14 Land and Soils

14.1 Introduction

This chapter describes the likely significant effects of the proposed development on land and soils (i.e. soils, geology and hydrogeology).

Chapter 4 provides a full description of the proposed development whilst **Chapter 5** describes the Construction Strategy. The following aspects are particularly relevant to the land and soils assessment:

- Design:
    - Design features of the Alps SWO and stormwater storage, interceptor sewers, WwTP, revetment and outfalls (long sea outfall and SWO at the WwTP site) will all have to take into account the particular ground conditions, groundwater regimes and the properties of the underlying soils and groundwaters to ensure that these do not have any deleterious effects.
- Operation:
    - Subsoils, bedrock and groundwater will not have any impact upon the proposed development once operational.
- Construction:
    - Excavations both above and below the water table will require special consideration in terms of both the stability of the excavations and the logistics behind facilitating the works, i.e. dewatering. Additionally, the presence of contaminated soils and groundwater add further complexity to the construction of the proposed development. Finally, the construction of the revetment upgrade, long sea outfall and SWO at the WwTP will need to take into account the surrounding environment in terms of works along the coast and upon the seabed.

14.2 Assessment Methodology

14.2.1 General

The following section outlines the legislation and guidelines considered, and the adopted methodology for preparing this chapter and undertaking the land and soils assessment.

14.2.2 Guidance and Legislation

This assessment has been undertaken with due regard to the overarching EIA guidance (described in **Section 1.4.3 of Chapter 1**) and Institute of Geologists Ireland (IGI) guidance[1].

The following legislation is particularly relevant to the management of groundwater:

- The EU Water Framework Directive (WFD), 2000/60/EC;
- The Groundwater Directive, 2006/118/EC;
- European Communities (Water Policy) Regulations 2014 (S.I. No. 350 of 2014);
- European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010), as amended by the European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2011 (S.I. No. 389 of 2011) and the European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2012 (S.I. No. 149 of 2012) and the European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. NO. 366 of 2016);
- European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009) as amended by the European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations 2012 (S.I. No. 327 of 2012);
- European Communities Environmental Objectives (Surface Water) (Amendment) Regulations 2015 (SI No. 386 of 2015);
- European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003) as amended by the European Communities (Water Policy) (Amendment) Regulations, 2005 (S.I. No. 413 of 2005);
- European Communities (Water Policy) (Amendment) Regulations, 2008 (S.I. No. 219 of 2008);
- European Communities (Water Policy) (Amendment) Regulations, 2010 (S.I. No. 93 of 2010);
- European Communities (Drinking Water) Regulations 2014 (S.I. No 350 of 2014);
- European Communities (Quality of Salmonid Waters) Regulations 1988 (SI no. 293 of 1988); and
- Water Services Acts (2007 – 2017).

[1] Institute of Geologists of Ireland (IGI 2013). Guidelines for the Preparation of Soil, Geology and Hydrogeology Chapters of Environmental Impact Statements.

14.2.3 Study Area

The study area for the land and soils assessment extends to areas within 2km of the planning boundary. For this assessment, the project is divided into four sections:

- Alps Storm Water Overflow (SWO) and stormwater storage tank;
- Interceptor sewers (including northern, southern and river crossing);
- WwTP and revetment; and
- Long sea outfall and SWO at WwTP.

14.2.4 Site Visits

A number of site visits to the study area were conducted in 2016 during the development of the Conceptual Site Model (CSM). Site walkovers and intrusive site investigation surveys were conducted where access was possible at this time. Site specific details were recorded and included logging of subsoil types, vegetation indicators, springs, drainage details and general trafficability of soils.

Where access was granted to proposed feature locations, subsoil deposits and selected exposures / sections were logged according to the standard[2].

The site was visited on 11 August 2017 in advance of the offshore site investigation. During this site visit, a walkover of the WwTP site and the revetment was carried out.

Arup carried out a site walkover of the WwTP site on 18 October 2017 to:

- Identify potential sources of contamination; and
- Inform the design of a geo-environmental site investigation.

In addition, between January and March 2018 the site was visited regularly to monitor the progress of the ground investigation at the WwTP site. Site walkovers were carried out at various stages, particularly during the site investigation works.

14.2.5 Consultation

Arup consulted with Wicklow County Council on 9 October 2017 in relation to information they may hold on their public register. In addition, Arup met with Wicklow County Council on the WwTP site on 18 October 2018 to carry out the site walkover and discuss any information that they may have in relation to the site history.

On 28 May 2018 Arup held a telephone conversation with the Environmental Protection Agency (EPA) in relation to the assessment of the radiological materials on the site.

[2] British Standard Institute (2015) BS 5930: 2015 - Code of Practice for Ground Investigations

On 19 June 2018 Arup held a telephone conversation with Wicklow County Council in relation to general queries on the need for a Discharge Licence under Section 4 of the Local Government (Water Pollution) Act 1977 during the construction of the proposed development.

14.2.6 Categorisation of the Baseline Environment

As part of the desk study that was undertaken to establish the baseline conditions (i.e. soils, geological and hydrogeological environment), the following sources of information were reviewed:

- An Foras Talúntais (1978). Ireland: Peatland Map. An Foras Talúntais, Dublin;
- Bing Maps (2018). Aerial photography[3];
- British Geological Survey (BGS) (2018). Offshore Bedrock Map, 1:250,000[4];
- Department of Communications, Climate Action and the Environment (2018). INFOMAR Seabed Mapping[5];
- Department of Communications, Energy and Natural Resources (2011). State Mining and Prospecting Facilities[6];
- Environment Protection Agency (EPA) (2018). EPA Maps, Corine Land Cover 2012[7];
- EPA (2018). EPA Maps, Water, Water Framework Directive[8];
- EPA (2018). EPA Maps, Environment and Wellbeing, Clean Water and Health[9];
- EPA (2018). Office of Licencing and Permitting[10].
- Google Maps (2018). Aerial photography[11];
- Geological Survey of Ireland (GSI) (2018). Geological maps of the site area produced by the Geological Survey of Ireland[12] including;
  - Quaternary Maps (GSI);
  - Bedrock Mapping;
  - National Landslide Database (GSI);
  - Karst Database (GSI);

[3] Available at: https://www.bing.com/maps, Accessed 18-07-2018
[4] Available at: http://www.maremap.ac.uk/view/search/searchMaps.html, Accessed 18-07-18.
[5] Available at: https://jetstream.gsi.ie/iwdds/delivery/INFOMAR_VIEWER/index.html, Accessed 18-07-18
[6] Available at: http://www.mineralsireland.ie/files/Competition_Booklet_May2011_web.pdf, Accessed 18-07-18
[7] Available at: https://gis.epa.ie/EPAMaps, Accessed 18-07-18
[8] Available from: https://gis.epa.ie/EPAMaps/, Accessed 18-07-18
[9] Available from: https://gis.epa.ie/EPAMaps/, Accessed 18-07-18
[10] Available at: http://www.epa.ie/licensing/, Accessed 18-07-18
[11] Available at: https://www.google.ie/maps, Accessed 18-07-2018
[12] Available at: http://map.geohive.ie/mapviewer.html, Accessed 18-07-2018

  - Historic Mine Sites - Inventory and Risk Classification;
- GSI (2014). Directory of Active Quarries, Pits and Mines in Ireland. 4th Ed[12];
- GSI (2003). Wicklow GWB: Summary of Initial Characterisation. Groundwater Bodies[13];
- National Parks and Wildlife Service (2018). Proposed / Designated NHA, SPA, SAC Sites[14];
- Ordnance Survey of Ireland (OSI) (2017). Current and historical Ordnance Survey (OS) maps (1837-1842 and 1888-1913) available for the study area at 1:2,500 and 1: 10,560 scales[15];
- OSI (2017). Aerial photography (1995, 2000, 2005)[15];
- Tietzsch-Tyler, D. & Sleeman, A. G. (1994). Geology of Carlow-Wexford 1: 100,000 scale Bedrock Geology Map Series, Sheet 19: GSI.
- Teagasc and the Environmental Protection Agency (EPA) (2017). Irish Soil Information System[16];
- UK Hydrographic Office, Admiralty Chart, 1978, Arklow to the Skerries Islands, 1:100,000, Sheet 1468, Admiralty Charts, UK.
- Water Framework Directive (WFD) Ireland (2018). Water Maps[17];
- Wicklow County Council (2018). Planning Departments of Local Authorities, (Section 261, Pits and Quarries Planning and Development Act 2000)[18];

Historic Ground Investigations

Ground investigation data from previous projects within the study area including:

- Geotech Specialists Limited on behalf of Wicklow County Council (2009). Arklow Water Supply Scheme Contract 5 – Site Investigation for Lamberton Distribution Mains, Report No. KD8096;
- Geotech Specialists Limited on behalf of Wicklow County Council (2011). Arklow Water Supply Scheme Contract 5 – Ground Investigation for Bridgewater Section, Report No. KD8096B;
- Glover Site Investigations on behalf of Arklow Urban District Council (1996). Arklow Main Drainage Contract 2 – Marine Site Investigations - dated November 1996;

---

13 Available at: https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/activities/understanding-ireland-groundwater/Pages/Groundwater-bodies.aspx, Accessed 18-07-18
14 Available at: http://webgis.npws.ie/npwsviewer/, Accessed 18-07-18
15 Available at: http://map.geohive.ie/mapviewer.html, Accessed 18-07-2018
16 Available at: http://gis.teagasc.ie/soils/index.php, Accessed September 2017
17 Available at: http://watermaps.wfdireland.ie/NsShare_Web/Viewer.aspx?Site=NsShare&ReloadKey=True, Accessed 18-07-18
18 Available at: https://www.wicklow.ie/Portals/0/Documents/Planning/Quarry-Registration/Quarry-Register/Registered%20Quarries%202004.pdf, Accessed 18-07-18

- Glover Site Investigations on behalf of Arklow Urban District Council (1997). Arklow Main Drainage Contract 2 – Marine Site Investigations Additional Works - dated May 1997;
- RPS Environmental (2005). Soil and Groundwater Investigation Report, Ferrybank, Arklow;
- RPS (2006). Geotechnical Interpretative Report, Ferrybank, Arklow.
- Tobin's Engineering (2005). SI Report, IFI Tank Farm Site, Arklow;
- Whiteford Geoservices Ltd on behalf of Arklow Town Council (2005). Arklow Main Drainage Scheme Southside Interceptor Sewers – Site Investigation Works, Report No. 454/05 - dated December 2005;
- Whiteford Geoservices Ltd on behalf of Arklow Town Council (2007) Additional Ground Investigation Works – North Quay, Arklow, Wicklow, Report No. 623/07 - dated May 2007;
- Geotech Specialists Limited on behalf of Wicklow County Council (2009) Arklow Water Supply Scheme Contract 5 – Site Investigation for Lamberton Distribution Mains, Report No. KD8096 - dated December 2009;
- Geotech Specialists Limited on behalf of Wicklow County Council (2011) Arklow Water Supply Scheme Contract 5 – Ground Investigation for Bridgewater Section, Report No. KD8096B - dated November 2011;
- Whiteford Geoservices Ltd on behalf of Arklow Town Council (2010) Arklow Main Drainage Scheme – Site Investigation Works, Report No. 775/08 - dated May 2010;
- Whiteford Geoservices Ltd on behalf of Wicklow County Council (2013) Arklow Sewerage Scheme Contract 6 Section 2", Report No. 1337-12 - dated September 2013.

A single ground investigation report held by the Geological Survey of Ireland (GSI) for the study area was sourced as follows:

- GSI (2006). Arklow Dock, Report No. 6924.

Project Specific Ground Investigations

As outlined in **Section 14.2.4**, three preliminary ground investigations were commissioned for the proposed development:

- A geotechnical ground investigation covering the area of the Alps SWO and stormwater storage tank and the interceptor sewers undertaken between August and November 2016 (Refer to **Appendix 14.8**);
- An offshore ground investigation within a 100m buffer of the footprint of the outfall that was undertaken between August and November 2017 (Refer to **Appendix 14.3**); and
- A geo-environmental investigation for the WwTP site that was undertaken in January and February 2018 which included a radiological survey of the site (Refer to **Appendix 14.5**).

14.2.7 Impact Assessment

The likely significant effects have been assessed by classifying the importance of the relevant attributes and quantifying the magnitude of any likely significant effects on these attributes. It should be noted that for the purpose of this assessment, likely significant effects and potential impacts are used interchangeably as this assessment has been undertaken drawn on the NRA guidelines[21].

This assessment has been undertaken in accordance with the EC Commission Guidance on the preparation of an EIAR[19] and the draft EPA guidelines on the preparation of an EIAR[20], along with the IGI guidance[1] which outlines a 13 step methodology that is divided across four distinct elements:

- Initial Assessment;
- Direct and Indirect Site Investigation;
- Mitigation Measures, Residual Impacts and Final Impact Assessment; and
- Completion of the Soils, Geological and Hydrogeological Sections of the EIAR.

Initial Assessment

The 'Initial Assessment' presents a description of the past and present uses of the land across the study area which may have a bearing on the proposed development. This includes a detailed description of the nature of the ground conditions within the planning boundary based on existing literature as well as site specific and neighbouring site investigation data.

Direct and Indirect Site Investigation

Sections 14.3.2 to 14.3.4 and **Section 14.3.9** provide discussion on the data available from the site-specific ground investigations (GI) carried out in relation to the proposed development. This, along with other sections from within **Sections 14.3.6 and 14.3.7** look at the regional setting. The information gathered on the baseline environment during ground investigations corresponds to the second element of the methodology, 'Direct and Indirect Site Investigation and Studies'.

Mitigation Measures, Residual Impacts and Final Impact Assessment

The outcome from examining this available data is a Conceptual Site Model (CSM). The CSM is a summary of geological conditions beneath the proposed development that considers the likely significant effects of the proposed development.

---

[19] European Commission (2017) Environmental Impact Assessment of Projects: Guidance on the preparation of the Environmental Impact Assessment Report
[20] EPA (2017) Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports (Draft August 2017);

Based on the derived CSM the area across the study area is classified as generally a Type B environment (Naturally dynamic hydrogeological environments e.g. groundwater discharge areas, areas underlain by regionally important aquifers, nearby spring rises, areas underlain by permeable subsoils).

A 'Feature Importance ranking' is then assigned to each feature (likely to be affected by the proposed development based on guidance from the National Roads Authority (NRA)[21] and IGI[1].

This facilitates the assessment of likely significant effects which has been undertaken in accordance with the guidance outlined in **Section 14.2.2**.

Section 14.5 outlines the 'Mitigation Measures and Monitoring' associated with the works in accordance with the above methodology.

Completion of the Soils, Geological and Hydrogeological Sections of the EIAR

This section has been prepared iteratively whilst undertaking the first three elements. Upon finalisation of the preceding steps, this information has been documented accordingly (i.e. as part of this chapter) which corresponds to the final element of the methodology 'Completion of the Soils, Geological and Hydrogeological Sections of the EIAR'.

In parallel with the EIAR process, the site has been assessed following the EPA guidance[22]. While this document outlines the approach which should be adopted in order to assess contamination present on a licensed site, it is widely accepted as best practice for the assessment of contaminated sites in advance of redevelopment. The Preliminary Site Assessment (PSA)[23] and Detailed Site Assessment (DSA)[24] required under this methodology are all included in **Appendix 14.1 and 14.2**.

---

[21] Note- The NRA merged with the Railway Procurement Agency (RPA) to become Transport Infrastructure Ireland (TII) in 2015. The NRA tables presented in Tables C2 to C6 of the IGI (2013) document can be found in Box 4.1, Box 4.3, Box 5.1, Box 5.3 and Box 5.4 of the NRA (2008) document available on the TII website.
NRA (2008). Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes. Available at: http://www.tii.ie/technical-services/environment/planning/Guidelines-on-Procedures-for-Assessment-and-Treatment-of-Geology-Hydrology-and-Hydrogeology-for-National-Road-Schemes.pdf [Accessed 6 August 2018]
[22] EPA (2013). Guidance on the management of Contaminated Land and Groundwater at EPA licensed sites. ISBN: 978-1-84095-511-8. Available at: https://www.epa.ie/pubs/advice/waste/contaminatedland/contaminatedland/Guidance_on_the_Management_of_Contaminated_Land_and_Groundwater_at_EPA_Licensed_Sites_FINAL.pdf
[23] Arup (2018). Arklow Waste Water Treatment Plant, Preliminary Site Assessment. 247825_PSA_31-07-2017
[24] Arup (2018). Arklow Waste Water Treatment Plant, Detailed Site Assessment for the Wastewater Treatment Plant. 247825-00_13-03-2018-DSA

14.3 Baseline Conditions

14.3.1 Introduction

As noted in **Section 14.2.7**, the existing soils, geology and hydrogeology in the study area have been interpreted from both desk study information and from project-specific site investigations. The current baseline would represent the 'Do Nothing Scenario' as required under the EC Guidance[19]. A conservative approach would be to assume no major changes to the baseline condition of the site over time.

14.3.2 SWO, Stormwater Storage Tank and Interceptor Sewers

14.3.2.1 Non-intrusive Investigations

Non-intrusive investigations such as geophysics were not carried out for the Alps SWO and Stormwater Storage Tank, Interceptor Sewers (including the river crossing).

14.3.2.2 Intrusive Investigation

Following the completion of the route selection process (Refer to **Appendix 3.2)**, ground investigation works were undertaken in August to November 2017 in order to further refine the CSM. The findings of this investigation are included in **Appendix 14.3**.

These works comprised of 18 cable percussion boreholes, seven of which are north of the river mouth moving east into the Irish Sea and are dealt with in the next section. The remaining 11 boreholes were completed within the study area for the SWO and stormwater tank, interceptor sewers and river crossing. The following physical works were undertaken in relation to this study area:

- 9 cable percussion boreholes to depths of between 6.5 and 12.90m BGL
- 2 cable percussion boreholes with follow-on rotary boreholes to depths of 25m BGL
- Recovery of soil, rock and groundwater samples for laboratory and contamination testing

The findings of this report are consistent with the findings of the previous ground investigations cited in **Section 14.2.6**.

14.3.3 WwTP site and Revetment

14.3.3.1 Non-Intrusive Investigations

A geophysical investigation was initially carried out by Minerex Geophysics Limited in March 2016[25] with subsequent surveys carried out by Murphy Surveys in 2016[26] and 2018[27] across the WwTP site (Refer to **Appendix 14.4**). These surveys were carried out to direct the intrusive investigation that would follow, investigate the presence of any anomalies and investigate the nature of the subsoils beyond the site boundary. The detailed methodology for undertaking this geophysical investigation is provided in **Appendix 14.4**. The geophysical investigation included:

- 2D-Resistivity – 2 D Resistivity imaging uses an array of electrodes to measure the variation in resistivity in the soils both along the survey line and with depth;
- Seismic refraction (p-wave) – seismic refraction measures the variation of velocities within the ground due to differing densities of soils; and
- Multichannel analysis of surface wave (MASW) (s-wave) – which is a method of seismic surveys which measures the stiffness of soils.

The 2D-resistivity survey covered the full length of the eastern and western sections of the WwTP site to provide information on bulk resistivity to highlight any anomalies. Two smaller seismic refraction and MASW surveys were carried out in the north-west and south-east of the WwTP site to provide information on the depth and extent of the made ground.

The information gathered during the desk study highlighted areas where materials with low levels of naturally occurring radioactivity were located. This material originated from when Arklow Gypsum Ltd was operational on the WwTP site. This material is derived from apatite, a naturally occurring material which was processed to produce phosphogypsum, a by-product generated during the production of phosphate fertilizers, that is known to contain naturally occurring radioactive material. In order to confirm the presence of this material and the level of radioactivity across the site, a non-intrusive radiological survey was carried out.

14.3.3.2 Intrusive Investigation

An intrusive ground investigation was carried out by Causeway Geotech Ltd. (Causeway) in January and February 2018 (Refer to **Appendix 14.5**). The detailed methodology for undertaking this investigation is provided in **Appendix 14.5**.

---

[25] Minerex Geophysics Limited (2016). Geophysical Survey. Site at Ferrybank, Arklow, County Wicklow. MGX File Ref: 6049d-005.doc
[26] Murphy Surveys (2016). Arklow SS Topo Survey. Drawing Nos. MSL15547-T_0 scale 1:1000 @ A1 and MSL15547-T_1 to MSL15547-T_4 scale 1:250 @A1.
[27] Murphy Surveys (2018). Survey Old Wallboard Factory Site North Quay Arklow. Drawing No. MSL24433_T_Rev1_0 to MSL24433_T_Rev1_4, Scale 1:250 @A1 and Drawing No. MSL24433_KP, MSL24433_XS_01 to MSL24433_XS_03, Scale 1:500 @A1.

Prior to the commencement of the ground investigation, all trial pit and borehole locations were checked for the presence of underground services by using Cable Avoidance Tool (CAT).

23 boreholes were drilled using cable percussion to a minimum of 1m into the clay layer above the bedrock to prove the full thickness of the sand and gravel aquifer which was a depth of approximately 20m Below Ground Level (mBGL).

Three of the boreholes were progressed further by rotary coring methods. These boreholes extended up to 26.5mBGL using rotary core follow-on to collect approximately 5m of bedrock core.

All boreholes were completed with groundwater monitoring installations monitoring the sand and gravel aquifer beneath the site. The boreholes that were drilled into bedrock were backfilled with bentonite clay to a point above the base of the sands and gravels. This bentonite clay prevented the formation of a pathway between the made ground and the aquifers beneath the WwTP site.

Three of the boreholes were completed with an additional narrow monitoring pipe installed in the made ground alongside the standpipe monitoring groundwater in the sand and gravel. These were installed to monitor potential landfill gas migrating from a historical landfill to the north-west of the site.

29 trial pits were excavated with a tracked excavator as part of the investigation. Logging of material was carried out in accordance with the relevant standard[28]. The depth of the trial pits ranged from a minimum depth of 0.8mBGL to a maximum depth of 3.10mBGL.

As part of the investigation, small, disturbed soil samples were retrieved at every 1m depth interval and from every change of strata during trial pitting and borehole drilling.

All soil samples from trial pits and boreholes were screened using a photo ionisation detector (PID) which tests on site for volatile organic carbons. A subset of the samples was sent to an accredited analytical laboratory and further tested for the analytical suites of contaminants highlighted in Table 2 of the Arklow Waste Water Treatment Plant Preliminary Site Assessment (PSA)[23] presented in **Appendix 14.1**. The subset of samples selected for further testing was based on the PID readings and visual and olfactory observations. Only those samples that were considered to be the most contaminated from each trial pit were sent for testing, along with the top samples recovered from the natural ground.

Following the completion of the site investigation, monitoring was carried out comprising:

- Continuous monitoring of water levels in all groundwater boreholes for three months using level loggers;
- Three occasions of groundwater level monitoring in all boreholes;

[28] British Standards (2015). Code of practice for ground investigations. BS5930:2015. 4th Ed. ISBN: 978 0 580 80062 7

- Three occasions of groundwater quality sampling and surface water quality sampling in a subset of the boreholes at high tide and low tide;
- Three occasions of gas monitoring to obtain data over a range of climatic conditions; and
- Laboratory analysis of water samples.

The groundwater, surface water and ground gas monitoring locations are presented on **Figure 14.10 in Volume 3**.

Following the intrusive investigations, all locations were surveyed relative to Ordnance Datum.

Following development of all wells, falling and rising head tests were carried out in five boreholes across the site to assess the permeability of the aquifer.

14.3.4 Long Sea Outfall and SWO at the WwTP

14.3.4.1 Non-Intrusive Investigations

An offshore geophysical survey was carried out by Apex Geoservices[29] between 6 and 16 March 2017 (Refer to **Appendix 14.6**). The detailed methodology for undertaking this investigation is provided in **Appendix 14.6**. This included the following investigation methods over an area of 75ha up to 1.5km offshore:

- Underwater Multichannel Analysis of Surface Waves (UMASW) to determine shear wave velocities in sediments which reflect the relative densities of the sediments;
- Sub bottom profiler single channel seismic reflection which can be used to identify the likely bedrock surface beneath the sea-bed; and
- Seismic Refraction surveys which allow an assessment of the condition of the bedrock.

The outfall study area is generally characterised by unconsolidated sediments over glacial till of variable thickness overlying undulating bedrock.

14.3.4.2 Intrusive Investigation

An offshore preliminary ground investigation was carried out by Causeway during 29 August - 11 November 2017 (Refer to **Appendix 14.3**). The works were affected by Storm Ophelia at this time resulting in the extended programme. The detailed methodology for undertaking this investigation is provided in **Appendix 14.3**.

[29] Apex Geoservices (2017). Report on the Geophysical Investigation for the Marine Outfall Pipeline, Arklow Waste Water Treatment Plant for Byrne Looby Arup. AGL16077_01

This investigation consisted of undertaking 18 boreholes, 11 of which were within the Avoca River and relate to the Alps SWO and stormwater storage tank and interceptor sewers. The remaining seven boreholes were completed within the study area for the long sea outfall.

These seven boreholes were completed using a combination of light cable percussive methods and rotary follow on drilling techniques to prove bedrock. Three of the boreholes (BH04, BH05 and BH06) were progressed to a depth of 25, 22.5 and 25.2m below seabed respectively without encountering bedrock. The remaining boreholes encountered bedrock between 9.5 to 11.6m below seabed except for BH08 which encountered rock at 23.5m below seabed.

14.3.5 Technical Limitations

The baseline data described and considered in this assessment includes existing data from earlier investigations within the study area and surrounds as well as dedicated field surveys commissioned specifically for the proposed development. The data collected provides a comprehensive dataset in relation to the soils, geology and hydrogeology within the study area.

The baseline data provides valuable information on the existing soils, geology and hydrogeological environment at point locations within the study area. Between each point the baseline data has been assessed by conservative interpretation. While soils, geology and hydrogeology can vary, the exploratory locations have been selected following the completion of the comprehensive baseline data collection. This review was completed by studying local geological maps, aerial photography, historic ground investigation and completing site walkovers to provide an understanding of the study area. The location and the spacing of the exploratory locations used as part of the intrusive investigation was chosen in order to gain an understanding of the soils, geology and hydrogeology beneath the site. The findings from the investigations for the majority of cases compared favourably with the desk study of existing information on the baseline conditions.

14.3.6 Regional Overview

The site of the proposed development, as illustrated in **Figure 1.1 of Volume 3** includes the footprint of terrestrial, riverine and marine lands within the planning boundary. The planning boundary of the proposed development is located in Arklow town, entirely within the administrative boundary of Wicklow County Council. Arklow town is a key hub of economic activity, shopping, education, recreation and administration for south-east Wicklow therefore the site of the proposed development is predominantly urban in character.

The proposed development is concentrated in the waterfront area of Arklow, with the proposed interceptor sewers located along the north and south quays (see **drawing W3136/802 and drawings W3136/700 to W3136/716 in Appendix 14.7** for more details). The proposed WwTP is located at the Old Wallboard site, at Ferrybank. The WwTP site is bounded to the east by Arklow Bay and to the south by the Arklow River, in a prominent location on the waterfront at the mouth of the estuary.

14.3.7 Regional Geomorphology and Topography

Arklow town is located in the catchment of the Avoca River which rises in the Wicklow mountains and flows down to the Irish Sea entering at the 'Harbour Mouth' in Arklow town that lies to the south-east of the proposed WwTP site[3,11].

The topography of the region is dominated by the Wicklow Mountains to the northwest. The topography varies between 800m Ordnance Datum (OD) at Tonelagee to an elevation of almost 0.0mOD in Arklow town. The existing ground level at the southern end of the WwTP site is at approximately 2.60mOD[30].

The landscape principally reflects the erosional and depositional legacy of the last period of glaciation. Glacial erosion of pre-existing topographic features and deposition of thick glacial drift deposits, mainly till (boulder clay) resulted in areas of rather subdued post-glacial topography away from the topographic highs of the Wicklow mountains.

The post-glacial landscape also reflects the effects of fluvial (river) processes that have altered the topography, albeit only to a small extent in this area, since the ice sheet retreat.

The geomorphology of the proposed development is predominantly that of a post glaciation, 'U-shaped' river valley. The ground levels fall along the river by approximately 5m. Ground levels in the bottom of the river valley are generally relatively flat, but can slope up relatively steeply at the valley extents. In addition, the proposed development is crossed locally in places by surrounding roads which appear to have been constructed generally on embankment, presumably to lift them out of the flood plain of the river. On either side of the river, alluvial floodplains are present, which are tens of metres wide in places. As would be expected, the watercourses have a tendency to meander within the flood plains, meaning that there is no consistent location of the watercourse within the valley bed.

A number of buried meltwater channels are located in this area and roughly follow the path of various streams and part of the Avoca River[30].

With reference to the GSI online mapping, the subsoils comprise primarily of made ground, with alluvium and rock outcrops at the western end of the pipeline[30].

The bathymetry of the seabed off the coast of Arklow was noted to vary from 0.0mOD (close to the shoreline) to -11.7mOD at a distance of 900m offshore at BH10. In general, the seabed gradually slopes downwards from the shoreline to the termination point of the proposed long sea outfall[29].

The coastline in the vicinity of the proposed development is characterised by sandy beaches[30].

---

[30] GSI Groundwater Data Viewer (2018). Available from: http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228 [Accessed 18 July 18]

A bathymetry survey[29] was carried out on the offshore section of the proposed development by Murphy Surveys Limited in August 2017 and compared to the admiralty chart from the UK Hydrographic Chart (sheet 1468)[31].

14.3.8 Regional Soils and Subsoils

The soils within the study area are described in the National Soil Survey (NSS)[32]. The general soil map of Ireland published by the NSS shows the study area to be underlain by urban soils or made ground. Further north and inland outside of the study area there are deposits of Irish Sea Till and Glacial Till derived from Lower Palaeozoic Sandstones and Shales.

The till of the study area principally reflects the depositional process of the last glaciation. Typically, during the ice advance, boulder clays were deposited subglacially as lodgement till over the eroded bedrock surface, whilst moraine granular deposits were laid down at the glacier margins. Subsequently, with the progressive retreat of the ice sheet from the region, granular fluvio-glacial deposits were laid down in places by melt waters discharging from the front of the glacier[30].

Boulder Clay is expected to be encountered across the footprint of the proposed development. Made ground is located extensively across the onshore parts of the study area.

River alluvium deposited from historic flooding events is mapped by the GSI along the banks of the Avoca River and along the Avoca River paleochannel. Beach sands and gravels are shown along the coast within 1km of the WwTP site[30,33].

The offshore ground conditions are expected to be made up of marine sediments (sands and gravels) c. 4.5m to 12.5m thick, overlying till c. 3.1 to 13m thick on weathered bedrock (Sandstones and Shales), from c. 9.5 to greater than 25.2m below seabed[32].

14.3.9 Regional Bedrock Geology

The 1:100,000 GSI bedrock geology map (Sheet 19) indicates that the site is underlain predominately by the Ordovician Kilmacrea Formation with the exception of the south-east corner which is underlain by the Ordovician Maulin Formation[30]. The regional geology is presented **on Figure 14.3 in Volume 3.**

The Kilmacrea Formation is described by the GSI as buff-weathering, grey and black slates and shale with occasional sandstones. The Maulin Foundation is described as dark blue-grey slates and phyllites.

---

[31] UK Hydrographic Office (1999). Republic of Ireland – East Coast. Arklow to the Skerries Islands. Scale: 1:100000 at lat 15°30'. Sheet no. 1468. 3rd Ed.
[32] NSS of Ireland (1980) Soil Associations of Ireland and Their Land Use Potential.
[33] GSI Groundwater Data Viewer (2017). Available from: http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228 [Accessed 18-07-18]

The Kilmacrea Formation dips reported in the vicinity of the site vary from 44º east-north-east to 80º south east. In general, the area is shown to comprise the south eastern limb of a large anticline with a north east to south west trending axis approximately 3km to the north west of the site.

A fault is shown trending generally SSW-NNE running beneath the south-east section of the site, separating the two formations.

According to the GSI Groundwater Data Viewer[30], there are no karst features present in close proximity to the site or the surrounding area.

The BGS 1:250,000 offshore map indicates that the area between Ferrybank and the proposed long sea outfall is underlain by Ordovician Slates[4].

14.3.10 Surface Water Bodies

The closest water body is the Avoca River which discharges into the Irish Sea at Ferrybank as described in detail in **Chapter 15**.

14.3.11 Regional Hydrogeology

The GSI has devised a system for classifying the aquifers in Ireland based on the hydrogeological characteristics, size and productivity of the groundwater resource into the National Draft Bedrock Aquifer Map[30],[34]. The three main classifications are: 'Regionally Important Aquifers', 'Locally Important Aquifers' and 'Poor Aquifers'. Each of these three types of aquifer is further subdivided and has a specific range of criteria associated with it such as the transmissivity (m^2/day), productivity, yield and the potential for springs. The aquifer designations in the vicinity of the study area are shown on **Figure 14.4 in Volume 3** and a summary is provided below:

- The Kilmacrea and Maulin Formations have been designated by the GSI as a 'Locally Important Aquifer' - Bedrock which is moderately productive only in Local Zones (LI). Locally Important aquifers are dominated by poor yielding boreholes with yields less than $40m^3$/d.
- A gravel aquifer which partly underlies the west of the WwTP site and extends west-north-west away from the site is designated by the GSI as a Local sand and gravel (Lg) aquifer. This is described by the GSI as an aquifer with a surface area between $1km^2$ and $10km^2$ which may supply excellent yields but due to its smaller size the amount of recharge available to meet abstractions can be limited.
- The Kilmacrea and Maulin formations are part of the Ordovician Metasediments within the Wicklow Groundwater Body. The GSI describe the Ordovician Metasediments as one of the better bedrock aquifers within the groundwater body.

[34] GSI Groundwater Data Viewer (2017). Available from: http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228 [Accessed 18-07-18]

- The majority of groundwater flow in the Kilmacrea and Maulin formations takes place mainly in the weathered zone in the upper 3m of the bedrock. The GSI states that deeper groundwater flow can take place in isolated fractures. Pumping tests have been undertaken by the GSI for the Maulin Formation and the Kilmacrea Formation which provided transmissivity values of $30m^2/d$ to $32m^2/d$ in these formations. Regional groundwater flow is dominated by the presence of the Avoca River with flow towards this surface water body. To the north of the WwTP site, the groundwater flow is likely to be characterised by the tidal influence of the Irish Sea.

14.3.11.1 Recharge

The average rainfall between 1984 and 2016 in the study area is approximately 79.26mm/yr. The average monthly rainfall values for Arklow that have been measured at Ballyrichard House during 1984 to 2016[35] are summarised in Table 14.1.

Table 14.1: Average Monthly Rainfall (mm) measured at Arklow town during 1984 – 2016[35].

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1984 - 2016	98	72	62	69	63	68	60	80	68	105	104	101

Recharge is the amount of rainfall that replenishes the aquifer. It is a function of the effective rainfall, the permeability and thickness of the subsoil and the aquifer characteristics. The GSI recharge map for the study area shows that recharge is approximately between 201mm/annum to 250mm/annum[30]. The approximate recharge in the study area is presented on **Figure 14.5 in Volume 3**.

14.3.11.2 Aquifer Vulnerability

Aquifer vulnerability is a measure of the likelihood with which the groundwater could be contaminated by human activity. Aquifer vulnerability depends on the intrinsic geological and hydrogeological characteristics of the aquifer.

Aquifer vulnerability is determined by the thickness and permeability of any overlying deposits. For example, bedrock with a thick, low permeability, clay-rich overburden is less vulnerable than bedrock with a thin, high permeability, gravelly overburden.

Aquifer vulnerability under the site has been classified by the GSI as low (Refer to **Figure 14.6 in Volume 3**). Aquifer vulnerability is relevant to the LI bedrock aquifer. The vulnerability of the Lg gravel aquifer is likely to be highly dependent on the thickness of the overlying soil and the depth to groundwater[30].

---

[35] Met Éireann, (2018). Climate, Available Data, Historical Data. Available at: https://www.met.ie/climate/available-data/historical-data, Accessed 18-07-18

14.3.11.3 Groundwater Hydrochemistry

Groundwater in the Ordovician bedrock of the Wicklow Groundwater Body that underlies the study area is generally soft to moderately soft (20–80 mg/l $CaCO_3$) and has low electrical conductivity (ranging from 130 to 220 µS/cm)[13].

Within the local area, the quality of the groundwater in the LI bedrock aquifer and the Lg gravel aquifer are considered to be heavily influenced by the Irish Sea, creating a brackish environment that is not potable.

According to the EPA, the Wicklow Groundwater Body was classified as having 'Good' status in conjunction with the WFD between 2010 – 2015 (refer to **Section 15.3 of Chapter 15** for further detail)[8]. The current status of the groundwater body is under review but the Wicklow Groundwater Body is 'at risk of not achieving good status'[17].

14.3.11.4 Sensitive Features

A small number of sensitive features have been identified as they may be dependent on the geology and hydrogeology characteristics including:

- Groundwater abstractions; and
- Groundwater dependent terrestrial ecosystems.

Groundwater abstractions

Based on GSI records[30], nine domestic, agricultural and industrial use groundwater wells are located within the study area. The abstractions identified (refer to Table 14.2) include 14 boreholes drilled to depths between 5.9 - 53.3m below ground level and have yields varying from 0 to 160m^3 per day. The closest abstraction to the WwTP site is used for domestic use only, however the approximate location of this borehole is only known to within 1km. The exact location of this borehole is unknown. The closest borehole with a high level of location accuracy is located approximately 850m south-west of the WwTP site and is used for industrial use.

The source that the groundwater is abstracted from is not stated but it is likely that it abstracts from the sands and gravels (Lg aquifer) and/or bedrock (LI Aquifer) beneath.

Consultation with Wicklow County Council has confirmed that they do not have records of any private groundwater abstractions within the study area.

Table 14.2: Summary of groundwater abstractions within 2km of the site.

Abstraction ID	Depth (mBGL)	Depth to Bedrock (mBGL)	Location Accuracy (m)	Townland	Use	Yield m3/d
3217SWW061	23.8	15.2	20	Ticknock	Unknown	22
3217SWW062	9	7.5	20	Abbeylands	Industrial use	60
3217SWW063	7.4	7.4	20	Abbeylands	Other	10

Abstraction ID	Depth (mBGL)	Depth to Bedrock (mBGL)	Location Accuracy (m)	Townland	Use	Yield m3/d
3217SWW064	5.9	3.5	20	Tinahask Upper	Other	12
3217SWW079	17.9	14.8	20	Seabank	Unknown	0
3217SWW098	36.6	27.4	20	Coolboy	Agri & domestic use	43.6
3217SWW043	61	0	100	Kilbride	Domestic use only	22
3217SWW070	6.1	0	100	Rock Big	Unknown	0
3217SWW006	31.7	9.1	1000	Killiniskyduff	Domestic use only	21.8
3217SWW007	27.4	3.1	1000	Tinahask Lower	Domestic use only	22
3217SWW011	25.9	0	1000	Seabank	Domestic use only	33
3217SWW048	48.7	21.3	1000	Arklow	Industrial use	55
3217SWW052	53.3	12	1000	Arklow	Domestic use only	160
3217SWW053	45.7	3.6	1000	Arklow	Domestic use only	55

The GSI and EPA have delineated certain areas nationwide as Source Protection Areas in order to provide protection for groundwater abstractions and public water supplies. There are no Source Protection Areas located beneath the site or within 2km of the site boundary[10,30] (Refer to **Figure 14.7 in Volume 3**).

In addition, there are no National Federation of Group Water Schemes Zones of Influence within the study area[30].

Groundwater dependent terrestrial ecosystems

The NPWS online database has been consulted to establish whether areas with national or international important ecological sites are located within the vicinity of the study area[14]. **Figure 11.4 in Volume 3** outlines the locations of the nearest Natura 2000 sites.

There are two proposed National Heritage Are (pNHA) sites within 2km of the study area. These are the Arklow Sand Dunes (Ref: 001746) located 1.9km to the north of the site and the Arklow Town Marsh (Ref: 001931) adjacent to the north west of the site.

The Arklow Town Marsh is a wetland area located north of the Avoca estuary north-west of the site. The wetland is noted to have been impacted by its close proximity to Arklow town and the nearby industry.

The Arklow Sand Dunes are a dune system connected to wet woodland located along the coast. Any activities associated with the construction or operation of the proposed development would be too distant to affect this site.

14.3.12 Site Specific Environmental Setting

14.3.12.1 Introduction

This section outlines the site-specific information available for the proposed development. This section describes the findings of the site-specific surveys commissioned for the proposed development as described in **Chapter 4**.

14.3.12.2 Site Walkover Surveys

Storm Water Overflow (SWO) and Stormwater Storage Tank and Interceptor Sewers

A number of site visits of the study area were conducted during the refinement of the Conceptual Site Model (CSM) in 2016.

Site specific details were recorded and included logging of subsoil types, vegetation indicators, springs, drainage details and general trafficability of soils.

Where access was granted to proposed specific scheme feature locations, subsoil deposits and selected exposures / sections were logged according to the British Standard Institute (BSI) BS 5930: 2015 - Code of Practice for Ground Investigations[28].

WwTP and Revetment

Arup carried out a site walkover of the WwTP and revetment site on 18 October 2017. They were assisted by representatives from Wicklow County Council who had useful local knowledge on the history of the site. A visual inspection was undertaken in addition to field notes and a detailed photographic record. The site walkover identified a number of features on the WwTP site of relevance (Refer to **Table 4 and Figure 2 in Appendix 14.1**). Photographs taken during the site walkover are presented in Appendix G of the PSA (Refer to **Appendix 14.1**) which show some of the features of concern that have been highlighted. Further detail on the site walkover is provided in **Section 2.2.9 of Appendix 14.1**).

Outfalls (Long Sea Outfall and SWO at WwTP)

A walkover of the WwTP site and the revetment was carried out in advance of the offshore GI in August 2017. Refer to **Chapter 15** for further information.

14.3.12.3 Topography/Bathymetry

Storm Water Overflow (SWO) and Stormwater Storage Tank

The ground level at the northern end of the site at the Alps (MHS1) rises from +2.166 m AOD to +4.6m AOD at the southern edge of the site.

Interceptor Sewers

Southern section of alignment from MHS1 to TSS3 (Coomie Lane to Harbour Road)

Ground levels through this section are generally level, with a slight fall at a shallow gradient from approximately +2.17m above Ordnance Datum (AOD) to +1.75m AOD, over a length of approximately 1.04km. This section can be broken into the following parts:

- Between MHS1 and MHS9, the ground levels drop from +2.17m AOD to +1.05m AOD over a length of approximately 420m;
- Between MHS9 and TSS1, the pipeline is within the river channel. The river bed levels drop from -0.30m AOD to -0.62m AOD over a length of approximately 260m, before rising again to +0.50m at manhole TSS1; and
- Between TSS1 and MHS16, the ground levels rise from +1.30m AOD to +1.75m AOD over a length of approximately 320m.

Central section of alignment from TSS3 to TSN8 (Harbour Road to Mill Road)

- The pipeline runs under the Avoca River from TSS3 to TSN6, with a channel bed level of approximately -4.5m AOD. Channel depth ~ 4.5m
- Ground level varies from c. 2.00m AOD to 1.80m AOD between TSN6 and TSN8, over a length of approximately 160m.

Northern section of the alignment from MHN1 to TSN7 (west of Bridge Street, Ferrybank to Mill Road):

As described above this section passes from west of Bridge Street, runs down the eastern bank of the Avoca River to the Marina at Mill Road. Levels through this section are as follows:

- MHN1 to TSN1 (~45m length in marsh land): rising from approximately +0.89AOD m to +1.60m AOD;
- TSN1 (Bridge Street) to MHN2A (Bridgewater Section) (~30m length): approximately +1.60m AOD to +3.06m AOD;
- MHN2A (Bridgewater) to TSN4 (end of North Quay) (~445m length): approximately +3.06m to +2.12m AOD; and
- TSN4 to TSN7 (Marina section (~200m length)) varies between +2.12 and +1.62 AOD.

WwTP and Revetment

According to the topographic survey carried out by Minerex[25] (Refer to **Appendix 14.4**), the WwTP site is predominately flat and largely covered with asphalt /concrete or derelict buildings. The ground level generally varies between approximately +1.5mOD to +2.5mOD apart from the area in the northern part of the WwTP site where the ground level is up to approximately +3.7mOD.

The topographic survey carried out by Murphy's Surveys (Refer to **Appendix 14.3**) shows that the top of the existing revetment varied between c. 4.42mOD in the south of the WwTP site to c. 6.25mOD in the north of the WwTP site. The revetment is steeper on its eastern side.

Outfalls

Long Sea Outfall

According to the bathymetry survey[29] (Refer to **Appendix 14.3**), the existing ground level at the landside end of the outfall is at approximately 2.60mOD. The seabed level varies from 0mOD (close to the shore) to -11.7mOD at the seaward end of the outfall. Generally, the ground is consistently and gradually sloping away from the shore as previously noted in **Section 14.3.7**.

SWO at WwTP

According to the bathymetry survey[29] (Refer to **Appendix 14.3**), the existing ground level on the landward side of the outfall is approximately 2.60mOD. The seabed level was noted as being -2.73mOD at the toe of the revetment (discharge point for SWO).

14.3.12.4 Site History/Man Made Features

Storm Water Overflow (SWO) and Stormwater Storage Tank

A summary of the site history is outlined in Table 14.3. From the historical maps[15], this land has remained vacant from 1837 until the present day.

Table 14.3: Summary of the relevant information presented on historical maps from 1837 - 2005[15]

Source	Date	Land use at the site	Land use in the vicinity of the site
Map from OSI Web Viewer	1837-1842	Open land adjacent to minor road	North: Avoca River East: Post Office on Main Street South: Castle (In ruins) West: Lane
Map from OSI Web Viewer	1888-1913	No Change	North: Avoca River East: Court House South: Castle (In ruins) West: Lane
Map from OSI Web Viewer	1995	No Change	North: Avoca River East: Court House South: Residential/Commercial Units West: Lane
Map from OSI Web Viewer	2000	No change	North: Avoca River East: Court House South: Castle (In ruins) West: Lane

Source	Date	Land use at the site	Land use in the vicinity of the site
Map from OSI Web Viewer	2005	No change	North: Avoca River East: Court House South: Residential/Commercial Units West: Lane

Interceptor Sewers

A summary of the sewer alignment history on the southern side of the Avoca River is outlined in Table 14.4.

Table 14.4: Summary of the relevant information presented on historical maps from 1838-2005 for the southern Interceptor Sewer

Source	Date	Land use at the site	Land use in the vicinity of the site
Between MHS1 and MHS9			
Map from OSI Web Viewer (Appendix A)	1837-1842	Open Land adjacent to river	North: Avoca River East: Avoca River/Arklow Bridge South: Residential/ commercial Units/ Grave Yard West: Open land
Map from OSI Web Viewer (Appendix A)	1888-1913	Open Land adjacent to river	North: Avoca River East: Avoca River/Arklow Bridge South: Residential/commercial Units/ Grave Yard (disused)/Gas Works West: Open land
Maps from OSI Web Viewer (Appendix A)	1995-2005	River Lane/River Walk	North: Avoca River East: Avoca River/Arklow Bridge South: Residential/commercial West: Open land
Between MHS9 and TSS1			
Map from OSI Web Viewer (Appendix A)	1837-1913	In river channel	North: Avoca River East: Avoca River South: Residential/commercial West: Residential/commercial
Map from OSI Web Viewer (Appendix A)	1995-2005	In river channel adjacent to Sourth Quay Wall	North: Avoca River East: Avoca River South: Residential/Commercial West: Residential/commercial
Between TSS1 and TSS3			
Map from OSI Web Viewer (Appendix A)	1837-1842	Open Land adjacent to river	North: Avoca River East: Avoca River South: Open Land West: Open Land

Source	Date	Land use at the site	Land use in the vicinity of the site
Map from OSI Web Viewer (Appendix A)	1888-1913	No Change	North: Avoca River East: Avoca River South: Boatbuilding Yard West: Open Land
Map from OSI Web Viewer (Appendix A)	1995-2005	South Quay Wall	North: Avoca River East: Avoca River South: Residential/Commercial/Industrial West: Open Land

Northern Interceptor Sewer

A summary of the site history along the route of the northern interceptor sewer is outlined in Table 14.5.

Table 14.5: Summary of the relevant information presented on historical maps from 1838-2005 for the northern Interceptor Sewer

Source	Date	Land use at the site	Land use in the vicinity of the site
MHN1 to TSN1			
Map from OSI Web Viewer (Appendix A)	1837-1842	Marsh Land	North: Grave Yard East: Open Land South: Avoca River West: Marsh
Map from OSI Web Viewer (Appendix A)	1888-1913	Marsh Land	North: Marsh Land/Residential Properties East: Masonic Hall South: Avoca River West: Marsh
Maps from OSI Web Viewer (Appendix A)	1995-2000	No change	North: Marsh/Residential Properties East: Residential South: Avoca River West: Marsh
Maps from OSI Web Viewer (Appendix A)	2005	No change	North: Marsh/Residential Properties East: Bridgewater Shopping Centre South: Avoca River West: Marsh
MHN2A to TSN4 (end of North Quay) (~445m length)			
Map from OSI Web Viewer (Appendix A)	1837-1842	Islands/Land at the edge of the Avoca River	North: Grave Yard East: Open Land South: Avoca River West: Marsh
Map from OSI Web Viewer (Appendix A)	1888-1913	Reclaimed Land at the edge of Avoca River	North: Open Land East: Open Land/Inlet South: Avoca River West: Avoca River

Source	Date	Land use at the site	Land use in the vicinity of the site
Maps from OSI Web Viewer (Appendix A)	1995-2000	North Quay	North: Residential/ Commercial Units/ Sports Field East: Marina/Industrial Land South: Avoca River West: Avoca River
Maps from OSI Web Viewer (Appendix A)	2005	No change	North: Bridgewater Shopping Centre/ Sports Field East: Marina/Industrial Land South: Avoca River West: Avoca River
TSN4 to TSN7 (Marina section) (~200m length))			
Map from OSI Web Viewer (Appendix A)	1837-1842	Islands/Land at the edge of the Avoca River	North and East: Open Land South and West: Avoca River
Map from OSI Web Viewer (Appendix A)	1888-1913	Dam/Reclaimed Land at the edge of the Avoca River	North: Open Land East: Kynock Factory and Chemical Works South: Avoca River West: Inlet and Avoca River
Maps from OSI Web Viewer (Appendix A)	1995-2005	Marina	North: Sports Field/Industrial East: Several long buildings which fit within the foot print of the site belonging to the Wallboard Factory South: Avoca River West: Avoca River

River Crossing

The central section of alignment, i.e. the river crossing runs from TSS3 to TSN8 (Harbour Road to Mill Road). A summary of the site history from TSN6 to TSN8 is outlined in Table 14.6 as there is no historic data from TSS3 to TSN6.

Table 14.6: Summary of the relevant information presented on historical maps from 1838-2005 for the river crossing[15]

Source	Date	Land use at the site	Land use in the vicinity of the site
Map from OSI Web Viewer (Appendix A)	1837-1842	Islands at the Estuary of the Avoca River	North: Open land East: Irish Sea South: Avoca River West: Avoca River
Map from OSI Web Viewer (Appendix A)	1888-1913	Open land which appears to have been reclaimed	North: Open land East: Kynock Factory and Chemical Works South: Avoca River West: Salvage Store, 2 slips, dam

Source	Date	Land use at the site	Land use in the vicinity of the site
Maps from OSI Web Viewer (Appendix A)	1995-2005	Road	North: Sports field East: Several long buildings which fit within the foot print of the site belonging to the Wallboard Factory South: Avoca River West: Marina, Boatyard

WwTP and Revetment

The site history is discussed in detail in Section 2.2 of the PSA (**Appendix 14.1**) with historical maps and photographs shown in Appendix A and Appendix B respectively within **Appendix 14.1.**

The WwTP site is located on land reclaimed from the Avoca River estuary. Once this land was reclaimed, Arklow Chemical Works (Limited) founded by Wicklow Copper Mine Company were established on the WwTP site. The chemical factory was purchased by Kynoch in 1895 and the Kynoch Explosives Factory was established at this location. The Kynoch Explosives Factory was an ammunitions factory that produced explosives including nitroglycerine, guncotton, picric acid and cordite. During this time, the operations associated with the chemical works continued to produce sulphuric acid required to produce cordite by pyrite burning.

The Kynoch Explosives Factory was subsequently sold in 1919 and most of the buildings were demolished at that time. The sea has reclaimed some of the site.

The site remained derelict until Arklow Gypsum Ltd plant was established in 1971. Arklow Gypsum Ltd plant was a subsidiary of NET, later known as Irish Fertilizer Industry (IFI). One of the by-products of phosphoric acid production in NET was the production of gypsum and Arklow Gypsum Ltd. was set up to use the gypsum produced in the manufacture of fertilizer to make plasterboard. IFI also stored Heavy Fuel Oil, Sodium Hydroxide and Nitric acid in tanks west of the Arklow Gypsum Ltd. site on the site known as the Foudi Site.

Anecdotal evidence from local residents suggests the following:

- All unwanted material from the Arklow Gypsum Ltd plant was dumped in the northern part of the WwTP site which is currently fenced off. There is a risk that this material is slightly radioactive;
- Guncotton is present in the ground throughout the WwTP site;
- A low-lying area in the north-western part of the WwTP site was likely to have been used as a dump for various types of materials from the Kynoch Explosives Factory. A diversion from the train tracks accessing this area can be seen on the historical map from 1910.

Long Sea Outfall and SWO at WwTP

From review of the aerial imagery[3,11],, rock armour was noted along the interface of the land and marine environment. Refer to **Chapter 15** for further details.

There is an underwater cable associated with Arklow Bank Wind Park within the vicinity of the offshore section of the proposed development.

The wayleave of the cable from the Wind Park and the offshore section of the proposed development do not intersect (Refer to **Figure 14.8 in Volume 3**).

14.3.12.5 Potential Sources of Contamination

Alps SWO and Stormwater Tank and Interceptor Sewers

At the Alps SWO and Stormwater Tank site and along the alignment of the interceptor sewers, no contaminated ground was found by previous site investigations. Contaminated ground was, however, found at a site to the east of Manholes TSN6 and TSN7.

At the request of Foudi Limited, an environmental assessment was completed by Tobin Consulting Engineers in December 2005[36] in relation to a planning application for a proposed residential development site on the North Quay of Arklow Harbour (See Appendix D in **Appendix 14.1**).

The site had an industrial use previously as the IFI Tank Farm, storing heavy fuel oil, nitric acid and sodium hydroxide.

Site works were completed on 14 October 2004. The works comprised 10 window sampler holes to depths of 2.0m – 3.0mBGL, with piezometers installed in 3 No. of these holes.

An asbestos survey was undertaken on the same day due to the uncertain nature of lagging around tanks and pipework within the site. The lagging was determined to be rockwool. However, it was noted that the buildings were predominately roofed with single skin asbestos cement sheeting with gutters and down-pipes made of asbestos cement, as well as asbestos vinyl floor tiles in one building.

Made Ground comprising gravels with red brick, glass and slag was encountered in 7 No. of these holes to depths of up to 2.5m.

Laboratory testing was carried out to determine the contaminant potential due to previous land use. This analysis does not suggest the natural soil has been impacted by this use. However, the Made Ground does have contaminant potential due to elevated levels of heavy metals and polycyclic aromatic hydrocarbons. The report concluded the most appropriate manner for dealing with this is to allow the Made Ground to remain in situ as no basement was proposed as part of the development.

WwTP and Revetment

According to Wicklow County Council, a former unlicensed town landfill is present (approximately 300m north-west of the WwTP site) that closed before 1977. The former landfill extended from the Bridgewater Shopping Centre in the west to the running track (located to the north of Mill Road) to the east.

[36] Tobin Consulting Engineers (2005). Site Investigation Programme for Foundi Limited, c/o ID Partnership Ireland Ltd. At IFI Tank Farm, Arklow, County Wicklow.

Much of the former landfill was removed during the construction of the commercial properties on North Quay. However, the running track area is understood to be still underlain by the former landfill.

Based on a site investigation of the neighbouring site the landfill extends beneath Mill Road and under the western extent of the Eirgas site next to Mill Road.

Other sources of historic contamination in the immediate vicinity of the WwTP site include the following:

- An incident in one of the tanks on the adjacent Foudi site, a former IFI tank farm, which allegedly led to hydrocarbon spillage into the ground;
- An explosion on the tank farm which led to the release of various contaminants.

Long Sea Outfall and SWO at WwTP

Three locations within Arklow Bay were identified as Dumping at Sea (DaS) sites (Refer to **Figure 14.7 in Volume 3**). These DaS sites have been used for the disposal of local dredge material.

The Clean Water and Health database available from the EPA[9] states that there is no WwTP for Arklow town and at present, there is untreated wastewater being discharged into the Avoca River. As discussed in detail in **Section 15.3 of Chapter 15**, the most recent water quality status report[37] showed the following:

- The overall WFD status of the Avoca River within the study area was ‘Moderate’;
- The Avoca Estuary was given ‘At risk’ status;
- Ecological status for Avoca Estuary was ‘Unassigned’;
- Chemical surface water status was classed as ‘Failing to achieve good status’;
- Hydro-morphological status was specified as ‘Moderate’; and
- A stretch of the Avoca River within the study area fails the Specific Pollutant Conditions.

The EPA introduced the system of Integrated Pollution and Prevention Control (IPPC) licencing in 1994 to control the emissions, including air, water, waste and noise, from various industrial activities in accordance with the requirement of the Environmental Protection Agency Act 1992, as amended[38]. There are two businesses within Arklow which are subject to Industrial Emissions Directive (‘IE’) Licences from the EPA (Refer to **Chapter 19** for more information):

- Avoca River Park Limited – located upstream of the proposed development adjacent to the Avoca River; and

[37] EPA (2012). Water Quality in Ireland 2010 – 2012. Available from: http://www.epa.ie/pubs/reports/water/waterqua/wqr20102012/WaterQualityReport.pdf, Accessed: 16/08/2018
[38] Environmental Protection Agency Act (1992). No. 7 of 1992. Available from: http://www.irishstatutebook.ie/eli/1992/act/7/enacted/en/print#sec2, Accessed 16/08/2018

- Sigma-Aldrich Ireland Limited – located on Vale Road adjacent to the M11 flyover and close to the Avoca River.

The Sigma Aldrich facility is also designated as a 'Seveso site', in accordance with Council Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances. This classification as a ‘Seveso site’ identifies the facility as an industrial establishment where dangerous substances are used or stored in large quantities.

14.3.12.6 Soils

Storm Water Overflow (SWO) and Stormwater Storage Tank

The ground conditions in the study area are available from the Geological Survey of Ireland (GSI) Data Viewer – Teagasc Soils layer[30]. The ground conditions at the Alps SWO and stormwater storage tank vary in terms of its soil, sub-soil and bedrock geology. The following subsoil groups occur along the SWO and stormwater storage tank site:

- AlluvMIN – Alluvial (mineral); and
- Made – Made Ground.

Results of site investigations at the SWO and Stormwater Storage Tank site are summarised in Table 14.7. From the site investigation, it is evident that bedrock is at the surface or near the surface. This is in line with the GSI maps. The main subsoils include Made Ground and Alluvium.

Table 14.7: Summary of SWO and Stormwater Storage Tank Site Investigation results

Lithology	Description	Depth (mBGL)	Thickness (m)
Topsoil		0 – 0.4	0.1 - 0.4
Made Ground (where present)	Soft, brown. Gravelly, sandy clay with fragments of red brick, timber, concrete, glass and ceramics.	0.3-3.2	0.4-2.8
Cohesive Alluvium (where present)	Very soft to soft sandy clay	1.6-2.2	0.6
Sand and gravels	Dense, dark greyish orange, silty, sandy gravel.	2.2->2.4 (base not proven)	>0.2
Shale/Sandstone	Weak dark brown grey, distinctly weathered, highly fractured Shale/sandstone which becomes weak to medium strong, dark grey, moderately to slightly fractured with depth.	0.1->20	1.2- >19.9

Interceptor Sewers

The following subsoil groups occur along the alignment of the proposed interceptor sewers:

- AlluvMIN – Alluvial (mineral);
- Made – Made ground; and
- Rck – Bedrock at or near surface.

Alluvial soils are evident along the course of the Avoca River and its tributaries. Made ground underlies the town of Arklow.

A summary of the length of the proposed development within each subsoil group is outlined in Table 14.8.

Table 14.8: Subsoil Classifications along alignment[30]

Subsoil Group	Length of proposed development within subsoil category (m)	% of proposed development within subsoil category
Alluvium	480	22.6%
Bedrock at or near surface	40	1.9%
Made ground	1,600	75.5%
TOTAL	2,120	100%

Southern Interceptor Sewer

Results of site investigation along the south interceptor sewers have been broken up into three sections and are summarised in Table 14.9. Between MHS1 and MHS9 the top of the bedrock is seen to increase in depth from at surface to undetected at a level of 15mBGL at MHS9. Underlying the made ground, the subsoils are mainly a mixture of medium dense sand and gravels, organic silts and clays and cohesive alluvium. The sands become more prominent towards MHS9 as the alignment gets closer to the Avoca River estuary.

From MHS9 -TSS1, the bedrock is only reached in a borehole near MHS9 at a depth of 17.6mBGL. Underlying the made ground, is mainly a mixture of medium dense sand and gravels and cohesive glacial till. A significant thickness of alluvium was found in a borehole dug in the river bed.

From TSS1 to TSS3, the bedrock was not reached in the site investigations carried out along this section of the alignment. Underlying the made ground, is mainly a mixture of medium dense sand and gravels, dense sand and gravels, and cohesive glacial till.

Table 14.9: Summary of southern Interceptor Sewer Site Investigation results

Lithology	**Description**	**Depth (mBGL)**	**Thickness (m)**
Between MHS1 and MHS9			
Topsoil (where present)		0 – 0.4	0.1 - 0.4
Made Ground (where present)	Made Ground – Varies	0.0-3.2	0.4-2.8
Cohesive Alluvium (where present)	Very soft to soft becoming stiff, gravelly very sandy clay	1.1-10	0.55-4.4
Soft Organic Silt and Clay (where present)	Very soft greyish brown sandy organic silty clay to soft organic clay	1.2-11.8	0.8-5
Sand and Gravels (where present)	Medium dense to dense sand and gravels	1.9->15	>0.2-5.4
Shale/Sandstone (where present)	Weak weathered, highly fractured Shale/sandstone which becomes weak to medium strong, dark grey, moderately to slightly fractured with depth.	0.1->27.8	>1.2- >19.9
Between MHS9 and TSS1			
Topsoil (where present)		0 – 0.2	0.1 - 0.2
Made Ground (where present)	Made Ground – Varies	0-5.8	0.1-5.8
Cohesive Alluvium (where present)	Soft sandy clay	3-10.3	0.4-3.7
Soft Organic Silt and Clay	Soft, dark brown, very peaty silt to soft black organic fine sandy clay	1.9-6.4	0.6-1.3
Sand and gravels (where present)	Medium dense sand and gravels	0.1-11.5	1.6-6.6
Cohesive Glacial Till (Boulder Clay)	Firm becoming stiff brown slightly gravelly, sandy, silty clay	2.3-15.8	1.9-8.2
Sand and Gravels (where present)	Dense sand and gravels	9.6-17.6	1.1-1.8
Sandstone (where present)	Large boulders	17.6-18.2	0.6
Between TSS1 and TSS3			
Topsoil (where present)		0-0.4	0.3-0.4
Made Ground (where present)	Made Ground – Varies	0-3.6	0.35-
Sand and Gravels (where present)	Medium dense sand and gravels	0.25-20.5	1.35-10
Cohesive Glacial Till (Boulder Clay)	Stiff, brown clay to stiff blue grey sandy silty clay	4.7-28	1-6
Sand and Gravels (where present)	Dense sand and gravels	2.7-25	0.2-5.3

Lithology	Description	Depth (mBGL)	Thickness (m)
Cohesive Alluvium (where present)	Soft sandy clay	7.2-10.5	0.4-0.9
Soft Organic Silt and Clay (where present)	Firm, greyish brown, sandy, peaty silt	1.6-2.2	0.8

River Crossing

Results of site investigation along the alignment of the river crossing (TSS3 to TSN8) which includes the river crossing are summarised in Table 14.10. The bedrock was not reached in any of the site investigations carried out in this section, although Amphibolite was found in one borehole at a depth of 18.00 mBGL. Underlying the made ground, both sides of the Avoca river, the subsoils are mainly a mixture of medium dense sand and gravels, dense sand and gravels and cohesive glacial till. Under the river bed, is cohesive glacial till and large depths of medium dense sands and gravels.

Table 14.10: Summary of the river crossing Site Investigation Results

Lithology	Description	Depth (mBGL)	Thickness (m)
Topsoil (where present)		0-0.3	0.3
Made Ground (where present)	Made Ground – Varies	0-3.2	0.35-2.9
Sand and Gravels (where present)	Medium dense sand and gravels	0-20.5	1-10
Cohesive Glacial Till (Boulder Clay)	Soft to very stiff, grey/brown sandy gravelly clay or silt	4.9-11.5	1.1-2.8
Sand and Gravels (where present)	Dense sand and gravels	1.6-25	2.4-5.1
Cohesive Alluvium (where present)	Soft grey slightly sandy silt	10.1-10.5	0.4
Soft Organic Silt and Clay	Soft black slightly gravelly very sandy silt with organic matter	1-2.3	1.3

Northern Interceptor Sewer

Results of site investigation along the northern interceptor sewer (MHN1 to TSN7) are summarised in Table 14.11. The bedrock was not reached in any of the site investigations carried out in this section. Underlying the made ground, the subsoils are mainly a 5m layer of medium dense sand and gravels overlying cohesive glacial tills and dense sand and gravels. A 5m layer of alluvium was found in a borehole adjacent to the river.

Table 14.11: Summary of northern Interceptor Sewer Site Investigation Results

Lithology	Description	Depth (mBGL)	Thickness (m)
Topsoil (where present)		0-0.55	0.1-0.55
Made Ground (where present)	Made Ground – Varies	0-2	0.1-2
Sand and Gravels (where present)	Medium dense sand and gravels	0.55-14.5	1.45-6.9
Cohesive Glacial Till (Boulder Clay)	Soft to firm, greyish brown, slightly sandy, silty clay or stiff brown clay	5.6-15.4	2.7-6.1
Sand and Gravels (where present)	Dense sand and gravels	2.5-23.5	0.9-10.8
Cohesive Alluvium (where present)	Soft sandy Clay	0.5-12.6	0.75-5
Soft Organic Silt and Clay	Soft to firm, brown, peaty silt /soft, brown, organic clay	7.1-10	2.4-2.9

WwTP and Revetment

The site investigations that have been undertaken (Refer to **Section 14.3**) are described in detail in the Detailed Site Assessment (DSA) that has been produced by Arup (Refer to **Appendix 14.2**). Specifically, Section 2.1 of the DSA details the soils identified underneath the WwTP site and revetment.

The soils under the WwTP site and revetment consist of made ground underlain by natural deposits. The made ground is present throughout the site from ground level. Typically, this layer of made ground is thicker (4.4mBGL in BH09) in the north and west where land was reclaimed from the old Avoca River, and thinner in the east and south of the site (0.5mBGL in TP15). The made ground consists of four subgroups:

- **Brown sand and gravel:** This soil group contains bricks and cement, with some occasional asbestos, gun cotton and brick lined chambers. In some locations green, orange and red staining of the soils was noted implying metal contamination.
- **Phosphogypsum deposits:** These deposits have been identified in the fenced area north of the site (TP24, TP25 and TP26) as a white silt. They are generated as a by-product of phosphate production and are mildly radioactive. The ground level in this location is approximately 0.5m to 1m higher than the ground level immediately to the south, indicating that phosphogypsum deposits may have been stockpiled here.
- **Infilled pond:** These deposits have been identified in BH08, BH09, BH11 and TP21 and are thickest in the north of the site in the area of a potential pond feature seen on the historic maps presented in the PSA.

These deposits are thinner towards the north-west and were not identified in the east of the WwTP site.

- **Black sand and gravel:** These deposits are located in the east (BH06A, BH08, TP02, TP06 – TP09, TP18) and west (BH05, BH17, TP05) of the WwTP site. It is anticipated that these deposits may extend across the site underneath the factory building currently in the centre of the WwTP site. This layer is associated with hydrocarbon and chemical odours identified in the trial pits.

The natural strata underlining the made ground consists of:

- **Sand and gravel:** These are likely to be estuarine deposits in the area of the old Avoca River channel to the north and beach deposits in the centre and south of the WwTP site
- **Clay:** This is described as soft to very stiff brownish-grey clay approximately 1m thick that is present across the north and centre of the WwTP site underlying the natural sand and gravel. A deeper clay layer (up to 6.8m thick), is also present across the WwTP site.
  This layer overlies the glacial sand and gravel deposits in the south and bedrock in the north and centre of the WwTP site may act as an aquiclude.
- **Glacial sand and gravel:** These deposits are more angular and less well sorted than the shallower sand and gravel deposits. These deposits are likely to be glacial deposits.

Long Sea Outfall and SWO at WwTP

The ground conditions beneath the offshore study area are summarised in Table 14.12.

Table 14.12: Offshore Ground Conditions

Lithology	Description	Depth (metre below ground level)	Thickness (m)
Sand and Gravel	Medium dense, yellowish-brown, slightly silty, gravelly, fine to coarse Sand. Or Medium dense, brown, sandy, slightly silty, fine to coarse Gravel. Note: Loose sand and gravel occasionally encountered within first 2m of seafloor.	0 – 14.7	4.5 – 14.7
Clay	Stiff, brown, slightly sandy, slightly gravelly, Clay.	4.5 – 14.7	1.9 – 13.0
Sand and Gravel	Dense, brown, slightly silty, gravelly, fine to coarse Sand. Or Dense, brown, sandy, slightly silty, fine to coarse Gravel.	8.3 – 17.5	1.6 – 3.4

Lithology	Description	Depth (metre below ground level)	Thickness (m)
Bedrock	1. Weathered to medium strong Amphibolite (BH05, BH07, BH09); 2. Very weak Breccia (BH07); and 3. Very weak to medium strong Slate (BH07, BH08, BH10)	11.6 – 23.5	Not proven

14.3.12.7 Bedrock Geology

Alps Storm Water Overflow (SWO) and Stormwater Storage Tank

The depth to bedrock will be a key component in determining the impact of the proposed development on the bedrock geology. As noted previously in **Sections 14.3.12.6** and **14.3.12.7**, rock is mapped close to the surface. On the basis of the site investigations, rock outcrops, or close to surface rock, occur at this area.

Interceptor Sewers

From the available SI along the southern alignment of the southern interceptor sewer, depth to bedrock along this alignment varies from rock being close or at the surface at MHS1 to depths increasing to undetectable from MHS10 onwards. Immediately south of MHS9 and Bridge Street, one hole encounters rock at 17.5mBGL. However, most of the holes do not extend to this level. Between Anchor Mews and South Green, a borehole extends to 28mBGL and does not encounter rock.

The bedrock was not reached in any of site investigations carried out along the central alignment (TSS3 to TSN8) and under the river crossing alignment, although the metaphoric rock Amphibolite was found in one borehole at a depth of 18.00 mBGL.

From the available SI for the northern interceptor sewer, none of the exploratory holes, which extended to 10m to 25mBGL, encountered rock.

WwTP and Revetment

The site investigations that have been undertaken (Refer to **Section 14.3**) are described in detail in the Detailed Site Assessment that has been produced by Arup (Refer to **Appendix 14.2**). Specifically, Section 2.1 of the DSA details the geology identified underneath the WwTP site.

Highly weathered sandstone and highly weathered dolerite have been identified in the rotary core follow on boreholes (BH04, BH05 and BH11) between 17.8 to 24m below ground level (-14.66mOD to -22.28mOD).

The weathered bedrock layer overlies medium strong to strong grey massive sandstone bedrock. This is present at 24m below ground level (-22.28mOD) in the north (BH11) and between 20 to 20.9m below ground level (-17.49mOD to -17.76mOD) in the south of the WwTP site (BH04 and BH05 respectively).

The regional geology is presented on **Figure 14.3 in Volume 3**.

Long Sea Outfall and SWO at WwTP

Three metamorphic rock types were identified during the offshore ground investigation;

- Weathered to medium strong Amphibolite (BH05, BH07, BH09);
- Very weak Breccia (BH07); and
- Very weak to medium strong Slate (BH07, BH08, BH10)

The bedrock was encountered between 10 - 28m below seabed.

The Amphibolite encountered was described as weak to medium strong, highly fractured, bluish grey Amphibolite. It was recorded as partially weathered with heavy, orangish-brown stains.

Breccia was encountered in BH07 only and was described as very weak, orange-brown Breccia. It was recorded as partially weathered with orange staining on the fracture surfaces.

The Slate was primarily described as very weak to weak, highly fractured orange-brown Slate that was partially weathered.

14.3.12.8 Karst Features

The karst database available on the GSI Groundwater Data Viewer – Karst Features layer was consulted. No limestone was noted in the area and therefore, no recorded karst features were identified within 1km of the study area[30].

14.3.12.9 Site Hydrogeology

Alps SWO and Stormwater Tank

As a result of the proximity of the proposed SWO and Stormwater tank to the river, the groundwater level will be similar to the river level. The Avoca River is in continuity with the groundwater in the sand and gravels throughout the study area and is likely to be at least partly dependent on water levels in the aquifer.

Interceptor Sewers

As a result of the proximity of the proposed interceptor sewer alignment to the river and sea, the groundwater level will be similar to the river level and sea level. The Avoca River is in continuity with the groundwater in the sand and gravels throughout the study area and is likely to be at least partly dependent on water levels in the aquifer. The sewer alignment closer to the sea is likely to be more influenced by the tidal cycle. During a tidal cycle, the water levels in Arklow Harbour range between 0.2m below groundwater level (in the sand and gravel aquifer at the low tide peak) to 0.3m above groundwater levels (in the aquifer at high tide peak).

WwTP and Revetment

The site investigations that have been undertaken (Refer to **Section 14.3**) are described in detail in the Detailed Site Assessment that has been produced by Arup (Refer to **Appendix 14.2**). Specifically, Section 2.2 of the DSA details the hydrogeology identified underneath the WwTP site.

The made ground and underlying sand and gravel deposits encountered were seen to be water bearing. All boreholes were installed with response zones in the sand and gravel aquifer under the made ground. The results of water level monitoring are summarised below:

- During a tidal cycle, the water levels in Arklow Harbour range between 0.2m below groundwater levels (in the sand and gravel aquifer at the low tide peak) to 0.3m above groundwater levels (in the aquifer at high tide peak).
- At low tide groundwater flows in a west to east-south-east direction toward the Irish Sea with a typical hydraulic gradient of 0.007.
- At high tide groundwater flow direction is changed and flows in a north-north-west to south-east direction with a typical hydraulic gradient of 0.004. This reflects the movement of the sea water into the aquifer as the water level along the coast rises above the water level in the aquifer.

Long Sea Outfall

Soils in relation to the long sea outfall are fully saturated.

14.3.12.10 Radiological Survey

The radiological survey that has been undertaken at the WwTP site (Refer to **Section 14.3**) is described in detail in the Detailed Site Assessment that has been produced by Arup (Refer to **Appendix 14.2**). Specifically, Section 2.3.2 of the DSA details the results of the radiological survey that has been undertaken.

The radiological survey consisted of a walkover survey and intrusive investigation that identified radiation slightly above background levels in the area containing phosphogypsum deposits, at two open pipes to the north of the main factory building and in a discrete location in the south of the WwTP site (TP27).

The survey has concluded that significant radiological contamination at the surface or immediate subsurface was not identified, however in regard to the phosphogypsum deposits in the north of the WwTP site:

"It should be noted that the non-intrusive survey reports on contamination in surface layers only, due to the shielding effect of soil overburden. The absence of contamination at deeper levels (>200mm) and across the whole site cannot be guaranteed."

14.3.12.11 Chemical Test Results

Alps SWO and Stormwater Tank

Given the previous site usage, no significant concerns were expected. Limited sulphate and pH testing was carried out in terms of determining the likely presence of aggressive soils at the locations of the SWO and stormwater tank. Nothing of note was observed.

Interceptor Sewers

Limited sulphate and pH testing was carried out in terms of determining the likely presence of aggressive soils at the locations of the interceptor sewers. Nothing of note was observed. As discussed in **Section 14.3.8.5**, the closest contaminated ground was found at a site to the east of Manholes TSN6 and TSN7.

WwTP and Revetment

The site investigations that have been undertaken are described in detail in the Detailed Site Assessment that has been produced by Arup (Refer to **Appendix 14.2).** Specifically, Section 2.3 of the DSA details the chemical tests results.

The following section presents a summary of the results of the assessment of the soil analysis, water quality and ground gas.

<u>Soil Analysis from the Made Ground</u>

The main findings of the soil analysis of the made ground are as follows:

- Asbestos was confirmed in four of the 87 samples analysed. Asbestos was detected at 0.09% to 4.5% by weight.
- Photo-Ionisation Detector (PID) readings carried out on-site generally recorded low levels of volatile organic carbons above the instrument detection limit which were scheduled for further lab testing; and
- Elevated concentrations of metals were recorded across the WwTP site in the brown sand and gravel. Hydrocarbon compounds were recorded in the black sand and gravel.

<u>Water Quality</u>

The main findings of the water quality analysis are as follows:

- Elevated levels of metal determinands were recorded in all groundwater samples from the sand and gravel aquifer;
- Elevated concentrations of copper were recorded in all groundwater and surface water samples; and
- Elevated concentrations of zinc were recorded in the majority of groundwater and surface water samples.

These elevated concentrations are likely to be associated with sediments from the Avoca mines which were washed down to the estuary of the Avoca River.

Ground Gas

The main findings of the ground gas analysis are as follows:

- There are low concentrations of methane and carbon dioxide present at the WwTP site; and
- Borehole gas flows recorded are low.

Long Sea Outfall

15 sediment samples from the offshore boreholes were compared to the limits defined in the EU Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Council Directive 1999/31/EC on the landfill of waste, referred to as the waste acceptance criteria (WAC). In addition, the samples were compared to the contents of the SEPA, NRW, NIEA and EA Hazardous Waste Classification Tool (version WM3 V1)[39] to determine if the materials were considered hazardous. This comparison was carried out using the HazWaste Online.

14 of the 15 samples were classified as suitable for disposal to a non-hazardous licensed landfill due to concentrations of chloride and Total Dissolved Solids. In 2 of those samples antimony was also detected at concentrations above the limits for an inert licensed landfill. Another sample also contained molybdenum and sulphates above the inert limits as well as elevated total organic carbon.

Soils results were compared to the “Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters” published by the Marine Institute of Ireland. This document sets out two levels of concentrations for heavy metals and hydrocarbons which need to be considered when looking at dumping at sea. It should be noted that we are proposing to excavate these soils and side cast.

The Guidance document refers to the following categories:

- Class 1:
  - Contaminant concentrations less than level 1.
  - Uncontaminated: no biological effects likely.
- Class 2:
  - Contaminant concentrations between level 1 and Level 2.
  - Marginally contaminated;
  - Further sampling & analysis necessary to delineate problem area, if possible.
- Class 3:
  - Heavily contaminated;
  - Very likely to cause biological effects/toxicity to marine organisms.

[39] SEPA, NRW, NIEA and EA (2018). Waste Classification. Guidance on the classification and assessment of waste (1st Ed v1.1), Technical Guidance WM3.

- Alternative management options to be considered.

Table 14.13 summarises the exceedances of the Level 1 criteria from the ground investigation for the long sea outfall.

Table 14.13: Outfall Soil sample results

Location	Depth	Classification	Contaminant
BH04	0.5	Between Level 1 and 2	As (20.6mg/kg, Level 1 Limit 9mg/kg), Cu (88.9mg/kg, Level 1 Limit 40mg/kg)
BH05	0.5	Between Level 1 and 2	As (10.4mg/kg, Level 1 Limit 9mg/kg)
BH07	1.5	Between Level 1 and 2	As (15.9mg/kg, Level 1 Limit 9mg/kg)
BH08	0.5	Between Level 1 and 2	As (10.5mg/kg, Level 1 Limit 9mg/kg)
BH09	2.5	Between Level 1 and 2	As (16.2mg/kg, Level 1 Limit 9mg/kg)
BH10	0.5	Between Level 1 and 2	As (14.9mg/kg, Level 1 Limit 9mg/kg)
BH10	1.5	Between Level 1 and 2	As (14.6mg/kg, Level 1 Limit 9mg/kg), Cd (0.92mg/kg, Level 1 Limit 0.7mg/kg), Ni (38.8mg/kg, Level 1 Limit 21mg/kg)
BH10	2.5	Between Level 1 and 2	As (14.4mg/kg, Level 1 Limit 9mg/kg), Ni (30.5mg/kg, Level 1 Limit, 21mg/kg)

Note that all of the exceedances while above the Level 1 criteria are below the Level 2 criteria from the Marine Institute's Dumping at Sea criteria[40].

The sediments in this case fall within Class 1 (uncontaminated) (7 samples) with the remaining 8 no. samples falling within Class 2, marginally contaminated.

The lower limits for the criteria are defined based on a number of factors.

"Lower level guidance values represent concentrations that are either a) at the upper *end* of the no-effect range or *b) at* background concentrations. *Upper level guidance values are set at the lower end of the known range of effective concentrations i.e. lowest concentrations shown to have adverse effects on marine organisms."*

[40] Cronin, M., McGovern, E., McMahon, T. & R. Boelens (2006). Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters. Marine Institute.

It should be noted that one factor which is relevant to Arsenic (As) only is that included as a footnote to Table 1.2 in the report:

"In some locations natural levels of arsenic will exceed this value (70mg/kg)and in such instances this guidance value will not be appropriate."

While none of our results exceed the upper limit, there is an acknowledgement that naturally occurring elevated arsenic (As) does occur in Irish Waters. Furthermore the lower limits for As and Nickel (Ni) are stated to be based on the "Effects Range Lower" (ERL). This is defined as the concentration that is rarely associated with toxicity for marine and estuarine sediments. This concentration is adopted based on the fact that there is insufficient Irish background data available for these metals.

Taking that into account and noting the consistently elevated concentrations of As, we would propose that these values represent naturally occurring elevated concentrations of As. Similarly Copper (Cu) and Cadmium (Cd) are each present in one location and represent isolated occurrences. Additionally the Cadmium concentration, while above the Level 1 limit (which is based on background concentrations) is still below the ERL (1.2mg/kg) as described above.

On this basis, and considering that only a limited volume of material is proposed for excavation, of which almost half would be classed as uncontaminated, the overall impact from these sediments, where the detected contaminants most likely represent elevated background concentrations, is negligible.

As stated, the environmental testing undertaken indicates that the marine sediments are very slightly contaminated at relatively low levels for some specific parameters.

14.3.13 Conceptual Site Model

14.3.13.1 Introduction

A CSM was developed based on the data obtained during the intrusive investigations i.e. borehole and trial pit logs, geophysical surveys and groundwater monitoring data.

The CSM (Refer to **Figures 14.11A to 14.11F in Volume 3 and Appendix 14.7**) summarises the important geological and hydrogeological features in the study area.

14.3.13.2 Importance of Features

A summary of the geological and hydrogeological features of relevance within the study area is presented in Table 14.14. In addition, the importance ranking of the highlighted feature is established based on the IGI guidance[1].

A proposed Natural Heritage Area is present covering the marsh area to the north-west of Bridge Street (Refer to **Chapter 11** for further information).

Table 14.14: Summary of the geological and hydrogeological features of importance

Feature		**Importance ranking**	**Justification**
Aquifer	Arklow gravel aquifer	Medium	This is a high-quality aquifer with a localised extent.
	Locally important bedrock aquifer	Medium	This is a medium quality attribute and is important on a local scale.
SAC's	None noted in the study area	Negligible	None noted in the study area
pNHA	Arklow Marsh	High	Site is a pNHA. See **Chapter 11** for details
Abstractions	None noted in the study area	Negligible	None noted in the study area.
Contaminated land	WwTP site, made ground	High	Extent of contaminated soil is significant on a local scale. The WwTP site has a previous heavy industrial usage.
	Marine sediments at the mouth of the old Avoca River channel.	High	Potentially contaminated river sediment deposited on the sea bed. Extent of contaminated soil is significant on a local scale.
Marine Sediments	Proposed long and outfall and SWO (marine section)	Low	Volume of soft soils underlying the outfalls are low on a local scale
	Mobilisation of sediments into the water column through the outfall construction process.	Low	Attribute has a low-quality significance due to naturally occurring contamination.

14.3.13.3 Environment Type

The geological and hydrogeological environment at and in the vicinity of the study area includes an area of groundwater discharge to surface water and highly permeable soils. Consequently, the geological and hydrogeological environment is considered to be naturally dynamic (type B) as per the IGI guidelines[1].

14.3.13.4 Activities/Environment Matrix

Table 14.15 outlines the required activities that would be undertaken during construction and operation, and the investigations, assessments and surveys that have been carried out to consider those activities.

Table 14.15: Details of proposed works as per the IGI Guidelines[1] and how they were undertaken to support this EIAR

Work Required under Activity and Type Class (based on IGI Guidelines)	Details of works completed to date
Earthworks	
Invasive site works to characterise nature, thickness, and stratification of soils and subsoils	Site specific site investigation carried out across the study area.
Works to determine groundwater level, flow direction and gradient.	Manual and electronic groundwater monitoring and comparison with sea tide levels within the WwTP.
Works to determine groundwater-surface water interaction.	Collection of groundwater and surface water samples for water quality analysis within the WwTP.
Storage/ transmission of leachable and/or hazardous materials	
Establish nature and quantity of leachable materials.	Collection of soil samples. Analysis for quality, including WAC and waste classification screening.
Site works to characterise nature, thickness, permeability and stratification of soils, subsoils, bedrock geology.	Site specific site investigation carried out across the study area.
Works to determine groundwater level, flow direction and gradient.	Manual and electronic groundwater monitoring and comparison with sea tide levels within the WwTP.
Works to determine groundwater-surface water interaction.	Collection of groundwater and surface water samples for water quality analysis within the WwTP.
Lowering of groundwater levels by pumping or drainage	
Establish sustainable yield and proposed daily abstraction rate or drainage system invert level (as appropriate)	Dewatering system designed to accommodate extracted water volume.
Works to determine summer level of the water table. Annual actual recharge and proposed maximum drawdown.	Manual and electronic groundwater monitoring and comparison with sea tide levels within the WwTP.
Works to determine aquifer properties, seasonal variations in water levels, extents of cone of depression or drawdown of surrounding water levels (as appropriate) and alterations in groundwater flow pattern.	Manual and electronic groundwater monitoring and comparison with sea tide levels within the WwTP.
Excavation of materials above the water table	
Site works to characterise nature, thickness, permeability and stratification of soils, subsoils, bedrock geology.	Site specific site investigation carried out across the study area.
Works to determine groundwater level, flow direction and gradient.	Manual and electronic groundwater monitoring and comparison with sea tide levels within the WwTP.
Excavation of materials below the water table	

Work Required under Activity and Type Class (based on IGI Guidelines)	Details of works completed to date
Site works to characterise nature, thickness, permeability and stratification of soils, subsoils, bedrock geology.	Site specific site investigation carried out across the study area.

14.4 Likely Significant Effects

14.4.1 Do Nothing Scenario

14.4.1.1 Alps SWO and Storm Water Storage Tank and Interceptor Sewers

In accordance with EC Guidance[19] and after reviewing the baseline data, the 'do nothing' scenario (i.e. if nothing is done) will result in no effect on the land and soils. Also, this situation is not likely to change over time and the likely significant effect on the land and soils can be considered negligible.

14.4.2 Assessment of Effects during Construction

14.4.2.1 Proposed SWO and Stormwater Tank

The potential impacts of the proposed 'Alps' SWO and Stormwater Tank on the Geological Features identified are listed below and discussed in the following sections thereafter:

- Compression of substrata;
- Loss of grassland/made ground;
- Loss of solid geology;
- Earthworks haulage;
- Impact on surrounding ground.
- Excavation of Soft Soils
- Impact of dewatering
- Impact on Bedrock Aquifer
- Groundwater Level and Flow
- Water Level in the Avoca River
- Pollution from Construction Activities
- Impact on Water Quality

Compression of Substrata

Subsoils are likely to be removed to allow construction of the SWO and Stormwater Tank.

Construction may result in increased loading on the sandstone/shale which could affect the current characteristics of the ground. However, given the general nature of these rocks, the significance of this potential impact is deemed to be Imperceptible.

Loss of Grassland/Made ground

It is expected that much of the topsoil and overburden at the proposed 'Alps' SWO and Stormwater Storage Tank site will be excavated to allow for construction of the proposed works and hardstanding for vehicular access. During the storage and transport of excavated material off-site there is the potential for silt or mud to enter adjacent water courses. Given the relatively small quantity of topsoil and overburden which will be removed, it is not considered to be a resource of any regional significance.

The overburden material will generally be suitable for re-use as an engineered fill for other adjacent development schemes, where they are available and subject to appropriate approvals/notifications. Residual material will need to be removed off-site to a suitable facility. It is also anticipated that all of the excavated topsoil may be reused in landscaping throughout the site where possible. The significance of this potential impact is Imperceptible. See **Chapter 16** for details on resource and waste management.

Loss of Solid Geology

Excavation of rock will be required to construct the proposed SWO and Stormwater Tank. The excavated material may be reused elsewhere on the proposed development if it can be shown to economically fulfil an appropriate engineering specification, such as pipe bedding or capping material.

The quantity of rock which will be removed is small and this is considered to be a small adverse impact. It is also of low importance, and there are readily available alternative sources of similar bedrock available. Therefore, this has been described as having an Imperceptible impact upon the local environment.

Earthworks Haulage

During earthworks, heavily loaded large earthmoving vehicles will travel through the proposed storm water tank and SWO site, causing ground vibrations, unwanted compaction and disturbance of natural ground on unfinished road surfaces. This will also result in increased traffic on the roads to and from the proposed 'Alps' site. Increased noise, dust and vibration will also be generated.

Details in relation to the disposal of these soils is discussed in **Chapter 16**.

These works are expected to have a low importance given that the volume of the material for removal is low on a local scale. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is Imperceptible.

Impact on Surrounding Ground

Soil and rock excavation has the potential to induce movement and settlement of surrounding ground and the potential to impact on adjacent assets.

The breaking of the bedrock could result in ground vibrations and destabilisation of existing slopes and existing rock slopes, with impacts felt in the immediate vicinity of the works.

These works may also give rise to excessive noise and vibration impacts and may result in the generation of dust.

These works are expected to have a low importance given the soils in question are to be generally removed and the pipe and stormwater tank in question will lie on rock. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is imperceptible.

Excavation of Soft Soils

Limited soft soils will require excavation and replacement when encountered at the base of excavations for the proposed SWO and storm water tank. These are expected to be localised and minor in extent. Given the relatively small quantity of soils which will be removed, it is considered to be a small adverse impact that does not have any regional significance. The significance of the potential impact is Imperceptible.

Impact of Dewatering

Due to the relatively high-water table in the area (approximately 2m below ground level), dewatering works may be required. However, due to the likely relatively low permeability of the rock, limited pumping of water will be required. Dewatering is considered to be a small adverse impact and the significance of this impact is moderate/slight. Discharge from the dewatering process would be passed to a suitably sized settlement pond or a proprietary silt removal system located within the working area, before discharge to the Avoca River or the local sewer network. Any discharge to either sewer or watercourse would be subject to a discharge licence.

Impact on Bedrock Aquifer

Excavation of shale and sandstone bedrock is required to construct the Alps SWO and stormwater storage tank. This bedrock is classified as a Locally Important Aquifer which has a medium importance. However, due to the nature of the excavation, the magnitude of the impact of this activity would be small adverse. The significance of the potential impact is slight.

Groundwater Level and Flow

Groundwater dewatering using a series of sumps and submersible pumps is proposed during the construction of the SWO and stormwater tank. To reduce the amount of dewatering required at any given time, it is likely that any sewer works will be constructed in sections.

The construction of these works will have a negligible effect on the groundwater levels and flows in the sand and gravels which have a low importance. Hence, the magnitude of the impact of this activity would be negligible and the overall significance rating of the impact of groundwater levels and flow is imperceptible.

Water Level in the Avoca River

The Avoca River is in continuity with the groundwater in the sand and gravels throughout the study area and is likely to be at least partly dependent on water levels in the aquifer.

As limited dewatering is proposed as part of the construction of the SWO and stormwater tank as outlined above, the effect on groundwater levels in the aquifer and river water levels in the Avoca River during construction is negligible. The magnitude of the impact of this activity would be negligible and the overall significance rating of the impact on river water levels and flow is imperceptible.

Pollution from Construction Activities

The construction of the proposed SWO and stormwater tank will require the use of fuels and materials which will have the potential to pollute the site, and adjacent, environment. Good housekeeping will be carried out on the sites during construction, and the proper use, storage and disposal of all substances and their containers will help prevent soil contamination. Pollution from construction activities is considered to be a small adverse impact and the significance of this impact is moderate/slight.

Impact on Water Quality

No planned construction activities have the potential to impact on groundwater or surface water quality. The unplanned activities which may impact upon the groundwater quality beneath the proposed scheme during the construction phase are:

- Accidental spillages of polluting materials onsite;
- Release of fines into the groundwater and surface water; and
- The potential for contaminated runoff to enter the groundwater and surface water.

If any of these occur, they may potentially contaminate the groundwater beneath the proposed development and also impact the groundwater quality at receptors such as the Avoca River. These are potential short-term impacts. The magnitude and significance of these potential impacts on the receptors are summarised below:

- The magnitude of this potential impact on the sand and gravel aquifer could potentially be small adverse leading to a significance rating of slight;
- The magnitude of this potential impact on the River Avoca and the Irish Sea could potentially be small adverse leading to a significance rating of slight.
- The magnitude of this potential impact on the Locally Important aquifer could potentially be small adverse leading to a significance rating of slight.

Summary of Proposed SWO and Stormwater Tank Construction Impacts

Table 14.16 summarises the predicted impacts during this phase of construction.

Table 14.16: Summary of Impacts on Geological Attributes at the Proposed SWO and Stormwater Tank

Feature/	**Importance**		**Magnitude of Impact**		**Significance of Impact**
	Ranking	**Justification**	**Ranking**	**Justification**	
Compression of substrata	Low	Subsoils are likely to be removed. Increased loading on Sandstone/shale only	Small adverse	Removal of soils and replacement with structure and pipeline will not impact on the characteristics of the soils and rock.	Imperceptible
Loss of Grassland/Made ground and Overburden	Low	Small layer of well drained/high fertility soil (topsoil)	Small adverse	Loss of a small proportion of local high fertility soils	Imperceptible
Loss of solid geology	Low	Attribute has a low value on a local scale	Small adverse	Excavation of approx.5.5m of rock Loss of small proportion of future quarry reserves	Imperceptible
Earthworks haulage	Low	Volume of material for removal is low on a local scale	Small adverse	Limited excavation and disposal	Imperceptible
Impacts on surrounding ground	Low	Soils will be removed. Foundations on rock	Small adverse	Movements expected to be minimal due to underlying ground conditions	Imperceptible
Excavation of soft soils	Low	Volume of soft alluvial soil is small	Small adverse	Only a small proportion/if any of soft soils beneath the foundations will require excavation	Imperceptible
Impact of Dewatering	Medium	Volume of water to be pumped is small due to the relatively low permeability of the bedrock	Small adverse	Limited pumping of water required	Slight

Feature/	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Impact on Bedrock Aquifer	Medium	Locally important aquifer.	Small adverse	Excavation of small portion of locally important aquifer.	Slight
Impact on groundwater flow and groundwater levels in the aquifer	Low	Groundwater flow may be affected temporarily on a local scale.	Negligible	Pumping of groundwater will not have an impact on groundwater levels or flow.	Imperceptible
Impact on water levels in the Avoca River	Low	Groundwater flow may be affected on a small scale only.	Negligible	Groundwater and other sources will continue feeding the Avoca River.	Imperceptible
Pollution from construction activities	Medium	Potential pollution is low on a local scale	Small adverse	Limited construction traffic and construction activities	Slight

14.4.2.2 Southern Interceptor Sewer (MHS1 to MHS9)

Section 5.6.3 of Chapter 5 describes in detail the construction methodology for the proposed interceptor sewer routes. The construction impacts of the proposed interceptor sewer route on the Geological Attributes identified are listed below:

- Loss of topsoil and overburden;
- Loss of solid geology;
- Excavation of soft mineral soils beneath the route;
- Earthworks haulage;
- Impact on surrounding ground.
- Impact of dewatering; and
- Pollution from Construction Activities.

Loss of Topsoil and Overburden

It is expected that much of the topsoil and overburden from MHS1 to MHS9 will be excavated to allow for construction of the proposed sewer at this location. During the storage and transport of excavated material off-site there is the potential for silt or mud to enter adjacent water courses. Given the relatively small quantity of topsoil and overburden which will be removed, it is not considered to be a resource of any regional significance.

The overburden material will generally be suitable for re-use as an engineered fill for other adjacent development schemes, where they are available and subject to appropriate approvals/notifications. See **Chapter 16** for details on resource and waste management. Residual material will need to be removed off-site to a suitable facility. It is also anticipated that all of the excavated topsoil may be reused in landscaping throughout the site where possible. The significance of this potential impact is Imperceptible.

Loss of solid geology

Excavation of rock will be required to construct the interceptor sewer at the start of the alignment where the rock is shallow. The excavated material may be reused elsewhere on the development if it can be shown to economically fulfil an appropriate engineering specification, such as pipe bedding or capping material.

The quantity of rock which will be removed is small and this is considered to be a small adverse impact. It is also of low importance, and there are readily available alternative sources of similar bedrock available. Therefore, this has been described as having an Imperceptible impact upon the local environment.

Excavation of soft soils beneath the route

Limited soft soils will require excavation and replacement when encountered at the base of excavations for the proposed alignment. These are expected to be localised and minor in extent. Given the relatively small quantity of soils which will be removed, it is considered to be a small adverse impact that does not have any regional significance. The significance of the potential impact is Imperceptible.

Earthworks haulage

During earthworks construction, heavily loaded large earthmoving vehicles will travel to the interceptor sewer, causing ground vibrations, unwanted compaction and disturbance of natural ground on unfinished road surfaces. This will also result in increased traffic on the roads to and from the sewer alignment. Increased noise, dust and vibration will also be generated.

Details in relation to the disposal of these soils is discussed in **Chapter 16.**

These works are expected to have a low importance given the volume of the material for removal is low on a local scale. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is Imperceptible.

Impact on Surrounding Ground

Soil and rock excavation has the potential to induce movement and settlement of surrounding ground. The breaking of the bedrock could result in ground vibrations and destabilisation of existing slopes and existing rock slopes, with impacts felt in the immediate vicinity of the works.

These works may also give rise to excessive noise and vibration impacts and may result in the generation of dust.

At the start of the alignment these works are expected to have a low importance given the soils in question are generally removed and the pipe in question will lie on rock. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is imperceptible. From MHS5 to MHS9, the pipe in question will lie on some soft soils. Settlement is likely to be small since the soil (mainly sands to be excavated) will be replaced with fill with similar densities.

Impact of Dewatering

Due to the relatively high-water table in the area (approximately 2m below ground level), dewatering works may be required. To reduce the amount of dewatering required at any given time, it is likely that the contractor would construct the sewer in sections. Due to the nature of the weathered rock groundwater cut off would not be possible using trench boxes and would only be achieved if temporary sheet piles were employed on either side of the trench excavation. Dewatering is considered to be a small adverse impact and the significance of this impact is moderate/slight. Discharge from the dewatering process would be passed to a suitably sized settlement pond or a proprietary silt removal system located within the working area, before discharge to the Avoca River or the local sewer network. Any discharge to either sewer or watercourse would be subject to a discharge licence

Groundwater Level and Flow

Groundwater dewatering using a series of sumps and submersible pumps is proposed during the construction of the sewer. To reduce the amount of dewatering required at any given time, it is likely that the sewer will be constructed in sections.

The construction of the sewer will have a negligible effect on the groundwater levels and flows in the sand and gravels which have a low importance. Hence, the magnitude of the impact of this activity would be negligible and the overall significance rating of the impact on groundwater levels and flow is imperceptible.

Water Level in the Avoca River

The Avoca River is in continuity with the groundwater in the sand and gravels throughout the study area and is likely to be at least partly dependent on groundwater levels in the aquifer for baseflow. As limited dewatering is proposed as part of the construction of the sewer e as outlined above, the effect on groundwater levels in the aquifer and river water levels in the Avoca River during construction is negligible. The magnitude of the impact of this activity would be negligible and the overall significance rating of the impact on river water levels and flow is imperceptible.

Pollution from Construction Activities

The construction of the proposed development will require the use of fuels and materials which will have the potential to pollute the site, and adjacent, environment. Good housekeeping will be carried out on the site during construction, and the proper use, storage and disposal of all substances and their containers will help prevent soil contamination.

Pollution from construction activities is considered to be a small adverse impact and the significance of this impact is moderate/slight.

Impact on Water Quality

No planned construction activities have the potential to impact on groundwater or surface water quality. The unplanned activities which may impact upon the groundwater quality beneath the proposed scheme during the construction phase are:

- Accidental spillages of polluting materials onsite;
- Release of fines into the groundwater and surface water; and
- The potential for contaminated runoff to enter the groundwater and surface water.

If any of these occur, they may potentially contaminate the groundwater beneath the proposed development and also impact the groundwater quality at receptors such as the Avoca River. These are potential short-term impacts. The magnitude and significance of these potential impacts on the receptors are summarised below:

- The magnitude of this potential impact on the sand and gravel aquifer could potentially be small adverse leading to a significance rating of slight;
- The magnitude of this potential impact on the River Avoca and the Irish Sea could potentially be small adverse leading to a significance rating of slight.
- The magnitude of this potential impact on the Locally Important aquifer could potentially be small adverse leading to a significance rating of slight.

Summary of southern Interceptor Sewer (MHS1 to MHS9) Impacts

Table 14.17 summarises the predicted impacts during this phase of construction.

Table 14.17: Summary of Impacts on Geological Attributes at the proposed southern Interceptor Sewer (MHS1 to MHS9)

Feature/	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Loss of Topsoil and Overburden	Low	Small layer of well drained/high fertility soil (topsoil)	Small adverse	Loss of a small proportion of local high fertility soils	Imperceptible
Loss of solid geology	Low	Attribute has a low value on a local scale	Small adverse	Excavation of approx. 2m of rock at start of alignment	Imperceptible
Excavation of soft soils	Low	Volume of soft alluvial soil/peat is small	Small adverse	Only a small proportion/if any of soft soils beneath the foundations will	Imperceptible

Feature/	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
				require excavation	
Earthworks haulage	Low	Volume of material for removal is low on a local scale	Small adverse	Limited excavation and disposal	Imperceptible
Impacts on surrounding ground	Low	Soils will be under a similar loading after construction compared to existing loading	Small adverse	Movements expected to be minimal due to underlying ground conditions	Imperceptible
Impact of dewatering	Medium	Contractor likely to construct sewer in sections. If high volume of water to be pumped, temporary sheet piling to be used	Small adverse	Construction technique will mitigate pumping required	Slight
Impact on groundwater flow and groundwater levels in the aquifer	Low	Groundwater flow may be affected temporarily on a local scale.	Negligible	Pumping of groundwater will not have an impact on groundwater levels or flow.	Imperceptible
Impact on water levels in the Avoca River	Low	Groundwater flow may be affected on a small scale only.	Negligible	Groundwater and other sources will continue feeding the Avoca River.	Imperceptible
Pollution from Construction Activities	Medium	Potential pollution is low on a local scale	Small adverse	Limited construction traffic and construction activities	Slight

14.4.2.3 Southern Interceptor Sewer (Bridge Underpinning)

Section 5.6.3.5 outlines the construction methodology for the Arklow Bridge works. The proposed construction impacts of these underpinning works on the Geological Attributes identified are listed below:

- Infilling of river channel;
- Earthworks haulage;
- Impacts on surrounding ground
- Installing sheet piles
- Impact of dewatering; and

- Pollution from Construction Activities.

Infilling of river channel

To facilitate underpinning of Arklow Bridge, a temporary causeway is required to support construction activities. A small portion of the river channel therefore will be infilled with inert fill and compacted. The temporary causeway will be contained on the river side to mitigate siltation migration into the Avoca River. The two most likely methods to achieve this containment would either be an additional row of sheet piles on the river side of the causeway or alternatively a row of stone gabions wrapped in a geotextile membrane (see **Section 5.6.3 of Chapter 5**). It is possible that fill will be lost through the pile clutches.

Earthworks haulage

During earthworks construction, heavily loaded large earthmoving vehicles will travel to the bridge location, causing ground vibrations, unwanted compaction and disturbance of natural ground on unfinished road surfaces. This will also result in increased traffic on the roads to and from the sewer alignment. Increased noise, dust and vibration will also be generated.

Details in relation to the disposal of these soils are provided in **Chapter 16**.

These works are expected to have a low importance given the volume of the material for infilling is low on a local scale. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is Imperceptible.

Impacts on surrounding ground

Underpinning and infilling, will induce a larger stress on the existing ground which has the potential to induce movement and settlement of surrounding ground.

These works are expected to have a low importance given the underlying soils which are medium dense and dense sands and gravels. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is imperceptible.

Installing Sheet Piles

Once the temporary causeway is in place, the sheet pile wall would be formed by vibrating steel sheets into the ground and the sheet piles would be interlocked to provide continuity. Sheet piling could result in ground vibrations and destabilisation of existing slopes with impacts felt in the immediate vicinity of the works.

Impact of Dewatering

To provide groundwater cut off, the temporary sheet piles should extend into the underlying Cohesive Deposits. Once both lines of sheet piles are in place, the excavation would be dewatered. Limited dewatering will be required during construction due to groundwater cut off.

Discharge from the dewatering process would be passed to a suitably sized settlement pond or a proprietary silt removal system located within the working area, before discharge to the Avoca River or the local sewer network. Any discharge to either sewer or watercourse would be subject to a discharge licence

Groundwater Level and Flow

Groundwater dewatering using a series of sumps and submersible pumps is proposed during these works. To reduce the amount of dewatering required at any given time, it is likely that the sewer will be constructed in sections.

The construction of the pipeline will have a negligible effect on the groundwater levels and flows in the sand and gravels which have a low importance. Hence, magnitude of the impact of this activity would be negligible and the overall significance rating of the impact of groundwater levels and flow is imperceptible.

Water Level in the Avoca River

The Avoca River is in continuity with the groundwater in the sand and gravels for throughout the study area and is likely to be at least partly dependent on water levels in the aquifer. As limited dewatering is proposed as part of the construction works as outlined above, the effect on groundwater levels in the aquifer and river water levels in the Avoca River during construction is negligible. The magnitude of the impact of this activity would be negligible and the overall significance rating of the impact on river water levels and flow is imperceptible.

Pollution from Construction Activities

The construction of the proposed development will require the use of fuels and materials which will have the potential to pollute the site, and adjacent, environment. Good housekeeping will be carried out on the sites during construction, and the proper use, storage and disposal of all substances and their containers will help prevent soil contamination. Pollution from construction activities is considered to be a small adverse impact and the significance of this impact moderate/slight.

Summary of southern Interceptor Sewer (Bridge Underpinning) Impacts

Table 14.18 summarises the predicted impacts during this phase of construction.

Table 14.18: Summary of Impacts on Geological Attributes at the proposed southern Interceptor Sewer (Bridge Underpinning)

Feature/	**Importance**		**Magnitude of Impact**		**Significance of Impact**
	Ranking	**Justification**	**Ranking**	**Justification**	
Infilling of river channel	Low	Fill is inert. Escape of fill through pile clutches is likely to be small	Small adverse	Loss of a small proportion of fill through the pile clutches	Imperceptible
Earthworks haulage	Low	Volume of material for infilling is low on a local scale	Small adverse	Limited haulage of fill	Imperceptible

Feature/	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Impacts on surrounding ground	Low	Underlying soils are medium dense and dense sand and gravels	Small adverse	Movements expected to be minimal due to underlying ground conditions	Imperceptible
Installing sheet piles	Low	Slopes are shallow and underlying soils are medium dense and dense sand and gravels	Small adverse	Instability unlikely due to underlying soils	Imperceptible
Impact of dewatering	Medium	Temporary sheet piling to be used	Small adverse	Construction technique will mitigate pumping required	Slight
Impact on groundwater flow and groundwater levels in the aquifer	Low	Groundwater flow may be affected temporarily on a local scale.	Negligible	Pumping of groundwater will not have an impact on groundwater levels or flow.	Imperceptible
Impact on water levels in the Avoca River	Low	Groundwater flow may be affected on a small scale only.	Negligible	Groundwater and other sources will continue feeding the Avoca River.	Imperceptible
Pollution from Construction Activities	Medium	Potential pollution is low on a local scale	Small adverse	Limited construction traffic and construction activities	Slight

14.4.2.4 Southern Interceptor Sewer (MHS9 to TSS1)

Section 5.6.3 of Chapter 5 outlines the construction methodology for the interceptor sewer. The proposed construction impacts of the construction of this section of the alignment on the Geological Attributes identified are listed below:

- Infilling of river channel;
- Earthworks haulage;
- Impacts on surrounding ground
- Installing sheet piles
- Impact of dewatering; and
- Pollution from Construction Activities.

Infilling of river channel

To facilitate construction of the interceptor sewer in the river channel, a temporary causeway will be required to support construction activities. A small portion of the river channel therefore will be infilled with inert fill and compacted. The causeway would be contained on the river side to mitigate siltation migration into the Avoca River. The two most likely methods to achieve this containment would either be an additional row of sheet piles on the river side of the causeway or alternatively a row of stone gabions wrapped in a geotextile membrane (see **Section 5.6.3 of Chapter 5**). It is possible that fill will be lost through the pile clutches.

Earthworks haulage

During earthworks construction, heavily loaded large earthmoving vehicles will travel to the interceptor sewer, causing ground vibrations, unwanted compaction and disturbance of natural ground on unfinished road surfaces. This will also result in increased traffic on the roads to and from the sewer alignment. Increased noise, dust and vibration will also be generated.

Details in relation to the disposal of these soils are provided in **Chapter 16**.

These works are expected to have a low importance given the volume of the material for infilling is low on a local scale. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is Imperceptible.

Impacts on surrounding ground

Infilling, will induce a larger stress on the existing ground which has the potential to induce movement and settlement of surrounding ground.

These works are expected to have a low importance given the underlying soils which are medium dense and dense sands and gravels. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is imperceptible.

Installing Sheet Piles

Once the temporary causeway is in place, the sheet pile wall would be formed by vibrating steel sheets into the ground and the sheet piles would be interlocked to provide continuity. Sheet piling could result in ground vibrations and destabilisation of existing slopes with impacts felt in the immediate vicinity of the works.

Impact of Dewatering

To provide groundwater cut off, the temporary sheet piles should extend into the underlying Cohesive Deposits. Once both lines of sheet piles are in place, the excavation would be dewatered. Limited dewatering will be required during construction due to groundwater cut off. Discharge from the dewatering process would be passed to a suitably sized settlement pond or a proprietary silt removal system located within the working area, before discharge to the Avoca River or the local sewer network. Any discharge to either sewer or watercourse would be subject to a discharge licence

Groundwater Level and Flow

Groundwater dewatering using a series of sumps and submersible pumps is proposed during the construction of the sewer. To reduce the amount of dewatering required at any given time, it is likely that the sewer will be constructed in sections.

The construction of the sewer will have a negligible effect on the groundwater levels and flows in the sand and gravels which have a low importance. Hence, the magnitude of the impact of this activity would be negligible and the overall significance rating of the impact on groundwater levels and flow is imperceptible.

Water Level in the Avoca River

The Avoca River is in continuity with the groundwater in the sand and gravels throughout the study area and is likely to be at least partly dependent on water levels in the aquifer. As limited dewatering is proposed as part of the construction of the sewer pipe as outlined above, the effect on groundwater levels in the aquifer and river water levels in the Avoca River during construction is negligible. The magnitude of the impact of this activity would be negligible and the overall significance rating of the impact on river water levels and flow is imperceptible.

Pollution from Construction Activities

The construction of the proposed development will require the use of fuels and materials which will have the potential to pollute the site, and adjacent, environment. Good housekeeping will be carried out on the sites during construction, and the proper use, storage and disposal of all substances and their containers will help prevent soil contamination. Pollution from construction activities is considered to be a small adverse impact and the significance of this impact moderate/slight.

Summary of southern Interceptor Sewer (MHS9 to TSS1) Impacts

Table 14.19 summarises the predicted impacts during this phase of construction.

Table 14.19: Summary of Impacts on Geological Attributes at the proposed southern Interceptor Sewer (MHS9 to TSS1)

Feature/	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Infilling of river channel	Low	Fill is inert. Escape of fill through pile clutches is likely to be small	Small adverse	Loss of a small proportion of fill through the pile clutches	Imperceptible
Earthworks haulage	Low	Volume of material for infilling is low on a local scale	Small adverse	Limited haulage of fill	Imperceptible

Feature/	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Impacts on surrounding ground	Low	Underlying soils are medium dense and dense sand and gravels	Small adverse	Movements expected to be minimal due to underlying ground conditions	Imperceptible
Installing sheet piles	Low	Slopes are shallow and underlying soils are medium dense and dense sand and gravels	Small adverse	Instability unlikely due to underlying soils	Imperceptible
Impact of dewatering	Medium	Temporary sheet piling to be used	Small adverse	Construction technique will mitigate pumping required	Slight
Impact on groundwater flow and groundwater levels in the aquifer	Low	Groundwater flow may be affected temporarily on a local scale.	Negligible	Pumping of groundwater will not have an impact on groundwater levels or flow.	Imperceptible
Impact on water levels in the Avoca River	Low	Groundwater flow may be affected on a small scale only.	Negligible	Groundwater and other sources will continue feeding the Avoca River.	Imperceptible
Pollution from Construction Activities	Medium	Potential pollution is low on a local scale	Small adverse	Limited construction traffic and construction activities	Slight

14.4.2.5 Southern Interceptor Sewer (TSS1 to TSS3), Northern Interceptor and River Crossing

Section 5.6 of Chapter 5 outlines the construction methodology for the proposed interceptor sewer route. Tunnelling techniques will be used to install the interceptor sewer on South Quay (between TSS1 and TSS3), the river crossing and the entire North Quay interceptor sewer (between TSN1 and TSN8).

The construction impacts of these sections on the Geological Attributes identified are listed below:

- Earthworks haulage;
- Ground movements of overlying soils/sediments; and
- Pollution from Construction Activities.

Earthworks haulage

During earthworks construction, heavily loaded large earthmoving vehicles will travel to the interceptor sewer, causing ground vibrations, unwanted compaction and disturbance of natural ground on unfinished road surfaces. This will also result in increased traffic on the roads to and from the sewer alignment. Increased noise, dust and vibration will also be generated.

Details in relation to the disposal of these soils are provided in **Chapter 16**.

These works are expected to have a low importance given the volume of the material is low on a local scale. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is Imperceptible.

Ground movements of overlying soils/sediments

Tunnelling works have the potential to cause disturbance of the watercourses due to either ground movements in the overlying sediments and/or release of tunnelling slurry into the water course during tunnelling works. Given the sensitive nature of the environment, this is considered as having a high importance, but given the nature of the ground conditions and the proposed construction methods (see **Section 5.6.3.4 of Chapter 5**), it is classified as having a small adverse impact. The overall impact would be described as Slight.

Pollution from Construction Activities

The construction of the proposed development will require the use of fuels and materials which will have the potential to pollute the site, and adjacent, environment. Good housekeeping will be carried out on the site during construction, and the proper use, storage and disposal of all substances and their containers will help prevent soil contamination. Pollution from construction activities is considered to be a small adverse impact and the significance of this impact moderate/slight.

Summary of southern Interceptor Sewer (TSS1 to TSS3), northern Interceptor Sewer and river crossing Impacts

Table 14.20 summarises the predicted impacts during this phase of construction

Table 14.20: Summary of Impacts on Geological Attributes at the southern Interceptor Sewer (TSS1 to TSS3), northern Interceptor Sewer and river crossing

Feature/	**Importance**		**Magnitude of Impact**		**Significance of Impact**
	Ranking	**Justification**	**Ranking**	**Justification**	
Earthworks haulage	Low	Volume of material for removal is low on a local scale	Small adverse	Limited excavation and disposal. Excavation footprint minimised through construction practise	Imperceptible

Feature/	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Ground movements of overlying soils/sediments	Low	Volume of material excavated is low	Small adverse	Movements expected to be minimal due to construction technique being used	Imperceptible
Pollution from Construction Activities	Medium	Potential pollution is low on a local scale	Small adverse	Limited construction traffic and construction activities	Slight

WwTP and Revetment

The likely significant effects of the construction of the proposed WwTP and revetment on land and soils are listed below and described in the following sections:

- Compression of substrata;
- Removal of contaminated soils;
- Groundwater quality;
- Groundwater flow; and
- Ground Movements.

Compression of Substrata

During earthworks, upgrading of the revetment and groundwater treatment, heavily loaded HGVs would travel through the WwTP site potentially generating ground vibration, unwanted compaction and disturbance of natural ground on unfinished road surfaces. Construction traffic may therefore result in increased loading on underlying soils which could affect the current characteristics of the ground by compressing substrata.

Given the nature of the soils and the site history of industrial use, the effect would be negligible, therefore the impact is deemed to be imperceptible and thus not significant during construction.

Removal of Contaminated Soils

The excavation on the WwTP site and removal of soils unsuitable for reuse or retention on site would be of low importance given the volume of the material that would be removed is low on a local scale. Further, where possible suitable material would be retained within the proposed development.

The removal of soils unsuitable for reuse or retention on site would be a small adverse effect, therefore this impact is deemed to be imperceptible during construction.

Groundwater Quality

Contaminated groundwater would be generated during excavation and removed from the excavated areas and either transported off site to a suitably licensed facility or stored and treated on site before disposal off site. Any groundwater removed from the excavated area would be required to undergo treatment given the background concentrations as described in **Section 14.3.12.11**. Groundwater would generally not be treated unless encountered during dewatering that would be required as part of the excavation activities. The volume of water requiring treatment will depend on the extent of the excavations requiring dewatering.

The removal and treatment of groundwater during dewatering and excavation would be negligible impact and the effect is deemed to be imperceptible during construction.

Refer to **Section 15.4 of Chapter 15** for further detail on the likely significant effects of the proposed development on surface water quality.

Groundwater Flow

During excavation, groundwater would be managed by dewatering the sands and gravels around the excavation area. Temporary construction methods such as sheet piles or other methods will be used to minimise water ingress into excavations. Limited pumping may be required to manage seepage, basal flow and rainfall into the excavated area. This may cause a cone of depression and redirect groundwater flow on a local scale.

The potential to influence groundwater flow would be negligible impact, therefore this effect is deemed to be imperceptible during construction.

Ground Movements

The excavation and dewatering activities generate the potential to induce ground movements and potentially settlement adjacent to excavations and dewatering operations across the study area. However this would be typical of a development of this scale and would be considered as standard for these types of works.

The potential to induce movement and settlement would be of low importance given the limited area to be excavated and the provision of appropriate temporary support measures, including but not limited to sheet piling. The potential to induce movement and settlement would be small adverse and this effect is deemed to be Slight.

Summary of Proposed WwTP and Revetment Impacts

Table 14.21 summarises the predicted impacts during this phase of construction

Table 14.21: Impacts on geological and hydrogeological attributes for the Proposed WwTP site.

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Compression of substrata	Low	Site history of industrial use.	Negligible	Removal of soils and replacement with structure will not impact on the characteristics of the soils.	Imperceptible
Removal of contaminated soils	Medium	Volume of material for removal is low on a local scale. Material will be retained on site where possible.	Negligible	Removal of contaminated soils on a local level. However, this may positively impact on the characteristics of the natural soils and groundwater.	Imperceptible
Impact on groundwater quality	Low	Volume of groundwater removed will be minor.	Negligible	Dewatering will be managed and pumped water will be treated if necessary prior to discharge or disposal off site under licence	Imperceptible
Impact on groundwater flow	Low	Groundwater flow may be affected on a small scale only.	Negligible	Pumping of groundwater will not have an impact due to the tidal influence on groundwater levels.	Imperceptible
Impacts on surrounding ground	Medium	Excavated area supported by temporary works such as but not limited to sheet piling.	Small Adverse	Movements expected to be minimal due to temporary works / support structure.	Slight

14.4.2.6 Long Sea Oufall and SWO at WwTP

Compression of Substrata

During construction of the long sea outfall and SWO, heavily loaded HGVs would travel through the WwTP site, potentially causing ground vibrations, unwanted compaction and disturbance of natural ground. Construction traffic may therefore result in increased loading on underlying soils which could affect the current characteristics of the ground by compressing substrata.

These works are expected to have a low importance given the volume of the material for removal is low on a local scale. The magnitude of the impact of this activity would be small adverse. The significance of the potential impact is Imperceptible.

Ground Movements

Soil excavation and/or the construction of the long sea outfall via tunnelling methods (using methods such as HDD) have the potential to induce movement and settlement of surrounding ground.

The potential to induce movement and settlement would be of low importance. Through the implementation of appropriate design and best practice construction methods, the potential to induce movement and settlement is deemed to be small adverse and thus the effect is Imperceptible during construction.

Mobilisation of Contaminated Sediment

Given the background concentrations as described in detail in **Section 14.3.12.11**, there is the possibility that contaminated sediments may be excavated during the construction of the long sea outfall.

This is considered as having a low importance as there are no ecologically designated sites in the immediate vicinity and the potential effects of the construction of the outfall on coastal processes (see **Chapter 15** and **Appendix 15.5**) are deemed not be significant. Two pNHA's are present nearby, one relating to Arklow Town Marsh (001931), which is upstream from the site of the outfall and the other relating to Arklow Sand Dunes to the north of the site. Given the nature of the ground conditions and the proposed construction methods, the potential to mobilise suspected contaminated sediment is deemed to be negligible and thus the effect is Imperceptible during construction.

Summary of Outfall and WwTP SWO Impacts

Table 14.22 summarises the likely impacts during this phase of construction.

Table 14.22: Impacts on geological and hydrogeological attributes for the Proposed Outfall and SWO (Marine Section)

Feature	**Importance**		**Magnitude of Impact**		**Significance of Impact**
	Ranking	**Justification**	**Ranking**	**Justification**	
Earthworks haulage	Low	Volume of material requiring excavation and removal off-site is small.	Small adverse	Excavation footprint minimised through construction practices.	Imperceptible
Impacts on surrounding ground	Low	Soils are generally sand and gravels or glacial tills.	Small adverse	Tunnelling through sand and gravel and/or glacial tills would not result in substantial ground movements.	Imperceptible
Mobilisation of suspected contaminated sediments during excavation	Low	Suspected locally contaminated seabed sediments.	Negligible	Based on ground conditions and testing results, there should be limited mobilisation of those sediments.	Imperceptible

14.4.3 Assessment of Effects during Operation

The operational phase of the proposed development will have an overall neutral long-term impact on land and soils.

The potential impacts on land and soils during the operational phase will be limited to accidental spillage of potentially polluting substances including fuel, oils, paints, incoming wastes and raw materials. All potential impacts on land and soils from the operation of the proposed development will be of Slight significance.

The pipes and tanks will convey and store wastewater and storm water which are potentially polluting. The pipes and tanks will be constructed in accordance with best practice measures and constructed with appropriate engineering supervision. Consequently, the risk of a leak from the sewers or tanks impacting on groundwater quality is considered to be negligible and the magnitude of the impacts on the aquifers will be Imperceptible.

The sewer pipes and associated shafts will comprise relatively small features within the bedrock and sand and gravel aquifers. In addition, the pipe is orientated generally normal to the groundwater flow direction in both aquifers and will therefore only present a small surface area (the diameter of the pipe) which groundwater would need to flow around.

Hence the operation of the interceptor sewer network will have a negligible impact on groundwater flows in both aquifers and a significance rating of Imperceptible for all receptors identified in Table 14.14.

Flow in the bedrock aquifer is facilitated by the natural connectivity of the fracture network. The fracture network provides pathways around the underground storage tanks and will not cause groundwater to rise at the location. As the storage tanks will cause groundwater to flow around them they have a permanent localised small adverse impact. Hence, the significance of the impact on groundwater flow will be Slight.

The proposed development will convey and store wastewater and storm water that are potentially polluting. The proposed development will be constructed in accordance with the relevant design standards by means of best practice measures under appropriate engineering supervision. All subsurface structures will also be lined with impermeable concrete.

Consequently, the risk of a leak from the proposed development impacting on soils, geology and hydrogeology is considered to be low. As such, effects on soils, geology and hydrogeology will be negligible and the effect of the proposed development is considered to be Imperceptible during operation.

14.5 Mitigation Measures and Monitoring

14.5.1 Mitigation

14.5.1.1 Mitigation During Construction

General

As outlined in **Section 5.8 of Chapter 5** and in the Outline CEMP (Refer to **Appendix 5.1**), the adopted construction techniques will comply with the requirements of statutory bodies (Building Control Amendment Regulations, Health Service Executive inspections, Irish Water inspections and compliance with Employers Requirements).

Precautionary measures will be taken to contain any areas within the planning boundary at risk of contaminated run-off in addition to the following:

- Potential pollutants shall be adequately secured against vandalism and will be provided with proper containment according to the relevant codes of practice. Any spillages will be immediately contained and contaminated soil shall be removed from the proposed development and properly disposed of in an appropriately licensed facility.
- Dust generation shall be kept to a minimum through the wetting down of haul roads as required and other dust suppression measures.
- Any stockpiles of earthworks and site clearance material shall be stored on impermeable surfaces and covered with appropriate materials.

- Silt traps shall be placed in gullies to capture any excess silt in the run-off from working areas.
- Soil and water pollution will be minimised by the implementation of good housekeeping (daily site clean-ups, use of disposal bins, etc.) and the proper use, storage and disposal of these substances and their containers as well as good construction practices as described in **Section 5.8 of Chapter 5** Construction Strategy, **Appendix 5.1** as well as the CIRIA guidance[41].
- A contingency plan for pollution emergencies will also be developed by the contractor prior to the commencement of the works and regularly updated during construction. This contingency plan will identify the actions to be taken in the event of a pollution incident in accordance with the CIRIA guidance[41] which requires the following to be addressed:
  - Containment measures;
  - Emergency discharge routes;
  - List of appropriate equipment and clean-up materials;
  - Maintenance schedule for equipment;
  - Details of trained staff, location and provision for 24-hour cover;
  - Details of staff responsibilities;
  - Notification procedures to inform the EPA or Environmental Department of the Wicklow County Council;
  - Audit and review schedule;
  - Telephone numbers of statutory water consultees; and
  - List of specialist pollution clean-up companies and their telephone numbers.

Alps SWO and Stormwater Tank

Compression of Substrata

- Excavations shall be kept to a minimum, using shoring or trench boxes where appropriate. For more extensive excavations, a temporary works designer shall be appointed to design excavation support measures in accordance with all relevant guidelines and standards.

Loss of grassland/made ground and solid geology

- All excavated material will, where possible, be reused as construction fill. The appointed contractor will ensure acceptability of the material for reuse for the proposed development with appropriate handling, processing and segregation of the material.

[41] Masters – Williams et al (2001) Control and management of water pollution from construction sites in their publication Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors

This material would have to be shown to be suitable for such use and subject to appropriate control and testing according to the Earthworks Specification(s).

- These excavated soil materials will be stockpiled using an appropriate method to minimise the impacts of weathering. Care will be taken in reworking this material to minimise dust generation, groundwater infiltration and generation of runoff. Any surplus suitable material excavated that is not required elsewhere for the proposed development, shall be used for other projects where possible, subject to appropriate approvals/notifications.

Earthworks Haulage

- Earthworks haulage will be along agreed predetermined routes along existing national, regional and local routes. Where compaction occurs due to truck movements and other construction activities on unfinished surfaces, remediation works will be undertaken to reinstate the ground to its original condition. Where practicable, compaction of any soil or subsoil which is to remain in situ along the sites will be avoided.
- Earthworks operations shall be carried out such that surfaces shall be designed with adequate falls, profiling and drainage to promote safe runoff and prevent ponding and flooding. Runoff will be controlled through erosion and sediment control structures appropriate to minimise the water impacts in outfall areas. Care will be taken to ensure that the bank surfaces are stable to minimise erosion.

Impact of Surrounding Ground

- Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations.
- Ground settlements will be controlled through the selection of a foundation type and method of construction which are suitable for the particular ground conditions.

Impact of Dewatering

- To reduce the amount of dewatering required at any given time, it is likely that the contractor would construct the sewer in sections. Discharge from the dewatering process would be passed to a suitably sized settlement pond or a proprietary silt removal system located within the working area where possible, before discharge to the Avoca River or the local sewer network. Any discharge to either sewer or watercourse would be subject to a WWDA.

Interceptor Sewers

Loss of topsoil/overburden and solid geology

- All excavated material will, where possible, be reused as construction fill. The appointed contractor will ensure acceptability of the material for reuse for the proposed development with appropriate handling, processing and segregation of the material.

This material would have to be shown to be suitable for such use and subject to appropriate control and testing according to the Earthworks Specification(s). These excavated soil materials will be stockpiled located within the working area where possible, using an appropriate method to minimise the impacts of weathering. Care will be taken in reworking this material to minimise dust generation, groundwater infiltration and generation of runoff. Any surplus suitable material excavated that is not required elsewhere for the proposed development shall be used for other projects where possible, subject to appropriate approvals/notifications.

Earthworks Haulage

- Earthworks haulage will be along agreed predetermined routes along existing national, regional and local routes. Where compaction occurs due to truck movements and other construction activities on unfinished surfaces, remediation works will be undertaken to reinstate the ground to its original condition. Where practicable, compaction of any soil or subsoil which is to remain in situ along the sites will be avoided.
- Earthworks operations shall be carried out such that surfaces shall be designed with adequate falls, profiling and drainage to promote safe runoff and prevent ponding and flooding. Runoff will be controlled through erosion and sediment control structures appropriate to minimise the water impacts in outfall areas. Care will be taken to ensure that the bank surfaces are stable to minimise erosion.

Impact of Surrounding Ground

- Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations. Monitoring will be more rigorous at Arklow bridge as it is a protected structure. This will include more frequent monitoring and more monitoring points. Monitoring points will be located on the face of the bridge piers and centred every 1m or at least one monitoring point for each phase in the underpinning procedure. Horizontal, vertical and rotational displacement in all directions will be monitored.
- Ground settlements will be controlled through the selection of a foundation type and method of construction which are suitable for the particular ground conditions

Impact of Dewatering

- To reduce the amount of dewatering required at any given time, it is likely that the contractor would construct the sewer in sections. Discharge from the dewatering process would be passed to a suitably sized settlement pond or a proprietary silt removal system located within the working area, before discharge to the Avoca River or the local sewer network. Any discharge to either sewer or watercourse would be subject to a EEDA.

Infilling of river channel and installing sheet piles:

- The causeway would be contained on the river side to mitigate against siltation migration into the Avoca River. The two most likely methods to achieve this containment would either be an additional row of sheet piles on the river side of the causeway or alternatively a row of stone gabions wrapped in a geotextile membrane. Either method would require that the containing material (i.e. the sheet piles or the gabion walls) are extended (i.e. to a height above the surface of the causeway) to be effective. The infilling will produce a favourable lateral force on the existing quay wall but an unfavourable lateral force on the sheet piles. Horizontal movement monitoring of the sheet piles will be implemented during construction activities to ensure that the movement does not exceed the design limitations.

WwTP and Revetment

Compression of substrata:

- Excavations and therefore the transport of soils across the site shall be kept to a minimum, using shoring or trench boxes where appropriate. For more extensive excavations, a temporary works designer shall be appointed to design excavation support measures in accordance with all relevant guidelines and standards.
- It should be noted that both the excavation and import of materials will be required for construction of the revetment.

Removal of contaminated soils:

- Excavations in made ground for the WwTP and the revetment will be monitored by an appropriately qualified person to ensure that any spots of contamination (such as nitrocellulose or asbestos) encountered are identified, segregated and stored in an area where there is no possibility of runoff generation or infiltration to ground or surface water drainage. Care will be taken to ensure no cross-contamination with clean soils elsewhere throughout the site.

Groundwater quality:

- Excavated contaminated soils will be segregated and stored in an area where there is no possibility of runoff generation or infiltration to ground or surface water drainage. Care will be taken to ensure no cross-contamination with clean soils elsewhere throughout the site.

Groundwater flow:

- Dewatering will be required for the construction of the WwTP. Discharge volumes could be up to 250m^3/day and would be passed to a suitably sized settlement pond or a propriety silt removal system, along with any other treatment as required by WCC before discharge to the Avoca River or the local sewer network. This will most likely include treatment to remove elevated heavy metals which were noted during the ground investigation. Any discharge to either sewer or watercourse would be subject to a WWDA.

Impact on surrounding ground:

- Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations.
- Ground settlements will be controlled through the selection of a foundation type and construction methods which are suitable for the particular ground conditions. See **Sections 5.6.4 and Section 5.6.6 in Chapter 5** for details.

Earthworks haulage:

- All excavated material will, where possible, be reused as construction fill. The appointed contractor will ensure acceptability of the material for reuse for the proposed development with appropriate handling, processing and segregation of the material. This material would have to be shown to be suitable for such use and subject to appropriate control and testing according to the Earthworks Specification(s). These excavated soil materials will be stockpiled using an appropriate method to minimise the impacts of weathering. Care will be taken in reworking this material to minimise dust generation, groundwater infiltration and generation of runoff. Any surplus suitable material excavated that is not required elsewhere for the proposed development shall be used for other projects where possible, subject to appropriate approvals/notifications.
- Where compaction occurs due to truck movements and other construction activities on unfinished surfaces, remediation works will be undertaken to reinstate the ground to its original condition. Where practicable, compaction of any soil or subsoil which is to remain in situ along the sites will be avoided.
- Earthworks operations shall be carried out such that surfaces shall be designed with adequate falls, profiling and drainage to promote safe runoff and prevent ponding and flooding. Runoff will be controlled through erosion and sediment control structures appropriate to minimise the water impacts in outfall areas. Care will be taken to ensure that the bank surfaces are stable to minimise erosion.

Outfalls (Long Sea outfall and SWO at WwTP)

Compression of Substrata and Ground Movements:

- Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations.
- Ground settlements will be controlled through the selection of methods of construction as outlined in **Section 5.6.5 of Chapter 5** which are suitable for the particular ground conditions.

Mobilisation of contaminated sediment:

- Based on ground conditions and construction methods, there should be limited mobilisation of those sediments.

- Best practice guidelines[42] will be adhered to as a minimum for any dredging exercises to be carried out. Measures to minimise disruption to the seabed and mobilisation of sediments will be applied and seabed conditions will be taken into account when selecting construction methods.

14.5.1.2 Mitigation During Operation

No mitigation has been proposed with respect to effects from operation of the proposed development in relation to land and soils.

14.5.2 Monitoring

14.5.2.1 Monitoring During Construction

Excavations in made ground will be monitored by an appropriately qualified person to ensure that any contaminated material is identified, segregated and disposed of appropriately. Any identified hotspots shall be segregated and stored in an area where there is no possibility of runoff generation or infiltration to ground or surface water drainage. Care will be taken to ensure that the hotspot does not cross-contaminate clean soils elsewhere.

Any excavation shall be monitored during earthworks to ensure the stability of side slopes and to ensure that the soils excavated for disposal are consistent with the descriptions and classifications according to the waste acceptance criteria testing carried out as part of the site investigations.

Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations. Monitoring will be more rigorous at Arklow bridge as it is a protected structure. This will include more frequent monitoring and more monitoring points. Monitoring points will be located on the face of the bridge piers and centred every 1m or at least one monitoring point for each phase in the underpinning procedure. Horizontal, vertical and rotational displacement in all directions will be monitored.

The construction of the offshore elements shall follow international best practice in regard to the management of the trenching / excavations, the stability of the excavation/trenched area and the disposal of any spoil generated from either the excavation or the tunnelling and/or horizontal directional drilling works.

Movement monitoring shall be carried out during any activities which may result in ground movements or movements of any nearby structures.

Water quality monitoring will be carried out at all discharge points as per the requirements of the issued WWDA.

[42] British Standards (2016) BS6349-5 - Maritime works – Part 5: Code of practice for dredging and land reclamation

14.5.2.2 Monitoring During Operation

Ongoing monitoring of the infrastructure for leaks shall be carried out during operation. If leaks are detected, the system should include measures for the management of any resulting contamination of the surrounding soils.

14.6 Residual Effects

With the implementation of the proposed mitigation measures and monitoring, the effect of the proposed development on land and soils is considered to be of negligible magnitude and imperceptible significance during construction and operation.

No residual effects of significance on land and soils have been identified.

14.7 References

An Foras Talúntais (1978). Ireland: Peatland Map. An Foras Talúntais, Dublin;

Apex Geoservices (2017). Report on the Geophysical Investigation for the Marine Outfall Pipeline, Arklow Waste Water Treatment Plant for Byrne Looby Arup. AGL16077_01

Arup (2018). Arklow Waste Water Treatment Plant, Preliminary Site Assessment. 247825_PSA_31-07-2017

Arup (2018). Arklow Waste Water Treatment Plant, Detailed Site Assessment for the Wastewater Treatment Plant. 247825-00_13-03-2018-DSA

Bing Maps (2018). Aerial photography. Available at: https://www.bing.com/maps, Accessed 18-07-2018;

British Geological Survey (BGS) (2018). Offshore Bedrock Map, 1:250,000. Available at: http://www.maremap.ac.uk/view/search/searchMaps.html, Accessed 18-07-18;

British Standards (2015). Code of practice for ground investigations. BS5930:2015. 4th Ed. ISBN: 978 0 580 80062 7

Causeway Goetech (2017). Arklow Sewerage Scheme – Marine Outfall Site Investigation. Report No. 17-0167.

Causeway Geotech (2018). Arklow WwTP Land – Ground Investigation. Report No. 17-1455.

Department of Communications, Climate Action and the Environment (2018). INFOMAR Seabed Mapping. Available at: https://jetstream.gsi.ie/iwdds/delivery/INFOMAR_VIEWER/index.html, Accessed 18-07-18;

Department of Communications, Energy and Natural Resources (2011). State Mining and Prospecting Facilities. Available at:

http://www.mineralsireland.ie/files/Competition_Booklet_May2011_web.pdf, Accessed 18-07-18;

EPA (2018). Corine Land Cover 2012 datasets. Available at: https://gis.epa.ie/EPAMaps, Accessed 18-07-18;

EPA (2018). DaS Permits, Dumping at Sea Search, Dumping at Sea, Water & Waste Water, Licensing and Permitting. Available at: http://www.epa.ie/terminalfour/DaS/DaS-search.jsp?status=%25&county=Wicklow&Submit=Search+by+Combination, Accessed: 16/08/2018

EPA (2018). EPA Maps, Environment and Wellbeing, Clean Water and Health. Available from: https://gis.epa.ie/EPAMaps/, Accessed 18-07-18

EPA (2018). EPA Maps, Water, Water Framework Directive. Available from: https://gis.epa.ie/EPAMaps/, Accessed 18-07-18

EPA (2018). Office of Licencing and Guidance. Available at: https://gis.epa.ie/EPAMaps, Accessed 18-07-18.

EPA (2013). Guidance on the management of Contaminated Land and Groundwater at EPA licensed sites. ISBN: 978-1-84095-511-8. Available at: https://www.epa.ie/pubs/advice/waste/contaminatedland/contaminatedland/Guidance_on_the_Management_of_Contaminated_Land_and_Groundwater_at_EPA_Licensed_Sites_FINAL.pdf

GSI (2018). Groundwater Data Viewer. Available from: http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228, Accessed 18-07-18

GSI (2018). Geological maps of the site area produced by the Geological Survey of Ireland. Available at: http://map.geohive.ie/mapviewer.html, Accessed 18-07-2018

GSI (2014). Directory of Active Quarries and Pits in Ireland. 4th Ed. ISBN 189970265-2. Database available at: http://map.geohive.ie/mapviewer.html, Accessed 18-07-2018

GSI (2003). Wicklow GWB: Summary of Initial Characterisation. Groundwater Bodies. Available at: https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/activities/understanding-ireland-groundwater/Pages/Groundwater-bodies.aspx, Accessed 18-07-18

Google Maps (2018). Aerial photography. Available at: https://www.google.ie/maps/, Accessed 18-07-2018;

Institute of Geologists of Ireland, 2013. Guidelines for the Preparation of Soil, Geology and Hydrogeology Chapters of Environmental Impact Statements.

Irish Statute Book (1992). Environmental Protection Agency Act, 1992. Available from: http://www.irishstatutebook.ie/eli/1992/act/7/enacted/en/print#sec2, Accessed 16/08/2018

Minerex Geophysics Limited (2016). Geophysical Survey. Site at Ferrybank, Arklow, County Wicklow. MGX File Ref: 6049d-005.doc

Murphy Surveys (2016). Arklow SS Topo Survey. Drawing Nos. MSL15547-T_0 scale 1:1000 @ A1 and MSL15547-T_1 to MSL15547-T_4 scale 1:250 @A1.

Murphy Surveys (2018). Survey Old Wallboard Factory Site North Quay Arklow. Drawing No. MSL24433_T_Rev1_0 to MSL24433_T_Rev1_4, Scale 1:250 @A1 and Drawing No. MSL24433_KP, MSL24433_XS_01 to MSL24433_XS_03, Scale 1:500 @A1.

National Parks and Wildlife Service (2018). Proposed / Designated NHA, SPA, SAC Sites. Available at: http://webgis.npws.ie/npwsviewer/, Accessed 18-07-18.

NRA (2008). Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes. Available at: http://www.tii.ie/technical-services/environment/planning/Guidelines-on-Procedures-for-Assessment-and-Treatment-of-Geology-Hydrology-and-Hydrogeology-for-National-Road-Schemes.pdf

NSS of Ireland (1980) Soil Associations of Ireland and Their Land Use Potential.

Tobin Consulting Engineers (2005). Site Investigation Programme for Foundi Limited, c/o ID Partnership Ireland Ltd. At IFI Tank Farm, Arklow, County Wicklow.

UK Hydrographic Office (1999). Republic of Ireland – East Coast. Arklow to the Skerries Islands. Scale: 1:100000 at lat 15°30'. Sheet no. 1468. 3rd Ed.

Water Framework Directive (WFD) Ireland (2018). Water Maps. Available at: http://watermaps.wfdireland.ie/NsShare_Web/Viewer.aspx?Site=NsShare&ReloadKey=True, Accessed 18-07-18