works are required in the vicinity of OBG18 Pike Bridge also for this purpose. A new outfall is proposed upstream of existing culvert UBG18A. UBG18A conveys a small drainage channel under the Royal Canal and railway prior to discharging to the Rye Water ~800m to the north. Any impact from this new outfall is likely imperceptible. No additional amendments are proposed to watercourse crossings, the surface water drainage network or flood regime of the area. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works

Water body affected (WFD Code)	Ecological Status Or Potential	Driving element for status classification	Significant Pressures	River Basin Management Plan (RBMP) Measures	Does the proposed DART+ West development prevent the achievement of the subject watercourses WFD Objectives?
				in Section 7.2.3 of the 2nd Cycle RBMP.	will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
TOLKA_020 (IE_EA_09T010 600)	Poor	Invertebrate Status or Potential	Agricultural - Pasture / Farmyards	Actions to address Agricultural pressures are set out in Section 7.1.6 of the 2nd Cycle RBMP.	In addition to the provision to OHLE, tracks north of M3 Parkway Station shall be adapted to be used as sidings by extending the double track and placing a crossover for the operation. The track works for the new sidings will require amendments to the surface water drainage network though area drained is effectively unchanged. Outfall locations are also unchanged. It should be noted that the M3 Parkway station is in close proximity to the Tolka flood plain. Nonetheless, no works are proposed that would likely have a perceptible impact on the existing flood regime. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
TOLKA_030 (IE_EA_09T010 800)	Poor	Invertebrate Status or Potential	Industry - EPA licensed facility Keepak Clonee - Nutrient and Organic	Actions to address industrial pressures are set out in Section 7.7 and 7.8 of the 2nd Cycle RBMP.	In addition to the provision to OHLE, minor works are to be undertaken at Dunboyne station to provide a traction substation. These works are unlikely to have a perceptible effect on the water quality of the subject waterbody. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
TOLKA_050 (IE_EA_09T011 100)	Poor	Invertebrate Status or Potential	Urban Run Off, Urban Waste Water	Actions to address pollution from urban waste-water and urban runoff are set out in Section 7.2.3 of the 2nd Cycle RBMP.	The proposed mainline runs roughly parallel with the Tolka_50 between M50/N3 interchange and Glasnevin at a distance of 150m at their closest. Track lowering will be required at the M50/N3 interchange and associated drainage works. The proposed drainage works will discharge to the existing surface water drainage network maintaining existing flow paths. Significant earthworks will be required in the vicinity of Ashtown to provide a new underbridge for road traffic. The works at this location are relatively close to the Tolka (<100m) though still outside the floodplain. Standard sediment control measures (outlined in the Environmental Operating Plan in Appendix D of Appendix A5.1 in Volume 4 of this EIAR) will be implemented to ensure that contaminated runoff does not reach the Tolka. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
Tolka_060 (IE_EA_09T011 150)	Moderate	Expert Judgement	Urban Run Off, Urban Waste Water	Actions to address pollution from urban waste-water and urban runoff are set out in	No significant works including any amendments to the drainage network are proposed that are likely to effect Tolka_060. Existing drainage flow paths and flow rates are to be maintained throughout this reach.

Water body affected (WFD Code)	Ecological Status Or Potential	Driving element for status classification	Significant Pressures	River Basin Management Plan (RBMP) Measures	Does the proposed DART+ West development prevent the achievement of the subject watercourses WFD Objectives?
				Section 7.2.3 of the 2nd Cycle RBMP.	The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
Broadmeadow_030 (IE_EA_08B020700)	Poor	Invertebrate Status or Potential	Agricultural, Domestic Waste Water, Hydromorphology-Channalisation	Actions to address Agricultural pressures are set out in Section 7.1.6 of the 2nd Cycle RBMP.Actions to address Domestic Waste Water pressures are set out in Section 7.1.2 of the 2nd Cycle RBMP.Actions to address hydromorphology are set out in Section 7.6.2 of the 2nd Cycle RBMP.	The Main Storage and Distribution Centre (MSDC) is located within the catchment of the Broadmeadow_030. The waterbody flows around the southern perimeter of the compound. The planned activities to be carried out will be the material storage, the loading/unloading of material and the pre-assembly of material. The MSDC is required to be operational for approximately 39 months in order to service the SET construction activities. There is potential for negative impacts to water quality during construction though this possibility is greatly reduced with in the incorporation of mitigation measures outlined in the Environmental Operating Plan in Appendix D of Appendix A5.1 in Volume 4 of this EIAR. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Status.
Royal Canal Main Line (Liffey and Dublin Bay) IE_09_AWB_RCMLE	Good	Invertebrate Status or Potential	No EPA Identified Pressures. Pressures likely include Urban Run Off, Urban Waste Water and Industry	Actions to address pollution from urban waste-water and urban runoff are set out in Section 7.2.3 of the 2nd Cycle RBMP.Actions to address industrial pressures are set out in Section 7.7 and 7.8 of the 2nd Cycle RBMP.	The Royal Canal is in close proximity to the proposed development for much of its length between the Dublin Docklands area extending west past Maynooth to the depot lands in Kildare. A large proportion of the existing track drainage network currently discharges to the Royal Canal. Once operational the potential sources for contaminants (diesel locomotives) will reduce. Throughout the development area amendments to the existing surface water drainage network are proposed at specific locations, these generally involve the formalisation of existing drainage pathways and will not significantly increase runoff rates or pollutants discharging to the canal. The development also requires the closure of multiple level crossings. The majority of these are to be replaced by a vehicle or pedestrian bridges over the canal and railway. There is potential for negative impacts to water quality during construction though this possibility is greatly reduced with the incorporation of mitigation measures outlined in the Environmental Operating Plan in Appendix D of Appendix A5.1 in Volume 4 of this EIAR. The proposed underpass and aqueduct at Ashtown will require ~50m length the Royal Canal to be dewatered to facilitate construction. Dewatering will be required with pumps and settlement tanks running 24 hours a day discharging water back into the canal and the duration needed will be approximately 1 year. Overall, in the context of an existing artificial water body the likely impacts to water quality and modifications are seen as minor. Impacts to water quality and hydromorphology of the Royal Canal are neutral, imperceptible permanent. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Ecological Potential.

Table 10-5 Water Framework Directive Assessment Summary - Transitional Waterbodies

Water body affected (WFD Code)	Ecological Status Or Potential	Driving element for status classification	Significant Pressures	RBMP Measures	Does the proposed DART+ West development prevent the achievement of the subject watercourses WFD Objectives?
Tolka Estuary (IE_EA_090_0200)	Moderate	Biological Status or Potential	Urban Waste Water	Actions to address pollution from urban waste-water and urban runoff are set out in Section 7.2.3 of the 2nd Cycle RBMP.	The South Dublin Bay and River Tolka Estuary SPA overlaps with the Tolka Estuary Waterbody. No significant works including any amendments to the drainage network are proposed that are likely to effect Tolka Estuary. Existing drainage flow paths and flows are to be maintained throughout this reach. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a negligible effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Ecological Potential.
Liffey Estuary Lower (IE_EA_090_0300)	Good	Biological Status or Potential	Urban Waste Water	Actions to address pollution from urban waste-water and urban runoff are set out in Section 7.2.3 of the 2nd Cycle RBMP.	The South Dublin Bay and River Tolka Estuary SPA and North Bull Island SPA are immediately downstream of the proposed development and overlap with the Liffey Estuary Lower waterbody. The Spencer Dock areas currently drains to The River Liffey via the local surface water drainage network. The proposed Spencer Dock Station will require considerable excavations with the proposed platforms being provided below ground level. During construction, an attenuation and settlement pond will be provided to manage runoff quality and discharge rates. Once operational all surface water runoff will be conveyed to a hydro-carbon interceptor and attenuation tank prior to being pumped at a suitable rate to the local drainage and subsequently discharging to the Liffey estuary. The reduction in pollution sources (diesel locomotives) combined with the incorporation of a hydro-carbon interceptor leads to an overall positive impacts to water quality. The proposed development will not hinder implementation of measures outlined in the 2nd Cycle RBMP. The proposed works will have a slight positive effect on the subject waterbodies significant pressures and will not prevent the attainment of Good Ecological.

10.6.2.3 Fluvial and Coastal Flooding

The site specific flood risk assessment carried out for the project has concluded that the vast majority of the proposed development is within flood zone C as per the OPW guidelines and at low risk of flooding. The notable exceptions are at Docklands / Newcomen and the lands between Maynooth and Kilcock. These areas are discussed below detailing the flood risk management measures inherent in their design.

10.6.2.3.1 Dockland Station / Newcomen Area

Existing information indicates that the Docklands / Newcomen area is liable to flood in extreme events with increased flooding likely due to future effects of climate change. Currently the Docklands / Newcomen area is defended to the 0.5% AEP coastal event (1 in 200 year). These municipal defences managed by the local authority and OPW will require adaption to reduce the impact of climate change in the future.

It is envisaged that flooding will be managed at this location through the adoption of flood resilient design and materials, flood warning systems and flood emergency response planning and implementation. Flood forecasting is appropriate as tidal inundation is the primary flood source. Two systems known as Triton and Tidewatch were developed for tidal flood forecasting and warning systems following the coastal flood event in February 2002. Both systems make use of weather and/or surge forecasts in the Irish Sea to provide future predictions of tide levels, with Tidewatch providing forecasts up to five days in advance and Triton two days in advance. The forecasts are used to implement emergency response procedures such as closing of flood gates within existing flood defences. For example, the flood defences along Spencer Dock. On receipt of a flood warning, the Spencer Dock Station flood emergency response plan will be enacted, which should include; preparatory actions (e.g. suspension of services from dockland station), post-flood clean up and reopening procedures. Due to the nature of the flooding (tidal), the impact of flood water displacement is envisaged to be negligible, and no compensation is required. The likely effects on flood risk at Docklands Newcomen are *negative, long-term, imperceptible to slight.*

10.6.2.3.2 Between Maynooth and Kilcock

There are two distinct flooding locations between Maynooth and Kilcock. These are:

OBG23 Jackson Bridge - Rail Track

The hydraulic modelling undertaken as part of this assessment has identified significant flooding in the vicinity of Jackson's Bridge. The track at this location cannot be raised due to potential conflicts with preserving heritage aspects of Jackson's Bridge. In order to provide a sufficient level of protection to the line, the development has been moved offline on a raised embankment over the floodplain. Proposed crossings have been sized as to maintain existing flood levels. Bridges soffits are to maintain a freeboard of >300 mm above the 1% AEP (+ climate change) flood level while the minimum rail level will maintain a freeboard of >500 mm above the 0.1% AEP (+ climate change) events. The proposed embankments at OBG23 will displace flood water and require compensation. Volumes of compensatory storage to be provided at OBH23 are shown in Table 10-6 below. The rail embankment bridge over the Lyreen has been sized to accommodate the immediate riparian zone and maximise conveyance. In addition, flood conveyance culverts are to be provided through the embankment to ensure that the embankments to ensure flow through the floodplain is maintained.

Table 10-6 Compensatory Storage Volumes Required at OBG23

Return Period	Flood Waters Displaced (m3)
Q1000MRFS	35239.68
Q100MRFS	27517.90
Q10MRFS	7547.43

Bailey's Bridge - Proposed Depot Site

The Ballycaghan Stream and the proposed depot lands have been assessed. The proposed development will require a diversion of the existing stream and provisions of compensatory storage. Depot level will be a minimum of 300 mm above the 0.1% AEP flood level (+ climate change). Residual flood risk will be managed by the implementation of a flood emergency response plan which should form part of the facilities management plan. The depot area and minor watercourse were not covered by the CFRAMS study. Volumes of compensatory storage required at OBG23 are shown in Table 10-7 below. Due to existing topography constraints, there will be an overprovision of compensatory storage in the 0.1% AEP event. A minor bund is to be provided along the eastern and southern boundary of the compensatory storage area adjacent to the depot with a height no greater than 1 m above existing ground levels.

Table 10-7 Compensatory Storage Volumes Required at Depot Site

Return Period	Flood Waters Displaced (m3)
Q1000MRFS	17,136
Q100MRFS	13,185
Q10MRFS	10,065

The measures proposed between Maynooth and Kilcock will ensure that the proposed development is defended to the 0.1% AEP event. The post development model shows flood pathways are maintained by the provision of flood conveyance culverts while displaced volumes are accommodated in the compensatory storage areas. The overprovision of compensatory storage will cause a minor reduction in peak runoff from the Ballycaghan Stream. The development results in a minor increase in flood levels immediately adjacent to the proposed development though this is seen as negligible overall. The likely effects on flooding between Maynooth and Kilcock are *negative, not significant to slight and permanent.*

10.6.2.4 Predicted Impact of Storm Discharge on Flooding

The existing drainage pathways for the proposed development will be maintained as part of the development during operation. The proposed development has been reviewed for likely effects on surface water and pluvial flooding, it is not envisaged that the proposed development will affect flooding from these sources. In existing developed areas runoff rates and volumes will be maintained. In areas where new hardstanding is proposed, runoff will be attenuated in line with TII guidelines incorporating SuDS where possible. The potential effects are *neutral, imperceptible and permanent.*

10.6.2.5 Predicted Impact on Hydromorphology

The proposed development will require works within the floodplain of the Lyreen River and realignment of the Ballycaghan Stream. It should be noted that both these watercourses have been significantly modified through agricultural drainage and provision of the existing railway/canal. The proposed crossing of the Lyreen in combination with flood conveyance culverts have been sized to minimize longitudinal severance through the riparian zone. Wetland areas are also to be incorporated into the proposed compensatory storage areas restoring ecosystem service provision. The realignment of the Ballycaghan Stream will be designed to closely match existing channel characteristics and includes an appropriately sized vegetated buffer. The likely effects to hydromorphology at the Lyreen and Ballycaghan Stream are *positive, imperceptible to slight and long term*.

The proposed development will also require modification to the Royal Canal with minor instream works for bridge crossing throughout and the provision of an aqueduct at Ashtown. Nonetheless in the context of an existing artificial water body the modifications are seen as minor. The likely effects to hydromorphology of the Royal Canal are *neutral, long-term and imperceptible*.

10.6.2.6 Royal Canal Water Levels

Multiple sections of track lowering are proposed throughout the development to allow for the sufficient OHLE clearances. Many of these locations are in close proximity to the Royal Canal with track levels being reduced to below existing canal Water levels. The proposed design ensures that the integrity of the canal is maintained. The likely effects are *neutral, imperceptible, and permanent*.

10.6.2.7 Predicted Impact of Storm Discharge of Pollutants

Existing drainage paths are to be maintained. The implementation of new filter drains and carrier drains trackside may decrease the time taken for surface waterborne pollutants to enter the receiving waterbodies. Where the railway is to be lowered a new drainage network will be provided. Drainage catchments will remain the same with discharge locations maintained. Nonetheless, there is a minor reduction in sources of pollution due to the electrification of the rolling stock and subsequent reduction of fuel and oil leaks. The minor amendments to the existing drainage networks will be likely have *positive, imperceptible, and permanent* effects.

10.6.2.8 Recreational and amenity waters

The operation phase will lead to an overall increase in train movements and resultant disturbance to the Royal Canal and adjacent paths. The activities at the depot is also likely to be perceptible from the canal. The likely effects are *negative, slight and long-term*.

10.7 Mitigation measures

10.7.1 Construction Mitigation

As is normal practice with infrastructure projects, an Environmental Operating Plan (EOP) and Construction Environmental Management Plan (CEMP) will be prepared for the proposed development and are included in Appendix A5.1 Construction Environmental Management Plan in Volume 4 of this EIAR. These will be developed by the selected contractor to suit the detailed construction methodology and allocate responsibilities to individuals in the construction team. In doing so, the measures detailed in the appended reports will be considered minimum requirements to be considered and improved upon. The level of detail provided within the current drafts of the Plans is sufficient to allow an assessment of the anticipated impacts including residual impacts.

The following will be implemented as part of this plan:

1. An Incident Response Plan (see Appendix F of Appendix A5.1 in Volume 4 of this EIAR) will be finalised detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, non-compliance with any permit or license, or other such risks that could lead to a pollution incident, including flood risks.
2. All necessary permits and licenses for in stream construction work will be obtained prior to the commencement of construction.
3. Inform and consult with Inland Fisheries Ireland and Waterways Ireland.

During construction, cognisance will have to be taken of the following guidance documents for construction work on, over or near water.

1. *Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites* (Eastern Regional Fisheries Board).
2. *Central Fisheries Board Channels and Challenges – The enhancement of Salmonid Rivers.*
3. *CIRIA C532 Control of Water Pollution from Construction Sites Guidance for Consultants and Contractors.*
4. *CIRIA C648 Control of Water Pollution from Constructional Sites.*

5. *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes (TII, 2006).*

Based on the above guidance documents concerning the control of construction impacts on the water environment, the following outlines the principal mitigation measures that will be adhered to for the construction phase, in order to protect all catchment, watercourse and ecologically protected areas from direct and indirect impacts:

General Mitigation Measures

1. Site works will be limited to the minimum required to undertake the necessary elements of the proposed development.
2. Surface water flowing onto the construction area will be minimised through the provision of berms, diversion channels or cut-off ditches.
3. Management of excess material stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be undertaken. This may involve allowing the establishment of vegetation on the exposed soil and bunding.
4. Protection of waterbodies from silt load will be carried out through the use of gully silt/sediment filters and shallow berms in hardstanding areas to provide adequate treatment of runoff to watercourses.
5. Settlement tanks, silt traps/bags and bunds will be used. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap.
6. The anticipated site compound/storage facility will be fenced off at a minimum distance of 5m from the top of bank. Any works within the 10 m buffer zone will require measures to be implemented to ensure that silt laden or contaminated surface water runoff from the compound does not discharge directly to the watercourse. A CEMP has been drafted and will need to be finalised by the appointed Contactor. See the Environmental Operating Plan (EOP) and Construction Environmental Management Plan (CEMP) in Appendix A5.1 Construction Environmental Management Plan in Volume 4 of this EIAR for further detail.
7. Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored, and disposed of in accordance with the TII document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be contained within bunded areas and set back a minimum of 20 m from watercourses.
8. Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner, off site, to prevent pollution.
9. The construction discharge will be treated such that it will not reduce the environmental quality standard of the receiving watercourses.

Specific Mitigation Measures - Concrete Works

The use and management of concrete in or close to watercourses must be carefully controlled to avoid spillage which has a deleterious effect on water chemistry and aquatic habitats and species. As the use of concrete cannot be avoided, the following control measures will be employed:

1. Hydrophilic grout and quick-setting mixes or rapid hardener additives shall be used to promote the early set of concrete surfaces exposed to water.
2. When working in or near the surface water and the application of in-situ materials cannot be avoided, the use of alternative materials such as biodegradable shutter oils shall be used.
3. Any plant operating close to the water will require special consideration on the transport of concrete from the point of discharge from the mixer to final discharge into the delivery pipe (tremie). Care will be exercised when slewing concrete skips or mobile concrete pumps over or near surface waters.
4. Placing of concrete in or near watercourses will be carried out only under the supervision of the Ecological Clerk of Works (ECoW).
5. The weather forecast will be consulted prior to commencing concrete pours. No such works will be undertaken if inclement weather is forecast such that precipitation may make it difficult to maintain a dry working area.

6. There will be no spills of concrete, cement, grout, or similar materials hosed into surface water drains. Such spills shall be contained immediately, and runoff prevented from entering the watercourse.
7. Concrete waste and wash-down water will be contained and managed on site to prevent pollution of all surface watercourses.
8. On-site concrete batching and mixing activities will only be allowed at the identified construction compound areas.
9. Washout from concrete lorries, with the exception of the chute, will not be permitted on site and will only take place at the construction compound (or other appropriate facility designated by the manufacturer).
10. Chute washout will be carried out at designated locations only. These locations will be signposted. The Concrete Plant and all Delivery Drivers will be informed of their location with the order information and on arrival to site.
11. Chute washout locations will be provided with an appropriate designated, contained impermeable area and treatment facilities including adequately sized settlement tanks. The clear water from the settlement tanks shall be pH corrected prior to discharge (which shall be by means of one of the construction stage settlement facilities) or alternatively disposed of as waste in accordance with the Contractor's Waste Management Plan.

10.7.1.1 Flooding

The Contractor will provide method statements for weather and tide/storm surge forecasting and continuous monitoring of water levels in the Liffey estuary and Lyreen River. The Contractor will also provide method statements for the removal of site materials, fuels, tools, vehicles, and persons from flood zones in order to minimise the risk to persons working on the site as well as potential input of sediment or construction materials into the river during flood events.

10.7.1.2 Royal Canal Water Levels

The works required for the track lowering adjacent to the canal will include measures to ensure the integrity of the canal liner is maintained during the construction phase and to limit the potential for water to leak from the canal. Thus, maintaining appropriate water levels for navigational and existing habitat provision.

10.7.1.3 Recreational and amenity waters

The construction phase will prohibit transit upstream or downstream of Ashtown for approximately 1 year while the underpass is constructed. No measures are proposed to mitigate this impact.

10.7.1.4 Monitoring Measures

Water quality monitoring will be undertaken in the Royal Canal, Lyreen River and Ballycaghan Stream, with monthly samples being taken from at least 12 months prior to commencement of construction until at least 24 months post-completion. The final number and location of sampling points will be determined by the Site Environmental Manager. The results of the water quality monitoring programme will be reviewed by the Site Environmental Manager and Ecological Clerk of Works on an ongoing basis during construction. In the event of any non-compliance with regulatory limits for any of the water quality parameters monitored, an investigation will be undertaken to identify the source of this non-compliance and corrective action will be taken where the this is deemed to be associated with the proposed development.

10.7.2 Operational Mitigation

There are no mitigation measures proposed for the operational phase of the proposed development.

10.8 Monitoring

Monitoring is not proposed for the operational phase.

10.9 Residual effects

The residual hydrological effects associated with the proposed development following the implementation of the mitigation measures outlined in Section 10.7, are outlined below.

10.9.1 Construction phase

Water Quality

Following the implementation of the measures outlined in the Environmental Operating Plan in Appendix D of Appendix A5.1 in Volume 4 of this EIAR, there will be *negative, slight, and temporary* residual effects on water quality during the construction phase of the proposed development.

Flood Risk

Mitigation in place during the construction phase will limit flood risk and reduce the potential for pollution events. With the inclusion of mitigation during the construction phase, the proposed development will likely have *negative, slight, temporary* effects on flood risk at the depot site during the construction phase.

Recreational and amenity waters

Transit along the canal upstream and downstream of Ashtown will be prohibited during the works. The likely effects remain *negative, moderate to significant and temporary.*

10.9.2 Operation Phase

The residual hydrological impacts associated with the operation phase of the proposed development are as identified in Section 10.6.2 of this chapter.

10.10 Cumulative effects

In terms of hydrology there is the potential for impacts to persist from the construction to the operational phase in addition to impacts migrating through connected catchments. Nonetheless, overall cumulative impacts are regarded as highly limited.

During construction, cumulative effects will not be any greater than the residual impacts described in Section 10.9. Measures to provide pollution control are to be in place throughout the development. Management and maintenance of these measures as outlined in the Environmental Operating Plan (Appendix D of Appendix A5.1 in Volume 4 of this EIAR) ensures cumulative impacts are restricted throughout the construction phase.

During operation impacts to water quality have the potential to be a slight positive due to the inclusion of source treatment in the form of SuDS measures and formalisation of historic drainage networks. Potential slight impacts resulting from the construction phase are temporary in nature and unlikely to have any significant ongoing cumulative impact during operation. Refer to Chapter 26 Cumulative Effects in Volume 2 of this EIAR for further discussion of hydrological impacts with other developments.

10.11 References

EPA (2017). Environmental Protection Agency Envision WFD Status

EPA (2017) Environmental Protection Agency Envision Surface Water Quality

GSI (2017). Geological Survey of Ireland Groundwater Data Viewer

GSI (2017). Geological Survey of Ireland (GSI) – Bedrock Geology

Teagasc – Subsoil Map

OPW (2021). FloodInfo.ie – CFRAMS mapping, ICPSS mapping, Flood Risk Management Plan Liffey Dublin Bay.

OSI (2021) Geohive map viewer – Historic 6" Mapping