REPORT

Hydrological and Hydrogeological Qualitative Assessment

Large Scale Residential Development on Lands at Kilbride, Arklow, Co. Wicklow

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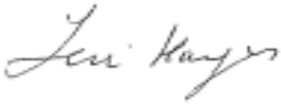
Signature		
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Date	19 May 2025	

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1. INTRODUCTION

1.1 Background

AWN have been requested by Donnachadh O'Brien & Associates Consulting Engineers (DOBA) on behalf of Certain Assets of Dawnhill and Windhill Limited to carry out a Hydrological and Hydrogeological Qualitative Assessment for a large-scale residential development located on "Lands at Kilbride", Arklow, Co. Wicklow.

Certain Assets of Dawnhill and Windhill Limited intend to apply for a 7-year planning permission for a Large Scale Residential Development at this site of c.28.47ha. The site is generally bounded by the town marsh to the south, M11 to the west, housing at Avondale Crescent/ Murrell Drive and St Joseph's School to the east and the Kilbride Industrial estate and Kilbride Road L-6179 to the north. The development will consist of 750 no. residential units comprising and will also include a local centre comprising a creche (c.1106sqm), 3 no. community/medical units, and 3 no. retail units (along with the apartments). Building heights will range from one to five storeys. The site will provide a pedestrian and cyclist path linking the site to the Marshland sports club and through into Avondale Crescent. Part of the new regional road is also proposed connecting to the Kilbride Road, and the new access road provided by the "Kilbride Education Campus" along with upgrade works to the Kilbride Road L6179. A boardwalk will be provided across the Arklow town marsh and Avoca River connecting the site to Arklow town.

This report mainly focuses on the proposed boardwalk which will be constructed across a pNHA marshland to the north of the Avoca River (Arklow Town Marsh). The scope of this desk top review is to assess the potential for any likely significant impacts on receiving waters during construction or post development. In particular, this review considers the likely impact of construction of the proposed development on the natural water regime (water flow and water quality) and overall water body status within the receiving environment.

This report was prepared by Teri Hayes and Marcelo Allende. Teri Hayes (BSc MSc PGeol EurGeol) is a Director and Hydrogeologist with AWN Consulting with 30 years of experience in water resource management, environmental assessment and environmental licensing. Teri is a former President of The International Association of Hydrogeologists (IAH, Irish Group) and is a professional member of the Institute of Geologists of Ireland (IGI) and European Federation of Geologists (EurGeol). She is listed on the EPA approved Institute of Geologists of Ireland 'Register of Competent Persons' in regard to Section 2.3 of the EPA Code of Practice. Her project experience includes contributions to a wide range of complex Environmental Impact Statements, planning applications and environmental reports for Industry Infrastructure and residential developments. She has considerable experience in undertaking planning applications and licence applications Teri has written and provided technical review and training on environmental programmes for both the public and private sector and has considerable experience in public presentations, stakeholder liaison and acting as a legal witness.

Marcelo Allende (BSc, BEng) is a Principal Environmental Consultant (Hydrologist) with AWN Consulting with over 20 years of experience in water resources technical studies, conceptual and numerical hydrological/hydrogeological modelling and environmental consultancy. Marcelo holds a degree in Water Resource Civil Engineering (BEng, Hons) from the University of Chile and a Bachelor of Science in Engineering (BSc, Hons). He has worked on a wide of range of projects including multi-aspect environmental investigations, geo-environmental impact assessments, surface and groundwater resource management, hydrological and hydrogeological conceptual and numerical modelling, strategic and site specific flood risk assessments (Stage 1,2 and 3), Due Diligence reporting, baselines studies, soils, surface water and groundwater monitoring and field sampling programmes on a variety of brownfield and greenfield sites throughout Ireland as well as overseas in Chile, Argentina, Peru and Panama. He is currently a member of the International Association of Hydrogeologists (IAH, Irish Group) and a member of Engineers Ireland (MIEI).

2. DESCRIPTION OF THE DEVELOPMENT AND CONSTRUCTION METHODOLOGY

2.1 Description of Development

It is proposed to construct greenway infrastructure in the form of a boardwalk which crosses the marshlands to the south of the proposed development in order to increase connectivity and permeability to the centre of Arklow Town. The proposed infrastructure shall traverse Wicklow County Council-owned lands and will consist of a 3.0m wide shared cycle and footpath along a raised decking structure. The proposed boardwalk shall traverse the marsh to the south of the LRD Scheme site at an elevated level of 3.50mOD, 500mm above the 1:100-year flood level of 3.05mOD along the length of the boardwalk.

The boardwalk is proposed between the proposed development at Kilbride, across the Arklow marshlands and Avoca River and will connect to the proposed Arklow to Shilelagh Greenway on the southern bank of the Avoca River. This Greenway starts adjacent to the public Cark Park in Arklow town centre. A River Walkway is being delivered by Wicklow County Council (WCC) as part of the Arklow Flood Relief Scheme and the Boardwalk will tie into the proposed levels of the River Walkway.

The proposed Boardwalk extends form the southern side of the residential development, through the internal cycle and pedestrian network of the residential development (refer to Figure 2-1 below). The boardwalk is elevated and extends approximately 650m across the marshlands, after which it crosses the Avoca River. Debris trap columns constructed in reinforced concrete are being provided by Wicklow County Council as part of the Avoca River Flood Relief scheme, and following extensive consultation with Wicklow County Council, the boardwalk will extend across the debris trap columns and will tie into the proposed levels of the Greenway on the southern side of the Avoca River. The Debris Trap piers and Greenway are approved works as part of the Flood Relief Scheme mentioned above (refer to Figure 2-2 below).

Figure 2-1. Site Location Map

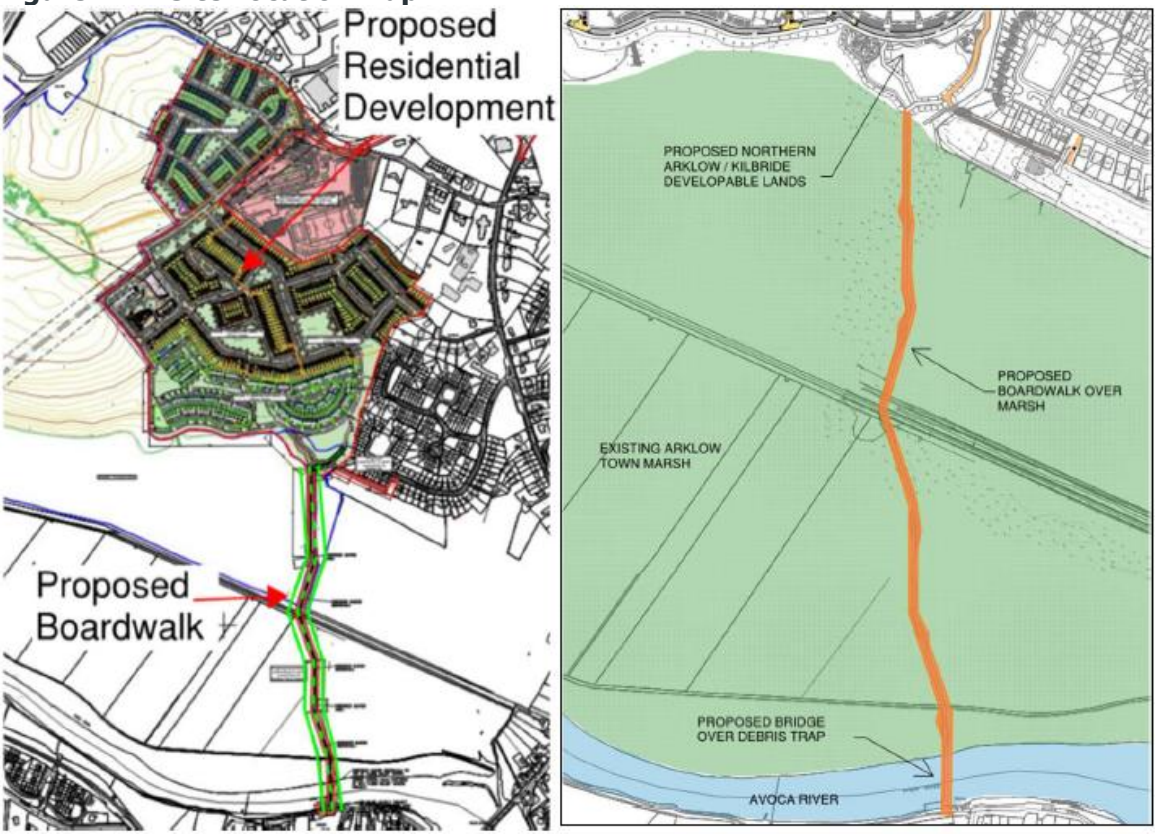
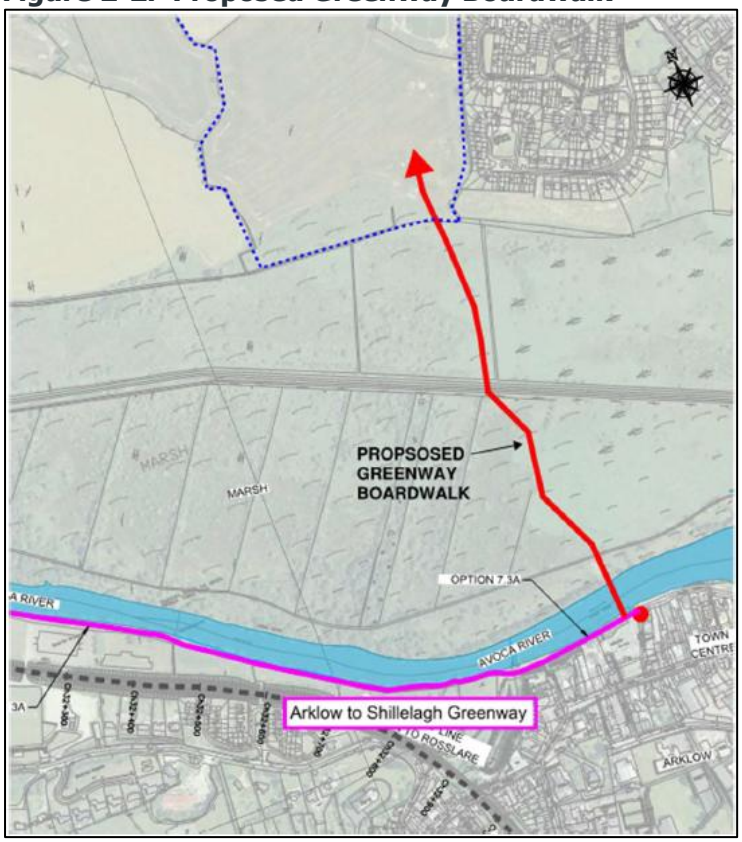


Figure 2-2. Proposed Greenway Boardwalk



2.2 Boardwalk Construction Methodology

DOBA has prepared and Outline Construction Methodology for the Greenway Boardwalk. This section summarises the main aspects of this methodology.

The boardwalk will be delivered as part of a phased LRD housing project, subject to planning approval. Part of the Lioncor Landholding included an approved residential scheme for 86 No units, (WCC Planning Reg. Ref. 23756). It is expected that delivery of this housing scheme will commence in Q3/4 2025 and that temporary construction access to the marsh for the boardwalk construction will be provided will be provided form this site.

In order to have the least impact on the existing marshland and vegetation it is proposed that access across the marsh for construction traffic will utilise temporary timber bog mats which will be placed on top of the marsh/wetland areas. Geotextile sublayers will be used underneath the bog mats where the marsh is extremely wet, and their load bearing capacity is estimated at 30 Ton.

As part of the proposed boardwalk and construction, it may be necessary to traverse existing field boundary drains or watercourses within the marsh which (such as the Marsh Stream presented in Section 3.1 below). It is proposed that any existing watercourses will be piped with single or twin 600mm diameter UPVC pipe and timber bog mats will be installed over the watercourses/ ditch to facilitate temporary construction traffic crossing and to ensure the existing natural flow of the ditch remains undisturbed. At the completion of the construction stage, these pipes will be removed and the ditch returned back to the pre-development condition.

The boardwalk will be founded on piles. The piling solution has been designed to ensure that the lightweight rigs can be used and 150/200mm diameter bottom driven steel tube mini piles are proposed to be used. The weight of these rigs is typically between 2 and 2.5 Tonnes.

The use steel end driven piled foundations will ensure that excavation of soils within the marsh area will be kept to a minimum. As the piles are end drive steel pile there are no soil arisings form the piling operation which will require disposal.

A steel framed lightweight temporary boardwalk has been designed to traverse the Marshland during the construction phase. Vertical supports will be at 6m, and it is intended that the steelwork deck will be delivered in prefabricated sections and lifted in position onto the support steels. To minimise construction work in the marshland, it is proposed that precast concrete pile caps will be used onto which the steel framed boardwalk will be connected.

With regard to the boardwalk construction across Avoca River, as part of the WCC/OPW flood defence scheme, construction access will be provided for the construction of the debris traps which are oval shaped concrete piers approximately 1600mm x 600mm. These are being supported on CFA piles to be installed in the riverbed. Temporary gravel working platforms will be provided for the construction of these works and it is intended that the boardwalk deck will be installed at the same time on completion of the debris trap concrete piers. All works within the Avoca River will be constructed during low flow and temporary gravel berms and flow diversions can be put in place to ensure a safe working platform in the riverbed to undertake the construction works.

Adjacent to the river walkway on the south bank of the Avoca River, a section of boardwalk will be constructed supported on this section will be constructed on CHS 200mm diameter end driven piles. Again, this section will be constructed off a temporary gravel platform constructed form the river bed at the edge of the river.

Tie in to the riverwalk Greenway on the southern bank of the Avoca River which will be constructed by Wicklow County Council as part of the Arklow Flood Relief Scheme.

Construction of the works requiring access to the river during normal and low flows (summer months) with contingency plans for periods of higher flows or flood events.

3. ASSESSMENT OF BASELINE WATER QUALITY, RIVER FLOW AND WATER BODY STATUS

3.1 Hydrological Catchment Description

The Proposed Development site lies within the Avoca-Vartry Catchment (Hydrometric Area 10) and Avoca River sub-catchment (WFD name: Avoca_SC_020, Id 10_9) (EPA, 2025) which is managed by the Wicklow County Council (WCC).

The Arklow Town Marsh is located north of the Avoca Estuary Transitional Waterbody (WFD Code: IE_EA_150_0100) on the perimeter of Arklow Town (refer to Figure 3-1 below). A pedestrian laneway runs in a general east to west direction through the site. The majority of the marsh is covered by a wet grassy compound. The area is designated as a proposed Natural Habitat Area (pNHA; site code 1931). The marshland is subject to fluvial and coastal flooding (refer to CFRAM maps, presented in Figure 3-2 and Figure 3-3 below). There is a river waterbody (Marsh Stream, associated with Avoca_030 waterbody, WFD Code IE_EA_10A031140) associated with the drainage of the marsh and outfalls into the Avoca Estuary c. 500 downstream of the proposed boardwalk.

According to the SSFRA carried out by DOBA Consulting Engineers, the proposed greenway and associated embankments located within the flood zone to the south of the site have been calculated to displace approximately 2900m3 of flood volume during the 1:1000-year event. The assessment proposes to provide compensatory storage in the southern greenspace (located in Flood Zone C) to account for any displaced volume lost to the greenway embankments. An area of approximately 2635m2 has been identified as being suitable to regrade the ground 1.1m lower than existing to allow for lost flood volume to be catered for.

Figure 3-1. Hydrological Map

Figure 3-2. CFRAM Fluvial Flooding Map

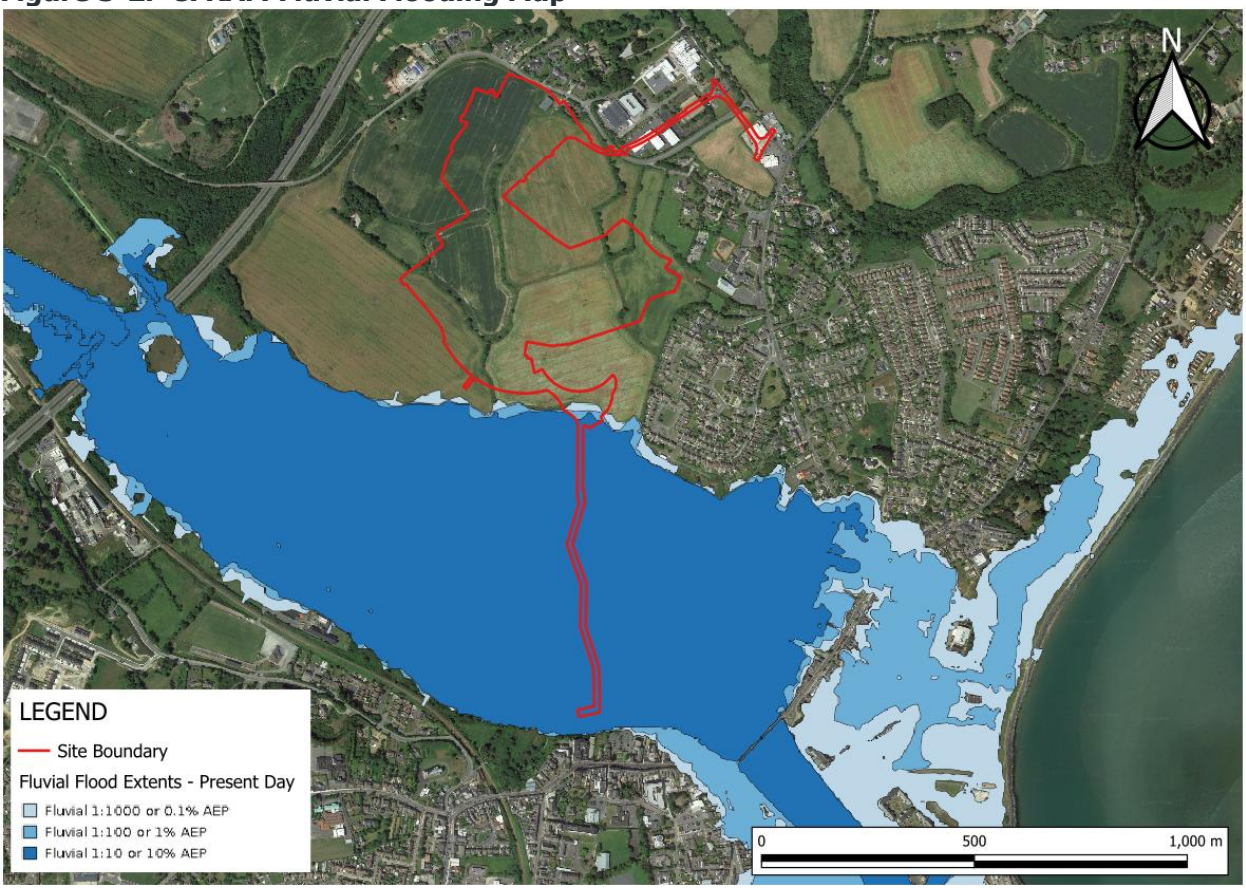


Figure 3-3. CFRAM Coastal Flooding Map

The Environmental Protection Agency (EPA, 2025) on-line mapping presents the available water quality status information for water bodies in Ireland.

The Avoca Estuary Transitional Waterbody has a WFD status (2016-2021) of 'Moderate' and a WFD risk score of 'At risk of not achieving Good Status'. The Avoca_030 river waterbody that drains the mashland has a WFD status (2016-2021) of 'Moderate' and a WFD risk score of 'Not at risk'.

According to the EPA (2025), the Avoca Estuary failed to achieve good status due to exceedance in cadmium, copper, lead and zinc, in addition to moderate hydromorphological and oxygenation conditions. The moderatre status for the Marsh Streram is based on expert judgement as there are no water quality station associated with this waterbody.

3.2 Aquifer Description & Superficial Deposits

A previous site investigation was conducted by the Flood Relief Scheme Design Team in 2019. Boreholes drilled as part of this site investigation indicated varying soil profiles, generally ranging as follows:

- 0 – 1.0m below ground: Peat/Silt
- 1.0m – 1.5m Silty Sand
- 1.5m – 3.0m Sand

Groundwater monitoring was carried out at installed standpipes that were installed at 5 No. locations across the marsh during September-October 2019 for a 6-week period to establish the hydrogeological regime of the marsh. During periods of no rainfall, the water level was recorded below ground level at the various test locations. For the remainder of the test period (i.e., after rainfall events), water levels recorded were above ground, showing a direct response to precipitation.

Inspection of Mapping from the Geological Society of Ireland (GSI, 2025 http://www.gsi.ie, accessed on 22-04-2025) indicates the bedrock underlying the site is part of the Kilmacrea Formation (code KA) which is described as dark grey slate, minor pale sandstone.

The GSI (2025) National Aquifer Map identifies gravel and bedrock aquifers beneath the subject site and they are classified as 'Locally Important Gravel Aquifer – Valley Setting' and 'Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones', respectively (refer to Figure 3-4 below). The proposed development is within the 'Wicklow' groundwater body (European Code: IE_EA_G_076) whose most recent WFD groundwater status (2016-2021) is 'Good' and its current WFD risk score is 'At risk of not achieving Good Status' by 2027.

Aquifer vulnerability is a term used to represent the intrinsic geological and hydrological characteristics that determine the ease with which groundwater may be contaminated generally by human activities. The GSI (2025) guidance presently classifies the bedrock aquifer vulnerability in the region of the subject site as 'Moderate' which indicates a general overburden depth >10m for moderately permeable sandy subsoils such as the existing subsoil in the marshland. This shows that the bedrock regional aquifer is moderately well protected by the marsh and alluvial deposits, although the water level associated with the gravel aquifer level is shallow and sensitive to local rainfall. The aquifer vulnerability class in the region of the site is presented as Figure 3-5 below.

Figure 3-4. Aquifer Classification Map (Source: GSI, 2025)

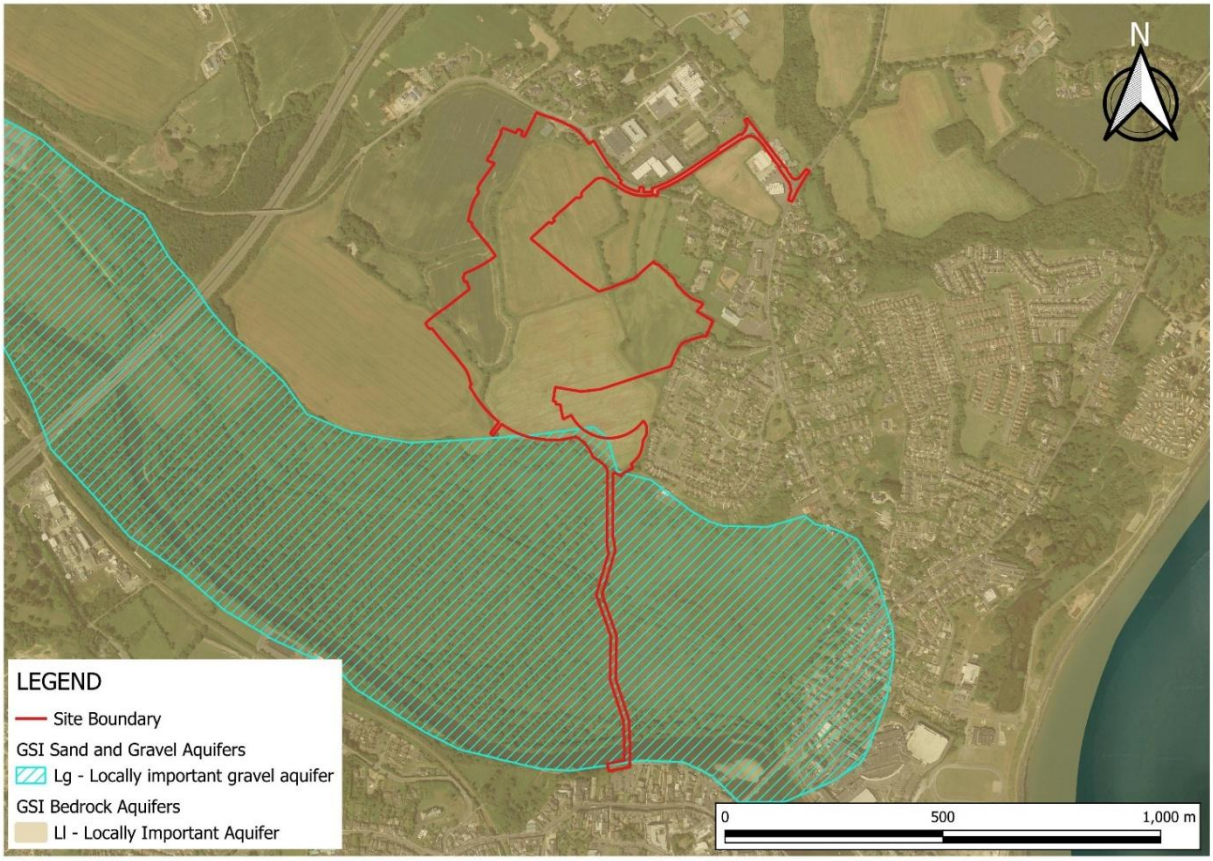
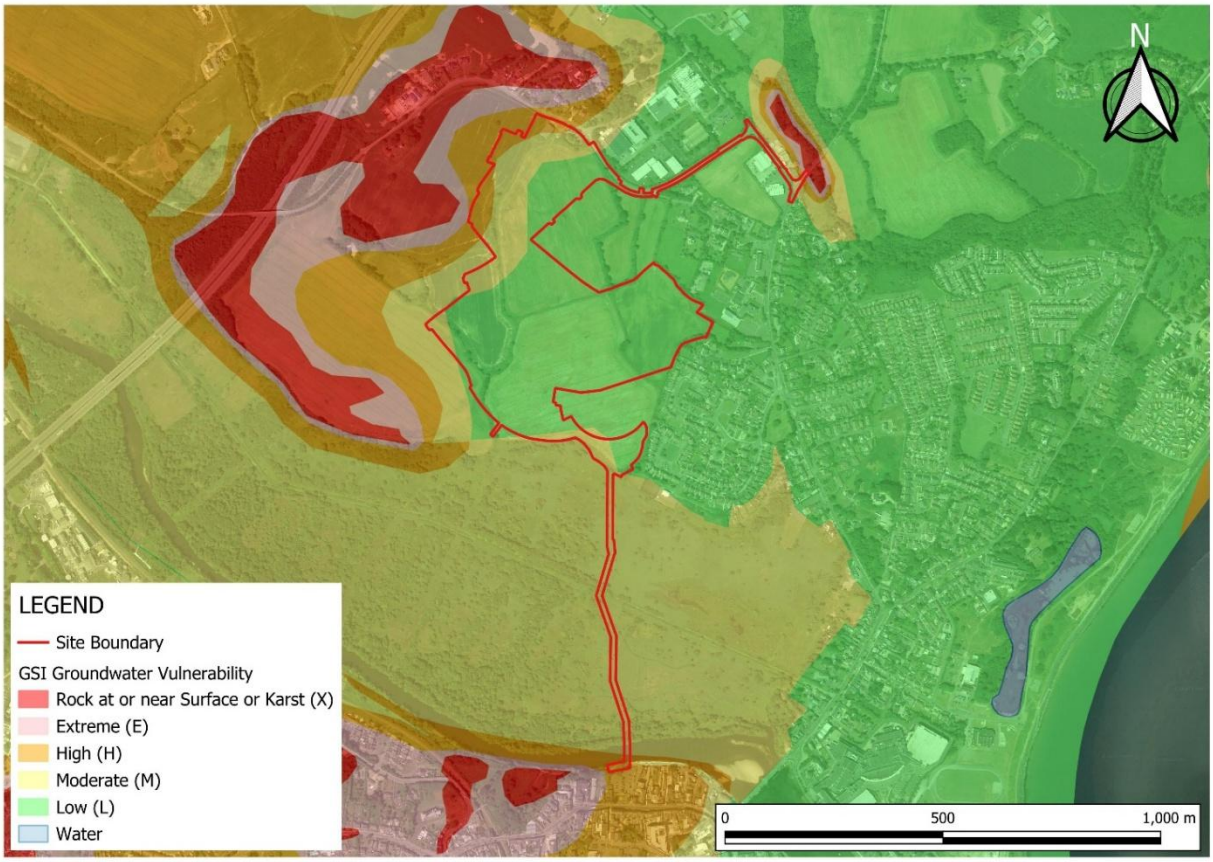


Figure 3-5. Aquifer Vulnerability Map (Source: GSI, 2025)



4. POTENTIAL IMPACTS

This section summarises the potential impacts associated with the proposed boardwalk during the construction and operational phase on the hydrological and hydrogeological environment.

4.1 Construction Impacts

4.1.1 Impacts on Water Quality

The construction of infrastructure near watercourses poses a significant risk in terms of contamination arising from spillages and sediment transport areas which can lead to degradation of water quality, ecological damage and flooding. The boardwalk support structures will not be constructed in-stream, but rather in the marsh (which is a flood plain), over timber bog mats. However, additional piles will be constructed in the Avoca River. It should be noted that these piles will be constructed whilst by Wicklow County Council is constructing the debris trap columns. These debris trap columns will be provided by Wicklow County Council as part of the Avoca River Flood Relief scheme and are not part of the proposed development. Although it will provide access to the in-stream construction works.

It should be also noted that, as the groundwater level in the marsh are shallow and seasonally over ground level, it will be likely that construction works in this area will be carry out when this water is exposed meaning potential for changes to the local hydrological regime in the marsh and its final receptor (Avoca Estuary).

The main contaminants arising from construction activities and runoff includes the following:

- Increase of silt and sediment loading arising from construction site runoff. Elevated silt loading can lead to long-term damage of aquatic ecosystems in the marsh or downstream in Avoca Estuary by overloading spawning grounds and gravel beds. Increase silt loads reduces 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. It should be noted that this effect will be attenuated by the use of bog mats; no backfilling or earthworks are foreseen
- Spillage of cementitious products such as concrete, grout and epoxies. Cementitious based products are highly alkaline and extremely corrosive which can result in significant impact to watercourses by altering the pH, smothering stream beds and physically damaging fish. However, it should be noted, that the only concrete work projected will be within the filly enclosed steel pile.

The above construction activities will require localised clearance although removal of topsoil/subsoil is not foreseen. These works would potentially increase the erosion potential of the area during heavy rainfall and flooding events during which sediment can be transferred to the river via overland flow. As mentioned above, the use of bog mats will avoid significant excavations resulting in the least possible disruption to the marsh.

Use of precast pile caps will reduce the in-situ concrete work on site. Pile caps will sit at or above existing ground level to reduce the excavation requirements on site, minimising the impacts on water quality mentioned above and maintain ecological water requirement flows through this sensitive area.

With regard to the boardwalk construction across the Avoca River, that the boardwalk deck will be installed at the same time on completion of the debris trap concrete pier by Wicklow County Council. Temporary gravel working platforms will be provided for the construction of these works and, as mentioned above, it is intended that all works within the Avoca River will be constructed during low flow and temporary gravel berms and flow diversions would be put in place to ensure a safe working platform in the riverbed to

undertake the construction works. It is believed that Wicklow County Council will be responsible for these flow diversion works as well as working platform in the riverbed.

4.1.2 Impact on Water Levels and Flooding

The proposed structure can adversely affect upstream and downstream water levels and flows of the waterbodies to intervene. The nature of the proposed development as a boardwalk means that the potential contaminant load and accidental spillage risk is minimal during operational phase.

As mentioned above, water levels across the marsh are shallow and respond directly to rainfall, rising above ground level after rainfall events and are therefore sensitive to ground level alterations or potential leakage due to construction works.

However, volumes displaced by the proposed temporary boardwalk, bog mats and localised temporary sheet piling during construction phase are considered to be small relative to the flow volumes in the receiving waterbody and will result in a non-significative effect in terms of quantity of flow affected. The bog mats will have sufficient load-bearing capacity for the construction equipment, so no displaced volume is expected from the weight of the machinery.

There is minimal impact on flooding during the construction phase. The volumes displaced by the proposed temporary boardwalk, bog mats and localised temporary sheet piling during construction phase are extremely small relative to the flow volumes in the receiving waterbody and will result in an imperceptible effect. As mentioned above, the site compound will be located outside the marsh and therefore will not have an impact on its local hydrology.

Construction works will be carried out during spring to autumn. As such, it is not expected significant dewatering volumes surface or groundwater during the construction phase. The 1% AEP event levels scenario plus 300mm freeboard was selected as the design flood level. Furthermore, additional freeboard considered up to the bottom of the boardwalk will allow even the flow associated with the 0.1% AEP event to be conveyed. However, as the marsh is located within Flooding Zones A and B, for the 10% AEP event the bog mats and temporary gravel platforms/berms will be inundated.

As mentioned above, the water levels in the marsh are very shallow and respond rapidly to rainfall events, so recurrent flooding is to be expected during the construction phase and mitigation measures will therefore be required to alleviate the risk associated with these events.

4.2 Operational Impacts

The existing surface water drainage systems in the marsh will be maintained as part of the development. The interception of rainfall by the boardwalk will be imperceptible in terms of runoff reduction.

The proposed boardwalk would be lightly trafficked and as no application of salts and grit during ice/snow conditions will be carried out. The proposed boardwalk does not result in an increased hardstanding area. The predicted impact of pollutants discharged into the marsh or Avoca River from the proposed hardstand surfaces is considered imperceptible.

The risk of pollution to both surface and groundwater resulting from accidental spillage is considered negligible, as the boardwalk would only accommodate pedestrians and cyclists. It is not anticipated that any chemicals or hydrocarbons will ever be transported across the bridge.

5. MITIGATION MEASURES

This section provides a series of mitigation measures proposed for the Construction Phase associated with the projected boardwalk across the marsh and the Avoca River.

5.1 General Measures to Safeguard Water Quality

The management of surface water during the construction phase will adhere to the recommendations of the CIRIA guides Control of Water Pollution from Construction Sites (2001) and Control of Water Pollution from Linear Construction Projects (2006).

5.1.1 Pollution Risk

During construction key requirements for control of chemical pollution risk will include:

- Storage – all equipment, materials and chemicals will be stored at the proposed site compound for the housing construction. Chemical, fuel and oil stores will be sited on impervious bases in the site compound and within a secured bund of 110% of the storage capacity, within the lay down area.
- The integrity and water tightness of all the bunding structures and their resistance to penetration by water or other materials stored therein shall also be tested and demonstrated.
- All fuel oil fill areas will have an appropriate spill apron.
- Vehicles and refuelling – standing machinery will have drip trays placed underneath to prevent oil and fuel leaks causing pollution. Where practicable, refuelling of vehicles and machinery will be carried out on an impermeable surface in designated areas, well away from any surface watercourse.
- Maintenance – maintenance to construction plant will not be permitted on site unless vehicles have broken down necessitating maintenance at the point of breakdown. All necessary pollution prevention measures will be put in place prior to commencement of maintenance in this instance.
- Mess, sanitation and welfare facilities will be required during construction and will be located at the construction compound. Foul effluent will make use of chemical facilities with periodic removal for offsite disposal.

No significant excavation works are foreseen. However, in the event that minor excavations are required, soil material excavated will be transferred directly to a dumper truck. The excavated material will be stored temporarily within the main temporary site compound.

5.1.2 Water Management

As mentioned above, water levels across the marsh are shallow and respond directly to rainfall, rising above ground level after rainfall events and are therefore sensitive to potential leakage due to construction works.

Because of this, it is proposed to establish a weather-based precautionary system for allowance to construction works on the marsh; construction works will be carried out during Spring-Autum period. Machinery works (such as drilling/piling) shall not be permitted on the marsh in the event of a heavy rainfall event. Heavy machinery works will be scheduled on a regular basis subject predicted dry conditions ahead. A cut-off point and a black/white system will be established at the entrance of the work area on the marsh to allow work to proceed.

In the event of expected heavy rainfall, all heavy machinery will be removed in advance from the marsh area and stored on the compound site. Works will only be resumed after approval of Ecological Clerk of Works (ECoW).

Extensive monitoring will be adopted to ensure that the water is of sufficient quality to discharge to the vegetated ground on the marsh. The use of additional settlement and silt traps and an oil interceptor (if

required) will be adopted if the monitoring indicates the requirements for the same with no excess silt or contaminated water permitted to discharge to the marsh.

It is further noted that works will be completed between the months of April to October, during the time of year when precipitation is low and the risk of flooding is minimised.

5.2 Measures to Safeguard against the Release of Hydrocarbons

To control and contain any potential hydrocarbon and other harmful substances spillage by vehicles during construction, it is recommended where possible to refuel plant equipment off the development site, thus mitigating this potential impact by avoidance. However, given the remote nature of the Site, this is not likely to be a practical measure for all equipment.

If fuelling must occur on site, then a discrete "fuel station" will be designated for the purpose of safe fuel storage and fuel transfer to vehicles. This fuel station will be bunded to 110% volume capacity of fuels stored at the site and will be located within the site compound. The bunded area will be drained by an oil interceptor and drainage of same will be controlled by a pent stock valve that will be opened to discharge storm water from the bund. A suitably qualified management company will take responsibility for management and maintenance of the oil interceptor and associated drainage on a regular basis, including decommissioning following construction.

Despite the management of refuelling and fuel storage, there remains the risk of leakage from vehicles and plant equipment during construction activity. The plant equipment used on site will require regular mechanical checks and audits to prevent spillage of hydrocarbons on the exposed ground (during construction).

In the event of an accidental spill during the construction, contamination occurrences will be addressed immediately, this includes the cessation of works in the area of the spillage until the issue is resolved. In this regard, spill kits will be kept in each vehicle associated with the Development i.e. spill kits will be readily available to all operators. Spill kits will contain a minimum of; oil absorbent granules, oil absorbent pads, oil absorbent booms, and heavy-duty refuse bags (for collection and appropriate disposal of contaminated matter). No materials contaminated or otherwise will be left on the Site. Spill kits will also be established at proposed construction areas, for example, a spill kit will be established and mobilised as part of the sheet piled area materials and equipment. Suitable receptacles for hydrocarbon contaminated materials will also be at hand.

Once the above measures are implemented the risk of hydrocarbon contamination intercepting the surface water network will be significantly reduced, however there remains a level of risk, and therefore both precautionary measures and emergency response protocols as specified in the CEMP will be implemented on site.

5.3 Measures to Safeguard against the Release of Cement-Based Products

The piles for the boardwalk will be filled with concrete and a single 25mm steel reinforcing bar. In-situ concrete will be placed with mini concrete trucks and concrete pumps will be utilised. This pouring of concrete will be located in the immediate vicinity of the marsh. The operation and management of these activities be carefully controlled to avoid spillage which will adversely affect the chemical water composition and aquatic habitats of species. As the use of concrete cannot be avoided the following control measures will be employed:

- Placing of concrete in or near watercourses will be carried out only under the supervision of the Ecological Clerk of Works (ECoW).

- No batching of wet-cement products will occur on site. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place.
- Where possible, pre-cast elements for culverts and concrete works will be used.
- No washing out of any plant used in concrete transport or concreting operations will be allowed on-site.
- Where concrete is delivered on site, only the chute shall be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any drain or watercourse will be allowed. Chute cleaning water is to be tanked and removed from the site to a suitable, non-polluting, discharge location.
- Use weather forecasting to plan dry days for pouring concrete.
- Ensure pour site is free of standing water, and plastic covers will be ready in case of sudden rainfall event.
- Disposal of raw or uncured waste concrete will be controlled to ensure that watercourses or other sensitive areas will not be impacted.
- No cement will be required for works associated with horizontal directional drilling under watercourses and no cement will be stored in the vicinity of watercourses during such works.

5.4 Measures to Safeguard against the Release of Other Pollutants

All precautions will be taken to avoid spillages of diesel, oil or other polluting substances during the construction phase. The Contractor is obliged to implement the following measures to prevent contamination of watercourses:

- No refuelling of construction vehicles or plant will take place within the 50m surface water buffer zone (i.e., away from the marsh).
- Undertaking refuelling of plant, equipment and vehicles will only be undertaken on impermeable surfaces.
- No maintenance of construction vehicles or plan will take place along the proposed boardwalk, except in a case of emergency.
- All potentially hazardous chemicals, fuel, hydraulic oils and lubricants will be stored in bunded areas (in accordance with established best practice guidelines) at the Site Compound.
- In order to reduce the risk of contamination arising as a result of spills or leakages, all fuels, chemicals, liquid and solid waste will be stored on impermeable surfaces.
- If there is a requirement to store hazardous chemicals on site, they will be stored within a bunded, locked COSHH container, with upkeep and security ensured by the contractor.
- All tanks and drums are to be bunded in accordance with established best practice guidelines.
- Re-fuelling of construction equipment and the addition of hydraulic oil or lubricants to vehicles / equipment will take place in designated bunded areas within the main construction compound and not on-site where reasonably practicable. If it is not possible to bring machinery to the refuelling point, fuel will be brought to site by a 4x4 in a double skinned bowser with drip trays. The bowser/4x4 will be fully stocked with spill kits and absorbent material, with delivery personnel being fully trained to deal with any accidental spills. The bowser will be bunded appropriately for the fuel usage volume for the time period of the construction.
- The plant and machinery used will be regularly inspected for leaks and fitness for purpose.
- Spill kits will be readily available to deal with accidental spillage at all times.
- A segregated waste storage will be available at the substation construction site.
- An inventory of all chemicals on site will be kept. It will include:
  - Procedures for storage of all materials listed
  - Location details of all materials listed
  - Volume and description of all substances stored on-site
  - Waste disposal records, including copies of all Waste Transfer Notes (WTN) detailing disposal routes and waste carriers used. Where waste is being shipped abroad, a copy of the Trans Frontier Shipping (TFS) document must be obtained from Dublin City Council and kept on site

along with details of the final destination and any relevant permits, licences or other relevant documentation.

- Chemical storage details will be part of routine site audits.
- Only where absolutely necessary should any hazardous waste be stored on site. If so, Hazardous Waste should be stored in a COSHH store. Only trained operatives should handle hazardous substances. Please note that COSHH data sheets are NOT risk assessments and all risk assessment should be carried out separately. All stored hazardous waste will be clearly labelled. All of these will be regularly inspected for visual signs of leaks or something that would impact on their capacity – e.g. where a drip tray is full of rainwater.

5.5 Measures to Safeguard against the Release of Sewerage

A self-contained port-a-loo system with an integrated waste holding tank will be used on site for toilet facilities, which will be located in the construction compound for the housing. This will be maintained by the service contractor as required and will be removed from the site on completion of the construction phase.

5.6 Measures to Safeguard against Impacts during Piling Works

In order to avoid the potential for adverse impacts to instream and marsh and in-stream habitats during the construction phase the method of piling to be implemented will be based on non-invasive techniques, ensured by the use of bog mats and lighter vehicles. This coupled with the set-back distances of the pile locations from the Avoca river, as well as the presence of the bedrock and overburden between the river and the pile locations at piers and abutments, will ensure that no noise or vibration associated with the piling will have the potential to cause injury to the local species (i.e. will not exceed the low guide value of the 183 dB within adjacent waters) within the river channel adjacent to the piling locations.

In addition, the timing of all piling works will be timed to occur outside the spawning season in the Avoca River. The use of non-invasive piling will also ensure that vibration levels associated with this piling will be low and will not present a risk of undermining the integrity of the marsh, Avoca riverbanks and their collapse.

With the implementation of the above measures, it is concluded that the piling works during the construction phase will not result in adverse effects to Annex 2 fish species, or species dependant on the hydrological and hydrogeological local environment associated with Avoca River and the marsh.

6. ASSESSMENT OF SOURCE-PATHWAY-RECEPTOR (SPR) MODEL

6.1 Assessment of Plausible Sources

A conceptual site model is developed based on a good understanding of the hydrological and hydrogeological environment, plausible sources of impact and knowledge of receptor requirements. This in turn allows possible Source Pathway Receptor (S-P-R) linkages to be identified. If no S-P-R linkages are identified, then there is no risk to identified receptors.

The proposed boardwalk is located across the Arklow Town Marsh pNHA located north of the Avoca Estuary Transitional Waterbody which is subject to fluvial and coastal flooding. Therefore, there is a 'direct' hydrological linkage between the proposed development and these receptors.

As mentioned above, water levels across the marsh are shallow and respond directly to rainfall, rising above ground level after rainfall events and are therefore sensitive to ground level alterations or potential leakage due to construction works.

As stated in Section 3.2 above, the site is underlain by a Locally Important Gravel Aquifer – Valley Setting and the Wicklow bedrock aquifer groundwater body (European Code: IE_EA_G_076), which has been investigated by the GSI and is described as a "Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones'. Groundwater movement in this category of aquifer is through joints and fractures, rather than through the rock mass.

Construction works will be carried out during spring to autumn. Nevertheless, as the groundwater level in the marsh are shallow and seasonally over ground level, it will be likely that construction works in this area will be carry out when this water is exposed (especially after rainfall events) meaning potential for changes to the local hydrological regime in the marsh and its final receptor (Avoca Estuary). As no excavation is foreseen, no dewatering from grave/bedrock aquifers is expected.

There is no potential for change in water levels or water volume in the marsh as a result of local changes in the hydrological regime at the site. However, as the water levels in the marsh are very shallow and respond rapidly to rainfall events, recurrent flooding would be expected during the construction phase and mitigation measures will therefore be required to alleviate the risk associated with these events.

If not mitigated, during the construction phase contaminated water can pose a temporary risk to the Avoca Marsh pNHA which ultimately discharge to the Avoca Estuary transitional waterbody. In particular, the proposed development will consist of the construction of a boardwalk across the marsh and the Avoca River which involves piling works.

If the installation is not executed correctly, there is a potential risk of compromising the integrity of the marsh during the boardwalk installation and piling processes. This could lead to contamination or destabilisation of the surrounding areas and potentially impact the aquatic habitat. However, the construction works and the proposed mitigation measures are informed by best practice guidance on the prevention of pollution during development projects as outlined in Section 5 above.

Construction Phase

The following potential sources are considered plausible risk scenarios for the proposed construction site:

i. Hydrocarbons or any hazardous chemicals will be stored in specific bunded areas in the compound area located outside the marsh. Refuelling of plant and machinery will also be carried out in bunded areas to minimise risk of any potential being discharged from the site. As a worst-case scenario, a rupture of a 1,000-litre tank to ground is considered in this analysis which disregards the effect of bunding. This would be a single short-term event.

ii. Leakage may occur from construction site equipment. As a worst-case scenario an unmitigated leak of 300 litres is considered. This would be a single short-term event.

iii. Use of wet cement is a requirement during construction. Run-off water from recent cemented areas will result in highly alkaline water with high pH. As this would only occur during particular phases of work this is again considered as a single short-term event rather than an ongoing event. However, as cement works will be confined to the enclosed pile location, no migration of cement is expected.

iv. During the construction phase, there is generally a potential for the works to impact on the water quality arising from erosion and sediment transport caused by the works situated within the marsh. However, no significant excavation works and earthworks are foreseen. Minor transport of soils could be related the rig vehicle equipment.

It should be noted that the above are temporary short-lived events that will not impact on the water status of waterbodies long-term and as such will not impact on trends in water quality and over all status assessment.

Operational Phase

During the operational phase, as mentioned above, the risk of pollution to both surface and groundwater resulting from accidental spillage is considered negligible, as the boardwalk would only accommodate pedestrians and cyclists. It is not anticipated that any chemicals or hydrocarbons will ever be transported across the bridge.

6.2 Assessment of Pathways

The following pathways have been considered within this assessment with impact assessment presented in Section 3.4:

The potential for offsite migration due to any construction discharges may be significant in the absence of mitigation/control measures presented in Section 5 above. There is a direct hydrological connection between the site and receiving waterbodies as follows.

i. Vertical migration to the regional underlying limestone is minimised due to the recorded 'Moderate' vulnerability present across the marsh in good aquifer protection from any localised diesel/ fuel oil spills during construction phase.

ii. There is a direct hydrological linkage for construction run-off or any small contaminant leaks from the site to Avoca Marsh pNHA and Avoca Estuary Transitional Waterbody through local run-off as the water level across the marsh are shallow and respond directly to rainfall, rising above ground level after rainfall events and are therefore sensitive to potential leakage due to construction works. However, it should be noted that the vegetation in the marsh would contain potential contaminants acting as a natural filter.

6.3 Assessment of Receptors

The receptors considered in this assessment include the following:

i. Underlying Locally Important Gravel Aquifer and Locally Important Bedrock Aquifer.
ii. Avoca Marsh pNHA (site code 1931).
iii. Avoca Estuary Transitional Body.

Other waterbodies that may be hydrologically connected to the proposed development site, but are located further away (namely Southwestern Irish Sea - Brittas Bay (HA 10) coastal waterbody) were excluded

from the assessment due to their distance from the subject site, the potential loading of contaminant from the site (risk scenarios presented in Section 6.1) and significant dilution through its pathway.

As no significant excavation works are foreseen,

6.4 Assessment of Source-Pathway-Receptor Linkages

Table 6-1 below describes the S-P-R model for the proposed development site and includes the robust mitigation and design measures which will be incorporated into the proposed development throughout the construction phase.

Table 6-1. Pollutant Linkage Assessment

Source	Pathways	Receptors Considered	Risk of Impact	Mitigation Measures
Construction Impacts				
Unmitigated leak from an oil tank to ground/ unmitigated leak from construction/rig vehicle (1,000 litres worst case scenario). Discharge to ground of runoff water with High pH from cement process/ hydrocarbons from construction vehicles/run-off containing a high concentration of suspended solids. Cement works will be confined to the enclosed pile location.	Vertical migration through overburden to underlying 'Locally Important Gravel Aquifer' and 'Locally Important Bedrock Aquifer', classified by the GSI as having a 'Moderate' (M) to vulnerability. Direct pathway through local rainfall, run-off and surface/ground water levels in the marsh	Underlying 'Locally Important Gravel Aquifer' and 'Locally Important Bedrock Aquifer' Avoca Marsh pNHA Avoca Estuary Transitional Waterbody	Low risk of migration through poorly connected fracturing within the limestone (Locally Important Aquifer) rock mass. No likely impact on the status of the aquifer/off site migration due to low potential loading, natural attenuation within overburden/marsh and discrete nature of fracturing reducing off site migration. High risk of temporary and significant impact due to accidental releases. There is a direct hydrological linkage between the proposed boardwalk and Arklow Town Marsh pNHA which discharges into Avoca Estuary Transitional Waterbody. Water levels across the marsh are shallow and respond directly to rainfall, rising above ground level after rainfall events and are therefore sensitive to ground level alterations or potential leakage due to construction works. Vegetation of the marsh itself would act as a first barrier to migration.	It is proposed to establish a weather-based precautionary system for allowance to construction works on the marsh. In the event of expected heavy rainfall, all heavy machinery will be removed in advance from the marsh area and stored on the compound site. In the event of unexpected heavy rainfall, any surface water pooling within sheet piled areas will be pumped from these areas be pre-treated and eventually returned to the marsh. These mitigation measures are outlined in a CEMP which will be a live document. It will set out requirements and standards which must be met during the construction stage and will include these, and other relevant mitigation measures outlined in the CEMP and any subsequent conditions relevant to the proposed boardwalk. These include management of soils, re-fuelling of machinery and chemical handling, control of water during the construction phase and treatment of discharge water where required.

7. CONCLUSIONS

A conceptual site model (CSM) has been prepared following a desk top review of the site and surrounding environs. Based on this CSM, plausible Source-Pathway-Receptor linkages have been assessed assuming an absence of any measures intended to avoid or reduce harmful effects of the proposed project (i.e., mitigation measures) in place at the proposed development site.

During construction phase there is a direct source-pathway linkage between the proposed boardwalk and open waters in the Arklow Marsh pNHA. There are mitigation and design measures which will be implemented to protect the hydrological and hydrogeological environment associated to the marsh and Avoca Estuary. There is a potential of accidental discharges should mitigation fail during the construction phase, however these are temporary short-lived events that will not impact on the water status of waterbodies long-term and as such will not impact on trends in water quality and over all status assessment.

The project-specific Construction and Environmental Management Plan (CEMP) which the works contractor will develop will implement strict mitigation measures to ensure the protection of the hydrological (and hydrogeological) environment during construction which will ensure that there will be no negative impact on the quantitative or qualitative or morphology of the nearby watercourses. These specific measures will provide further protection to the receiving hydrological and hydrogeological environment.

8. REFERENCES

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