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MONA OFFSHORE WIND PROJECT

Environmental Statement

Volume 3, Chapter 1: Geology, Hydrogeology and Ground Conditions

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Image of an offshore wind farm

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Glossary

Term	Meaning
Abstraction licence	The authorisation granted by the Environment Agency to allow the removal of surface water or groundwater.
Aquifer	A water-bearing geological unit that can yield economically viable amounts of groundwater.
Groundwater	Water that is contained in underground rocks and sediments below the ground surface.
Mona Onshore Development Area	The area of land to be temporarily or permanently occupied during the construction, operations and maintenance and decommissioning of the Mona Offshore Wind Project.
Source Protection Zone	Groundwater catchment areas defined by travel time around important potable groundwater abstraction sites to safeguard drinking water quality. Certain land-uses are controlled or prohibited with certain source protection zone areas.

Acronyms

Acronym	Description
AOD	Above Ordnance Datum
BGS	British Geological Survey
BSI	British Standards Institute
CCBC	Conwy County Borough Council
CEA	Cumulative Effects Assessment
CIRIA	Construction Industry Research and Information Association
CoCP	Code of Construction Practice
DCC	Denbighshire County Council
DCO	Development Consent Order
DMRB	Design Manual for Roads and Bridges
EHO	Environmental Health Officer
GCR	Geological Conservation Review
GHGC	Geology, Hydrogeology and Ground Conditions
GPP	Guidance for Pollution Prevention
LCRM	Land Contamination Risk Management
LDP	Local Development Plan
MDS	Maximum Design Scenario

Acronym	Description
MHWS	Mean High Water Springs
MSA	Mineral Safeguarded Area
NGET	National Grid Electricity Transmission
NNR	National Nature Reserves
NORA	NERC Open Research Archive
NPS	National Policy Statement
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
RIGS	Regionally Important Geological Sites
SPZ	Source Protection Zone
SSSI	Sites of Special Scientific Interest
WFD	Water Framework Directive
WLGA	Welsh Local Government Association

Units

Unit	Description
cm	Centimetres
km^2	Square kilometres
L/s	Litres per second
m	Metres
mm	Millimetres

1 Geology, Hydrogeology and Ground Conditions

1.1 Introduction

1.1.1 Overview

1.1.1.1 This chapter of the Environmental Statement presents the assessment of the potential impact of the Mona Offshore Wind Project on geology, hydrogeology and ground conditions. Specifically, this chapter considers the potential impact of the Mona Offshore Wind Project landward of Mean High Water Springs (MHWS) during the construction, operations and maintenance, and decommissioning phases.

1.1.1.2 The assessment presented also informs and is informed by the following technical chapters:

- Volume 3, Chapter 2: Hydrology and flood risk of the Environmental Statement
- Volume 3, Chapter 3: Onshore ecology of the Environmental Statement
- Volume 3, Chapter 7: Land use and recreation of the Environmental Statement.

1.1.1.3 This chapter draws upon information contained within Volume 3, Annex 1.1: Aquifers, groundwater abstractions and ground conditions and Annex 1.2: Hydrogeological risk assessment for groundwater supply Sources of the Environmental Statement. These annexes present the desk-based information regarding geology, hydrogeology and ground conditions and the preliminary hydrogeological appraisal of groundwater supplies identified within the Geology, Hydrogeology and Ground Conditions (GHGC) study area, respectively.

1.1.1.4 The chapter also draws upon information in Volume 7, Annex 2.4: Water Framework Directive surface water and groundwater assessment of the Environmental Statement. The annex includes a Water Framework Directive (WFD) compliance assessment to demonstrate how any impact on WFD receptors caused by the different activities associated with the Mona Offshore Wind Project fits with the objectives of any affected WFD groundwater bodies within the Zone of Influence.

1.2 Legislative and policy context

1.2.1 Legislation

1.2.1.1 The legislative context for the Mona Offshore Wind Project is set out in Volume 1, Chapter 2: Policy and legislative context of the Environmental Statement. In addition, the following legislation has also been considered:

- Part IIA of the Environmental Protection Act 1990
- Environment Act 1995
- The Contaminated Land (Wales) Regulations 2006
- Environmental Permitting (England and Wales) Regulations (2016)
- Water Resources Act 1991
- Water Act 2003
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2003, which transpose the WFD into UK law
- Groundwater (England and Wales) Regulations 2019, which transpose the Groundwater Directive (GWD) 2006/118/EC in England and Wales
- Waste (England and Wales) Regulations 2011 (as amended), which transpose the Waste Framework Directive (Directive 2008/98/EC) of the European Parliament and of the Council on Waste into UK law
- Water Supply (Water Quality) Regulations 2016
- Private Water Supply (Wales) Regulations 2017.

1.2.2 Planning policy context

1.2.2.1 The Mona Offshore Wind Project will be located in Welsh offshore waters (beyond 12 nautical miles (nm) from the Welsh coast) and inshore waters, with the onshore infrastructure located wholly within Wales as set out in Volume 1, Chapter 1: Introduction of this Environmental Statement. As the Mona Offshore Wind Project is an offshore generating station with a capacity of greater than 350 MW located in Welsh waters, it is a Nationally Significant Infrastructure Project (NSIP) as defined by Section 15(3) of the Planning Act 2008 (as amended) (the 2008 Act). As such, there is a requirement to submit an application for a Development Consent Order (DCO) to the Planning Inspectorate to be decided by the Secretary of State for the Department for Energy Security and Net Zero.

1.2.3 National Policy Statements

1.2.3.1 There are currently six energy National Policy Statements (NPSs), three of which identify policy relevant to offshore wind development and the Mona Offshore Wind Project, specifically:

- Overarching NPS for Energy (NPS EN-1) which sets out the UK Government's policy for the delivery of major energy infrastructure (Department for Energy Security & Net Zero, 2024a)
- NPS for Renewable Energy Infrastructure (NPS EN-3) (Department for Energy Security & Net Zero, 2024b)

- NPS for Electricity Networks Infrastructure (NPS EN-5) (Department for Energy Security & Net Zero, 2024c).

1.2.3.2 NPS EN-1 includes guidance on what matters are to be considered in the assessment. This is summarised in Table 1.1 below. NPS EN-1 also highlights a number of factors relating to the determination of an application and in relation to mitigation. These are summarised in Table 1.2 below. NPS EN-3 and NPS EN-5 do not contain provisions relevant to geology, hydrogeology or ground conditions.

Table 1.1: Summary of the NPS EN-1 provisions relevant to geology, hydrogeology and ground conditions.

Summary of NPS EN-1 provision	How and where considered in the Environmental Statement
The Applicant should ensure that the Environmental Statement clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance. [Paragraph 5.4.17 of NPS EN-1].	The effects of the Mona Offshore Wind Project on designated geological sites are considered in section 1.8 of this chapter.
The Applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests. [Paragraph 5.4.19 of NPS EN-1]	Sites of geological interest have largely been avoided by the refinement of the Mona Onshore Development Area (in particular, the Onshore Cable Corridor) and construction techniques. Mitigation measures relating to geology, hydrogeology and ground conditions are set out in section 1.7 of this chapter.
To further minimise any adverse impacts on geodiversity, where appropriate, Applicants are encouraged to produce and implement a Geodiversity Management Strategy to preserve and enhance access to geological interest features, as part of development proposals. [Paragraph 5.4.38 of NPS EN-1]	Features of geological interest have largely been avoided by the refinement of the Mona Onshore Development Area (in particular the Onshore Cable Corridor) and through the use of trenchless construction techniques. There are no nationally or regionally designated sites of geological interest within the Mona Onshore Development Area. On this basis, a Geodiversity Management Strategy has not been prepared as part of the Mona Offshore Wind Project.
Applicants should ensure that a site is suitable for its proposed use taking into account ground conditions and any risk arising from land instability and contamination. For developments on previously developed land, applicants should ensure that they have considered the risk posed by contamination and where contamination is present, applicants should consider opportunities for remediation where possible. [Paragraphs 5.11.17-18 of NPS EN-1].	Ground conditions including areas of mining are identified in Volume 7 Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. The annex also summarises a qualitative assessment of the risks posed by land contamination. The potential for contamination is also assessed in paragraphs 1.4.1.71 to 1.4.1.81 and section 1.8.8 to section 1.8.11 of this chapter.
Applicants should safeguard any mineral resources on the proposed site as far as possible, taking into account the long-term potential of the land use after any future decommissioning has taken place. [Paragraph 5.11.19 of NPS EN-1].	The Mona Onshore Development Area has been located to avoid significant harm to mineral resources where possible. The approach to site selection and consideration of alternatives is set out in Volume 1, Chapter 4: Site selection and consideration of alternatives of the Environmental Statement
The Environmental Statement should describe: • the existing quality of waters affected by the proposed project and the impacts of the proposed project on water quality, noting any relevant existing discharges, proposed new discharges and proposed changes to discharges;	Hydrogeological resources, groundwater abstractions and Source Protection Zones (SPZ) within the Mona GHGC study area are identified in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. Potential impacts on groundwater supply sources are considered in Volume 7, Annex 1.2: Hydrogeological risk

Summary of NPS EN-1 provision	How and where considered in the Environmental Statement
• existing water resources affected by the proposed project and the impacts of the proposed project on water resources, noting any relevant existing abstraction rates, proposed new abstraction rates and proposed changes to abstraction rates (including any impact on or use of mains supplies and reference to Abstraction Licensing Strategies) and also demonstrate how proposals minimise the use of water resources and water consumption in the first instance • existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project and any impact of physical modifications to these characteristics • any impacts of the proposed project on water bodies or protected areas under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 and source protection zones (SPZs) around potable groundwater abstractions • how climate change could impact any of the above in the future • any cumulative effects [Paragraph 5.16.7 of NPS EN-1	assessment for groundwater supply sources of the Environmental Statement. Potential impacts on the environmental objectives of the Water Framework Directive are set out in Volume 7, Annex 2.4: Water Framework Directive surface water and groundwater assessment of the Environmental Statement. Future baseline conditions associated with climate change are included within section 1.4.3, of this Environmental Statement chapter. Cumulative effects on geology, Hhydrogeology and ground conditions are considered within section 1.10, of this Environmental Statement chapter.

Table 1.2: Summary of NPS EN-1 policy on decision making relevant to geology, hydrogeology and ground conditions.

Summary of NPS EN-1 and policy	How and where considered in the Environmental Statement
Development proposals provide many opportunities for building-in beneficial biodiversity or geological features as part of good design. The Secretary of State should give appropriate weight to environmental and biodiversity enhancements, although any weight given to gains provided to meet a legal requirement (e.g. under the Environment Act 2021) is likely to be limited. [Paragraph 5.4.46 of NPS EN-1]	Mitigation measures relating to geology, hydrogeology and ground conditions are set out in section 0 of this chapter.
"*In taking decisions, the [Secretary of State] should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment*." [Paragraph 5.4.48 of NPS EN-1].	Designated sites and areas of geological interest are identified in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. The sensitivity assigned to these receptors is set out in Table 1.2 and Table 1.3 in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environment Statement.
Where a proposed development on land within a Site of Scientific Interest (SSSI) the Secretary of State should use requirements and/or planning obligations to mitigate the harmful aspects of the development and, where possible, to ensure the conservation and enhancement of the site's biodiversity or geological interest. [Paragraph 5.4.50 of NPS EN-1]	SSSIs designated on the basis of geological, geomorphological interest or hydrogeological dependence are identified in Volume 7, Annex 1.1: Aquifer, groundwater abstractions and ground conditions of the Environmental Statement and described in section 1.4. Potential impacts on those features are assessed in section 1.8 of this chapter.

Summary of NPS EN-1 and policy	How and where considered in the Environmental Statement
The Secretary of State should give due consideration to regional or local designations. However, given the need for new nationally significant infrastructure, these designations should not be used in themselves to refuse development consent. Development will still be expected to comply with the biodiversity and geological conservation requirements set out in the NPS. [Paragraph 5.4.52 of NPS EN-1].	Regionally designated sites of geological interest are identified in Volume 7, Annex 1.1: Aquifer, groundwater abstractions and ground conditions of the Environmental Statement. Potential impacts on those features are assessed in section 1.8 of this chapter.
Where a proposed development has an impact upon a Mineral Safeguarding Area the Secretary of State should ensure that appropriate mitigation measures have been put in place to safeguard mineral resources. [Paragraph 5.11.28 of NPS EN-1]	The Mona Onshore Development Area has been located to avoid significant harm to mineral resources where possible. The approach to site selection and consideration of alternatives is set out in Volume 1, Chapter 4: Site selection and consideration of alternatives of the Environmental Statement.
The Secretary of State should satisfy itself that a proposal has regard to the River Basin Management Plans and meets the requirements of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (including regulation 19). The Secretary of State must refuse development consent where a project is likely to cause deterioration of a water body or its failure to achieve good status or good potential, unless the requirements set out in Regulation 19 are met. [Paragraph 5.16.14 of NPS EN-1].	The potential adverse effects on groundwater as a result of the Mona Offshore Wind Project (e.g. from an increased demand for water and discharges to water) are identified in section 1.8 of this chapter. The potential effects on surface watercourses and ecological habitats are set out in Volume 3, Chapter 2: Hydrology and flood risk, and Chapter 3: Onshore ecology (respectively) of the Environmental Statement. Potential impacts on the environmental objectives of the Water Framework Directive are set out in Volume 7, Annex 2.4: Water Framework Directive surface water and groundwater assessment of the Environmental Statement.

1.2.4 Planning Policy Wales

1.2.4.1 The geology, hydrogeology and ground conditions impact assessment has been made with consideration to Planning Policy Wales Edition 11 (Welsh Government, 2021). Key provisions are set out in Table along with details as how these policies have been addressed in the assessment.

Table 1.3: Planning Policy Wales policies of relevance to geology, hydrogeology and ground conditions.

Policy	Key provisions	How and where considered in the Environmental Statement
Characteristics of Local Landscapes	Planning authorities should protect the features and qualities for which Geoparks and RIGS have been designated, and are encouraged to promote opportunities for the incorporation of geological features within the design of development, particularly where relevant evidence is provided by Green Infrastructure Assessment. Some statutory Sites of Special Scientific Interest (SSSIs) are also designated for their nationally important geological or geomorphological features, and planning authorities have a duty to further the	Features of geological interest have largely been avoided by the refinement of the Mona Onshore Development Area (in particular the Onshore Cable Corridor) and through the use of trenchless construction techniques.

Policy	Key provisions	How and where considered in the Environmental Statement
	conservation and enhancement of those features.	
Safeguarding Minerals Resources and Infrastructure	Planning authorities should consider the long term and the need for preventative action to avoid the creation of problems in the future. Safeguarding does not indicate an acceptance of mineral working, but that the location and quality of the mineral is known and that the environmental constraints associated with extraction, including the potential for extraction of mineral resources prior to undertaking other forms of development, have been considered	The Mona Onshore Development Area has been located to avoid significant harm to mineral resources where possible. The approach to site selection and consideration of alternatives is set out in Volume 1, Chapter 4: Site selection and consideration of alternatives of the Environmental Statement.
De-risking Development	When considering development proposals planning authorities should take into account the nature, scale and extent of surface and subsurface hazards which may pose risks to health and environment, to ensure that: • new development is not undertaken without an understanding of the risks, including those associated with the previous land use, pollution, groundwater, flood risk, subsidence, landslips, rock falls, mine and landfill gas emissions and rising groundwater from abandoned mines	Ground conditions including areas of mining are identified in Volume 7 Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement and assessed in section 1.8. The annex also summarises a qualitative assessment of the risks posed by land contamination.

1.2.5 Local Planning Policies

1.2.5.1 The assessment of potential changes to geology, hydrogeology and ground conditions has also been made with consideration to the specific policies set out in Adopted Local Development Plans (LDPs) of Conwy County Borough Council (CCBC) (adopted in October 2013) and Denbighshire County Council (DCC) (adopted in June 2013). Replacement LDPs are currently being drafted by CCBC and DCC and will be considered upon publication. Key provisions are set out in Table 1.4 along with details as to how these have been addressed within the assessment.

Table 1.4: Local Planning Policy of relevance to geology, hydrogeology and ground conditions.

Policy	Key provisions	How and where considered in the Environmental Statement
Conwy County Borough Council: Adopted Local Development Plan (October 2013)		
Strategic Policy DP/1 – Sustainable Development Principles	Development will only be permitted where it is demonstrated that it is consistent with the principles of sustainable development. Development proposals should also where appropriate:	Measures to protect groundwater resources from spillages and leakages during construction are defined within the Outline Code of Construction Practice (CoCP) (Document Reference J26).

Policy	Key provisions	How and where considered in the Environmental Statement
	h. Protect the quality of natural resources including water, air and soil in line with Strategic Policy NTE1.	
Strategic Policy NTE/1 – The Natural Environment	In seeking to support the wider economic and social needs of the Plan Area, the Council will seek to regulate development so as to conserve and, where possible, enhance the Plan Area's natural environment, countryside and coastline. This will be achieved by: a. Safeguarding the Plan Area's biodiversity, geology, habitats, history and landscapes through the protection and enhancement of sites of international, national, regional and local importance, in line with Policy DP/6 – National Planning Policy and Guidance' i. Preventing, reducing or remedying all forms of pollution including air, light, noise, soil and water, in line with Policy DP/6.	The Mona Onshore Development Area seeks to avoid harm to designated sites of geological interest. The approach to site selection and consideration of alternatives is set out in Volume 1, Chapter 4: Site selection and consideration of alternatives of the Environmental Statement.
Strategic Policy MWS/1 – Minerals and Waste	The Council will ensure that there is sufficient provision of mineral resources and waste management facilities, while safeguarding the natural and built environment by: a. Safeguarding permitted reserves of hard rock at Penmaenmawr, Raynes (Llysfaen), Llanddulas and St George and additional resources of hard rock as identified on the proposals map in line with Policies MWS/2 – 'Minerals' and MWS/3 – 'Safeguarding Hard Rock and Sand and Gravel Resources' c. Designating buffer zones around quarries to protect amenity and ensuring that mineral operations are not unduly constrained by other land users in line with Policy MWS/4 – 'Quarry Buffer Zones' d. Safeguarding sand and gravel resources as identified on the proposals map in line with Policy MWS/3 h. Designating a landfill buffer zone around Llanddulas landfill site to ensure that only appropriate development in this location is permitted in line with Policy MWS/8 – 'Landfill Buffer Zone'.	The location of the Mona Onshore Development Area seeks to avoid safeguarded mineral resources. The site selection process will continue to refine the area needed to support the construction of the Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor, Onshore Substation and associated infrastructure. The Llanddulas landfill site will be avoided by using trenchless cabling techniques as described in Volume 1, Chapter 3: Project description of the Environmental Statement. Further details are provided in the Outline Landfall Construction Method Statement (Document Reference J26.14).
Denbighshire County Council: Adopted Local Development Plan (June 2013)		
Policy VOE 5 – Conservation of natural resources	Planning permission will not be granted for development proposals that are likely to cause significant harm to the qualifying features of internationally and nationally designated sites of nature conservation,	The location of nationally and regionally important geological sites are identified in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and conditions of the Environmental Statement. The

Policy	Key provisions	How and where considered in the Environmental Statement
	priority habitats, priority species, regionally important geodiversity sites, or to species that are under threat.	potential impacts to these sites of geological interest are set out section 1.8 of this chapter.
Policy PSE 15 - Safeguarding Minerals	High quality resources of minerals, including limestone, sand and gravel, Denbigh Gritstones, igneous and volcanic deposits will be safeguarded from development that would result in its permanent loss or hinder future extraction. Development will only be permitted where: 1. it can be demonstrated that the need for the development outweighs the need to protect the mineral resource; or 2. where such development would not have a significant impact on the viability of that mineral being worked; or 3. where the mineral is extracted prior to the development.	The location of the Mona Onshore Development Area seeks to avoid safeguarded mineral resources. The site selection process has refined the area needed to support the construction of the Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor, Onshore Substation and associated infrastructure. The approach to site selection is set out in Volume 1, Chapter 4: Site selection and consideration of alternatives of the Environmental Statement.
Policy PSE 16 - Mineral buffer zones	Sensitive development within buffer zones, as defined on the proposals map, will not be permitted unless it can be demonstrated that working has ceased and will not be resumed. Extensions to quarries will only be permitted where a suitable buffer can be retained, i.e. where such an extension would not cause other development to become part of a buffer, and where it can be demonstrated that there is no unacceptable impact on the environment or human health.	

1.2.6 Consultation

1.2.6.1 A summary of the key issues raised during consultation activities undertaken to date specific to geology, hydrogeology and ground conditions is presented in Table 1.5 below, together with how these issues have been considered in the production of this Environmental Statement chapter.

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Table 1.5: Summary of key consultation issues raised during consultation activities undertaken for the Mona Offshore Wind Project relevant to geology, hydrogeology and ground conditions.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
31 May 2022	Natural Resources Wales (NRW) Response to Scoping	NRW (A) note that there are Source Protection Zones (SPZs) at Trofarth Farm and Llannerch Park.	The location and extent of these SPZs have been identified. The SPZs do not fall within the GHGC study area.
31 May 2022	NRW Response to Scoping	Contaminated land is mentioned within the Scoping Report. NRW (A) remind the applicant that both contaminated land as statutorily defined contaminated land under Part 2A of the Environmental Protection Act 1990, or land affected, and land affected by contamination (as often associated with brownfield sites) that needs to be dealt with through planning, should be scoped in. It should be noted that there is Wales specific guidance on land contamination. Please refer to Land Contamination: a guide for developers (WLGA, 2017) for the type of information that NRW (A) required in order to assess risks to controlled waters from the site.	Potential areas of contaminated land have been considered in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, paragraphs 1.4.1.71 to 1.4.1.81 of this chapter and section 1.8.8 to section 1.8.10 of this chapter. The Wales-specific guidance has been considered throughout this chapter.
31 May 2022	NRW Response to Scoping	NRW (A) note that impacts proposed to be scoped out of the project include spillages. NRW (A) advise that further information with regards to the operational aspects should be provided to clarify how spillages have been ruled out, for example, will refuelling ever be necessary? Will the cable be fluid filled?	The activities required to be undertaken during the operations and maintenance phase are described in Volume 1, Chapter 3: Project Description of the Environmental Statement. The onshore export cables will not be fluid filled, no refuelling will be necessary for the operation of the Onshore Substation and there will be no bulk storage of chemicals.
31 May 2022	NRW Response to Scoping	NRW (A) agree with the proposed 1km receptor buffer [to be used in the assessments] based on the available information. NRW (A) concur that dependant on specific activities it is proposed the 1km receptor buffer may need to be changed, e.g. if a large groundwater abstraction or dewatering activity is proposed.	Noted. There are no large groundwater abstractions or dewatering activities proposed as part of the construction of the Mona Offshore Wind Project based on the information available. However, if such activities are identified through the detailed design process, the receptor buffer in these locations will be considered. Where required, environmental permits (for abstraction or dewatering) will be secured prior to construction commencing.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
31 May 2023	Dwr Cymru Welsh Water	Asset Protection: Our strong recommendation is that your site layout takes into account the location of the assets crossing the site and should be referred to in any master-planning exercises or site layout plans submitted as part of any subsequent planning application. We also request an accurate location plan of the proposed pipeline so that we can assess its impacts on our infrastructure further. Further information regarding Asset Protection is provided in the attached Advice and Guidance note.	Locations where the Onshore Cable Corridor will cross existing infrastructure are identified in the Onshore Crossing Schedule (see Volume 5, Annex 4.3 of the Environmental Statement). The Onshore Crossing Schedule also describes the proposed technique that will be used to cross the infrastructure.
01 June 2023	NRW S42 Consultation Response	Table 16.14 Measures adopted as part of the Mona Offshore Wind Project, and the primary and tertiary measures outlined, however, is considered to be “fairly high-level and does not provide the details or risk assessments that should be included”.	The Mona Onshore Development Area has been refined following the statutory consultation: the preferred option of the Onshore Cable Corridor and the Onshore Substation have been selected; a schedule has been prepared showing the crossing technique that will be employed along the Onshore Cable Corridor; and the indicative layout of the Onshore Substation has been provided. Outline construction method statements for key activities (e.g. watercourse crossings) are provided in the CoCP. Additional detail (including risk assessments) will be undertaken during the detailed design process.
01 June 2023	NRW S42 Consultation Response	More information should be provided on the Horizontal Directional Drilling (HDD) area from offshore to onshore, the method used, the depth, the drilling for the Onshore Cable Corridor and how this will interact with the local water table and regional groundwater levels and flows. This will require a controlled waters risk assessment to support the use of this cabling method. The details indicate cofferdams and dewatering for the reception pits – dewatering over 20 m^3/day may require a Water Resource Abstraction Licence and we recommend early engagement with NRW Permitting Teams. This type of licence will also be required for trenched cabling methods that require dewatering.	Groundwater near the landfall is described in paragraphs 1.4.1.47 and 1.4.1.48. An Outline Landfall Construction Method Statement is included within the Outline CoCP (Document Reference J26.14). It provides a description of the methods that will be employed at the transition joint bay and is based on a trenchless technique design. This design does not include open cut trenching seaward of MHWS and therefore, does not require the use of cofferdams. A final Landfall Method Statement will be prepared during detailed design and will be informed by the results of intrusive investigations. Where required, environmental permits (for abstraction or dewatering) will be secured prior to construction commencing.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
01 June 2023	NRW S42 Consultation Response	Confirmation is sought on whether the cables will be fluid filled. If they are, please consider the “Approach to Groundwater Protection” guidance position statement C5 and submit any risk assessment for their use.	The onshore export cables for the Mona Offshore Wind Project will not be fluid filled. Information about the Onshore Cable Corridor design is provided in Volume 1, Chapter 3: Project description of the Environmental Statement.
01 June 2023	NRW S42 Consultation Response	NRW (A) note the potential use of a septic tank for foul water disposal, and advise that an environmental permit may be required.	An Outline Construction Surface Water and Drainage Management Plan has been prepared (Document Reference J26.6) . Where required, environmental permits (for foul water discharge) will be secured prior to construction commencing.
01 June 2023	NRW S42 Consultation Response	NRW (A) understand that the private water supply survey and risk assessment is yet to be completed and advise that this is done as soon as possible to allow time to monitor sensitive sources of supply and for mitigation measures to be agreed with the source owner or user.	A preliminary hydrogeological assessment of groundwater source supplies is provided in Volume 7, Annex 1.2 of the Environmental Statement.
01 June 2023	NRW S42 Consultation Response	From the information provided NRW (A) note that the Code of Construction Practice (CoCP) is a live document and will be updated as the works commence. The generic details for the pollution preventions measures are suitable to be protective of groundwater, but more specific details may be required once all the surveys are completed, and the final Onshore Cable Corridor is set.	The CoCP is supported by a number of management plans that provide specific measures for controlling impacts. The final versions of these management plans will be prepared prior to construction and will be in general accordance with the outline versions submitted in the DCO application.
01 June 2022	Conwy County Borough Council (CCBC) Response to Scoping	The Environmental Statement should address the impact of the construction, operation and decommissioning phases on mineral resources, including permitted reserves and other mineral resources safeguarded in the Local Development Plan.	Mineral safeguarded areas are considered in section paragraphs 1.4.1.25 to 1.4.1.26 of this chapter and section 1.8.4 of this chapter
15 June 2022	Planning Inspectors Scoping Opinion	The Planning Inspectorate has queried the proposed methodology to rely on desk-based data. It considers that limiting the approach to desk study only may not provide sufficient baseline information to inform the assessment. The Applicant is advised to discuss and	The Mona Onshore Development Area has been refined following the statutory consultation: the preferred option of the Onshore Cable Corridor and the Onshore Substation have been selected. The Mona Offshore Wind Project has undertaken a programme of ground investigation at the Mona Landfall and Onshore Substation during Q3/Q4 2023.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
		agree the need for intrusive site investigation with NRW and the relevant local authority.	Geophysical surveys have also been undertaken along the Onshore Cable Corridor and Onshore Substation; the results are reported in Volume 7, Annex 5.3: Onshore Geophysical Survey Report of the Environmental Statement. ..
16 June 2023	CCBC – contacted via email	Private water supplies Chapter 16 confirms they will be undertaking a more detailed study of private water supplies through undertaking appropriate risk assessment. The Principal Environment Officer would look to be consulted on the mapping and identification of those supplies to ensure that there is no impact from the proposed development and if required a plan to protect those supplies identified.	The Environment Office at Conwy County Borough Council and Denbighshire County Council have been contacted to request details of the private water licences they currently manage. Information on these licences is presented in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. The risk to private groundwater supply sources is evaluated in Volume 7, Annex 1: Hydrogeological risk assessment for groundwater supply sources of the Environmental Statement.

1.3 Baseline methodology

1.3.1 Relevant guidance

1.3.1.1 The characterisation of the baseline environment for geology, hydrogeology and ground conditions has considered the following guidance:

- Defra Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance (Defra, 2012)
- Development of Land Affected by Contamination: A Guide for Developers (WLGA & NRW, 2023v4)
- CIRIA Document C552 – Contaminated Land Risk Assessment: A Guide to Good Practice (CIRIA, 2001a)
- CIRIA Document C532 – Control of Water Pollution from Construction Sites: Guidance for Consultants and Contractors (CIRIA, 2001b);
- CIRIA Document C649 – Control of Water Pollution from Linear Construction Projects
- CIRIA Document C741 – Environmental good practice on site guide (fourth edition)
- Land Contamination: Risk Management (LCRM) (Environment Agency, 2020)
- Design Manual for Roads and Bridges (DMRB) (October 2019) Sustainability and Environment Appraisal: LA 109 - Geology and soils, Revision 0
- DMRB (March 2020) Sustainability and Environment Appraisal: LA 113 - Road drainage and the water environment, Revision 1.

1.3.2 Scope of the assessment

1.3.2.1 The scope of this Environmental Statement has been developed in consultation with relevant statutory and non-statutory consultees as detailed in Table 1.5

1.3.2.2 Taking into account the scoping and consultation process, Table 1.6 summarises the issues considered as part of this assessment.

Table 1.6: Issued considered in this assessment.

Activity	Potential effects scoped into the assessment
Construction phase	
Open cut trenching: • Onshore Cable Corridor • 400 kV Grid Connection Corridor	Loss or damage to nationally designated sites and non-designated sites of geological and geomorphological interest
Trenchless techniques: • Onshore Cable Corridor • 400 kV Grid Connection Corridor	
Construction compounds	
Open cut trenching: • Onshore Cable Corridor • 400 kV Grid Connection Corridor	Sterilisation of safeguarded limestone mineral resources

Activity	Potential effects scoped into the assessment
Onshore Substation	
Open cut trenching: • Onshore Cable Corridor • 400 kV Grid Connection Corridor	Alteration to groundwater quantity or quality (in superficial aquifer and bedrock aquifers) Impact on private groundwater abstractions (quantity, reliability and quality)
Trenchless techniques: • Onshore Cable Corridor • 400 kV Grid Connection Corridor	
Onshore Substation	
Trenchless techniques - • Landfall	Deterioration of groundwater quality in bedrock aquifer by mobilisation of contaminants (Llanddulas Beach landfill)
Open cut trenching: • Onshore Cable Corridor • 400 kV Grid Connection Corridor	Deterioration of groundwater quality (in glacial till and bedrock aquifers) by disturbance and mobilisation of existing areas of contamination associated with recent or historical land use. Deterioration in groundwater quality as result of accidental spillage of potentially polluting substances
Trenchless techniques: • Onshore Cable Corridor • 400 kV Grid Connection Corridor	
Onshore Substation	
Construction compounds	
Trenchless techniques: • Onshore Cable Corridor • 400 kV Grid Connection Corridor	Ground stability issues associated with areas of historical deep mining
Onshore Substation	
Operation and maintenance	
Onshore Cable Corridor	Sterilisation of safeguarded limestone mineral resources Alteration to groundwater quantity or quality (in superficial aquifer and bedrock aquifers) Impact on private groundwater abstractions (quantity, reliability and quality)
400 kV Grid Connection Corridor	
Onshore Substation	
Decommissioning	
Removal of Onshore Cable Corridor	Loss or damage to nationally designated sites and non-designated sites of geological and geomorphological interest. Sterilisation of safeguarded limestone mineral resources Alteration to groundwater quantity or quality (in superficial aquifer and bedrock aquifers) Impact on private groundwater abstractions (quantity, reliability and quality) Deterioration in groundwater quality as result of accidental spillage of potentially polluting substances
Removal of 400 kV Grid Connection Cable Corridor	
Removal of Onshore Substation	

1.3.2.3 Effects which are not considered likely to be significant have been scoped out of the assessment. A summary of the effects scoped out, together with justification for scoping them out, is presented in Table 1.7.

Table 1.7: Impacts scoped out of the assessment for geology, hydrogeology and ground conditions.

Potential impact	Justification
Loss of, or damage to locally designated sites of geological and geomorphological interest (GCR and RIGS).	No impact predicted as locally important designated sites are all situated outside of Mona Onshore Development Area.
Temporary or permanent alteration to the hydrogeological regime of groundwater dependent designated sites, in terms of levels, discharge rates, flow, temperature or water quality.	The construction of the onshore transmission assets has the potential to impact the hydrogeological regime at sites that are dependent on groundwater. Designated sites identified within the GHGC study area are not considered to have a direct groundwater dependence contributing to their designation. Impacts on the ecology of these designated sites are considered in Chapter 3: Onshore ecology of the Environmental Statement.
Temporary or permanent alteration to the quantity or quality of groundwater discharge to surface waters fed by groundwater discharge (baseflow) from underlying aquifer units.	Small surface watercourses present within study area and crossed by the Onshore Cable Corridor do not receive significant groundwater discharge (baseflow) given their position above glacial till or localised areas of exposed bedrock where groundwater is expected to present at significant depth. Flow in these watercourses is dependent on surface runoff as opposed to groundwater discharge. Any direct impacts on surface watercourses during the construction, operational and maintenance and decommissioning phase will be assessed in Chapter 2: Hydrology and flood risk of the Environmental Statement.
Temporary or permanent impact on groundwater quantity or quality in the Secondary A glaciofluvial sand and gravel aquifer due to the construction, operations and decommissioning of the Mona Onshore Cable Corridor, Onshore Substation and 400 kV Grid Connection Corridor.	BGS geological mapping suggests that glaciofluvial deposits rarely occur within the Onshore Cable Corridor and will be limited extent where present. This suggests groundwater in glaciofluvial deposits is unlikely to be of resource value, nor will it support important groundwater dependent receptors. A preliminary review of risk to groundwater abstractions has been undertaken following land-owner consultation and is presented in Volume 7, Annex 1.2: Groundwater sources of supply – hydrogeological risk assessment of the Environmental Statement.. The risk assessment will be updated during detailed design.
Temporary or permanent impact on groundwater quantity or quality in the Secondary B bedrock aquifer of the Silurian Elwy Formation due to the construction, operations and maintenance and decommissioning of Mona Onshore Cable Corridor, Onshore Substation and 400 kV Grid Connection Corridor.	The impact on groundwater in the Clwyd Limestone Group Principal aquifer has been shown to be not significant in EIA terms. No assessment is therefore required for the Elwy Formation aquifer given it has a lower receptor sensitivity as it is a Secondary B aquifer.
Direct impact on licensed groundwater abstractions within the GHGC study area.	All active, licensed, groundwater abstractions are at very low risk of any impact resulting from the construction, operations and maintenance and decommissioning of the transmission assets, given: • They are located a significant distance (greater than 1 km) from the east end of the Mona Onshore Development Area • They are situated in a presumed down-hydraulic gradient position from the Mona Onshore Development Area and Onshore Substation at a lower elevation, adjacent to the Afon Elwy which represents the likely local groundwater receptor and hydraulic minimum

Potential impact	Justification
	• The east end of the Mona Onshore Development Area is situated above glacial till, which is likely to be thick • The east end of the Mona Onshore Development Area is situated above bedrock of Clwyd Limestone Group which dips east beneath the aquifers of the Warwickshire Group to the northeast.
Direct impact on groundwater Source Protection Zones within the GHGC study area.	*Trofarth Farm SPZ* Located over 8 km from the Mona Onshore Development Area and above Silurian bedrock aquifer of the Elwy Formation. Given the low permeability of this Secondary B aquifer and the large distance from the Mona Onshore Development Area it is not considered to be at any risk from the construction, operations and maintenance and decommissioning of the Mona Onshore Cable Corridor, Onshore Substation and 400 kV Grid Connection Corridor. *Llannerch Park SPZ* This abstraction source is unlikely to be at any risk as it is considered to be located in a different groundwater catchment from the transmission assets, given: • It is situated on the opposite (east) side of the Afon Elwy, with a capture zone that extend to the southeast away from the Mona Onshore Development Area • It is located approximately 3.5 km east of the Mona Onshore Development Area.
The impact of ground gas generation on human health and other environmental receptors, during the construction, operations and maintenance and decommissioning phases.	The desk top study did not identify deposits that may produce significant quantities of ground gas. The only exception is Llanddulas Beach Landfill site which was shown to have had included gas and leachate control (Lle Geo-Portal for Wales). The former landfill site has been assessed separately herein.
Deterioration of groundwater quality in the Clwyd Limestone Group bedrock aquifer by the mobilisation of contamination associated with the historical Llanddulas Beach Landfill site during the operations and maintenance and decommissioning phases.	Any impact on groundwater quality in the Clwyd Limestone Group bedrock aquifer will be avoided during construction by the use of trenchless techniques and implementation of the associated method statement for drilling under the Llanddulas Beach Landfill Site.

1.3.3 Methodology to inform baseline

1.3.3.1 The baseline environment for geology, hydrogeology and ground conditions was established by undertaking a desktop study that reviews the following:

- Publicly available data sources available from the following organisations:
  - BGS
  - NRW
  - CCBC
  - DCC
  - Coal Mining Authority
- Information contained in a Groundsure Enviro-Geo Insights report for the GHGC study area. That report includes:

  - General information regarding geological, hydrogeological and hydrological setting
  - Groundwater abstraction licences
  - Current and historical landfill sites
  - Current and historical waste sites
  - Pollution incidents
  - Discharge consents
  - Current and historical land-use
  - Mining and ground working areas (coal and non-mining)
  - Geotechnical constraints
- Historical Ordnance Survey mapping and some aerial photography.

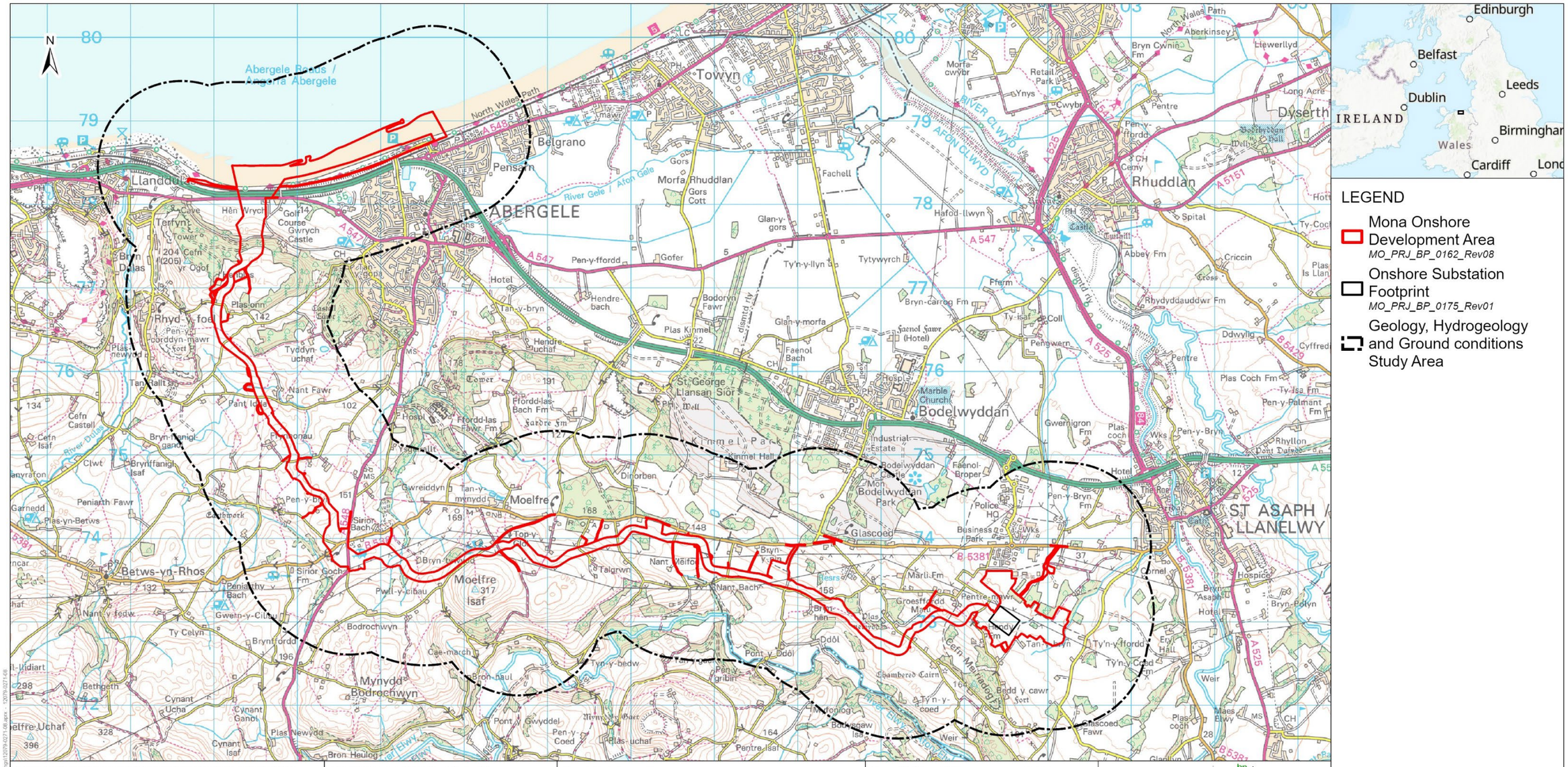
1.3.3.2 The key datasets obtained as part of the desktop study are presented in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. Following the refinement of the Mona Onshore Development Area post statutory consultation, this desk-based information has been augmented by information relating to private groundwater abstractions. A preliminary risk assessment for groundwater supply sources is presented in Volume 7, Annex 1.2: Hydrogeological risk assessment for groundwater supply sources of the Environmental Statement. The details of proposed intrusive surveys being undertaken by the Mona Offshore Wind Project to inform detailed design are also outlined in the chapter in Table 1.15.

1.3.4 Study area

1.3.4.1 The geology, hydrogeology and ground conditions study area, hereafter referred to as the GHGC study area, to be used for the assessment focuses on areas located above MHWS where potential impacts are most likely to occur on geological and hydrogeological receptors. As such, the GHGC study area includes:

- The area of land to be temporarily or permanently occupied during the construction, operations and maintenance and decommissioning of the Mona Offshore Wind Project (hereafter referred to as the Mona Onshore Development Area) as defined by the red line boundary shown in Figure 1.1.
- Geological and hydrogeological receptors within 1km of the Mona Onshore Development Area. The 1km buffer was selected for the GHGC study area as potential impacts on hydrogeological receptors are likely to occur within this distance. Potential impacts on geological receptors may occur within a shorter distance, however a conservative approach has been followed and a consistent buffer has been applied for all receptors
- Ground condition constraints within the Mona Onshore Development Area.

1.3.4.2 The GHGC study area and Mona Onshore Development Area are shown in Figure 1.1.



Service Layer Credits: World Topographic Map: Esri UK, Esri, TomTom, Garmin, FAO, NOAA, USGS
World Hillshade: Esri, USGS

Data Sources: RPS / bp / EnBwW

Geodetic Information:
Datum: OSGB 1936. Projection: British National Grid.
Scale@ 378.9mm x 214.9 mm:1:50,000

0 0.25 0.5 1 nm
0 0.5 1 2 km

Partners in UK offshore wind

Project Name:
MONA OFFSHORE WIND PROJECT

Drawing Title:
GEOLOGY, HYDROGEOLOGY AND GROUND CONDITIONS STUDY AREA

Drawing Number:
12079-0271-08

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Figure 1.1: Geology, hydrogeology and ground conditions study area

1.3.5 Desktop study

1.3.5.1 Information on geology, hydrogeology and ground conditions within the GHGC study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 1.8 below.

Table 1.8: Summary of key desktop reports

Title	Source	Year	Author
Geological Viewer	BGS Map Viewers	-	BGS
Geoindex (Onshore)	BGS Map Viewers	-	BGS
Sheet 95, Rhyl, Solid alongside Drift, 1:63,360	BGS Maps Portal	1970	BGS
Sheet 107, Denbigh, Solid and Drift, 1:50,000	BGS Maps Portal	1985	BGS
Warren, P.T., Price, D., Nutt, M.J.C. and Smith, E.G. 1984. Geology of the country around Rhyl and Denbigh. Mem. Br. Geol. Surv., sheets 95 and 107.	BGS Memoir Portal	1984	BGS
Aquifer designation – bedrock	NRW interactive map of data about the natural environment	-	NRW
Aquifer designation – superficial deposits	NRW interactive map of data about the natural environment	-	NRW
The physical properties of major aquifers in England and Wales	NERC Open Research Archive (NORA)	1997	BGS (Allen, D J, Brewerton, L J, Coleby, L M, Gibbs, B R, Lewis, M A, MacDonald, A M, Wagstaff, S J, and Williams, A T.)
The physical properties of minor aquifers in England and Wales	NERC Open Research Archive (NORA)	2000	BGS (Jones, H K, Morris, B L, Cheney, C S, Brewerton, L J, Merrin, P D, Lewis, M A, MacDonald, A M, Coleby, L M, Talbot, J C, McKenzie, A A, Bird, M J, Cunningham, J, and Robinson, V K.)
Groundwater vulnerability	NRW interactive map of data about the natural environment and GeoIndex Onshore	-	NRW and BGS
Groundwater safeguard zones	NRW interactive map of data about the natural environment	-	NRW
BGS Hydrogeology Map: Map No. 19, Clwyd and Cheshire Basin, 1:100,000	BGS Scans Viewer	1989	BGS
WFD groundwater bodies (Cycle 2)	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and NRW
WFD river water bodies (Cycle 2)	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and NRW

Title	Source	Year	Author
Geological Conservation Review (GCR) sites	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and NRW
Regionally Important Geological and Geomorphological Sites (RIGS)	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and NRW
Protected Sites (Sites of Scientific Interest, Special Areas of Conservation)	Lle Geo-Portal for Wales. Spatial Dataset; NRW interactive map of data about the natural environment and Groundsure Enviro-Geo Insights Report	-	Partnership between Welsh Government and NRW
Main Rivers in Wales	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and NRW
Groundsure Enviro-Insights Report including historical maps	Groundsure	2022	Produced by Groundsure on the basis of dataset sets relevant to the Environment and Ground Conditions.
Private groundwater abstraction licences	CCBC and DCC	2023	CCBC and DCC

1.3.6 Identification of designated sites

1.3.6.1 All designated sites within the GHGC study area and qualifying interest features that could be affected by the construction, operations and maintenance, and decommissioning phases of the Mona Offshore Wind Project were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the GHGC study area were identified using a number of sources. These sources included the Lle Geo-Portal for Wales - Spatial Dataset; NRW interactive map of data about the natural environment and Groundsure Enviro-Geo Insights Report
- Step 2: Information was compiled on the relevant geology and hydrogeological qualifying interests for each of these sites
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site directly overlaps with the Mona Onshore Development Area
  - A designated site was considered potentially to have hydraulic continuity with the Mona Onshore Development Area and could potentially be affected.

1.3.7 Site specific surveys

1.3.7.1 A desk-based site-specific survey has been undertaken, whereby landowners were asked to provide information on private groundwater supply sources to inform the baseline conditions reported in the Environmental Statement. The results of these surveys are discussed in paragraphs 1.4.1.59 and 1.4.1.60.

1.4 Baseline environment

1.4.1 Baseline characterisation

1.4.1.1 A summary of the geology, hydrogeology and ground conditions baseline environment is provided in the following sections.

Hydrology and topography

1.4.1.2 The Mona GHGC study area is situated in the surface water catchment of four NRW Main Rivers (see Volume 7, Annex 2.2: Surface watercourses and NRW flood zones of the Environmental Statement):

- Afon Elwy, that defines the south and east boundary to the GHGC study area up to its confluence with Afon Clwyd
- Afon Clwyd, that flows north to its mouth at Rhyl
- Afon Dulas, that flows north to its mouth between Llanddulas and Abergele, defining the west boundary to the GHGC study area
- Afon Gele, a short watercourse that flows north onto the low-lying, drained, coastal marshes between Abergele and the mouth of Afon Clwyd.

1.4.1.3 There are also several small watercourses within the GHGC study area many of which discharge to the Main Rivers. Ordnance Survey mapping also identifies many small ponds and water bodies, most notably at low elevation at the east end of Mona Onshore Development Area. These hydraulically isolated ponds are situated upon low permeability glacial till. Further information on surface watercourses can be found within Volume 3, Chapter 2: Hydrology and flood risk of the Environmental Statement.

1.4.1.4 Topography within the GHGC study area is depicted in Figure 1.1 and is dominated by two areas of high ground. A north ridge of high ground extends southeast away from the coast at Llanddulas up to Bryn-y-Pin on the B5381 to the south of Bodelwyydan. This ridge of high ground passes behind Abergele and forms the inland boundary of the low-lying land between Abergele and the mouth of Afon Clwyd. Elevations along this ridge are typically below 200 m above Ordnance Datum (AOD) but include the pronounced peak of Cefn yr Ogof and local summits at Gopa Wood and Tower Hill.

1.4.1.5 To the south of this north ridge, there is an area of high ground that extends approximately west to east on either side of Afon Elwy. This southern area of high ground is more elevated than the north ridge with peak elevations that commonly exceed 250 m AOD and reaching a maximum height of 317 m AOD at Moelfry Isaf.

1.4.1.6 The Mona Onshore Development Area rises over the north ridge high ground, from the point of coastal landfall. Topography rises steeply to a maximum height of 180 m AOD.

1.4.1.7 South of the north ridge, the Mona Onshore Development Area crosses an undulating area with an elevation of between 120 m AOD and 160 m AOD. The Mona Onshore Development Area crosses the A548 at an elevation of approximately 160 m AOD and travels east to the Onshore Substation Site and National Grid connection at Bodelwyddan. East of the A548, the Mona Onshore Development Area either follows lower lying land along the B5381 to Moelfre or ascends the north flank of Moelfre Isaf, reaching a maximum elevation of approximately 290 m AOD. East of Bryn-y-pin the Mona Onshore Development Area follows a local ridge of high ground up to Glascoed.

East of Glascoed, topography declines towards the east end of the Mona Onshore Development Area at 40 m AOD. The east end of the Mona Onshore Development Area is located approximately 475 m west of the Afon Elwy which has an elevation of between 10 and 20 m AOD.

Geology

1.4.1.8 A summary of the regional geological sequence is provided in Table 1.9 and presented in Figure 1.1 and Figure 1.2 of Volume 7, Annex 1.1: Aquifers, groundwater abstraction and ground conditions of the Environmental Statement.

Bedrock

1.4.1.9 The bedrock in this area of North Wales gets progressively younger from the southwest to the northeast. The oldest bedrock comprises a thick sequence of silty mudstones and subordinate sandstones of the Elwy Formation. These rocks are often disturbed and are highly fractured and faulted. This Silurian bedrock dips to the northeast, becoming overlain by the Ffernant Formation (formerly Carboniferous Basement Beds).

1.4.1.10 The Ffernant Formation is of Carboniferous age and is composed of thin sequence of red and purple silty mudstones, siltstones and sandstones with conglomerates. The Ffernant Formation is overlain by a thick sequence of Carboniferous limestones of the Clwyd Limestone Group. This group comprises a diverse range of limestones, with subordinate sandstone and mudstone units. Further, to the northeast the Carboniferous limestones are overlain by predominantly red, brown or purple-grey sandstone, siltstone and mudstone sequence of the Warwickshire Group. The entire Carboniferous bedrock sequence is significantly fractured and faulted.

1.4.1.11 The youngest bedrock in the regional sequence is Permo-Triassic sandstone of the Kinnerton Sandstone Formation. This bedrock lies outside of the GHGC study area.

1.4.1.12 As shown in Figure 1.1 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, the Mona Onshore Development Area travels south for approximately 1.7 km across the Carboniferous limestones of the Clwyd Limestone Group. These limestones form the first, north ridge of high ground that passes behind Abergele. These limestones are karstic in nature, with cave development in many places, most notably around Cefn yr Ogof and Gwrych Castle Wood.

1.4.1.13 The GHGC study area then crosses a thin band of the Carboniferous Ffernant Formation before passing onto Silurian mudstones of the Elwy Formation. The Elwy Formation underlies the south area of high ground that includes Moelfre Isaf. The Mona Onshore Development Area is situated above the mudstones of the Elwy Formation for approximately 7 km before crossing back on to the Clwyd Limestone Group in the east, at a point near Bryn-y-Pin Mawr on the B5381, where topography begins to decline.

1.4.1.14 Finally, the GHGC study area passes onto sandstones of the Carboniferous Warwickshire Group at a point near St Asaph business park. The Warwickshire Group underlies the final 2 km of the GHGC study area including the majority of the Onshore Substation, although the boundary between these two bedrock units shown on BGS mapping is inferred.

Table 1.9: Regional geology and hydrogeological classification for the GHGC study area.

Era	Group	Formation	Description*	Thickness*	Aquifer designation (NRW)	BGS hydrogeological description
Superficial geology						
Quaternary		Tidal Flat Deposits	Tidal flat deposits, including mud flat and sand flat deposits. They consist of unconsolidated sediment, mainly mud and/or sand	-	Secondary Undifferentiated	Not described
		Marine Beach Deposits	Shingle, sand, silt and clay; may be bedded or chaotic; beach deposits may be in the form of dunes, sheets or banks; in association with the marine environment.	-	Secondary A	Not described
		Storm Beach Deposits	A low rounded ridge of coarse materials (gravels, cobbles and boulders) piled up by very powerful storm waves at the inland margin of a beach, above the level reached by normal spring tides.	-	Secondary A	Not described
		Glacial Till (Devensian)	Unconsolidated mixed deposit consisting of a heterogenous mixture of clay, sand, gravel, and boulders varying widely in size and shape	-	Secondary Undifferentiated	Not described

Era	Group	Formation	Description*	Thickness*	Aquifer designation (NRW)	BGS hydrogeological description
	Glaciofluvial Deposits[#]		Unconsolidated material by glacial river waters and consisting of boulders, gravel, sand, silt and clay from ice sheets or glaciers.	-	Secondary A	Not described
	Alluvium[#]		Sorted/Semi-sorted clay, silt, sand and gravel deposited by a river, stream or other body of running water.	-	Secondary A	Not described
	Head Deposits		Poorly sorted and poorly stratified, angular rock debris and/or clayey hillwash and soil creep. Can comprise gravel, sand and/or clay.	-	Secondary Undifferentiated	Not described
	River Terrace Deposits		Sand and gravel, locally with lenses of silt, clay or peat.		Secondary A	Not described
Bedrock geology						
Permo-Triassic	Sherwood Sandstone Group	Kinnerton Sandstone Formation	Sandstone, red-brown to yellow, generally pebble-free, fine- to medium-grained, cross-stratified.	Can be > 150 m	Principal	Highly productive aquifer. Significant intergranular flow. Sandstone, with some conglomerates, aquifer yielding up to 25 L/s in Eden and Clwyd valleys
Carboniferous	Warwickshire Group		Predominantly red, brown or purple-grey sandstone, siltstone and mudstone, some grey strata, coals not common, local conglomerates, localised beds of limestone.	Up to 1,200 m	Secondary A	Not described

Era	Group	Formation	Description*	Thickness*	Aquifer designation (NRW)	BGS hydrogeological description
	Clwyd Limestone Group		Diverse range of limestone facies with subordinate sandstone and mudstone units.	Up to 900 m	Principal	Moderately productive aquifer. Flow is virtually all through fractures and other discontinuities. Massive karstic limestone aquifer with rapid response to rainfall. Yields highly variable from dry to 40 L/s
	Not Applicable	Ffernant Formation (formerly the Carboniferous Basement Beds)	Red, purple and variegated silty mudstones, siltstones and sandstones with lenticular bodies of conglomerate.	Up to 330 m	Secondary A	Not described
Silurian	Not Applicable	Elwy Formation	Silty mudstones and subordinate sandstones with lateral facies changes.	>1,750 m	Secondary B (Sandstones horizons Secondary A)	Low productivity aquifer. Flow is virtually all through fractures and other discontinuities. Highly indurated argillaceous rocks with limited groundwater.

Greyed out rows denote geological units that do not underlie the Mona GHGC study area but are part of the regional sequence.

* Geological descriptions and indicative unit thicknesses have been taken from the BGS Lexicon of Named Units or the BGS Memoir for the area (Warren et al., 1983).

# Denotes superficial deposits of minor importance within the Mona GHGC study area

Superficial deposits

Glacial till and glaciofluvial deposits

1.4.1.15 With the exception of the Mona Landfall, the superficial geology within the GHGC study area is dominated by glacial till. The BGS geological memoir for the area describes the glacial till in fresh exposures as consisting of '*a stiff, steel grey to blue black clay with numerous pebbles and boulders*' (Warren *et al*., 1984). Warren *et al*. (1984) also states there is evidence that the upper 2 m to 3 m of the till can occur as a friable yellow clay with angular stones more numerous pebbles on boulders. Geological logs for the area around Abergele and Bodelwyddan commonly describe the glacial till as a red clay that can exceed 4.4 m in depth (Warren *et al*., 1984).

1.4.1.16 Glacial till occurs as either:

- Thin patches on relatively high ground
- Extensive till deposits with a relatively smooth surface filling low ground, with a thickness of up to 30 m in the main valleys
- As 'drumlins' and associated glacial structures which have a height of up to 3 m (see Figure 1.2 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement).

1.4.1.17 As can be seen in Figure 1.2 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, almost the entire Mona Onshore Development Area is shown to be underlain by glacial till, except for:

- Small 'windows' where superficial deposits are absent, most notably at summit of local high ground along the north ridge of high ground and Moelfre Isaf in the south
- Small areas of glaciofluvial deposits associated with the glacial till
- Localised areas alluvial deposits where the Mona Onshore Development Area crosses small surface watercourses.

1.4.1.18 Glacial till is most continuous and is likely to be thickest in the east half of the Mona Onshore Development Area where elevations decline towards the Onshore Substation. In general, the glacial till can be expected to be a relatively thick, cohesive, clay-rich deposit.

1.4.1.19 As shown in Figure 1.2 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, two drumlin features are located partially in or cross the Mona Onshore Development Area. Drumlins are low, oval or elongated mounds or small hills consisting of compacted till that were formed by the movement of glacial ice. These glacial features have no formal designation.

1.4.1.20 Small areas of glaciofluvial deposits are found in association with the glacial till. Warren *et al*. (1984) describe the glaciofluvial deposits as being either:

- Irregular, mound-like patches of ill-sorted, poorly bedded or unbedded gravel (and sand) overlying bedrock or till
- Flattish spreads of generally cross-bedded sands and gravels.

1.4.1.21 It can be seen in Figure 1.2 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, that glaciofluvial deposits are rare within the GHGC study area and of limited extent. The Mona Onshore

Development Area is shown to cross these deposits in a single, small area to the north of the A548 crossing in the west.

Marine beach deposits and storm beach deposits

1.4.1.22 Marine beach deposits are present along the coastline within the GHGC study area including the Mona Landfall site at Llanddulas. Warren *et al*. (1984) describes present day marine beach deposits as consisting of sand, with some mud and shingle.

1.4.1.23 Storm beach deposits fringe the marine beach deposits at the Mona Landfall, forming a raised bar along the beach with a height above MHWS. In this area the coarse beach gravels are described as being up to 10 cm in diameter.

Local geological records

1.4.1.24 The expected geological sequence within the Mona GHGC study area has been corroborated using borehole records on the BGS GeoIndex Onshore platform. The geological logs for four boreholes and one mine audit identified within the Mona GHGC study area are provided in Appendix A of Volume 1, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, wherein their location is shown in Figure 1.1 and Figure 1.2. These logs demonstrate:

- There are no publicly available borehole records for the Silurian bedrock (Elwy Formation) within the Mona GHGC study area
- Glacial till is thick in the east and northeast where it is continuous and can exceed 30 m in depth
- The glacial till is often red or reddish, particular in the east
- In the west, where elevations are highest, the composition and thickness of superficial deposits is more variable. Sand and gravel are more common and the superficial deposits are commonly thinner than seen in east.

Mineral safeguarding areas

1.4.1.25 The Carboniferous bedrock of the Clwyd Limestone Group is designated a Mineral Safeguarded Area (MSA) for limestone in the adopted LDPs of CCBC and DCC. As shown in Figure 1.1 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, the east and west ends of the Mona Onshore Development Area are situated above the Clwyd Limestone Group and associated MSA. In these areas the limestone is largely concealed beneath glacial till, except where windows in the glacial till expose the bedrock at high elevation.

1.4.1.26 River Terrace Deposits, principally present within the valley of the Afon Elwy are also designated a MSA for sand and gravel by CCBC and DCC. Given the Mona Onshore Development Area does not cross this MSA and it is located at a lower topographic elevation, these sand and gravel minerals resources are not considered further.

Quarrying and mining

Current operations

1.4.1.27 No active mining operations have been identified within the GHGC study area.

1.4.1.28 St George Quarry (also known as Parc-y-meirch Quarry) is an active limestone quarry located approximately 2.5 km southeast of Abergele, Conwy. It is one of CCBC's three working quarries: it has planning permission until 2035 and predominantly serves

northeast Wales. CCBC has defined a 200 m buffer zone around the quarry to reduce potential conflicts between land uses.

1.4.1.29 The south tip of the quarry and the buffer zone extend into the GHGC study area, however, the Mona Onshore Development Area is located outside this buffer zone and is underlain by Silurian bedrock of the Elwy Formation. On this basis, St George Quarry is not considered further in this assessment.

1.4.1.30 No active quarries or quarry buffer zones were identified in the GHGC study area in the DCC planning area.

Historical operations

1.4.1.31 The Coal Authority confirmed the absence of coal mining in the GHGC study area in their response to the Mona Scoping Report (The Planning Inspectorate, 2022).

1.4.1.32 The BGS geological memoir for Rhyl and Denbigh does, however, identify widespread historical mining, most notably of lead, zinc, copper and iron ores (Warren *et al*., 1984). Further information regarding mining is also provided in *The Non-Ferrous Mines of Denbighshire* report (Foster-Smith, 1972). Within the GHGC study area this mineralisation is associated with the Carboniferous bedrock and is often closely related to faulting of the Carboniferous limestone and Carboniferous Basement Beds (i.e. the Ffernant Formation). Warren *et al*. (1984) identified the following historical mines within the GHGC study area:

- Cefn yr Ogof (NGR SH 917 773) lead and zinc mine
- Castell Cawr lead and zinc mines:
  - Extensive working of veins crossing the north end called Ffos-y-Bleiddiaid (NGR SH 936 766)
  - Workings on south edge, on the long abandoned Tyddyn Morgan Mine (NGR SH 937 764)
- Nant Uchaf Mine (NGR SH 934 760) - Southwest of Abergele (Lead, Zinc, Iron and Manganese)
- Bodelwyddan Mine (NGR SH 997 749) – A lead and zinc mine that was active between 1851 and 1858; it was abandoned in 1859
- Score Mine (NGR SH 993 737) also known as Cefn Mine. A lead and zinc mine that was abandoned in 1851
- Coed-Carreg-Dafydd lead mine (NGR SH 995 733)
- Pant y Celyn Lead Mine (NGR SJ 013 727) also known as Coed Celyn Mine.

1.4.1.33 The location of these historical mines is shown in Figure 1.6 of Volume 7, Annex 1.1: Aquifer, groundwater abstractions and ground conditions of the Environmental Statement and are all associated with the limestone of the Clwyd Limestone Group or the underlying Ffernant Formation. These mines are all comparatively deep and are associated with the disused shafts commonly identified on Ordnance Survey mapping obtained for the area.

1.4.1.34 There is little detailed information regarding these historical mines, except for Bodelwyddan Mine that was obtained from BGS borehole records for borehole SJ07NW94. Although situated to the north of the Mona Onshore Development Area, those records confirm the extent and depth of the worked mineral veins and the location of historical shafts. The records also confirm that there has been historical

monitoring of groundwater levels and groundwater discharge from the now flooded sections of the mine.

1.4.1.35 The mining dataset provided in the Groundsure Enviro-Geo report is presented Figure 1.6 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. The dataset includes:

- Non-coal mining areas – Areas where there is the potential for historical non-coal mining to have affected an area, based on expert knowledge, literature and the Digital Geological Map of Britain. These zones are classified based on the likelihood of mining and the following data has been presented:
  - Zone D, underground mining is known or considered likely to have occurred within or close to the area
  - Zone E, underground mining is known to have occurred within or very close to the area
- British Pits (BritPits) – BGS database of closed and active surface and underground mineral workings.

1.4.1.36 Based on the BGS reporting and the Groundsure Enviro-Geo Insights report dataset, three areas that may be affected by historical mining have been identified in the Mona Onshore Development Area. These areas are situated in the east and west, where the Mona Onshore Development Area is underlain by Carboniferous bedrock of the Clwyd Limestone Group or Ffernant Formation, and include:

1. The area located within the Mona GHGC study area between Cefn yr Ogof and Gwrych Castle (approximately 0.75 km south of the Mona Landfall). It includes disused shafts identified on Ordnance Mapping towards the top of the coastal high ground. These features are likely to relate to the Cefn yr Ogof mine and is situated above limestones of the Clwyd Limestone Group
2. The area located around Sinan, south of Glascoed and west Cefn Meiriadog (approximately 2 km south of Bodelwyddan and 3.5 km from the east end of the GHGC study area). This area includes the Score (Cefn) Mine and Coed-Carreg-Dafydd Mine and is situated above limestones of the Clwyd Limestone Group.
3. Small area of historical mining that appears to be associated with the Panty Celyn Lead Mine, in the southeast of the Mona GHGC study area. This activity is situated around the exposed bedrock at higher elevation on the flanks of Bryn Meriadog. This area is located immediately south of the Mona Onshore Development Area including the Onshore Substation.

1.4.1.37 The presence of historical deep mining does have implications with respect to geotechnical considerations and may potentially affect soil quality principally through the historical disposal of mine waste and tailings. Areas (1) and (2) are considered relevant to the Mona Onshore Development Area. Area (3) is unlikely to represent a risk for the Transmission Assets, given their distance of separation and the fact that this part of the Mona Onshore Development Area is underlain by glacial till and is at a lower topographic elevation.

1.4.1.38 In addition to the historical deep mining, many small surface quarries have been identified within the GHGC study area from historical mapping and at certain points within the Mona Onshore Development Area (See Figure 1.6 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement). These sites are typically small, old and commonly associated with local

limestone or clay extraction. Although former quarries do represent potential sites for uncontrolled waste disposal, these sites are considered to represent a low risk given their small size and old age. As such, they have not been evaluated in any further detail for the Environmental Statement but will be examined further as part of site investigation to be undertaken as part of detailed design.

Hydrogeology

Aquifer units

1.4.1.39 Aquifers in Wales are classified by NRW and the BGS (British Geological Survey, 2022) on the following basis:

- Principal aquifer – the geological unit that provides significant quantities of water and can support water supply and/or baseflow to rivers, lakes and wetlands on a strategic scale. They typically have a high intergranular and/or fracture permeability meaning they usually provide a high level of water storage
- Secondary A aquifer – the geological unit that provides modest amounts of water, but the nature of the rock or the aquifer's structure limits their use. They support water supplies at a local rather than strategic scale (such as for private supplies) and remain important for rivers, wetlands and lakes
- Secondary B aquifer – Dominated by lower permeability layers that may store and yield limited amounts of groundwater
- Secondary (undifferentiated) aquifer - Where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type, but generally have only a minor resource value
- Unproductive strata - These rocks have negligible significance for water supply or baseflow to rivers, lakes and wetlands. They consist of bedrock or superficial deposits with a low permeability that naturally offer protection to any aquifers that may be present beneath.

1.4.1.40 Aquifer classifications for bedrock and superficial geology within the GHGC study area are summarised in Table 1.9 and shown in Figure 1.3 and Figure 1.4 in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement respectively. Table 1.9 also provides the BGS hydrogeological description for each bedrock unit.

1.4.1.41 With regards to superficial geology, the majority of the GHGC study area is underlain by glacial till which is classified a Secondary (Undifferentiated) aquifer unit. Given its clay-rich nature and low permeability, groundwater will be restricted to localised granular lenses or layers in the glacial till which do not typically form significant groundwater bodies. As its aquifer classification suggests, localised groundwater within the glacial till is not considered to be of significant resource value. The majority of the Mona Onshore Development Area and the Onshore Substation are underlain by the Secondary (Undifferentiated) aquifer which is thickest in the east.

1.4.1.42 Granular glaciofluvial deposits, found in association with the glacial till in the west, can form locally important groundwater bodies and are classified as a Secondary A aquifer unit. The importance of these aquifers is, dependent on their thickness and the lateral extent of these deposits. The extent of these deposits in the GHGC study area is limited. The local geological records in Appendix A of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement provide little detail regarding the glaciofluvial deposits, however BGS geological maps

show these deposits extend to less than 0.024 km^2 within the Mona Onshore Development Area.

1.4.1.43 The Silurian bedrock of the Elwy Formation is overlain by till in areas of high ground in the south and central areas of the GHGC study area. The mudstones and siltstones that dominate the Elwy Formation have little intergranular porosity and low permeability. Groundwater in this formation is restricted to fractures and faults or associated with zones of weathering, typically at shallow depth. The possible presence of groundwater in shallow weathered Elwy Formation is shown by shallow wells and springs on OS mapping, with springs commonly marking the contact between the exposed bedrock and glacial till. The Elwy Formation does contain some localised groundwater bearing sandstones units and these can support small domestic supplies (BGS, 1989), but are not located in the GHGC study area. The Elwy Formation is classified a Secondary B aquifer unit reflecting its low permeability and the fact groundwater is typically of little resource importance.

1.4.1.44 The most important aquifers within the GHGC study area are associated with the carboniferous bedrock that underlies the GHGC study area in the northwest and east. Limestones of the Clwyd Limestone Group are classified as a Principal Aquifer, suggesting significant groundwater can be obtained from this unit. However, these karstic limestones are unpredictable in terms of their permeability distribution with a low storage potential. As stated by Jones *et al*. (2000), these limestones have minimal primary porosity or permeability with groundwater storage and movement restricted to solution enlarged fractures. As these fractures are not regularly spaced, nor extensively interconnected, failure to intersect a water-bearing fracture commonly results in a dry or low yielding borehole. Jones *et al*. (2000) also, state that discharge from the fractured limestone systems occurs at a small number of large springs with high (albeit seasonally variable) flow rates. No large springs have been identified in the GHGC study area. It can be concluded that groundwater levels in the limestones will, therefore, be variable, but are likely to be at considerable depth beneath areas of high ground.

1.4.1.45 The underlying mudstones, siltstones and sandstone of the Ffernant Formation are classified a Secondary A aquifer unit, reflecting their potential to be of local resource importance. Similarly, the overlying sandstones, siltstones and mudstones of the Warwickshire Group are classified a Secondary A aquifer unit. The sandstones of the Warwickshire Group are groundwater bearing, however Warren *et al*. (1984) state that these sandstones are well cemented giving them very low permeability. They also state the principal significance of the upper carboniferous bedrock sequence is to hydraulically separate the Carboniferous limestones from the overlying Permo-Triassic aquifers. The Onshore Substation Site is shown to be underlain by this Secondary A aquifer unit over the majority its area, although the boundary with the limestone of the Clwyd Limestone Group is inferred as the bedrock is concealed beneath glacial till.

1.4.1.46 The BGS borehole records provided in Appendix A of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement confirmed the following:

- Where present, groundwater in the limestone aquifer of the Clwyd Limestone Group is located at significant depth beneath areas of high ground.
- The hydraulic properties of the limestone aquifer of the Clwyd Limestone Group are spatially variable and can be unproductive where groundwater bearing fissures and fractures are not present (See BGS Ref. SH97NW91)

- The absence of any borehole records for Silurian bedrock (Elwy Formation) area suggesting it is not important with respect to water resources. This also reflects its designation as a Secondary B aquifer.

Groundwater occurrence across the GHGC study area

1.4.1.47 The west end of the GHGC study area crosses Marine Beach Deposits and a ridge of Storm Beach Deposits. These predominantly granular deposits will contain groundwater at shallow depth. The groundwater contained in the marine beach deposits will be saline and non-potable.

1.4.1.48 Groundwater will be present beneath the ridge of Storm Beach Deposits. Given its coastal setting, this groundwater is likely to brackish or saline in nature, although a small surface lens of fresher water may develop above more saline waters beneath given its height above MHSW.

1.4.1.49 The west end of the GHGC study area passes onto low-lying glacial till immediately south of the A55. The till is likely to be thick in this low-lying area, with localised groundwater occurrence possible at shallow depth. In this area, the till conceals limestone of the Clwyd Limestone Formation. Groundwater levels in this limestone aquifer are uncertain, but likely to approach sea level.

1.4.1.50 On the north ridge of high ground between Cefn yr Ogof and Gopa wood, the GHGC study area is situated above glacial till except around the local summits that are formed of Carboniferous bedrock of the Clwyd Limestone Group. The till will be of a variable thickness, often shallow, and localised groundwater bodies may be encountered. BGS borehole records (in Appendix A of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement) show unconfined groundwater to be present at considerable depth in the Clwyd Limestone Group aquifer in this area.

1.4.1.51 To the south, the Silurian bedrock may contain some groundwater in shallow fractures or a surface weathered zone. However, this groundwater will be of limited extent and little resource value. Much of the GHGC study area is underlain by glacial till, with small windows of exposed bedrock. Localised areas of groundwater may be present at shallow depth. Small areas of glaciofluvial deposits are present in association with the glacial till in this area. Although glaciofluvial deposits can contain groundwater, geological mapping suggests that these water bodies will be of small extent and limited resource value in the GHGC study area and little importance within the Mona Onshore Development Area.

1.4.1.52 The south part of the Mona Onshore Development Area, from the crossing of the A548 to the Onshore Substation and Grid Connection is almost entirely underlain by glacial till. BGS borehole records confirm that the till thickens to the east, becoming more continuous as the topographic elevation declines. In the area to the north of Moelfre Isaf, the till within the GHGC study area includes multiple drumlins, although only two are shown to be crossed wholly or partially by the Mona Onshore Development Area. These features form locally thicker mounds of glacial till.

1.4.1.53 Across the south and east parts of the GHGC study area, bedrock is concealed beneath glacial till that potentially exceeds a thickness of 30 m in places. The bedrock aquifers include limestone of Clwyd Limestone Group and sandstones of the Warwickshire Group aquifer. In the east, at lower topographic elevation, groundwater in these bedrock aquifers is likely to be confined by the overlying till and would only be encountered at significant depth. Given that the bedrock aquifers in this area will ultimately discharge to low-lying local surface watercourses it is considered unlikely

that artesian groundwater conditions (i.e. groundwater levels above ground level) will be encountered in these confined aquifer units.

Water Framework Directive Groundwater Bodies

1.4.1.54 The GHGC study area crosses three groundwater bodies defined for the Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy) (WFD). These groundwater bodies and their status is summarised in Table 1.10 and shown within Volume 7, Annex 2.4: Water Framework Directive surface water and groundwater assessment of the Environmental Statement.

Table 1.10: Summary of WFD groundwater bodies within the GHGC study area.

* Water Framework Directive (WFD) groundwater body status determined for Cycle 2 (2014-2019)

Reference	Name	Position in GHGC study area	Overall status*	Quantitative status*	Chemical status*
GB41001G202100	Clwyd Permo-Triassic Sandstone	Northeast of the first ridge of high ground immediately south of Llanddulas and Abergele	Good	Good	Good
GB41002G200100	Clwyd Silurian	Southwest of the first ridge of high ground immediately south of Llanddulas and Abergele. West of the A458.	Good	Good	Good
GB41002G203000	Conwy	Southwest of the first ridge of high ground immediately south of Llanddulas and Abergele. East of the A458.	Poor	Good	Poor

1.4.1.55 The Clwyd Permo-Triassic Sandstone and Clwyd Silurian groundwater bodies currently have good status (2019). The Conwy groundwater body has poor overall status, which relates to the assessment of its chemical status in relation to the 'groundwater impacts on surface water' test.

Licensed groundwater abstractions

1.4.1.56 One licensed groundwater abstraction source has been identified in the GHGC study area. The abstraction, GWA_02, is shown in Figure 1.3 and Figure 1.4. of Volume 7, Annex 1.1: Aquifer, groundwater abstractions and ground conditions of the Environmental Statement as well as in Figure 1 of Volume 7, Annex 1.2 Hydrogeological risk assessment for groundwater supply sources of the Environmental Statement.

1.4.1.57 The licensed abstraction source is situated above the Principal aquifer of the Clwyd Limestone Group. It is located c. 50 m from the Mona Onshore Development Area at Bryn-y-pin and is recorded as being a historical abstraction source from the Clwyd Limestone Group.

1.4.1.58 The closest active licensed abstraction sources (GWA_06 and GWA_07) are situated in the north of St Asaph, approximately 1.6 km northeast of the Mona Onshore Development Area and immediately west of the Afon Elwy. These sources are located above bedrock of the Warwickshire Group. These licensed abstractions are located a significant distance from the east end of the Mona Onshore Development Area. The abstractions are presumed to be down-hydraulic gradient from the Onshore Substation

given their low elevation and position near the Afon Elwy which represents the local receptor for groundwater.

Private groundwater supply sources

1.4.1.59 Ordnance Survey mapping (1:25,000 scale) identifies many 'wells' across the GHGC study area, most notably in areas of high elevation that are underlain by the Silurian bedrock and commonly overlain by glacial till. The highest density of 'wells' are found in the area extending from the northwest to northeast of Moelfre Isaf, at comparatively high elevations above 160 m AOD. Only one of these wells appears to be situated within the Mona Onshore Development Area, although several are located in relatively close proximity. Although there are no licensed abstractions in the low permeability Silurian bedrock, the presence of these wells suggest small abstractions for agricultural purposes may be relatively common and some shallow water is accessible at low volumes.

1.4.1.60 A survey of private groundwater abstractions was undertaken through dialogue with landowners within the GHGC study area. The outcome of that survey and associated hydrogeological risk assessment is presented in Volume 7, Annex 1.2: Hydrogeological risk assessment for groundwater supply sources of the Environmental Statement.

1.4.1.61 A total of nine private groundwater supply sources have been identified in the GHGC study area through consultation with CCBC, DCC and landowner surveys (Ref. PWS 01 to PWS 09 inclusive). The location and geological setting of those nine private groundwater supply sources is shown in Figure 1 of Volume 7, Annex 1.2: Hydrogeological risk assessment for groundwater supply sources of the Environmental Statement.

Groundwater and historical mining

1.4.1.62 The physical properties of minor aquifers in England (BGS, 2000) confirms that mines were historically worked around Abergele and St Asaph. Information obtained during mining and the driving of drainage tunnels indicate that rock structure largely controls the seaward movement of groundwater (Richards, 1959). Seven of the eight historical mines recorded by BGS, discussed in section 1.4.1.32, are located within the Clwyd Limestone Group. Subsequently, the rock structures influencing groundwater flow will be characteristic of karstic hydrogeological flow regimes. Studies have shown that variation in limestone permeability result in highly variable groundwater levels, which can result in the so-called 'chessboard and staircase' drainage pattern (Smith, 1921).

1.4.1.63 Gravity drainage was used in lead-zinc mines, with several schemes involving drainage tunnels (known as 'adits') undertaken since 1818. These adits encountered many natural solution caverns. By providing zones of high permeability the drainage tunnels and shafts also affected natural flow systems of the area. Flows from drainage tunnels can be substantial, for example a discharge of approximately 2,900 m^3/day was recorded from an adit at Bodelwyddan on 19 May 1998 [NGR SJ 0048 7506]. Information provided with the BGS geological records for a borehole at Bodelwyddan Mine (BGS Ref. SJ07NW94) in Appendix 1 of Volume 7, Annex 1.1: Aquifers, groundwater abstraction and ground conditions of the Environmental Statement, confirmed the historical monitoring of groundwater and groundwater discharge from the now flooded sections of the mine.

1.4.1.64 It is also noted that historical licensed abstraction source GWA_03 was stated to be a mine adit. Given its position approximately 600 m east of Bodelwyddan it is likely to be associated with the former Bodelwyddan Mine.

Groundwater Source Protection Zones

1.4.1.65 There are no groundwater SPZs within the GHGC study area. The closest SPZs are:

- Llannerch Park abstraction borehole situated approximately 3.5 km east of the Mona Onshore Development Area. It is above the Permo-Triassic sandstone aquifer of the Kinnerton Sandstone Formation. It has a capture zone that extends southeast away from the GHGC study area and is outside the area of potential influence.
- Trofarth Farm abstraction borehole located more than 8 km west southwest of the Mona Onshore Development Area and above Silurian bedrock aquifer of the Elwy Formation. It is considered outside the area of potential influence.

Summary of groundwater receptors

1.4.1.66 Private and licensed groundwater supply sources represent important and sensitive groundwater receptors within the GHGC study area.

1.4.1.67 The surface watercourses that cross the Mona Onshore Development Area also constitute potential groundwater receptors, where they are in hydraulic continuity with aquifers in the underlying bedrock and/or superficial deposits. Groundwater within these aquifer units will tend to flow towards, and discharge to, these watercourses. However, the discontinuous nature of groundwater in the glacial till and its limited resource potential suggests that the groundwater contribution to these small watercourses will be of limited importance to their flow regime which will be principally surface water dominated.

1.4.1.68 The desktop study has not identified any groundwater dependent protected sites within the GHGC study area.

1.4.1.69 Despite the importance of the Carboniferous limestone aquifers, springs are not a common feature on Ordnance Survey mapping for the GHGC study area. Springs are most commonly observed at relatively high elevation on the north side of Moelfre Isaf in the areas underlain by Silurian bedrock of the Elwy Formation.

1.4.1.70 The ultimate receptor of groundwater in aquifers underlying the GHGC study area is the coastline to which all watercourses ultimately flow and groundwater is discharged.

Ground conditions

1.4.1.71 A preliminary assessment of ground conditions with the GHGC study area has been undertaken and presented in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. In addition to historical mining operations and safeguarded mineral operations described above, other activities that may represent potential risk to land or groundwater quality have been assessed and summarised below.

Landfill sites

1.4.1.72 The historical NRW Llanddulas Beach landfill and licensed waste site (reference LF_01A, LF_01B and WS_01, in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement) extends from west to east, along the ridge of Storm Beach Deposits immediately north of the A55 and coastal railway line. This closed landfill site crosses the Mona Onshore Development Area. The landfill site is a narrow, raised feature formed by the historical disposal of a range of waste types that include household waste and possible industrial waste. The landfill has been subject to historical leachate and gas monitoring.

1.4.1.73 Ty Mawr Ucha Farm landfill is the only active landfill identified within the GHGC study area (reference LF_02 in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement). The landfill and licensed waste site are situated immediately west of the A548, near Abergele Hospital. The site is located approximately 700 m from northeast of the Mona Onshore Development Area, on the opposite side of a local topographic high, in an area that is underlain by glacial till and Silurian bedrock of the Elwy Formation. Given this setting it is considered to represent a low soil and groundwater contamination risk with regards to the Mona Onshore Development Area.

1.4.1.74 A small historical landfill site that received inert and household waste is identified at Moelfre and is situated immediately north of the Mona Onshore Development Area (reference LF_03 in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement). This site is considered to represent a low soil and groundwater contamination risk in relation to the Mona Onshore Development Area given it is a small, historical landfill site, that is underlain by low permeability glacial till and Silurian bedrock of the Elwy Formation and is located 500 m to the north.

1.4.1.75 The historical Plas Newydd Cefn landfill site (reference LF_04 in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement) is the most easterly landfill site identified in the GHGC study area. The landfill is recorded as having historically received industrial and commercial waste. The landfill site is considered to represent a low soil or groundwater contamination risk with respect to the and Onshore Cable Corridor given its small size (less than 0.004 km^2), its old age and its position approximately. 200 m north of the Mona Onshore Development Area on the opposite side of a local area of topographic high ground.

Other recent and historical land-uses

1.4.1.76 The Waterloo Service Station is the only active petrol station within the Mona GHGC study area. It is located on the B5381, near the Penreefail crossroads with the A548 and is situated above glacial till and Silurian bedrock of the Elwy Formation. Given its proximity to the Mona Onshore Development Area, it does represent a possible soil or groundwater contamination risk with respect to the transmission assets. There is also a former petrol station in St Asaphs, however it is located more than 1.3 km northeast of the Mona Onshore Development Area.

1.4.1.77 Several licensed industrial activities have been identified at the east end of the GHGC study area at St Asaph business park (ref. HA_01 to HA_04). These sites operate inorganic processes within the former Pilkington's Special Glass site (that ceased manufacturing in 2008) and the active Qioptiq Ltd site. The sites are situated between 100 m to 200 m outside Mona Onshore Development Area. Although this area is underlain by glacial till, these sites could potentially represent a possible soil or groundwater contamination risk with respect to the transmission assets.

1.4.1.78 Many other recent and historical land-uses have been identified within the GHGC study area (as shown in Figure 1.5 Volume 7 Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement). Recent or current land-uses include, unspecified tanks, slurry stores or beds, hoppers and silos. Recent industrial land-uses are most common in the east end of the Mona Onshore Development Area around St Asaphs and considered to be a low soil or groundwater contamination risk in relation to the Mona Onshore Cable Corridor, Onshore Substation and 400 kV Grid Connection Cable Corridor.

1.4.1.79 Historical land uses include small unspecified quarries, old tanks and old mine shafts. These historical features were identified from OS mapping and are typically old features, that commonly predate the 1970's and often date back to mining or local stone / clay recovery in the 19th and early 20th Century. When considering recent industrial land uses, comparatively few historical land uses have been identified in or near the Mona Onshore Development Area, with the exception of the area around Sinan, between Cefn Meriadog and Glascoed. These features are generally related to the historical metal mining and are considered likely to represent a relatively low soils or groundwater contamination risk in relation to the Mona Onshore Development Area although geotechnical and geoenvironmental considerations will be required during detailed design.

Pollution incidents

1.4.1.80 One pollution incident (of category 2) was identified within the GHGC study area and is shown in Figure 1.5 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. This incident affected land and is located around St Asaph outside the Mona Onshore Development Area. Given its location, it is considered likely to represent a low contamination risk for soils and groundwater in relation to the Mona Onshore Cable Corridor, Onshore Substation and 400 kV Grid Connection Corridor.

Licensed discharges to groundwater

1.4.1.81 Nine of the ten licensed discharges to groundwater within the GHGC study area are situated more than 100 m outside of the Mona Onshore Development Area. The closest discharge consent is GD_09 and is adjacent to the Mona Onshore Development Area. As described in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, none of these sites are considered to represent a high risk to groundwater quality given the characteristics of the treated effluent within the consented discharges. However, certain measures may be required should groundwater management be required in relation to the Mona Onshore Cable Corridor, Onshore Substation and 400 kV Grid Connection Corridor.

1.4.2 Designated sites

1.4.2.1 Designated geological, geomorphological or groundwater dependant sites identified for the GHGC study area are described in Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement. There are four SSSIs within the GHGC study area; two of which fall within or are crossed by the Mona Onshore Development Area. These sites are designated for ecological features, however Llanddulas Limestone and Gwrych Castle Wood SSSI includes caves, which represent features of geological and geomorphology interest.

1.4.3 Future baseline scenario

1.4.3.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended) requires that as well as a description of the current baseline, the Environmental Statement must include "*an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*". In the event that Mona Offshore Wind Project does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

1.4.3.2 The baseline conditions associated with geology, hydrogeology and ground conditions are not subject to significant change should the Mona Offshore Wind Project not come forward. In the absence of construction and operations of the onshore infrastructure little change is expected with regards to the following:

- Geology
  - Designated and non-designated sites and features of geological or geomorphological significance.
- Hydrogeology
  - Groundwater bodies/aquifer units
  - Groundwater levels and groundwater flow patterns
  - Groundwater recharge rates
  - Groundwater quality and the level of groundwater abstraction
  - Groundwater discharge to groundwater dependent receptors
- Ground Conditions
  - Areas of potentially contaminated land/groundwater relating to historical or recent land-use.
  - Operation of permitted landfill sites/ waste facilities.

1.4.3.3 Climate change represents the only possible mechanism that could potentially result measurable changes to hydrogeology, through changes to the amount and distribution of recharge to aquifers. The Meteorological Office provide UK Climate Projections (UKCP) the most recent being for 2018 (UKCP18). The projected climate change impacts on rainfall and river flow for Wales could involve decreasing summer rainfall and increasing winter rainfall resulting in more severe low flow events in rivers and high peak river flows.

1.4.4 Data limitations

1.4.4.1 The assessments presented in this chapter are largely based on the results of a desktop study of baseline conditions. At this stage no site-specific geological, hydrogeological or ground condition survey data has been gathered. The use of publicly available data sources is considered sufficient, given the rural setting of the site and conservative nature of the assessments undertaken, particularly with respect to mitigating possible effects. The desk-based assessments have been augmented with a site-specific desk-based survey regarding private groundwater supply sources near the Mona Onshore Development Area. This site specific data, is presented in Volume 7, Annex 1.2: Hydrogeological risk assessment for groundwater supply sources of the Environmental Statement.

1.4.4.2 The Mona Offshore Wind Project has undertaken a campaign of ground investigations during Q3/Q4 of 2023 to gather site specific ground conditions information. This information will be used to inform detailed design.

1.5 Impact assessment methodology

1.5.1 Overview

1.5.1.1 The geology, hydrogeology and ground condition impact assessment has followed the methodology set out in Volume 1, Chapter 5: EIA methodology of the Environmental

Statement. Specific to the geology, hydrogeology and ground condition impact assessment, the following guidance documents have also been considered:

- Welsh Local Government Association (WLGA) and NRW (2017) Development of land affected by contamination: A Guide for developers, version 3
- Environment Agency (2020) Land contamination risk management (LCRM)
- Construction Industry Research and Information Association (CIRIA) (2006) Technical Guidance C648: Control of Water Pollution from Linear Construction Projects
- Environment Agency (2018) The Environment Agency's approach to groundwater protection, version 1.2
- NetRegs (2022) Guidance for Pollution Prevention (GPPs)
- CIRIA (2001) Contaminated land risk assessment: A guide to good practice (C552)
- Design Manual for Roads and Bridges (DMRB) (October 2019) Sustainability and Environment Appraisal: LA 109 - Geology and soils, Revision 0
- DMRB (March 2020) Sustainability and Environment Appraisal: LA 113 - Road drainage and the water environment, Revision 1
- British Standards Institute (BSI) (2013) BS10175: Code of Practice for Investigation of Potentially Contaminated Sites.

1.5.1.2 In addition, the geology, hydrogeology and ground conditions impact assessment has considered the legislative framework defined in paragraph 1.2.1.1.

1.5.2 Impact assessment criteria

1.5.2.1 The criteria for determining the significance of effects is a two stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in Volume 1, Chapter 5: EIA methodology of the Environmental Statement.

1.5.2.2 The criteria for defining magnitude in this chapter are outlined in Table 1.11 below.

Table 1.11: Definition of terms relating to the magnitude of an impact.

* The assessment of impacts on groundwater dependent, surface water receptors (i.e. rivers or streams) or ecological receptors will be considered in Chapter 2: Hydrology and flood risk and Chapter 3: Onshore ecology of this Environmental Statement respectively.

Magnitude of impact	Definition
High	**Geology** A large change from baseline conditions, that results in the large-scale loss or deterioration in condition of the geological feature, site or resource affected. The impact is typically of wide spatial extent, long term duration (i.e. up to 10 years) and low reversibility (Adverse). **Groundwater/Hydrogeology** A large change from baseline conditions in an aquifer unit, that results in severe deterioration of groundwater quality, groundwater levels, groundwater flow and/or resource utility, for example: • a deterioration in overall WFD status for a groundwater body

Magnitude of impact	Definition
	• rendering the groundwater in an aquifer unit non-potable through the introduction of hazardous substances into groundwater, failure against prescribed concentrations for pollutants (i.e. statutory Drinking Water Standards), or reduction in resource availability • render existing groundwater supply sources (borehole, well or spring) permanently non-viable • cause a large impact on groundwater dependent watercourse in terms of flow, overall WFD status of the water body or failure against statutory Environmental Quality Standards* • cause statutory monitoring targets for ecological site to be failed. These impacts are likely to be of wide spatial extent, of long term duration (i.e. up to 10 years) and of low reversibility (Adverse),
	Geology A large change from baseline conditions, that results in major improvement in the condition of the geological feature or site affected. The impact will be of wide extent and of long-term duration (Beneficial), **Groundwater/Hydrogeology** A large change from baseline conditions in an aquifer unit, that results in significant improvement in groundwater quality, groundwater levels, groundwater flow and/or resource utility, for example: • an improvement in the overall WFD status for a groundwater body • rendering a previously contaminated aquifer potable or increasing resource availability • rendering existing groundwater sources of supply viable • cause a large beneficial impact on a groundwater dependent receptor (e.g. watercourse in terms of flow, or water quality, or WFD status; achieving statutory monitoring targets for ecological site)*. These impacts are likely to be of wide spatial extent and of long term duration (Beneficial).
Medium	**Geology** A moderate change from baseline conditions, that results in the loss or deterioration in condition of part of the geological feature, site or resource affected. The impact is typically of local to wide spatial extent, medium duration (i.e. up to five years) and of low reversibility (Adverse), **Groundwater/Hydrogeology** A moderate change from baseline conditions in an aquifer unit, that results in the deterioration of groundwater quality, groundwater levels, groundwater flow and/or resource utility, for example: • a deterioration in WFD criteria for certain parameters, although the overall WFD status may not change • a deterioration in groundwater quality in an aquifer and/or possible failure against certain prescribed concentrations (i.e. statutory Drinking Water Standards) • deterioration in quality, quantity, or reliability of groundwater source of supply (borehole, well or spring) or render existing groundwater supply sources (borehole, well or spring) temporarily non-viable • cause a moderate impact on groundwater dependent watercourse in terms of flows, or WFD status or failure relative to statutory Environmental Quality Standards • cause statutory monitoring targets for ecological site to be failed*.

Magnitude of impact	Definition
	These impacts are likely to be of local to wide spatial extent, or of medium duration (i.e. up to five years) and/or of low reversibility (Adverse).
	Geology A moderate change from baseline conditions, that results in improvement in the condition of part of the geological feature or site affected. The impact is typically of local to wide spatial extent, medium duration and of low reversibility (Beneficial). **Groundwater/Hydrogeology** A moderate change from baseline conditions in an aquifer unit, that results in the improvement in groundwater quality, groundwater levels, groundwater flow and/or resource utility. These impacts are likely to be of local to wide spatial extent, of medium duration (Beneficial).
Low	**Geology** Some measurable change from baseline conditions, that results in a small deterioration in condition of part of the geological feature, site or resource affected. The impact is typically of limited spatial extent and may be of short duration (i.e. up to two years) and/or reversible (Adverse) **Groundwater/Hydrogeology** Some measurable change from baseline condition, that results in a small deterioration of groundwater quality, groundwater levels, groundwater flow and/or resource utility but does not change its regulatory status (e.g. overall WFD status) or utility of resource given. The impacts are small, likely to be of limited spatial extent, or of short duration (i.e. up to two years) and/or reversible (Adverse).
	Geology Some measurable change from baseline conditions, that results in a small improvement in condition of part of the geological feature, site or resource affected. The impact is typically of limited spatial extent and may be of short duration and/or reversible (Beneficial) **Groundwater/Hydrogeology** Some measurable change from baseline condition, that results in a small improvement of groundwater quality, groundwater levels, groundwater flow and/or resource utility. This may result in measurable effects on groundwater dependent receptors. These impacts are likely to be of limited spatial extent, or short duration and/or reversible (Beneficial).
Negligible	**Geology** A small measurable change from baseline conditions of short duration (i.e. up to one year), but **no material change** to the status or condition of the geological feature, site or resource affected (Adverse or Beneficial.) **Groundwater/Hydrogeology** A small measurable change from baseline condition of short duration (i.e. up to one year), but no change in the status of groundwater quality, quantity or flow within the aquifer unit affected or its utility (adverse or beneficial), A small measurable change from baseline condition of short duration (i.e. up to one year), but no change in the status of groundwater dependent receptor affected (e.g. river, stream, borehole, well, spring or wetland) (Adverse or Beneficial) and their utility.
No change	**Geology and Groundwater/Hydrogeology** No change from baseline conditions. No measurable impact either adverse or beneficial.

1.5.2.3 The criteria for defining sensitivity in this chapter are outlined in Table 1.12 and are based criteria presented in Design Manual for Roads and Bridges (DMRB) LA 104 Environmental assessment and monitoring (HE, 2020).

Table 1.12: Definition of terms relating to the sensitivity of the receptor.

Sensitivity	Definition
Very High	Very high importance and rarity, international scale and very limited potential for substitution. **Geology** UNESCO World Heritage Sites, UNESCO Global Geoparks and GCR where citations indicate features of international importance. Geology meeting international designation citation criteria which is not designated as such **Groundwater/Hydrogeology** Principal aquifer providing a nationally important water resource and/or supporting a groundwater dependant site protected under international/EC legislation. Groundwater within an inner source protection zone (SPZ1) **Contamination** Human health: very high sensitivity land use such as residential or allotments.
High	High importance and rarity, national scale and limited potential for substitution **Geology** Geological site of national importance (e.g. GCR or SSSI or National Nature Reserves (NNR)). Geology meeting national designation citation criteria which is not designated as such. **Groundwater/Hydrogeology** Principal aquifer providing locally important water resource and/or supporting a groundwater dependent site of national importance or a river ecosystem. Groundwater supports a Groundwater Dependent Terrestrial Ecosystem defined for the WFD Groundwater within an outer source protection zone (SPZ2) Licensed groundwater supply sources **Contamination** Human health: high sensitivity land use such as public open space
Medium	High or medium importance and rarity, regional scale, limited potential for substitution **Geology** Geological site of regional importance (e.g. RIGS, LNR). Geology meeting regional designation citation criteria which is not designated as such **Groundwater/Hydrogeology** Secondary aquifer unit providing a locally important water resource and/or groundwater dependent sites of local importance. Private groundwater supply source Groundwater within the total catchment source protection zone (SPZ3) **Contamination** Human health: medium sensitivity land use such as commercial or industrial
Low	Low or medium importance and rarity, local scale **Geology** Non-designated geological features of local interest (e.g. non designated geological exposure, former quarries/mining sites).

Sensitivity	Definition
	Groundwater/Hydrogeology Secondary aquifer unit of providing water resource of limited local importance with little connection to surface water **Contamination** Human health: low sensitivity land use such as highways and rail
Negligible	Very low importance and rarity, local scale **Geology** No geological exposures, little/no local interest. **Groundwater/Hydrogeology** Unproductive strata **Contamination** human health: undeveloped surplus land/no sensitive land use proposed

1.5.2.4 The significance of the effect upon geology, hydrogeology and ground conditions is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 1.13. Where a range of significance of effect is presented in Table 1.13, the final assessment for each effect is based upon expert judgement.

1.5.2.5 For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended).

Table 1.13: Matrix used for the assessment of the significance of the effect.

Sensitivity of Receptor	Magnitude of Impact				
	No Change	**Negligible**	**Low**	**Medium**	**High**
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major
Very High	No change	Minor	Moderate or Major	Major	Major

1.6 Key parameters for assessment

1.6.1 Maximum design scenario

1.6.1.1 The maximum design scenario (MDS) identified in Table 1.14 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the Project Design Envelope provided in Volume 1, Chapter 3: Project description of the Environmental Statement. Effects of greater adverse significance are not predicted to arise should

any other development scenario, based on details within the Project Design Envelope (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

Table 1.14: MDS considered for the assessment of potential impacts on geology, hydrogeology and ground conditions.

[a] C=construction, O=operations and maintenance, D=decommissioning

Potential impact	Phase[a] C	O	D	MDS	Justification
The impact of loss of, or damage to, designated sites of geological and geomorphological interest.	✓	×	✓	**Construction phase** <u>Open cut trenching along the Onshore Cable Corridor</u>: • The area of the permanent Onshore Cable Corridor is up to 450,000 m^2 based on a corridor measuring 30 m wide and 15 km in length. The temporary working corridor requires an additional 44 m wide corridor (making the total width of the Onshore Cable Corridor (temporary and permanent requirements) 74 m wide. The total temporary area of disturbance for the Onshore Cable Corridor is up to 1,110,000 m^2. • There are up to four cable trenches within the permanent Onshore Cable Corridor, each trench measures up to 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m. • The maximum number of joint bays along the Onshore Cable Corridor is 80 (based on a minimum distance of 750 m between each joint bay on up to four trenches). The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 32,000 m^3 of material excavated for the joint bays) • The maximum number of link boxes along the Onshore Cable Corridor is 80 (based on a distance of 750 m between each link box on up to four trenches). The area of each link box is up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 6 m^3 (a total of 480 m^3 of material excavated for the link boxes). <u>Open cut trenching along the 400 kV Grid Connection Cable Corridor:</u> • The area of the permanent 400 kV Grid Connection Cable Corridor is up to 16,000 m^2 based on a corridor measuring 16 m wide and 1 km in length. The temporary working corridor requires an additional 32 m wide corridor (making the total width of the route to grid connection (temporary and permanent requirements) 48 m wide. The total area of	The use of open cut trenching methods along the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor represents the greatest potential for damage to designated geological resources and change the natural processes of erosion. The maximum area of disturbance required for the construction of the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor and the associated infrastructure increases the likelihood of interaction with areas of geological and geomorphological interest and increases the potential for damage to occur. The Onshore Substation is not situated near any geological sites and is not therefore included in the MDS.
Loss of, or damage to non-designated sites of geological and geomorphological interest (Drumlins).	✓	×	✓		

Potential impact	Phase[a] C	O	D	MDS	Justification
				temporary disturbance for the 400 kV Grid Connection Cable Corridor is up to 48,000 m^2. • There are up to two cable trenches within the permanent 400 kV Grid Connection Cable Corridor, each trench measures up to 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m • The maximum number of joint bays along the 400 kV Grid Connection Cable Corridor is two (based on one joint bay on up to two trenches). The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 800 m^3 of material excavated for the joint bays) • The maximum number of link boxes along the 400 kV Grid Connection Cable Corridor is two (based on one link box on up to two trenches). The area of each link box is up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 6 m^3 (a total of 12 m^3 of material excavated for the link boxes). <u>Haul road</u> • There is one haul road within the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor along the length of the corridor; it is 6 m wide excluding passing places. It will be constructed using imported engineered granular fill with geotextile layers with a nominal thickness of 400 mm and a maximum thickness of up to 1,000 mm. <u>Trenchless techniques</u> • The maximum number of trenchless technique locations along the Onshore Cable Corridor is 45 and three along the 400 kV Grid Connection Cable Corridor. The temporary works areas for trenchless techniques will measure up to 2,500 m^2 and will be located within the 74 m temporary construction corridor. <u>Construction compounds</u> • One primary construction compound (measuring up to 22,500 m^2) and up to four secondary construction compounds (each measuring up to 15,000 m^2) will be located within the	

Potential impact	Phase[a] C	O	D	MDS	Justification
				Mona Onshore Development Area. Soils will be removed and stored; crushed stone or other suitable material will be used to create hardstanding. **Decommissioning phase** • The Onshore Cable and 400kV Grid Connection Cable will remain in situ , however some of the other onshore infrastructure (e.g. link boxes) may be removed.	
Sterilisation of safeguarded limestone mineral resources.	✓	✓	✓	**Construction phase** Onshore Cable Corridor • The area of the permanent Onshore Cable Corridor is up to 450,000 m^2 based on a corridor measuring 30 m wide and 15 km in length. • There are up to four cable trenches within the permanent Onshore Cable Corridor, each trench measures 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m. 400 kV Grid Connection Cable Corridor • The area of the permanent 400 kV Grid Connection Cable Corridor is up to 16,000 m^2 based on a corridor measuring 16 m wide and 1 km in length • There are up to two cable trenches within the permanent 400 kV Grid Connection Cable Corridor, each trench measures 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m. Onshore Substation • The maximum footprint of the Onshore Substation will measure 65,000 m^2: this area will include the substation buildings. The earthworks to create the platform will measure up to 75,000 m^2. The Onshore Substation will comprise up to four buildings. The maximum dimensions of the main building are 15 m high, 40 m wide and 90 m long. • Access to the Onshore Substation will be via a new permanent access road measuring up to 8 m wide (up to 15 m wide including drainage) and 800 m in length.	The maximum area occupied by the Onshore Cable Corridor, 400 kV Grid Connection Cable, Onshore Substation and the associated infrastructure represents the maximum area of safeguard mineral resources that could be affected. The Onshore Cable Corridor and 400 kV grid connection cable shall remain in situ in decommissioning phase.

Potential impact	Phase[a] C	O	D	MDS	Justification
				• The maximum area for the attenuation pond is 10,000 m^2. **Operations and maintenance phase** • The expected lifetime of the Mona Offshore Wind Project is 35 years. **Decommissioning phase** • The Onshore Cable and 400kV Grid Connection Cable will remain in situ, however some of the other onshore infrastructure (e.g. link boxes) may be removed. • The Onshore Substation and access road will be removed.	
Alteration to groundwater quantity or quality in the glacial till superficial aquifer (Secondary undifferentiated).	✓	✓	✓	**Construction phase** <u>Open cut trenching along the Onshore Cable Corridor</u>: • The area of the permanent Onshore Cable Corridor is up to 450,000 m^2 based on a corridor measuring 30 m wide and 15 km in length. The temporary working corridor requires an additional 44 m wide corridor (making the total width of the Onshore Cable Corridor (temporary and permanent requirements) 100 m wide representing an area of up to 1,110,000 m^2 • There are up to four cable trenches within the permanent Onshore Cable Corridor, each trench measures 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m • The depth of stabilised backfill in each of the four onshore cable trenches is up to 600 mm. Surplus material excavated from the trenches will be spread on site. • The maximum number of joint bays along the Onshore Cable Corridor is 80 (based on a minimum distance of 750 m between each joint bay on up to four trenches). The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 32,000 m^3 of material excavated for the joint bays) • The maximum number of link boxes along Onshore Cable Corridor is 80 (based on a distance of 750 m between each link box on up to four trenches). The area of each link box is	The maximum area required for the construction of the Onshore Cable Corridor, 400 kV Grid Connection Cable, Onshore Substation and the associated infrastructure represents the greatest area of glacial till that could be affected in terms of recharge capability. The number of cable trenches, link boxes and joint bays represents the maximum numbers of structures that may require dewatering.
Alteration to groundwater quantity or quality in the Clwyd Limestone Group bedrock aquifer (Principal aquifer).	✓	✓	✓		The depth of the Onshore Cable and 400 kV Grid Connection Cable trench represents the MDS for affecting groundwater quality of Principal and Secondary A aquifers by open cut trench construction as in some locations of the Onshore Cable and 400 kV Grid Connection Cable superficial deposits may be locally thin and there is the potential for the cable trenches to intersect the Principal and Secondary A aquifers and therefore, create a pathway. Trenchless techniques represent the MDS for affecting groundwater quality and flow of the Principal and Secondary A aquifers as these methods go deep below the ground (potentially bypassing lower permeability superficial deposits)
Alteration to groundwater quantity or quality in the bedrock aquifers of the Ffernant Formation and Warwickshire Group (Secondary A aquifers).	✓	✓	✓		

Potential impact	Phase[a] C	O	D	MDS	Justification
				up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 6 m^3 (a total of 480 m^3 of material excavated for the link boxes) • Dewatering of cable trenches, joint bays and link boxes will be required. • Cable trenches will be backfilled with 0.6 m of stabilised fill and reinstated to ground level with the stored excavated soils. <u>Open cut trenching along the 400 kV Grid Connection Cable Corridor:</u> • The area of the permanent 400 kV Grid Connection Cable Corridor is up to 16,000 m^2 based on a corridor measuring 16 m wide and 1 km in length. The temporary working corridor requires an additional 32 m wide corridor (making the total width of the route to grid connection (temporary and permanent requirements) 48 m wide representing an area of up to 48,000 m^2. • There are two cable trenches within the permanent 400 kV Grid Connection Cable Corridor, each trench measures 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m • The depth of stabilised backfill in each of the two onshore cable trenches is up to 600 mm. Surplus material excavated from the trenches will be spread on site • The maximum number of joint bays along the 400 kV Grid Connection Cable Corridor is two (based on one joint bay on up to two trenches). The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 800 m^3 of material excavated for the joint bays) • The maximum number of link boxes along the 400 kVGrid Connection Cable Corridor is two (based on one link box on up to two trenches). The area of each link box is 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 6 m^3 (a total of 12 m^3 of material excavated for the link boxes)	and may create a pathway for contaminants to the groundwater resource within the principal aquifer with minimal potential for attenuation. The dimensions of the main buildings at the Onshore Substation represent the MDS as the largest area of disturbance to the Principal and Secondary A aquifers from the construction of foundations. Piled foundations are represent the MDS as they may create possible transport pathways to Principal and Secondary A aquifers, which would otherwise be concealed beneath low permeability till.

Potential impact	Phase[a] C	O	D	MDS	Justification
				• Dewatering of cable trenches, joint bays and link boxes will be required. • Cable trenches will be backfilled with 0.6 m of stabilised fill and reinstated to ground level with the stored excavated soil. <u>Haul road</u> • There is one haul road within the 400 kV Grid Connection Cable Corridor for the length of the corridor; it is 6 m wide excluding passing places. It will be constructed using imported engineered granular fill with geotextile layers with a nominal thickness of 400 mm and a maximum thickness of up to 1000 mm. <u>Trenchless techniques</u> • The maximum number of trenchless technique locations along the Onshore Cable Corridor is 45 and three on the 400 kV Grid Connection Cable Corridor. trenchless techniques will require a temporary working area up to 2,500 m^2. and will be located within the 74 m temporary construction corridor. • During drilling the trenchless technique boreholes will be stabilised using bentonite mud before the permanent ducts are installed. <u>Onshore Substation</u> • The maximum footprint of the Onshore Substation will measure 65,000 m^2 and will include the substation buildings. The earthworks to create the platform which will measure up to 75,000 m^2. The Onshore Substation will comprise up to four buildings. The maximum dimensions of the main building are 15 m high, 40 m wide and 90 m long. • The excavation for the substation will be up to 6 m deep. Dewatering of the excavation will be required if groundwater is encountered. The excavation will be backfilled with a 6F2 type fill material to platform level. • A piled foundation solution will be required.	

Potential impact	Phase[a] C	O	D	MDS	Justification
				• Access to the substation will be via a new permanent access road will be created measuring up to 8 m wide (up to 15 m wide including drainage) and 800 m in length. • The area of temporary works (including construction compounds) will extend up to 150,000 m^2. • The maximum area for the attenuation pond is 10,000 m^2. **Operations and maintenance phase** • The expected lifetime of the Mona Offshore Wind Project is 35 years. **Decommissioning phase** • The Onshore Cable and 400kV Grid Connection Cable will remain in situ, however some of the other onshore infrastructure (e.g. link boxes) may be removed. The Onshore Substation and access road will be removed.	
Impact on private groundwater supply sources in terms of abstraction quantity, abstraction reliability and abstraction quality.	✓	✓	✓	**Construction phase** <u>Open cut trenching along the Onshore Cable Corridor</u>: • The area of the permanent onshore cable corridor is up to 450,000 m^2 based on a corridor measuring 30 m wide and 15 km in length. The temporary working corridor requires an additional 44 m wide corridor (making the total width of the Onshore Cable Corridor (temporary and permanent requirements) 74 m representing an area of up to 1,110,000 m^2 • There are up to four cable trenches within the permanent Onshore Cable Corridor, each trench measures up to 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m • The maximum number of joint bays along the Onshore Cable Corridor is 80 (based on a minimum distance of 750 m between each joint bay). The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 32,000 m^3 of material excavated for the joint bays)	The maximum area required for the construction of the Onshore Cable Corridor, 400 kV Grid Connection Cable, Onshore Substation and the associated infrastructure represents the greatest area that could be affected in terms of recharge capability. The number of cable trenches, link boxes and joint bays represents the maximum numbers of structures that may require dewatering.

Potential impact	Phase[a] C	O	D	MDS	Justification
				• The maximum number of link boxes along the Onshore Cable Corridor is 80 (based on a distance of 750 m between each link box). The area of each link box is up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 6 m^3 (a total of 480 m^3 of material excavated for the link boxes) • Dewatering of cable trenches, joint bays and link boxes will be required. • Cable trenches will be backfilled with 0.6 m of stabilised fill and reinstated to ground level with the stored excavated soils. <u>Open cut trenching along the 400 kV Grid Connection Cable Corridor:</u> • The area of the permanent 400 kV Grid Connection Cable corridor is up to 16,000 m^2 based on a corridor measuring 16 m wide and 1 km in length. The temporary working corridor requires an additional 32 m wide corridor (making the total width of the route to grid connection (temporary and permanent requirements) 48 m wide representing an area of up to 48,000 m^2 • There are up to two cable trenches within the permanent 400 kV Grid Connection Cable corridor, each trench measures up to 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m • The maximum number of joint bays along the 400 kV Grid Connection Cable corridor is two (based on one joint bay on up to two trenches) • The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 800 m^3 of material excavated for the joint bays) • The maximum number of link boxes along the 400 kV Grid Connection Cable Corridor is two (based on one link box on up to two trenches)	

Potential impact	Phase[a] C	O	D	MDS	Justification
				• The area of each link box is up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 6 m^3 (a total of 12 m^3 of material excavated for the link boxes) • Dewatering of cable trenches, joint bays and link boxes will be required. • Cable trenches will be backfilled with 0.6 m of stabilised fill and reinstated to ground level with the stored excavated soils. <u>Haul road</u> • There is one haul road within the 400 kV Grid Connection Cable Corridor for the length of the corridor; it is up to 6 m wide excluding passing places. It will be constructed using imported engineered granular fill with geotextile layers with a nominal thickness of 400 mm and a maximum thickness of up to 1000 mm. <u>Trenchless techniques</u> • The maximum number of trenchless technique locations along the Onshore Cable Corridor is 45 and three on the 400 kV Grid Connection Cable Corridor. Trenchless techniques will require a temporary working area of up to 2,500 m^2 and will be located within the 74 m temporary construction corridor. • During drilling the trenchless technique boreholes will be stabilised using bentonite mud before the permanent ducts are installed. <u>Onshore Substation</u> • The maximum footprint of the Onshore Substation will measure up to 65,000 m^2: this area will include the substation buildings. The earthworks to create the platform will measure up to 75,000 m^2. The Onshore Substation will comprise up to four buildings. The maximum dimensions of the main building are 15 m high, 40 m wide and 90 m long. • The excavation for the substation will be up to 6 m deep. Dewatering of the excavation will be required if groundwater is encountered. The excavation will be backfilled with a 6F2 type fill material to platform level.	

Potential impact	Phase[a] C	O	D	MDS	Justification
				• A piled foundation solution will be required. • Access to the substation will be via a new permanent access road will be created measuring up to 8 m wide (up to 15 m wide including drainage) and 800 m in length • The area of temporary works (including construction compounds) will extend up to 150,000 m^2. • The maximum area for the attenuation pond is 10,000 m^2. **Operations and maintenance phase** • The expected lifetime of the Mona Offshore Wind Project is 35 years. **Decommissioning phase** • The Onshore Cable and 400kV Grid Connection Cable will remain in situ , however some of the other onshore infrastructure (e.g. link boxes) may be removed The Onshore Substation and access road will be removed.	

Potential impact	Phase[a] C	O	D	MDS	Justification
Deterioration of groundwater quality in the Clwyd Limestone Group bedrock aquifer by the mobilisation of contamination associated with the historical Llanddulas Beach Landfill site	✓	×	×	**Construction phase** <u>Trenchless techniques at the Transition Joint Bay</u> • Maximum trenchless technique burial depth landward of MHWS is up to 30 m • There will be up to four trenchless technique entry pits The trenchless technique working compound area measures 200 m x 150 m and will include the duct assembly working area (measuring 800 m x 50 m) •	Mobilisation of contamination largely relates to disturbance through construction activities associated with the creation of migration pathways created during construction.
Deterioration of groundwater quality in the glacial till aquifer by the disturbance and mobilisation of existing areas of contamination associated with recent or historical land-use	✓	×	×	**Construction phase** <u>Open cut trenching along the Onshore Cable Corridor</u>: • The area of the permanent Onshore Cable Corridor is up to 450,000 m^2 based on a corridor measuring 30 m wide and 15 km in length. The temporary working corridor requires an additional 44 m wide corridor (making the total width of the Onshore Cable Corridor (temporary and permanent requirements) 74 m wide representing an area of up to 1,110,000 m^2 • There are up to four cable trenches within the permanent Onshore Cable Corridor, each trench measures up to 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m	Mobilisation of contamination largely relates to disturbance through construction activities associated with the creation of migration pathways created during construction. No new effects anticipated during the decommissioning of assets. In terms of contamination to the groundwater in the glacial till may create pathways for contaminants, however trenchless techniques represent the MDS as they go deeper below the ground, increasing the likelihood of hydraulically connecting with groundwater in secondary aquifers.
Deterioration in groundwater quality in bedrock aquifers through	✓	×	×	• The maximum number of joint bays along the Onshore Cable Corridor is 80 (based on a minimum distance of 750 m between each joint bay). The area of each joint bay is up to	Mobilisation of contamination largely relates to disturbance through construction activities

Potential impact	Phase[a] C	O	D	MDS	Justification
the disturbance and mobilisation of existing areas of contaminated land associated with recent or historical land-use.				200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 32,000 m^3 of material excavated for the joint bays) • The maximum number of link boxes along the Onshore Cable Corridor is 80 (based on a distance of 750 m between each link box). The area of each link box is up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 480 m^3 (a total of 60 m^3 of material excavated for the link boxes) • Dewatering of cable trenches, joint bays and link boxes will be required. <u>Open cut trenching along the 400 kV Grid Connection Cable Corridor:</u> • The area of the permanent 400 kV Grid Connection Cable Corridor is up to 16,000 m^2 based on a corridor measuring 16 m wide and 1 km in length. The temporary working corridor requires an additional 32 m wide corridor (making the total width of the route to grid connection (temporary and permanent requirements) 48 m wide representing an area of up to 48,000 m^2 • There are up to two cable trenches within the permanent 400 kV Grid Connection Cable Corridor, each trench measures up to 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m • The maximum number of joint bays along the 400 kV Grid Connection Cable Corridor is two (based on one joint bay on up to two trenches). The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 800 m^3 of material excavated for the joint bays) • The maximum number of link boxes along the 400 kV Grid Connection Cable Corridor is two (based on one link box on up to two trenches). The area of each link box is up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 6 m^3 (a total of 12 m^3 of material excavated for the link boxes)	associated with the creation of migration pathways created during construction. No new effects anticipated during the decommissioning of assets. In terms of contamination to the groundwater in the bedrock aquifers both crossing options may create pathways for contaminants, however trenchless techniques methods represent the MDS scenario as they go deeper below the ground, increasing the likelihood of hydraulically connecting with groundwater in bedrock aquifers.

Potential impact	Phase[a] C	O	D	MDS	Justification
				• Dewatering of cable trenches, joint bays and link boxes will be required. <u>Haul road</u> • There is one haul road within the 400 kV Grid Connection Cable Corridor for the length of the corridor; it is up to 6 m wide excluding passing places. It will be constructed using imported engineered granular fill with geotextile layers with a nominal thickness of 400 mm and a maximum thickness of up to 1000 mm. <u>Trenchless techniques</u> • The maximum number of trenchless technique locations along the Onshore Cable Corridor is 45 and three on the 400 kV Grid Connection Cable Corridor. Trenchless techniques will require a temporary working area measuring up to 2,500 m^2) and will be located within the 74 m temporary construction corridor. <u>Onshore Substation</u> • The maximum footprint of the Onshore Substation will measure 65,000 m^2: this area will include the substation buildings. The earthworks to create the platform will measure up to 75,000 m^2. The Onshore Substation will comprise up to four buildings. The maximum dimensions of the main building are 15 m high, 40 m wide and 90 m long. • The excavation for the substation will be up to 6 m deep. Dewatering of the excavation will be required if groundwater is encountered. • Access to the substation will be via a new permanent access road will be created measuring up to 8 m wide (up to 15 m wide including drainage) and 800 m in length • The area of temporary works (including construction compounds) will extend up to 150,000 m^2.	
Deterioration in groundwater quality as a result of accidental release or spillage of potentially polluting substances, during the	✓	×	✓	**Construction phase** <u>Open cut trenching along the Onshore Cable Corridor:</u>	Fuels and chemicals will be stored at construction compounds and trenchless technique compounds. The maximum number of construction compounds and trenchless

Potential impact	Phase[a] C	O	D	MDS	Justification
construction and decommissioning phase				• The area of the permanent Onshore Cable Corridor is up to 45,000 m^2 based on a corridor measuring 30 m wide and 15 km in length. The temporary working corridor requires an additional 44 m wide corridor (making the total width of the Onshore Cable Corridor (temporary and permanent requirements) 74 m wide representing an area of up to 1,110,000 m^2 • There are up to four cable trenches within the permanent Onshore Cable Corridor, each trench measures up to 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m • The maximum number of joint bays along the Onshore Cable Corridor is 80 (based on a minimum distance of 750 m between each joint bay). The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 32,000 m^3 of material excavated for the joint bays) • The maximum number of link boxes along the Onshore Cable Corridor is 80 (based on a distance of 750 m between each link box). The area of each link box is up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 60 m^3 (a total of 480 m^3 of material excavated for the link boxes) • Dewatering of cable trenches, joint bays and link boxes will be required. <u>Open cut trenching along the 400 kV Grid Connection Cable Corridor:</u> • The area of the permanent 400 kV Grid Connection Cable Corridor is up to 16,000 m^2 based on a corridor measuring 16 m wide and 1 km in length. The temporary working corridor requires an additional 32 m wide corridor (making the total width of the route to grid connection (temporary and permanent requirements) 48 m wide representing an area of up to 48,000 m^2 • There are up to two cable trenches within the permanent 400 kV Grid Connection Cable Corridor, each trench	technique compounds represents the MDS scenario for the risk of spillages.

Potential impact	Phase[a] C	O	D	MDS	Justification
				measures up to 2.5 m wide at the top, 1.5 m at the base and the depth is 1.8 m • The maximum number of joint bays along the 400 kV Grid Connection Cable Corridor is two (based on one joint bay on up to two trenches). The area of each joint bay is up to 200 m^2 and each joint bay is 2 m deep; the volume of material excavated per joint bay is 400 m^3 (a total of 800 m^3 of material excavated for the joint bays) • The maximum number of link boxes along the 400 kV Grid Connection Cable Corridor is two (based on one link box on up to two trenches). The area of each link box is up to 6 m^2 and each link box is 1 m deep; the volume of material excavated per link box is 6 m^3 (a total of 12 m^3 of material excavated for the link boxes) • Dewatering of cable trenches, joint bays and link boxes will be required. <u>Onshore Substation</u> • The maximum footprint of the Onshore Substation will measure 65,000 m^2: this area will include the substation buildings. The earthworks to create the platform will measure up to 75,000 m^2. The Onshore Substation will comprise up to four buildings. The maximum dimensions of the main building are 15 m high, 40 m wide and 90 m long. • The excavation for the substation will be up to 6 m deep. Dewatering of the excavation will be required if groundwater is encountered. <u>Construction compounds</u> • One primary construction compound (measuring up to 22,500 m^2) and up to four secondary construction compounds (each measuring 15,000 m^2) will be located along the Onshore Cable Corridor. Soils will be removed and stored; crushed stone or other suitable materials will be used to create hardstanding	

Potential impact	Phase[a] C	O	D	MDS	Justification
				• A temporary works area (including construction compounds) will be required to support the construction of the substation extending to 150,000 m^2. <u>Trenchless technique compounds</u> • Trenchless techniques will require a temporary working area measuring up to 2,500 m^2) and will be located within the 74 m temporary construction corridor. **Decommissioning phase** • The Onshore Cable and 400kV Grid Connection Cable will remain in situ , however some of the other onshore infrastructure (e.g. link boxes) may be removed The Onshore Substation and access road will be removed.	
Ground stability issues associated with areas of historical deep mining operations	✓	×	×	**Construction phase** <u>Onshore Substation</u> • The maximum footprint of the Onshore Substation will measure up to 65,000 m^2: this area will include the substation buildings. The earthworks to create the platform will measure up to 75,000 m^2. The Onshore Substation will comprise up to four buildings. The maximum dimensions of the main building are 15 m high, 40 m wide and 90 m long • Access to the substation will be via a new permanent access road will be created measuring up to 8 m wide (up to 15 m wide including drainage) and 800 m in length • The area of temporary works (including construction compounds) will extend up to 150,000 m^2. <u>Trenchless techniques</u> • The maximum number of trenchless technique locations along the Onshore Cable Corridor is 45 and three on the 400 kV Grid Connection Cable Corridor. Trenchless techniques will require a temporary working area measuring up to 2,500 m^2) and will be located within the 74 m temporary construction corridor.	In terms of ground stability issues associated with areas of historical deep mining, the greatest footprint of the Onshore Substation and trenchless techniques represent the MDS as they go deeper below the ground, increasing the likelihood of interacting with historical mining activities. .

1.7 Measures adopted as part of the Mona Offshore Wind Project

1.7.1.1 For the purposes of the EIA process, the term 'measures adopted as part of the project' is used to include the following measures (adapted from IEMA, 2016):

- Measures included as part of the project design. These include modifications to the location or design of the Mona Offshore Wind Project which are integrated into the application for consent. These measures are secured through the consent itself through the description of the development and the parameters secured in the DCO and/or marine licences (referred to as primary mitigation in IEMA, 2016).
- Measures required to meet legislative requirements, or actions that are generally standard practice used to manage commonly occurring environmental effects and are secured through the DCO requirements and/or the conditions of the marine licences (referred to as tertiary mitigation in IEMA, 2016).

1.7.1.2 A number of measures (primary and tertiary) have been adopted as part of the Mona Offshore Wind Project to reduce the potential for impacts on GHGC. These are outlined in Table 1.15 below. As there is a commitment to implementing these measures, they are considered inherently part of the design of the Mona Offshore Wind Project and have therefore been considered in the assessment presented in section 1.8 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures).

Table 1.15: Measures adopted as part of the Mona Offshore Wind Project.

Measures adopted as part of the Mona Offshore Wind Project	Justification	How the measure will be secured
Primary measures: Measures included as part of the project design		
Use of trenchless techniques for the construction of the Onshore Cable Corridor beneath the Llanddulas Limestone and Gwrych Castle Wood SSSI. A method statement for the crossing will be prepared in discussion with NRW and will form part of the detailed Construction Method Statement.	To avoid disturbance to the limestone caves of the Llanddulas Limestone and Gwrych Castle Wood SSSI.	The preparation of a detailed Construction Method Statement would be secured as a requirement of the DCO.
Tertiary measures: Measures required to meet legislative requirements, or adopted standard industry practice		
Preparation of a detailed Code of Construction Practice (CoCP) to ensure the effective management of environmental impacts during the construction phase of onshore and intertidal elements of the Mona Offshore Wind Project. The detailed CoCP will be in general accordance with the Outline CoCP within the DCO application (Document Reference J26) and include regulatory guidance and industry best practice guidance including:	To manage the potential construction impacts to groundwater from: • surface water runoff and groundwater • spillages • unforeseen areas of soil or groundwater contamination • disruption to private groundwater supply sources	The preparation of a detailed CoCP would be secured through a requirement n the DCO. The detailed CoCP will include the following detailed management plans: Construction Surface Water and Drainage Management Plan; Spillage and Emergence response Plan and Discovery Strategy for Contaminated Land

Measures adopted as part of the Mona Offshore Wind Project	Justification	How the measure will be secured
• A detailed Construction Surface Water and Drainage Management Plan • A detailed Spillage and Emergency Response Plan. • A detailed Discovery Strategy for Contaminated Land. • Mitigation measures for private groundwater supply sources: The Outline CoCP will ensure all abstraction licensing and permitting requirements for the construction phase are obtained in advance of construction commencing.		
Preparation of a detailed Onshore Construction Method Statement. The results of intrusive site investigations will inform the detailed design and construction methods including at the Onshore Substation and trenchless crossing locations as required. The detailed design will also take into account the potential for deep mines in areas of historical mining activity.	To demonstrate that the construction of piled foundations would not create a pathway for pollutants. The site investigations would confirm the suitability of geology for trenchless techniques and the absence of localised impacted soils and groundwater. To demonstrate the construction activity in areas of historic mining would not lead to ground stability issues,	The preparation of a detailed CoCP that will include a detailed Onshore Construction Method Statement would be secured through a requirement in the DCO.
Preparation of a detailed Landfall Construction Method Statement that will include a controlled water risk assessment for trenchless techniques under the Llanddulas Beach landfill Site	To avoid the deterioration of groundwater quality from mobilisation of contaminants.	The preparation of a detailed CoCP that will include a detailed Landfall Construction Method Statement would be secured through a requirement in the DCO.
Preparation of a detailed Soil Management Plan for the area around non-designated geological features (drumlins).	To minimise impact on drumlins.	The preparation of a detailed CoCP that will include a detailed Soil Management Plan would be secured through a Requirement in the DCO.

1.8 Assessment of significant effects

1.8.1 Overview

1.8.1.1 The impacts of the construction, operations and maintenance, and decommissioning phases of the Mona Offshore Wind Project have been assessed on geology, hydrogeology and ground conditions. The potential impacts arising from the construction, operations and maintenance and decommissioning phases of the Mona Offshore Wind Project are listed in Table 1.14, along with the MDS against which each impact has been assessed.

1.8.1.2 A description of the potential effect on geology, hydrogeology and ground conditions receptors caused by each identified impact is given below.

1.8.2 Loss of, or damage to, designated sites of geological and geomorphological interest.

1.8.2.1 The only designated site of geological and geomorphological interest within the Mona Onshore Development Area is the Llanddulas Limestone and Gwrych Castle Wood SSSI. The construction of the Mona Onshore Cable Corridor and associated haul roads may have an impact on designated geological and geomorphological features present.

1.8.2.2 Whilst the Traeth Pensarn SSSI also falls within the Mona Onshore Development Area it does not contain any geological or geomorphological features as part of its designation.

Construction phase

Magnitude of impact

1.8.2.3 The Mona Onshore Development Area crosses the Llanddulas Limestone and Gwrych Castle Woodland SSSI, and there is the potential that the construction of the Mona Onshore Cable Corridor will lead to temporary or permanent damage to the limestone features on the site. Through the implementation of the mitigation of trenchless crossing techniques, a method statement for this technique and micro-siting (see Table 1.15) some minor deterioration in condition of part of the site may occur, but that direct impact is predicted to be of limited spatial extent albeit long-term or permanent. The magnitude is therefore, considered to be **low.**

1.8.2.4 All other impacts on the SSSI will be considered in Volume 3, Chapter 3: Onshore ecology of the Environmental Statement.

Sensitivity of the receptor

1.8.2.5 The Carboniferous Limestone bedrock, topography (i.e. the Carboniferous Limestone escarpments) and soil conditions have given rise to a complex and interesting range of plant communities of national importance. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of the effect

1.8.2.6 The impact on the SSSI is largely mitigated by the application of trenchless crossing techniques. Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

1.8.3 Loss of, or damage to non-designated features or sites of geological and geomorphological interest

1.8.3.1 The construction of the Mona Onshore Cable Corridor and 400 kV Grid Connection Corridor and associated haul roads have the potential to directly impact non-designated features of geological and geomorphological interest. Numerous drumlins have been identified in the GHGC study area, most notably around Moelfre Isaf. Only two drumlins have been identified that cross or are located partially within the Mona Onshore Development Area. These features are not present in the vicinity of the Onshore Substation. No other non-designated features or sites of geological or

geomorphological interest are located within the Mona Onshore Development Area. A commitment has been made to restore any drumlins affected during construction using the retained glacial material as outlined in the Soil Management Plan (see Table 1.15).

Construction phase

Magnitude of impact

1.8.3.2 The construction of the Mona Onshore Cable Corridor and 400 kV Grid Connection Corridor and associated haul roads across the non-designated drumlins will result in the deterioration in condition of some of these geological features. The direct impact on certain drumlins will be of local spatial extent, medium term duration, and of medium reversibility. With the implementation of an appropriate Soil Management Plan to restore the drumlins (see Table 1.15) the magnitude is considered to be **low**.

Sensitivity of receptor

1.8.3.3 Given that the drumlins are not designated, they are deemed to be of low rarity but of local importance, and are vulnerable to impacts of Mona Onshore Cable Corridor and 400 kV Grid Connection Corridor construction. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

1.8.3.4 Overall, the magnitude of the impact is deemed to be medium and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.8.3.5 During decommissioning, the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor will remain in situ, but other onshore infrastructure (e.g. link boxes) may be removed. Where the link boxes coincide with the location of drumlins the impact will be direct, of local spatial extent, medium term duration and medium reversibility. With the implementation of soil restoration measures similar to those in the soil management plan the magnitude is considered to be **negligible**.

Sensitivity of receptor

1.8.3.6 Drumlins are deemed to be of low rarity but of local importance and are vulnerable to impacts of Mona Onshore Cable Corridor and 400 kV Grid Connection Corridor construction. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

1.8.3.7 Overall, the magnitude of the impact is deemed to be medium, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** adverse significance, which is not significant in EIA terms.

1.8.4 Sterilisation of safeguarded limestone mineral resources

1.8.4.1 Minerals can only be extracted (or ‘worked’) where they naturally occur. Sterilisation of mineral resources is when a resource cannot be extracted or ‘worked’ due to the presence of non-mineral development.

1.8.4.2 Approximately 5.2 km of the east and west ends of the Mona Onshore Development Area are situated above safeguarded limestone mineral resources of the Clwyd Limestone Group.

1.8.4.3 The MDS for geology, hydrogeology and ground conditions (summarised in Table 1.14) assumes that the onshore export cables will remain in place after decommissioning. The assessment of the Mona Offshore Wind Project for the construction phase will therefore apply to the operations and maintenance and decommissioning phases also.

Construction, Operations and maintenance and Decommissioning phases

Magnitude of impact

1.8.4.4 Despite the narrow width of the permanent Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor (i.e. up to 30 m) up to 156,000 m^2 of safeguarded limestone could be impacted by the construction of the onshore transmission assets. However, the limestone is commonly concealed by a considerable depth of glacial till: the borehole log reference SH97NE 175 (in Appendix A of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement) measures the limestone is locally encountered at depths exceeding 40 m. The depth of overburden material suggests that the extraction of this limestone resource would be commercially unviable. Given the large area of safeguarded limestone in the local area relative to that affected by the permanent Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor, the magnitude of the impact on the safeguarded resource is considered to be **low**.

Sensitivity of the receptor

1.8.4.5 The mineral safeguarded area defined for limestone is of local importance. Given the large area safeguarded limestone in the local area, the sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

1.8.4.6 Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

1.8.5 Alteration to groundwater quantity or quality in the glacial till superficial aquifer (Secondary undifferentiated)

1.8.5.1 The MDS for the construction and decommissioning phases is summarised in Table 1.14. Glacial till underlies the majority of Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor and Onshore Substation. The glacial till is thickest in areas of lower elevation at the east end of the Mona Onshore Development Area most notably in the vicinity of the Onshore Substation. The construction, operations and maintenance, and decommissioning of excavations for the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation may therefore have an impact on groundwater in the glacial till secondary undifferentiated aquifer in terms of its quantity and quality.

Construction phase

1.8.5.2 Temporary dewatering required during the construction of cable trenches (Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor) and Onshore Substation may locally lower groundwater level within the glacial till superficial aquifer. This may result in changes to shallow groundwater flow directions, and/or reduction in the quantity of groundwater within localised water-bearing units in the glacial till. Construction may also adversely impact water quality, although these potential effects are considered separately in section 1.8.12 in relation to accidental releases and spillage of hazardous substances.

Magnitude of impact

1.8.5.3 With the implementation of tertiary measures of the Outline CoCP (Document Reference J26), the impact on localised, discontinuous groundwater within the glacial till will be a small and localised change to groundwater levels, groundwater flow and resource utility. This direct impact on the glacial till aquifer is predicted to be of limited, local spatial extent, will be of short duration and high reversibility. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

1.8.5.4 The glacial till aquifer underlying most of the Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor and Onshore Substation is designated a Secondary undifferentiated aquifer. It is characterised by localised groundwater occurrence that is of limited resource potential, limited utilisation at a local scale and with limited connection to other potentially groundwater dependant receptors. The sensitivity of this receptor is therefore considered to be **low**.

Significance of effect

1.8.5.5 Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

1.8.5.6 The inert granular fill used in the trenches for the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor and as sub-base for the Onshore Substation , may create new pathways for shallow groundwater flow in the glacial till. This may provide increased localised connectivity of water bearing horizons at shallow depth within the glacial till aquifer, principally between joint bays. However, a large increase in connectivity with potential groundwater dependent receptors (groundwater supply sources, watercourses or ecological sites) is considered unlikely to occur given limited importance of groundwater within the glacial till.

Magnitude of impact

1.8.5.7 The impact on groundwater within the glacial till will be a small and localised change but there will be no change in the status of groundwater quality, quantity or flow. This direct impact on the glacial till aquifer is predicted to be of limited, albeit long term to permanent duration. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

1.8.5.8 The glacial till aquifer underlying most of the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor is designated a Secondary undifferentiated aquifer that is characterised by localised groundwater occurrence that is of limited resource potential,

limited utilisation at a local scale and with limited connection to other potentially groundwater dependant receptors. The sensitivity of this receptor is therefore considered to be **low**.

Significance of effect

1.8.5.9 Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

1.8.5.10 As summarised in the MDS Table 1.14, the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor will remain in situ however the link boxes may be removed. The Onshore Substation and access road will also be removed. The impact of decommissioning phase will therefore largely reflect that described for the operations and maintenance phase. Localised dewatering may only be required during the removal of link boxes and the Onshore Substation. The removal of these structures may locally lower groundwater levels resulting in changes to flow directions and quantity within localised groundwater bearing units in the till.

Magnitude of impact

1.8.5.11 The impact on groundwater within the glacial till will be a small and localised change to groundwater levels, groundwater flow and resource utility. This direct impact on the glacial till aquifer is predicted to be of limited, local spatial extent albeit long term to permanent duration. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the shallow glacial till aquifer receptor

1.8.5.12 The glacial till aquifer underlying most of the Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor and the Onshore Substation is designated a Secondary undifferentiated aquifer that is characterised by localised groundwater occurrence that is of limited resource potential, limited utilisation at a local scale and with limited connection to other potentially groundwater dependant receptors. The sensitivity of this receptor is therefore considered to be **low**.

Significance of effect

1.8.5.13 Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** significance, which is not significant in EIA terms.

1.8.6 Alteration to groundwater quantity or quality in the Clwyd Limestone Group bedrock aquifer (Principal aquifer)

1.8.6.1 The east and west end of the Mona Onshore Development Area is situated above limestone of the Clwyd Limestone Group, which is designated a Principal aquifer unit. This Principal aquifer is generally concealed beneath a thick layer of glacial till, except for small windows in those deposits in localised areas of high ground, principally in the west. Groundwater in the limestone aquifer is expected be located at considerable depth in the areas of high elevation or confined by thick till at lower elevation at the east end of the route corridor.

1.8.6.2 The MDS for the construction, operations and maintenance and decommissioning phases is summarised in Table 1.14. The construction, operations and maintenance,

and decommissioning of the Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor and Onshore Substation (southwest corner) may have a potential impact on groundwater within the Principal aquifer formed by limestones of the Clwyd Limestone Group, where they are situated directly above the limestone bedrock or they penetrate through thin glacial till.

Construction phase

Magnitude of impact

1.8.6.3 Where the Clwyd Limestone Group is concealed beneath significant depth of till, principally in the east of the Mona Onshore Development Area, no pathways are expected to be created and hence **no change** to groundwater is expected to the bedrock Principal aquifer during the construction of Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor and Onshore Substation .

1.8.6.4 Elsewhere, where the overlying glacial till is expected to be thinner or absent, the creation of small, localised pathways to the underlying bedrock aquifer may occur during construction, particularly if piling is required. These pathways could increase recharge to the underlying aquifer. Given these pathways will be of limited local extent, the considerable depth to groundwater in the Principal aquifer and the fact the additional recharge will generally be of reasonable quality, a small localised change from baseline conditions could potentially occur but no change to the status of groundwater quality, quantity or flow within the aquifer or its utility is predicted. The magnitude of the impact on groundwater in the Principal aquifer of the Clwyd Limestone Group is therefore, considered to be **negligible**.

Sensitivity of the receptor

1.8.6.5 Given its designation as a Principal aquifer but limited utilisation as a source of groundwater supply, the sensitivity of the Clwyd Limestone Group aquifer is considered to be **high**.

Significance of effect

1.8.6.6 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

1.8.6.7 An increase in recharge to the underlying Principal aquifer may occur during the operations and maintenance phase where new pathways to the Principal aquifer have been created (see above). However, any increase in recharge to Principal aquifer via these pathways is considered unlikely to have a have measurable effect on groundwater quantity or quality, given the localised nature of the effect, the good water quality expected for that recharge and depth to groundwater in the underlying aquifer in these areas. The magnitude of this impact is also considered to be **negligible**.

Sensitivity of receptor

1.8.6.8 Given its designation as a Principal aquifer, the sensitivity of the Clwyd Limestone Group aquifer is considered to be **high**.

Significance of effect

1.8.6.9 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.8.6.10 As for construction, no measurable impact on groundwater quantity or quality in the Principal aquifer is predicted during the decommissioning phase. The magnitude of the impact on groundwater in the principal aquifer of the Clwyd Limestone Group is therefore, considered to be **negligible**.

Sensitivity of receptor

1.8.6.11 Given its designation as a Principal aquifer, the sensitivity of the Clwyd Limestone Group aquifer is considered to be **high**.

Significance of effect

1.8.6.12 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be **minor** adverse significance, which is not significant in EIA terms.

1.8.7 Alteration to groundwater quantity or quality in the bedrock aquifers of the Ffernant Formation and Warwickshire Group (Secondary A aquifers)

1.8.7.1 The east end and west end of the Mona Onshore Development Area is situated above Secondary A bedrock aquifers of the Ffernant Formation and Warwickshire Group. In the east, these Secondary A sandstone aquifers are concealed and potentially confined beneath a thick layer of glacial till. In the west, the sandstone aquifers are concealed beneath glacial till that is expected to be thinner. Groundwater levels in these bedrock aquifers are uncertain but are likely to be situated at depth beneath areas of high ground in the west and confined at depth beneath thick till in the east.

1.8.7.2 The MDS for the construction and decommissioning phases is summarised in Table 1.14. The construction, operations and maintenance, and decommissioning of the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor and Onshore Substation can only have an impact on groundwater quality or quantity in the Ffernant Formation and Warwickshire Group aquifers, where they are situated directly above the sandstones in areas of high-ground or new pathways are created through the glacial till during construction.

Construction phase

Magnitude of impact

1.8.7.3 Where the sandstone bedrock aquifers are concealed beneath significant depth of till in the east (e.g. under the Onshore Substation), no pathways are expected to be created and **no change** is expected on groundwater quality, level or flow.

1.8.7.4 Elsewhere, where the overlying glacial till is expected to be thinner and small, localised pathways to the underlying aquifer may be created during construction. These pathways could result in increased recharge to underlying aquifer. Given these pathways will be of limited local extent and the recharge will generally be of reasonable quality, some change from baseline conditions may potentially occur, although no change to the aquifers regulatory status or resource utility is predicted. To reflect

uncertainty regarding the depth to groundwater in the sandstone bedrock aquifers, the magnitude of the impact on groundwater in the Secondary A aquifers is therefore, considered to be **low**.

Sensitivity of receptor

1.8.7.5 Given the Ffernant Formation and Warwickshire Group are designated Secondary A aquifers of possible local importance, the sensitivity of the receptor is considered to be **medium**.

Significance of effect

1.8.7.6 Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

1.8.7.7 An increase in recharge to the underlying Secondary A aquifer may occur during the operations and maintenance phase where new pathways to the Secondary A aquifer have been created along the Onshore Cable Corridor and 400 kV Grid Connection Cable Corridor and Onshore Substation (see above).

1.8.7.8 Given these pathways will be of limited local extent and the recharge can be expected to be of reasonable quality, some change from baseline conditions may potentially occur, although no change to the aquifers regulatory status or resource utility is predicted. To reflect uncertainty regarding the depth to groundwater in the sandstone bedrock aquifers the magnitude is also considered to be **low**.

Sensitivity of receptor

1.8.7.9 Given the designation of the Ffernant Formation and Warwickshire Group as Secondary A aquifers of possible local importance, the sensitivity of the receptor is considered to be **medium**.

Significance of effect

1.8.7.10 Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.8.7.11 As for construction and operations and maintenance, the magnitude of long-term impacts on groundwater quantity or quality in the Secondary A sandstone aquifers via new pathways created during construction is considered to be **low**.

Sensitivity of receptor

1.8.7.12 Given the designation of the Ffernant Formation and Warwickshire Group as Secondary A aquifers, the sensitivity of the receptor is considered to be **medium**.

Significance of effect

1.8.7.13 Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

1.8.8 Impact on private groundwater supply sources in terms of abstraction quantity, abstraction reliability and abstraction quality.

1.8.8.1 The construction, operations and maintenance, and decommissioning of the Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor and Onshore Substation have the potential to have a direct impact on private groundwater supply sources. Groundwater dewatering, new pathway creation, accidental releases of hazardous substances and/or the mobilisation of contamination all have the potential to affect groundwater supply sources situated near or down hydraulic gradient from the Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor and Onshore Substation. An assessment of risk has been undertaken for all groundwater supply sources (licensed and private) identified within the Mona Onshore Development Area The risk level for each groundwater supply source is presented Volume 7, Annex 1.2: Hydrogeological risk assessment for groundwater supply sources of the Environmental Statement. Mitigation will be implemented according to the level of risk (see Table 1.16).

1.8.8.2 Of the nine private groundwater supply sources identified, two were identified as being of moderate risk or high risk (PWS 02 and PWS 08), one was identified as Low to Moderate Risk (PWS 02) and the second required the Applicant to consult further with the landowner as the location of the supply source and tied property is not known (PW06 and PWS 07). The remaining groundwater supply sources were considered to be at No Risk or Low Risk.

Construction phase

Magnitude of impact

1.8.8.3 The construction of the Onshore Cable Corridor, 400 kV Grid Connection Cable Corridor and Onshore Substation, most notably dewatering of cable trenches, could impact proximal private groundwater supply sources, most notably those situated in down hydraulic gradient position. That impact has the potential to be direct and continuous. However, with the implementation of the mitigation measures outlined in Table 1.15 the magnitude of impact is considered to be **low**.

Sensitivity of private groundwater supply sources

1.8.8.4 Although of high importance to the properties that depend on them private groundwater supply sources are of local importance. These groundwater receptors have a sensitivity considered to be **medium**.

Significance of effect

1.8.8.5 Overall, the magnitude of the impact is deemed to be medium, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

1.8.8.6 The backfill of cable trenches and/or the interception of underlying permeable bedrock has the potential to create new groundwater flow pathways that could impact the flow and/or quality of groundwater to proximal private groundwater supply sources, most notably those situated in down hydraulic gradient position. However, as the cable trenches are backfilled with excavated material and groundwater control is only temporary, the magnitude of that will be lower than for the construction phase. For the purpose of this assessment that impact is considered to have the potential to be direct and continuous. With the implementation of the mitigation measures as identified (Volume 7, Annex 1.2: Hydrogeological risk assessment for groundwater supply sources of the Environmental Statement) the potential impact on private groundwater abstractions and the magnitude of the impact is therefore considered to be **low**.

Sensitivity of private groundwater supply sources

1.8.8.7 Private groundwater supply sources are of local importance to the properties they supply. These groundwater receptors have a sensitivity considered to be **medium**.

Significance of effect

1.8.8.8 Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.8.8.9 As summarised in the MDS Table 1.14, the Mona Onshore Cable Corridor and 400 kV Grid Connection Corridor will remain in situ however, some onshore infrastructure (e.g. link boxes) may be removed during decommissioning. The Onshore Substation, associated infrastructure and access road will also be removed. The impact of decommissioning phase will, therefore, largely reflect that described for the operations and maintenance phase. However, there is the potential for new groundwater flow pathways to be created in localised areas as a result of the removal of link boxes and the Onshore Substation sub-surface features. The impact is considered to be **low**.

Sensitivity of private groundwater supply sources

1.8.8.10 Private groundwater supply sources are of local importance to the properties they supply. These groundwater receptors have a sensitivity considered to be **medium**.

Significance of effect

1.8.8.11 Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

1.8.9 Deterioration of groundwater quality in the Clwyd Limestone Group bedrock aquifer by the mobilisation of contamination associated with the historical Llanddulas Beach Landfill site

1.8.9.1 The construction of the Mona Onshore Cable Corridor could result in the disturbance of the Llanddulas Beach Landfill site. If the integrity of the basal liner, surface or side-walls of the landfill site were compromised this could lead to the mobilisation of contamination (i.e. leachate and/or waste) during the construction and decommissioning phase. This has the potential to result in the deterioration of groundwater quality in the underlying Clwyd Limestone Group Principal aquifer.

Construction phase

Magnitude of impact

1.8.9.2 The MDS summarised in Table 1.14 states that a trenchless drilling approach, will be adopted to cross the landfill site. By careful design (to be described in the detailed Landfall Construction Method Statement (identified in Table 1.15) and drilling beneath the Llanddulas Landfill Site, the mobilisation of contamination (i.e. leachate) within the landfill can be avoided and the risk of any deterioration in groundwater quality in the underlying Principal aquifer of the Clwyd Limestone Group avoided. By adopting a trenchless drilling approach the magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

1.8.9.3 Given its designation as a Principal aquifer, the sensitivity of the Clwyd Limestone Group aquifer is considered to be **high**.

Significance of effect

1.8.9.4 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

1.8.10 Deterioration of groundwater quality in the glacial till aquifer by the disturbance and mobilisation of existing areas of contamination associated with recent or historical land-use

1.8.10.1 Recent or historical land-use has the potential to result in localised areas of soil and groundwater contamination. That contamination can be disturbed and mobilised during construction of the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation and supporting infrastructure.

1.8.10.2 As shown in Figure 1.5 and Figure 1.6 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, few high-risk sites of potential contamination have been identified within the Onshore Cable Corridor, 400 kV Grid Connection Corridor or Onshore Substation given the rural site setting. Where high risk sites are present within the Onshore Cable Corridor they are typically associated with the four former deep mining areas identified in the desktop study (see section 1.8.11). Llanddulas Beach landfill site is the notable exception and is therefore, assessed separately in section 1.8.9

1.8.10.3 Historical licensed industrial activity land-uses were identified around St Asaph Business Park to the north of the Onshore Substation site, outside of the Mona Onshore Development Area. That area is also underlain by thick glacial till, so there does not appear to be a significant pathway connecting these potentially contaminative historical industrial sources to soil and groundwater within the Mona Onshore Development Area. These possible contamination sources are unlikely to represent a risk to soil or groundwater quality during the construction and are not considered further in the assessment.

1.8.10.4 Most of the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation and supporting infrastructure are underlain by glacial till. Given the shallow nature of the proposed construction works it is the groundwater in the till that is most likely to be affected by any shallow contamination. However, the cohesive nature of the till and the discontinuous occurrence of groundwater therein, results in that contamination being localised and constrained with limited migration pathways.

1.8.10.5 As summarised in Table 1.15, intrusive site investigations are proposed for geotechnical and geo-environmental purposes as a tertiary measure within the Mona Onshore Development Area. Those investigations will provide site-specific ground condition information including in areas of historical mining activities.

Construction phase

Magnitude of impact

1.8.10.6 There are few areas recent or historical land-use with a high risk of causing shallow soil or groundwater contamination within the Mona Onshore Development Area. Given the low permeability nature of the superficial deposit and discontinuous nature of groundwater therein, possible disturbance of land contamination could result in small, measurable but localised change in groundwater quality albeit in very few places along the Onshore Cable Corridor, 400 kV Grid Connection Corridor and the Onshore Substation. By including a contamination discovery strategy and requirement for undertaking a piling risk assessment for deep foundation solutions (for the Onshore Substation) (see Table 1.15), the risk from any contamination will be effectively managed and mitigated. The magnitude of this impact is predicted to be of local spatial extent, medium-term duration and medium reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the shallow glacial till aquifer

1.8.10.7 The glacial till aquifer underlying most of the Mona Onshore Development Area is designated as a Secondary undifferentiated aquifer that is characterised by localised groundwater occurrence of limited resource potential, limited utilisation at a local scale and with limited connection to other receptors. The sensitivity of this receptor is therefore considered to be **low**.

Significance of effect

1.8.10.8 Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

1.8.11 Deterioration in groundwater quality in bedrock aquifers through the disturbance and mobilisation of existing areas of contaminated land associated with recent or historical land-use

1.8.11.1 Recent or historical land-use has the potential to result in localised areas of soil and groundwater contamination. That contamination can be disturbed and mobilised during construction of the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation and supporting infrastructure.

1.8.11.2 As shown in Figure 1.5 and Figure 1.6 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement, few high-risk sites of potential contamination have been identified within the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation given the rural site setting. Where present in the Onshore Cable Corridor and 400 kV Grid Connection Corridor, they are typically associated with the four former deep mining areas identified in the desktop study (See section 1.8.11). Llanddulas Beach Landfill site is the notable exception and is therefore assessed separately in section 1.8.9.

1.8.11.3 Historical licensed industrial activity land-uses were identified in the east around St Asaph Business Park, to the north of the Onshore Substation outside of the Mona

Onshore Development Area. However, as that area is underlain by thick glacial till these potentially contaminative historical industrial activities are considered unlikely to represent a risk to soil or groundwater quality during the construction of transmission assets.

1.8.11.4 Most of the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation and supporting infrastructure are underlain by glacial till. The underlying bedrock is exposed by small windows in the till, most notably in areas of high elevation in the west. Groundwater in the most important Carboniferous bedrock aquifers (i.e. of the Clwyd Limestone Group, Ffernant Formation and Warwickshire Group) are either located at considerable depth beneath the ground surface or are confined and/or concealed by thick glacial till. In both instances, this indicates long and/or complex pathways for shallow surface contamination to affect groundwater quality in the underlying limestone and sandstone aquifers.

1.8.11.5 As summarised in Table 1.15, intrusive site investigations are proposed geotechnical and geo-environmental purposes as a tertiary measure within the Mona Onshore Development Area. Those investigations will target areas of possible concern, most notably in relation to historical mining activities.

Construction phase

Magnitude of impact

1.8.11.6 There are few areas of recent or historical land-use with a high risk of causing shallow soil or groundwater contamination within the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation. Given the depth to the groundwater and/or the presence of thick low permeability till, possible disturbance of land contamination could result in a small, measurable but localised change in groundwater quality albeit in localised areas. By implementing a contamination discovery strategy and requirement for undertaking piling risk assessment for deep foundation solutions (for the Onshore Substation) (outlined in Table 1.15) the risk of mobilising existing contaminants from construction activities will be effectively managed and mitigated. The magnitude of this impact predicted to be of local spatial extent, medium-term duration and medium reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the bedrock aquifer receptor

1.8.11.7 The bedrock underlying the Mona Onshore Development Area is designated as a Principal aquifer (Clwyd Limestone Group), Secondary A aquifer (Ffernant Formation and Warwickshire Group) or Secondary B aquifer (Elwy Formation. The sensitivity of these bedrock aquifer receptors is therefore considered to be **medium** or **high**.

Significance of effect

1.8.11.8 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium or high. The effect will, therefore, be of **negligible** or **minor** adverse significance, depending on which aquifer unit is potentially affected, which is not significant in EIA terms.

1.8.12 Deterioration in groundwater quality by the accidental release or spillage of potentially polluting substances during the construction and decommissioning phase

1.8.12.1 Potentially polluting substances will be stored, handled and used within the Mona Onshore Development Area during the construction phase and decommissioning phase. Notable substances include fuels, lubricants and hydraulic oils associated with plant and machinery. Other substances such as foul water generated from welfare facilities will also require appropriate management. As outlined in Table 1.15 measures will be included in the Construction Surface Water and Drainage Management Plan (Document Reference J26.6) and Spillage and Emergency Response Plan (Document Reference J26.1) to ensure all controlled water receptors are protected during the proposed the proposed construction and decommissioning works. ng of the relevant personnel.

Construction phase

Magnitude of impact

1.8.12.2 The majority of the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation are situated upon glacial till. Given the low permeability of the till and discontinuous nature of groundwater therein, any accidental release to ground is likely to remain localised. The delivery of the Outline CoCP will mean the magnitude for this impact on the glacial till aquifer will be local spatial extent, short-term duration and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

1.8.12.3 Groundwater in the bedrock aquifer units that underlie the Onshore Cable Corridor, 400 kV Grid Connection Corridor and Onshore Substation is either located at considerable depth beneath the ground surface or are confined/concealed beneath glacial till. In either scenario the pathway for an accidental release to reach groundwater is either long or hydrogeologically complex. With the addition of the measures in the Outline CoCP (Document Reference J26) there will be no measurable impact on groundwater quality in the underlying bedrock aquifer. The magnitude of this impact is therefore, considered to be **negligible**.

Sensitivity of receptor

1.8.12.4 The sensitivity of groundwater receptors present within the GHGC study area have been defined in preceding sections as follows:

Superficial geology

- Glacial till (Secondary undifferentiated) aquifer – **Low** sensitivity.

Bedrock geology

- Limestones of the Clwyd Limestone Group (Principal) bedrock aquifer – **High** sensitivity
- Sandstones of the Ffernant Formation and Warwickshire Group (Secondary A) bedrock aquifers – **Medium** sensitivity
- Mudstones of the Elwy Formation (Secondary B) bedrock aquifer – **Low** sensitivity.

Significance of effect

1.8.12.5 Overall, the magnitude of the impact has been assessed for each aquifer unit as follows:

Superficial geology

- Glacial till (Secondary undifferentiated) aquifer - The magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

Bedrock geology

- Limestones of the Clwyd Limestone Group (Principal) bedrock aquifer – The magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms
- Sandstones of the Ffernant Formation and Warwickshire Group (Secondary A) bedrock aquifers – The magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms
- Mudstones of the Elwy Formation (Secondary B) bedrock aquifer –The magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.8.12.6 As summarised in the MDS Table 1.14, it is proposed to remove the Mona Onshore Cables and 400 kV Grid Connection Cables via the link boxes during decommissioning. The link boxes, Onshore Substation and associated infrastructure will also be removed. The impact is therefore considered to be **negligible**.

Sensitivity of receptor

1.8.12.7 The sensitivity of groundwater receptors present within the Mona GHCC study area have been defined in preceding sections as follows:

Superficial geology

- Glacial till (Secondary undifferentiated) aquifer – **Low** sensitivity

Bedrock geology

- Limestones of the Clwyd Limestone Group (Principal) bedrock aquifer – **High** sensitivity
- Sandstones of the Ffernant Formation and Warwickshire Group (Secondary A) bedrock aquifers – **Medium** sensitivity
- Mudstones of the Elwy Formation (Secondary B) bedrock aquifer – **Low** sensitivity.

Significance of effect

1.8.12.8 Overall, the magnitude of the impact has been assessed for each aquifer unit as follows:

Superficial geology

- Glacial till (Secondary undifferentiated) aquifer - The magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

Bedrock geology

- Limestones of the Clwyd Limestone Group (Principal) bedrock aquifer – The magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.
- Sandstones of the Ffernant Formation and Warwickshire Group (Secondary A) bedrock aquifers – The magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms
- Mudstones of the Elwy Formation (Secondary B) bedrock aquifer –The magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible or minor** adverse significance, which is not significant in EIA terms.

1.8.13 Ground stability associated with areas of historical deep mining operations

1.8.13.1 The following three areas within the Mona Onshore Development Area were identified in the desktop study as potentially being situated above or near historical deep mining operations (as shown in Figure 1.6 of Volume 7, Annex 1.1: Aquifers, groundwater abstractions and ground conditions of the Environmental Statement):

- Area to the west of Gwrych Castle (approximately 0.75 km south of the Mona Landfall) associated with Cefn yr Ogof
- Area around Sinan, south of Glascoed and west of Cefn Meiriadog that crosses the Onshore Cable Corridor and includes the Score (Cefn) Mine and Coed-Carreg-Dafydd Mine.
- Small area of historical mining that appears to be associated with the Panty Celyn Lead Mine, in the southeast of the Mona GHGC study area. This activity is situated around the exposed bedrock at higher elevation on the flanks of Bryn Meriadog, immediately south of the Mona Onshore Development Area including the Onshore Substation.

1.8.13.2 These old areas of mining activity that date back to the 19th and early 20th Century are typically associated with shafts or other associated features relating to deep mining operations. The construction of the Onshore Cable Corridor, Onshore Substation, 400 kV Grid Connection Cable Corridor and associated infrastructure using heavy plant and machinery has the potential cause ground stability issues should they be situated

above or near such structures. This in turn may represent a risk to the integrity of transmission assets and their operation, as well as a safety risk.

Construction phase

Magnitude of impact

1.8.13.3 The features associated with historical deep mining operations are likely to be either shafts or adits associated with the mines or localised areas of historical extraction and associated waste disposal.

1.8.13.4 To mitigate the impact of ground stability issues associated with historical deep mining operations a historical mining activity assessment will be undertaken as part of the Construction Method Statement (see Table 1.15). The assessment will include a site investigation to further characterise the mining features/structures and to identify and implement remedial works required to minimise the potential impact to the Onshore Cable Corridor, Onshore Substation and 400 kV Grid Connection Cable Corridor. Although any impact will be of local spatial extent, the magnitude of the short-term impact would be large and may be of limited reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible.**

Sensitivity of the receptor

1.8.13.5 Ground stability issues could affect the integrity of the transmission assets themselves or safety of construction workers. For the purpose of this assessment the sensitivity of these receptors is therefore considered to be **high**.

Significance of effect

1.8.13.6 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

1.9 Cumulative effects assessment methodology

1.9.1 Methodology

1.9.1.1 The Cumulative Effects Assessment (CEA) takes into account the impact associated with the Mona Offshore Wind Project together with other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see Volume 5, Annex 5.1: CEA screening matrix of the Environmental Statement). Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

1.9.1.2 The geology, hydrogeology and ground conditions CEA methodology has followed the methodology set out in Volume 1, Chapter 5: EIA methodology of the Environmental Statement. As part of the assessment, all projects and plans considered alongside the Mona Offshore Wind Project have been allocated into ‘tiers’ reflecting their current stage within the planning and development process, these are listed below.

1.9.1.3 A tiered approach to the assessment has been adopted, as follows:

- Tier 1
  - Under construction

  - Permitted application
  - Submitted application
  - Those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact
- Tier 2
  - Scoping Report has been submitted and is in the public domain
- Tier 3
  - Scoping Report has not been submitted or is not in the public domain
  - Identified in the relevant Development Plan
  - Identified in other plans and programmes.

1.9.1.4 This tiered approach is adopted to provide a clear assessment of the Mona Offshore Wind Project alongside other projects, plans and activities.

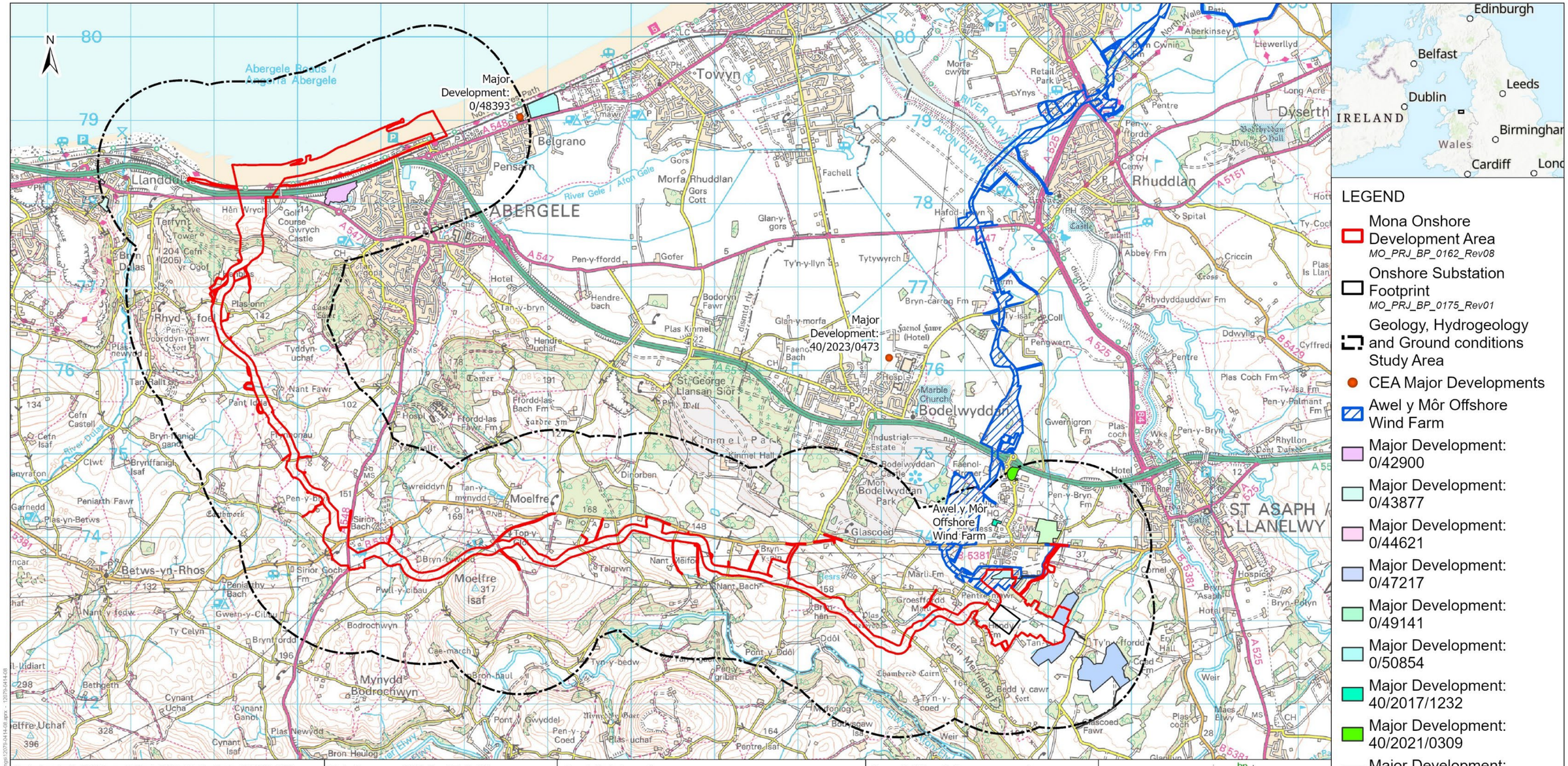
1.9.1.5 The specific projects, plans and activities scoped into the CEA, are outlined in Table 1.16.

Table 1.16: List of other projects, plans and activities considered within the CEA.

Project/Plan	Status	Distance from the Mona Onshore Development Area (km)	Distance to Onshore Substation (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Tier 1							
Awel y Môr Offshore Wind farm (Onshore Infrastructure)	Application Determined	0	0.1	Application for the construction of an offshore windfarm. Consent granted in Q3 2023.	Construction to commence in 2026.	Site to be commissioned by 2030.	Yes
Major Development: 40/2017/1232	Granted	0.64	1.09	Application for the erection of the seven industrial units with associated parking, landscaping and external storage areas	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
Major Development: 46/2021/0159	Granted	0.23	0.80	Application for the erection of a commercial vehicle sales unit (sui generis). Formation of associated parking area, landscaping and associated works. Outline Planning application for the erection of five business buildings.	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
Major Development 40/2021/0309	Granted	1.01	1.56	Erection of a 198 bed Registered Care Home (Use Class C2), landscaping, parking facilities and associated works (Resubmission).	Construction to commence in 2024.	N/A	Yes
Major Development 0/42900	Approved	0.32	9.15	Erection of 156 dwellings, access works and landscaping.	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes

Project/Plan	Status	Distance from the Mona Onshore Development Area (km)	Distance to Onshore Substation (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Major Development: 0/43877	Approved	1.02	11.68	Demolition of derelict dwelling and outbuildings, proposed residential development of 15 dwellings including road widening (outline planning permission) (Approval of Matters Reserved for Subsequent Approval Under Code reference: 0/37619).	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
Major Development: 0/44621	Approved	0.98	11.82	Demolition of single storey extensions to and the remodelling & refurbishment of the Fair View Inn into a 6 person 4 bedroom house. The construction of 24 new build 1 and 2 bedroom apartments over 3 and 2.5 storeys with associated car parking and ancillary facilities.	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
Major Development: 0/47217	Approved	0.9	8.12	Residential Housing Estate consisting of 14. No new residential dwelling houses (Outline Application)	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
Major Development: 0/49141	Approved	0.97	8.04	Demolition of existing buildings and erection of an over 55s affordable housing development comprising of 43 apartments, access, parking, landscaping, drainage infrastructure and associated development.	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
Major Development: 0/50854	Application submitted 22/06/2023	1.03	7.94	Certificate of Lawful Development for the siting of 393 static caravan units with 12 month occupancy in any year plus 12 touring caravans with occupancy between 21st March and 31st October inclusive.	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes

Project/Plan	Status	Distance from the Mona Onshore Development Area (km)	Distance to Onshore Substation (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Mona Offshore Wind Project
Major Development: 0/48393	Approved	0.9	8.12	Details of the appearance of the development and the landscaping to the development site.	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
Tier 3							
St. Asaph Solar Farm	Pre-application	0	0.87	A proposed solar farm with a potential generating capacity of between 10MW and 350Mw.	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
NGET 31/2023/0525	Pre-application (EIA screening request)	0.03	0.41	Extension to the existing Bodelwyddan electricity substation (EIA Screening Opinion request).	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
NGET	Pre-application	0.03	0.41	Application under section 37 of the Electricity Act 1989 for the installation of new overhead lines.	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes
NGET	Pre-application	0.03	0.41	Permitted development comprising extension to the GIS hall required to facilitate the extension to the existing Bodelwyddan electricity substation	Not provided but assumed to overlap with Mona Offshore Wind Project	Not provided but assumed to overlap with Mona Offshore Wind Project	Yes



Service Layer Credits: World Topographic Map: Esri UK, Esri, TomTom, Garmin, FAO, NOAA, USGS
World Hillshade: Esri, USGS

Data Sources: RPS / bp / EnBwW

Geodetic Information:
Datum: OSGB 1936. Projection: British National Grid.
Scale@ 378.9mm x 214.9 mm:1:50,000

0 0.25 0.5 1 nm
0 0.5 1 2 km

Partners in UK offshore wind

Project Name: MONA OFFSHORE WIND PROJECT

Drawing Title: CUMULATIVE PROJECTS SCREENED INTO THE CEA ASSESSMENT

Drawing Number: 12079-0414-08

VER	DATE	DETAILS	BY	CHECK
08	13/02/24	FINAL	JM	CR

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Figure 1.2: Cumulative projects screened into the CEA assessment

1.9.2 Maximum design scenario

1.9.2.1 The MDS identified in Table 1.17 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the Project Design Envelope provided in Volume 1, Chapter 5: Project Description of the Environmental Statement as well as the information available on other projects and plans, in order to inform the MDS. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (e.g. different turbine layout), to that assessed here, be taken forward in the final design scheme.

1.9.2.2 The CEA has considered the Mona Offshore Wind Project, alongside the National Grid Bodelwyddan substation extension proposal. The information publicly available up to three months before application (see Volume 1, Chapter 3: Environmental Impact Assessment Methodology of the Environmental Statement) was considered in this CEA. The CEA has therefore been undertaken based on the latest available information in the public domain up to the 21 November 2023, which is the Autumn 2023 consultation material (National Grid, 2023). If further information is available for the proposal before the Mona Offshore Wind Project receives Development Consent, the Applicant will review the information and provide any update needed to the CEA.

1.9.2.3 The MARES Connect project is proposing to submit a planning application in 2024 for an interconnector cable, landfall and onshore substation with connection to the National Grid. The project has identified several landfall zones and zones for its onshore substation and there is the potential for overlap with the Mona Onshore Development Area. The CEA has not considered the Mona Offshore Wind Project, alongside the MARES Connect project as insufficient information was publicly available prior to the Mona Offshore Wind Project DCO submission (see Volume 1, Chapter 3: Environmental Impact Assessment Methodology of the Environmental Statement). However, if further information becomes available for the proposal before the Mona Offshore Wind Project receives Development Consent, the Applicant will review the information and provide any update needed to the CEA.

Table 1.17: MDS considered for the assessment of potential cumulative effects on geology, hydrogeology and ground conditions.

[a] C=construction, O=operations and maintenance, D=decommissioning

Potential cumulative impact	Phase[a]			MDS	Justification
	C	O	D		
Alteration to groundwater quantity or quality in the glacial till superficial aquifer (Secondary undifferentiated).	✓	✓	✓	MDS as described for the Mona Offshore Wind Project (Table 1.14) assessed cumulatively with the following other projects/plans: **Tier 1** • Awel y Môr Offshore Wind farm (onshore infrastructure) • Major Development: 40/2017/1232 • Major Development: 46/2021/0159 • Major Development 40/2021/0309 • Major Development 0/42900 • Major Development: 0/43877 • Major Development: 0/44621 • Major Development: 0/47217 • Major Development: 0/49141 • Major Development: 0/50854 • Major Development: 0/48393 **Tier 3** • Mares Connect • St. Asaph Solar Farm • Major Development 31/2023/0525 (NGET) • NGET – overhead lines • NGET – Permitted development	The MDS assumes that there is an overlap in the construction timeframes of these projects and the Mona Offshore Wind Project
Alteration to groundwater quantity or quality in the bedrock aquifers of the Ffernant Formation and Warwickshire Group (Secondary A aquifers).	✓	✓	✓		

Potential cumulative impact	Phase[a]			MDS	Justification
Deterioration in groundwater quality as a result of accidental release or spillage of potentially polluting substances, during the construction and decommissioning phase.	✓	×	✓		
Deterioration of groundwater quality in the glacial till aquifer by the disturbance and mobilisation of existing areas of contamination associated with recent or historical land-use.	✓	×	×		
Deterioration in groundwater quality in bedrock aquifers through the disturbance and mobilisation of existing areas of contaminated land associated with recent or historical land-use.	✓	×	×		

1.10 Cumulative effects assessment

1.10.1 Introduction

1.10.1.1 A description of the significance of cumulative effects upon geology, hydrogeology and ground condition receptors arising from each identified impact is given below.

1.10.2 Alteration to groundwater quantity or quality in the glacial till superficial aquifer (Secondary undifferentiated).

Tier 1

Construction phase

Magnitude of impact

1.10.2.1 The Awel y Môr project involves the construction of cable trenches. Temporary dewatering of the cable trenches may be required during construction. This may locally lower groundwater level, resulting in changes to flow directions, and/or reduce the quantity of groundwater within localised water-bearing units in the till within the cumulative GHGC study area. The cumulative impact is predicted to be of limited local spatial extent, short term duration and of and moderate reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

1.10.2.2 Major development 0/4290 is located approximately 100 m from the Mona Onshore Development Area and involves the construction of 156 dwellings. Dewatering is likely to be required which may temporarily reduce the quantity of groundwater within the water bearing units of the glacial till. The cumulative impact is predicted to be of limited local spatial extent, short term duration and of and moderate reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**. The other Tier 1 developments are located some distance from the Mona Onshore Development Area and therefore are unlikely to have a cumulative impact.

Sensitivity of the receptor

1.10.2.3 The glacial till is a Secondary undifferentiated aquifer, characterised by localised groundwater occurrence, limited resource potential and limited utilisation at a local scale and with limited connection to other groundwater dependant receptors. The sensitivity of this receptor is therefore considered to be **low**.

Significance of effect

1.10.2.4 Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

1.10.2.5 The inert granular fill within the onshore export cables, may create new shallow pathways for groundwater flow in the glacial till. This may provide increased localised connectivity between water bearing horizons at shallow depth in the glacial till aquifer within the cumulative GHGC study area. However, a large increase in connectivity with potential groundwater dependent receptors is considered unlikely to occur. The

cumulative effect is predicted to be of limited local spatial extent albeit long term to permanent duration. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

1.10.2.6 The potential for changes to groundwater quality and quantity during the operation of the other Tier 1 developments is more localised and the magnitude of the cumulative impacts is therefore, considered to be **low**.

Sensitivity of the receptor

1.10.2.7 The glacial till is a Secondary undifferentiated aquifer, characterised by localised groundwater occurrence, limited resource potential and limited utilisation at a local scale and with limited connection to other groundwater dependant receptors. The sensitivity of this receptor is therefore considered to be **low**.

Significance of effect

1.10.2.8 Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.10.2.9 The impact of the decommissioning phase will largely reflect that described for the operations and maintenance phase given onshore export cables will be left in situ within the cumulative GHGC study area. However, the Onshore Substation and some other onshore infrastructure may be removed. The impact on groundwater within the glacial till will be a small and localised change to groundwater levels, groundwater flow and resource utility. The cumulative effect is predicted to be of limited local spatial extent albeit long term to permanent duration. It is predicted that the impact will affect the receptor directly. The magnitude of the cumulative impact is therefore, considered to be **low**.

Sensitivity of the receptor

1.10.2.10 The glacial till is a Secondary undifferentiated aquifer, characterised by localised groundwater occurrence, limited resource potential and limited utilisation at a local scale and with limited connection to other groundwater dependant receptors. The sensitivity of this receptor is therefore considered to be **low**.

Significance of effect

1.10.2.11 Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Tier 3

Construction phase

Magnitude of impact

1.10.2.12 The NGET and the St Asaph solar farm developments are likely to have localised impacts on the quantity and quality of the groundwater in the superficial aquifer due to the localised nature of the groundwater within the glacial till and the absence of lateral continuity. The cumulative impact is predicted to be of limited local spatial extent, short

term duration and of and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of the cumulative impact is therefore, considered to be **low** adverse.

Sensitivity of the receptor

1.10.2.13 As discussed above, the glacial till is a Secondary undifferentiated aquifer. The sensitivity of this receptor is considered to be **low**.

Significance of effect

1.10.2.14 Overall, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore, be of **negligible** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

1.10.2.15 The quantity and quality of groundwater in the superficial aquifer is unlikely to be affected during the operation of the Tier 3 developments. Therefore, the magnitude of the cumulative impact is considered to be **low** .

Sensitivity of the receptor

1.10.2.16 As discussed above, the glacial till is a Secondary undifferentiated aquifer. The sensitivity of this receptor is considered to be **low**.

Significance of effect

1.10.2.17 Overall, the magnitude of the cumulative impact is deemed to be no change and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore, be of **no change** significance, which is not significant in EIA terms

Decommissioning phase

Magnitude of impact

1.10.2.18 The magnitude of impact will be the same as construction and is therefore, considered to be **negligible** adverse.

Sensitivity of the receptor

1.10.2.19 As discussed above, the glacial till is a Secondary undifferentiated aquifer. The sensitivity of this receptor is considered to be **low**.

Significance of effect

1.10.2.20 Overall, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore, be of **negligible** adverse significance, which is not significant in EIA terms

1.10.3 Alteration to groundwater quantity or quality in the bedrock aquifers of the Ffernant Formation and Warwickshire Group (Secondary A aquifers).

Tier 1

Construction phase

Magnitude of impact

1.10.3.1 The sandstone bedrock aquifer of the Warwickshire Group within the cumulative GHGC study area are concealed beneath a significant depth of glacial till. As no pathways to the bedrock are expected to be created during construction within the CEA the magnitude of the cumulative effect is therefore considered to be **negligible**.

Sensitivity of the receptor

1.10.3.2 The Warwickshire Group sandstones are designated Secondary A aquifer of possible local importance. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

1.10.3.3 Overall, the magnitude of the cumulative impact is deemed to be no change and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be **minor** adverse, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

1.10.3.4 In the absence of new pathways to the concealed bedrock aquifer being created during constriction within the CEA and given local recharge can be expected to be of reasonable quality the magnitude of the cumulative effect is considered to be **negligible**.

Sensitivity of the receptor

1.10.3.5 The sandstones of the Warwickshire Group are designated a Secondary A aquifer of possible local importance. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

1.10.3.6 Overall, the magnitude of the cumulative impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be **minor** adverse, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.10.3.7 As for the construction phase the magnitude of the long-term cumulative effect on the Warwickshire Group bedrock aquifer is considered to be **negligible.**

Sensitivity of the receptor

1.10.3.8 The sandstones of the Warwickshire Group are designated a Secondary A aquifer of possible local importance. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

1.10.3.9 Overall, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be **minor** adverse, which is not significant in EIA terms.

Tier 3

Construction phase

Magnitude of impact

1.10.3.10 Given the depth of the overlying till material, the construction of the Tier 3 developments is unlikely to create a pathway to the bedrock aquifer. The magnitude of the cumulative impact is therefore, considered to be **negligible**.

Sensitivity of receptor

1.10.3.11 The Warwickshire Group sandstones are designated Secondary A aquifer of possible local importance. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

1.10.3.12 Overall, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be **minor** adverse, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

1.10.3.13 No new pathways will be created with the bedrock aquifer during the operation of the Tier 3 developments. The magnitude of the cumulative impact is therefore, considered to be **negligible**.

Sensitivity of receptor

1.10.3.14 The Warwickshire Group sandstones are designated Secondary A aquifer of possible local importance. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

1.10.3.15 Overall, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be **minor** adverse, which is not significant in EIA terms

Decommissioning phase

Magnitude of impact

1.10.3.16 As per the construction phase, no pathways will be created during the decommissioning of the Tier 3 developments. The magnitude of the cumulative impact is therefore, considered to be **negligible** adverse.

Sensitivity of receptor

1.10.3.17 The Warwickshire Group sandstones are designated Secondary A aquifer of possible local importance. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

1.10.3.18 Overall, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be **minor** adverse, which is not significant in EIA terms

1.10.4 Deterioration in groundwater quality as a result of accidental release or spillage of potentially polluting substances, during the construction and decommissioning phase

Tier 1 and Tier 3

Construction phase

Magnitude of impact

1.10.4.1 The storage, transportation and use of potentially polluting substances during the construction phase for developments with the cumulative GHGC study area has the potential to directly impact groundwater in the shallow underlying aquifer. This risk is managed by measures outlined in the Outline CoCP that will accompany all such developments within the cumulative GHGC study area. By implementing those measures the magnitude of this cumulative effect will be minimised. The magnitude of the cumulative impact on the glacial till aquifer is considered to be **low.**

1.10.4.2 The magnitude of the cumulative impact on the is therefore considered to be **low**.

Sensitivity of the receptor

1.10.4.3 The cumulative GHGC study area is directly underlain by a thick sequence of glacial till that is classified a Secondary undifferentiated aquifer unit. The sensitivity of this receptor is considered to be **low**.

Significance of effect

1.10.4.4 Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be **negligible**, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.10.4.5 The cumulative effect for the decommissioning phase is considered to have the same magnitudes as defined for the construction phase. By implementing those measures in the Outline CoCP for decommissioning the magnitude of cumulative effect will be minimised. The magnitude of impact is therefore considered to be **low**.

Sensitivity of the receptor

1.10.4.6 The cumulative GHGC study area is directly underlain by a thick sequence of glacial till that is classified a Secondary undifferentiated aquifer unit. The sensitivity of this receptor is considered to be **low**.

Significance of effect

1.10.4.7 Overall, the magnitude of the cumulative impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be **negligible** adverse, which is not significant in EIA terms.

Tier 3

Construction phase

Magnitude of impact

1.10.4.8 The Tier 3 projects may give rise to small, localised point source impacts on groundwater and land quality. However, these risks will be managed using a CoCP (or equivalent) that will be required as a condition of planning consent. By implementing those measures the magnitude of this cumulative effect will be minimised. The magnitude of the cumulative impact on the glacial till aquifer is considered to be **low.**

Sensitivity of receptor

1.10.4.9 The cumulative GHGC study area is directly underlain by a thick sequence of glacial till that is classified a Secondary undifferentiated aquifer unit. The sensitivity of this receptor is considered to be **low**.

Significance of effect

1.10.4.10 Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be **negligible**, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

1.10.4.11 As for construction, the magnitude of the cumulative impact on the glacial till aquifer is considered to be **low**

Sensitivity of receptor

1.10.4.12 The sensitivity of the receptor is considered to be **low**.

Significance of effect

1.10.4.13 Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be **negligible**, which is not significant in EIA terms.

1.10.5 Deterioration of groundwater quality in the glacial till aquifer by the disturbance and mobilisation of existing areas of contamination associated with recent or historical land-use

Tier 1

Construction phase

Magnitude of impact

1.10.5.1 Historical licensed industrial activity land-uses have been identified around St Asaph Business Park in the vicinity of the cumulative GHGC study area, albeit largely outside of the Mona Onshore Development Area. The potential risk associated with soil and groundwater conditions within these areas shall mitigated through the implementation of a contamination discovery strategy and investigations as part of the Outline CoCP for Awel y Môr Offshore Wind farm and as a planning condition for other major developments considered in the cumulative GHGC study area. Given the low permeability of the till and discontinuous nature of groundwater therein, it is also reasonable to expect the magnitude of this impact will not be greater than for the CEA than for Mona in isolation. The magnitude of this cumulative effect is therefore, considered to be **low**.

Sensitivity of the receptor

1.10.5.2 The glacial till is Secondary undifferentiated aquifer, characterised by localised groundwater occurrence, limited resource potential, limited utilisation at a local scale and with limited connection to other groundwater dependant receptors. The sensitivity of this receptor is therefore considered to be **low**.

Significance of effect

1.10.5.3 Overall, the magnitude of the cumulative impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **negligible or minor** adverse significance, which is not significant in EIA terms.

Tier 3

Construction phase

Magnitude of impact

1.10.5.4 In the absence of significant sources of contamination, it is unlikely for cumulative impacts to occur. The magnitude of this cumulative effect is therefore, considered to be **low**.

Sensitivity of receptor

1.10.5.5 The underlying glacial till is a Secondary undifferentiated aquifer. The sensitivity of this receptor is considered to be **low**.

Significance of effect

1.10.5.6 Overall, the magnitude of the cumulative impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **negligible** or **minor** adverse significance, which is not significant in EIA terms.

1.10.6 Deterioration in groundwater quality in bedrock aquifers through the disturbance and mobilisation of existing areas of contaminated land associated with recent or historical land-use.

Tier 1

Construction phase

Magnitude of impact

1.10.6.1 Historical licensed industrial activity land-uses have been identified around St Asaph Business Park in the vicinity of the cumulative GHGC study area, albeit largely outside of the Mona Onshore Development Area. The potential risk associated with soil and groundwater conditions within these areas shall mitigated through the implementation of a contamination discovery strategy and requirement for undertaking a piling risk assessment for deep foundation solutions as part of the Outline CoCP for all developments considered in the cumulative GHGC study area. Given the bedrock aquifer in the cumulative GHGC study area is concealed beneath deep glacial till, the magnitude of this impact is therefore, considered to be **negligible**.

Sensitivity of the receptor

1.10.6.2 The Warwickshire Group sandstones are designated Secondary A aquifer of possible local importance. The sensitivity of the receptor is therefore considered to be **medium**.

Significance of effect

1.10.6.3 Overall, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

Tier 3

Construction phase

Magnitude of impact

1.10.6.4 As the bedrock aquifers are generally concealed beneath the glacial till, the potential magnitude of the cumulative impact is limited. The magnitude of this impact is therefore, considered to be **negligible**.

Sensitivity of receptor

1.10.6.5 The Warwickshire Group sandstones are designated Secondary A aquifer of possible local importance. The sensitivity of the receptor is therefore considered to be **medium**.

Significance of effect

1.10.6.6 Overall, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **negligible** significance, which is not significant in EIA terms

1.11 Transboundary effects

1.11.1.1 A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regard to geology, hydrogeology and ground conditions from the Mona Offshore Wind Project upon the interests of other states.

1.12 Inter-related effects

1.12.1.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Mona Offshore Wind Project (construction, operations and maintenance, and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three phases (e.g. subsea noise effects from piling, operational turbines, vessels and decommissioning)
- Receptor led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on geology, hydrogeology and ground conditions, such as deterioration of groundwater, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

1.12.1.2 A description of the likely interactive effects arising from the Mona Offshore Wind Project on geology, hydrogeology and ground conditions is provided in Volume 3, Chapter 11: Inter-related effects of the Environmental Statement.

1.13 Summary of impacts, mitigation measures and monitoring

1.13.1.1 Information on geology, hydrogeology and ground conditions within the GHGC study area was collected through a review of desktop information.

- Table 1.18 presents a summary of the potential impacts, measures adopted as part of the project and residual effects in respect to geology, hydrogeology and ground conditions. The impacts assessed include:
  - The impact of loss of, or damage to, designated sites of geological and geomorphological interest
  - Loss of, or damage to non-designated sites of geological and geomorphological interest
  - Sterilisation of safeguarded limestone mineral resources
  - Alteration to groundwater quantity or quality in the glacial till superficial aquifer (Secondary undifferentiated)
  - Alteration to groundwater quantity or quality in the Clwyd Limestone Group bedrock aquifer (Principal aquifer)
  - Alteration to groundwater quantity or quality in the bedrock aquifers of the Ffernant Formation and Warwickshire Group (Secondary A aquifers)
  - Impact on private groundwater supply sources in terms of abstraction quantity, abstraction reliability and abstraction quality
  - Deterioration of groundwater quality in the Clwyd Limestone Group bedrock aquifer by the mobilisation of contamination associated with the historical Llanddulas Beach Landfill site.
  - Deterioration of groundwater quality in the glacial till aquifer by the disturbance and mobilisation of existing areas of contamination associated with recent or historical land-use.
  - Deterioration in groundwater quality in bedrock aquifers through the disturbance and mobilisation of existing areas of contaminated land associated with recent or historical land-use.
  - Deterioration in groundwater quality as a result of accidental release or spillage of potentially polluting substances, during the construction and decommissioning phase
  - Ground stability issues associated with areas of historical deep mining operations.
- Overall it is concluded that there will be no significant effects arising from the Mona Offshore Wind Project during the construction, operations and maintenance or decommissioning phases.
- Table 1.19 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The cumulative impacts assessed include:
  - Alteration to groundwater quantity or quality in the glacial till superficial aquifer (Secondary undifferentiated)
  - Alteration to groundwater quantity or quality in the Clwyd Limestone Group bedrock aquifer (Principal aquifer)

  - Alteration to groundwater quantity or quality in the bedrock aquifers of the Ffernant Formation and Warwickshire Group (Secondary A aquifers)
  - Impact on private groundwater supply sources in terms of abstraction quantity, abstraction reliability and abstraction quality
  - Deterioration of groundwater quality in the glacial till aquifer by the disturbance and mobilisation of existing areas of contamination associated with recent or historical land-use
  - Deterioration in groundwater quality in bedrock aquifers through the disturbance and mobilisation of existing areas of contaminated land associated with recent or historical land-use
  - Deterioration in groundwater quality as a result of accidental release or spillage of potentially polluting substances, during the construction and decommissioning phase.
- Overall, it is concluded that there will be no significant cumulative effects from the Mona Offshore Wind Project alongside other projects/plans.
- No potential transboundary impacts have been identified in regard to effects of the Mona Offshore Wind Project.

Table 1.18: Summary of potential environmental effects, mitigation and monitoring.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D							
The impact of loss of, or damage to, designated sites of geological and geomorphological interest.	✓	×	×	Construction method statement - Trenchless crossing techniques method statement	C:Low	C:High	C: Minor adverse	N/A	C: Minor adverse	N/A
Loss of, or damage to non-designated sites of geological and geomorphological interest.	✓	×	✓	Micro-siting of Onshore Cable Corridor and 400 kV Grid Connection Corridor. Restoration of drumlins as part of soil management plan	C:Low D: Negligible	C: Low D: Low	C: Minor adverse D: Negligible	N/A	C:Minor adverse D:Negligible	N/A
Sterilisation of safeguarded limestone mineral resources.	✓	✓	✓	Site selection	C:Low O:Low D:Low	C:Medium O:Medium D:Medium	C:Minor adverse O: Minor adverse D: Minor adverse	N/A	C:Minor adverse O: Minor adverse D: Minor adverse	N/A
Alteration to groundwater quantity or quality in the glacial till superficial aquifer.	✓	✓	✓	Outline CoCP	C:Low O:Low D:Low	C:Low O:Low D:Low	C:Minor adverse O: Minor adverse D: Minor adverse	N/A	C:Minor adverse O: Minor adverse D: Minor adverse	N/A
Alteration to groundwater quantity or quality in the Clwyd Limestone Group bedrock aquifer (Principal aquifer).	✓	✓	✓	None	C: Negligible O: Negligible D: Negligible	C:High O:High D:High	C:Minor adverse O: Minor adverse D: Minor adverse	N/A	C:Minor adverse O: Minor adverse D: Minor adverse	N/A

Description of impact	Phase[a]			Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D							
Alteration to groundwater quantity or quality in the bedrock aquifers of the Ffernant Formation and Warwickshire Group (Secondary A aquifers).	✓	✓	✓	None	C: Negligible O: Negligible D: Negligible	C:Medium O:Medium D:Medium	C:Minor adverse O: Minor adverse D: Minor adverse	N/A	C:Minor adverse O: Minor adverse D: Minor adverse	N/A
Impact on private groundwater supply sources in terms of abstraction quantity, abstraction reliability and abstraction quality.	✓	✓	✓	CoCP - Hydrogeological risk assessment for groundwater supply sources and associated mitigation measures	C:Low O:Low D:Low	C:Medium O:Medium D:Medium	C:Minor adverse O: Minor adverse D: Minor adverse	N/A	C:Minor adverse O: Minor adverse D: Minor adverse	N/A
Deterioration of groundwater quality in the Clwyd Limestone Group bedrock aquifer by the mobilisation of contamination associated with the historical Llanddulas Beach Landfill site.	✓	×	×	Landfall Construction Method Statement	C: Negligible	C: High	C:Minor adverse	N/A	C:Minor adverse	N/A
Deterioration of groundwater quality in the glacial till aquifer by the disturbance and mobilisation of existing areas of contamination associated with recent or historical land-use.	✓	×	×	Construction Method Statement - Piling risk assessment for deep foundations. CoCP – Dsicovery strategy for contamination	C:Low	C:Low	C:Negligible	N/A	C: Negligible	N/A
Deterioration in groundwater quality in bedrock aquifers through the disturbance and mobilisation of existing areas of contaminated land associated with recent or historical land-use.	✓	×	×	Construction Method Statement - Piling risk assessment for deep foundations. Outline CoCP – Dsicovery strategy for contamination	C: Negligible	C:Medium or High	C:Negligible	N/A	C: Minor adverse	N/A

Description of impact	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Deterioration in groundwater quality as a result of accidental release or spillage of potentially polluting substances, during the construction and decommissioning phase.	✓	×	✓	CoCP – Spillage and Emergency Response Plan	C: Low to Negligible D:Negligible	C:Low to High D:Low to HIgh	C:Negligible to Minor adverse D:Negligible to Minor adverse	N/A	C: Negligible to Minor adverse D: Negligible to Minor adverse	N/A
Ground stability issues associated with areas of historical deep mining operations.	✓	×	×	Construction Method Statement - historical mining activty assessment)	C:Negligible	C:High	C:Minor adverse	Historical mining risk assessment	C:Minor adverse	N/A

Table 1.19: Summary of potential cumulative environmental effects, mitigation and monitoring.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Tier 1 and Tier 3										
Alteration to groundwater quantity or quality in the glacial till superficial aquifer.	✓	✓	✓	Outline CoCP	C:Low O:Low D:Low	C:Low O:Low D:Low	C:Minor adverse O: Minor adverse D: Minor adverse	N/A	C:Minor adverse O: Minor adverse D: Minor adverse	N/A
Alteration to groundwater quantity or quality in the bedrock aquifers of the Ffernant Formation and Warwickshire Group (Secondary A aquifers).	✓	✓	✓	None	C: Negligible O: Negligible D: Negligible	C:Medium O:Medium D:Medium	C:Minor adverse O: Minor adverse	N/A	C:Minor adverse O: Minor adverse	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
							D: Minor adverse		D: Minor adverse	
Deterioration in groundwater quality as a result of accidental release or spillage of potentially polluting substances, during the construction and decommissioning phase.	✓	×	×	Measures within the Outline CoCP	C: Low	C:Low	C:Negligible	N/A	C:Negligible	N/A
Deterioration of groundwater quality in the glacial till aquifer by the disturbance and mobilisation of existing areas of contamination associated with recent or historical land-use.	✓	×	×	Construction Method Statement - Piling risk assessment for deep foundations. CoCP – Dsicovery strategy for contamination	C:Low	C:Low	C:Negligible	N/A	C: Negligible	N/A
Deterioration in groundwater quality in bedrock aquifers through the disturbance and mobilisation of existing areas of contaminated land associated with recent or historical land-use.	✓	×	×	Construction Method Statement - Piling risk assessment for deep foundations. CoCP – Dsicovery strategy for contamination	C: Negligible	C:Medium/	C:Minor adverse	N/A	C: Minor adverse	N/A

1.14 References

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