

NRW Marine Licencing Team
Welsh Government Offices
Cathays Park
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Dear NRW Marine Licencing Team,

Environmental Impact Assessment Scoping Opinion Addendum for Cardigan Tidal Flood Risk Management Scheme

1 Introduction

This letter comprises a request for an update to the Environmental Impact Assessment (EIA) Scoping Opinion provided on 11th December 2023 from Ceredigion County Council (CCC) and 14th December from Natural Resources Wales (NRW) Marine Licencing Team (hereafter referred to as the '2023 EIA Scoping Opinion') for the Cardigan Tidal Flood Risk Management Scheme (TFRMS, henceforth referred to as 'the Scheme'). We would like to request an update of the EIA Scoping Opinion on the following matters:

- To scope out certain topics on the basis of further information; and
- To provide further details on the impacts intended to be scoped in for the topics remaining scoped in, and a high level overview of the methodology to be completed for these topics.

A combined EIA Screening and Scoping Request was issued to CCC and NRW Marine Licencing Team on 22nd September 2023 (hereafter referred to as the '2023 Scoping Report'). The responses from both CCC and NRW confirmed that the Scheme requires EIA. The topics scoped in following the 2023 EIA Scoping Opinion are summarised in Table 1.

Table 1 – 2023 EIA scoping opinion summary

Topic	Terrestrial (CCC)		Marine (NRW)	
	Construction	Operation	Construction	Operation
Population and Human Health	Scoped In	Scoped In	Scoped In	Scoped Out
Biodiversity and Nature Conservation	Scoped In	Scoped In	Scoped In	Scoped In (comments in relation to long term effects from loss of intertidal habitats)
Water	Scoped In	Scoped In	Scoped In (comments in relation to physical processes and	Scoped In (comments in relation to physical

Topic	Terrestrial (CCC)		Marine (NRW)	
	Construction	Operation	Construction	Operation
			geomorphology only)	processes and geomorphology only)
Land Use and Soil	Scoped In	Scoped Out	Scoped In	Scoped Out
Air	Scoped In	Scoped Out	Scoped In	Scoped Out
Climate	Scoped In	Scoped Out	Scoped In	Scoped Out
Material Assets/Transport	Scoped In	Scoped Out	Navigational Risk Assessment to be undertaken as part of the EIA	
Historic Environment	Scoped In	Scoped In	Scoped In	Scoped In
Landscape and Visual	Scoped In	Scoped In	Scoped In	Scoped In
Cumulative Effects	Scoped In*	Scoped In*	Scoped In	Scoped In

*Cumulative effects were not specifically mentioned in the 2023 Scoping Opinion from CCC, however they were proposed to be scoped in in the 2023 Scoping Report and so are shown as scoped in here.

2 Overview of the Scheme

The Scheme is located towards the centre of Cardigan town in west Wales. The permanent works are proposed to be located on the north bank of the Afon Teifi. The Scheme is bound to the west by Castle Street (SN177458) and to the east by Gloster Row car park (SN180459). The location of the Scheme is shown on the Location Plan provided in Appendix A.1.

The lower quayside areas of Cardigan have previously been inundated by the tide, which affects the Strand area. Low lying residential and commercial properties are affected by a tidal return period of approximately 1 in 1-year annual exceedance probability. It is thought that the onset of property flooding is near or at this level of probability with several properties having threshold levels of 3.100m above ordnance datum (AOD) and below. The Scheme is proposed to reduce this risk of property flooding.

The proposed Scheme will comprise of a continuous flood defence structure designed to fit within the various constraints along the Afon Teifi frontage between Cardigan Bridge (Castle Street) and Gloster Row car park (approximately 300 to 400m in length). The flood defences will need to achieve a consistent level of 4.95mAOD to provide the scheme design standard of 1 in 200 years annual exceedance probability (AEP) with allowance for climate change, which will make the structures up to approximately 2m tall above general ground level (though lower in some sections). The defence will be composed of sheet piles, topped with a reinforced concrete wall for certain sections. This will be supported on the riverside by a lower toe berm (embankment). Within the central area there is a proposed boat ramp to enable canoe/kayak access to the water for the scouts and water sports activity centre. The existing slipway/river access point at Gloster Row car park will be removed. Towards Cardigan Bridge (Castle Street) there will be further improvements to the street scene.

Since the issue of the 2023 Scoping Report the design has been subject to several changes. The Indicative Layout Plan (Appendix A.2) shows the proposed alignment of flood defences and numbering system used to describe each Area of the Scheme. The following changes to the Scheme design have been made:

- In order to reduce the length of piled foundations, a stone embankment will be placed in front of the flood defence wall for the majority of the alignment, to provide stability. The

embankment will be designed to allow for intertidal habitats to colonise, reducing the effect of the increased footprint of the flood defence structure.

- The entire alignment of the flood wall in Area 3 will be along the riverward face of the existing wall. This change will enable a more efficient and simple construction methodology and remove the requirement to demolish all buildings except the garage/office structure to the eastern side of the Old Foundry site.
- The flood defence wall in Area 4 will be aligned to create an area of saltmarsh on land which is currently poor semi-improved grassland to the east of the Gloster Row car park along with part of the car park itself. By aligning the flood defence wall in this way, the Scheme will deliver no net loss of intertidal habitats which are categorised as Habitats of Principal Importance. There is also the potential that there will be a net gain of these habitats compared with the baseline, which will form part of the requirement to deliver an overall Net Benefit for Biodiversity (NBB). The loss of an area of the car park will be mitigated through the re-design of the car park to minimise the number of car parking spaces lost, if any.

3 Environmental effects proposed to be Scoped Out

The potentially significant environmental effects which are proposed to be scoped out following the consideration of further information are associated with the following topics:

- Population and Human Health (Construction and Operation)
- Water Environment (Construction and Operation)
- Land Use and Soil (Construction)
- Air Quality (Construction)
- Climate (Construction)
- Material Assets/Traffic and Transport (Construction)

Population and Human Health

Summary of effects scoped in previously

The 2023 Scoping Opinion required the following potentially significant environmental effects from construction, as described in the 2023 Scoping Report, to be assessed within the EIA:

- Potential for negative temporary construction effects relating to noise, vibration, pollution, dust, footpath closure and diversions, traffic disruption, reduced amenity access, reduced recreational capacity, and changes to water navigation. The temporary effects may impact residents, business owners and users, users of transport infrastructure and users of recreational facilities.
- Potential for permanent negative effects due to the demolition of buildings.
- Potential for positive effects on the local economy during construction through employment of a local contractor or contractors and an increase in trade for local shops and businesses.

The 2023 Scoping Report listed the following potentially significant environmental effects during operation to be assessed within the EIA:

- Potential for negative effects to Public Rights of Way (PRoW) due to flood detriment.



- Potential for permanent effects to river navigation from the sections of the Scheme encroaching into the river.
- Potential for permanent positive effects due to the reduction in flood risk and the provision of an area of public open space.

Effect to scope out based on additional information - Construction

It is proposed to scope out the following potentially significant environmental effect from construction:

- Potential for permanent negative effects due to the demolition of buildings.

Negative effects relating to demolition are no longer expected to occur as design changes now mean that only one building (garage/office structure to the eastern side of the Old Foundry site) requires demolition to enable the construction of the Scheme. It is considered that the demolition of one building would not generate a wider significant environmental effect upon the availability of housing/business premises in the area as the building is not classed as either. The building is understood to have an outstanding enforcement action against it as planning permission was not originally granted. The building may be demolished prior to construction of the Scheme under the outstanding enforcement action or as part of the enabling works for the Scheme. Given that the landowner/property owner is engaged with regarding the demolition of the building, it is not considered that there will be any significant environmental effects resulting from the demolition. It is therefore considered that no further assessment is required.

Effects to scope out based on additional information - Operation

It is proposed to scope out the following potentially significant environmental effects from operation:

- Potential for negative effects to PRoW due to flood detriment.

There was concern that construction of the Scheme would increase flood risk to the PRoW (78/23) on the opposite bank of the Afon Teifi. The Hydraulic Modelling Report (Appendix B) has demonstrated that the defences will cause no detriment in any of the tested flood events and therefore no increase in flood risk to PRoW 78/23. It is therefore considered that there is not likely to be a significant environmental effect.

- Potential for permanent effects to river navigation from the sections of the Scheme encroaching into the river.

During the operational phase, it is not anticipated that there will be any effects upon the navigation of the Afon Teifi as there will not be a significant change to the navigable section of the river channel. The flood defence wall will be offset from the existing wall by no more than 1.5m along the entire length. This, along with the embankment footprint, will not extend into the more central navigable section of the river. Due to the tidal nature of the Afon Teifi at Cardigan the navigable width of the river changes over the course of the day such that there will be times when the embankment is not submerged. Furthermore, Cardigan Bridge (Castle Street) impedes navigation of larger vessels upstream past the Scheme Area; this section of river is primarily used by canoes and kayaks, which would not be affected by the small footprint of the works. There will therefore be no impediment to river navigation from the Scheme, and it is considered that a Navigational Risk Assessment is not required for the operational phase.

Water Environment



The 2023 Scoping Opinion required the following potentially significant environmental effects, as described in the 2023 Scoping Report, to be assessed within the EIA. After further investigation it is now proposed to scope out all effects within the Water Environment topic.

Effects to scope out based on additional information - Construction

- Impacts to water quality from construction related impacts (e.g., pollution, siltation).

The option selected intends to utilise construction from land in so far as possible to minimise potential construction related impacts to water quality. Potential effects to water quality during construction were assessed within the Water Framework Directive (WFD) Scoping Assessment (Appendix C) which concluded that as the works are located within an estuary which is likely to be naturally turbid due to the changing tidal movements, small releases in sediment are unlikely to be noticeable and conditions would be expected to return to baseline conditions relatively quickly. Furthermore, assuming the best standard practice pollution prevention measures are in place, potential effects on water quality are considered to be negligible and no further assessment is required.

The WFD Compliance Assessment will be completed to support the EIA and planning application.

Effects to scope out based on additional information - Operation

- Changes in flood risk.

Due to the nature of the proposed development, only positive effects on flooding are anticipated as evidenced by the findings of the Hydraulic Modeling Report (Appendix B). Therefore, it is considered that no further assessment is required for changes in flood risk during operation.

Land Use and Soil

The 2023 Scoping Opinion required the following potentially significant environmental effect from construction, as described in the 2023 Scoping Report, to be assessed within the EIA. No effects from operation were identified. After further investigation it is now proposed to scope out all effects within the Land Use and Soil topic.

Effects to scope out based on additional information - Construction

- Potential impact due to mobilisation of existing contamination, including asbestos.

Ground investigation works undertaken in 2022 recorded the presence of elevated levels of Polycyclic Aromatic Hydrocarbons (PAH) at the centre of the site at a depth of 0.5m. The levels recorded are considered to be only slightly elevated in respect to risk to human health (public open space Generic Assessment Criteria (GAC)). Asbestos was identified in low quantities on-site in the 2015 ground investigation and suspected asbestos was noted in 2022. The asbestos fibres have been quantified at up to 2.116% of the mass of material and so the risk remains low provided that disturbance is minimised. Asbestos Containing Material (ACM) has also been observed by site workers on both sides of the riverbed at low tide.

The conclusions of the Contaminated Land Interpretation Report (Appendix D) produced following the 2022 ground investigation works, state that the possibility of significant harm to the identified receptors has not been proven at the site and is not likely to occur as a direct result of the construction of the Scheme.

The report concludes that sheet piling along the bank of the Afon Teifi is unlikely to create a new pathway to the controlled waters and may break the pre-existing pathway due to their low permeability. Any disturbance of sediments during construction of the embankment and sheet pile installation will be mitigated in accordance with standard best practice measures.

Concrete surfacing at the top of the defence will reduce the likelihood of human contact with any existing localised PAH and asbestos contamination and prevent infiltration of new contaminants from the adjacent roadway or Cardigan town into the ground and groundwater. Asbestos which may be present within the soil is likely to be limited in quantity, cement bound, and waterlogged, limiting the potential for the generation of airborne fragments. Any remaining risk can be mitigated through the use of appropriate Personal Protective Equipment (PPE) and good personal hygiene.

Appropriate mitigation strategies will be put in place to contain and remove any potentially contaminated soils encountered which were not previously identified during previous investigation works. Mitigation will include measures to ensure the safety of construction personnel and prevent further contamination of the environment, through appropriate testing and disposal.

It is considered that with the implementation of best practice mitigation measures, no further assessment is required. Full details are provided in the Contaminated Land Interpretation Report (Appendix D).

As discussed in the Water Environment section above, any negative effects to water quality can be mitigated through standard practice pollution prevention measures are in and therefore no further assessment is required. Mitigation measures will be recorded within the Scheme's Construction Environmental Management Plan (CEMP).

Air Quality

The 2023 Scoping Opinion required the following potentially significant environmental effects from construction, as described in the 2023 Scoping Report, to be assessed within the EIA. No effects from operation were identified. After further investigation it is now proposed to scope out all effects within the Air Quality topic.

Effects to scope out based on additional information - Construction

- Impact of dust generation

In accordance with the Institute of Air Quality Management (IAQM)'s "Guidance on the assessment of dust from demolition and construction"¹ (IAQM, 2024), dust is defined as 'solid particles that are suspended in air or that have settled out onto a surface after having been suspended in air'. It includes particles that give rise to soiling (deposited dust) and to human health and ecological effects.

In Wales, a Dust Risk Assessment is typically required when a development could cause significant dust emissions during construction, demolition or operation, especially when located near to sensitive receptors. The Dust Risk Assessment is used to determine the appropriate mitigation measures to include in a Dust Management Plan (DMP) for a development based on the level of risk (low, medium or high).

¹ IAQM, 2024. *Guidance on the assessment of dust from demolition and construction*. V2.2. January 2024.



Based on the criteria outlined within the IAQM guidance, it is evident that the proposed development would not fall within the low-risk category and would instead be either medium or high risk due to the scale of the works and the presence of sensitive human and ecological receptors. As a precautionary approach, all IAQM recommended dust mitigation measures for medium and high-risk developments will be implemented in the Scheme's DMP, as part of the CEMP. These are detailed within Appendix E.

It is therefore considered that no further assessment of the impacts of dust generation will be required as there will be no significant environmental effect with the implementation of standard good practice.

- Impact of vehicular emissions on local air quality

In accordance with EPUK/IAQM Land-Use Planning and Development Control: Planning for Air Quality guidance, an air quality assessment is required where there is a change of Heavy-Duty Vehicle (HDV) flows of more than 100 per day measured as an annual average daily traffic flow (AADT), or more than 25 within an Air Quality Management Area (AQMA).

There are no AQMAs within 1km of the Scheme Area and therefore the 100 per day change in HDV flow threshold applies. The construction of the Scheme will not generate sufficient HDV flows to warrant the need for further assessment. Estimates of vehicle movements based on the updated Scheme design will mean that HDV flows will be less than 100 per day. The DMP as described above contains actions to reduce emissions from vehicles and plant, with all vehicles to be European Emissions Standard Euro VI compliant and plant to be Stage V compliant where feasible. It is therefore considered that no further assessment of construction vehicle emissions is required.

Climate

No operational potentially significant environmental effects were identified. The 2023 Scoping Report noted that the Scheme will reduce the risk of flooding and associated environmental, social and economic impacts. The Scheme therefore contributes to climate change adaptation and provides increased environmental and community resilience. Greenhouse Gas (GHG) emissions from operation will be minimal and associated with maintenance only.

The 2023 Scoping Opinion required the following potentially significant environmental effects from construction, as described in the 2023 Scoping Report, to be assessed within the EIA. After further investigation it is now proposed to scope out all effects within the Climate topic.

Effects to scope out based on additional information - Construction

- Construction of the flood defences will require use of natural resources i.e. construction material production and energy, which will result in the release of carbon emissions.

It is considered that the proposed development itself is relatively small scale, and its construction is unlikely to significantly add to climate change through the generation of emissions or the use of resources. However, in line with Welsh Government policies and guidance, including actions under the Well-being of Future Generations Act 2015, the sustainability and contribution of the proposed development to climate change have been considered.

To minimise embedded carbon and emissions associated with the production of construction materials and energy usage during construction, alternative designs and construction methodologies have been considered through the design development and this will be discussed within the

Alternatives chapter of the Environmental Statement. The discussion will document the consideration of more sustainable alternatives which allow for reductions in carbon and encourage energy efficiency.

As per the recommendations of the Outline Climate Change Adaption Report (Appendix F), the materials selected for use will be chosen based on their adaptability to changing climatic conditions including extreme temperatures but also increased precipitation. As the proposed Scheme is essential for affording greater protection to the local area against future flood events and storm surges, the selection of materials capable of resisting these conditions is key to a design which will continue to provide protection in the future.

Where possible, in line with these material specification parameters, material selection will be based upon their local availability to limit emissions associated with transportation. A carbon calculator is being utilised to help select materials with less life cycle embodied carbon. Encroachment onto saltmarsh and mudflat habitats has been limited as far as reasonably possible to reduce the loss of established carbon sinks. The NBB approach ensures that there will be an overall net gain in biodiversity and potential for associated carbon sinks.

It is therefore considered that due to the active sustainable resource management approach taken, no further assessment is required as effects to climate are likely to be negligible.

- Construction plant will result in carbon emissions.

As explained above, the sustainability and contribution of the proposed development to climate change has been considered to reduce potential effects on climate. Appropriate construction plant will be selected partly based upon its energy efficiency (European emission standard Stage V compliant) and associated emissions, with the intention of limiting effects on the environment. Therefore, it is considered that no further assessment is required.

Material Assets/Traffic and Transport

Summary of effects scoped in previously

The 2023 Scoping Opinion required the following potentially significant environmental effects during construction, as described in the 2023 Scoping Report, to be assessed within the EIA:

- Potential impact on local traffic due to road closures and traffic associated with construction of the flood defences (deliveries and plant movements) could contribute to road congestion in Cardigan and affect the use of certain roads and the bridge for periods during the construction phase.
- Installation of the proposed flood defences could have a temporary effect on utilities infrastructure.
- Potential demolition of buildings.

No operational potentially significant environmental effects were identified. Operational effects related to the navigation of the river channel have been scoped out within the Population and Human Health section.

Effects scoped out based on additional information - Construction

It is proposed to scope out the following potentially significant environmental effects from construction:



- Installation of the proposed flood defences could have a temporary effect on utilities infrastructure.

Potential impacts to utilities due to the construction of the Scheme will be discussed in greater detail within the Project Description chapter of the Environmental Statement. The presence of utilities has been considered throughout the design development. Any impacts to utilities in the area are expected to be temporary and negligible as any disruptions will be limited. Where utility diversions are required, whether temporary or permanent, these will require separate consents to be in place prior to the commencement of works. Therefore, it is not considered that further assessment is required.

- Potential demolition of buildings.

As described within the Population and Human Health section, negative effects associated with the demolition of buildings are not expected to occur as only one building, which is neither a residential dwelling or business property, requires demolition to enable the construction of the Scheme. It is not considered that there will be any significant environmental effects resulting from demolition. Therefore, it is considered that no further assessment will be required.

Major Accidents and Disasters

The assessment of Major Accidents and Disasters was not previously presented in the 2023 Scoping Report and no reference was made to it in the 2023 Scoping Opinion.

As disasters, accidents and incidents are not clearly quantified or defined by the the Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2017 and the Marine Works (Environmental Impact Assessment) Regulations 2017 (collectively the 'EIA Regulations'), professional judgement is used to determine whether a potential event may be classified as major and therefore whether there is a need for assessment within EIA.

Major accidents and disasters can be categorised into natural and man-made risks. Natural risks typically comprise extreme weather events and natural disasters such as earthquakes and volcanic eruptions whilst man-made risks typically comprise accidents such as plane crashes, car crashes, terrorist attacks or explosions.

Due to the location of the proposed development within Cardigan, west Wales, the greatest natural risk would be posed by extreme weather events such as extreme temperatures or rainfall/droughts, which are somewhat likely to occur. However, due to the nature of the proposed development, an improved level of protection will be provided against future flood events which will benefit the local area during operation.

Whilst man-made risks are possible, it is highly unlikely that most man-made risks including plane crashes and terrorism would not occur in the area and impact the proposed development. The most likely man-made risks are vandalism and car crashes which could both affect the integrity of the flood defences. Due to the central location of the proposed development, serious cases of vandalism are less likely to occur as the defences will be highly visible to the public. Car crashes and vandalism may have the potential to cause damage to the flood defences, but it is anticipated that this damage would be relatively minor and could be repaired and therefore, not decrease the standard of flood protection afforded by the assets in the long term.

As noted within the discussion on climate above, the Outline Climate Change Adaption Report (Appendix F) recommends the selection of materials appropriate for changing climatic conditions and

also recommends that the design considers the need for future upgrades to the defences. Where possible these recommendations will be incorporated into the design of the Scheme.

In summary, the proposed development is considered unlikely to result in major accidents and disasters or increase existing vulnerability to such events. Further assessment is therefore not deemed necessary.

4 Topics proposed to be Scoped In

Considering the above, the topics proposed to be scoped in to the EIA are as follows:

- Population and Human Health (supported by a Noise and Vibration Impact Assessment)
- Biodiversity and Nature Conservation
- Historic Environment
- Landscape and Visual Impact Assessment
- Traffic and Transport
- Cumulative Effects

Population and Human Health

Table 2 summarises the potentially significant environmental effects from construction which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 2 – Population and human health – potentially significant environmental effects (construction)

Environmental Effect	Receptor	Assessment methodology
Potential for negative temporary construction effects relating to noise, vibration, pollution, dust, footpath closure and diversions, traffic disruption, reduced amenity access, reduced recreational capacity, and changes to water navigation.	Local residents, businesses, recreational users, all river users	Qualitative assessment of the magnitude of change related to the protection of local businesses and local employment. Due to a lack of widely accepted best practice assessment guidance, professional judgement will be utilised to determine significance. The construction noise and vibration assessment will follow the Code of practice for noise and vibration control on construction and open sites – Part 1: Noise and Part 2: Vibration (BS 5228:2009+A1:2014). A Navigational Risk Assessment will be completed to assess risks and hazards to river users from construction of the Scheme.

Environmental Effect	Receptor	Assessment methodology
Potential for positive effects on the local economy during construction through employment of a local contractor or contractors and an increase in trade for local shops and businesses.	Local residents and businesses	Qualitative assessment of the magnitude of change related to the protection of local businesses and local employment. Due to a lack of widely accepted best practice assessment guidance, professional judgement will be utilised to determine significance.

Table 3 summarises the potentially significant environmental effects from operation which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 3 – Population and human health – potentially significant environmental effects (operation)

Environmental Effect	Receptor	Assessment methodology
Potential for permanent positive effects due to the reduction in flood risk.	Residential and business properties currently at risk of flooding.	Comparison of the number of properties at risk of flooding before and after construction of the Scheme. Due to a lack of widely accepted best practice assessment guidance, professional judgement will be utilised to determine significance.
Potential for permanent positive effects due to the provision of an area of public open space.	Public users	Qualitative assessment of the positive magnitude of change in relation to the creation of public open space. Due to a lack of widely accepted best practice assessment guidance, professional judgement will be utilised to determine significance. The assessment will partly be informed by the assessment within the Landscape and Visual chapter.

Biodiversity and Nature Conservation

Table 4 summarises the potentially significant environmental effects from construction which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 4 – Biodiversity and nature conservation – potentially significant environmental effects (construction)



Environmental Effect	Receptor	Assessment methodology
The site is a sensitive location, with potential impacts on the following protected sites and associated features: - Afon Teifi Special Area of Conservation (SAC) / Site of Special Scientific Interest (SSSI) - Cardigan Bay and West Wales Marine SAC	Protected sites and their associated features	Undertake assessment on the significance of predicted impacts to protected sites and their associated features based on both the 'importance' of a feature and the nature and magnitude of the impact that the proposed development will have upon features. The assessment will reference the outcome of the Habitat Regulations Assessment (HRA) in relation to the SAC sites. To be undertaken in line with the following impact assessment guidance: Chartered Institute of Ecology and Environmental Management (CIEEM) in the Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018); and CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland, Terrestrial, Freshwater and Marine (CIEEM, 2024).
Potential impacts to protected habitats and species, both terrestrial and estuarine. Including direct impacts to intertidal habitats (e.g. habitat loss, impacts from vehicle movements on the foreshore), and potential impacts on migratory and non-migratory fish species.	Protected habitats and species including: - Intertidal mudflats; - Saltmarsh; - Poor semi-improved neutral; grassland; - Running water; - Broadleaved scattered trees; - Amenity grassland; - Amphibians and reptiles; - Bats; - Birds; - Fish; - Invertebrates; - Otter; and - West European hedgehog.	Undertake assessment on the significance of predicted impacts to terrestrial and estuarine protected habitats and species based on both direct impact and indirect impacts and the magnitude of the impact that the proposed development will have. To be undertaken in line with the following impact assessment guidance: Chartered Institute of Ecology and Environmental Management (CIEEM) in the Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018); and CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland, Terrestrial, Freshwater and Marine (CIEEM, 2024).

Environmental Effect	Receptor	Assessment methodology
Potential spread of Invasive Non-Native Species (INNS).	Habitats	Undertake assessment into the significance of the likely spread of INNS based upon the likely impacts to habitats both within and outside of the Scheme Area. To be undertaken in line with the following impact assessment guidance: Chartered Institute of Ecology and Environmental Management (CIEEM) in the Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018); and CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland, Terrestrial, Freshwater and Marine (CIEEM, 2024).
Potential negative effect on trees in the Scheme Area due to potential removal/felling and construction works.	Trees and Root Protection Areas (RPAs)	Undertake assessment into the significance of tree removal and the magnitude of the impact that the proposed development will have. An Arboricultural Impact Assessment will be completed following an arboricultural survey which took place in July 2025. To be undertaken in line with the following impact assessment guidance: Chartered Institute of Ecology and Environmental Management (CIEEM) in the Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018); and CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland, Terrestrial, Freshwater and Marine (CIEEM, 2024). BS 5837:2012 Trees in relation to design, demolition and construction – Recommendations (BSI, 2012).

Table 5 summarises the potentially significant environmental effects from operation which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 5 – Biodiversity and nature conservation – potentially significant environmental effects (operation)

Environmental Effect	Receptor	Assessment methodology
Reduced flood risk could result in reduced potential for environmental pollution during and following a flood event.	SAC and SSSI	Qualitative assessment based upon professional judgement and the magnitude of the impact that the proposed development will have. (CIEEM) in the Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018); and CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland, Terrestrial, Freshwater and Marine (CIEEM, 2024).
Impacts to protected species from artificial lighting.	Nocturnal species	Qualitative assessment based upon professional judgement and the magnitude of the impact that the proposed development will have. (CIEEM) in the Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018); and CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland, Terrestrial, Freshwater and Marine (CIEEM, 2024).

Water Environment

Table 6 summarises the potentially significant environmental effects from construction which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 6 – Water environment – potentially significant environmental effects (construction)

Environmental Effect	Receptor	Assessment methodology
Impacts to hydromorphology and physical processes from construction of the flood defence within the channel.	Afon Teifi hydromorphology and physical processes	Qualitative assessment based upon professional judgement and the magnitude of the impact that the proposed development will have. An updated Geomorphology Technical Note and the WFD Compliance Assessment will be

Environmental Effect	Receptor	Assessment methodology
		completed to support this assessment.

Table 7 summarises the potentially significant environmental effects from operation which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 7 - Water environment – potentially significant environmental effects (operation)

Environmental Effect	Receptor	Assessment methodology
Impacts to hydromorphology and physical processes due to the permanent narrowing of the channel.	Afon Teifi hydromorphology and physical processes	Qualitative assessment based upon professional judgement and the magnitude of the impact that the proposed development will have. An updated Geomorphology Technical Note and WFD Compliance Assessment will be completed to support this assessment.

Historic Environment

Table 8 summarises the potentially significant environmental effects from construction which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 8 – Historic environment – potentially significant environmental effects (construction)

Environmental Effect	Receptor	Assessment methodology
Potential for direct impacts to scheduled monument(s).	Scheduled monuments including: CD003 Cardigan Bridge CD123 Cardigan Castle CD141 Cardigan Town Walls CD116 Old Castle Mound PE073 St Dogmaels Abbey	Assessment of value to be undertaken using professional judgement informed by consideration against the four heritage values, aesthetic, historic, communal and evidential. Assessment will be undertaken in line with general EIA methodology and the latest best practice guidance from Cadw including: • Conservation Principles (Cadw, 2011) • The Setting of Historic Assets in Wales (Cadw, 2017)

Environmental Effect	Receptor	Assessment methodology
		- Heritage Impact Assessment in Wales (Cadw, 2017) - Managing the Marine Historic Environment of Wales (Cadw 2020) The significance of the effect is to be determined based upon the combination of the value of the historic asset and magnitude of change.
Potential for impacts on the historical setting of the Scheme Area.	Historical setting and character	Assessment of value to be undertaken using professional judgement informed by the contribution of setting to the value of historic assets. Assessment will be undertaken in line with general EIA methodology and the latest best practice guidance from Cadw as noted above. The significance of the effect is to be determined based upon the combination of the value of the historic setting and magnitude of change.
Potential for direct impacts to conservation area.	Aberteifi/Cardigan conservation area	Assessment will be undertaken in line with general EIA methodology and the latest best practice guidance from Cadw as noted above. The significance of the effect is to be determined based upon the combination of the value of the conservation area and magnitude of change.
Potential for direct impacts on currently unknown archaeological remains.	Unknown archaeological remains	Assessment will be undertaken in line with general EIA methodology and the latest best practice guidance from Cadw as noted above. The significance of the effect is to be determined based upon the combination of the value of any potential archaeological remains and magnitude of change.

Table 9 summarises the potentially significant environmental effects from operation which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 9 – Historic environment – potentially significant environmental effects (operation)

Environmental Effect	Receptor	Assessment methodology
Potential for impacts on the historical setting of the Scheme Area.	Historical setting	Assessment of value to be undertaken using professional judgement informed by the contribution of setting to the value of the historic setting. Assessment will be undertaken in line with general EIA methodology and the latest best practice guidance from Cadw as noted above. The significance of the effect is to be determined based upon the combination of the value of the historic asset and magnitude of change.
Positive impacts relating to reduced flood risk to heritage assets.	Heritage assets	Assessment will be undertaken in line with general EIA methodology and the latest best practice guidance from Cadw as noted above. The significance of the effect is to be determined based upon the combination of the value of heritage assets and the magnitude of change.

Landscape and Visual

The Landscape and Visual Impact Assessment Methodology, Zone of theoretical visibility drawing, Landscape character areas (LCAs) sketch, list of receptors scoped in/out, and viewpoint locations sketch was shared with CCC (Owain Evans, Development Management Team Leader for the South) on 31/01/2025.

CCC responded that the radius of viewpoints covered was satisfactory, with the works unlikely to impact upon any viewpoint at a greater distance than those covered, although an additional viewpoint was added on the south bank of the river opposite the development. No other comments were received.

Table 10 summarises the potentially significant environmental effects from construction which will be assessed in the EIA, and the receptors affected. The LCAs forming the landscape receptors are shown in Appendix G (shared with CCC on 31/01/2025).

Table 10 – Landscape and visual – potentially significant environmental effects (construction)

Environmental Effect	Receptor	Assessment methodology
Change to landscape character during construction from the introduction of new elements such as site compounds and access routes, welfare, hoarding, construction plant, material storage or stockpiling, or from removal of buildings, trees or vegetation to construct the Scheme.	LCA1 Cardigan urban area (host character area) LCA2 River and intertidal habitat (host character area) LCA4 Southern enclosed slopes (intervisible with the scheme at a distance of 180m).	As per Landscape and Visual Impact Assessment Methodology (Appendix H).
Change to visual amenity during construction from the addition of site compounds and access routes, welfare, hoarding, construction plant, material storage or stockpiling; or from the appearance of the flood defence wall before final finishes are applied. Where buildings, trees or vegetation are removed to enable construction, currently hidden views could be opened up, or hoarding or other construction activities could block views.	Local residents Occupiers of buildings used for employment Pedestrians, cyclists and road users Visitors to attractions, such as the Cardigan Castle and Gardens Members of the public enjoying hospitality and public amenity locations Individuals and groups using the river Individuals and groups participating in outdoor leisure activities, such as walking and running, especially those using PRoW or the Wales Coast Path.	

Table 11 summarises the potentially significant environmental effects from operation which will be assessed in the EIA, and the receptors affected.

Table 11 – Landscape and visual – potentially significant environmental effects (operation)

Environmental Effect	Receptor	Assessment methodology
Change to landscape character during operation from the introduction of new elements and materials to build the flood defence scheme or associated public realm enhancements, or from the removal or degradation of an element or	As construction receptors	As attached Landscape and Visual Impact Assessment Methodology (Appendix H).

Environmental Effect	Receptor	Assessment methodology
feature which formed a key part of the character of the area. There could be a change in appearance of the river corridor resulting from hydrological change as a result of the Scheme.		
Change to visual amenity during operation from the introduction of new elements and materials to build the Scheme or associated public realm enhancements, or from blocking or limiting of existing views. There could be a change in appearance of the river corridor resulting from hydrological change as a result of the Scheme.	As construction receptors	

Traffic and Transport

Table 12 summarises the potentially significant environmental effects from construction which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 12 – Traffic and transport – potentially significant environmental effects (construction)

Environmental Effect	Receptor	Assessment methodology
Potential impact on local traffic due to road closures and traffic associated with construction of the flood defences (deliveries and plant movements) could contribute to road congestion in Cardigan and affect the use of certain roads and the bridge for periods during the construction phase.	Local road network	High level quantitative and qualitative assessment using Automatic Traffic Count (ATC) survey data collected in May 2025, to establish baseline traffic flows. The assessment will be based on guidance from Technical Advice Note (TAN) 18: Transport and IEMA Guidelines: Environmental Assessment of Traffic and Movement (IEMA, 2023).

Cumulative Effects

Table 13 summarises the potentially significant environmental effects from both construction and operation which will be assessed in the EIA, the receptors affected and outlines the proposed assessment methodology.

Table 13 – Cumulative effects – potentially significant environmental effects (construction and operation)

Environmental Effect	Receptor	Assessment methodology
Potential for inter-project cumulative effects (from other projects).	To include as appropriate; local residents, businesses, recreational users, ecological receptors, local roads, historical receptors and landscape character areas.	A review will be undertaken of approved planning applications within 500m of the project boundary to determine if there is likely to be any inter-project cumulative effects. In the event that a significant cumulative effect is identified, suitable mitigation will be developed to reduce the significance of the effect.
Potential for intra-project cumulative effects (due to interactions between topics).		A review will be undertaken following the completion of individual topic assessments to determine if there is likely to be any intra-project cumulative effects. Some topics inherently considered other topics within their assessment, notably Population and Human Health. In the event that a significant cumulative effect is identified, suitable mitigation will be developed to reduce the significance of the effect.

5 Overarching Assessment Methodology

General impact assessment methodology applicable to the EIA will be outlined within the EIA Methodology chapter of the Environmental Statement. The impact assessment methodology will follow the standard approach for EIA of:

- Description of the baseline environment
- Determination of the sensitivity of the environmental receptor
- Determination of the magnitude of the impact
- Assess the significance of the effect
- Identify mitigation measures to prevent or reduce negative effects
- Assess the residual effect following mitigation

Technical chapters of the EIA will reference specific guidance on impact assessment. Specific guidance will not be listed within the introductory chapters of the Environmental Statement to avoid duplication. Guidance for each environmental topic is generally published by professional institutions, and this guidance is typically widely regarded as the best practice approach to impact assessment. For any topics for which there is no existing industry standard or published guidance for environmental assessment, the general EIA methodology outlined within the EIA Methodology chapter of the Environmental Statement should be applied to the assessment of impacts.

6 Scoping Summary

As discussed, we would like to request an update of the 2023 EIA Scoping Opinion and have provided additional information to demonstrate that certain effects and topics can now be scoped out of the assessment.

Table 14 provides a summary of the topics scoped in and out of the EIA.

Table 14 Scoping summary

Topics scoped in	Topics scoped out
Population and Human Health (Construction and Operation)	
Water Environment (Construction and Operation)	Land Use and Soil (Construction and Operation)
Biodiversity and Nature Conservation (Construction and Operation)	Air Quality (Construction and Operation)
Historic Environment (Construction and Operation)	Climate (Construction and Operation)
Landscape and Visual (Construction and Operation)	Material Assets (Construction and Operation)
Traffic and Transport (Construction)	Major Accidents and Disasters (Construction and Operation)
Cumulative Effects (Construction and Operation)	

7 Next Steps

Following confirmation of the scope of the EIA for the Cardigan TFRMS the following activities are planned:

- Completion of the EIA and production of the Environmental Statement – present to early-2026
- Completion of any further surveys required to support the EIA and associated assessments – present to early-2026
- Pre-Application Consultation – spring 2026
- Submission of planning application – spring/summer 2026

Yours sincerely,

David Johnson

Principal Environmental Scientist



8 Appendices

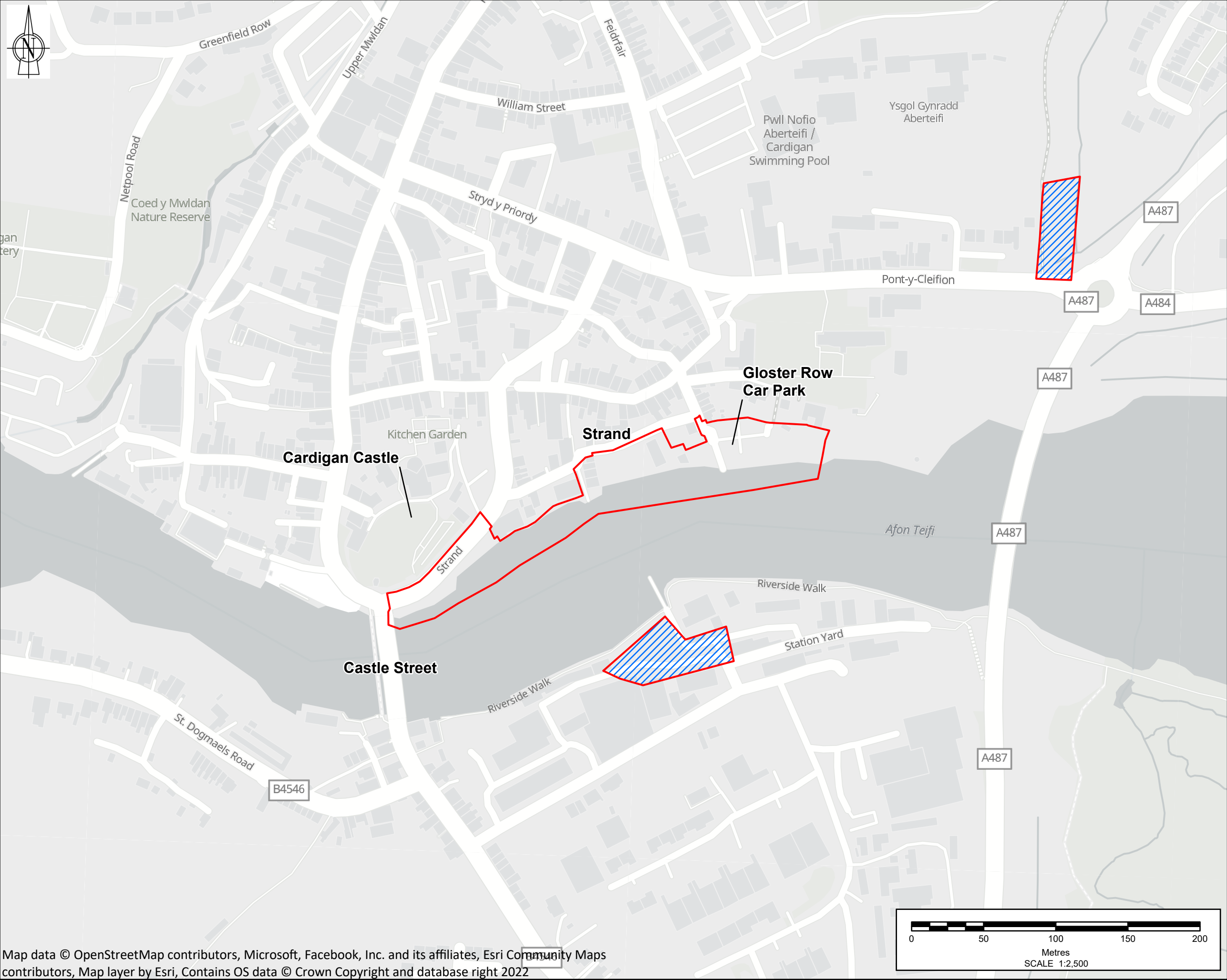
Appendix	Appendix Title
Appendix A	Figures - Location Plan, Indicative Layout Plan
Appendix B	Hydraulic Modelling Report
Appendix C	WFD Scoping Assessment
Appendix D	Contaminated Land Interpretation Report
Appendix E	IAQM Dust Management Mitigation Measures
Appendix F	Outline Climate Change Adaptation Report
Appendix G	Landscape Character Areas
Appendix H	LVIA Methodology



Appendix A: Figures

A.1 - Location Plan: Drawing 4021883-BUK-ZZ-00-DR-EN-00005





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- Legend**
- SCHEME AREA
 - INDICATIVE COMPOUND/LAYDOWN AREAS



SAFETY HEALTH AND ENVIRONMENT INFORMATION
IN ADDITION TO THE HAZARDS OR RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, THE FOLLOWING SIGNIFICANT RESIDUAL RISKS SHOULD BE NOTED. FURTHER DETAILS ARE INCLUDED IN THE CDM DESIGN RISK MANAGEMENT REGISTER

CONSTRUCTION						
MAINTENANCE / CLEARING / OPERATION						
DECOMMISSIONING / DEMOLITION						

P02	MA	MH	DJ	AH	29/07/2025	FOR INFORMATION
P01	MA	MH	DJ	AH	09/06/2025	FOR INFORMATION
Rev	Drawn	Chkd	Rvwd	Apprvd	Date	Description

Designed by: MA Date: JULY 2025
Status:

Client

Client Drawing No. Revision

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Project:
CARDIGAN TIDAL FLOOD RISK MANAGEMENT SCHEME

Drawing title:

LOCATION PLAN

Drawing scale: 1:2,500 Sheet size: A3
Drawing no. 4021883-BUK-ZZ-00-DR-EN-00005 Revision P02

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A.2 - Indicative Layout Plan: Drawing 4021883-BUK-ZZ-00-DR-EN-00008



Appendix B: Hydraulic Modelling Report 123666-BUK-ZZ-00-RP-HY-00003



FINAL

CARDIGAN HYDRAULIC MODELLING REPORT

Project no. 4020621

Prepared for:

Natural Resources Wales

February 2024

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ABBREVIATIONS

AEP	<i>Annual Exceedance Probability</i>
EX	<i>Existing situation</i>
PR	<i>Proposed defence</i>
FB	<i>Freeboard</i>
FDL	<i>Flood Defence Level</i>
FM	<i>Flood Modeller</i>
PWL	<i>Peak Water Level</i>
RUA	<i>Residual Uncertainty Allowance</i>
SoP	<i>Standard of Protection</i>
QMDF	<i>Mean Daily Flow</i>
QMED	<i>Median Annual Maximum Flood</i>
Q100	<i>1% AEP fluvial event</i>
Q1000	<i>0.1% AEP fluvial event</i>
MHWS	<i>Mean High Water Spring</i>
T200	<i>0.5% AEP tide</i>
T1000	<i>0.1% AEP tide</i>

1. Introduction

Cardigan in Ceredigion has a history of flooding and several significant flood events have occurred in Cardigan between 2000 and 2020. The lowest lying residential and commercial properties in the Strand area have a threshold level below 3.100m AOD and are predicted to be affected by tidal events smaller than 50% Annual Exceedance Probability (AEP). Binnies has been commissioned by NRW to design a flood defence solution in the Strand area. As part of this design work, hydraulic modelling is required to:

- confirm if the proposed Flood Defence Level (FDL) of the defence (4.95m OD) provides the required standard of protection; and
- to assess what, if any, detriment results from the proposed flood defences in the Strand area of Cardigan.

2. Model Development

2.1 Data

The data from sources as listed in Table 2-1 were used in the development of the model.

Table 2-1 Model data and sources

Data	Source	Description
Topographic survey	Afon Mwldan & Afon Teifi Topographic Survey, Storm Geomatics Ltd for NRW, December 2020	Cross-section survey was used to develop the 1D model. This included details of the two bridges. Figure 2.1 shows the location of surveyed cross-sections.
LiDAR	https://datamap.gov.wales/maps/lidar-viewer/	LiDAR data (2020-22) was used to generate extended cross-sections and reservoir units to represent out of bank flows.
Coastal Flood Boundary	https://www.gov.uk/government/publications/coastal-flood-boundary-conditions-for-uk-mainland-and-islands-design-sea-levels	The Environment Agency Coastal Flood Boundary was used to create the downstream tidal boundary condition.
Typical tidal cycle	Admiralty Total Tide software	Used to obtain predicted tide cycle for the open coast near Cardigan and then used to generate different tidal boundaries as required.

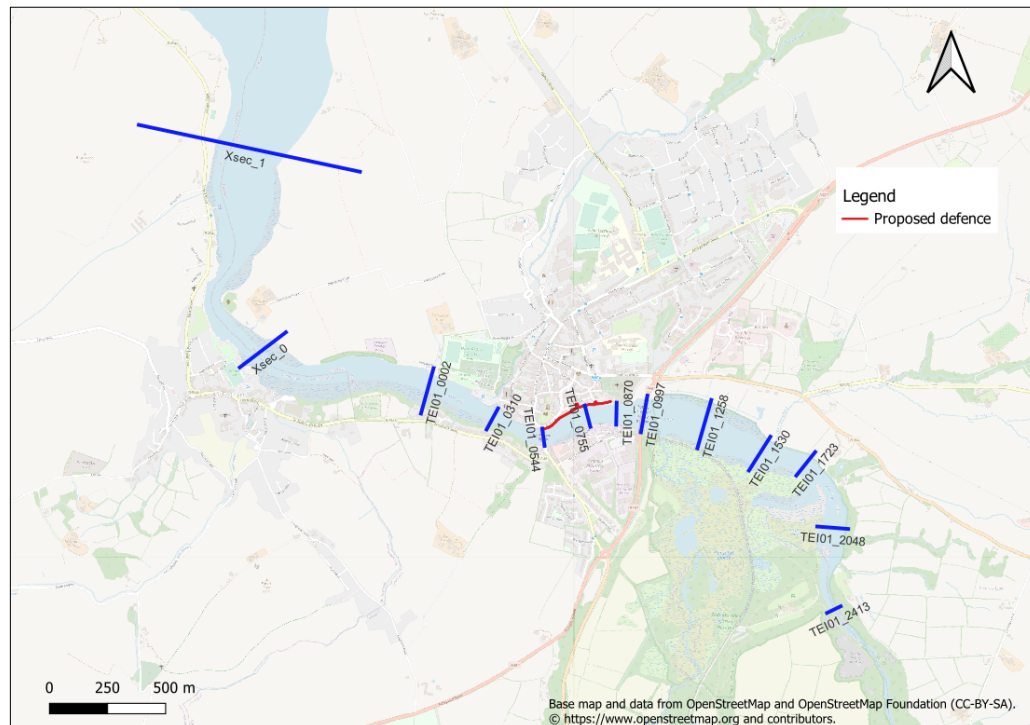


Figure 2.1 Cardigan Study Area

2.2 Software and model dimension

The hydraulic model was developed in Flood Modeller (FM) v6.1 as a 1D only model.

2.3 Model boundaries

(a) Upstream boundary

A single flow-time boundary representing the Afon Teifi is included in the model. A hydrological assessment was carried out to determine peak flows for different AEP floods.

Catchment descriptors for the Afon Teifi were obtained from the Flood Estimation Handbook (FEH) web-service. This provided catchment descriptors as far as the tidal limit, which is located around 3.5km upstream of Cardigan. Between the tidal limit and Cardigan there are several tributaries that needed to be accounted for in the flood estimation calculations. Catchment descriptors from these tributaries were also obtained from the FEH web-service. Area-weighting was then used to provide an updated set of catchment descriptors for the Afon Teifi to Cardigan. As a result, the catchment area was increased from 942 km² at the tidal limit to 968 km² at Cardigan; this small increase in area means that there was very little change to catchment descriptors from the catchment area to the tidal limit.

The FEH statistical method was applied to estimate flood flows. QMED was calculated from catchment descriptors and then adjusted using the Teifi @ Glanteifi (62001) gauging station as a donor site. The Teifi @ Glanteifi is located around 10km upstream of Cardigan and its use as a donor site reduces the estimate of QMED from 366.4 m³/s to 250.3 m³/s.

A pooling group was then generated. Following a review of the pooling group two gauging stations were removed due to having strong influence from reservoirs within their catchments, which is not reflective of the Teifi catchment. The Generalised Extreme Value (GEV) distribution provided the best statistical fit. The resulting growth curve factors and peak flows for a range of AEP floods is provided in Table 2-2.

Table 2-2 Afon Teifi Design Flows

AEP	Growth Curve Factor	Peak Flow (m ³ /s)
50% (QMED)	1.000	250.3
20%	1.316	329.4
10%	1.553	388.7
3.33%	1.959	490.3
2%	2.165	541.9
1%	2.468	617.7
0.50%	2.783	696.7
0.1%	3.616	905.0

The second Revitalised Flood Estimation Handbook (ReFH2) rainfall-runoff method was to generate the hydrograph shape, which was then scaled to fit to the required peak design flow.

(b) Downstream boundary

The Afon Teifi flows into the sea at Cardigan Bay, and so a tidal downstream boundary was used. The tidal boundary was derived using a combination of Admiralty Total Tide software and the Environment Agency Coastal Flood Boundary dataset (2018).

2.4 Model geometry

(a) Existing scenario

The existing model is created based on the cross-section survey (see Figure 2.1). Two sections (Xsec_0 and Xsec_1) were generated from LiDAR in the downstream sections where survey was not carried out. This was to allow the placement of the downstream boundary further towards the sea and away from the study area.

Cross section TEI01_0755 captures the existing flood wall adjacent to the Strand and Castle Street Bridge (TEI01_0544) marks the downstream end of the flood defence. There was no cross section at the upstream end of the flood defence. Therefore, cross section TEI01_0870 was created at the upstream end of the flood defence by replicating TEI01_0755 and interpolating the bed level. The existing defence levels are taken from the topographic survey.

Three reservoir units were included in the model to represent the low-lying areas of floodplain where floodwater could spill over banks and accumulate. The stage-area relationship for reservoir units was derived from LiDAR. The reservoir units were connected to the river channel using side spills. The spill section data was taken from the bank levels of adjacent river cross sections. The reservoir units and their representative floodplain area are shown in Figure 2.2.

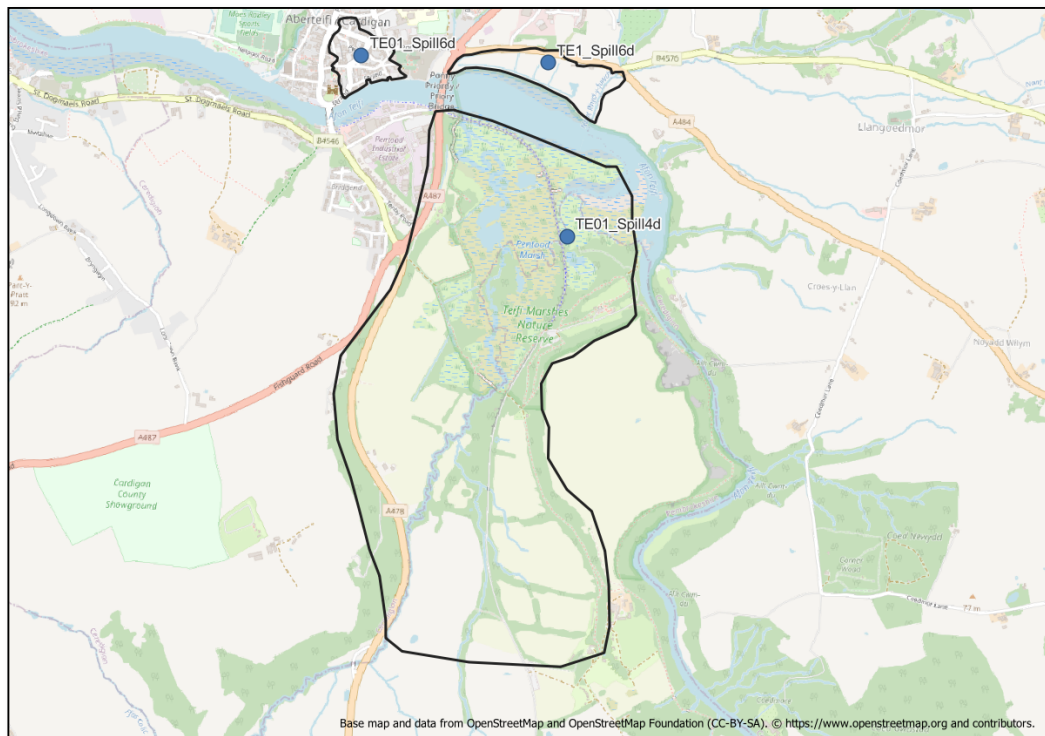


Figure 2.2 Reservoir Units

(b) Proposed scenario

The proposed model is created by modifying cross sections TEI01_0755 and TEI01_0870 to reflect the - alignment and crest level (4.95m AOD) of the proposed flood defence.

2.5 Structures

There are two bridges within the study area:

- **Priory Bridge:** modelled using a USBPR bridge unit (TEI01_0997B). The bridge has four piers with triangular faces, making up five openings. The width of openings ranges from 23.8m to 28.9m and the clearance above bed level through the central openings is over 7m.
- **Castle Street Bridge:** modelled using an ARCH bridge unit (TEI01_0538B). The downstream cross-section (TEI01_0538) has smaller area of opening compared to the upstream cross-section (TEI01_0544). Therefore, the downstream cross section would control the flow and hence it is used to represent the Bridge cross section. The bridge has five openings of varying width. The three central arches have a maximum width of around 9.7m, whilst the left-arch has a maximum width of 8.8m and the right-arch 8.4m. The heights above bed level of the arches range from 5.3m to 6.6m. There is a footbridge just downstream of the Castle Street Bridge. This is not included because the openings of the arch bridge are much smaller compared to that of the footbridge and therefore the road bridge acts as the flow control at this location.

The flow around and over the bridges is modelled using 1D spill units with spill levels taken from the survey data.

2.6 Climate Change

(a) Fluvial climate change

The Climate change uplift for peak fluvial inflows is considered based on Flood Consequence Assessments: Climate Change Allowances, September 2021 ([Flood Consequences Assessments: Climate change \(gov.wales\)](#)). For the West Wales river basin district this gives an uplift of 25% to flood flows for the 2050s epoch and 30% uplift for the 2080s epoch.

(b) Tidal climate change

The Sea Level rise allowances were considered based on emissions scenario RCP8.5 70th percentile. This was obtained from the UK Climate Projections (UKCP18) product (Sea level anomalies for marine projections around UK coastline, 2007-2100) ([Product Selection - UKCP \(metoffice.gov.uk\)](#)). Sea level rise as given in Table 2-3 for two different time frames were considered:

1. Sea level rise at the end of the 2050s epoch (i.e., 2069) was considered along with the 2050s fluvial climate change uplift.
2. Sea level rise in 2123 was considered along with 2080s fluvial climate change uplift to assess 100 years of climate change impacts.

Table 2-3 Sea level rise

Year	Sea level Rise (m)
2069	0.478
2123	0.984

3. Results

3.1 Detriment

The Existing [EX] and Proposed [PR] scenarios were simulated for different combinations of tidal and fluvial events. The peak water levels for both scenarios and the difference in peak water levels are presented in Table 3-1 and Table 3-2 for the present-day and with climate change respectively. For all present-day and climate change events, the change in peak water level is within the NRW specified detriment tolerance of 5mm. The proposed flood defence is overtopped during the 0.1% AEP flood with MHWS tidal boundary (2123 climate change).

Table 3-1 Assessment of detriment: present-day (PWL in mOD)

Event (Fluvial+ Tidal)	TEI01_0870			TEI01_0755			TEI01_0544		
	PWL: EX	PWL: PR	Change (m)	PWL: EX	PWL: PR	Change (m)	PWL: EX	PWL: PR	Change (m)
QMDF + T200	3.658	3.658	0.000	3.653	3.655	0.002	3.655	3.654	-0.001
QMED + T200	3.727	3.728	0.001	3.717	3.716	-0.001	3.710	3.710	0.000
QMDF + T1000	3.808	3.808	0.000	3.805	3.806	0.001	3.805	3.805	0.000
QMED + T1000	3.877	3.878	0.001	3.867	3.867	0.000	3.862	3.862	0.000
Q100 + MHWS	3.520	3.521	0.001	3.424	3.426	0.002	3.304	3.305	0.001
Q1000 + MHWS	4.483	4.483	0.000	4.378	4.379	0.001	4.266	4.267	0.001

Table 3-2 Assessment of detriment: climate change (2123) scenarios (PWL in mOD)

Event (Fluvial+ Tidal)	TEI01_0870			TEI01_0755			TEI01_0544		
	PWL: EX	PWL: PR	Change (m)	PWL: EX	PWL: PR	Change (m)	PWL: EX	PWL: PR	Change (m)
QMDF + T200	4.454	4.459	0.005	4.458	4.458	0.000	4.462	4.455	-0.007
QMED + T200	4.555	4.556	0.001	4.545	4.545	0.000	4.538	4.539	0.001
QMDF + T1000	4.791	4.795	0.004	4.790	4.793	0.003	4.787	4.790	0.003
QMED + T1000	4.878	4.879	0.001	4.868	4.867	-0.001	4.862	4.863	0.001
Q100 + MHWS	4.417	4.419	0.002	4.334	4.337	0.003	4.248	4.251	0.003
Q1000 + MHWS	5.273	5.268	-0.005	5.180	5.175	-0.005	5.071	5.066	-0.005

3.2 Residual Uncertainty Allowance

The RUA was calculated based on the existing guidance and is detailed in Appendix A. The following secondary variables were considered in the calculation of RUA.

- Model inflows
- Channel roughness
- Channel bed level
- Downstream tidal boundary level
- Bridge coefficient

From the calculations, a RUA allowance of 0.35m is recommended. This allowance only accounts for uncertainties in hydrological and hydraulic variables. Any other sources of uncertainties (such as settlement of embankments) should also be considered if appropriate.

3.3 Standard of Protection (SoP)

- The SoP provided by the proposed flood defence based on a flood defence level of 4.95m OD with 0.35m freeboard was assessed for different combinations of tidal levels and fluvial inflows. The results for present-day are in Table 3-3, results for climate change to 2069 are in Table 3-4. During a 0.5% AEP tide the lowest freeboard is 0.71m, reducing to 0.57m for a 0.1% AEP tide. The 0.5% AEP design standard is therefore maintained with adequate freeboard in 2069 regardless of the fluvial input (within the anticipated range of flows).
- There is no freeboard for the 0.1% fluvial event; the defence is overtopped up to a depth of 0.13m. In the 1% AEP fluvial event there is a predicted 0.78m freeboard. This is caused by Castle Street Bridge, which forms a constriction in the channel and generates a large head loss when the fluvial flows start to exceed the 1% AEP.

(a) Table 3-4 and results for climate change to 2123 are in 2123 climate change

The **2123 climate change** results are summarised below:

- During a 0.5% AEP tidal event the lowest predicted freeboard is 0.40m. This reduces to 0.07m for a 0.1% AEP tidal event. The 0.5% AEP design standard is therefore maintained in 2123 regardless of the fluvial input (within the anticipated range of flows).
- There is no freeboard for the 0.1% fluvial event; the defence overtops up to a depth of 0.32m. In the 1% AEP fluvial event there is a predicted 0.53m freeboard; the reason for the large difference between these two events is explained above.

Table 3-5.

(b) Present-day

The results from the **present-day** assessment are summarised as follows:

- During a 0.5% AEP tidal event the lowest freeboard (FB) available is 1.22m, reducing to 1.07m for a 0.1% AEP tidal event. In fluvial events, estimated freeboard is also over 1m for the 1% AEP, reducing to 0.47m for a 0.1% AEP fluvial event.
- For extreme tidal events, there is an increase of 0.08m in peak water level when increasing the applied fluvial flow input from QMDF to QMED. The fluvial input, within

the anticipated range of flows, when combined with an extreme tidal event therefore does not impact the design standard of the defences in the present-day.

Table 3-3 Standard of Protection: Present-day

Event	TEI01_0870		TEI01_0755		TEI01_0544	
	PWL (m OD)	FB (m)	PWL (m OD)	FB (m)	PWL (m OD)	FB (m)
QMDF + T200	3.65	1.30	3.65	1.30	3.65	1.30
QMED + T200	3.73	1.22	3.71	1.24	3.71	1.24
QMDF + T1000	3.80	1.15	3.80	1.15	3.80	1.15
QMED + T1000	3.88	1.07	3.86	1.09	3.86	1.09
Q100 + MHWS	3.52	1.43	3.43	1.52	3.31	1.64
Q1000 + MHWS	4.48	0.47	4.38	0.57	4.27	0.68

(c) 2069 climate change

The **2069 climate change** results are summarised as follows:

- During a 0.5% AEP tide the lowest freeboard is 0.71m, reducing to 0.57m for a 0.1% AEP tide. The 0.5% AEP design standard is therefore maintained with adequate freeboard in 2069 regardless of the fluvial input (within the anticipated range of flows).
- There is no freeboard for the 0.1% fluvial event; the defence is overtopped up to a depth of 0.13m. In the 1% AEP fluvial event there is a predicted 0.78m freeboard. This is caused by Castle Street Bridge, which forms a constriction in the channel and generates a large head loss when the fluvial flows start to exceed the 1% AEP.

Table 3-4 Standard of Protection: 2069

Event	TEI01_0870		TEI01_0755		TEI01_0544	
	PWL (m OD)	FB (m)	PWL (m OD)	FB (m)	PWL (m OD)	FB (m)
QMDF + T200	4.14	0.81	4.14	0.81	4.13	0.82
QMED + T200	4.24	0.71	4.22	0.73	4.21	0.74
QMDF + T1000	4.29	0.66	4.28	0.67	4.28	0.67
QMED + T1000	4.38	0.57	4.37	0.58	4.36	0.59
Q100 + MHWS	4.17	0.78	4.08	0.87	3.98	0.97
Q1000 + MHWS	5.08	-0.13	4.97	-0.02	4.87	0.08

(d) 2123 climate change

The **2123 climate change** results are summarised below:

- During a 0.5% AEP tidal event the lowest predicted freeboard is 0.40m. This reduces to 0.07m for a 0.1% AEP tidal event. The 0.5% AEP design standard is therefore maintained in 2123 regardless of the fluvial input (within the anticipated range of flows).
- There is no freeboard for the 0.1% fluvial event; the defence overtops up to a depth of 0.32m. In the 1% AEP fluvial event there is a predicted 0.53m freeboard; the reason for the large difference between these two events is explained above.

Table 3-5 Standard of Protection: 2123

Event	TEI01_0870		TEI01_0755		TEI01_0544	
	PWL (m OD)	FB (m)	PWL (m OD)	FB (m)	PWL (m OD)	FB (m)
QMDF + T200	4.46	0.49	4.45	0.50	4.45	0.50
QMED + T200	4.55	0.40	4.54	0.41	4.54	0.41
QMDF + T1000	4.79	0.16	4.79	0.16	4.78	0.17
QMED + T1000	4.88	0.07	4.87	0.08	4.86	0.09
Q100 + MHWS	4.42	0.53	4.34	0.61	4.25	0.70
Q1000 + MHWS	5.27	-0.32	5.18	-0.23	5.07	-0.12

(e) Summary

- The proposed flood defence level of 4.95m OD provides a minimum freeboard of 0.40m for a 0.5% AEP tidal event including 100 years of sea level rise.
- The flood defence level is also above 0.1% AEP tidal level for the same climate change scenario, although freeboard is minimal.
- The proposed defences are predicted to provide protection against a 1% fluvial event with 100 years of climate change. However, it is predicted that they will be overtopped during a 0.1% AEP fluvial event by 2069.
- Castle Street Bridge creates a significant flow constriction. During a 0.1% AEP flood, this constriction generates a large head loss across the bridge, which is the primary cause of the defences being overtopped.

4. Conclusion

4.1 Summary

A 1D-only hydraulic model of Afon Teifi at Cardigan has been built to assess tidal and fluvial flood events. The model has been used to assess the possible impact on predicted flood levels associated with the proposed flood defences along the Strand. The model has also been used to assess the standard of protection provided by the proposed defences.

The results indicate that the defences will cause no detriment in any of the tested flood events i.e., any increase in water level did not exceed 0.005m (5mm), which is within the NRW-specified detriment tolerance.

The residual uncertainty analysis (RUA) was calculated to be 0.35m from five secondary variables using First Order Error Analysis. A summary of the minimum freeboard (based on an FDL of 4.95m OD) for the 0.5% AEP and 0.1% AEP tides in different climate change epochs of the proposed defence is provided in Table 4-1. This shows that the FDL provides more freeboard than the calculated RUA for the proposed 0.5% AEP tidal event design standard over the next 100 years. It also shows the proposed defence level is above the 0.1% AEP tide level, albeit with only 70mm of freeboard in 100 years' time.

Table 4-1 Summary of Available Freeboard for Tidal Events

Climate Change Epoch	Extreme Tide	
	0.5% AEP	0.1% AEP
Present day	1.22m	1.07m
2069	0.71m	0.57m
2123	0.40m	0.07m

The proposed defence will also provide protection against the 1% AEP fluvial event over the next 100 years (with minimum predicted freeboard of 0.53m). However, the constriction presented by Castle Street Bridge means that by the 2050's epoch (i.e., 2069), the 0.1% AEP fluvial event will overtop the defence.

4.2 Assumptions and limitations

- The predicted standard of protection is based on an uncertainty analysis that considered hydraulic and hydrologic parameters only.
- The RUA assessment uses the 'Proposed' model, analysing a 0.5% AEP tidal event combined with a QMED fluvial event.
- The limited gauge data available means that no model calibration has been carried out. A calibrated model would reduce uncertainties, which would be reflected in a reduction of the RUA.
- The results from simulations used for Residual Uncertainty Analysis indicate the model to be sensitive to inflows but that it is not very sensitive to bed levels, channel roughness bridge coefficients. However, these findings are based on the extrapolation of results from small changes to parameters and does not constitute a full sensitivity analysis of the model.

APPENDICES

Appendix A: Residual Uncertainty Allowance

A.1 Introduction

As part of the flood risk study and the assessment of the SoP provided by flood defences along the Afon Teifi at Cardigan, NRW have requested that the Residual Uncertainty Allowance (RUA) is also considered. RUA is often referred to as freeboard. When flood defences are designed, a RUA is added to the modelled top water level to account for uncertainties in model parameters such as peak flow, channel roughness etc. and this forms the Flood Defence Level (FDL). The following section describes the method used to calculate the RUA following the relevant guidance¹. This assessment only accounts for uncertainties in hydrological and hydraulic parameters.

A.2 First Order Error Analysis

This method of calculating the RUA assesses the sensitivity of water levels (the primary variable) to different independent model variables. The uncertainty contributions from each independent variable are then combined to give a total estimate of the RUA. Although it is expected that the behaviour of a river system to changes in hydrological and hydraulic variables is non-linear, this method assumes that if the change is only small then that behaviour can be treated as linear.

(b) Step A – Secondary Variables

The first step is to list the secondary variables that contribute to the primary variable of interest i.e., water levels along the watercourse. **Error! Reference source not found.** describes the variables that might be considered for this model and discusses the reason for their selection or rejection for the next stage of the assessment.

Table 1: Possible secondary variables affecting the primary variable (water level)

Secondary Variable	Description	Reason for Selection or Rejection
Understanding of hydrological conditions throughout the catchment	The catchment is predominately rural catchment consisting mostly of grassland with some arable and woodland. The underlying geology is uniformly very low permeability bedrock.	SELECTED: these secondary variables essentially constitute the uncertainty of the model inflows. The understanding of hydrological conditions and availability of gauge records is wrapped up in the performance of the FEH statistical method and the uncertainty in the FEH statistical method is well documented.
Availability/length of gauging records	Glanteifi (ref: 62001) is the nearest gauging station on the Afon Teifi to Cardigan with a gauge record dating back to 1959. Its catchment area is within 10% of the total catchment area to Cardigan.	
Performance of FEH statistical method	The presence of Glanteifi gauging station will improve the performance of the FEH statistical method. The site	

¹ Accounting of residual uncertainty: updating the freeboard guide, Report – SC120014, Environment Agency, 2017

Secondary Variable	Description	Reason for Selection or Rejection
	is suitable for both QMED and pooling.	
Information on channel geometry	The topographic survey used in the model is recent having been carried out in December 2020.	SELECTED: although the survey is recent it is noted that there are areas of 'soft bed'. The tidal nature of this reach means that sediments are likely to be fine and mobile and therefore bed levels may be susceptible to changes over even short periods of time.
Information of structure geometry	Modelled structures are based on topographic survey (as described above).	REJECTED: the survey is recent and there is no reason to believe that structure dimensions have changed.
Floodplain flow interactions	Upstream of Cardigan there are some large areas of floodplain storage but as the Teifi flows through Cardigan it is well constrained in all but the most extreme events.	REJECTED: this is a simplified modelling approach that represents the storage behind flood defences and not the flow routes that may occur. Bank levels are based on recent topographic survey and storage volumes calculated using recent LiDAR giving good confidence on how and when the channel interacts with the floodplain.
Structure coefficients	There are two bridge structures on the Afon Teifi near Cardigan. Upstream is the relatively modern A487, which has a deck level well above flood levels and narrow concrete piers and modelled using the USPBR bridge unit. At the town centre is located Castle Street Bridge, which is much lower and consists of 5no. arched openings and is modelled using the ARCH bridge unit.	SELECTED: Although the structures are schematised using accurate topographic survey and are unlikely to change significantly overtime, without gauge data there is some uncertainty around hydraulic performance. Changes to structure coefficients could have a localised impact on water levels.
Variations in channel roughness	Channel roughness along the Afon Teifi is low at 0.030 based on the bed being made-up of fine sediments. Bank roughness is higher at 0.060 to represent vegetation growth varying from grass to shrubs and trees.	SELECTED: The selection of Manning's 'n' is a subjective process and average channel roughness can be expected to change throughout the year with vegetation growth.
Model parameters	No unusual parameters were applied to run the model.	REJECTED: no unusual parameters applied and therefore adjustments would create unusual parameter values and more uncertainty.
Superelevation	The reach of proposed flood defence is located on the outside of a shallow bend.	REJECTED: the bend is very shallow and superelevation effects is not expected to be significant.
Downstream boundary conditions	The Teifi is strongly tidally influenced at Cardigan. For extreme fluvial events a MHWS boundary has been applied.	SELECTED: A MHWS tidal boundary is applied but as the name suggests there will be variation around the mean.

(c) Step B – Estimating Change

The second step is to estimate the change in the primary variable (water level) produced by a small change in each secondary variable. For the five selected secondary variables (refer to Table 1 above) the 'small change' made are described in Table 2 below.

Table 2: Secondary variables affecting the primary variable (water level)

Secondary Variable	'Small change' made
Model Inflows*	+5% applied to model inflow
Channel Roughness	+0.005 roughness applied to all channel sections in model
Channel Bed level	+0.05m applied to bed level of the three river sections adjacent to the proposed flood defence (TEI01_0870, TEI01_0755 and TEI01_0544)
Downstream Tidal Boundary	+0.1m increase in peak tide level
Bridge Coefficient	-5% change in calibration coefficient of Castle Street Bridge (TEI01_0538B)

**includes uncertainty of understanding of hydrological conditions throughout the catchment, availability/length of gauging records and principally the performance of FEH statistical method*

The model has been run for the proposed design standard (0.5% AEP tidal event with a QMED fluvial event) to establish the baseline. The model is then run with a 'small change' of a secondary variable, each tested independently of each other. The change in water level from the baseline is then calculated. The average (mean) impact on the primary variable (water level) has been taken from nodes adjacent to the proposed flood defence as well as the maximum change that occurs along this reach; these results are summarised in Table 3.

Table 3: Change in primary variable (water level)

Variable	Change in primary variable (m)	
	Average	Maximum
Model Inflows	0.013	0.016
Channel Roughness	0.006	0.007
Channel Bed level	0	0
Downstream Conditions	0.101	0.102
Bridge Coefficient	-0.002	-0.002

(d) Step C – Estimating Uncertainty in the Secondary Variables

The third step is to estimate uncertainty in the secondary variables. The original freeboard guidance used standard deviations to define uncertainty. The latest guidance discusses uncertainty in terms of confidence intervals. The confidence interval is not prescribed by the guidance, but notionally would be expected to be 90% or 95% and, where possible, the same interval should be applied to all secondary variables. Table 4 provides an assessment of the change in each secondary variable for the 90% confidence interval.

Table 4: Secondary Variable 90% Confidence Interval

Secondary Variable	90% Confidence Interval
Model Inflow	Design flow estimates for an ungauged catchment using the FEH statistical method results in very large uncertainty intervals. The upper value for the 95% confidence interval at an ungauged site for QMED is stated as 102% increase, i.e. the QMED peak flow estimate for the Teifi at Cardigan may be as high as 505 m³/s compared to the design flow estimate of 250 m³/s. It might be justifiable to reduce this confidence band because Glanteifi gauging station (ref: 62001) is located not too far upstream and through which at least 90% of the Teifi catchment at Cardigan flows. However, in this instance a precautionary approach has been taken and the 90% confidence interval has been set to 102%. ▪ 90% confidence interval = 102% (1.02)
Channel Roughness	Manning's <i>n</i> channel roughness in the model generally varies along the bed and bank in a range of 0.030 to 0.070. Figure 4.1 is taken from the fluvial freeboard guidance note² and shows one standard deviation of 'n' value for a range of Manning's 'n' values. If we assume an average roughness along the modelled reach of the Teifi is <i>n</i> = 0.050 this gives one standard deviation of <i>n</i> as being 0.015; two standard deviations approximates to the 95% confidence interval, therefore <i>n</i> = 0.030 has been taken as the 90% confidence interval. ▪ 90% confidence interval = 0.030 Source: US Army Corps of Engineers Figure 4.1 Standard deviation in Manning's <i>n</i> values

² Figure 6.4 from Fluvial Freeboard Guidance Note – Research and Development, Technical Report W187, Environment Agency (2000)

Secondary Variable	90% Confidence Interval
Channel Geometry	There is no set method for estimating the confidence intervals on channel geometry. The survey applied in the model is recent, so we can have high confidence in its representativeness. However, the bed likely consists of fine sediments and may be quite mobile given the tidal influences upon it. We have assumed that a change in the bed level (cross-sectional area) of more than 20% is unlikely to occur and therefore have set the 90% confidence interval to 20%. ▪ 90% confidence interval = 20% (0.2)
Downstream Conditions	The downstream boundary conditions are based on the Coastal Flood Boundary 2018 dataset and for which confidence intervals are provided. For the 50% AEP tide, which is used in the model, the 97.5% confidence band is between 3.58m OD and 3.73m OD compared to the design tide peak of 3.63m OD. For simplicity, the higher level of 3.73m OD is taken as the 90% confidence interval, giving a maximum variation of 0.10m. ▪ 90% confidence interval = 0.10m
Bridge Coefficients	There is no guidance as to confidence intervals in regards of structure coefficients. We have accurate survey of Castle Street Bridge and the ARCH bridge unit in FM is utilised to represent it, which is based on typical arched bridges in the UK. It is, however, unlikely that the hydraulics of the bridge would be perfectly represented in the model and if suitable data existed, it would most likely require some adjustment to the calibration coefficient to provide a better match to observed conditions. We would expect the calibration coefficient to vary by more than 20% only in exception circumstances and therefore have set the 90% confidence interval to 20%. ▪ 90% confidence interval = 20% (0.2)

(e) Step D – Estimating Total Uncertainty in the Primary Variable

The formula for estimating the total uncertainty in the primary variable is given in the box below, which is an extract from the guidance for accounting for uncertainty:

Making these assumptions simplifies the analysis and supports the following practical method to estimate the primary uncertainty (R_{unc}):

$$R_{unc} = \sqrt{\left[\left(\frac{\partial R}{\partial x}\right) x_{unc}\right]^2 + \left[\left(\frac{\partial R}{\partial y}\right) y_{unc}\right]^2 + \left[\left(\frac{\partial R}{\partial z}\right) z_{unc}\right]^2}$$

where:

R is the total uncertainty in the primary source interest (at the same level of confidence as the secondary uncertainties)

$\left(\frac{\partial R}{\partial x,y,z}\right)$ are partial derivatives that represent the relationship between a small change in the components and the resulting change in the primary uncertainty; the relative size of the partial derivative 'weights' the contribution for each component

In more descriptive terms:

- The ∂R term is the change in primary variable (peak water level) resulting from a small change in a secondary variable, refer to Table 3.
- The $\partial x, \partial y, \partial z$ terms are the change in the secondary variable (represented by the percentage change to model inflow and channel geometry and by value for channel roughness and downstream conditions); refer to Table 2.
- The x_{unc} , y_{unc} and z_{unc} are the uncertainties in the secondary variables (represented by the percentage change to model inflow, channel geometry and bridge coefficients and by value for channel roughness and downstream conditions); refer to Table 4.
- The equation is expanded or contracted as required depending on the number of secondary variables assessed.

Applying the above formula using average change in primary variables provide a RUA of 0.29m. Using the maximum change in primary variables, the RUA is 0.35m, which is a more conservative estimate and is recommended for use in this assessment. The secondary variables of channel geometry, bridge coefficients and channel roughness contribute very little to the overall RUA (<1%). The uncertainty in the downstream conditions contributes to around 10% of the RUA, whilst model inflow uncertainty accounts for nearly 90% of RUA.

Appendix C: WFD Scoping Assessment 123666-BUK-ZZ-00-RP-EN-00013



FINAL

CARDIGAN TIDAL FLOOD RISK MANAGEMENT SCHEME

Water Framework Directive Assessment

Project no. 123666

Prepared for:

Natural Resources Wales

February 2024



Details of document preparation and issue:

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WFD Compliance Assessment of Cardigan Tidal Flood Risk Management Scheme

Stage 1 Step 1: proposal details.

Project details where <u>NRW is the project proponent/instigator</u>	
NRW Project reference	Cardigan Tidal Flood Risk Management Scheme
Type of scheme	The scheme will comprise a flood defence structure adjacent to the Afon Teifi.
What ongoing maintenance work will be required? All structures will require maintenance	The inspection and maintenance of flood defence walls will be carried out in line with NRW protocols.
Breakdown of physical works involved (e.g. new weir, bank reinforcement, riparian vegetation management)	The lower quayside areas of Cardigan have been inundated by the tide, which affects the Lower Strand and the Cattle Market areas. Low-lying residential and commercial properties are affected by a tidal return period of approximately 1:1 year annual chance of probability. The Cardigan Tidal Flood Risk Management Scheme (FRMS) is proposed to address this risk of property flooding. The scheme is currently at the start of outline design and therefore the design description may be subject to change following the evolution of the design, including construction arrangements. The scheme will comprise a series of flood defence structures designed to fit within the various constraints along the Afon Teifi frontage between Cardigan Bridge and Gloster Row Car Park (approximately 300 to 400 m). To provide the scheme design standard of 1 in 200 AEP with allowance for climate change, the flood defences will need to achieve structures up to approx. 2m above general ground level (though lower in many sections). The approximate alignment of the flood defences is shown on Drawing 123666-BUK-ZZ-00-DR-EN-00053 (Appendix B), and comprises four discrete sections (S1-S4). The anticipated construction methodology comprises: • Installation of a temporary construction compound on the northern riverbank, although it is currently uncertain where this will be located. Options include the derelict area adjacent to Cardigan Bridge (but this option is unlikely), Gloster Row Car Park (with a new access

	required), the Bathroom Centre warehouse (but this option is unlikely). • Provision of a secondary compound on the southern bank of the Afon Teifi in order to deliver materials across the river by boat to the compound on the northern side of the channel. • A temporary access ramp will need to be constructed from the site compound to the foreshore to enable access for vehicles and equipment, although the existing slipways will be utilised wherever feasible. Access is assumed to be from the foreshore to Section 3. • Pre-augering of the ground on the foreshore will be required prior to the installation of sheet piles, which will assist in avoiding unnecessary vibration affecting local people and ecology. • For Section 1 and 2 construction of the sheet piles is anticipated to be undertaken on the foreshore immediately in front of the existing river wall where the flood defence is offset into the river as access from the landward side is expected to be too complex. For Sections 3 and Section 4 as a worst-case it has also been assumed that construction will be undertaken on the foreshore. For all piling options along the foreshore (section 1 and 2) an approximately 1m high temporary piling platform of clean rip-rap stone will be required. The piling platform will extend approximately 3m further into the river than the flood defence wall, and then grade down to meet the existing river bed. For piling options from land if deemed possible (section 3 and 4), temporary works would be required to enable access from the landward side and temporary works will be required from the foreshore to stabilise the existing river wall. A piling platform comprising a 600mm layer of crushed stone will be situated on the landward side. • Construction of a replacement slipway will involve localised working along the margin of the river. The form of construction will involve creating reinforced concrete slipway ramps. The slipway is assumed
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	to not extend significantly beyond the alignment of the new flood defences.
Location of activity	The Cardigan FRMS is located towards the centre of Cardigan town in southwest Wales and covers the north banks of the Afon Teifi. The locations of the proposed works are shown on the supporting drawing 123666-BUK-ZZ-00-DR-EN-00053.
Length / size of works (m)	Approximately 300 – 400 m in length.
Estimated extent of footprint/impact of the works	Approximately 1,200 m ² in area.
Timing of works	The anticipated construction duration will be between 12 months and 24 months. The expected start date is not known at the time of writing this report. Standard working hours will be adopted from 8 AM to 6 PM Monday to Friday, and 8 AM to 1 PM on Saturday (no work on Sundays or Bank Holidays). It is assumed that not all in-channel works can be undertaken at low tide, therefore some piling works will be completed in the river.
Map of site included and scaled plan	123666-BUK-ZZ-00-DR-EN-00054.P01 (Appendix A) 123666-BUK-ZZ-00-DR-EN-00055.P01 (Appendix B) 123666-BUK-ZZ-00-DR-EN-00053.P01 (Appendix C)
Project documents	Cardigan FRMS HRA: 123666-BUK-ZZ-00-RP-EN-00012 (in DRAFT at time of writing) PEA: 123666-BUK-ZZ-00-RP-EN-00006 Phase 1 Habitat Survey Map (123666-BUK-ZZ-00-DR-EN-00001)
NRW team	Cardigan Tidal FRMS Project Team (assessment completed by Binnies UK Ltd)
Lead officer	Chris Pratt
Date of assessment	May 2023

Stage 1, Step 2: Collate baseline information on all water bodies at risk from the proposal.

Date of classification information: 2021 Cycle 3 classification

Water body ID	Water body name	Water body type	HMWB	Overall water body status	Morphology status*	Relevance to the proposal
GB511006206900	Teifi Estuary	Transitional	No	Moderate	High	Proposed works are within the transitional water body.
GB110062039070	Piliau- headwaters to the confluence with Teifi	River	No	Moderate	Not High	Proposed works are downstream of this water body.
GB110062043563	Teifi – Afon Ceri to estuary	River	No	Moderate	Not Detailed	Proposed works are downstream of this water body.
GB41002G203300	Teifi and Coastal Ceredigion	Groundwater	No	Poor	Not High	Proposed works are located above this groundwater body.

*where there is no information, or a null value then assume it is at good status for morphology (or hydromorphology for TraC water bodies) or, if the water body is designated HMWB the morphological status is **not applicable (please be aware that these water bodies are still sensitive to physical modifications)**.

The potential for the proposal to affect the following water bodies was also initially considered but can be ruled out without further consideration:

- Mwldan – Water body ID GB110062039160 (See drawing 123666-BUK-ZZ-00-DR-EN-00054.P01 in Appendix A) – This water body is a tributary of the Teifi Estuary approximately 300m downstream of the proposed works. Any pollution resulting from the proposed works can only be transported to the Mwldan through tidal currents. The tidal extent of this waterbody is minimal and as such the waterbody will not be affected. The proposed works are not on a migration route for fisheries for this waterbody.
- Cardigan Bay South Coastal – Water body ID GB621009580000 (See drawing 123666-BUK-ZZ-00-DR-EN-00054.P01 in Appendix A) – This water body is approximately 5 km downstream of the proposed works. Any pollution resulting from the proposed works will have dissipated by the time water reaches Cardigan Bay South and would therefore not lead to an effect.
- All tributaries of the Teifi - Afon Ceri to estuary water bodies (See drawing 123666-BUK-ZZ-00-DR-EN-00054.P01 in Appendix B) will be **screened in and scoped in** as per the Teifi - Afon Ceri to estuary. They are not referenced in Stage 1, Step 3 and Stage 2, Step 1 due to the number of waterbodies and the scoping decision being the same.

Stage 1, Step 3: Risk Screening - Teifi Estuary

Water body name: Teifi Estuary Water body ID: GB511006206900			
Question number	Risk screening questions	Name of activity	Screening decision – delete as appropriate
Q1.1	Is the proposal in a water body at high status or high status for morphology or hydromorphology?	All	Yes water body is at high status for morphology – complete detailed assessment for Teifi Estuary.
Q1.2	Is the activity listed in Annex D as a green activity? Complete new row for each activity	N/A	N/A (screened into detailed assessment in Q1.1)
Q1.3	Are there any potential cumulative/in combination impacts? Or is there Local Expert Override*?	N/A	N/A (screened into detailed assessment in Q1.1)
Q1.4	Is the water body at Good overall status?	N/A	N/A (screened into detailed assessment in Q1.1)
Q1.5	Record best practice measures that the works include to help achieve the objectives of the water body.	All works will be undertaken by an NRW framework contractor who will implement best practice techniques to control pollution and siltation. As with all works carried out by NRW framework contractors, the contractor will be required to prepare and comply with a Pollution Prevention Plan, including spill response plans, and a Biosecurity Risk Assessment. Works method statements will be agreed by NRW before works start. Best-practice guidelines (e.g. GPP5: Works and maintenance in or near water, Version 1.2, 2018 and Pollution Prevention Guidelines, CIRIA 2015) will be followed as a minimum to prevent potential adverse effects from pollution and the spread of Invasive Non-Native Species (INNS). A Construction Environmental Management Plan (CEMP) would be produced for the works.	

Stage 1, Step 3: Risk Screening - Piliau- headwaters to the confluence with Teifi

Water body name: Piliau- headwaters to the confluence with Teifi Water body ID: GB110062039070			
Question number	Risk screening questions	Name of activity	Screening decision – delete as appropriate
Q1.1	Is the proposal in a water body at high status or high status for morphology or hydromorphology?	N/A	No (water body NOT at high status or high status for morphology)
Q1.2	Is the activity listed in Annex D as a green activity? Complete new row for each activity	Operation of temporary compounds during the construction phase to store plant & machinery, materials, and fuel & oils.	No (not listed in Annex D) – complete scoping assessment for each water body
		Construction of a temporary access ramp to the foreshore and a permanent replacement slipway	No (Bed reinforcement is classed as Red and in Annex D) – complete scoping assessment for each water body
		Pre-augering and installation of sheet piles from a temporary piling platform formed from clean rip-rap stone.	No (Bank reinforcement over 100m is classed as Red and in Annex D) – complete scoping assessment for each water body
Q1.3	Are there any potential cumulative/in combination impacts? Or is there Local Expert Override*?	N/A	N/A screened in at Q1.2
Q1.4	Is the water body at Good overall status?	N/A	N/A screened in at Q1.2

Water body name: **Piliau- headwaters to the confluence with Teifi**

Water body ID:

GB110062039070

Question number	Risk screening questions	Name of activity	Screening decision – delete as appropriate
Q1.5	Record best practice measures that the works include to help achieve the objectives of the water body.	All works will be undertaken by an NRW framework contractor who will implement best practice techniques to control pollution and siltation. As with all works carried out by NRW framework contractors, the contractor will be required to prepare and comply with a Pollution Prevention Plan, including spill response plans, and a Biosecurity Risk Assessment. Works method statements will be agreed by NRW before works start. Best-practice guidelines (e.g. GPP5: Works and maintenance in or near water, Version 1.2, 2018 and Pollution Prevention Guidelines, CIRIA 2015) will be followed as a minimum to prevent potential adverse effects from pollution and the spread of Invasive Non-Native Species (INNS).	

Stage 1, Step 3: Risk Screening - Teifi – Afon Ceri to estuary

Water body name: Teifi – Afon Ceri to estuary Water body ID: GB110062043563			
Question number	Risk screening questions	Name of activity	Screening decision – delete as appropriate
Q1.1	Is the proposal in a water body at high status or high status for morphology or hydromorphology?	N/A	No (water body NOT at high status or high status for morphology)
Q1.2	Is the activity listed in Annex D as a green activity? Complete new row for each activity	Operation of temporary compounds during the construction phase to store plant & machinery, materials, and fuel & oils.	No (not listed in Annex D) – complete scoping assessment for each water body
		Construction of a temporary access ramp to the foreshore and a permanent replacement slipway	No (Bed reinforcement is classed as Red and in Annex D) – complete scoping assessment for each water body
		Pre-augering and installation of sheet piles from a temporary piling platform formed from clean rip-rap stone.	No (Bank reinforcement over 100m is classed as Red and in Annex D) – complete scoping assessment for each water body
Q1.3	Are there any potential cumulative/in combination impacts? Or is there Local Expert Override*?	N/A	N/A screened in at Q1.2
Q1.4	Is the water body at Good overall status?	N/A	N/A screened in at Q1.2
Q1.5	Record best practice measures that the works include to help achieve the objectives of the water body.	All works will be undertaken by an NRW framework contractor who will implement best practice techniques to control pollution and siltation. As with all works carried out by NRW framework contractors, the contractor	

Water body name: **Teifi – Afon Ceri to estuary**

Water body ID: **GB110062043563**

Question number	Risk screening questions	Name of activity	Screening decision – delete as appropriate
		will be required to prepare and comply with a Pollution Prevention Plan, including spill response plans, and a Biosecurity Risk Assessment. Works method statements will be agreed by NRW before works start. Best-practice guidelines (e.g. GPP5: Works and maintenance in or near water, Version 1.2, 2018 and Pollution Prevention Guidelines, CIRIA 2015) will be followed as a minimum to prevent potential adverse effects from pollution and the spread of Invasive Non-Native Species (INNS).	

Stage 1, Step 3: Risk Screening - Teifi and Coastal Ceredigion

Water body name: Teifi and Coastal Ceredigion Water body ID: GB41002G203300			
Question number	Risk screening questions	Name of activity	Screening decision – delete as appropriate
Q1.1	Is the proposal in a water body at high status or high status for morphology or hydromorphology?	N/A	No (water body NOT at high status or high status for morphology)
Q1.2	Is the activity listed in Annex D as a green activity? Complete new row for each activity	Operation of temporary compounds during the construction phase to store plant & machinery, materials, and fuel & oils.	No (not listed in Annex D) – complete scoping assessment for each water body
		Construction of a temporary access ramp to the foreshore and a permanent replacement slipway	No (Bed reinforcement is classed as Red and in Annex D) – complete scoping assessment for each water body
		Pre-augering and installation of sheet piles from a temporary piling platform formed from clean rip-rap stone.	No (Bank reinforcement over 100m is classed as Red and in Annex D) – complete scoping assessment for each water body
Q1.3	Are there any potential cumulative/in combination impacts? Or is there Local Expert Override*?	N/A	N/A screened in at Q1.2
Q1.4	Is the water body at Good overall status?	N/A	N/A screened in at Q1.2
Q1.5	Record best practice measures that the works include to help achieve the objectives of the water body.	All works will be undertaken by an NRW framework contractor who will implement best practice techniques to control pollution and siltation. As with all works carried out by NRW framework contractors, the contractor	

Water body name: **Teifi and Coastal Ceredigion**

Water body ID: **GB41002G203300**

Question number	Risk screening questions	Name of activity	Screening decision – delete as appropriate
		will be required to prepare and comply with a Pollution Prevention Plan, including spill response plans, and a Biosecurity Risk Assessment. Works method statements will be agreed by NRW before works start. Best-practice guidelines (e.g. GPP5: Works and maintenance in or near water, Version 1.2, 2018 and Pollution Prevention Guidelines, CIRIA 2015) will be followed as a minimum to prevent potential adverse effects from pollution and the spread of Invasive Non-Native Species (INNS). A piling risk assessment will be completed to avoid preferential pathways to the groundwater body.	

Stage 2: Scoping Assessment

Stage 2, Step 1: Teifi Estuary - Relate activity to water body quality elements

Scoping table for Transitional and Coastal water bodies Water body name: Teifi Estuary Water body ID: GB511006206900			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
Transitional and Coastal water bodies	Choose one of the following: Direct – risk of direct impact Indirect – risk of indirect impact N/A – no impact pathway N/A – other – include additional text to explain	Further detail on potential impacts. Where N/A is included then provide detail to explain.	Briefly describe any measure included within the proposal at this point that will ensure the potential effects are avoided. Where impacts can be avoided through measures already included in the scheme then add Scoped Out . Or where further assessment is required add Scoped In
Hydromorphology – hydromorphology constitutes both ‘hydrology’ and ‘geomorphology’ and describes the physical characteristics and processes of a water body. Could the proposal lead to changes in:			
- morphological conditions, for example depth variation, the seabed and intertidal zone structure - tidal patterns, for example, dominant currents - freshwater flow - wave exposure	Direct – risk of direct impact	The water body is at High status for Morphology.	A detailed/further assessment is required. Scoped In (Stage 1, step 3)
Is the proposal in a HMWB?	No	N/A	N/A

Scoping table for Transitional and Coastal water bodies

Water body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
Water quality An activity can modify the flow of water, introduce artificial materials, or remove sediment and/ or vegetation. These can all affect the water quality – particularly physico-chemical aspects of water quality – such as levels of dissolved oxygen, nutrients, and ammonia. Include water quality in the detailed assessment if the activity could affect:			
• water clarity (turbidity or suspended particulate matter concentration) • thermal conditions (including shading) • oxygen levels – dissolved oxygen conditions • nutrients - dissolved inorganic nitrogen • microbial patterns • salinity/conductivity • is in a water body with a phytoplankton or opportunistic macroalgae status of moderate, poor or bad • is in a water body with a history of harmful algae (where there is an existing designation for the area, information should be available; however, local water quality officers will be able to help).	Direct – risk of direct impact Indirect – risk of indirect impact	Baseline data: Dissolved Inorganic Nitrogen (DIN): Moderate Dissolved Oxygen (DO): High Phytoplankton: High Specific pollutants: High Construction During construction, temporary compounds are used for the storage of plant & machinery, construction materials and fuel & oil. They must be operated in a manner which prevents the loss of chemicals and sediments directly into the environment. These substances can be washed into the water body introducing specific pollutants and nutrients bound to sediments. The clarity of the water can be compromised and oxygen	The works are within an estuary which may naturally be turbid due to the changing tidal movements. A small release of sediment is not likely to be noticeable and conditions will return to baseline relatively quickly. The potential impact is therefore considered negligible if suitable avoidance measures are adopted. See Q1.5: Stage 1, Step 3 for avoidance measures. Scoped Out.

Scoping table for Transitional and Coastal water bodiesWater body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		levels can decrease leading to negative impacts on biota. Similarly, construction activities on the foreshore can mobilise sediments resulting in increased turbidity and the indirect release of nutrients and chemicals which may have accumulated; other contaminants may include concrete washings. These can have a negative impact on biota. Operational There are no mechanisms identified which can result in a negative impact during operation of the flood defence.	Scoped Out.

Chemicals – A detailed assessment will also be required if the activity uses or releases chemicals, for example, through sediment disturbance or building works. This is necessary when either the:

Scoping table for Transitional and Coastal water bodies

Water body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
- chemicals are on the Environmental Quality Standards Directive (EQSD) list - activity disturbs sediment with contaminants (for estuarine and coastal above Cefas Action Level 1). - or, if the activity releases chemicals on the EQSD list and has a mixing zone, like a discharge pipeline or outfall, follow the Environment Agency's surface water pollution risk assessment guidance. This is part of the Environmental Permitting Regulations guidance.	Direct – risk of direct impact	Baseline data: Priority hazardous substances: High Priority substances: High Construction There are no chemicals to be released into the Teifi as part of the proposed scheme. Materials to be used are not thought to be on the EQSD list. Construction activities can increase the risk of the release of chemicals, either directly from compounds where materials are stored or spills and leaks from machinery or disturbance of sediments with contaminants above Cefas Action Level 1. The implementation of best practices during construction activities will reduce the risk from compounds and spills. No evidence is available to indicate sediments may be contaminated with such contaminants. No release of	See Q1.5: Stage 1, Step 3 for avoidance measures. Method statements to be prepared by the contractor and agreed by NRW. Fully stocked spill kits should be available and staff trained on how to use them. Scoped Out.

Scoping table for Transitional and Coastal water bodies

Water body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		chemicals on the EQSD list is considered likely, any potential impact is considered negligible. Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Scoped Out.
Biology Identify if the activity or project could impact on the abundance or composition of the biological elements listed below: Biological elements for transitional (T) and coastal (C) waters under the directive are: • Benthic invertebrates (T, C) • Fish (T) • Phytoplankton (T, C) • Macroalgae (T, C) • Angiosperms (T, C) Could the proposal lead to:			
• changes to the composition and abundance of aquatic flora • changes to the composition and abundance of benthic invertebrate fauna		Baseline data: Invertebrates: Good Phytoplankton: High Angiosperm: Good Macroalgae: Good Opportunistic macroalgae: Good Fuciod extent: High	

Scoping table for Transitional and Coastal water bodies

Water body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
	Direct – risk of direct impact Indirect – risk of indirect impact	Construction There is the potential for the killing and/or injury of aquatic flora and invertebrates resulting directly from the installation of the piling platform and tracking of machinery on the foreshore. Also, there is potential for indirect impacts on aquatic flora and fauna communities resulting from increased siltation. However, any impact on communities of aquatic flora and invertebrates will be temporary and affect only a very small area of the water body where the construction activities are carried out and is therefore unlikely to affect the composition and abundance of aquatic and invertebrate fauna at a water body scale.	See Q1.5: Stage 1, Step 3 for avoidance measures. The scale of change at the site compared to the size of the water body is small and so no negative impact at the water body scale is anticipated. Scoped Out.

Scoping table for Transitional and Coastal water bodies

Water body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		Operational Construction of the flood defence wall will encroach in some parts towards the channel of the river. This is seen in the second part of section 1, and section 2 with an encroachment of 5m anticipated to be the worst case scenario (see 123666-BUK-ZZ-00-DR-EN-00053). Encroachment will result in the permanent loss of some habitat, and possible changes to other habitats as a result of modified hydromorphology.	The scale of change of the flood defence alignment from existing compared to the size of the water body is small and so no negative impact at the water body scale is anticipated. Scoped Out.
For TraC water bodies – scope in if the footprint (where footprint can be direct or a plume i.e. chemical or thermal; for dredging multiply the area by 1.5x) of your activity is:			
0.5km² or larger 1% or more of the water body's area	Direct – risk of direct impact	The working site contains and lies within 500m of the higher sensitivity habitat <i>saltmarsh</i>	Any temporary works and the final alignment of defences will impact sensitive habitats.

Scoping table for Transitional and Coastal water bodies

Water body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
• Within 500m of any higher sensitivity habitat (see table below) • 1% or more of any lower sensitivity habitat (see table below)		and the lower sensitivity habitat <i>intertidal soft sediments like sand and mud</i>. The worst case sees piling from the foreshore of the flood defence in S3 and S4. The temporary works could damage or destroy saltmarsh present within S3 and S4 (see Appendix C). Temporary works could damage or destroy intertidal mud habitat within S1 and S2 (see Appendix C). The footprint of the working site is to be confirmed but is expected to be around 9,000 m². Only approximately 3,500 m² of this is within the Teifi Estuary Waterbody.	Scoped In for further assessment.

Fish fauna (Transitional water bodies only): could the proposal lead to:

Scoping table for Transitional and Coastal water bodies

Water body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
• changes to the composition, abundance and age structure of fish fauna • an impact on normal fish behaviour like movement, migration, or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow) • entrainment or impingement of fish • refuge/predation areas Or: is the proposal in an estuary and could affect fish in the estuary; is outside the estuary but could delay or prevent fish entering it; or, could affect fish migrating through the estuary	Direct – risk of direct impact	Baseline data: Fish: Good Construction There is the potential for disturbance of fish due to noise resulting from the movement of plant and machinery on the foreshore and from the installation of the sheet piles. Migrating fish could experience masking and behavioural effects from piling works due to the presence of another overriding sound. Such an effect may result in individuals not responding to potentially threatening situations such as collision with vessel propellers. Behavioural effects could result in individuals being at greater risk of predation or having a lower chance of successfully completing migrations. Therefore, there is the potential for the indirect injury or mortality of some individuals.	Pre-augering prior to the installation of sheet piles will assist in avoiding unnecessary vibration. The channel width of the Teifi is approximately 50m where works will be carried out, allowing fish to avoid the noise and vibration emitted. Good construction practices such as controls on the machinery used and seasonal/ tidal timing constraints will limit negative impacts; as will construction only taking place during daytime hours. Consultation with the Fisheries Team at NRW will be required if this is deemed not possible. Scoped In for further assessment to confirm construction periods and suitability of mitigation measures.

Scoping table for Transitional and Coastal water bodiesWater body name: **Teifi Estuary**

Water body ID: GB511006206900

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		Operational There is the potential for narrowing of the channel leading to hydromorphological changes following the completion of the works. This could impact the hydromorphology and river bed resulting in impacts on fish.	The scale of potential change to fish habitat, from the new alignment compared to the size of the water body is small and so no negative impact at the water body scale is anticipated. Scoped Out.

Info for TraC water bodies

Extract from EA Clearing the water for All

Higher and lower sensitivity habitats for TraC water bodies

Higher sensitivity habitats ²	Lower sensitivity habitats ³
chalk reef	cobbles, gravel and shingle
clam, cockle and oyster beds	intertidal soft sediments like sand and mud
intertidal seagrass	rocky shore
maerl	subtidal boulder fields
mussel beds, including blue and horse mussel	subtidal rocky reef
polychaete reef	subtidal soft sediments like sand and mud
saltmarsh	
subtidal kelp beds	
subtidal seagrass	

² Higher sensitivity habitats have a low resistance to, and recovery rate, from human pressures.

³ Lower sensitivity habitats have a medium to high resistance to, and recovery rate from, human pressures.

Stage 2, Step 1: Piliau- headwaters to the confluence with Teifi - Relate activity to water body quality elements

Scoping table for River and Lake water bodies Water body name: Piliau – headwaters to the confluence with Teifi Water body ID: GB110062039070			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
Rivers and Lake water bodies	Choose one of the following: Direct – risk of direct impact Indirect – risk of indirect impact N/A – no impact pathway N/A – other – include additional text to explain	Further detail on potential impacts. Where N/A is included then provide detail to explain.	Briefly describe any measure included within the proposal at this point that will ensure the potential effects are avoided. Where impacts can be avoided through measures already included in the scheme then add Scoped Out . Or where further assessment is required add Scoped In
Hydromorphology – hydromorphology constitutes both ‘hydrology’ and ‘geomorphology’ and describes the physical characteristics and processes of a water body. Could the proposal lead to:			
- changes to flows, for example, changes to wetted width or depth profile, - abstraction of water (changes to quality and dynamics of water flow), - changes the physical form including structure and substrate of the river/ lake bed or connection to groundwater,	Indirect	Construction Construction activities on the foreshore can mobilise sediments resulting in increased turbidity. This can have a negative impact on biota.	This water body is a tributary of the Teifi Estuary and is approximately 250m upstream of the proposed works. Any hydromorphological impacts resulting from the proposed works will be minimal as the tidal extent of this water body is minimal. Scoped Out .

Scoping table for River and Lake water bodies Water body name: Piliau – headwaters to the confluence with Teifi Water body ID: GB110062039070			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
or alter the process of sediment transport (erosion, deposition or transfer)?		Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Scoped Out.
Is the proposal in a HMWB?	No	NA	NA
Water quality An activity can modify the flow of water, introduce artificial materials, or remove sediment and/or vegetation. These can all affect the water quality – particularly physico-chemical aspects of water quality - such as levels of dissolved oxygen, nutrients and ammonia.			
Include water quality in the detailed assessment if the activity could affect:			
- water clarity (turbidity or suspended particulate matter concentration) - temperature - oxygen levels - nutrients: total phosphorus concentration (Lakes); soluble reactive phosphorus concentration (Rivers). - salinity/conductivity - acidification status	Indirect – risk of indirect impact	Baseline data: Ammonia: High DO: High pH: High Phosphate: Moderate Temperature: High Construction See Teifi Estuary.	This water body is a tributary of the Teifi Estuary and is approximately 250m upstream of the proposed works. Any water quality impacts resulting from the proposed works will be

Scoping table for River and Lake water bodies

Water body name: Piliau – headwaters to the confluence with Teifi

Water body ID: GB110062039070

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	minimal as the tidal extent of this water body is minimal. Scoped Out. Scoped Out.
Chemicals - A detailed assessment will also be required if the activity uses or releases chemicals, for example, through sediment disturbance or building works. This is necessary when either the:			
- chemicals are on the Environmental Quality Standards Directive (EQSD) list - or, if the activity releases chemicals on the EQSD list and has a mixing zone, like a discharge pipeline or outfall, follow the Environment Agency's surface water pollution risk assessment guidance. This is part of the Environmental Permitting Regulations guidance.	Indirect – risk of indirect impact	Baseline data: Not Assessed Construction See Teifi Estuary.	See Q1.5: Stage 1, Step 3 for avoidance measures. Method statements to be prepared by the contractor and agreed by NRW. Fully stocked spill kits should be available and staff trained on how to use them. This water body is a tributary of the Teifi Estuary and is approximately 250m upstream of the proposed works.

Scoping table for River and Lake water bodies

Water body name: Piliau – headwaters to the confluence with Teifi

Water body ID: GB110062039070

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Any chemical impacts resulting from the proposed works will be minimal as the tidal extent of this water body is minimal. Scoped Out. Scoped Out.
Biology Expert judgement will be required to consider whether any changes to the hydromorphology or water quality brought about by the project will potentially impact upon the Biological Quality Elements (BQEs) and may cause deterioration in status. Identify if the activity or project could impact on the abundance or composition of the following biological elements: benthic invertebrates, phytoplankton, acrophytes and phytobenthos or fish. Could the proposal lead to:			
- changes to the composition and abundance of aquatic flora, and/ or - changes to the composition and abundance of benthic invertebrate fauna?		Baseline Macroinvertebrates: High Construction There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Scoped Out.

Scoping table for River and Lake water bodies

Water body name: Piliau – headwaters to the confluence with Teifi

Water body ID: GB110062039070

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Scoped Out.
Fish fauna: could the proposal lead to:			
• changes to the composition, abundance, and age structure of fish fauna, • an impact on normal fish behaviour like movement, migration, or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow), • entrainment or impingement of fish, • refuge/ predation areas?		Baseline Fish: Moderate Construction There is the potential for disturbance of fish due to noise resulting from the movement of plant and machinery on the foreshore and from the installation of the sheet piles. Migrating fish could experience masking and behavioural effects from piling works due to the presence of another overriding sound. Such an effect may result in individuals not responding to potentially threatening	Pre-augering prior to the installation of sheet piles will assist in avoiding unnecessary vibration. The channel width of the Teifi is approximately 70m wide where works will be carried out; allowing fish to avoid the noise and vibration emitted. Good construction practices such as controls on the machinery used and seasonal/ tidal timing constraints will limit negative impacts; as will construction only taking place during daytime hours. Works should avoid the fish migration periods. Consultation with the Fisheries Team at NRW will be required if this is deemed not possible.

Scoping table for River and Lake water bodies

Water body name: Piliau – headwaters to the confluence with Teifi

Water body ID: GB110062039070

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		situations such as collision with vessel propellers. Behavioural effects could result in individuals being at greater risk of predation or having a lower chance of successfully completing migrations. Therefore, there is the potential for the indirect injury or mortality of some individuals. Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Scoped In for further assessment to confirm construction periods and suitability of mitigation measures. Scoped Out.

Stage 2, Step 1: Teifi – Afon Ceri to estuary - Relate activity to water body quality elements

Scoping table for River and Lake water bodies Water body name: Teifi – Afon Ceri to estuary Water body ID: GB110062043563			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
Rivers and Lake water bodies	Choose one of the following: Direct – risk of direct impact Indirect – risk of indirect impact N/A – no impact pathway N/A – other – include additional text to explain	Further detail on potential impacts. Where N/A is included then provide detail to explain.	Briefly describe any measure included within the proposal at this point that will ensure the potential effects are avoided. Where impacts can be avoided through measures already included in the scheme then add Scoped Out . Or where further assessment is required add Scoped In
Hydromorphology – hydromorphology constitutes both ‘hydrology’ and ‘geomorphology’ and describes the physical characteristics and processes of a water body. Could the proposal lead to:			
- changes to flows, for example, changes to wetted width or depth profile, - abstraction of water (changes to quality and dynamics of water flow), - changes the physical form including structure and substrate of the river/ lake bed or connection to groundwater,	Indirect	Construction Construction activities on the foreshore can mobilise sediments resulting in increased turbidity. This can have a negative impact on biota.	This water body is a tributary of the Teifi Estuary and is approximately 250m upstream of the proposed works. Any hydromorphological impacts resulting from the proposed works will be minimal as the tidal extent of this water body is minimal. Scoped Out .

Scoping table for River and Lake water bodies Water body name: Teifi – Afon Ceri to estuary Water body ID: GB110062043563			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
or alter the process of sediment transport (erosion, deposition or transfer)?		Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Scoped Out.
Is the proposal in a HMWB?	No	NA	NA
Water quality An activity can modify the flow of water, introduce artificial materials, or remove sediment and/or vegetation. These can all affect the water quality – particularly physico-chemical aspects of water quality - such as levels of dissolved oxygen, nutrients, and ammonia. Include water quality in the detailed assessment if the activity could affect:			
- water clarity (turbidity or suspended particulate matter concentration) - temperature - oxygen levels - nutrients: total phosphorus concentration (Lakes); soluble reactive phosphorus concentration (Rivers). - salinity/conductivity - acidification status	Indirect – risk of indirect impact	Baseline data: Ammonia: High DO: High pH: High Phosphate: Moderate Temperature: High Construction See Teifi Estuary. Operational There are no mechanisms identified which can result	This water body is a tributary of the Teifi Estuary and is approximately 250m upstream of the proposed works. Any water quality impacts resulting from the proposed works will be minimal as the tidal extent of this water body is minimal. Scoped Out. Scoped Out.

Scoping table for River and Lake water bodies

Water body name: Teifi – Afon Ceri to estuary

Water body ID: GB110062043563

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		in a negative impact during the operation of the flood defence.	
Chemicals - A detailed assessment will also be required if the activity uses or releases chemicals, for example, through sediment disturbance or building works. This is necessary when either the:			
- chemicals are on the Environmental Quality Standards Directive (EQSD) list - or, if the activity releases chemicals on the EQSD list and has a mixing zone, like a discharge pipeline or outfall, follow the Environment Agency's surface water pollution risk assessment guidance. This is part of the Environmental Permitting Regulations guidance.	Indirect – risk of indirect impact	Baseline data: Not Assessed Construction See Teifi Estuary. Operational There are no mechanisms identified which can result in a negative impact during	See Q1.5: Stage 1, Step 3 for avoidance measures. Method statements to be prepared by the contractor and agreed by NRW. Fully stocked spill kits should be available and staff trained on how to use them. This water body is a tributary of the Teifi Estuary and is approximately 250m upstream of the proposed works. Any chemical impacts resulting from the proposed works will be minimal as the tidal extent of this water body is minimal. Scoped Out. Scoped Out.

Water body ID: GB110062043563

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		the operation of the flood defence.	
Biology Expert judgement will be required to consider whether any changes to the hydromorphology or water quality brought about by the project will potentially impact upon the Biological Quality Elements (BQEs) and may cause deterioration in status. Identify if the activity or project could impact on the abundance or composition of the following biological elements: benthic invertebrates, phytoplankton, acrophytes and phytobenthos or fish. Could the proposal lead to:			
- changes to the composition and abundance of aquatic flora, and/ or - changes to the composition and abundance of benthic invertebrate fauna?		Baseline Macroinvertebrates: High Construction There are no mechanisms identified which can result in a negative impact during the operation of the flood defence. Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Scoped Out. Scoped Out.

Scoping table for River and Lake water bodies

Water body name: Teifi – Afon Ceri to estuary

Water body ID: GB110062043563

Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
Fish fauna: could the proposal lead to:			
• changes to the composition, abundance, and age structure of fish fauna, • an impact on normal fish behaviour like movement, migration, or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow), • entrainment or impingement of fish, • refuge/predation areas?		Baseline Fish: Moderate Construction There is the potential for disturbance of fish due to noise resulting from the movement of plant and machinery on the foreshore and from the installation of the sheet piles. Migrating fish could experience masking and behavioural effects from piling works due to the presence of another overriding sound. Such an effect may result in individuals not responding to potentially threatening situations such as collision with vessel propellers. Behavioural effects could result in individuals being at greater risk of predation or having a lower chance of successfully completing	Pre-augering prior to the installation of sheet piles will assist in avoiding unnecessary vibration. The channel width of the Teifi is approximately 70m wide where works will be carried out; allowing fish to avoid the noise and vibration emitted. Good construction practices such as controls on the machinery used and seasonal/tidal timing constraints will limit negative impacts; as will construction only taking place during daytime hours. Works should avoid the fish migration periods. Consultation with the Fisheries Team at NRW will be required if this is deemed not possible. Scoped In for further assessment to confirm construction periods and suitability of mitigation measures.

Scoping table for River and Lake water bodies Water body name: Teifi – Afon Ceri to estuary Water body ID: GB110062043563			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures included in the proposal
		migrations. Therefore, there is the potential for the indirect injury or mortality of some individuals. Operational There are no mechanisms identified which can result in a negative impact during the operation of the flood defence.	Scoped Out.

Stage 2, Step 1: Teifi and Coastal Ceredigion - Relate activity to water body quality elements

Scoping table for Groundwater bodies Water body name: Teifi and Coastal Ceredigion Water body ID: GB41002G203300			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures already included in the proposal
Groundwater	Choose one of the following: Direct – risk of direct impact Indirect – risk of indirect impact N/A – no impact pathway N/A – other – include additional text to explain	Further detail on potential impacts. Where N/A is included then provide detail to explain.	Briefly describe any measure included within the proposal at this point that will ensure the potential effects are avoided. Where impacts can be avoided through measures already included in the scheme then add Scoped Out . Or where further assessment is required add Scoped In
Identify if the activity/ project has the potential to impact on the quality or quantity of groundwater. Hydrogeological regime: Could the proposal lead to:			
- a significant change to groundwater flows, for example, below ground structures which restricts or alters baseflow to dependent surface water or wetlands - abstraction of groundwater in large volumes or near sensitive locations - a significant change to groundwater chemistry due to inputs	N/A – no impact pathway	Baseline data: Overall water body: Poor Groundwater quantitative tests: Good Quantitative Groundwater Dependent Terrestrial Ecosystems test: Good Quantitative Dependent Surface Water Body Status: Good Quantitative Saline Intrusion: Good	

Scoping table for Groundwater bodies Water body name: Teifi and Coastal Ceredigion Water body ID: GB41002G203300			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures already included in the proposal
of pollutants to the ground over a large area potential impact on ground water dependant terrestrial ecosystems e.g. wetlands		Quantitative Water Balance: Good Chemical Groundwater tests: Poor Chemical Drinking Water Protected Area General Chemical test: Good Chemical Groundwater Dependent Terrestrial Ecosystems test: Good Chemical Dependent Surface Water Body Status: Poor Chemical Saline Intrusion: Good Trend Assessment – Groundwater supporting element: High Construction The working site is located over this groundwater body. Due to the scale and nature of the works and no groundwater abstraction, good construction practices will make any potential groundwater impacts negligible. Operational There is not thought to be a mechanism by which operating the	See Q1.5: Stage 1, Step 3 for avoidance measures. Scoped Out. Scoped Out.

Scoping table for Groundwater bodies Water body name: Teifi and Coastal Ceredigion Water body ID: GB41002G203300			
Elements	Applicable	Potential Impact (include direct and indirect potential impacts)	Avoidance measures already included in the proposal
		flood defence can impact groundwater.	

Invasive Non-Native Species Refer to the Check Clean Dry campaign to help prevent the spread of invasive plants and animals in British waters. You can find out more about INNS and biosecurity on the GB Non-native Species Secretariat website and on the INNS and Biosecurity section of the NRW Intranet . For additional information about INNS distribution check the following: NBN Atlas Wales INNS Portal	
Risks of introducing or spreading INNS include: - materials or equipment that have come from, had use in or travelled through other water bodies - activities that help spread existing INNS, either within the immediate water body or to other water bodies. Each project should have a biosecurity risk assessment/ plan as a matter of course. NRW Draft Biosecurity Risk Assessment/Plan Template . For complex large scale projects, it may be necessary to develop a more in-depth biosecurity plan using guidance on the GBNNSS website .	
Does the proposal have the potential to introduce or spread INNS?	Yes – the introduction of plant and machinery onto the foreshore could lead to INNS spread without control. A Biosecurity Risk Assessment will need to be carried out.

WFD Protected Areas

If the proposed activity is within, or hydrologically connected to, a Protected Area. If the activity is hydrologically linked, then as a general rule those Protected Areas within 2 km of the proposed activity will be most at risk.

Protected Areas and Critical sensitive habitats/ species		
Consider if Protected Areas are at risk from the proposal. These include:	Applicable	How have you considered the potential impacts?
Protected Areas:		
• SACs	Yes	A Habitats Regulation Assessment (HRA) is being conducted to assess potential impacts on Afon Teifi SAC, Cardigan Bay SAC and West Wales Marine SAC.
• SPAs	No	
• RAMSAR	No	
• Bathing Waters	Yes	BW ID 38630 – Poppit West is of Excellent quality. Due to the scale and nature of the works, there is no risk to this bathing water, which lies approximately 5km downstream.
• Shellfish Waters	No	
• Surface Water Drinking Water Protected Areas	No	
• Ground Water Drinking Water Protected Areas	No	
• Urban Waste Water Treatment Directive: designated Nutrient Sensitive Area	No	
• Nitrate Vulnerable Zones	No	
Other Protected and Priority habitats and species.		
• Nationally or locally protected areas e.g. SSSI, NNR etc	Yes	There are three designated sites within 2km of the Scheme, with one of these partially within the Scheme and one hydraulically linked to the site. These are discussed further below. The scheme lies within the Afon Teifi SSSI. SSSI Assent will be required for any operations within the Afon Teifi SSSI. Teifi Estuary Woodlands & Marshes SSSI is located 1.1km upstream of the scheme and is hydrologically linked. No

Protected Areas and Critical sensitive habitats/ species		
Consider if Protected Areas are at risk from the proposal. These include:	Applicable	How have you considered the potential impacts?
		impacts are anticipated due to the scoped out elements of water quality and chemistry discussed previously. Coedmor National Nature Reserve lies approximately 2.25km upstream and has been screened out for further assessment due to the distance from the works.
Section 6 Biodiversity and resilience of ecosystems duty (Environment (Wales) Act 2016) here – other Protected and Priority habitats and species. The S6 duty requires that public authorities must seek to maintain and enhance biodiversity so far as consistent with the proper exercise of their functions and in so doing promote the resilience of ecosystems.		
Identify if there is a risk that the activity/ project could impact on a water dependant priority habitat and or species which are either critical to the ecological health of the water body or sensitive to changes proposed on the water body.		
Section 7 list of priority habitats e.g. wetlands	Yes	Intertidal mudflats and saltmarsh already covered above in Stage 2 Step 1 of this assessment.
Section 7 list of priority species e.g. water voles	Yes	- Birds including kingfisher, merlin, osprey, barn owl and reed bunting have been recorded within 1km of the proposed working area. Birds may be temporarily disturbed by the works. No vegetation is to be removed for the proposed work. Works should avoid breeding bird season (March to September, inclusive), subject to consents and permissions. If works extend into the breeding bird season and distressed waterbirds are noted by the supervising Engineer, activities should be stopped immediately. If this is not possible then an Ecologist should be consulted to specify appropriate methods of working and breeding bird surveys undertaken. - Brown hairstreak has been recorded within 1km of the proposed works. However, there is limited suitable habitat for

Protected Areas and Critical sensitive habitats/ species		
Consider if Protected Areas are at risk from the proposal. These include:	Applicable	How have you considered the potential impacts?
		this species within the working area so it is assumed not present. • Atlantic salmon and sea lamprey have been recorded within the Teifi. Effects on fish have been considered with mitigation and scoped in at Stage 2, Step 1. • Slow-worm and common lizard have been recorded within 1km of the proposed scheme. Terrestrial and aquatic invertebrate surveys will be undertaken and the recommendations followed. • Bats are likely to be present within the Scheme area. Further surveys are required to define the mitigation; initially, this will comprise of a preliminary bat roost assessment. • Otters are known to use the River Teifi and are a feature of the Afon Teifi SAC. A pre-construction check for otter field signs should be undertaken approximately 8 weeks prior to works commencing. If any field signs are observed, then a licence from Natural Resources Wales may be required. A pre-works check to verify that no otter holts are present within any working areas should be conducted immediately prior to any works being undertaken. Piling works should be undertaken during daylight hours to prevent any impact to feeding/ foraging otter. Any open excavations or trenches should be covered at night to avoid mammals becoming trapped. • Bottlenose dolphin are known to frequent the lower reaches of the river and there exists the potential for the species to be present and impacted by the works. A pre-construction check should be conducted to verify that bottlenose dolphins or harbour porpoise are not present within any working area

Protected Areas and Critical sensitive habitats/ species		
Consider if Protected Areas are at risk from the proposal. These include:	Applicable	How have you considered the potential impacts?
		and should be conducted immediately prior to any works being conducted. If areas of habitat suitable for bottlenose dolphin are to be disturbed as part of the Scheme, then a Precautionary Method of Working Statement would need to be implemented and works carried out under the supervision of an Ecological Clerk of Works.
Ecosystem Resilience		
The Environment (Wales) Act 2016, Section 3 states that the objective of the sustainable management of natural resources is to maintain and enhance the resilience of ecosystems and the benefits they provide now and for future generations		
Consideration of ecosystem resilience – diversity, extent, condition, connectivity.	Yes	- Habitats will be impacted and reduced in extent, locally impacting ecosystem resilience. - Opportunities for saltmarsh creation to mitigate should be investigated.

Summary of step 1 scoping

Q2.1 Is there a risk that a component of the proposal may cause deterioration of any element that makes up water body status?	Yes – all potential impacts have been assessed considering the avoidance measures already included in the proposal and there is still a potential risk to a water body quality element or risk of deterioration.
--	--

Stage 2, Step 2: Summary of scoping decision of the project ‘alone’

Q2.2 Is there a risk that a component of the proposal may prevent the water body or Protected Area from achieving its objectives in the future?	Yes – all potential impacts have been assessed considering the avoidance measures already included in the proposal and there is a potential risk any water body or protected area from achieving its objects in the future.
--	---

Stage 2, Step 3: Assessing potential in combination and/or cumulative impacts

Are there any activities or projects which may act in combination and/or cumulative? <i>If none, put 'N/A'</i>	Nature of the in-combination/cumulative effect (if any)	Avoidance measures Include details of how measures already included in the proposal would be applied, and who would be responsible for applying them.	Can the risk of deterioration or prevention of achieving water body objectives from in combination/ cumulative effects be ruled out? 'YES' (or N/A) or 'NO' (where there is any uncertainty then add 'Don't know/uncertain')
N/A			N/A
Scoping decision of the project cumulatively or 'in combination'		Potential cumulative/in combination impacts conclusion	
Q2.3 Can the risk of deterioration or prevention of achieving water body objectives from in combination and or cumulative effects be ruled out?	(a) If the right-hand column is 'YES' or 'N/A' in all cases	YES , It can be concluded that potential deterioration or prevention of achieving water body objectives from in combination / cumulative effects can be ruled out	

Stage 2, Step 4: Overall scoping decision

Overall scoping decision	
Q2.4 Is there a potential risk that the proposal may cause deterioration or prevent a water body from meeting its objectives either alone or in combination?	There is a potential risk the proposal may cause deterioration or prevent the water body from meeting its objectives and therefore a detailed compliance assessment is required.

Conclusion of WFD Regulations 2017 Compliance Assessment & Authorisation

WFD stage 2 scoping has been completed and the activity/project is considered as having a risk of causing deterioration and detailed assessment is required to confirm if the scheme is compliant with the WFD Regulations 2017.	
Name of authorising officer	Alex Finlow
Job title and date	Environmental Scientist January 2024
Technical specialist comments	Provided below
Name, job title and date	Provided below (various responses)

Consultation with technical advisors/specialists

Relevant section of the WFD compliance assessment	Date(s) of correspondence* and any meeting(s) with technical advisor(s) and include the name of the technical advisor	Description of how the comments from technical advisors have been considered
Stage 1, Step 3	NRW Consultee Responses Oct 2023. Jason Jones Fisheries Specialist 'It doesn't appear to assess the potential impacts on waterbodies further upstream that are linked to the estuary. The migratory fish passing through the estuary will contribute to the fish populations of the water bodies upstream. If migration patterns are impacted by disturbance from (e.g. from piling activities) this may influence the distribution of migratory species through the catchment and so impact the WFD status of waterbodies elsewhere in the catchment, potentially leading to deterioration and failure to meet WFD objectives. Do these other waterbodies need to be assessed?'	'Page 4 of the WFD assessment states 'All tributaries of the Teifi - Afon Ceri to estuary water bodies (See drawing 123666-BUK-ZZ-00-DR-EN-00054.P01 in Appendix B) will be screened in and scoped in as per the Teifi - Afon Ceri to estuary. They are not referenced in Stage 1, Step 3 and Stage 2, Step 1 due to the number of waterbodies and the scoping decision being the same.'
	Rowland Sharpe Marine Specialist A screening and scoping exercise has been undertaken by NRW for WFD. For TraC waters, I can agree that hydromorphology, biology (habitats, composition and abundance) and fish are scoped in for detailed assessment. I agree that the downstream Bathing Water and coastal WFD water body Cardigan Bay South do not need further assessment.	'GPP5 is referred to in response to Q1.5, reference to a CEMP will be provided in this location also. Detailed Assessment Scope included in version P02.'

	I would recommend use of a Construction Environment Management Plan for avoidance measures such as those for fish and pollution prevention. The applicant should take note of the guidance in the Guidance for Pollution Prevention documents, particularly GPP5 Works and Maintenance in or near water. The applicant will need to calculate the footprint of their development as per the metrics on pg 18 and include this in their detailed assessment. A detailed assessment has not been provided at this stage; we look forward to seeing this. Fish comments I agree that a detailed assessment is needed for fish quality elements.'	
All Stages	Ceredigion Environment Team (Bethan) Both Heidi and I have taken a look at the WFD screening/scoping paper. We are both quite happy with the contents and don't have any comments to make.	Noted, no action required.
All Stages	Dale Cox (Geomorphology) I've reviewed the sections of the screening and scoping which apply to the 'river' waterbodies and have no further comments regarding the screening that has been undertaken. The works are being undertaken on the Teifi estuary waterbody, which I note you have also consulted with the marine team on.	Noted, no action required.

*Attach a copy or a link on DMS to written correspondence for the audit trail

Proposed Scope of Detailed Assessment

The proposed scope of the detailed assessments scoped into the WFD assessment are set out below.

Fish (construction)

Impacted waterbodies:

- 'Piliau – headwaters to the confluence with Teifi' (GB110062039070) and all other tributaries of the Teifi - Afon Ceri to estuary (See drawing 123666-BUK-ZZ-00-DR-EN-00054.P01 in Appendix B).
- 'Teifi Estuary' (GB511006206900).

Risk to WFD Compliance:

- Underwater noise and vibration from piling and pre-augering pose a risk of physiological effects, masking (impairment of the ability to detect sounds), and effects on behaviour and migration.

Scope of detailed assessment:

1. Review of HRA mitigation for lamprey and salmon and Ecological Impact Assessment (EcIA) mitigation for fish populations. An EcIA will be completed for the EIA proposed for the scheme.
2. Review NRW fisheries survey data for 'Teifi Estuary' and 'Piliau – headwaters to the confluence with Teifi' only.
3. Desk-based assessment if the HRA (see report reference 123666-BUK-ZZ-00-RP-EN-00012) and EcIA mitigation is adequate for wider fish species present in surveys that are not covered within the HRA.
4. Detail what further mitigation is required, if any.

Higher sensitivity habitats and lower sensitivity habitats (construction and operation)

Impacted waterbodies:

- 'Teifi Estuary' (GB511006206900).

Risk to WFD Compliance:

- Loss and/or deterioration of saltmarsh and intertidal soft sediments like sand and mud.

Scope of detailed assessment:

1. An Ecological Impact Assessment (EcIA) will be completed for the scheme, detailing appropriate mitigation for the impact saltmarsh and intertidal soft sediments to reduce effects.

2. The results of the EclA will be used to support the detailed assessment of effects on saltmarsh and intertidal soft sediments for the WFD Assessment. Mitigation identified for the EclA will be included in the detailed assessment and further measures will be included if necessary.

Morphology (construction and operation)

Impacted waterbodies:

- 'Teifi Estuary' (GB511006206900).

Risk to WFD Compliance:

- Effect on the hydro-morphological supporting elements of:
 - o quantity, structure and substrate of the bed; and
 - o structure of the intertidal zone.
- The following hydro-morphological supporting elements are not proposed for detailed assessment due to the location of the proposed works in the upper estuary and the nature of the proposed works:
 - o Depth variation;
 - o Tidal regime;
 - o Freshwater flow; and
 - o Wave exposure.

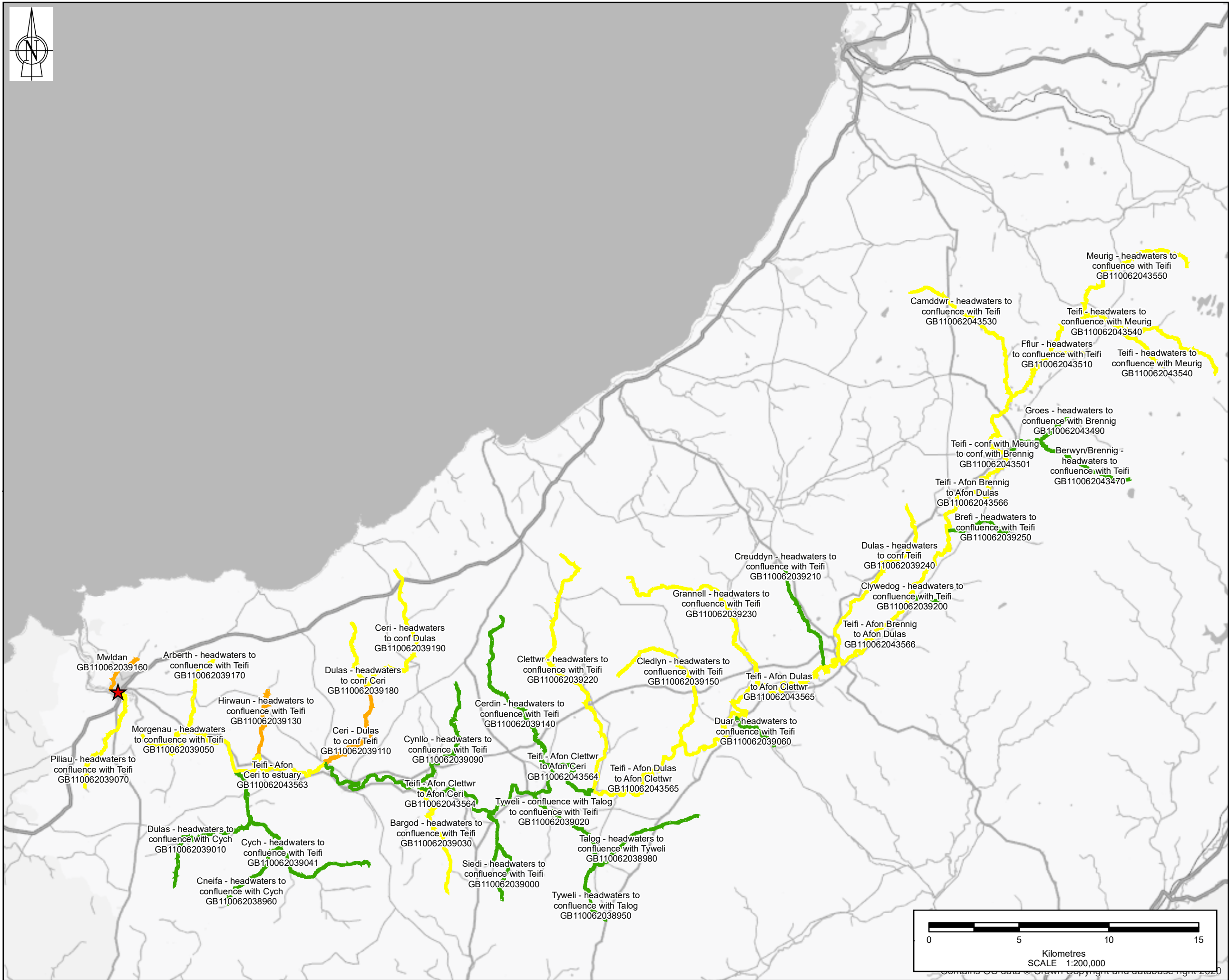
Scope of detailed assessment:

1. Geomorphological walkover of the Scheme Area by a geomorphologist, using field-based GIS mapping software to detail physical biotopes at low tide and capture georeferenced photo. The survey will focus on a visual assessment of the quantity, structure and substrate of the bed and the structure of the intertidal zone. This is expected to be carried out alongside the updated Phase 1 habitat survey.
2. The 1D hydraulic model will require additional scenarios to be run including:
 - a. Fluvial inflows of Q50, Q1 and 1 in 2-year events; and
 - b. Tidal boundary conditions of highest astronomical tide, lowest astronomical tide, mean high water springs and mean low water springs.
3. Review geomorphological survey data against the 1D model hydraulic outputs and provide an interpretation of how the scheme will impact the quantity, structure and substrate of the bed based on bed shear stress calculations.
4. Review geomorphological survey data against the proposed works and provide an interpretation of how the scheme will impact the structure of the intertidal zone.

Appendices

Appendix A, 123666-BUK-ZZ-00-DR-EN-00054 P01

Appendix B, 123666-BUK-ZZ-00-DR-EN-00055 P01

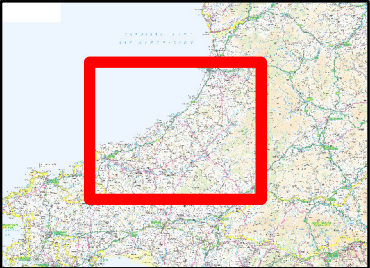


Note: The limits, including the height and depths of the Works, shown in this drawing are not to be taken as limiting the obligations of the contractor under Contract.

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OS [100019741]

Legend

- ★ WORKS BOUNDARY LOCATION
- WFD RIVER WATER BODIES CYCLE 3
- GOOD
 - MODERATE
 - POOR



SAFETY HEALTH AND ENVIRONMENT INFORMATION						
IN ADDITION TO THE HAZARDS OR RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, THE FOLLOWING SIGNIFICANT RESIDUAL RISKS SHOULD BE NOTED. FURTHER DETAILS ARE INCLUDED IN THE CDM DESIGN RISK MANAGEMENT REGISTER						
CONSTRUCTION						
NOT APPLICABLE						
MAINTENANCE / CLEARING / OPERATION						
NOT APPLICABLE						
DECOMMISSIONING / DEMOLITION						
NOT APPLICABLE						

P01	AJ	JH	EN	DH	28/06/2023	FOR INFORMATION
Rev	Drawn	Chkd	Rvwd	Apprvd	Date	Description

Designed by: **AJ** Date: JUNE 2023

Client

Client Drawing No.	Revision
--------------------	----------

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Project:

NRW NGF CARDIGAN TIDAL FRMS

Drawing title:

**WFD ASSESSMENT
WATER BODY MAP
200K EXTENT**

Drawing scale: 1:200,000	Sheet size: A3
Drawing no. 123666-BUK-ZZ-DR-EN-00055	Revision P01

Appendix C, 123666-BUK-ZZ-00-DR-EN-00053 P01

Appendix D: Contaminated Land Interpretation Report 4021883- BUK-ZZ-00-RP-GE-00001



NATURAL RESOURCES WALES CARDIGAN TIDAL FLOOD RISK MANAGEMENT SCHEME (TFRMS)

Contaminated Land Interpretation Report

Project no. 4021883

July 2025

Prepared for:

Natural Resources
Wales

(NRW)

Prepared by:

Binnies UK Limited

(BUKL)



Details of document preparation and issue:

Version no.	Prepared	Checked	Reviewed	Approved	Issue date	Issue status
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Project no.: 4021883

File name: 4021883-BUK-ZZ-00-RP-GE-00001

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APPENDICES

Appendix A:	Risk Assessment Methodology
Appendix B:	Historical Maps
Appendix C:	Drawings
Appendix D:	WYG Factual Report (2015)
Appendix E:	CJ Associates Factual Report (2022)
Appendix F:	Groundsure Report

1. Introduction

1.1 Instruction

Binnies UK Limited (BUKL) was instructed by Natural Resources Wales (NRW, "the client") to provide a Contaminated Land Interpretive Report for The Cardigan Tidal Flood Risk Management Scheme (FRMS). A contaminated land interpretation report is required to understand the geoenvironmental risks to human health and controlled waters and assess the impact of the proposed works on environmental receptors.

1.2 Site Details

The site is located in Cardigan (Aberteifi), in Ceredigion, southwest Wales. It is positioned along the right bank (northern bank) of the River Teifi (flowing east to west) between grid references SN 17783 45866 and SN 18109 45969. The scheme covers an approximate distance of 400m length of the right bank on the River Teifi, upstream of Cardigan Bridge. The nearest postcode is SA43 1EX. The site is accessed via the road named "The Strand".

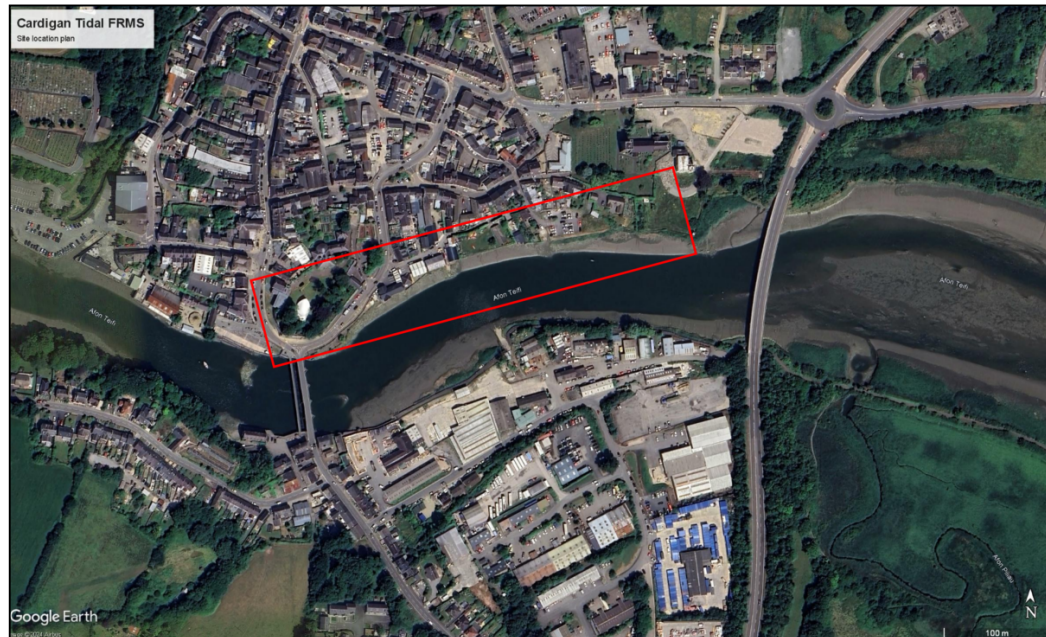


Figure 1-1 Site Location Plan

Cardigan Town Centre is located to the north of the site characterised by a mixture of residential and commercial properties. Cardigan Castle is situated to the northwest. The south side of the river is populated by industrial buildings.

1.3 Proposed works

The proposed works are currently in the outline design phase at the time of writing but comprise a flood defence wall to protect the town from flooding. It is understood that this defence will comprise sheet piled walls to a depth to be confirmed but currently anticipated to be 4m below ground level (bgl) (-0.5m Ordnance Datum, OD). An embankment to support these piles is also proposed. Drawings of the planned works have been added to Appendix C.

1.4 Scope

The aims of this report are to outline contaminated land concerns to inform detailed design and inform future survey scoping (i.e. assess whether any additional intrusive investigations are warranted). The proposed construction approach of piling and piling depths in areas where ground investigations have already taken place will be considered.

The scope of this report is based on the following objectives:

- A review of available published information / Groundsure report;
- Consult and review relevant information held by appropriate statutory authorities;
- A review of any previous site investigation reports available;
- Review the historical developments of the site and surrounding area;
- Assess the risk of ground gas generation and accumulation including radon;
- Assess the potential risks from past and present mining and quarrying activities;
- Identify the need for any additional investigations, including recommendations for ground investigation if required;
- Development of a Conceptual Site Model (pCSM), which outlines pollutant linkages; and
- Inform detailed design with respect to contamination.

These objectives have been selected following relevant guidance documents published by British Standards (BSI, 2017; BSI, 2015), the Environment Agency (EA) (Environment Agency, 2021) and the Association of Geotechnical & Geoenvironmental Specialists (AGS) as referenced throughout the report.

1.5 Limitations

This report interprets ground conditions based on the information available to Binnies at the time of writing. The nature of a natural material such as soils and bedrock are inherently variable and as such Binnies cannot be held liable should the ground conditions vary widely between exploratory locations. Furthermore, chemical contamination undergoes many transformative effects (including but not limited to chemical reaction with other substances in the environment, degradation, biological uptake, and movement with groundwater). As such, any data on chemical concentrations older than circa five years should be treated as indicative at best and not be relied upon as a true reflection of the current geoenvironmental situation. Any additional limitations and assumptions have been highlighted throughout this report.

1.6 Sources of information

The published information review has been undertaken using data contained within the Groundsure report (GS-SQR-C8M-SGX-TC2). The full ground sure report can be found in Appendix F and contains the following factual information:

- Historical OS mapping (back to 1840s);
- Past land use;
- Waste and landfill sites;
- Current and recent industrial activity;

- Hydrogeology and hydrology (including Water Framework Directive);
- Flooding (river, coastal, surface water and groundwater);
- Designations (environmental, visual, cultural, agricultural and habitats);
- Geology (British Geological Survey (BGS) mapping 10k, 50k, and borehole records);
- Natural ground subsidence (BGS GeoSure);
- Mining and ground workings;
- Ground cavities and sinkholes;
- Radon;
- Soil chemistry; and
- Railway infrastructure and projects (including Royal Mail Tunnels).

Additional sources of information obtained from the following publicly available sources:

- Topographical Maps (Ordnance Survey, 2024);
- BGS Geological Maps and Memoirs (BGS, 2024);
- Aerial and Street View Photography (Google Earth, 2024; Google, 2024);
- Records of Mines and Mineral Deposits (Mining Remediation Authority, 2024);
- Unexploded Ordnance (UXO) (Zetica, 2024);
- Additional environmental information (DEFRA, 2022); and
- Flood Records (NRW, 2024).

Existing information has also been collated from reports produced by others; the contents of which are assumed to be an accurate representation of the prevailing site conditions. The following reports have been provided and reviewed as part of this desk study:

- Ground Investigation Report by WYG Environment Planning Transport Ltd for Natural Resources Wales (WYG, 2015).
- Ground Investigation Report by CJ Associates on behalf of Binnies UK Ltd for Natural Resources Wales (CJ Associates, 2022).
- NRW NGF CARDIGAN TIDAL FRMS Ground Investigation Report and Seepage Assessment by Binnies UK Ltd for Natural Resources Wales (Binnies, 2022).

2. Published Information

2.1 Historical Developments

Published historical Ordnance Survey maps (Groundsure, 2024), aerial photography (Google Earth, 2024) and Google Street View photography (Google, 2024) have been reviewed to gain an understanding of the historical development of the site and the surrounding areas. The information reviewed dates from 1887 to the present. However, it is noted that the historical data available does have gaps and may not give a full chronology of the development of the site and surrounding areas. A summary of the pertinent information is presented in Table 2-1 below.

Table 2-1: Summary of historical developments

Date	Source (Map Scale)	On site developments	Off-site developments
1887-1889	Ordnance survey 1:10,560	The map has a low resolution however, it appears to show buildings along the north riverbank within the footprint of the site.	The town of Cardigan is well established and is heavily populated with agricultural land in the surrounding area. Cardigan Bridge is mapped to the southwest of the site, and a ferry crossing is mapped to the southeast of the site. A brickworks is labelled 500m to the north of the site.
1890	Ordnance survey 1:2,500	Confirms unlabelled buildings along the right (north) bank of the River Teifi to the west of the site. A smithy is labelled in the mid-west region within the site boundary, and another is labelled to the east of the site. A sparser area with several unlabelled buildings to the east of the site.	No major developments can be seen however the higher resolution reveals more domestic houses to the North of the river with a church and graveyard labelled to the northeast of the site. To the south of the river, more industrial land is noted with a transport terminal, iron foundry, sawmill, timber yard (all 100m to the south) and smithy (200m to the southwest) labelled.
1904	County series 1:10,560	No major developments.	Cambrian Quay is labelled to the west of the site alongside the river. 250m west (beyond the quay), a gas works is labelled. A malthouse is labelled to the North of Cardigan town (380m north of the site).
1906	County series 1906 1:2,500	No major developments. The smithy is still present on-site.	No major developments.
1938	County series 1:10,560	No major developments.	No major developments.
1948	County series 1:10,560	No major developments.	No major developments.
1962-1963	Provisional 1:10,560	No major developments.	No major developments.
1965	National Grid 1:2,500	The smithy is no longer labelled. The high water level of medium tides is marked. Tivy house is located to the east of the site.	In the northeast, Cardigan and District Hospital is labelled next to the church. Three garages are labelled approximately 100m from the site to the north.
1976	National Grid 1:2,500	No major developments.	No major developments. Minor expansion of the industrial estate to the south of the river Teifi.

Date	Source (Map Scale)	On site developments	Off-site developments
1980-1981	National Grid 1:10,000	No major developments.	The gas works to the west of the quay is no longer mapped. Continued expansion of the town to the north.
1990-1995	National Grid 1:2,500	No major developments.	Priory Bridge is now mapped to the east of the site. Significant changes to the industrial site on south of the River Teifi including numerous new buildings, a bus depot and an electrical substation (all approximately 200m south of site).
2003	Ordnance survey 1:1,250	A road is now present where the buildings to the southwest of the site were, a car park is now labelled to the northeast of the site and Priory Bridge is now mapped to the east.	No major developments.
2006	Google Earth aerial imagery	The smithy to the centre-east of the site is shown as a small grassy area with an unlabelled building	No major developments
2023	Google Earth aerial imagery	No major developments	Demolition of the Cardigan and District Hospital is underway to the northeast of the site

Historical land use provided by GroundSure has been reviewed at the site and in the surrounding area. Potentially contaminative features have been listed. Additional details have been provided for historical land use located on the north side of the River Teifi.

Table 2-2 Historical industrial land use within 300m of the site

Land Use	No. Records	Dates	Approximate distance and direction	Details
Land Use <100m of the site				
Smithy	3	1906-1948	On-site	- The historical smithy is now mapped as a residential property and land associated with a scout hut. - A historical quay located to the west of the site is now occupied by restaurants and cafes. - The historical hospital to the east of the site has recently been demolished. - The Iron foundry, railway, unspecified pit were on the far side
Quay	6	1906-1992	5 - 90m west and southwest (down gradient)	
Hospital	4	1938-1992	5-10m east (up gradient)	
Iron Foundry	3	1904-1948	65-70m southwest (cross gradient)	
Railway sidings	8	1888-1962	65-198m southeast (cross gradient)	

Land Use	No. Records	Dates	Approximate distance and direction	Details
Unspecified Pit	1	1962	90m south (cross gradient)	of the River Teifi and as such, taken to be cross gradient.
Land Use 100-300m of the site				
Railway building	9	1888-1962	100-200m south (cross gradient)	- An unspecified wharf is associated with the repurposed quay to the west of the site. - An ambulance station is still present where historical records exist. - Records relating to historical gas works, depots and tanks are located in an area now a present-day car park. - Cardigan cemetery is present where historical records indicate.
Unspecified Wharf	1	1888	125m west (down gradient)	
Unspecified Heap	1	1938	140m southeast (cross gradient)	
Ambulance Station	2	1980-1992	140m northeast (up gradient)	
Iron Foundry	1	1888	160m west (down gradient)	
Smithy	2	1888	175-225m south and southwest (cross gradient)	
Unspecified Pit	1	1980	215m southeast (cross gradient)	
Gas Works	5	1887-1904	260-290m west (down gradient)	
Unspecified Depot	2	1980-1992	260m west (down gradient)	
Cemetery	3	1888-1992	275m west (down gradient)	
Rifle Range	1	1888	270m south east (cross gradient)	
Unspecified Tank	3	1938-1992	280-300m west (down gradient)	

2.2 Environmental Database Information

Relevant environmental permits and incidents within 500m detailed within the Groundsure report are summarised below in Table 2-3.

Table 2-3: Summary of environmental database information

Data type	Entries on-site	Entries off-site	Details
Current Land Usage			
Current industrial land use	1	31	On-site: Relating to mooring and unloading facilities Off-site: Notable industries include motoring, construction, waste storage, processing and disposal, cooling and refrigeration, electrical services.
Agency and hydrological			
Licensed industrial activities	0	4	Relates to Cardigan Abattoir LTD (320m southeast, cross gradient). Current status unconfirmed, last date noted as effective is 2015.
Licensed Discharges to controlled waters	3	45	On-site: Combined Sewer Overflow (CSO) and Emergency Overflow (EO) at Cardigan Pumping Station (PS) No.2 and also Sewer Storm Overflow at Gloster RW overflow. Off-site: Mostly relates to sewage treatment works discharges with Teifi as receiving watercourse.
Pollution incidents to controlled waters, Prosecutions relating to controlled waters, Substantiated pollution incident register, Water Industry Act referrals	1	15	On-site: Incident date 01/08/2013. No further information is provided. Off-site: All incidents noted at either minor impact or no impact. Pollutants include asbestos, oils, sewage, fuel and carcasses.
Waste and Landfill			
Active or recent landfills	0	0	No records within 500m
Licensed Waste Site	0	8	All records relate to Viv Williams Skips: Material Recycling Treatment Facility (350m southeast of the site, cross gradient) Issue Date – 2010, Status: Issued/effective

Data type	Entries on-site	Entries off-site	Details
Waste exemptions	0	10	Relating to storing and treating waste for various industries such as factories, plumbing and chemists. Distance ranges from 300m to 470m
Hazardous substances			
Fuel station entries	0	2	Located 90m north (up gradient) and 340m southwest (cross gradient) of the site. Status: Obsolete

Historical tanks within 500m have been reviewed and summarised below:

Table 2-4 Historical tanks within 500m

Land Use	No. Records	Dates	Approximate distance and direction	Details
Unspecified Tanks	13	1890-1995	80-475m	- Records are associated with the historical quay (80m west, down gradient), former garage (90m north, up gradient), hospital and ambulance station (5-160m east, up gradient), the former foundry and railway (160m southwest, cross gradient) and the gasworks at a previous industrial unit (now a cemetery car park, 265-290m west, down gradient).
Tanks	5	1890-1978	85-465m	
Gas Works	5	1890-1906	265-290m	

Historical energy features within 500m have been reviewed and summarised below:

Table 2-5 Historical energy features within 500m

Land Use	No. Records	Dates	Approximate distance and direction	Details
Electricity Substation	7	1973-1997	165-405m	- The nearest historical electrical substation was located 165m northwest (up gradient) and appears derelict on current aerial imagery. - Historical gasworks records are associated with an area to the southwest (down gradient) now designated as a cemetery car park.
Gas Works	4	1890-1906	265-290m west, down gradient	

Historical garages within 500m have been reviewed and summarised below:

Table 2-6 Historical garages within 500m

Land Use	No. Records	Dates	Approximate distance and direction	Details
Garage	11	1965-1997	90-120m north (up gradient)	Three historical garage records are located on the north side of the River Teifi. One record is associated with current-day T.M. Daniel Garage. Two records are no longer mapped as garages (Groundsure report dates these as from 1960s to 1990s).

Waste management sites (including historical landfill sites, licenced waste sites, and waste exemptions) within 500m have been reviewed and summarised below:

Table 2-7 Historical landfills within 500m

Land Use	No. Records	Dates	Approximate distance and direction	Details
Landfill	1	First recorded 1910	475m to the north (up gradient)	Waste type: Inert, industrial, commercial, household. Located where the brickworks used to be.

2.3 Unexploded Ordnance

A review of publicly available unexploded ordnance (UXO) risk mapping indicates that the site is shown to be located in an area with low potential for wartime bombs to be present (Zetica, 2024). Although a rifle range previously existed within the study area, distance and proximity (270m to the south east, on the far side of the River Teifi) is such that small arms UXO are not anticipated to have adversely affected the site.

2.4 Geology

Published geology has been reviewed including England and Wales Geological Map 1:50,000 scale Sheet 193 Solid and Drift Edition (BGS, 1989) and the GeoIndex Interactive Map viewer by the British Geological Survey (BGS, 2024).

Made Ground is mapped throughout the site and it is presumed that the site is situated on reclaimed land. Superficial deposits are identified as tidal river deposits and glacial till. The permeability is expected to range from low to high. Bedrock is comprised of Mudstone belonging to the Nantmel Mudstone Formation.

Two faults are recorded 280m southeast (indicated on the geological map as the Newport Sands Fault) and 330m north of the site (indicated on the geological map as the Ogof Cadno fault). Both are listed as inferred with unknown displacement. Both dip to the south.

The Groundsure report shows Made Ground to cover the vast majority of the site extending a considerable distance into Cardigan Town. The permeability is expected to be variable with the maximum potential permeability as very high.

Further details regarding geology following site investigation are included in section 2.13.

2.5 Hydrogeology

The superficial aquifer underlying the site is classified as Secondary Undifferentiated. These are aquifers where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the soil type. These have only a minor value.

Two Secondary A aquifers are located within 200m of the site. Secondary A aquifers comprise permeable layers that can support local water supplies and may form an important source of base flow to rivers.

The bedrock aquifer is classified as Secondary B which is defined as mainly lower permeability layers that may store and yield limited amounts of groundwater through characteristics like thin cracks (called fissures) and openings or eroded layers.

Groundwater vulnerability is mapped in the Groundsure report as one kilometre grid squares. The site is located near the intersection of four of these kilometre-squares and as such, it is shown to range from low to high, with high vulnerability in both bedrock and superficial aquifers in the south east and low vulnerability in the superficial aquifer in the north. Given the site setting and history of land use, it is considered likely that the low vulnerability is more appropriate.

No abstractions are recorded within 2km of the site and the site is not located within a source protection zone (SPZ).

2.6 Hydrology

The site is located within the Teifi Water Framework Directive (WFD) operational catchment. The River Teifi runs along the southern border flowing east to west, discharging into the Irish sea approximately 3km downstream.

The Teifi currently has an overall WFD classification of 'Moderate' with a chemical rating of 'Good'. The Teifi and Coastal Ceredigion groundwater body currently has a WFD classification of 'Poor'.

There are two nearby watercourses, River Piliau confluences with the Teifi approximately 230m upstream of the site and River Mwldan confluences with the Teifi approximately 300m downstream of the site. Other smaller unnamed tributaries also discharge into the Teifi at various points upstream and downstream of the site.

The site is located within an area classified as having a high risk of river and coastal flooding which is defined as having a greater than or equal to 1 in 30 chance of flooding in any given

year. The vast majority of the site is situated in an area designated as Flood Zone 3 which is defined as land with a 1 in 100 or greater chance of flooding each year.

Some areas of the site are at risk of surface water flooding. The highest risk is a 1 in 30 year rainfall event where depths are modelled to reach between 0.1 and 0.3m. The majority of site is not classed as being vulnerable to surface water flooding.

The site is at moderate risk of groundwater flooding on the northern bank of the Teifi. The remainder of the site has a negligible risk.

2.7 Mining and Mineral Extraction

Evidence has been sought to identify any mining, quarrying, and land reclamation operations, past and present, which have taken place within the vicinity of the site.

Mining (non-coal)

The site is located in an area containing a Class B Vein Mineral where localised underground mine workings may have occurred in the past. Class B vein minerals may include base metals such as copper, lead, tin, or zinc. While these metals have historically been mined in Wales, no other evidence regarding mining exists at the site. However, a risk for unrecorded metal workings cannot be ruled out.

No other notable evidence for underground workings within 1km of the site have been identified.

Surface ground workings

Various surface ground workings have been identified close to the site. These areas involved ground excavation and may have been backfilled.

Table 2-8 Surface ground workings records within 250m

Land Use	No. Records	Dates	Approximate distance and direction	Details
Quay	6	1906-1992	5-90m south west (down gradient)	Associated with the historical quay to the west of the site
Unspecified Wharf	1	1888	125m west (down gradient)	
Unspecified Pit	2	1962-1980	90-215m south east (cross gradient)	All records are located on the south of the River Teifi where various industrial activities have existed.
Unspecified Heap	1	1938	135m south east (cross gradient)	

One record of surface mineral workings or BritPit has been identified at 331m north of the site (up gradient). The commodity has been labelled as sand. The current status of the site is "ceased".

Coal Mining

The site lies outside the Mining Remediation Authority (formerly known as Coal Authority) Consultation Area and is not located within a coalfield area. Therefore, the risks from historical coal mining activities are deemed to be very low and do not require further consideration.

2.8 Radon and Ground Gas Potential

Ground Gas

There have been no significant sources of ground gas identified on or within 500m of the site based on current and historical mapping and BGS records. There is no record of biodegradable or putrescible material deposition on site.

Organic matter is present within the superficial deposits, however, based on the proposed works (i.e. the proposed works are unlikely to create confined spaces) the risk of natural ground gas generation and adverse human health effects is very low.

Ground gas monitoring has been undertaken as part of previous ground investigations, and no significant levels of gas were recorded.

Considering the low likelihood of ground gas affecting workers and other visitors to the site the risk is considered low. Therefore, no special protective measures are required.

Radon

The site is located within an area where an estimated 10 - 30% of homes are above the Action Level (termed an 'Affected Area') of 200 Bq m⁻³ and indicates that radon protection measures are required for new buildings. In Affected Areas radon concentrations are generally low in well-ventilated workplaces such as workshops, but problems have been found in some more confined workplaces, such as offices, where rates of ventilation are relatively slow. HSE guidance suggests that where a building is in an Affected Area, the employer should take a precautionary approach and undertake measurements in all buildings located within an Affected Area. As no buildings or other habitable confined spaces are associated with the proposed development, no further action is required.

Should long term (ie permanent) site staff be required, it would be prudent to arrange monitoring of any poorly ventilated areas to determine if there is a risk to site staff.

2.9 Ground Stability

Two landslips within 250m of the site are recorded. One to the southwest and one to the northeast. Landslips are defined as mass movement deposits, primarily superficial deposits that have moved down slope under gravity.

The risk of shrink swell clays, running sands, compressible deposits, collapsible deposits and natural ground subsidence is classified as very low or negligible. The risk of landslides is low to very low.

2.10 Archaeology

Numerous listed buildings are located within 250m of the site. Many are associated with Cardigan Castle and grounds located on the western side of the site. Cardigan Bridge ~25m to the southwest of the site is also listed. The full list can be found in the Groundsure report (Groundsure, 2024).

Cardigan Town is designated as a conservation area. These are areas of special architectural or historical interest where the character and appearance of which is deemed desirable to preserve or enhance.

Four scheduled ancient monument designations are located within 250m of the site and are considered areas of national importance. Cardigan Bridge, Cardigan Castle and two designations for Cardigan Town Walls are all listed.

Cardigan Castle is a registered Park and Garden, defined as parks and gardens assessed to be of special historic importance.

2.11 Environmental Sensitivity

The River Teifi is classified as a Site of Special Scientific Interest (SSSI) defined as areas displaying the best examples of UK flora, fauna or geological or physiographical features. The designation covers the Teifi from headwaters to coast including four Teifi Estuary Woodland and Marshes areas within 2km of the site.

The site is located within a Special Area of Conservation (SAC) defined as areas best representing the range and variety within the European Union of habitats and (non-bird) species. This designation has been assigned due to a wide variety of features of interest that can be found in the Groundsure report (Groundsure, 2024).

Two areas of designated ancient woodland are located approximately 100m and 300m from the site, defined as areas that have been continuously wooded since 1600AD.

Agricultural land designations have been assessed at the site and in the local area. No such designations are present within the site boundary. The closest designation is approximately 20m to the east where a Grade 4 – poor quality agricultural land is present. A Grade 3a – Good to Moderate quality agricultural land is present on the opposite bank of the River Teifi.

2.12 Summary of Geoenvironmental Pollution Linkages and Preliminary Conceptual Site Model (pCSM)

Potential pollutant linkages have been established based on the information presented in this section. A viable pollution linkage requires three elements: a source, a pathway and a receptor. If one component is missing, there is no viable pollution linkage.

The preliminary Conceptual Site Model (CSM) incorporates evidence from the review of published information, site walkover and historical ground investigations. The creation of a CSM is a key component of the Land Contamination Risk Management (LCRM) methodology and incorporates ground conditions and possible contaminant linkages; it forms the basis for Generic Quantitative Risk Assessment (GQRA) in accordance with current guidelines.

Sources

The following potential sources of contamination have been considered:

- Extensive Made Ground on-site following land reclamation, in hydraulic continuity with the surrounding area.
- Industrial units (bathroom supply shop & old forge crafts, a former smithy) on the riverbank in the west of the site.
- Road adjacent to the west of the site.
- Industrial land use in Cardigan Town (including petrol filling stations 90-120m north of the site, hospital and ambulance station with associated tanks 5-160m east of the site, and a landfill 475m north of the site).
- River sediments potentially affected by industrial land uses (those mentioned in the bullet point above and land uses on the other side of the river, including a foundry, saw mill, and timber yard).

Receptors

Receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by sources of contamination. Receptors considered to be present at the site include:

- Human Health: Groundworkers and construction personnel and future site users. Of these, the most sensitive receptor are considered future site users.
- Controlled Waters: The River Teifi. This river is both a SSSI and SAC and as such may be considered very vulnerable.
- Controlled Waters: Underlying secondary aquifers (vulnerability is considered low). No SPZs or groundwater abstractions were noted which reinforces the limited sensitivity of groundwater at this site.

Pathways

The following potential pathways have been considered:

- Direct contact with both construction workers and site users, and incidental ingestion and inhalation of particles. Direct contact between aggressive ground and infrastructure.
- Migration of contaminants in the soil leachate.
- Vertical and lateral migration of contaminated groundwater, including along proposed sheet piles.
- Disturbing and mobilising river sediments during construction.
- Surface water run-off from the site to south, to the river and from the adjacent road and other offsite sources on to the site.

A graphical representation of the preliminary CSM is provided as Figure 2-1 Preliminary Conceptual Site Model schematic diagram.

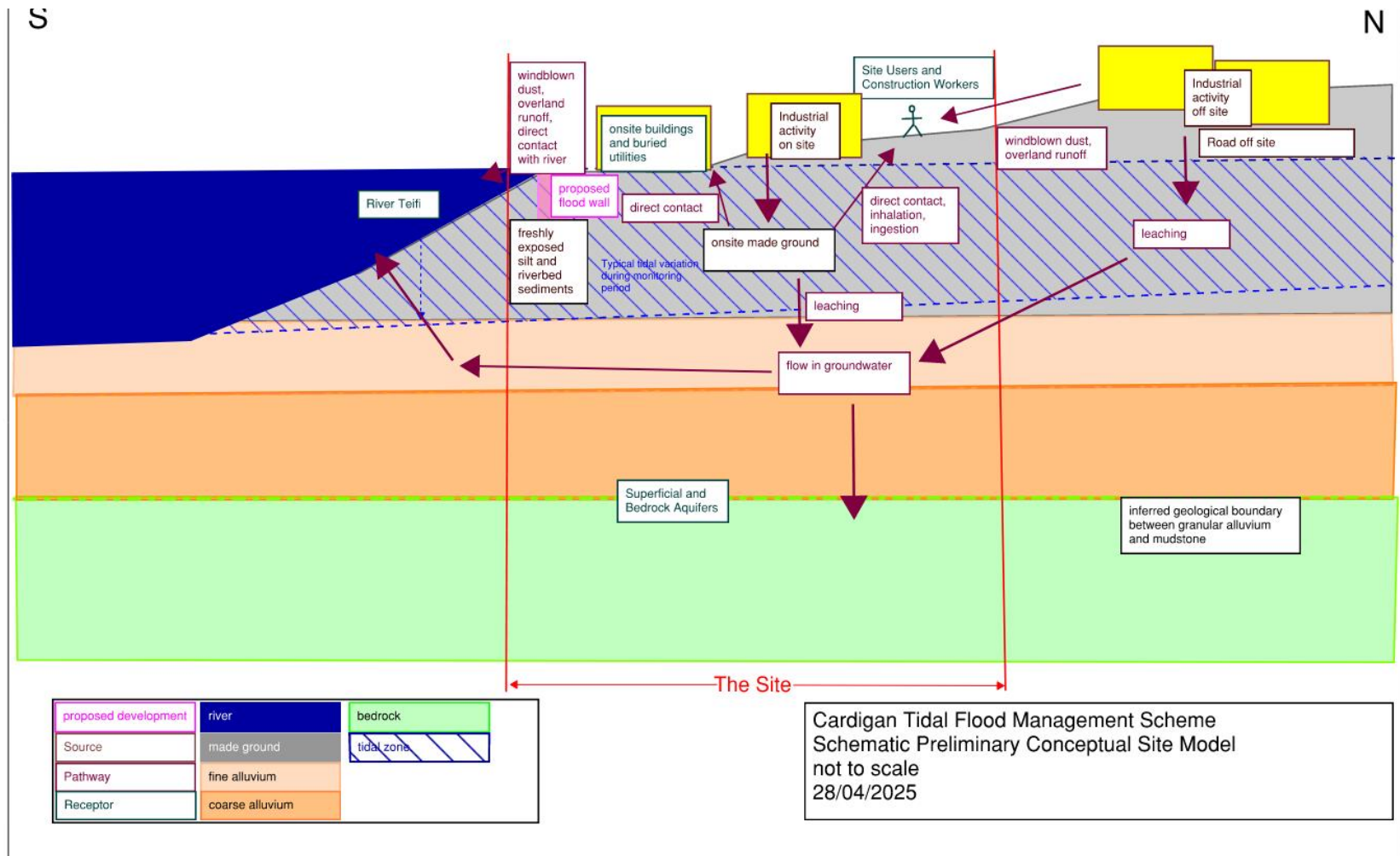


Figure 2-1 Preliminary Conceptual Site Model schematic diagram.

2.13 Previous Investigations

Two previous ground investigations have taken place in 2015 and 2021, the results of which were interpreted in Binnies, 2022, for geotechnical and hydrogeological purposes. These investigations have been summarised in this section.

A generic quantitative risk assessment (GQRA) has been carried out by screening contamination testing results gathered as part of these investigations against Generic Assessment Criteria (GAC). Considering the future use of the site, Public Open Space (park) GACs have been selected as the most appropriate for human health consideration using a conservative 1% Soil Organic Matter (SOM). For Environmental sensitivity, a qualitative approach has been adopted due to very limited data that represents current site conditions.

(a) Ground Investigation by WYG Environment Planning Transport Ltd for Natural Resources Wales (WYG, 2015)

The 2015 ground investigation consisted of 10 no. dynamic sample boreholes and 12 no. hand pits, 1 no. machine excavated trial pit and 1 no. handheld windowless sample borehole. Standpipes were installed to enable future ground gas and groundwater monitoring. Geotechnical and geoenvironmental samples were collected and underwent lab analysis.

The strata encountered consisted of topsoil, Made Ground, alluvium and Nantmel Mudstone Formation. Made Ground was found in the majority of boreholes at depths ranging from ground level to 5.3m below ground level (bgl). Olfactory evidence of contamination was encountered in one borehole (PBH7, now outside the current site boundary) at approximately 2.5m bgl, where a hydrocarbon odour was noted.

Groundwater strikes occurred in eight out of ten boreholes and three out of twelve trial pits. All strikes were within the Made Ground or alluvial deposits. Groundwater monitoring took place approximately one month after the initial ground investigation, the groundwater level in six boreholes was monitored. Groundwater was recorded between 2.11m and 2.74m bgl. Variable head permeability tests were also undertaken. Four were in the coarse grained alluvium and recorded a permeability between 8.8×10^{-6} and 4.6×10^{-5} metres per second (m/s). One was in the mudstone (at PH6 from 5.50 to 6.00mbgl) and recorded a permeability of 3.2×10^{-5} m/s.

Ground gas and groundwater monitoring took place on one occasion approximately one month after the initial ground investigation. Based on these monitoring results the Characteristic Situation has been assessed as CS1 based on guidance from CIRIA R149 and therefore the risk is very low. Only one round of monitoring may not be sufficient to gain reliable results that are representative of long term site conditions.

In total, 16 no. geoenvironmental soil samples were analysed at the lab. The analysis suite consisted of metals, PAHs, EPHs, pH, asbestos screening, asbestos quantification and BTEX. No testing of leachability of potential contamination in the soil samples was undertaken. No water samples were tested for concentrations of dissolved contaminants.

An interpretation of the lab test results and the screening exercise is summarised in

Table 2-9. No values of PAHs, or BTEX compounds exceeded the chosen GAC. Please note that contamination concentrations change over time (due to attenuation and biodegradation for

example) and as such, the values found in 2015 likely no longer represent the current situation with respect to contamination.

Table 2-9 Summary of contamination during the 2015 ground investigation

Contaminant	Recorded Min (mg/kg)	Recorded Max (mg/kg)	GAC [POS _(park)] (mg/kg)	Exceedances	Details
Hydrocarbons – gasoline range organics (GRO) (C4-C8) (C8-C12) (C4-C12)	<0.1	C4-C12: 158	Aliphatics C5-C6: 90,000 Aliphatics C6-C8: 150,000 Aliphatics C8-C10: 14,000 Aliphatics C10-C12: 21,000	None	Recorded on the south of the River Teifi where olfactory contamination in the borehole was identified by contractors. Location no longer within site boundary but may be relevant as a potential upstream source for contamination of river sediments.
Asbestos	2.116%		0.001%	PBH4@0.5-1m	Recorded on the east side of the site, east of the car park. Chrysotile cement bound debris quantified at 2.116% of material mass (fibres).

Although low concentrations of GRO were encountered in one soil sample in this study, it was below GAC for Public Open Space park and located outside the current site boundary. Due to the age of testing it is no longer considered representative of current conditions on site as the contaminant is subject to changes such as attenuation or biodegradation.

Several samples screened for asbestos detected fibres but their concentration was <0.001% and so deemed to be very low risk. The single sample recorded a Chrysotile fibre concentration of 2.116% was part of cement bound debris, and if left undisturbed is low risk. Asbestos is not considered reactive and as such, results are still considered representative unless it is recorded as having been physically removed from the site.

(b) Ground Investigation by CJ Associates on behalf of Binnies for Natural Resources Wales (CJ Associates, 2022).

The 2022 ground investigation consisted of 2 no. dynamic sample boreholes with geotechnical and geoenvironmental lab analysis conducted on soil samples. Installation of 2 no. data loggers was carried out for continuous monitoring of water levels. Geotechnical and geoenvironmental samples were collected and underwent lab analysis.

The strata encountered consisted of topsoil, Made Ground, alluvium and Nantmel Mudstone Formation. Made Ground was found in both boreholes to a maximum depth of 4.75m bgl. No olfactory contamination was noted.

No groundwater strikes were recorded during the ground investigation.

In total, 10 no. Suite E and 7 no. Suite H (Inert Waste Acceptance Criteria, WAC) geoenvironmental tests were analysed at the lab. The analysis suite consisted of metals, PAHs, TPHs, asbestos screening and asbestos quantification. These results were screened against the same GACs as the 2015 investigation. No exceedances of metals or TPHs were encountered in the 2022 investigation. No testing of leachability of potential contamination in the soil samples was undertaken (aside from WAC). No water samples were tested for concentrations of dissolved contaminants.

An interpretation of the test results is summarised in Table 2-10 and Table 2-11, below.

Table 2-10 Summary of contamination encountered during the 2022 ground investigation.

Contaminant	Min (mg/kg)	Max (mg/kg)	GAC [POS _(park)] (mg/kg)	Exceedances	Details
PAHs - Dibenzo(ah)anthracene	<0.04	1.79	1.15	BH02@0.5m	Slight exceedances above human health GAC. Located in the centre of the site where the current-day scout hut is.
PAHs - Benzo(b)fluoranthene	<0.05	15.7	13	BH02@0.5m	
Asbestos	N/A	N/A	N/A	N/A	During the 2021 investigation, possible asbestos-bound cement tiles on the foreshore of the site were identified by the investigating supervisor. These were not analysed and the tiles remain as "suspected asbestos".

Table 2-11 Summary of WAC testing (10:1 leachate extraction) exceedances during the 2022 ground investigation.

Contaminant	Min	Max	Inert Waste Landfill Limit	Exceedances	Details
Total Organic Carbon	0.57%	6.47%	3%	BH03@0.5m (3.54%) BH02@0.5m (6.47%)	WAC tests are intended to assess the potential for contaminants to leach from waste under landfill

Contaminant	Min	Max	Inert Waste Landfill Limit	Exceedances	Details
Antimony	0.01 mg/kg	0.07 mg/kg	0.06 mg/kg	BH03@3.0m	conditions, not the total contaminant levels or site-specific risks to receptors. Exceedances in WAC limits do not automatically mean that waste is hazardous or unsuitable for reuse on-site; they only indicate that it might not meet landfill-specific criteria.
Chloride	20 mg/kg	1260 mg/kg	800 mg/kg	BH02@0.5m	
PAH sum of 17	<0.08 mg/kg	104 mg/kg	100 mg/kg	BH02@0.5m	
Lead	0.01 mg/kg	2.14 mg/kg	0.5 mg/kg	BH02@0.5m	
Sulphate as SO ₄	39 mg/kg	1061 mg/kg	1000 mg/kg	BH02@4.0m	

WAC test results provide an indication of leachability although the extraction process used is specific to landfills and as such is not truly representative of the environment in situ. Nonetheless, the low values encountered in soil and WAC indicate that it is unlikely that the site is currently adversely affecting the water environment.

(c) NRW NGF CARDIGAN TIDAL FRMS Ground Investigation Report (GIR) and Seepage Assessment by Binnies UK Ltd for Natural Resources Wales (Binnies, 2022).

This assessment interpreted the geotechnical results of the two ground investigations and provided an assessment of the groundwater flow regime at the site.

The ground investigations have been interpreted to comprise a geological sequence of Made Ground, underlain by fine grained alluvium followed by a coarse alluvium. Bedrock is comprised of Mudstone belonging to the Nantmel Mudstone Formation. Fine grained alluvium was found to be predominately either clay or silt soils with some to occasional sand and gravels – and will typically behave as a low permeability material. Coarse grained alluvium comprised sands and sandy gravels with little to no fines content. Although a variable alluvial material was found (comprising a range from very sandy gravelly clay to clayey or silty sands and gravels) this was omitted from the ground model due to its inconsistent presence on site. The Nantmel formation was described as a weak to moderately strong thinly laminated Mudstone and within the study was encountered at a depth of 11m bgl in borehole BH03 and proved to a depth of 14.6m bgl.

Soil permeability was given a characteristic design value of 1×10^{-5} m/s in the Made Ground and fine grained alluvium and 5×10^{-5} m/s in the coarse alluvium. Permeability in the bedrock was not relevant to this GIR and not assessed.

Groundwater was found to be tidally influenced and unconfined.

Seepage was modelled and a design with a low permeability (1×10^{-7} m/s, typical for a sheet piled wall with unsealed clutches) extending to -0.5m OD was found to prevent water from seeping below the wall during a flooding event. Piling the foundations at this depth was also found to be sufficient from a stability point of view.

3. Geoenvironmental Hazards

The preliminary Conceptual Site Model (CSM) has been refined from the information available in the historical ground investigations to develop into a revised CSM. As discussed above, a viable pollution linkage requires all three elements (a source, a pathway and a receptor) to be present. If one component is missing, there is no viable pollution linkage.

3.1 Sources

The following potential sources of contamination have been considered:

- Extensive Made Ground on-site following land reclamation and hydraulic continuity with the surrounding area. Some concentrations of asbestos and PAHs exceed the relevant human health screening level indicating that the Made Ground is a credible source of contamination in localised areas. There may be further or more recent hot spots of localised elevated levels of contamination that could pose a risk to controlled waters but based on the concentrations encountered (no free phase contamination observed) in the most recent investigations the risk of significant pollution is likely to be low unless new sources are introduced.
- Existing contamination of sediments within the river foreshore (intertidal zone). No samples of the river sediments have recently been obtained and tested. The possibility of contamination to be present in the river sediments cannot therefore be ruled out.
- Industrial units (bathroom supply shop & old forge crafts) on the riverbank to the west of the site. Road adjacent to the west of the site. Although no evidence of contamination was found in the western portion of the site, limited access means that the possibility cannot be ruled out.
- Industrial land use in Cardigan Town, up hydraulic gradient. The localised and limited nature of contamination encountered in the ground investigation is such that, although it cannot be ruled out, it is not considered likely that the environment at the site has been significantly compromised by contamination from Cardigan Town.

Although low concentrations of GRO were encountered in one soil sample in the 2015 study, it was located outside the current site boundary and as such is not considered representative of conditions on site. This is particularly the case given the age of the sample and the potential for it to be attenuated or degraded. No other samples exceeded the GAC for human health.

3.2 Receptors

Receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by sources of contamination. Receptors considered to be present at the site include:

- Human Health: Groundworkers and construction personnel.
- Human Health: Future site users.
- Controlled Waters: The River Teifi.

- Controlled Waters: Underlying secondary aquifers.

3.3 Pathways

The following potential pathways have been considered:

Table 3-1 Pathways and their viability

Pathway	Discussion
Direct contact, incidental ingestion and inhalation of particles.	PAHs encountered typically sorbs to soil particles and adsorbs strongly to organic matter. Such matter containing the contamination has potential to come into contact with humans directly or via windblown dust. Very low volatility makes it unlikely to migrate as a vapour. Pathway to construction workers viable with no mitigation measures. Pathway to end users likely broken by the design of the flood wall and associated concrete covering up bare exposed soils.
Migration of contaminants in the soil leachate.	The elevated PAHs encountered both have very low water solubility indicating that it is unlikely to be mobilised through leaching. Limited quantities of contamination encountered in the soil limits the likelihood of high concentrations in the leachate.
Vertical and lateral migration of contaminated groundwater. Groundwater flow is towards the River Teifi (to the south). Vertical migration increased by the tidal effect on groundwater at this location.	The elevated PAHs encountered both have very low water solubility indicating that it is unlikely to be dissolved into water and become mobile through movement of groundwater or surface waters. No groundwater testing undertaken but limited quantities of contamination encountered in the soil limits the likelihood of high concentrations being dissolved in the groundwater. Sheet pile wall likely to be founded in the cohesive alluvium which is relatively impermeable and will not introduce a new pathway of significant viability.

Surface water runoff.	Pathway remains viable with the potential to carry contamination sorbed soil particles overground and into surface waters.
River Sediments disturbed during construction.	The presence of contamination has not been assessed within the river foreshore sediments which means that this pathway cannot be ruled out.

3.4 Revised Conceptual site model

The above sources, pathways and receptors have been considered as part of the Contaminated Land Risk Assessment in accordance with LCRM (2019) and a revised CSM is presented as Table 3-2, below.

The risk posed by any contaminant in soil or groundwater will depend on the nature of the hazard, the likelihood of exposure, the pathway by which exposure occurs and likely effects on the receptor. Where a contaminant linkage is identified, an assessment is undertaken to assess the likelihood that each potential linkage exists, based upon the consideration of:

- (i) The likelihood of an event (probability) – considers both the presence of the hazard and receptor and the integrity of the pathway; and
- (ii) The severity of the potential consequence – considers both the potential severity of the hazard and the sensitivity of the receptor.

The definition of risk and risk characterisations have been adopted from CIRIA 552, which is reproduced in Appendix A:

Table 3-2 Revised conceptual site model

Source	Pathway	Receptor	Severity	Probability	Risk	Assessment of risk and possible mitigation
Onsite: Made Ground present across the site Locally elevated concentrations of PAHs and asbestos encountered in Made Ground. Potential contaminants not included in assessment: Per- and polyfluoroalkyl substances (PFAS).	Direct contact, incidental ingestion and inhalation of particles.	Human Health: Groundworkers and construction personnel.	3	M	AR	Made Ground has been encountered in previous investigations across the site to depths of over 5m. Asbestos has been found in boreholes on-site and may pose a risk to workers if free fibres become airborne. Exposure to groundworkers and personnel can be mitigated through the use of appropriate personal protective equipment (PPE), damping down excavated soils to prevent fibres becoming airborne, and maintaining good personal hygiene.
		Human Health - Future site users.	3	VL	A	Elevated concentrations of some contaminants have been recorded on-site including asbestos and PAHs. The amount of footfall at the future site is not expected to be high. The level of risk is dependent on the design of flood defences, but current sheet piled wall and pavement at surface break this pathway by covering exposed soils preventing direct contact or production of dust.
	Infiltration and lateral migration of contaminants through the ground.	Controlled Waters: The River Teifi.	3	L	A	The River Teifi is in a SSSI. The site and proposed works are located on the banks of the watercourse. Permeability of Made Ground and alluvium may allow for the migration of contaminants down hydraulic gradient to the river. Limited quantities of mobile contamination encountered (small quantities of hydrocarbons and metals in recent WAC testing) limit the source. PAHs likely to sorb to soil and organics, only becoming mobile through transport of such matter by surface runoff. Proposed sheet piles are expected to be driven into cohesive material such that no new pathways are created. The relatively low permeability of the sheet pile wall may also inhibit migration of contamination into controlled waters.

Source	Pathway	Receptor	Severity	Probability	Risk	Assessment of risk and possible mitigation
	Infiltration and vertical migration of contaminants through the ground.	Controlled Waters - Underlying Secondary Aquifers.	2	L	A	The secondary superficial aquifer is potentially vulnerable due to moderate permeability in coarse grained alluvial soils. Made Ground likely to be hydraulically connected to the superficial aquifer, meaning that a pathway may already exist. Limited quantities of mobile contamination encountered (small quantities of hydrocarbons and metals in recent WAC testing) indicate that the Made Ground is likely to be a limited source of contamination. PAHs likely to sorb to soil and organics, only becoming mobile through transport of such matter. Proposed sheet piles are expected to be driven into cohesive alluvial material, which would limit vertical migration of contaminants therefore not creating a new pathway.
Onsite: Industrial units on the riverbank to the west of the site. Asbestos encountered. Some portions not fully surveyed. Potential contaminants include asbestos, heavy metals, hydrocarbons, sulphates, PFAS.	Migration of contaminants in the soil leachate leading to direct contact, incidental ingestion and inhalation of particles.	Human Health: Groundworkers and construction personnel.	3	M	AR	Small fragments of asbestos fibre containing materials have been found near the industrial units in the west of the site (TT4, at 217913E – 245934N, PBH3, at 218023.86E - 245961.22N , and PBH4, at 218056.21E - 245966.70N). Although the quantity encountered is low, disturbance of asbestos containing materials has the potential to release free fibres for inhalation, resulting in devastating health effects. There is a high quantity of Made Ground at this site; the variable nature of Made Ground is such that further asbestos and other contaminants may be present, particularly as limited site access has lead to a gap in the data set. Mitigation includes PPE and water based dust suppression.
	Infiltration and lateral migration of contaminants through the ground	Controlled Waters: The River Teifi	3	L	A	Contamination sources at the units may migrate through the site via Made Ground or granular portions of the alluvium which can have locally high permeability. The River Teifi is down hydraulic gradient of the site and could receive any contamination present. Proposed sheet piles are expected to be driven into cohesive material such that no new pathways are created. The relatively low permeability of the sheet pile wall may also inhibit migration of contamination into controlled waters.

Source	Pathway	Receptor	Severity	Probability	Risk	Assessment of risk and possible mitigation
	Infiltration and vertical migration of contaminants through the ground	Controlled Waters - Underlying Secondary Aquifers	2	L	A	Vertical migration of contaminants into the superficial and bedrock aquifers may be possible due to localised high permeability associated with the Made Ground and coarse grained alluvium. Proposed sheet piles are expected to be driven into cohesive alluvial material, which would limit vertical migration of contaminants therefore not creating a new pathway.
Onsite: Contaminated sediments within the River Teifi foreshore Potential contaminants include heavy metals, hydrocarbons, sulphates, PFAS.	Disturbance through excavation or piling	Controlled Waters: The River Teifi	3	M	AR	Contaminants from offsite sources may have washed into the River Teifi and settled in foreshore sediments within the site boundary. These may become disturbed by the construction and could migrate into the river without control measures in place (eg if contaminated silt is exposed at low tide and left to be in contact with the river at high tide). The amount of contamination within the sediment is unknown at present and testing samples from the formation level may mitigate this risk (by proving the absence of contamination). Alternatively, sediment control measures and/ or preventing water ingress into excavations may prevent a pathway forming between potentially contaminated sediments and controlled waters.
Offsite: Road adjacent to the west of the site Area near road not surveyed. Potential contaminants include hydrocarbons, heavy metals, asbestos, and volatile organic compounds (VOCs).	Surface water run-off	Human Health: Groundworkers and construction personnel	3	M	AR	Contaminants associated with vehicles and other anthropogenic activities may migrate to the site via surface water run-off and then eventually discharge to the River Teifi. The area of the site adjacent to the road has not been tested for the presence of contamination.
		Controlled Waters: The River Teifi	3	H	AR	
Offsite: Industrial land use in Cardigan Town Potential contaminants include heavy metals, hydrocarbons,	Migration of contaminants in the soil leachate and ground gas or dust leading to direct contact, incidental	Human Health - Future site users	3	L	A	The site is located down hydraulic gradient of the town of Cardigan. Contaminants have the potential to migrate laterally onto the site and could cause negative impacts on human health. The limited and localised nature of contamination encountered in previous investigations suggests that widespread contamination has not occurred. The proposed design includes a paved surface

Source	Pathway	Receptor	Severity	Probability	Risk	Assessment of risk and possible mitigation
sulphates, PFAS, asbestos, and hazardous ground gases.	ingestion and inhalation of particles.					which would break underground aspects of this pathway (windblown dust would remain a viable pathway).
	Infiltration and lateral migration of contaminants through the ground	Controlled Waters: The River Teifi	3	L	A	The site is located down hydraulic gradient of the town of Cardigan and lies between it and the River Teifi. Therefore, contaminants have the potential to migrate laterally through the site and impact the river. The limited and localised nature of contamination encountered in previous investigations suggests that widespread contamination has not occurred. Proposed sheet piles are expected to be driven into cohesive material such that no new pathways are created. The relatively low permeability of the sheet pile wall may also inhibit migration of contamination into controlled waters.

4. Conclusions

4.1 Summary

The following potential sources of contamination have been identified as part of the conceptual site model following recent ground investigations.

- Extensive Made Ground on-site following land reclamation that is in hydraulic continuity with the surrounding area. Limited and isolated concentrations of contamination are present within the Made Ground and due to their type and nature do not pose a significant risk to the site.
- Industrial / commercial units on the riverbank in the west of the site.
- Road adjacent to the west of the site.
- Industrial land use in Cardigan Town.

Previous ground investigations have undertaken geoenvironmental testing of soil samples analysing a wide range of common contaminants. Testing has identified Chrysotile asbestos present within cement bound fragments in the Made Ground. Asbestos was identified in low quantities on-site in the 2015 ground investigation and suspected asbestos was noted in 2022. The asbestos fibres have been quantified at up to 2.116% of the mass of material and so the risk remains low provided that disturbance is minimised. Asbestos Containing Material (ACM) has also been observed by site workers on both sides of the riverbed at low tide.

Elevated levels of PAHs were recorded in the 2022 ground investigation in the centre of the site at a depth of 0.5m; these were only slightly elevated with respect to a human health risk (public open space GAC).

4.2 Limitations and Data Gaps

There is an area in the west of the site adjacent to the road that has not undergone any geotechnical investigation or contamination testing. In addition, access constraints meant limited assessment could be undertaken in the centre of the site (near the Bathroom Centre). It is likely that these areas are underlain by Made Ground which may contain harmful pollutants. Previous investigations only tested for contamination in soils and did not test for leachability or presence of dissolved contamination in groundwater or surface water. Although the concentrations of contaminants encountered in the soils were relatively low, the risk to controlled waters from contaminants already dissolved has not been assessed fully.

Should it be desired to eliminate these data gaps then further targeted site investigations could be undertaken to gather soil leachate and groundwater data to inform a Generic Quantitative Risk Assessment using Environment Agency Environmental Quality Standard (EQS) water quality target guidelines for fresh water or coastal waters (whichever is most suitable). Whilst unlikely, should elevated concentrations of contaminants be encountered from additional site investigations then a further Detailed Quantitative Risk Assessment may be required using models such as Environment Agency Remedial Targets Methodology (level 1 to 4) or similar. Alternatively, if further investigation is not undertaken, appropriate mitigation strategies should be in place if potentially contaminated soils are encountered during construction.

Limited information exists regarding the presence or absence of contamination in the sediments within the River Teifi. As there is a potential to disturb these sediments during construction, it could be beneficial to understand what risk that poses to fish and invertebrates within the river. Sediment quality sampling, using Cefas action levels to identify parameters as well as those specified in the WFD, along the relevant stretch of the river (a single sample run at approximately 20m intervals) would provide reassurance about contamination in this SSSI affecting the designated receptors. This data would also inform and allow a WFD assessment to be undertaken.

4.3 Conclusions

The significant possibility of significant harm to the identified receptors has not been proven at this site and is not likely to occur as a direct result of construction of the proposed defences.

The proposed designs consist of installing sheet piles along the riverbank to a depth of up to 4m (approximately -0.5m AOD). Made Ground is currently widespread and underlain by alluvial soils. It is likely that the tidal variation of groundwater rising into the Made Ground and shallow alluvium creates an existing migration pathway to the superficial aquifer. The sheet piles, which are to be driven into predominantly cohesive alluvium, are unlikely to create a new pathway to controlled waters and may break the aforementioned pre-existing pathway. This is due to the very low permeability of the sheet piles, which may reduce the migration of contamination into the River Teifi from Made Ground sources, potentially improving the current situation. The construction of the embankment and installation of the sheet piles, however, may disturb the sediments within the River Teifi foreshore and create a new pathway between shallowly buried contamination and the river.

Concrete surfacing at the top of the defences will reduce the likelihood of human contact with existing localised PAH and asbestos contamination and prevent infiltration of new contaminants from the adjacent roadway or Cardigan Town into the ground and groundwater.

Although there is likely further asbestos fragments present in the soil, it is of limited quantities, likely cement bound, and anticipated to be waterlogged such that release of airborne fibres is unlikely. Assuming soil is not allowed to become desiccated, remaining risks posed to workers can be mitigated by appropriate PPE and good personal hygiene.

Appropriate mitigation strategies should be in place to contain and remove potentially contaminated soils if they are encountered during construction that were not identified during the previous investigation work. These should include measures to ensure the safety of construction workers, to prevent further contamination of the environment, and an appropriate testing and disposal strategy if contaminated soils are to be removed from site.

5. Recommendations

A significant possibility of significant harm has not been proven at this site and further detailed assessment is unlikely to be required. The expected permanent works are not anticipated to increase risk to the environment from the presence of contamination as no new pollution linkages are anticipated to be created by the works. The low permeability sheet piles and hard surfacing will likely act to break existing pollution linkages, thereby improving the present situation.

Data gaps do exist as described in section 4.2 above, particularly from lack of investigation data in the west of the site and in the sediment on the river foreshore, but also from no leachability testing in soils or testing for the presence of contamination in groundwater. However, it is not anticipated that concentrations of potential pollutants in groundwater will be significant on site given the limited concentrations encountered in the soils.

There is the potential for a new pollutant linkage to be created during construction due to disturbance of sediments in the river foreshore that may contain pollutants. It is therefore recommended that a series of hand-dug trial pits or hand auguring exercise be undertaken during low tide to obtain samples to determine the presence or absence of contamination at the proposed formation level of the new embankment. These samples should be analysed against Cefas action levels to identify parameters as well as those specified in the WFD. A single line of samples spaced at approximately 50m centres along the length of the scheme would provide sufficient number and spatial coverage for contaminant testing to enable robust data analysis. Wider spacing of samples or analysis would still provide an indication of contamination in the river sediments and inform the level of contamination that may be encountered during construction.

The following general mitigation measures should be undertaken to protect controlled waters and construction workers during construction:

- If trenches are to be excavated in Made Ground to install the sheet piled walls they should be backfilled with clean fill;
- Formal monitoring of Made Ground and natural soils, and groundwater for potential contamination. Monitoring should include the use of a photo-ionisation detector (PIDs) for volatile organic compounds / petroleum hydrocarbons, and formal sampling of soils and groundwater should indications of contamination be observed;
- Any visual or olfactory evidence of contamination encountered during construction works should be further investigated to determine spatial extents and concentrations (it is possible that works will need to be stopped during this investigation into unexpected contamination);
- Standard practices for protecting the water environment should be adhered to (e.g. bunded fuel storage, use of plant nappies, suitable spill kits with trained personnel, silt fencing);
- Risks posed to workers from contamination in the partially saturated soil and water can be mitigated by appropriate PPE and good personal hygiene. Where desiccated soils are disturbed during construction such that dust could be created, then mitigation to control dust (e.g. damping down soils) should be in place; and

- Appropriate PPE should be used at all times.

Appropriate management strategies should be in place to deal with potentially contaminated soils if they are encountered during construction. These should include measures to ensure the safety of construction workers, to prevent further contamination of the environment, and an appropriate storage, testing and disposal strategy if contaminated soils are to be removed from site.

It is advised that the above should be included in the Construction Environmental Management Plan (CEMP) for the project.

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APPENDICES

Appendix A: Risk Assessment Methodology

The criteria used for risk assessment are based on C552 (CIRIA, 2001) guidance. The severity and probability is classified according to the criteria in Table B1 and Table B2. The overall evaluation of the level of risk is shown in Table B3 and recommended associated actions shown in Table B4.

Table B1: Likelihood/probability of the risk occurring

Code	Meaning	Geoenvironmental Risks (CIRIA C552)
VL	Improbable/Negligible	Contaminant linkage may be present but the circumstances under which harm would occur are improbable
L	Remote/Low likelihood	Contaminant linkage may be present, and there is a possibility of the risk occurring although there is no certainty that it will do so.
M	Occasional/Medium likelihood	Contaminant linkage may be present, and it is probable that the risk will occur over the long term
H	Probable/Reasonably foreseeable	
VH	Frequent/High likelihood	Contaminant linkage may be present, and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor.

Table B2: Severity/consequence of risk

Code	Meaning	Geoenvironmental Risks (CIRIA C552)
1	Negligible	Damage to non-sensitive ecosystems or species Minor damage to buildings or structures No harm or pollution of water
2	Marginal	No significant harm to human health in either short or long term No pollution of sensitive controlled waters, no more than slight pollution of non-sensitive waters Significant damage to buildings or structures Requirements for protective equipment during site works to mitigate health effects
3	Serious	Harm to human health from long-term exposure
4	Critical	Slight pollution of sensitive controlled waters (surface waters or aquifers) or pollution of other water bodies Significant effects on sensitive ecosystems or species
5	Catastrophic	Acute risks to human health Catastrophic damage to buildings/property (e.g. by explosion) Direct pollution of sensitive water receptors or serious pollution of other controlled water (watercourses or groundwater) bodies.

Table B3: Assessed Risk

SEVERITY LIKELIHOOD		Negligible	Marginal	Serious	Critical	Catastrophic
		1	2	3	4	5
Improbable/Negligible	VL	N	N	A	A	A
Remote/Low likelihood	L	N	A	A	AR	AR
Occasional/Medium likelihood	M	A	A	AR	AR	UA
Probable/Reasonably foreseeable	H	A	AR	AR	UA	UA
Frequent/High likelihood	VH	A	AR	UA	UA	UA

Table B4: Risk Response

Code	Meaning	Response needed
UA	Unacceptable	Action essential. Remediation, mitigation or site investigation required.
AR	Action required	Action required if reasonably practicable. Site investigation required.
A	Acceptable	Risk to be managed.
N	Negligible	No action required.

Appendix B: Historical Maps

[GS-JOR-8I3-GJM-GE4_smallScale.pdf](#)

[GS-JOR-8I3-GJM-GE4_Landline_indexMap.pdf](#)

[GS-JOR-8I3-GJM-GE4_Landline_2_1_largeScale.pdf](#)

[GS-JOR-8I3-GJM-GE4_Landline_1_1_largeScale.pdf](#)

[GS-JOR-8I3-GJM-GE4_2500_largeScale.pdf](#)

Appendix C: Drawings

[4021883-BUK-ZZ-00-DR-GE-00001](#)

[4021883-BUK-ZZ-00-DR-GE-00002](#)

[4021883-BUK-ZZ-00-DR-GE-00003](#)

[4021883-BUK-ZZ-00-DR-GE-00004](#)

[4021883-BUK-ZZ-00-DR-GE-00005](#)

[4021883-BUK-ZZ-00-DR-GE-00006](#)

Appendix D: WYG Factual Report (2015)

[A088137 - Cardigan FAS factual GI Report April 15 DRAFT.pdf](#)

[A088137 2 \(Proposed Site Investigation Layout Plan 1\).pdf](#)

Appendix E: CJ Associates Factual Report (2022)

[2071916 Cardigan Flood Risk Management Factual Report v2.pdf](#)

Appendix F: Groundsure Report

[GS-SQR-C8M-SGX-TC2.pdf](#)

Appendix E: IAQM Dust Management Mitigation Measures

Mitigation: Communications

- Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.
- Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.
- Display the head or regional office contact information.
- Develop and implement a Dust Management Plan (DMP)

Site management

- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
- Make the complaints log available to the local authority when asked.
- Record any exceptional incidents that cause dust and/or air emissions, either on- or off-site, and the action taken to resolve the situation in the logbook.

Monitoring

- Undertake regular on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary, with cleaning to be provided if necessary.
- Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked.
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.
- Agree need for dust deposition, dust flux, or real-time PM10 continuous monitoring locations with the Local Authority. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences. Further guidance is provided by IAQM on monitoring during demolition, earthworks and construction.

Preparing and maintaining the site

- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
- Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.
- Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.
- Avoid site runoff of water or mud.
- Keep site fencing, barriers and scaffolding clean using wet methods.
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover to prevent dispersion.
- Cover, seed or fence stockpiles to prevent wind whipping.

Operating vehicle/machinery and sustainable travel

- Ensure all vehicles switch off engines when stationary - no idling vehicles.
- Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment where practicable.
- Impose and signpost a maximum-speed-limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable

additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).

- Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.
- Implement a Travel Plan that supports and encourages sustainable travel.

Operations

- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes and conveyors and covered skips.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.

Mitigation: Measures specific to demolition

- Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).
- Ensure effective water suppression is used during demolition operations. Handheld sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.
- Bag and remove any biological debris or damp down such material before demolition.

Mitigation: Measures specific to earthworks

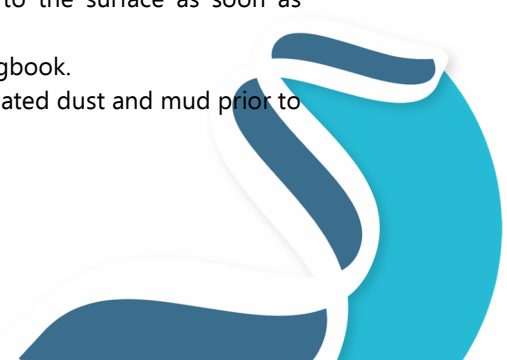
- Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.
- Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
- Only remove the cover in small areas during work and not all at once.

Mitigation: Measures specific to construction

- Avoid scabbling (roughening of concrete surfaces) where possible.
- Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
- Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
- For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust.

Mitigation: Measures specific to track-out

- Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site.
- Avoid dry sweeping of large areas.
- Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
- Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
- Record all inspections of haul routes and any subsequent action in a site logbook.
- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).

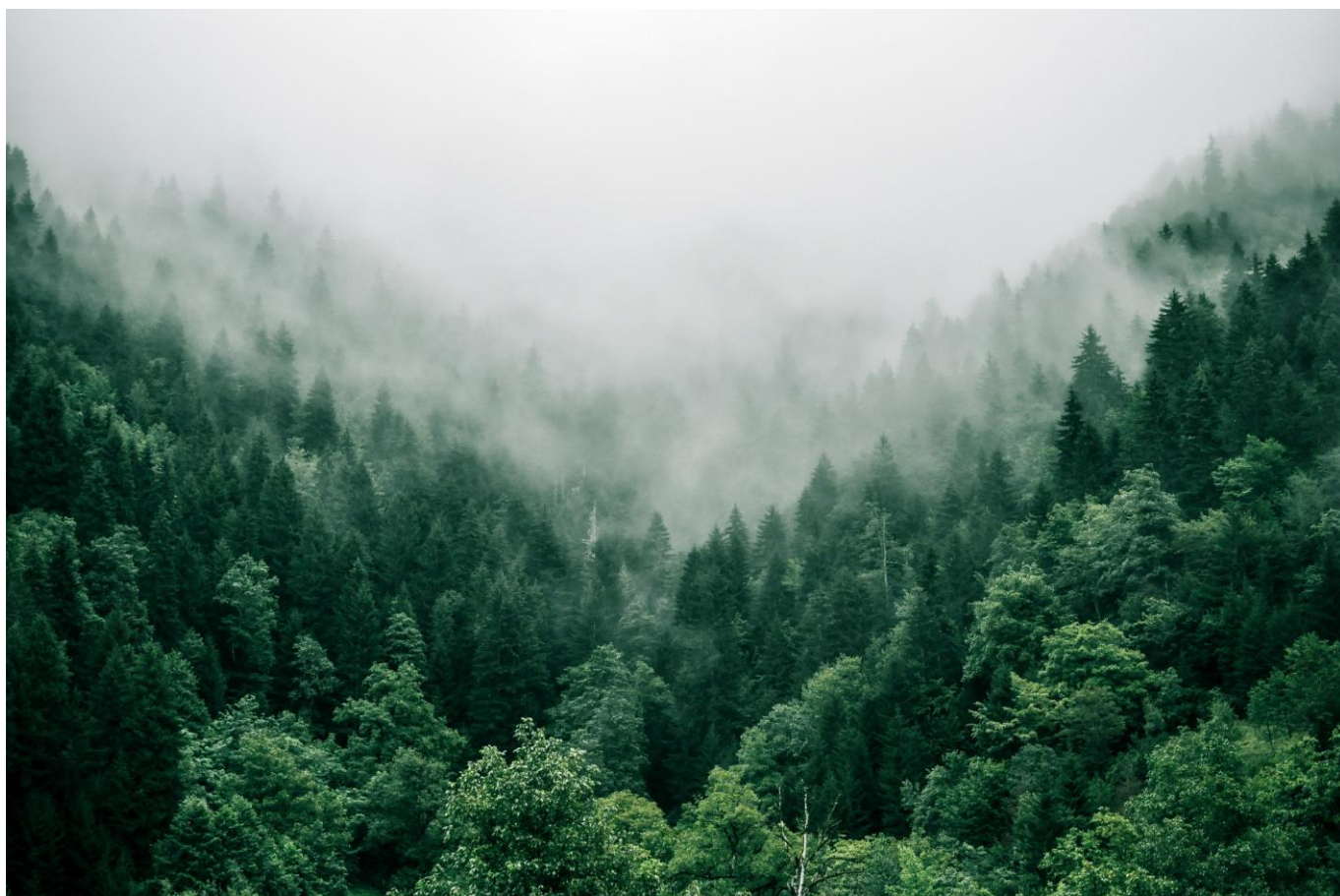


- Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.
- Access gates to be located at least 10 m from receptors where possible.



Appendix F: Outline Climate Change Adaptation Report 3040565-2(R02) Cardigan Tidal FRMS Outline Climate Change Adaption Report.pdf





Cardigan Tidal FRMS - Outline Climate Change Adaption Report

3040565-2(R02)

JUNE 2025

NATURE POSITIVE GENERAL NOTES

Project No.: 3040565-2(R02)

Title: Cardigan Tidal FRMS Outline Climate Change Adaption Report

Date: 30th June 2025

Status: Final

**Initial Technical
Note Author**

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1 INTRODUCTION AND METHODOLOGY

This Technical Note has been compiled to assess climate considerations to inform the design the Cardigan Tidal FRMS.

Future climate has been assessed using UK Climate Projection (UKCP18) probabilistic (25km) projections which provide conditional probability density functions to express the relative strength of the evidence from models and observations which support future climate outcomes (scenarios). The probability distributions provide information on ranges of outcomes and the relative likelihood of alternative outcomes within these ranges. For this assessment the 50th percentile (as per Department of Infrastructure guidance) was used; values were extracted also for the 10th and 90th percentile to give an indication of probability distribution.

UKCP18 uses emissions scenarios based on those used in the Intergovernmental Panel on Climate Change's (IPCC) assessment report (AR5). These Representative Concentration Pathways (RCPs) specify GHG concentrations that would result in target amounts of radiative forcing at the top of the atmosphere by 2100, relative to pre-industrial levels. Four RCPs are used in UKCP18: RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5 (the numbers denote radiative forcing levels in W/m^2). As a conservative approach and aligned with industry practice (e.g. Environment Agency requirements for Climate Change Risk Assessments¹), this assessment considers the potential climate variables at RCP 8.5, which is the worst-case, high-emissions, climate scenario. This scenario has been considered in relation to the proposed scheme lifespan, to include projections up to 2100.

An initial technical note, comprising Sections 2.1 and 2.2 of this final technical note, was circulated to key stakeholders in the design team for the Cardigan Tidal FRMS. The impact of climate change and any possible climate change resilience measures were then discussed with these stakeholders in a workshop held virtually on 15th May 2025. A summary of this workshop and the discussion points are summarised in Section **Error! Reference source not found.** This resulting Outline Climate Change Adaptation Report is a representation of the climate change considerations as of May 2025, a time where design freeze is at approximately 30%. This Outline Climate Change Adaptation Report will not be subject to further updates and represents a point in time, the Design Report produced at the end of detailed design will summarise the outcome of each of the recommendations.

¹ Environment Agency (2023) Climate change: risk assessment and adaptation planning in your management system. Accessed online: <https://www.gov.uk/guidance/climate-change-risk-assessment-and-adaptation-planning-in-your-management-system#complete-your-risk-assessment>

2 CLIMATE CHANGE

The UK has a temperate oceanic climate, being on the western boundary of Europe, adjacent to the Atlantic Ocean. This climate generally features cool summers and mild, wet winters, with a relatively narrow annual temperature range (Peel et al, 2007). Prevailing south-westerly winds bring warm and moist air, influenced by the Atlantic Meridional Overturning Circulation (AMOC), resulting in a milder climate than maritime areas at similar latitudes elsewhere in the world. However, being located close to the path of the polar jet stream, frequent changes in pressure and weather are typical in a single day.

The nearest weather station to Cardigan is in Aberporth, 5 miles away. It recorded information relating to temperature and precipitation for thirty-year periods between 1971 and 2020, as shown in Table 1.

The climate in Aberporth has been slowly changing over the most recent decades. Temperature has increased across the decades studied, with an increase of 0.5°C from the average annual maximum temperatures of 1971 – 2000 to those in 1991 – 2020. The maximum temperature of the warmest and minimum temperature of the coldest days have increased, alongside an increase in total annual rainfall. The driest month has typically been in Spring, and the wettest month in Autumn; both the wettest and the driest months have seen increases in rainfall.

Table 1: Climate change in Aberporth since 1971

Climate Change Variable	1971 – 2000	1981 – 2010	1991 – 2020
Average Annual Maximum Temperature (°C)	12.3	12.5	12.8
Warmest Month (Max Temperature (°C))	August (18.1)	August (18.2)	July (18.3)
Coldest Month (Min Temperature (°C))	February (2.6)	February (2.7)	February (3.3)
Total Annual Rainfall (mm)	870	888	927
Driest Month (mm)	May (48)	April (53)	April (54)
Wettest Month (mm)	October (104)	October (112)	November (117)

2.1 Future climate change

Future climate change across the UK is expected to comprise warmer, wetter winters and hotter, drier summers, with more frequent and intense weather extremes.

There is high confidence under all climate scenarios that mean and extreme temperatures across Europe will increase (IPCC, AR6, 2022²). Hot spells across the UK are expected to become more frequent and intense, and with longer duration.

Under the worst-case emissions scenario, Table 2 shows that maximum summer **temperatures** in the Cardigan area could rise by approximately 0.9°C in the near term (2020 – 2039), up to approximately 2.3°C in the medium term (2040 – 2059), and 4.8 °C in the long term (2080 – 2099). Similarly, minimum winter temperatures will increase by approximately 0.8°C in the near term (2020 – 2039), up to approximately 2.0°C in the medium term (2040 – 2059), and 3.4°C in the long term (2080 – 2099). Extreme heat events, detailed in Table 3, are also predicted to increase in terms of maximum temperatures, possibly reaching up to 38.0 °C by 2100.

Table 2 and Table 3 also reflect potential changes in **precipitation**. Table 2 details decreases of spring precipitation by up to -37% by 2100, and increases of autumn precipitation by up to 28% by 2100. Table 3 predicts increases in autumn extreme precipitation events.

Table 2: Projected change in temperature precipitation rate in the Cardigan area, showing the 50th, 10th and 90th percentile. (UKCP18)

Climate Variable	Time Horizon (relative to 1981 – 2000)		
	2020 – 2039	2050 – 2069	2080 – 2099
Maximum summer air temperature anomaly at 1.5m (°C)	+0.90	+2.34	+4.91
	(-0.13 to +1.94)	(+0.43 to +4.31)	(+1.64 to +8.15)
Minimum winter air temperature anomaly at 1.5m (°C)	+0.77	+1.98	+3.36
	(-0.04 to +1.65)	(+0.55 to +3.52)	(+1.20 to +5.75)
Spring precipitation rate anomaly (%)	-7.19	-22.83	-37.06
	(-26.43 to 11.80)	(-46.98 to +2.59)	(-63.44 to -3.98)
Autumn precipitation rate anomaly (%)	+5.68	+12.90	+27.52
	(-6.32 to +19.14)	(-5.31 to +33.65)	(+1.54 to +58.57)

² <https://www.ipcc.ch/report/ar6/wg2/>

Table 3: Projected extreme summer temperatures and winter precipitation rates in Cardigan 25km grid cell. showing the 50th, 10th and 90th percentile. (UKCP18)

Climate Variable	Time Horizon (relative to 1981 – 2000)		
	2020 – 2039	2050 – 2069	2080 – 2099
Extreme (1 in 100 year) maximum summer air temperature at 1.5m (°C)	33.31	35.17	37.98
	(31.61 to 35.34)	(32.02 to 38.85)	(32.41 to 43.64)
Extreme (1 in 100 year) 1-day total precipitation in autumn (mm)	67.78	70.86	74.94
	(57.15 to 82.05)	(59.13 to 86.75)	(61.31 to 93.49)
Extreme (1 in 100 year) 5-day total precipitation in autumn (mm)	129.10	132.55	137.21
	(118.66 to 141.33)	(119.89 to 149.39)	(119.75 to 161.60)

Whilst model outputs vary on likely changes **wind** speed, The UK Climate Projections 2018 (UKCP18) suggest that Wales will face more intense **storms**, with higher wind speeds and heavier rainfall, particularly during autumn and winter months. This is attributed to a warmer atmosphere holding more moisture, leading to more severe precipitation events. The combination of heavier rainfall and sea level rise is expected to lead to more frequent and severe flooding events, impacting infrastructure, agriculture, and communities across Wales. In addition, coastal areas are particularly vulnerable to coastal flooding and erosion due to rising sea levels and intensified storm activity³.

Sea level is projected to rise across the UK. Figure 1 represents the sea level rise projections 2020 – 2140 in the Cardigan tidal gauge area at emissions scenario SSP5-8.5. Each arrow represents the predicted sea level rise at the 50th percentile, for each decade. The 50th percentile average suggests in 2040 the sea level will rise 0.18 m from the baseline, 0.33 m in 2060, 0.52 m in 2080, and 0.77 m in 2100.

³ Welsh Gov (2022) Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales. Accessed online: https://www.gov.wales/sites/default/files/publications/2022-11/guidance-for-flood-and-coastal-erosion-risk-management-authorities-in-wales_0.pdf?utm_source=chatgpt.com

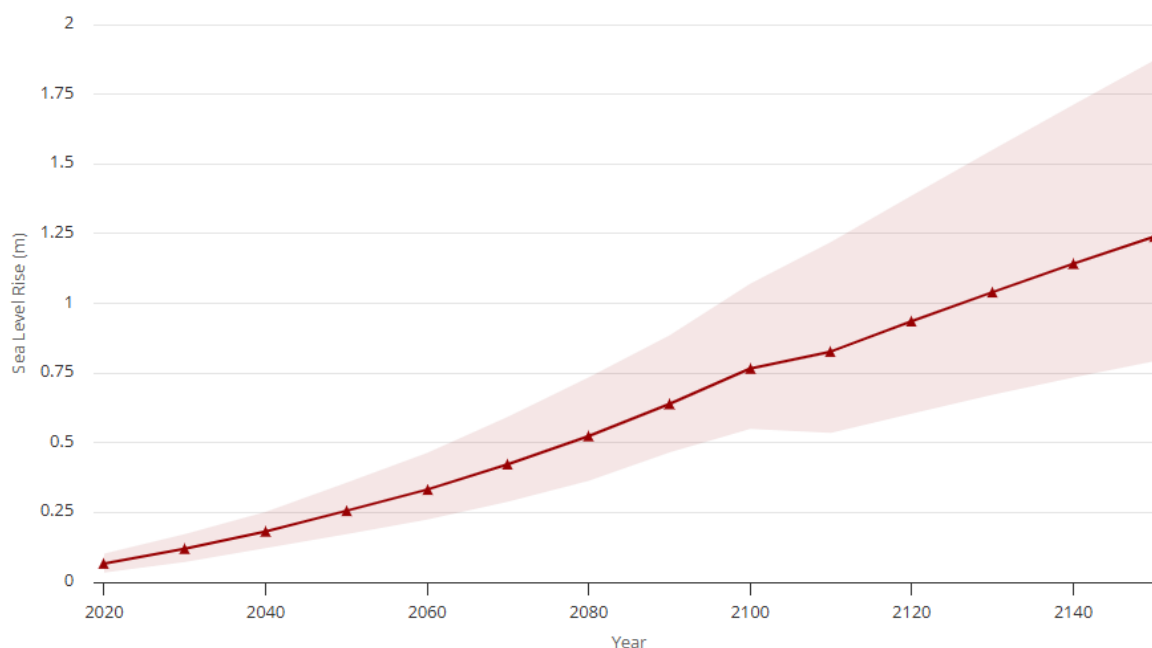


Figure 1: Projected Sea Level Change for emissions scenario SSP5-8.5; Fishguard Tide Gauge, Relative to 2005 (1995 – 2015) 2021 IPCC 6th Assessment Report (extracted from World Bank, 2025)*

*The shaded area represents 17th-83rd percentiles

For Ceredigion in particular, the UKCP **sea level** projections suggest a worst-case 95th percentile rise of 1.42 m by 2120 (Table 4).

Table 4: UKCP18 projections of mean sea level rise, relative to a baseline of 1981-2000. Data from Welsh Gov (2022).

Local Authority Area	Allowance (percentile)	Mean sea level rise (meters)	
		2100	2120
Ceredigion	70 th	0.8	1.04
	95 th	1.07	1.42

In summary, the scheme will need to be designed to be resilient to the following climate variables, as detailed in Table 5.

Table 5: Summary of climate variables in a RCP 8.5 scenario to 2100

Variable	Expected value / change
Average maximum summer air temperature	~23°C
Extreme (1 in 100 year) maximum summer air temperature	~38°C
Decrease in precipitation during dry months	Decrease of ~37%
Increase in precipitation during wet months	Increase of ~28%
Extreme (1 in 100 year) 5-day total precipitation in wet months	137 mm
Sea level rise (projection until 2120)	Up to 1.42 m
Winds and storm	No long-term trend in wind speed can be determined with confidence. However, increase in extreme climate events are likely to increase the magnitude and likelihood of storm events, including storm surges.

2.2 Climate change resilience measures

The following measures may not all be feasible for this project, but are suggested at this initial stage to be discussed with the design team.

Material specifications

- In the initial design phase, consider use of materials and equipment with superior qualities with regards to extreme or variable operating conditions. Cross check equipment and material specifications with maximum projected temperatures (up to ~38°C).
 - Use higher-grade steel, advanced coatings and protection systems, especially with projected warmer, wetter winters accelerating corrosion rates.
 - Factor in more frequent freeze-thaw cycles and thermal stresses from hotter summers into fatigue analysis and joint design.

Foundations

- Consider changes in soil moisture regimes (drier summers causing shrink-swell of clays, wetter winters leading to higher pore pressures). Design embedment depth and anchorage accordingly.
- Implement scour-resistant designs to combat increased flow velocities and turbulence from extreme rainfall and storm surges.

Design

- Ensure design accounts for higher water levels, including increase in precipitation of ~28% in wetter months, 137 mm total precipitation over 5 days and a sea-level rise of up to 1.42 m.
- Build in capacity for future upgrades or additional loading. Design barriers that can be raised or reinforced later if sea levels rise faster than anticipated.
- Consider combining sheet-pile barriers with nature-based solutions like salt marshes, mudflats, and managed realignment to dissipate wave energy and reduce loading on hard infrastructure.

Monitoring

- Integrate sensors for structural health monitoring (strain gauges, corrosion sensors, pore pressure monitors) to detect early signs of degradation.
- Establish robust, climate-adaptive inspection and maintenance regimes to address accelerated wear and tear.

3 CONCLUSIONS

The climate change resilience measures proposed in Section 2.2 were discussed in an online workshop on 15th May 2025 with key stakeholders in the design team for the Cardigan Tidal FRMS. The key points regarding the feasibility of these measures are detailed in Table 6, alongside with the next steps that were identified.

Table 6: The feasibility of recommended resilience measures

Recommendation	Feasibility and next steps
Material specifications	
Use of materials and equipment with superior qualities with regards to extreme or variable operating conditions. Cross check equipment and material specifications with maximum projected temperatures (up to ~38°C).	Materials specifications are yet to be developed, heat tolerance will be considered as part of the development of these specifications. An update will be provided in the Design Report on these points.
Foundations	
Consider changes in soil moisture regimes (drier summers causing shrink-swell of clays, wetter winters leading to higher pore pressures). Design embedment depth and anchorage accordingly.	The effects of changing soil moisture regimes have been considered in the development of the design, and will continue to be developed. An update will be provided in the Design Report on these points.
Implement scour-resistant designs to combat increased flow velocities and turbulence from extreme rainfall and storm surges.	Potential for scour has been and will be further considered in the design, including consideration of extreme flows. An update will be provided in the Design Report on those points.

Recommendation	Feasibility and next steps
Design	
Ensure design accounts for higher water levels, including increase in precipitation of ~28% in wetter months, 137 mm total precipitation over 5 days and a sea-level rise of up to 1.42 m	Flood modelling has, and will, account for the effects of climate changes (refer to the Hydraulic Modelling Report 123666-BUK-ZZ-00-RP-HY-00003 and the Flood Consequences Report which is yet to be written). Design of surface water drainage will take into account the potential for climate change, and an update will be provided in the Design Report.
Build in capacity for future upgrades. Design flood defences that can be raised or reinforced later if sea levels rise faster than anticipated.	The design of the flood defence is currently to 1 in 200 years with 100yr of climate change which is considered to be a conservative level of flood defence. Therefore, the capacity for future upgrades is not considered necessary taking into account the lifespan of the Scheme.
Build in capacity for additional loading (of defence and any additional features such as bus shelters or signage) to account for more frequent and/or extreme high winds	The effects of wind loading have been and will be considered further as the design progresses, an update will be provided in the Design report.
Consider combining sheet-pile barriers with nature-based solutions like salt marshes, mudflats, and managed realignment to dissipate wave energy and reduce loading on hard infrastructure.	Where possible, nature-based solutions are being integrated into the design of the Scheme. An update will be provided in the Design Report.
<i>[Additional measure discussed in workshop, not outlined in Section 2.2]</i> Ensure resilient landscaping (particularly those plants that are drought tolerant) that can provide shade to help mitigate against high temperatures and also allow for natural flood management.	Planting plans will specify resilient planting.

Recommendation	Feasibility and next steps
Monitoring	
Integrate sensors for structural health monitoring (strain gauges, corrosion sensors, pore pressure monitors) to detect early signs of degradation.	Integrated sensors are not feasible for the scheme (due to differing lifespan of sensors to the Scheme as a whole), however monitoring regimes and regular maintenance will be specified for the Scheme.
Establish robust, climate-adaptive inspection and maintenance regimes to address accelerated wear and tear.	A monitoring and maintenance regime will be specified for the scheme. This will include factors which could be exacerbated by climate change

REFERENCES

Environment Agency (2023) Climate change: risk assessment and adaptation planning in your management system. Accessed online: <https://www.gov.uk/guidance/climate-change-risk-assessment-and-adaptation-planning-in-your-management-system#complete-your-risk-assessment>

Met Office (2018) UK Climate Projections 2018. Accessed online: <https://www.metoffice.gov.uk/research/approach/collaboration/ukcp>

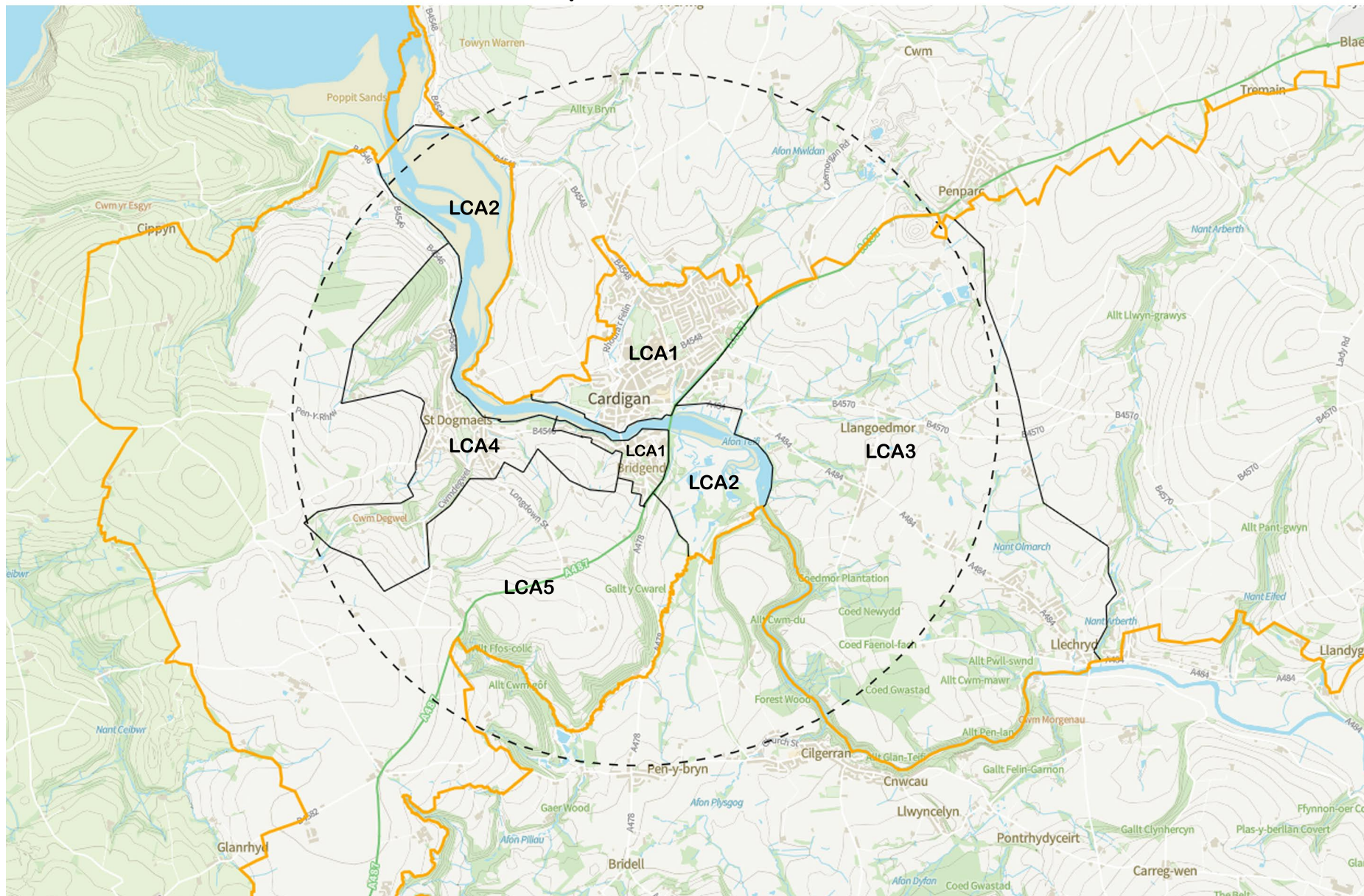
Welsh Gov (2022) Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales. Accessed online: https://www.gov.wales/sites/default/files/publications/2022-11/guidance-for-flood-and-coastal-erosion-risk-management-authorities-in-wales_0.pdf?utm_source=chatgpt.com

World Bank (2025) Climate Change Knowledge Portal. Accessed online: <https://climateknowledgeportal.worldbank.org/>

Appendix G: Landscape Character Areas 4021883-BUK-ZZ-00-SK-L-00005



Landscape Character Areas



20/01/2025

 LVIA Study Area

FloodDefWall Line LVIA3KM

 3km Buffer

SKETCH



Purpose :

This sketch is an informal tool for communicating and collaborating on projects. It shall not be considered as a project output, part of a project output or as satisfying a contractual requirement. All details are indicative and subject to further design and collaboration.

Originator : Heather Goodrick

Sketch Name : 4021883-BUK-ZZ-00-SK-L-00005

Date : 20/21/2025

Esri, Intermap, NASA, NGA, USGS, Esri UK, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS

Appendix H: LVIA Methodology 4021883-BUK-ZZ-00-RP-L-00002



Appendix XX: LVIA Methodology

Introduction

1. *"Landscape and Visual Impact Assessment is a tool used to identify and assess the significance of and the effects of change resulting from development on both the landscape as an environmental resource in its own right and people's views and visual amenity."* (Guidelines for Landscape and Visual Assessment (Third Edition) (GLVIA3), paragraph 1.1). Wherever possible, identified effects are quantified, but the nature of landscape and visual assessment requires interpretation using professional judgement. In order to provide a level of consistency to the assessment, the prediction of magnitude and assessment of significance of the residual landscape and visual effects have been based on pre-defined criteria.
2. The Guidelines for Landscape and Visual Assessment (Third Edition) (GLVIA3) states that *"professional judgement is a very important part of the LVIA"* (paragraph 2.23) and that *"in all cases there is a need for the judgements that are made to be reasonable and based on clear and transparent methods so that the reasoning applied at different stages can be traced and examined by others."* (paragraph 2.24). It continues at paragraph 3.32 to state that "there are no hard and fast rules about what effects should be deemed 'significant' but LVIAs should always distinguish clearly between what are considered to be the significant and non-significant effects."
3. Landscape and Visual Assessments are separate, though linked processes which GLVIA3 notes are *"related but very different considerations"*. The assessment of the potential effect on the landscape is carried out as an effect on the environmental resource (i.e. the landscape). Visual effects are assessed as an inter-related effect on people.
4. Landscape effects derive from changes in the physical landscape elements which may give rise to changes in its distinctive character and how this is experienced, including consideration of aesthetic and perceptual aspects.
5. Visual effects relate to changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes and to the overall effects with respect to visual amenity.

Establishing the Study Area

6. The study area for landscape character has been established using NRW guidance note 46 (GN46): Using LANDMAP in Landscape and Visual Impact Assessments (NRW, updated March 2023). A list of potentially relevant aspect areas from all five LANDMAP aspects was made using the filtering exercise described in GN46. The exercise was carried out with the assistance of a Zone of Theoretical Visibility (ZTV) plan (see drawing 4021883-BUK-ZZ-00-DR-L-00003), whereby aspect areas which overlap with the ZTV and, in some cases, have high or outstanding evaluations in LANDMAP (as per GN46), were filtered in. The boundary of the study area is made up from all the LANDMAP aspect areas filtered in through the filtering exercise and is shown on drawing 4021883-BUK-ZZ-00-SK-L-00004.
7. LANDMAP is a tool describing the Welsh landscape baseline, aimed at helping decision making and natural resource planning. LANDMAP is not a character assessment itself but is a collection of five aspect area datasets which describe the characteristics of the landscape at a local level, evaluate their importance and recommend locally appropriate management guidelines. The five aspects are: geological landscape; landscape habitats; visual and sensory; historic landscape; and cultural heritage.

8. The study area for visual amenity is the extent of visibility as shown on the ZTV. The ZTV will be verified on site by the Landscape Architect.

Scoping

9. For Landscape Character, in the absence of a published landscape character assessment at a local level, the study area is divided into appropriately-scaled Landscape Character Areas (LCAs) by the Landscape Architect. Each LCA has their own separate defining characteristics which make up the fabric of the landscape and set them apart from one another. These LCAs were defined using desktop study including analysis of LANDMAP and other data sources, and will be verified on site by the Landscape Architect. They are shown on drawing 4021883-BUK-ZZ-00-SK-L-00005. In line with GN46, as the development is of limited vertical elevation the search area is initially set at a 3km buffer from the proposed development. Character areas identified within the 3km buffer may extend beyond the buffer line, however no new character areas will be identified which begin beyond the 3km buffer.
10. Of the LCAs identified, an initial scoping exercise has been undertaken to identify which of the LCAs may experience significant effects to their character as a result of the proposed development. This is because GLVIA3 states that, in line with a proportionate approach, LVIA should focus on receptors which may experience significant effects.
11. National Landscape Character Assessments and Marine Character Assessments published by NRW have been used to inform the baseline but are considered to cover too broad an area on which to assess the likely effects of the proposed development as receptors in their own right.
12. Potential receptors of visual amenity have been previously identified (see *LVIA Scope: Scope for a landscape and visual impact assessment for Cardigan TFRMS*, Binnies, 2024) and refined through consultation with the Local Planning Authority (email from Sarah Smyth, 14/09/23). The ZTV was used to identify the groups of people whose views may be affected by the proposed development

Establishing the Baseline

13. The **baseline** for consideration of landscape and visual effects is evaluated through desk study (including LANDMAP analysis, landscape character assessments and ZTV analysis) and a site visit by the Landscape Architect and is the current situation at the time of the assessment, unless noted otherwise. Operational developments and those under construction are considered as part of the baseline and included as part of the assessment of landscape and visual effects.
14. The **future baseline** is considered to be changes to the landscape which are considered certain or likely to happen – including consented proposals which are not yet present in the landscape but are expected to be constructed. These may or may not be included as part of the landscape and visual baseline depending on individual project circumstances and the approach and reasoning is set out within the assessment.
15. A key part of the visual amenity baseline is the establishment of the ZTV, which shows the areas from which the development is theoretically visible, and therefore helps identify the 'visual receptors', i.e. the people who may have views of the proposed development, as well as aiding viewpoint selection and indicating the development's potential influence on the wider landscape.
16. The ZTV was mapped by application of Viewshed software on a 1m Digital Surface Model dataset, a Lidar dataset that includes locations and heights of building and vegetation as well as landform. The height of the development was set at 4.95m AOD and the observer height was set at 1.7m.

17. It should be noted however that the ZTV shows only whether the proposed development will theoretically be visible; it does not show how easily noticeable or identifiable it is likely to be. In line with GLVIA, the ZTV is supplemented by a site visit by a Landscape Architect, in order to verify the ZTV and establish the extent of visibility.
18. The ZTV was used to identify the groups of people whose views may be affected by the proposed development, and to locate viewpoints to represent the visual amenity receptors. Photographs showing views from a number of representative viewpoints are used to aid the visual appraisal, and all photographic viewpoints are located within areas shown to have visibility in the ZTV. Viewpoint locations are selected following production of the ZTV and desktop study exercises and refined through the site visit.
19. Viewpoints frequented by members of the public, such as from public rights of way (PRoW) or settlements, as well as viewpoints from which the proposed development is likely to be prominent, are favoured as there are likely to represent a greater concentration of potentially affected users.

Visual Aids

20. A photographic record will be captured by the Landscape Architect during the site visit to aid in the presentation of the LVIA. One visit will be undertaken to collect photographs, during winter only.
21. The Landscape Institute published the Landscape Institute Technical Guidance Note (TGN) 06/19: Visual Representation of development proposals in September 2019 (under review from January 2024). TGN 06/19 has been used to inform this methodology, which provides guidance on appropriate photography and visualisation techniques for use within LVIA and LVA, and which itself accords with the principles of GLVIA. Both GLVIA and TGN 06/19 advocate a proportionate approach based on professional judgement.
22. Baseline photographs as well as Type 1 visualisations (annotated viewpoint photographs) will be used to inform the appraisal process. TGN 06/19 describes that Type 1 visualisations are appropriate for use in LVIA to show the extent and position of the site and features. It is not considered that photomontage visualisations (either Type 3 or 4) or 3D wireline/model (Type 2) are proportionate. This is due to the limited nature and scale of the proposed works.
23. Viewpoints have been selected to show representative views experience by identified receptors. Preliminary viewpoint locations were selected using the ZTV and desk-based study and are shown on drawings 4021883-BUK-ZZ-00-DR-L-00001 and 4021883-BUK-ZZ-00-DR-L-00002. Locations were all publicly accessible and will be agreed in advance with the Local Planning Authority. Locations will be refined and finalised on site and are marked up on the plan in the photographic report. Some locations were chosen as much to show where the site is not visible.
24. A Panasonic DMC-G5 Compact System Camera with a 25mm fixed lens will be used to take the baseline photographs. The DMC-G5 has a sensor size of 17.3 x 13.0mm, giving a horizontal field of view of 38.2° when the 25mm fixed lens is used. This gives a similar horizontal field of view to a full frame sensor camera with a 50mm lens (FFS+50mm). In line with a proportionate approach, TGN 06/19 advises that a FFS+50mm camera and lens combination are not required when taking photographs to be used in Type 1 annotated viewpoint photographs. The camera will be raised on tripod set to take an image at 1.7m.
25. As recommended by TGN 06/19, single frame annotated images are presented on A3 sheets (one image per A3 sheet), see Appendix X. A location plan showing the viewpoint locations and direction of view is in Appendix X.

Landscape Effects

26. The starting point for any assessment is a desk-based assessment of published landscape studies, which may include landscape character assessments, sensitivity and capacity studies and/or landscape designation reviews. These documents are listed in the assessment references and relevant extracts may be included as appendices where this is judged appropriate.
27. The landscape effects of the proposed development are considered against the key characteristics of the receiving landscape. The degree to which the proposed development changes "*distinct and recognisable pattern of elements, or characteristics, in the landscape that make one landscape different from another, rather than better or worse*" ('An Approach to Landscape Character Assessment', Natural England, 2014), enables a judgement to be made as to the significance of the effect in landscape character terms.
28. Direct and indirect landscape effects are defined in GLVIA3. Direct effects may be defined as resulting "*directly from the development itself*" (paragraph 3.22). An indirect (or secondary) effect is one that results "*from consequential change resulting from the development*" (paragraph 3.22) and is often produced away from the site of the proposed development or as a result of a complex pathway or secondary association. The direct or physical landscape effects of the proposed development would generally be limited to within the planning application boundary. The indirect landscape effects are concerned with the visual effects and relate to effects associated with the introduction of the development seen in the context of the existing landscape and visual character of the view.
29. In order to reach an understanding of the effects of development upon the landscape resource it is necessary to consider different aspects of the landscape baseline including:
 - **Landscape Fabric/Elements:** The individual features of the landscape, such as hills, valleys, woods, hedges, tree cover, vegetation, buildings and roads for example which can usually be described and quantified.
 - **Landscape key characteristics:** The particularly notable elements or combinations of elements which make a particular contribution to defining or describing the character of an area, which may include experiential characteristics such as wildness and tranquility.
30. The **sensitivity** (high, medium, low) of the landscape to a particular development is considered on a case by case basis and considers the susceptibility of the landscape, which varies depending on the type of development proposed and the particular site location, and the landscape value (identified as national, regional, or community). As stated in GLVIA3, '*LVIA sensitivity is similar to the concept of landscape sensitivity used in the wider arena of landscape planning, but is not the same*'.
31. **Landscape value:** The importance attached to a landscape, often used as a basis for designation or recognition which expresses national or local authority consensus, because of its special qualities/attributes. The factors which are considered in landscape include aesthetic or perceptual aspects such as scenic beauty, tranquility or wildness or cultural associations as well as recreational/community value, conservation interests, landscape character and condition and representativeness/rarity.
32. **Landscape susceptibility** according to GLVIA3 means "*the ability of the landscape to accommodate the proposed Development without undue consequences for maintenance of the baseline situation and/or the achievement of landscape planning policies and strategies*". In LITGN-2024-01 published by the Landscape Institute in August 2024 (Notes and Clarifications on aspects of the 3rd Edition of Guidelines on Landscape and Visual Impact Assessment), the Landscape Institute clarifies that susceptibility means the ability of the landscape to accommodate the *type or nature* of the change and should not be confused with assessments of magnitude. Judgements on landscape susceptibility

(high, medium, low) include references to both the physical and aesthetic characteristics of the type of proposed development, the scale of the change, and landscape features and characteristics that affect the landscape's ability to accommodate the change.

33. Susceptibility of landscape character areas are influenced by their characteristics and are often considered (though often recorded as 'sensitivity' rather than susceptibility) within landscape character assessments and capacity studies.
34. Susceptibility of designated landscapes is influenced by the nature of the special qualities and purposes of designation and/or the valued elements, qualities or characteristics, indicating the degree to which these may be unduly affected by the development proposed.
35. The criteria and the detailed judgements regarding susceptibility and value of landscape receptors are identified within the sensitivity tables included within this assessment.
36. Sensitivity is judged taking into account the component judgments about the value and susceptibility of the receptor as illustrated by the table below. Where sensitivity is judged to lie between levels, an intermediate assessment will be adopted.

		Susceptibility		
		High	Medium	Low
Value	National	High	High/Medium	Medium
	Regional	High/Medium	Medium	Medium/Low
	Community	Medium	Medium/Low	Low

37. The **magnitude of landscape change** arising from the proposed development at any particular location is assessed in terms of its size or scale, geographic extent of the area or receptor that is influenced and its duration and reversibility.
38. The **scale** of the change takes account of:
 - degree of loss or alteration to key landscape features/elements; characteristics; and for designated areas – special qualities and/or purposes of designation;
 - distance from the development;
 - landscape context to the development;
39. The approach to assessing effects on landscape character is to consider the key characteristics for the LCA within which the proposed development is located (host) and the adjacent LCAs (non-host) and identify which of these the proposed development would affect. For the host LCAs, a large scale change in landscape character is likely to occur where key characteristics would be lost or substantially changed. Where particular views are a key characteristic of a landscape area, large or medium scale landscape character effects may occur where the proposed development becomes a key feature of those views.
40. Where multiple landscape assessments of different scales cover the same geographical area, the effects are assessed on the assessment at the most appropriate scale. In this case there is no published Landscape Character Assessment of a suitable scale. Therefore, LCAs have been drawn up at a suitable scale within the study area for this assessment. The resulting LCAs have then be scoped

in or out of the LVIA as receptors to change, based on the likelihood of significant effects on the key characteristics.

41. Having established the size/scale of change (large, medium, small, negligible) to the landscape baseline, the geographic **extent** of the change can be identified (wide, intermediate, localised or limited) and a judgement made as to the degree of change for each landscape receptor.
42. **Duration** and reversibility can be linked depending on the nature of the development. Reversibility is a judgement about the ability and practicality of the proposed development to be reversible (such as wind farms which are predominantly reversible), partially reversible to something similar (such as mineral extraction¹) or a permanent change in the landscape (such as housing). Duration reflects how long the change will last. The following definitions of duration have been applied in this assessment:

Short term	During the construction and up to 1 year following completion
Medium Term	Up to 5 years following completion of the project
Long term	Between 5 and 15 years following completion of the project
Permanent	Greater than 15 years following completion of the project

43. Magnitude is considered taking into account the three contributory factors as illustrated by the diagrams included below, see paragraph 57.

Visual Effects

44. In order to identify the significance of a visual effect it is necessary to establish the relative sensitivity of the viewers (people) and the magnitude of the change they experience. In this case sensitivity is a combination of both susceptibility of the viewer to the proposed change and the value of the views.
45. Those living within view of the proposed development are usually regarded as the highest susceptibility group as well as those engaged in outdoor pursuits for whom landscape experience is the primary objective. The susceptibility of potential visual receptors will also vary depending on the activity of the receptor. For visual receptors susceptibility and value are closely linked - the most valued views are also likely to be those where viewer's expectations will be highest.
46. The **value** of public views, which is the focus of GLVIA3, is identified as national, regional or community and will vary depending on the nature, location and context of the view and the recognised importance of the view. Considerations include cultural associations; designation or policy protection; views of or from landmarks; and/or the scenic quality of the view. The value attributed relates to the value of the view, e.g. a National Trail is nationally valued for access, but not always for the available views from every section.
47. Visual receptor **susceptibility** is defined as in accordance with the criteria below.
 - **High** - Local residents; users of outdoor recreation focussed on the appreciation of views including footpaths, beauty spots and picnic areas; people experiencing views to or from important features of physical, visual, cultural or historic interest.

¹ GLVIA3 page 91, paragraph 5.52

- **Medium** - Local road users and travellers on trains. People engaged in outdoor recreation with some appreciation of the landscape e.g. road cycling, nature conservation, golf and water based recreation.
 - **Low** - Workers, users of facilities and commercial buildings (indoors) experiencing views from buildings. Road and rail users on fast moving commuting or trunk routes. Visual receptors where views are incidental to the activity and/or location.
48. Sensitivity is judged taking into account the component judgments about the value and susceptibility of the receptor as illustrated by the table below. Where sensitivity is judged to lie between levels, an intermediate assessment will be adopted.

		Susceptibility		
		High	Medium	Low
Value	National	High	High/Medium	Medium
	Regional	High/Medium	High/Medium	Medium/Low
	Community	High/Medium	Medium	Low

49. The **magnitude of visual change** arising from the proposed development at any particular location is assessed in terms of its size or scale (large, medium, small, negligible), geographic extent of the area or receptor that is influenced (wide, localised, limited) and its duration (short, medium, long, permanent).
50. Representative viewpoints are used as 'samples' on which to base judgements of the scale of effects on visual receptors. The wider extent of the effect and its duration are not captured in the viewpoint analysis (as a viewpoint cannot capture these factors for an entire route or area). As duration and extent are necessary considerations in determining magnitude of change; magnitude and significance judgements are provided for visual receptors and not for all representative viewpoints. The exceptions to this are specific viewpoints – where people visiting that location to look at the view are assessed as a visual receptor group.
51. With the exception of specific viewpoints, each route and receptor group will encompass a range of possible views, which might vary from no view of the development to very clear, close views. Therefore, effects are described in such a way as to identify where views towards the development are likely to arise and what the scale and duration and **extent** (wide, intermediate, localised, limited) of those views are likely to be. In some cases this will be further informed by a nearby viewpoint and in others it will be informed with reference to ZTV studies, aerial photography and site visits. Each of these individual effects are then considered together in order to reach a judgement of the effects on the visual receptors along that route, or in that place.
52. The **scale of effect** arising from the proposed development at any particular viewpoint reflects the degree to which the nature of the views from that location would be changed and is taking into account:
- The distance of the viewpoint from the development;
 - the degree to which the development is visible or screened;
 - the angle of view in relation to main receptor activity or main focus of the view;
 - the horizontal and vertical field of view occupied by the development; and
 - the extent and nature of other built development visible.

53. The approach to assessing effects on views is to assume that the change would be seen in clear visibility and the assessment is carried out on that basis. Where there are operational (and consented) developments considered as part of the baseline, the visual effects consider the effects of adding the proposed development to that baseline. Where appropriate, comment may be made on lighting and weather conditions.
54. **Duration** reflects how long the change will last and is rated in the same way as described above for landscape effects (see paragraph 42).
55. For visual receptors moving through the landscape (e.g. road and rail users), the length of their journey during which they would see the development is reflected in the judgement of the geographic extent of effects.
56. Magnitude is considered taking into account the three contributory factors as illustrated by the diagrams included below in paragraph 57.

Magnitude of Landscape and Visual Change

57. Scale of effect is the first factor in determining magnitude; which may be higher if the effect is particularly widespread and/or long lasting, or lower if it is constrained in geographic extent and/or timescale. The tables below illustrate how this judgement is considered as a two-step process. Firstly, scale and extent are considered, for which the outcomes are illustrated by the first part of the table; the second part of the table illustrates the influence of duration on this initial judgement. Where magnitude is judged to lie between levels, an intermediate assessment will be adopted.

Scale / extent	Large	Medium	Small	Negligible
Wide	Substantial			
Intermediate		Moderate		
Localised			Slight	
Limited				Negligible

Stage 1 Result / Duration	Substantial	Moderate	Slight	Negligible
Permanent	Substantial			
Long-term		Moderate		
Medium-term			Slight	
Short-term				Negligible

Significance of Landscape and Visual Effects

58. The significance of any identified landscape or visual effect is assessed as major, moderate, minor or negligible. These categories are based on the consideration of sensitivity with the predicted magnitude of change. The table below is not used as a prescriptive tool and illustrates the typical outcomes, allowing for the exercise of professional judgement. In some instances a particular parameter may be considered as having a determining effect on the analysis.

		Magnitude of Change			
		Substantial	Moderate	Slight	Negligible
Receptor Sensitivity	High	Major	Major/ Moderate	Moderate	Minor
	Medium	Major/ Moderate	Moderate	Moderate/ Minor	Minor/ Negligible
	Low	Moderate	Moderate/ Minor	Minor	Negligible

59. Where the effect has been classified as Major or Major/Moderate this is considered to be equivalent to likely significant effects referred to in the EIA Regulations. Where 'Moderate' effects are predicted, professional judgement will be applied to ensure that the potential for significant effects arising has been thoroughly considered.

Beneficial/Adverse

60. Landscape and visual effects can be beneficial or adverse and in some instances may be considered neutral. Neutral effects are those which overall are neither adverse nor positive but may incorporate a combination of both. The assessment of whether an effect is beneficial or adverse is independent of magnitude of change and therefore significance of effect; the judgement of significance will be made first before the judgement as to whether the change is adverse or beneficial. In line with LITGN-2024-01, whether an effect is beneficial, neutral or adverse will take into account how the design responds to its environment and whether it is appropriate in the context of its surroundings, and will not solely be based on the assessor's judgement of 'beauty'. The assessment will include justification as to why the effect is considered to be adverse, beneficial or neutral. GLVIA3 indicates at paragraph 2.15 that this is a "*particularly challenging*" aspect of assessment, especially in the context of a changing landscape.

Cumulative Effects

61. In a broad generic sense, cumulative impacts "*result from the incremental changes caused by other past, present or reasonably foreseeable actions together with the project*"². However, an assessment of cumulative effects should focus on whether there are any potential cumulative impacts which are reasonably foreseeable and which are likely to influence the decision making of the proposed development, rather than an assessment of every potential cumulative effect³, which in practice means focussing on other nearby development proposals and the effects that might arise from the combined influence of those developments on landscape and visual receptors.
62. As recommended by the NatureScot cumulative guidance, this assessment focusses on the "*additional cumulative change which would be brought about by the proposed development*"⁴.
63. As noted above, operational developments are included in the baseline, consented development which are expected to be constructed, form part of the future baseline and will be included as such. However, where there is some uncertainty regarding the future construction of consented developments, they may be considered as the first scenario of the cumulative assessment.
64. Proposals in planning are considered where there is good reason to assume that the timing of decisions may be similar and significant cumulative effects are likely. The assessment of effects is considered within the cumulative assessment.
65. Proposals in scoping are noted but not considered within the cumulative assessment, as there is no certainty that these proposals will progress to planning submissions and the nature of the proposed schemes may be subject to change.
66. The assessment is based on the same landscape and visual baseline and receptor groups as the main LVIA, and the methodology is also the same in terms of forming and expressing judgements.

² GLVIA3 page 120, paragraph 7.1 quoting Hyder, 1999 'Guidelines for the assessment of indirect and cumulative impacts as well as impact interactions'

³ GLVIA3 page 121 paragraph 7.5.

⁴ Assessing the Cumulative Impact of Onshore Wind Energy Developments, NatureScot, 2021

67. Cumulative effects on landscape receptors arise from combined direct and/or indirect effects on the same receptor – such as two developments within the same character area; or one development within, and one visible from, a designated area.
68. Cumulative effects on visual receptors arise either from two (or more) developments both being visible from the same place; or from sequential views as people travel.
69. In order to simplify what may otherwise be a complex assessment, the following approaches are also used:
 - The cumulative assessment considers scenarios within which developments may be 'grouped' - for instance two nearby cumulative proposals may be considered in one scenario if it is considered that the cumulative effects arising if one or both are developed are likely to be similar.
 - Receptors judged to receive Negligible or Slight-Negligible magnitude effects are not considered for cumulative effects on the basis that any significant effects arising would primarily be caused by the cumulative developments and would be unlikely to be contributed to by the proposed development.
 - Only those receptors judged likely to experience effects from the cumulative development(s) being considered within a given scenario are described within that scenario.
70. Qualitative assessment of design and aesthetic considerations arising as a result of cumulative development, and/or considerations set out within local guidance provided in relation to cumulative development, is also provided where relevant.

ANNEX 1: GLOSSARY OF TERMS

Term	Definition
CLVIA	Cumulative Landscape and Visual Impact Assessment.
Cumulative Effects	Cumulative effects are the additional effects arising from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions.
Direct Effect	A direct (or primary) effect may be defined as an effect that is directly attributable to the development. ⁵
GLVIA3	'Guidelines for Landscape and Visual Impact Assessment, Third Edition', published jointly by the Landscape Institute and Institute of Environmental Management and Assessment 2013.
Indirect Effect	An indirect (or secondary) effect is an effect that results indirectly from the proposed project as a consequence of the direct effect, often occurring away from the site, or as a result of a sequence of interrelationships or a complex pathway. They may be separated by distance or in time from the source of the effects. ⁶
Key Characteristics	Those combinations of elements which are particularly important to the current character of the landscape and help to give an area its particularly distinctive sense of place.
LVIA	Landscape and Visual Impact Assessment.
Landscape Capacity	The amount of change which a particular landscape character type or area is able to accommodate without significant detrimental effects on its character. Capacity is likely to vary according to the type and nature of change proposed.
Landscape Character	The distinct and recognisable pattern of elements in the landscape that makes one landscape different from another, rather than better or worse. ⁷
Landscape Character Areas	These are single unique areas which are the discrete geographical areas of a particular landscape type. ⁸
Landscape Character Types	These are distinct types of landscape that are relatively homogeneous in character. They are generic in nature in that they may occur in different areas in different parts of the country, but wherever they occur, they share broadly similar combinations of geology, topography, drainage patterns, vegetation and historical land use and settlement pattern, and perceptual and aesthetic attributes.
Landscape Effects	Effects on the landscape as a resource in its own right. ⁹
Landscape Elements	Individual components which make up the landscape such as trees and hedges.

⁵ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p155

⁶ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p156

⁷ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p156

⁸ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p157

⁹ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p157

Term	Definition
Landscape Features	Particularly prominent or eye-catching elements, like tree clumps, church towers or wooded skylines.
Landscape Quality or Condition	This is a measure of the physical state of the landscape. It may include the extent to which a typical character is represented in individual areas, the intactness of the landscape and the condition of individual elements. ¹⁰
Landscape Receptor	Defined aspects of the landscape resource that have the potential to be affected by a proposal.
Landscape Resource	The combination of elements that contribute to landscape context, character and value.
Landscape Value	The relative value or importance attached to different landscapes by society on account of their landscape qualities. ¹¹
Level of Effect	Determined through the combination of sensitivity of the receptor and the proposed magnitude of change brought about by the development.
Magnitude (of effect)	A term that combines judgements about the size and scale of the effect, the extent of the area over which it occurs, whether it is reversible or irreversible and whether it is short or long term in duration.
Mitigation	Measures including any process, activity or design to avoid, reduce, remedy or compensate for adverse environmental impact or effects of a development.
Photomontage	A visualisation which superimposes an image of a proposed development upon a photograph or series of photographs.
Residential Visual Amenity	A collective term describing the views and visual amenity from a residential property, relating to the type, nature, extent and quality of views that may be experienced from the property and its 'domestic curtilage' including gardens and access driveway. Residential Visual Amenity is only one component of the overall Residential Amenity, others being for example noise, shadow flicker and access amongst others.
Residual Effects	Potential environmental effects remaining after mitigation.
Sense of Place	The essential character and spirit of an area: <i>genius loci</i> literally means 'spirit of the place'.
Sensitivity	A term applied to specific receptors, combining judgements of the susceptibility of the receptor to the specific type of change or development proposed and the value related to that receptor. ¹²
Significant Effects	It is a requirement of the EIA Regulations to determine the likely significant effects of development on the environment which should relate to the level of an effect and the type of effect. Where possible significant effects should be mitigated.

¹⁰ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p157

¹¹ The Landscape Institute; Technical Guidance Note 02/21 Assessing Landscape Value Outside National Designations

¹² The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p157

Term	Definition
	The significance of an effect gives an indication as to the degree of importance (based on the magnitude of the effect and sensitivity of the receptor) that should be attached to the impact described. Whether an effect should be considered significant is not absolute and requires the application of professional judgement.
Type or Nature of Effect	Whether an effect is direct, indirect, temporary or permanent, positive (beneficial), neutral or negative (adverse) or cumulative.
Visual amenity	Value of a particular place in terms of what is seen by visual receptors taking account of all available views and the total visual experience.
Visual Effect	Effects on specific views and on the general visual amenity experienced by people. ¹³
Visual Receptors	Individuals and/or defined groups of people who have the potential to be affected by a proposal.
Visualisation	Computer simulation, photomontage or other technique to illustrate the appearance of a development. ¹⁴
Wildness	A quality of appearing to be remote, inaccessible and rugged with little evidence of human influence.
Wireframe or Wireline	A computer generated line drawing of the DTM (Digital Terrain Model) and the proposed development from a known location.
Zone of Theoretical Visibility (ZTV)	Area within which a proposed development may have an influence or an effect on visual amenity. ¹⁵

¹³ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p158

¹⁴ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p158

¹⁵ The Landscape Institute/Institute of Environmental Management and Assessment; *Guidelines for Landscape and Visual Impact Assessment*; Spon; 2013; p158