Connah's Quay Low Carbon Power

Environmental Statement Volume IV

Appendix 13-F: Hydraulic Modelling Report

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Planning Act 2008 (as amended)
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2)(a)
Revision 00

August 2025

Prepared for:
Uniper UK Limited

Prepared by:
AECOM Limited

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1. Introduction

1.1.1 AECOM Limited (AECOM) has been commissioned by Uniper UK Ltd (hereafter referred to as the 'Applicant) to undertake hydraulic modelling to support **Appendix 13-C: Flood Consequences Assessment** (**FCA**) (**EN10166/APP/6.4**) for the development of the Connah's Quay Low Carbon Power project. (the 'Proposed Development'). The Study Area considered as part of this hydraulic modelling report is the Order Limits for the Proposed Development, as described in **Chapter 4: The Proposed Development (EN010166/APP/6.2.4).**

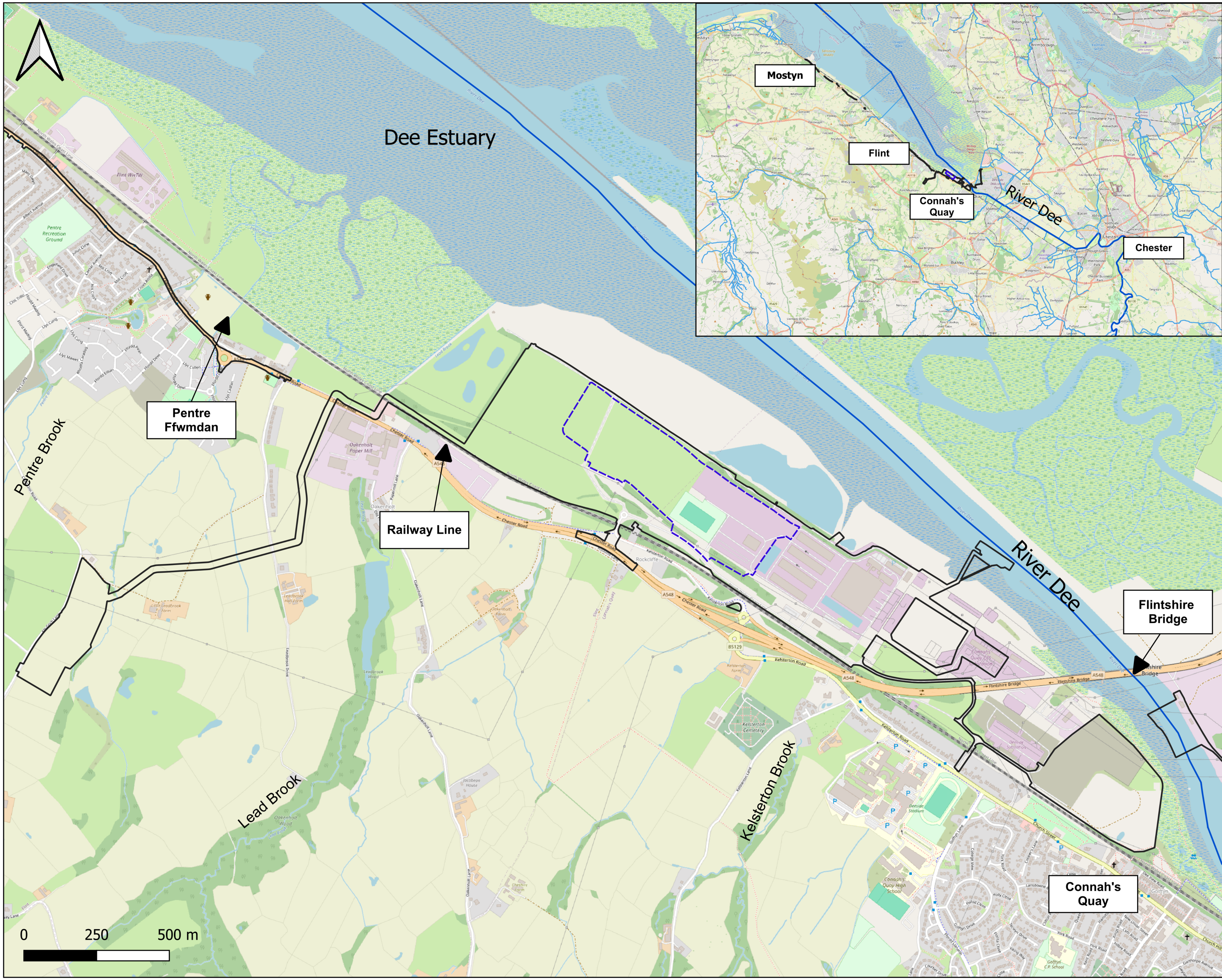
1.1.2 This hydraulic modelling report is an appendix to **Chapter 13: Water Environment and Flood Risk** (**EN010166/APP/6.2.23**), which specifically supports **Appendix 13-C: FCA** (**EN10166/APP/6.4**). This report describes the fluvial and tidal hydraulic modelling completed for the River Dee and the Dee Estuary.

1.1.3 The main focus of this hydraulic modelling report will be the Operational Footprint to be raised to 7.4m AOD (hereafter referred to as the Operational Footprint). This is located within the Main Development Area as described in **Chapter 3: Location of the Proposed Development (EN010166/APP/6.2.3)** and forms part of the Construction and Operation Area. No consideration has been given to the Accommodation Works Areas.

1.2 Location

1.2.1 The Proposed Development, shown in **Figure 13-F1**, is located on the northern side of Connah's Quay and approximately 4.5 km south-east of Flint and 14 km west of Chester (approximate National Grid Reference (NGR) SJ 27475 71345). Historic mapping indicates that the Main Development Area of the Proposed Development consists of land that was previously lower-level marshland that has been reclaimed by land raising as part of the wider power station development. The majority of the existing Connah's Quay Power Station is developed and incorporates power generation facilities and associated infrastructure.

1.2.2 The River Dee (Main River) flows in a south-east to north-west direction along the northern boundary of the Order limits and opens out into the tidal Dee Estuary at the A548 flyover adjacent to the Construction and Operation Area. The watercourse is tidal approximately 16 km upstream of the Proposed Development to Chester Wier. Several ordinary watercourses are also located within close proximity to the Construction and Operation Area (**Figure 13-F1**), including Lead Brook, Kelsterton Brook, Pentre Brook and a number of unnamed ordinary watercourses. The key sources of flood risk to the Operational Footprint that have been addressed within this report are the tidal and fluvial flood risk associated with the River Dee.



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LEGEND

- Operational Footprint
- Order limits
- River Dee
- Watercourses

Project Title

CONNAH'S QUAY LOW CARBON POWER

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FINAL

Drawing Title

PROPOSED DEVELOPMENT LOCATION OVERVIEW

Client

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Approver	HJ	Date	30/07/2025

AECOM
6th Floor,
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AECOM

Drawing Number FIGURE 13F-1 Rev 1

1.3 Project Background

Proposed Development

1.3.1 The Proposed Development comprises the demolition of an existing gas treatment plant (GTP) and above-ground installation (AGI), store buildings, and contractors' facilities associated within the existing Connah's Quay Power Station and the construction, operation (including maintenance) and decommissioning of a proposed low carbon Combined Cycle Gas Turbine (CCGT) Generating Plant fitted with Carbon Capture Plant (CCP). A description of the Proposed Development, including details of maximum parameters, is set out in **Chapter 4: The Proposed Development (EN010166/APP/6.2.4)**.

1.3.2 This modelling report primarily focusses on the flood risk impacts to the Operational Footprint as this is the proposed location of highly vulnerable infrastructure. The Operational Footprint is shown in **Figure 13F-2**. The wider Proposed Development is considered in more detail within **Appendix 13-C: FCA** (**EN10166/APP/6.4**).

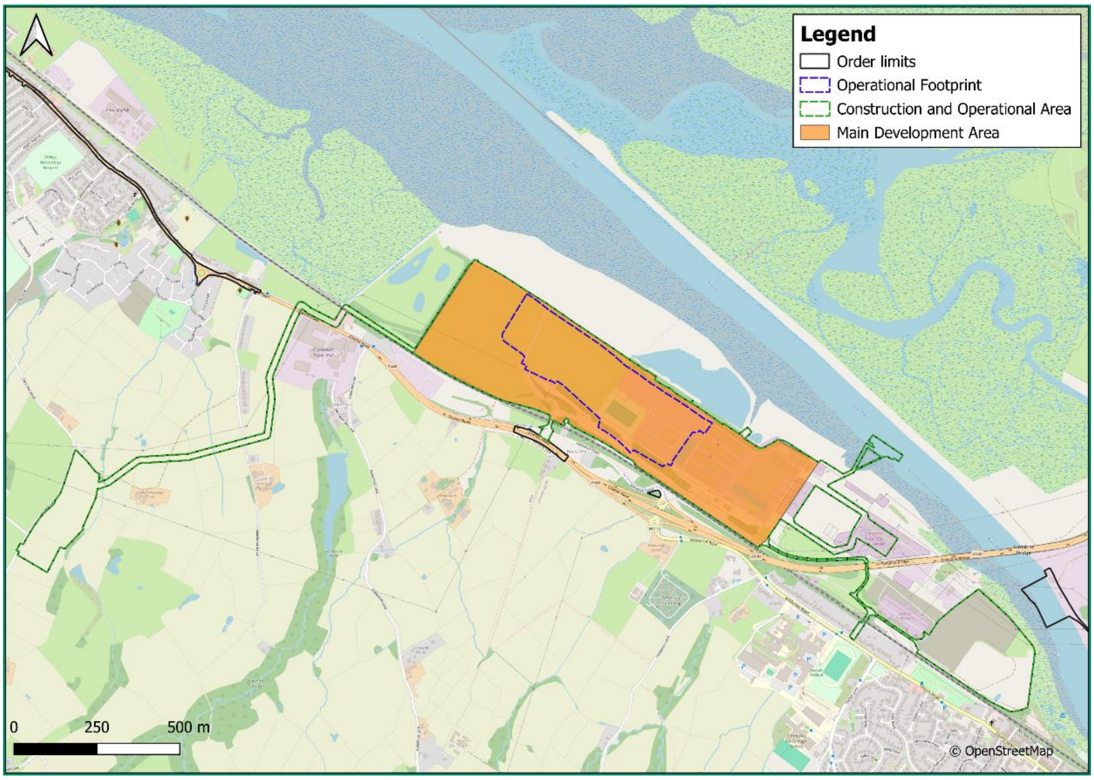

Figure 13F-2: Operational Footprint in relation to the wider Order limits

1.4 Aims and Objectives

1.4.1 The overall aim of the hydraulic modelling is to better quantify fluvial and tidal flood risk at the Operational Footprint and inform **Appendix 13-C: FCA** (**EN10166/APP/6.4**). To fulfil this aim, the following tasks have been carried out:

- initial data collection, including any available existing hydraulic modelling and historic flood records;
- carried out a review of existing hydraulic modelling and associated fluvial and tidal hydrology and identification of key flooding mechanisms at the Construction and Operation Area;
- carried out a site walkover to ground truth potential flood connectivity to the Construction and Operation Area;
- prepared a Modelling Method Statement outlining the hydraulic modelling approach for agreement with NRW;
- baseline hydraulic model construction, refinement, and simulation for a range of Annual Exceedance Probability (AEP) events for both fluvial and tidal scenarios, including the application of the latest climate change allowances in accordance with Natural Resources Wales (NRW) guidance[1];
- undertaken model proving, including a verification exercise and sensitivity analysis, in order to enhance confidence in the model and associated outputs;
- proposed hydraulic model construction, refinement, and simulation for a range of Annual Exceedance Probability (AEP) events for the tidal scenario, including the application of the latest climate change allowances in accordance with NRW guidance; and
- produced a hydraulic modelling report presenting key results which were used to inform **Appendix 13-C: FCA** (**EN10166/APP/6.4**).

[1] NRW (2021) Flood Consequences Assessments: Climate Change allowances. Available from https://www.gov.wales/sites/default/files/publications/2021-09/climate-change-allowances-and-flood-consequence-assessments_0.pdf

2. Data Collection

2.1 Overview

2.1.1 This section discusses the key information collated to inform the hydraulic modelling and any particular limitations of it.

2.2 Previous Studies

2.2.1 In 2021, three FCA reports were produced by S M Foster Associates Limited[2] on behalf of the Applicant which assessed three separate development areas of the Order limits (Southern Site, existing Connah's Quay Power Station and the Northern Site).

2.2.2 The FCAs demonstrated that the majority of the Northern Site (part of the Main Development Area) was not located in an area at risk of flooding from the sea, however the conclusions were based on broadscale 1D modelling outputs and no site-specific hydraulic modelling was undertaken. It was recommended in the 2021 report that the land should be raised to mitigate the risk of tidal flooding in the future from the Dee Estuary.

2.3 Liaison with Natural Resources Wales

2.3.1 During the course of the hydraulic modelling AECOM has liaised with NRW to agree on the pertinent decisions. **Table 1** presents a record of key consultation with NRW and the key outcomes.

[2] S M Foster Associates (2021) Connah's Quay Power Station Flood Consequences Assessment

Table 1: Record of NRW consultation

Date of Consultation	Key Considerations	Key outcomes
February 2024	Scoping Report submitted to NRW, feedback was received March 2024 (**Appendix 1-B: Scoping Opinion** (**EN010166/APP/6.4**)).	It was confirmed that NRW have a combined Flood Modeller Pro (FMP)-TUFLOW fluvial-tidal hydraulic model of the tidal River Dee available. However, as stated within NRW's EIA Scoping Response '*the tidal Dee model does not include the Site within the 1D-2D model extent and it is therefore likely that some additional modelling will be required to quantify the flood risk posed to the Site, whether this be an update to the existing model or a new study, and to assess the impact on flood risk elsewhere, especially as the Scoping Report indicates, land raising of up to 1 metre will be required on parts of the site*.'
April 2024	Initial data request submitted to NRW for the hydraulic model of the River Dee.	Receipt of: 2020 River Dee hydraulic model and 2022 breach model outputs June 2024.
May 2024	Meeting between AECOM and NRW to discuss the modelling approach.	Agreement in principle to extend the existing modelling downstream, climate change allowances and scenario testing.

Date of Consultation	Key Considerations	Key outcomes
August 2024	Modelling method statement issued to NRW for comment. Feedback was received on 03/10/2024.	Agreement for the extension of the 1D-2D hydraulic modelling to Flint. No ordinary watercourses to be modelled though consultation with Flintshire County Council was recommended and justification provided within the reporting.
October 2024	Email correspondence regarding assessment of wave overtopping in the Dee Estuary.	NRW confirmed that *'It's unlikely that wave overtopping is a significant risk at the site and that overtopping risk (and associated breach) from still water level is likely to be the dominant risk.'*
February 2025	Meeting between AECOM and NRW to discuss modelling results and calibration/verification outcomes.	NRW were presented with the hydraulic modelling results and verification outputs. Agreement that the results indicate the model is over estimating water levels at Connah's Quay and because it verifies well at Mostyn Docks and Chester this is not a major concern. Glasswalling in the 1D only reach upstream of the model is not a concern and likely a conservative estimate for this assessment.
May 2025	NRW's review of the hydraulic model received 08/06/25.	NRW provided hydraulic model review comments for the Baseline model and hydraulic modelling report. Hydraulic model was not considered acceptable. The main issues were clarification needed on climate change year used

Date of Consultation	Key Considerations	Key outcomes
		for the tidal estimates, use of levee markers for Flood Modeller cross-sections, set-up of the model defences in the vicinity of the Main Development Area, application of North Wales Tidal Defence Survey and no breach assessment undertaken
May 2025	Meeting between AECOM and NRW to agree undefended and proposed modelling approaches on 21/05/25.	NRW were presented with the hydraulic modelling approach addressing review comments. The approach covered the climate change scenarios, undefended scenario, breach analysis levee markers, manning's roughness and comparison with previous results. The methodology was agreed in principle by NRW in lieu of receiving the hydraulic model, hydraulic modelling report and FCA. It was agreed that the undefended scenario would remove the need to undertake breach modelling at the Proposed Development.

2.4 NRW's 2020 River Dee Hydraulic Model

2.4.1 NRW's River Dee Hydraulic Model was produced in 2020 to supplement broadscale modelling for NRW flood risk maps. The model is built on a number of previous modelling studies undertaken for the River Dee, with the first iteration of the model (a 1D only model) produced in 2005. The hydraulic model was subsequently updated in 2007, 2011, 2015, 2016, 2017, 2020 and finally in 2022 to include up to date climate change allowances within the tidal boundaries.

2.4.2 A model review was undertaken by AECOM at the outset of this project in July 2024. A summary of the model review is provided within **Annex B**. Section 3 of this report describes the methodology undertaken to implement the model updates.

2.5 Site Walkover

2.5.1 A site visit was carried out by AECOM on 19 August 2024 to gain a better understanding of the catchment, identify key in-channel structures, other hydraulic controls within the study area and to establish whether any ordinary watercourses impact flood risk at the Construction and Operation Area.

2.5.2 The key findings from the site visit were:

- the existing power station is built on a platform above the surrounding saltmarsh floodplain. The raised ground effectively provides a sea defence from the tidal Dee Estuary (**Figure 13F-3**). There are no formal defences but a gabion wall with access points and partial raised bunds are found along on the frontage at the Main Development Area;
- there is no clear flood connectivity between the ordinary watercourses and the Main Development Area including Kelsterton Brook. Ground elevations are raised at the Main Development Area and any overtopping of the watercourses would not be expected to have an impact on flood risk to the Operational Footprint and subsequently have not been represented as part of this modelling. This has been highlighted in the methodology statement to NRW and Flintshire County Council were asked to provide commentary but none was received; and
- locations and approximate dimensions of two additional flow paths representing an access road under Flintshire Bridge and the adjacent railway to be included in the model (**Figure 13F-4**). Further detail is provided in Section 3.5.

Figure 13F-3:Typical raised platform the power station is built upon looking south-west

Figure 13F-4: Access Road flow path near the railway looking north-west

2.6 Historic Flood Information

2.6.1 NRW's Recorded Flood Extents[3] have been reviewed, which shows areas that have been recorded to have flooded in the past from rivers, the sea or surface water.

2.6.2 **Table 2** describes all records of historic flooding within the vicinity of the Proposed Development. The closest is the Oct/Nov 2000 associated with Kelsterton Brook however, there are no historic records of flooding within the Construction and Operation Area (**Figure 13F-5**).

Table 2: List of recorded flood outlines within close proximity to the Site

Date of event	Location	Source of flooding	Mechanism of Flooding
1964	Jubilee Street, Shotton	Fluvial (Main River)	Channel capacity exceeded
1964	Wepre Brook at Shotton	Fluvial (Main River)	Channel capacity exceeded
1964	Shotton Lane, Shotton	Surface Water	Local drainage systems exceeded

[3] Natural Resources Wales' DataMapWales, Recorded Flood Extents: https://datamap.gov.wales/layers/inspire-nrw:NRW_HISTORIC_FLOODMAP [Accessed July 2025]

Date of event	Location	Source of flooding	Mechanism of Flooding
Oct/Nov 2000	Kelsterton Lane, 70m south of the Construction and Operation Area	Fluvial (Ordinary Watercourse)	Channel capacity of the Kelsterton Brook exceeded
Oct/Nov 2000	Swinchard Brook, Flint	Fluvial (Main River)	Channel capacity exceeded

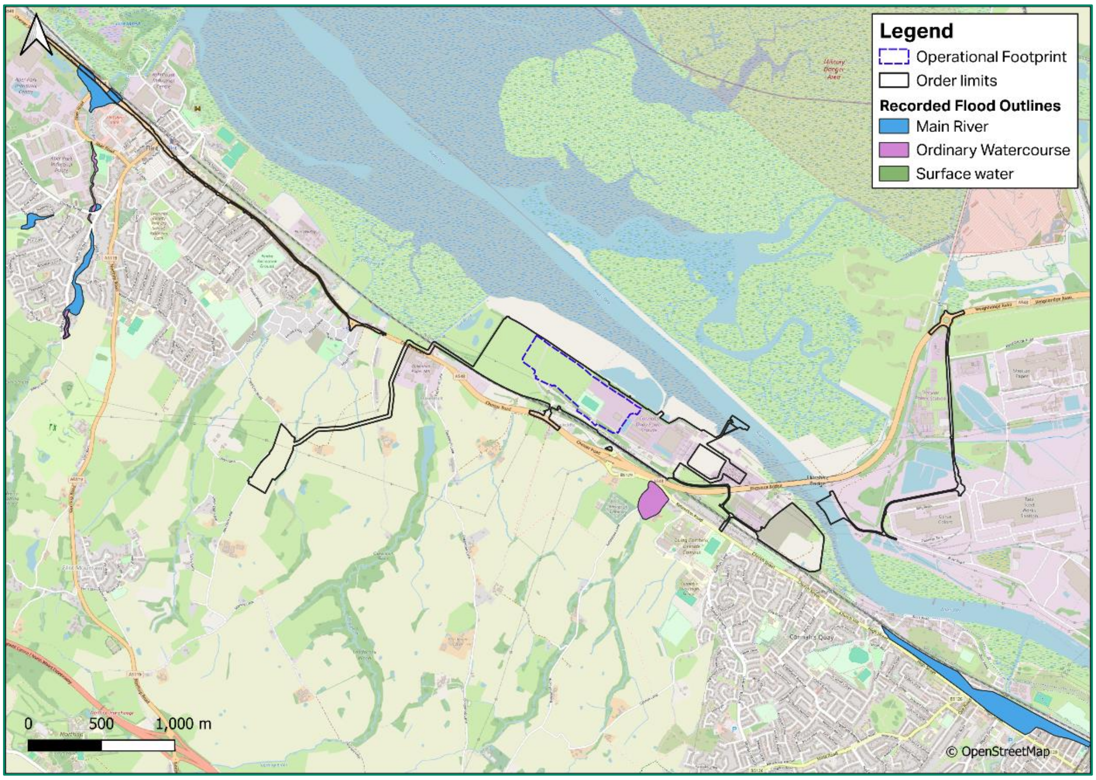

Figure 13F-5: NRW's Recorded Flood Outlines

2.7 Terrain Data

2.7.1 The most recent LiDAR data has been downloaded from NRW's DataMapWales[4], as well as from the Environment Agency's National LiDAR Programme[5] for any areas of the catchment north of the River Dee which are situated in England. The LiDAR data, flown in 2022 has a 1 m resolution grid. This is the most up to date topographic data for the entire model area and has been used to define the floodplain geometry in the 2D hydraulic model. **Figure 13F-6** shows the LiDAR data throughout the 2D model extent.

2.7.2 A topographic survey was received in January 2025, and a mesh was created using the dataset. The resulting mesh layer showed a significantly lower level of detail than the LiDAR DTM. As a result, this survey has not been incorporated into the model. However, a spot check of the LiDAR DTM versus the topographic survey data shows in general the LiDAR DTM is within +/-

[4] Natural Resources Wales DataMapWales: https://datamap.gov.wales/ [Accessed 24/07/2025]
[5] Environment Agency National LiDAR Programme: https://environment.data.gov.uk/dataset/2e8d0733-4f43-48b4-9e51-631c25d1b0a9 [Accessed 24/07/2025]

0.15 m of the survey and generally within +/- 10 mm along the frontage that determines the tidal spill level.

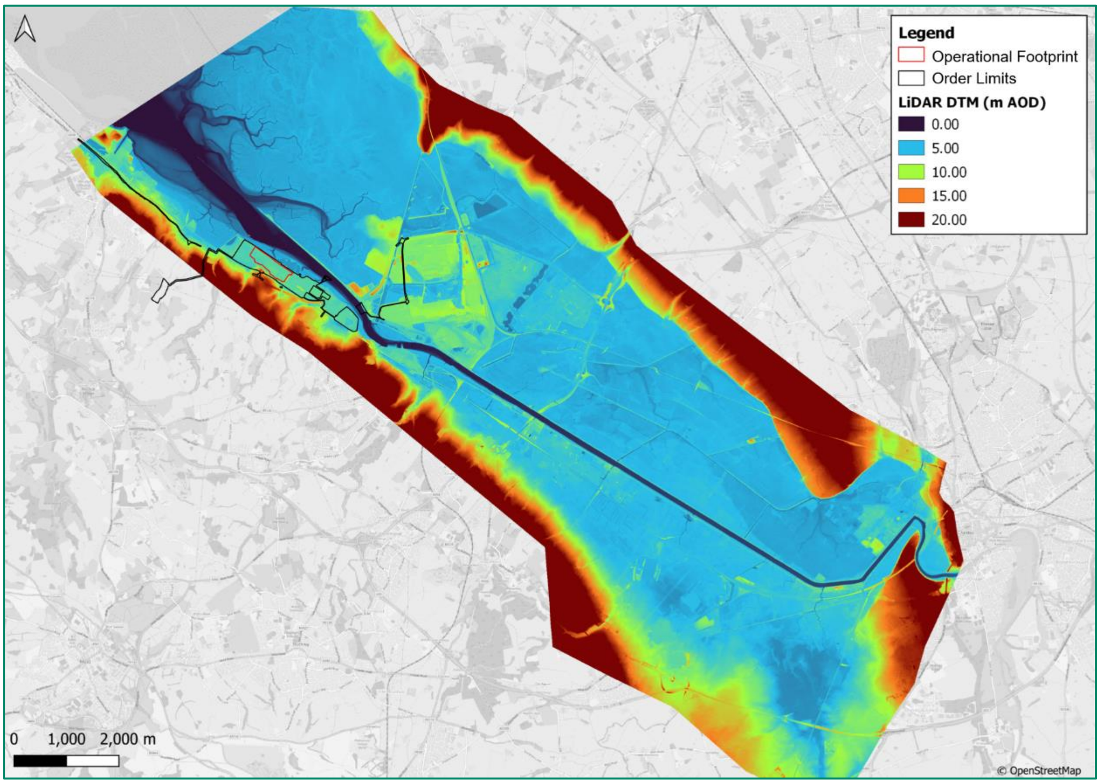

Figure 13F-6: 1m LiDAR Coverage of 1D-2D model extents

2.8 Hydrometric Data

2.8.1 A National River Flow Archive (NRFA) gauge is situated within the River Dee at Chester (Station 67033: Dee at Chester Suspension Bridge). It should be noted that there has been no daily flow data recorded since September 2013 due to issues with ultrasonics. This has not been used as part of this study. There are no other known river gauges in vicinity of the study area.

2.8.2 Admiralty Total Tide data is available for Hilbre Island, Mostyn Docks, Connah's Quay and Chester and has been used to determine the base predicted tide within the Dee Estuary (Section 3.7).

2.9 Flood Defences

2.9.1 The flood defences in NRW's received model are based on the North Wales Tidal Defence Survey which were added to the model in 2020 (**Figure 13F-7**). It is understood from NRW that the sea defences were surveyed in 2016. The sea defences have been retained from the NRW 2020 River Dee Model on the left and right bank of the River Dee upstream of the existing Connah's Quay Power Station site. Defences on the left bank of the River Dee along the boundary of the existing Connah's Quay Power Station site are private defences and there is little information about the current condition, standard of protection or the maintenance/management regime of the defences. The site walkover (Section 2.5) identified the defences at the existing Connah's Quay Power Station site are generally raised ground along the Dee Estuary frontage with a setback partial gabion wall which has access openings to the existing Connah's Quay Power Station site. Construction information provided by the Applicant shows that the observed gabion wall is actually an earthwork embankment built as a screening mound with one side having a gabion construction. **Figure 13F-8** shows the construction of the screening mound. It was agreed with NRW in May 2025 that the private defences at the existing Connah's Quay Power Station site would be removed from the baseline model to create a partial undefended model and a conservative estimate of flood risk at the Construction and Operation Area, as described in Section 3.5.

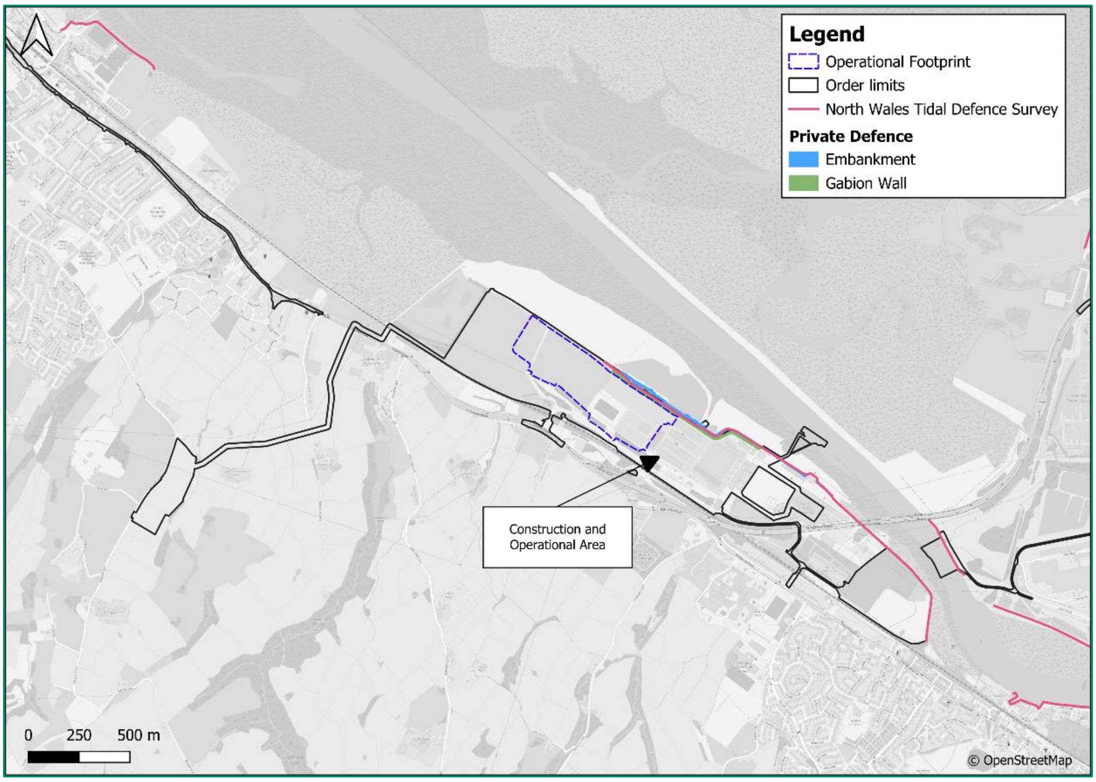

Figure 13F-7: Location of defences at the Construction and Operational Area

Figure 13F-8: Historic construction photograph, circa 1995

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3. Hydraulic Model Build

3.1 Overview

3.1.1 This section describes the updates made to the 2020 NRW River Dee model as part of the Connah's Quay Low Carbon Project hydraulic modelling.

3.2 Model Software Selection

3.2.1 Flood Modeller Pro (FMP) provides a one-dimensional (1D) package for modelling river channels, including in-channel structures such as bridges and culverts. FMP computes the varying water levels and velocities within the channel, and the associated transference of channel flow to the floodplain when hydraulically linked to a two-dimensional (2D) model.

3.2.2 TUFLOW is a 2D hydraulic modelling package that simulates the hydrodynamic behaviour of floodwater across the land surface using a grid-based approach. The combination of FMP and TUFLOW permits the full hydraulic linkage between the channel and floodplain, enabling water from the 1D channel to enter the 2D floodplain, and vice versa.

3.2.3 The models have been simulated using FMP version 7.0 and TUFLOW version 2023-13-AF, which were the latest versions available at the start of the project.

3.3 Model Extent

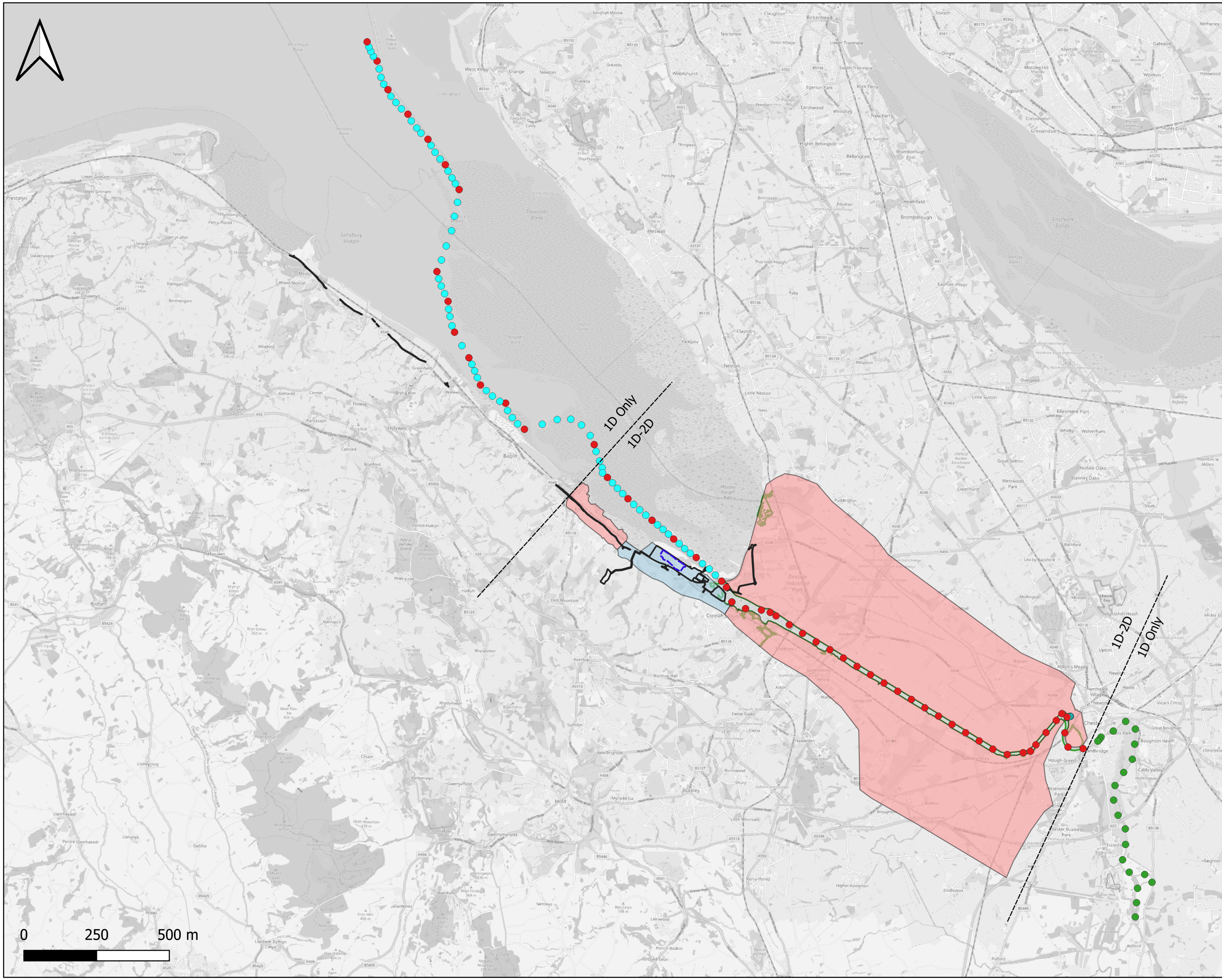
3.3.1 The 1D model extents have been retained from NRW's River Dee Hydraulic Model whilst the 1D-2D representation of the model has been extended from Flintshire Bridge to Flint. The 1D and 1D-2D hydraulic model extents are shown in **Figure 13F-9** and approximate upstream and downstream co-ordinates presented in **Table 3**.

3.3.2 Two separate 2D domains were created in order to improve resolution within the Construction and Operation Area whilst keeping run times low. A 4 m grid resolution has been used within the Construction and Operation Area and surrounding areas and the 10 m grid resolution from NRW's River Dee Hydraulic Model has been retained for the remainder of the model. The floodplain downstream of Flintshire Bridge has been represented in 2D on the left bank of the River Dee whilst the River Dee Estuary is retained as extended 1D cross sections. This is to allow for the tidal water levels to be suitably represented in the Dee Estuary and any overland connectivity to and from the Operational Footprint to be assessed.

Table 3: Upstream and Downstream extent of the Main River modelled in 1D domain

	Upstream Extent		Downstream Extent	
	Location	**Grid Reference**	**Location**	**Grid Reference**
1D	Eaton Park, south of Chester	SJ 41800 60029	Mouth of the Dee Estuary	SJ 17715 87791

	Upstream Extent		Downstream Extent	
	Location	**Grid Reference**	**Location**	**Grid Reference**
1D-2D	Grosvenor Bridge, Chester	SJ 40208 65537	Flint Foreshore, Flint	SJ 24532 73933



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LEGEND

- Operational Footprint
- Order limits

1D Model Nodes

- Cross Sections from LiDAR 2003 Bathymetry
- Interpolates
- Cross Sections from River Dee Weir to Ironbridge Hydrographic Survey (2002)

2D Model Domain

- 4m Grid Resolution
- 10m Grid Resolution

Project Title

CONNAH'S QUAY LOW CARBON POWER

Copyright

Drawing Status

FINAL

Drawing Title

MODEL EXTENT

Client

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Bristol, BS1 6EW,
United Kingdom

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Drawing Number **FIGURE 13F-9** Rev 1

3.4 1D Model Build

3.4.1 The 1D model representation has primarily been retained from NRW's 2020 River Dee Hydraulic Model. This includes the extended 1D cross sections which represent the Dee Estuary and upstream of Chester Weir. All cross sections downstream of Chester Weir to the mouth of the Dee Estuary were derived from a combination of 2003 Bathymetry Survey and LiDAR DTM. Despite the age of these data sources, the cross sections have been retained from NRW's 2020 River Dee Hydraulic Model as the best available data. 1D cross sections have been trimmed to the 2D surveyed banks.

3.4.2 Following the review of the received NRW 2020 River Dee hydraulic model (**Annex B**), a series of updates were identified to improve the model for this site-specific study and presented to NRW in the Modelling Method Statement. The following updates were carried out:

- 1D cross sections within the estuary downstream of Flintshire Bridge have been georeferenced based on their chainage from Flintshire Bridge;
- Interpolates have been added downstream of Flintshire Bridge to increase 1D cross section frequency;
- panel markers have been added to all cross sections to improve conveyance;
- 1D-2D linking has been updated throughout the model extent, to ensure it aligns with the locations of cross sections; and
- 1D and 2D bank levels have been updated to ensure they are consistent throughout the model.

3.4.3 It is noted that the inclusion of 1D levee markers in the River Dee Estuary was not taken forward because they do not represent the flooding mechanisms in the estuary sufficiently within the 1D model. The 1D levee markers restrict hydraulic calculations to the channel until the bank is overtopped however, within the River Dee Estuary the water level rises on both sides of the bank due to inlets and rivelets. A check was undertaken using the 1D only model of the River Dee with the inclusion of 1D levee markers but this caused widespread instability due to the funneling of large volumes through the narrow channel.

3.4.4 **Figure 13F-9** shows the location of all 1D nodes, including those in the Dee Estuary, which have been georeferenced based on their chainage. The nodes have been categorised based on their data source.

3.5 2D Model Build

3.5.1 The 2D floodplain has been updated to incorporate the latest LiDAR data, which was flown in 2022 and has a 1m resolution.

3.5.2 The representation of all floodplain culverts, bridges and underpasses within NRW's 2020 River Dee Hydraulic Model has been retained. These are generally represented as 1D ESTRY culverts with SX connections to the 2D domain. Following the site walkover (Section 2.5) two additional structures, representing the road under Flintshire Bridge and the adjacent railway were identified as having potential flow paths to the Construction and Operation

Area. These have been represented as ESTRY rectangular culverts. The dimensions of these openings have been estimated from a combination of approximate measurements taken during the site walkover (Section 2.5) and aerial imagery.

3.5.3 **Figure 13F-10** shows the location of the two additional structures represented in the floodplain using ESTRY.

3.5.4 It is noted that for the fluvial simulations the 1D-2D linking of the Shropshire Union Canal outfall to the River Dee was removed from the model due to instabilities. This is located approximately 13 km upstream of the Construction and Operation Area and does not impact the outcomes of this assessment.

3.5.5 Throughout the model domain, existing banklines have been checked against LiDAR data to ensure that they are suitable.

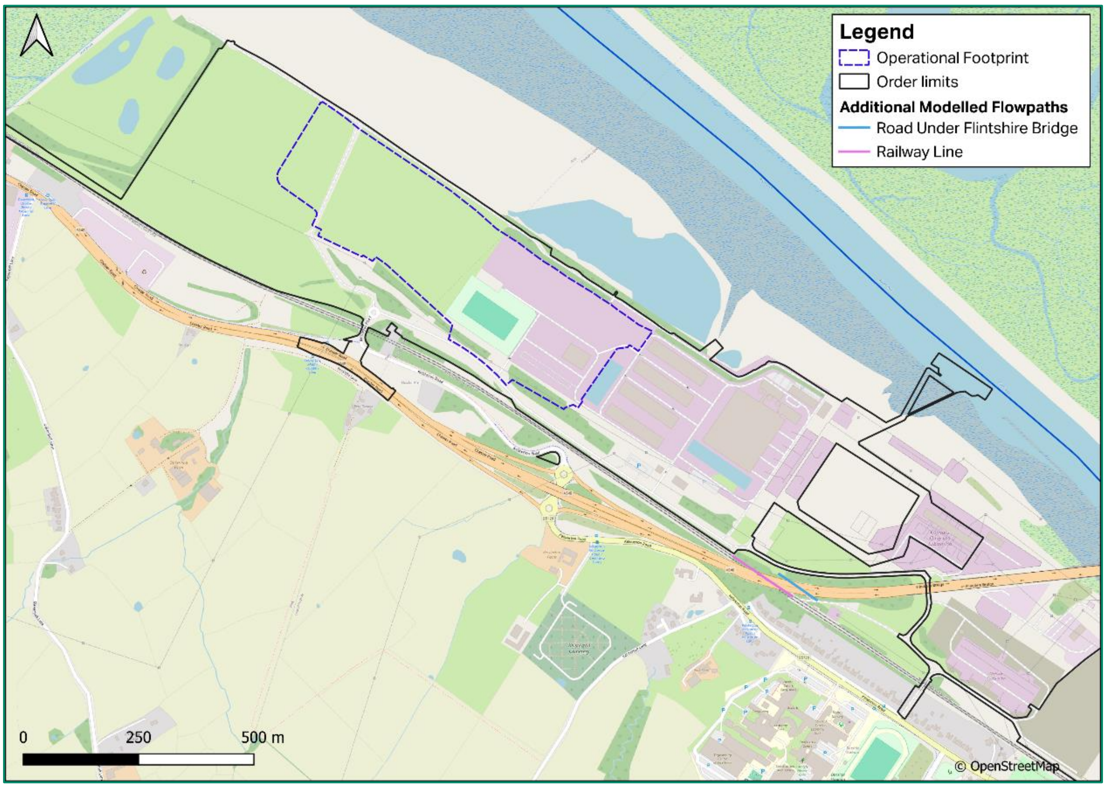


Figure 13F-10: Structures identified on site walkover and modelled as additional flowpaths

Flood Defences (partially undefended model)

3.5.6 For the purposes of design, it was agreed with NRW in May 2025 that the private defences at the existing Connah's Quay Power Station site would be removed from the baseline model to create a partial undefended model. This gives a conservative estimate of flood risk at the Operational Footprint, as we are not able to confirm that the defences will be in place for the lifetime of the development.

3.5.7 To represent an undefended scenario the 2d_zln defence representing the 2016 North Wales Tidal Defence Survey has been removed from the received model along the frontage of the existing Connah's Quay Power Station site. Following NRW's review of the hydraulic model in May 2025, the raised embankments and the gabion wall (screening mound) adjacent to the existing

Connah's Quay Power Station site (Section 2.9) have also been removed from the model. These have been removed using 2D z-shapes to flatten the embankments in the LiDAR DTM to the surrounding ground level. This means that the Construction and Operation Area is undefended and overtopping is predominately controlled by the existing access road along the River Dee frontage. The North Wales Tidal Defence Survey partially surveyed this access road. A check was undertaken on the surveyed levels against the LiDAR DTM, and it was concluded that the LiDAR DTM is considered a good representation of the elevations of the road.

3.5.8 The North Wales Tidal Defence Survey has been retained in all other areas. A check on the North Wales Tidal Defence Survey against the LiDAR DTM data has been undertaken and found to show a reasonable consistency.

3.5.9 **Figure 13-F11** displays the defences removed from the model surrounding the Construction and Operation Area.

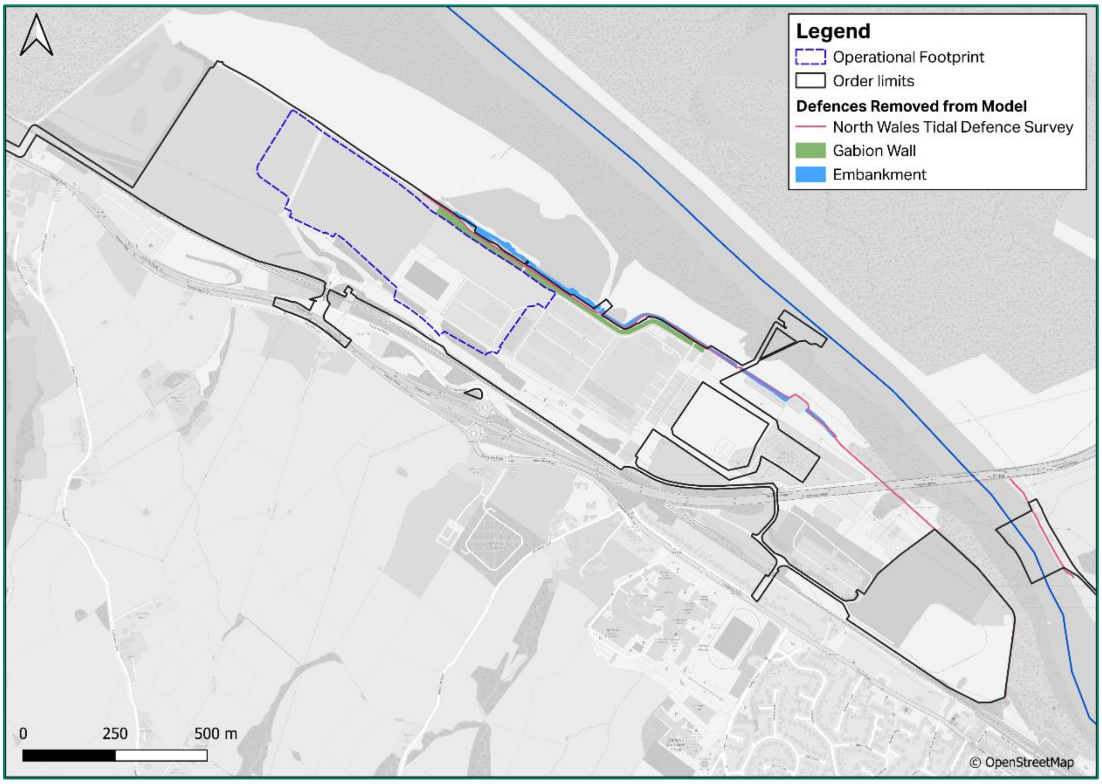


Figure 13-F11: Defences removed from the model at Construction and Operation Area to create the "Partially Undefended Scenario"

3.6 Manning's Roughness Coefficients

3.6.1 Manning's n roughness coefficients used to define in the watercourse and structures in NRW's 2020 River Dee Hydraulic Model were reviewed. The Manning's Roughness values were retained and are considered representative of the catchment for both the 1D and 2D model domains. Sensitivity analysis was undertaken to understand the impacts on the model results from these assumptions (Section 7.2).

1D Roughness

3.6.2 The Manning's Roughness values used for the 1D FMP channel and 1D ESTRY structures are summarised in **Table 4**. The Dee Estuary has a uniform Manning's Roughness value of 0.010.

Table 4: 1D Manning's Roughness Values

Feature	Manning's n Value
Dee Estuary	0.01
River Dee	Between 0.021 and 0.08
1D Culverts	Between 0.01 and 0.02

2D Roughness

3.6.3 Manning's n roughness values throughout the majority of the 2D domain were assigned based on the material layers shown in OS Master Map (OSMM) data. The 2017 OSMM data in the received model has been retained for the 10 m domain upstream of the existing Connah's Quay Power Station. Recent OSMM data has been used through the 4 m grid cell detailed domain, as well as the 10 m grid cell domain downstream of the existing Connah's Quay Power Station, which was received from the Applicant in May 2025. Where the OSMM did not cover the entire model extent at Flint, downstream of the Construction and Operation Area, Ordnance Survey Local Map information was used. Whilst this dataset is not as detailed as OSMM it was considered to be suitable for the purposes of this modelling assessment. The OSMM data has not been updated for the 10 m grid cell domain upstream of the Construction and Operation Area, where the 2017 dataset used in the previous study has been retained. This 2017 OSMM has been reviewed against recent land use changes and was concluded to be broadly consistent along the major flow paths.

3.6.4 The different material layers were assigned feature codes with corresponding values in the TUFLOW material file. A summary of the key feature codes used in the study area, as well as the corresponding material types and roughness values, are provided in **Table 5**.

Table 5: 2D Manning's Roughness Values

Feature Code	Material Type	Manning's n Value
10021	Buildings	0.5
10053	Residential Gardens	0.040
10054	General Surface	0.050
10089	Water Inland	0.035
10056	Grass / Parkland	0.030
10111	Woodland	0.100
10119	Roads, Tracks & Paths	0.020
10167	Railway	0.050

3.6.5 It was found that the 2017 OSMM data retained for the upstream of the model contains an OSMM Feature Code of 10054 (General Surface) for all fields and open spaces. This is specified as a Manning's Roughness value of 0.05. The updated OSMM specifies fields and open spaces as OSMM Feature Code

10056 (Grass/Parkland). This is specified as a Manning's Roughness value of 0.03 which is lower than the upstream OSMM layer. This is likely a consequence of changes to the granularity of the OSMM polygons in rural areas since 2017[6]. No new OSMM data is available for the upstream of the model and this will not impact the overland flow at or near the Operational Footprint.

3.7 Boundary Conditions

Downstream Tidal Boundaries

3.7.1 The model requires a tidal water level to be specified as the downstream boundary, which can be used to apply both design tidal water curves and for verification. The full Technical Note for the calculation of updated tidal boundaries is provided in **Annex C** of this document.

3.7.2 The nearest Standard ports within the Admiralty Tide Tables are Mostyn Docks in the Dee estuary and Gladstone Dock in the Mersey estuary. Hilbre Island is a Secondary (harmonic) port at the mouth of the Dee Estuary, close to the open boundary of the model. Connah's Quay and Chester are Secondary (non-harmonic) stations within the estuary and provide high water elevations and times.

3.7.3 The previous model used Gladstone Dock located on the nearby Mersey estuary. The tidal curves at Gladstone Dock, Hilbre Island and Mostyn Docks are all very similar. The small differences in the phasing (timing) and the amplitude of the constituents that combine to form the tide will result in the subtle differences. Each of these is then transformed differently as the tidal wave progresses up the Dee estuary to Connah's Quay and Chester. Whilst a reasonable calibration may be possible using Gladstone Dock, it is likely that a better calibration would be achieved using Hilbre Island. Following consultation with NRW, new tidal boundaries have been calculated which use the Hilbre Island tide station for the base tide.

3.7.4 New tidal boundary conditions for the hydraulic model of the River Dee Downstream of Connah's Quay have been created to include storm surge and sea level rise to achieve the extreme water levels predicted by the Coastal Flood Boundaries (CFB) data[7]. There is no requirement for accounting for wave action within the estuary as agreed with NRW (**Annex A**).

3.7.5 The water levels for five epochs have been determined: 2024, 2044, 2074 and 2124, for return periods of 2, 10, 20, 25, 50, 100, 200 and 1000 years alongside the Mean High Water Springs (MHWS). The higher central (70th percentile from UKCP18 RCP 8.5), upper end allowance (95th percentile from UKCP18 RCP 8.5) and H++ scenarios have been assessed.

3.7.6 A head-time tidal downstream boundary was applied to the 1D model at the node closest to Hilbre Island (Est_1000). The 70th Percentile present day and future 2074 data have been used for the design events, with the 95th Percentile future 2074 data used as part of a sensitivity test (Section 7). The future 2100

[6] Ordnance Survey, 2024, *OS MasterMap Topography Layer: April 2024 Release Note*. Available at: https://www.ordnancesurvey.co.uk/documents/product-support/release-notes/osmm-topography-layer-April2024-release-note-v1.0.pdf (Accessed: 25 June 2025).

[7] • Environment Agency, 2018, Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels (2018), Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels (2018) - data.gov.uk accessed 9th May 2023

data has also been used as a future resilience test, or if the design life of the development was to extend. **Table 6** presents a summary of the maximum water levels calculated for use within the hydraulic model.

3.7.7 For fluvially dominant events a future 2074 MHWS tidal boundary has been applied.

Table 6: Applied Peak Still Water Level

Epoch	AEP Event (%)	70th Percentile Peak Still Water Level [mOD]	95th Percentile Peak Still Water Level [mOD]
Present Day (2024)	2	5.36	N/A
	0.5	5.93	N/A
	0.1	6.15	N/A
Future (2074)	MHWS	4.48	N/A
	0.5	6.31	6.45
	0.1	6.53	6.67
Future (2100)	0.5	6.60	6.85
	0.1	6.82	7.07

Upstream Fluvial Boundaries

3.7.8 No updates have been made to the fluvial hydrology as part of this project as they were produced in 2022 and considered suitable for the purposes of this assessment, as agreed with NRW. This is supported by the results shown in Section 6.3.

3.7.9 The final fluvial peak flow estimates used in this assessment are shown in **Table 7**. This includes the upper end estimates allowance for climate change for the 2080s for the River Dee catchment[8].

Table 7: Peak Fluvial Flows

AEP Event	Peak Flow [m^3/s]
1% AEP + 45% climate change	599.2
0.1% AEP + 45% climate change	953.5

3.7.10 Two fluvial inflows are applied on the River Dee and tributary at the upstream extent of the hydraulic model:

- For all tidal dominant scenarios a constant fluvial inflow of 30 m^3/s has been applied to the River Dee and 1 m^3/s to the tributary. This is consistent with NRW's 2020 River Dee Hydraulic Model tidal assessment.

[8] NRW (2021) Flood Consequences Assessments: Climate Change allowances. Available from https://www.gov.wales/sites/default/files/publications/2021-09/climate-change-allowances-and-flood-consequence-assessments_0.pdf - accessed 24/07/2025

- For the fluvially dominant scenarios the River Dee inflow is applied as a ReFH unit and tributary as a QT boundary. Fluvial inflows have been retained from NRW's River Dee Hydraulic Model.

Initial conditions

3.7.11 Initial conditions for the 1D FMP model have been generated using steady state simulation for the future 2074 epoch. To allow the more extreme models to initialise, the 0.5% and 0.1% AEP events for the 2100 epoch use initial conditions generated for the future 2100 epoch. Initial conditions have been applied in the IEF using steady state conditions.

Summary of boundary conditions

3.7.12 **Table 8** provides a summary of the boundary conditions applied for the tidally and fluvially dominant scenarios.

Table 8: Summary of tidal and fluvial boundary conditions

Scenario	Epoch	Tidal Boundary	Fluvial Boundary
Tidal Dominant	Present Day (2024)	2% AEP, 0.5% AEP, 0.1% AEP 70th percentile data	River Dee: 30 m^3/s Constant Tributary: 1 m^3/s Constant
	Future (2074)	0.5% AEP, 0.1% AEP 70th and 95th percentile data	
	Future (2100)	0.5% AEP, 0.1% AEP 70th and 95th percentile data	
Fluvial Dominant	Future (2074)	MHWS	1% AEP + 45% Climate Change 0.1% AEP + 45% Climate Change

4. Baseline Model Simulations and Proving

4.1 Overview

4.1.1 This section provides a summary of the tidal and fluvial model simulations undertaken as part of this study along with commentary on model stability. For all simulations the model was simulated in the partially undefended scenario (undefended at the Construction and Operation Area, defended throughout the wider model) that removes the private defences and screening mound along the frontage of the existing Connah's Quay Power Station site described in Section 2.9. At the request of NRW a sensitivity simulation was completed that retained the screening mound at the existing Connah's Quay Power Station site however this did not show worse flooding than the baseline scenario and is therefore not reported further. The baseline is considered the worst-case scenario for the assessment.

4.1.2 It was agreed with NRW at the meeting in May 2025 that the undefended scenario presented in this report represents the worst-case scenario for the Proposed Development. Therefore, no breach analysis has been undertaken as part of this assessment.

4.2 Model Runs

4.2.1 The following tidal AEP events have been simulated for the baseline scenario (partially undefended scenario) using model set up in Section 3 and boundary conditions presented in Section 3.7.

- 0.5% AEP (present day 70th percentile);
- 0.5% AEP (2074 70th percentile);
- 0.1% AEP (present day 70th percentile); and
- 0.1% AEP (2074 70th percentile).

4.2.2 The following fluvial AEP events have been simulated using boundary conditions presented in Section 3.7:

- 1% AEP (+45% climate change, upper end estimate); and
- 0.1% AEP (+45% upper end estimate).

4.2.3 Further future resilience scenarios reported in Section 8.3 were simulated using the following tidal AEP events:

- 0.5% AEP (2074, 95th percentile);
- 0.1% AEP (2074, 95th percentile);
- 0.5% AEP (2100, 70th percentile); and
- 0.1% AEP (2100, 70th percentile).

4.3 Model Timestep

4.3.1 The model timesteps were aligned with the smallest grid cell size (i.e. 4 m). The 1D FMP and ESTRY timestep was set to 1sec and the 2D TUFLOW timestep was set to 2sec. For the 10 m grid this leaves a 2D timestep of 1/5 the grid cell size which is within the recommended range stated in the TUFLOW Manual.

4.4 Model Stability

4.4.1 Mathematical instabilities can occur in hydraulic models which are evident when significant oscillations or mass balance errors (the artificial gain or loss of water) occur.

4.4.2 A bitmap of the FMP convergence plot for the 0.1% AEP 2074 (95th percentile) tidal simulation is presented in **Figure 13F-12**. This is the most extreme event simulated (including the simulation of the fluvially dominated scenarios). There are limited convergence issues in this model, with only a few small peaks throughout. The model convergence is considered acceptable for a 1D-2D model of this scale. The stage hydrographs throughout the model are smooth indicating that the flood wave is being conveyed through the model in a realistic manner. All modelling parameters have been retained at default values. No 1D ESTRY negative depths are experienced throughout the duration of the model for all AEP events simulated, for both tidal and fluvial scenarios. The FMP 1D mass balance error is within +/- 0.3% for all simulations.

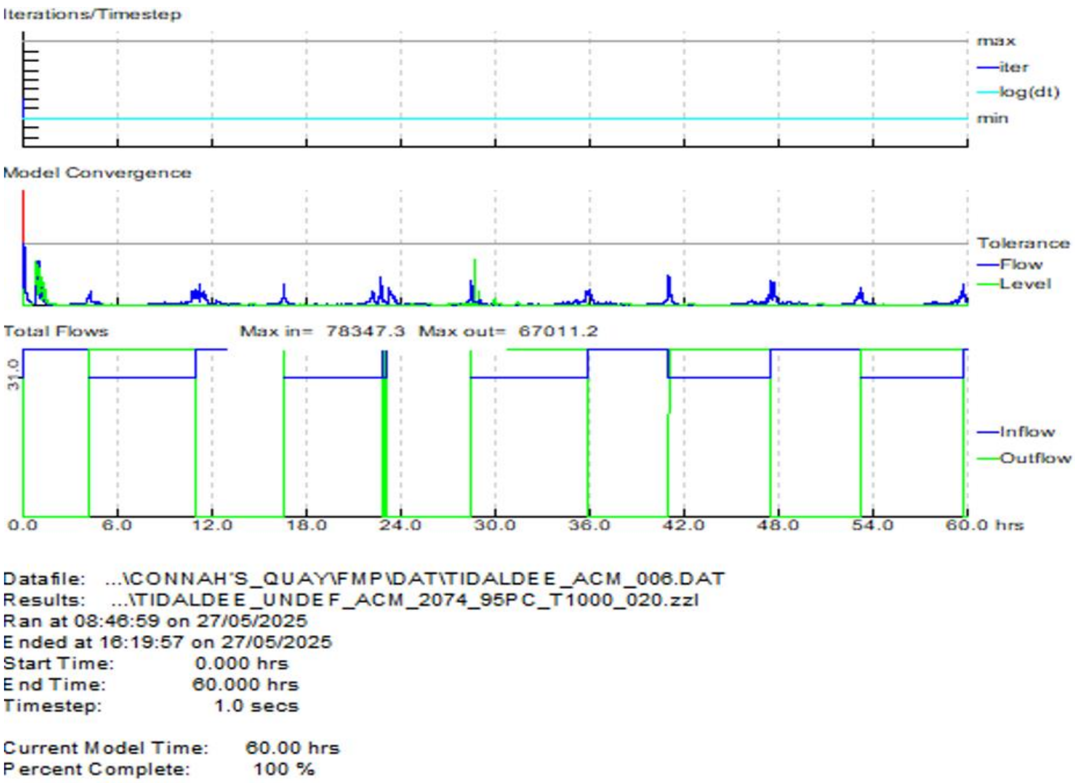


Figure 13F-12: 1D Convergence Plot for the 0.1% AEP 2074 Simulation

4.4.3 **Figure 13F-13** displays the TUFLOW 2D Mass Balance output (Cumulative Mass Error %) for the present day 2024 events and future 2074 tidal events. The mass error is shown to exceed +/- 1% for the first 30hrs of simulation for the majority of tidal events simulated. This then falls within the accepted tolerances during and after the peak of the event. The mass balance error is occurring during the wetting of cells in the initial tidal cycles prior to the peak of the event and is centred around tidal inlets at Flint and Wepre Brook. Whilst being within +/- 1% is the normal criteria for a "healthy" model, the mass balance error is occurring great enough distance from the Construction and Operation Area and critically is within tolerance during the peak of the event. It is therefore concluded that this does not impact the assessment at the Operational Footprint.

4.4.4 There are some instances of 2D negative depths within the model simulations (a total of 5890 for the 0.1% AEP 2074 event), which are centred around Wepre Brook and occur throughout the duration of the simulation. Whilst an effort has been made to remove these negative depths, due to the distance between Wepre Brook and the Construction and Operation Area these are not expected to have an impact on the conclusions at the Operational Footprint and these have not all been resolved for this project.

4.4.5 Commentary on the model checks and warning is provided within the model log which has been supplied with the hydraulic model.

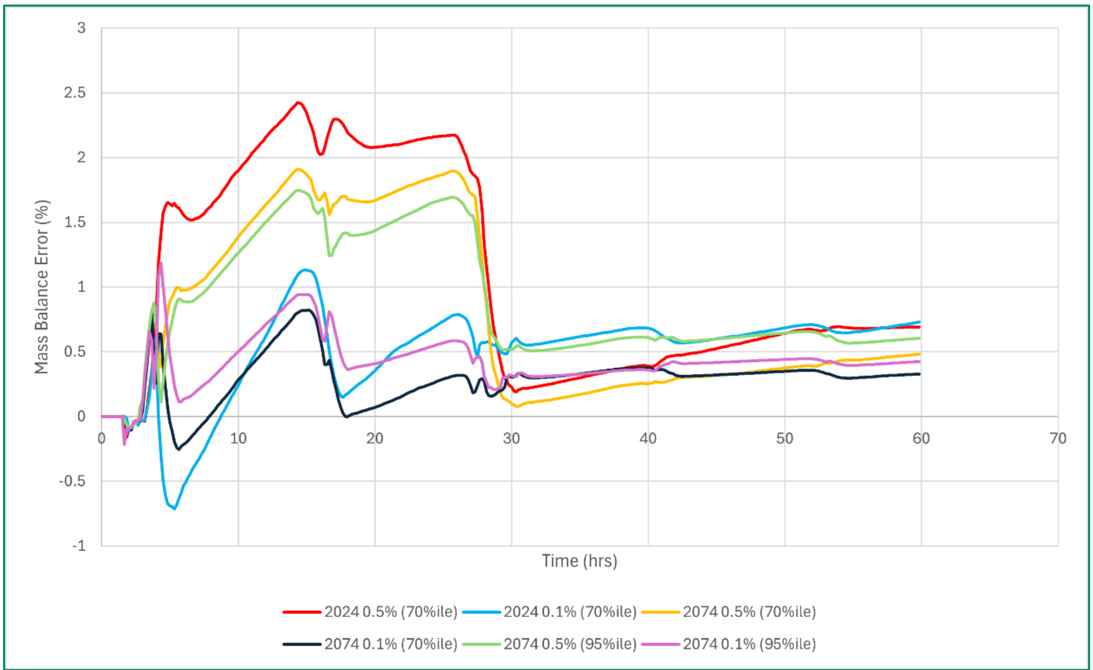


Figure 13F-13: 2D Cumulative Mass Error (%) for the 0.1% AEP 2074 Event

4.4.6 It should be noted that 4 nodes in the upstream extent of the 1D only model experience glass-walling. The nodes that experience glass-walling are situated upstream of Chester Wier and approximately 23 km from the Construction and Operation Area. This glass-walling was present in the received NRW 2020 River Dee Hydraulic Model and has not been updated as part of this study. The glass-walling means that the upstream floodplain is constricted and there is less floodplain storage. This means that larger volumes of water may be transferred downstream leading to potentially raised water elevations on the River Dee. This suggests that there would be an over-estimation of water levels on the River Dee towards the Construction and Operation Area. It was agreed with NRW at a meeting on 26 January 2025

(**Annex A**) that as this is a conservative estimate it is considered acceptable for these to remain in the model. Any future modelling study should review the representation of the floodplain upstream of Chester Weir.

5. Confidence in Model Results

5.1 Overview

5.1.1 All models vary in their ability to replicate real-life, and this section intends to outline how confident AECOM is in the results. The equations used in the model software have been developed from extensive research and whilst they are still generally approximations of the physical processes involved, the implications of the approximations are well understood. Uncertainty can be introduced during the model build when the data is limited, and assumptions must be made. This section firstly verifies the model results against previous studies and then presents the results of sensitivity testing to quantify the uncertainty.

5.1.2 Model calibration is a process of adjusting model parameters to match the results of the model with existing criteria. Whereas verification is a process of comparing model results to a real system and the behaviours exhibited within that system. Calibration or verification of a hydraulic model should always be carried out if there is appropriate data available. Calibration or verification against observed flood events improves confidence in the model's prediction of design flood events.

5.1.3 It is not documented if NRW's 2020 River Dee Hydraulic Model was calibrated or verified and therefore it has been assumed it has not. Unfortunately, there is no observed gauged data available at or near the Construction and Operation Area to carry out a full calibration exercise. A verification exercise has been carried out using TotalTide software predicted tide levels along the Dee Estuary.

5.2 Admiralty Total Tide Data

5.2.1 In order to verify the hydraulic model, an annual predicted tide curve was generated for 2024 at Hilbre Island using Admiralty Total Tide software. A 35-day period was then chosen between 25/02/2024 and 31/03/2024 to capture the Spring Tide and Neap tide cycle. The hydraulic model was simulated in 1D only using this 35-day tidal curve as the downstream boundary and a constant baseflow for the River Dee. Simulating in 1D only is acceptable because there is no out of bank flooding in this simulation.

5.2.2 The modelled results were compared with the Admiralty Total Tide data at 3 key locations throughout the model extent: Mostyn Docks (downstream of the Construction and Operation Area), Connah's Quay (closest to the Construction and Operation Area) and Chester (upstream of the Construction and Operation Area). **Table 9** displays the approximate locations of the stations.

5.2.3 It should be noted that the predicted data at Chester and Connah's Quay does not consist of a full hydrograph and instead only shows the timings and levels of high/low tide. For the purposes of the figures, the low tide level has been located at -1 m AOD for these locations.

Table 9: Approximate Locations of Admiralty Stations

Admiralty Location	Approximate Grid Reference
0464 Mostyn Docks	SJ 15773 80756
0463 Connah's Quay	SJ 30158 69381
0462 Chester	SJ 40159 67358

Mostyn Docks

5.2.4 **Figure 13F-14** shows the modelled results compared to predicted tide levels at Mostyn Docks over a 14-day period. **Figure 13F-15** shows the same data focused over a 2-day period when the tide level is highest (Spring Tide).

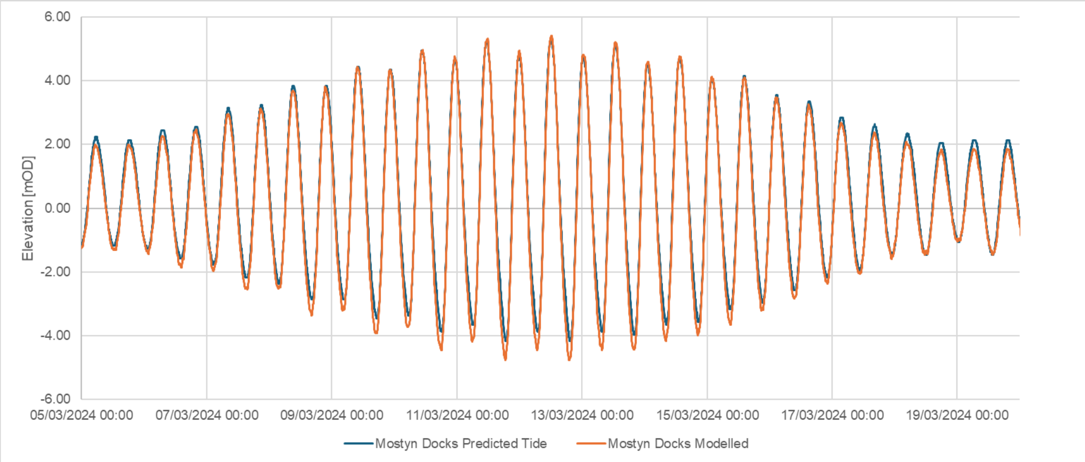


Figure 13F-14: Water Level at Mostyn Docks over a 14 Day Period

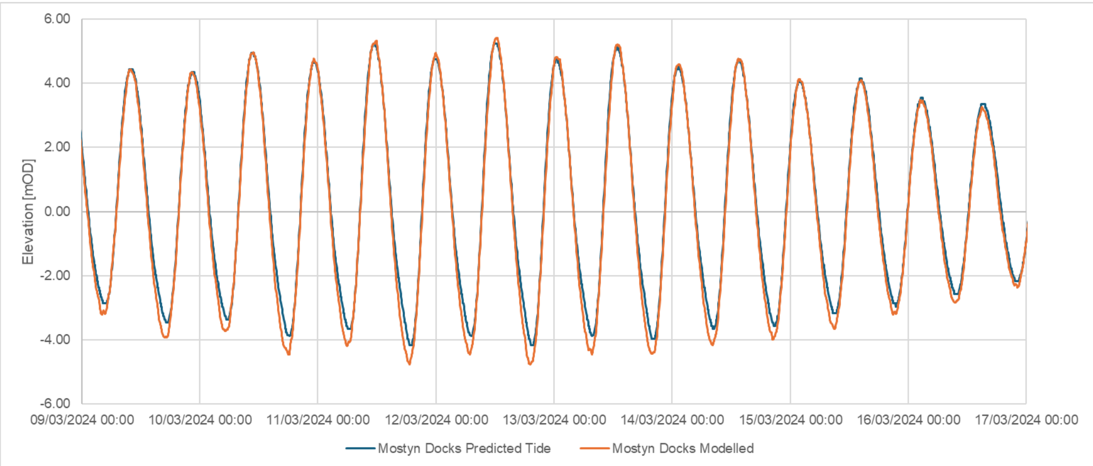


Figure 13F-15: Water Level at Mostyn Docks over a 2 Day Period

5.2.5 The modelled results at Mostyn Docks are very similar to the predicted tide levels at this location. The timings of high/low tides show a good fit to the predicted tide and the modelled high-water levels are shown to have a good correlation within ±0.3 m throughout the entire simulation. The low tide level is lower in the modelled outputs compared to the predicted dataset, by up to c. -0.60 m, however this is not expected to have an impact on the maximum flood modelling outputs and could be explained by the geometry of the cross section being slightly different due to the dynamic nature of the estuary.

5.2.6 At this location it is considered that the tidal water levels verified well.

Chester

5.2.7 **Figure 13F-16** shows the modelled results compared to predicted tide levels at Chester over a 14-day period. **Figure 13F-17** shows the same data focussed over a 2-day period when the tide level is highest (Spring Tide).

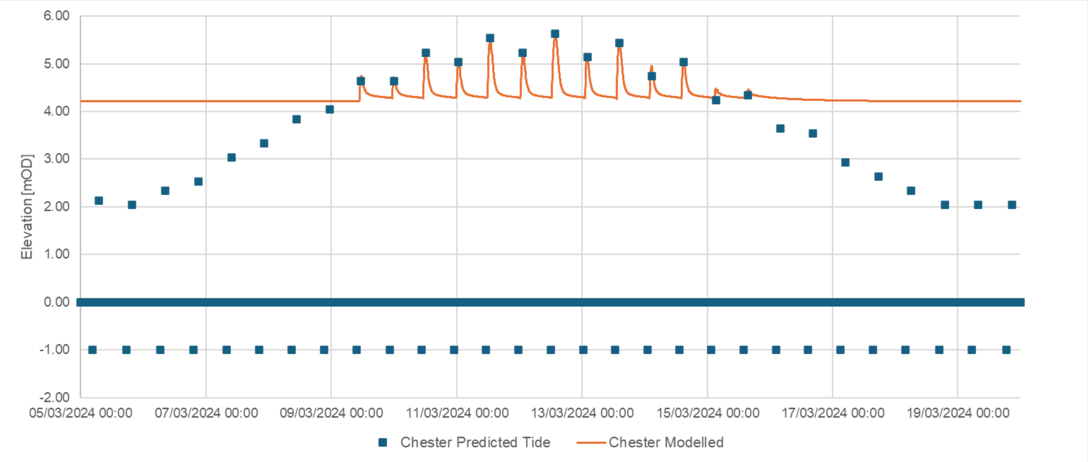


Figure 13F-16: Water Level at Chester over a 14 Day Period

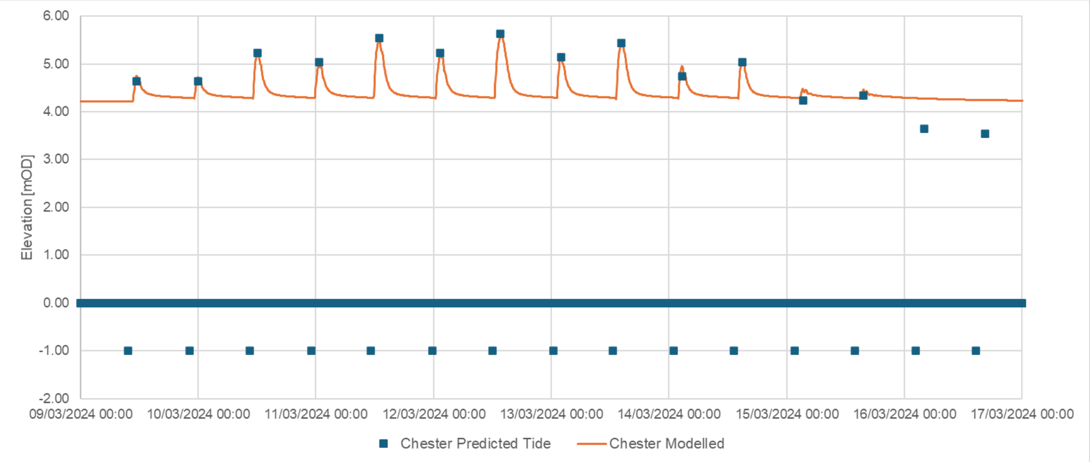


Figure 13F-17: Water Level at Chester over a 2 Day Period

5.2.8 The modelled results are relatively similar to the predicted tide levels at this location. The timings and levels of high tides show a good match, with the modelled outputs showing a slightly increased high-water level. The difference between high water levels is within a minimum and maximum of -0.03 m and +0.26 m throughout the model duration. The low tide levels show variation, with the modelled levels levelling off at 4.21 mOD. This is due to Chester Weir keeping the water level at 4.21 m AOD within the hydraulic model.

5.2.9 At this location it is considered that the tidal water levels verified well.

Connah's Quay

5.2.10 **Figure 13F-18** shows the modelled results compared to predicted tide levels at Chester over a 14-day period. **Figure 13F-19** the same data focussed over a 2-day period when the tide level is highest (Spring Tide).

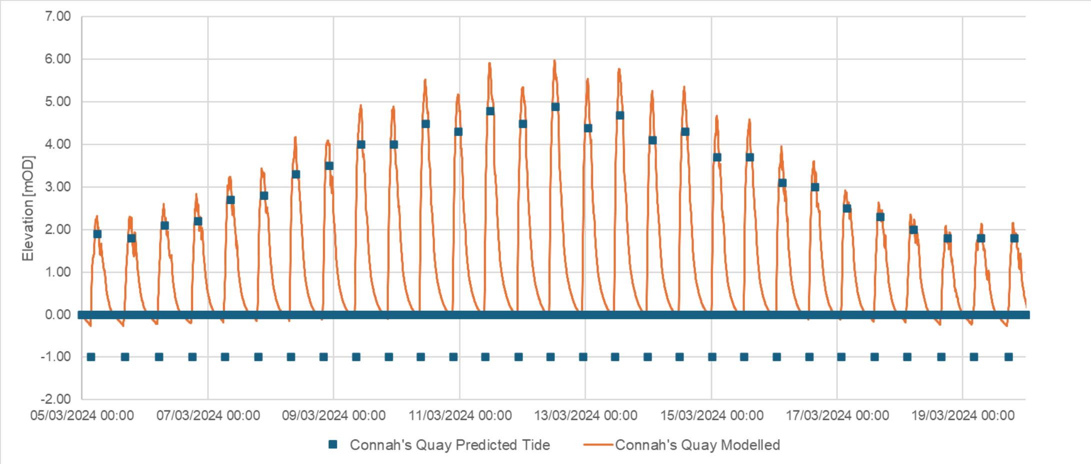


Figure 13F-18: Water Level at Connah's Quay over a 14 Day Period

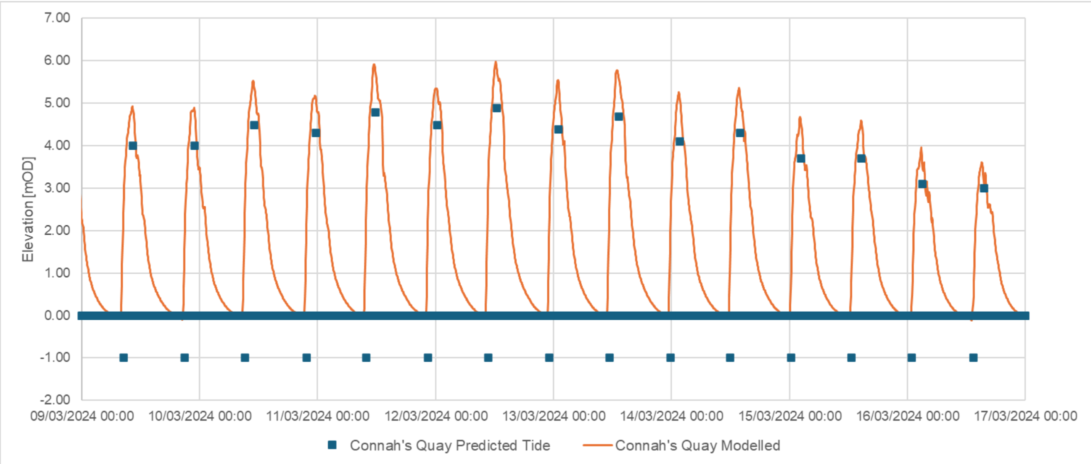


Figure 13F-19: Water Level at Connah's Quay over a 2 Day Period

5.2.11 At Connah's Quay the model results show a consistently higher level than the predicted high tide water levels up to a maximum of +1.16 m. The high-water level timings are within +/-1hr with an average of c.-0.25hrs. The timings of low tides are within +/- 1hr with an average of c. -0.41hrs.

5.2.12 Given the difference in maximum water level between the modelled and predicted tide a number of sensitivity tests have been undertaken on model parameters (varying fluvial inflows, Manning's roughness and bed elevations) to understand what influence they have on the results. The sensitivity tests showed some variation to the timings, level and shape of the tide curve at Connah's Quay; however, there was no significant change in the high-water level estimation compared to the baseline model results and the water level was continually overestimated at Connah's Quay. This is an indication that either the model is misrepresenting the estuary hydraulics due to the 1D representation, or there are issues with the predicted tide level data at Connah's Quay.

5.2.13 To test this a simple, 2D only TUFLOW model of the estuary was built using the 2003 bathymetry data and simulated with the Hilbre Island tidal boundary to understand if the 1D representation of the estuary impacts the verification results. The results were similar to the 1D-2D model and therefore it is concluded this is likely an issue with the predicted data for tide levels at Connah's Quay. The model cannot be verified at Connah's Quay until the underlying data is confirmed. However, as the model is currently overpredicting water levels at Connah's Quay it would suggest that it is a more conservative estimate with the available data. To build confidence in the model results observed water level data is required at Connah's Quay and should be considered prior to detailed design, as detailed in the **Framework CEMP** (**EN010166/APP/6.5**).

Verification Conclusion

5.2.14 Through this verification process it has been demonstrated that:

- The model verifies well at Mostyn Docks;
- The model verifies well at Chester; and
- At Connah's Quay the results were not fully verified but is likely to be over predicting the water levels.

5.2.15 Whilst there is uncertainty in the modelled results, which is typical for hydraulic modelling, they are considered suitable to progress the project, particularly as they appear to be overpredicting the water levels. If further confidence in the modelled results is needed it is recommended that observed data at Connah's Quay is collected to suitably calibrate the model.

6. Model Results

6.1 Overview

6.1.1 In this section the baseline hydraulic model results are described for each of the simulated tidal and fluvial design events described in Section 4, and the mechanism of flooding within the Construction and Operation Area and Operational Footprint are discussed. Maximum flood depth figures for each event simulated have been provided within **Annex D** of this document.

6.1.2 The assessment of future flood resilience simulations (2074 95th percentile and 2100 70th percentile) are described in the Section 7.3.

6.2 Tidal Flooding

6.2.1 At the Operational Footprint, the flooding mechanism is tidally dominated. **Figure 13F-20** displays the maximum flood extents for all simulated tidally dominant present day and future epoch (2074) AEP events (70th percentile data). The figure shows water to be generally confined to the Dee Estuary and little out of bank flooding is seen across the Construction and Operation Area. The Operational Footprint is not shown to flood for any simulated present day or future event, however parts of the Construction and Operation Area are shown to be flooded. All areas within the Construction and Operation Area that are shown to be flooded (the Repurposed CO_2 Connection Corridor adjacent to the railway in the north-west and the Construction & Indicative Enhancement Area in the south-east (C&IEA) are areas not proposed for any future formal development.

6.2.2 It should be noted that during the design flood event (0.5% AEP 2074 70th percentile), the Operational Footprint is not shown to flood. Section 6.2.4 provides an overview of the flooding mechanisms through the Construction and Operation Area for the most extreme event simulated, the 0.1% AEP 2074 event.

6.2.3 **Table 10** presents the maximum water levels extracted from Node Est_23500i. The cross section at this location has the lowest bank level adjacent to the Operational Footprint (7.04 m AOD).

Table 10: Maximum Water Level Outputs

Epoch	AEP (%)	70th Percentile Maximum Water Level (m AOD)
Present Day	0.5	6.46
	0.1	6.65
Future (2074)	0.5	6.80
	0.1	6.97

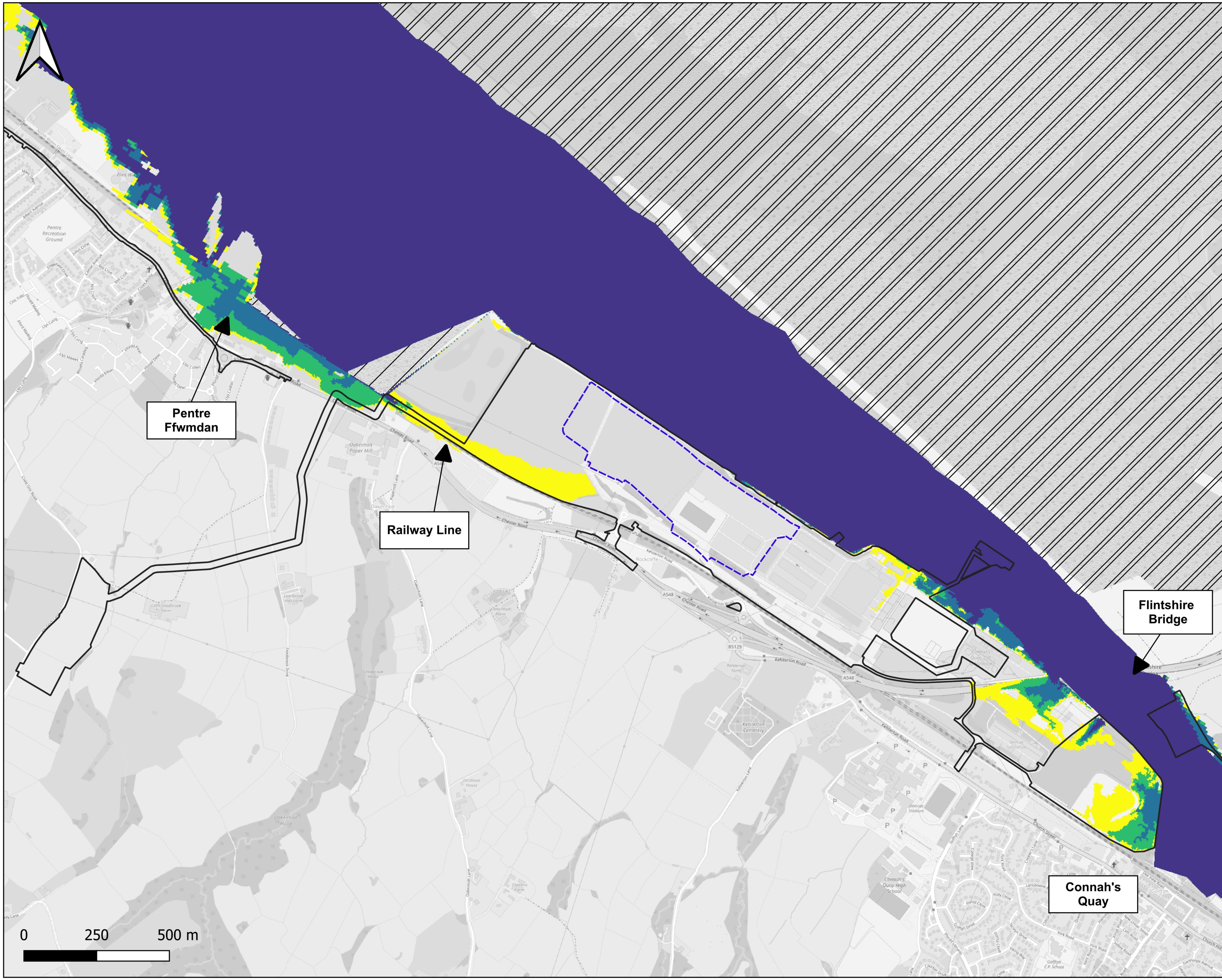
Tidal 0.1% AEP 2074

6.2.4 **Figure 13F-21** shows the maximum depth results for the tidal 0.1% AEP 2074 70th percentile event at the Construction and Operation Area. No part of the Operational Footprint is flooded during this event, although parts of the wider Construction and Operation Area are expected to be inundated by floodwater.

Floodwater overtops the left bank of the Dee Estuary near Pentre Ffwrndan 2.5 hours into the simulation, before flowing south-east along the railway line and flooding the western side of the Order limits. Flood depths reach 2.76 m within Pentre Ffwrndan and 1 m - 1.5 m within the Order limits along the railway line. Water also flows out of bank adjacent to Flintshire Bridge 27.5 hours into the simulation, before flooding the south-eastern extent of the Order limits. A maximum depth of c.1 m is reached in this location.

6.2.5 The two areas within the Construction and Operation Area shown to be flooded are the Proposed CO_2 Connection Corridor (adjacent to the railway in the north-west) and the Construction & Indicative Enhancement Area (in the south-east). Both of these areas are not proposed for any future permanent development.

6.2.6 The maximum level reached in the 1D channel adjacent to the Operational Footprint is 6.97 m AOD for the future tidal 0.1% AEP 2074 event.



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LEGEND

- Operational Footprint
- Order limits
- Dee Estuary (1D Only)

Maximum Flood Extents

- 0.5% AEP 2024
- 0.1% AEP 2024
- 0.5% AEP 2074
- 0.1% AEP 2074

Project Title

CONNAH'S QUAY LOW CARBON POWER

Copyright

Drawing Status

FINAL

Drawing Title

TIDAL SCENARIO MAXIMUM FLOOD EXTENTS (70TH PERCENTILE)

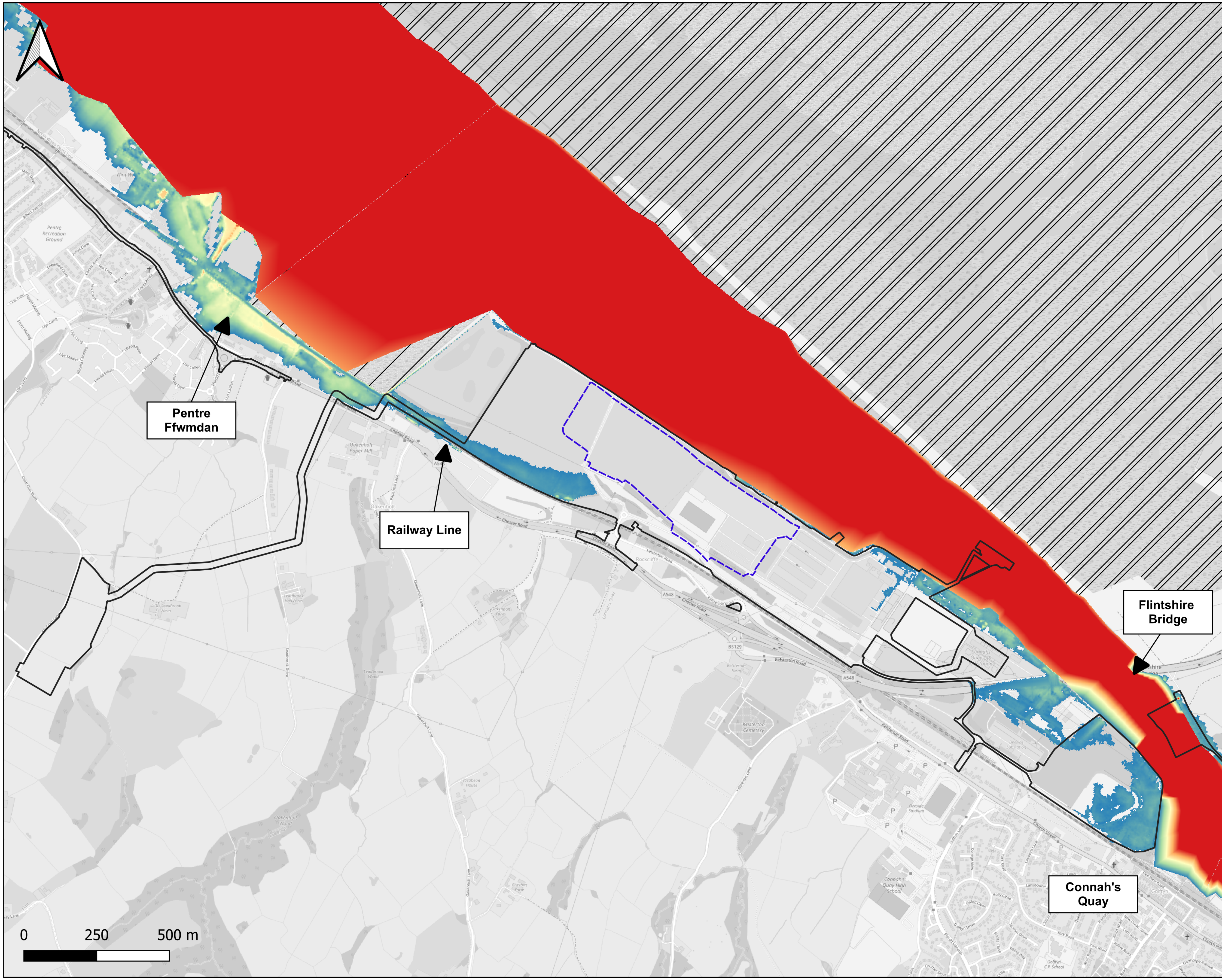
Client

UNIPER UK LTD

Scale at A3 1:12000	
Drawn AH	Checker RC
Approver HJ	Date 29/07/2025

AECOM
6th Floor,
3 Rivergate,
Temple Quay,
Bristol, BS1 6EW,
United Kingdom

Drawing Number **FIGURE 13F-20** Rev 1



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LEGEND

Operational Footprint

Order limits

Dee Estuary (1D Only)

Maximum Depth (m)

0.00

1.00

2.00

3.00

4.00

Model Run File:
TidalDee_UNDEF_2074_70pc_T1000_ACM_020

Project Title

CONNAH'S QUAY LOW CARBON POWER

Copyright

Drawing Status

FINAL

Drawing Title

TIDAL SCENARIO
0.1% AEP (2074)
MAXIMUM FLOOD DEPTH

Client

UNIPER UK LTD

Scale at A3 1:12000	
Drawn AH	Checker RC
Approver HJ	Date 29/07/2025

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Temple Quay,
Bristol, BS1 6EW,
United Kingdom

AECOM

Drawing Number **FIGURE 13F-21** Rev 1

6.3 Fluvial Flooding

6.3.1 Two scenarios have been simulated to represent a fluvially dominated flood event on the River Dee with a MHWS downstream boundary.

6.3.2 **Figure 13F-22** displays the maximum water level throughout the length of the modelled River Dee for both the 0.1% AEP 2074 tidal scenario and the 0.1% AEP +45% climate change fluvial scenario. As displayed in **Figure 13F-22**, flooding mechanisms are fluvially dominated upstream of Chester Weir and partially into Chester. Downstream of the location of the Shropshire Union Canal's outfall into the River Dee (1D model node 00010113210u), flood mechanisms become tidally dominated. The Construction and Operation Area is located approximately 13 km downstream of this location so is clearly tidally dominated.

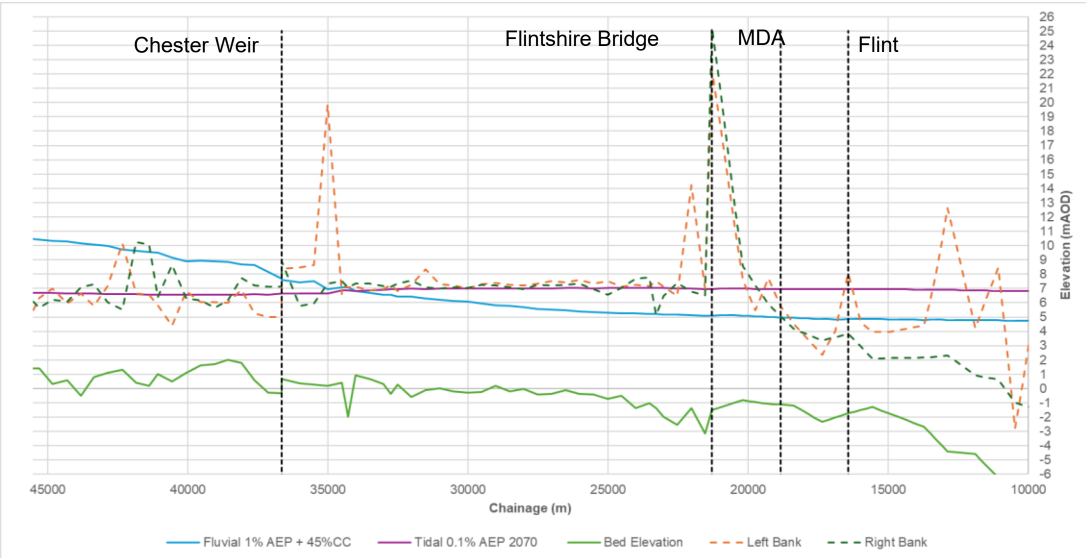
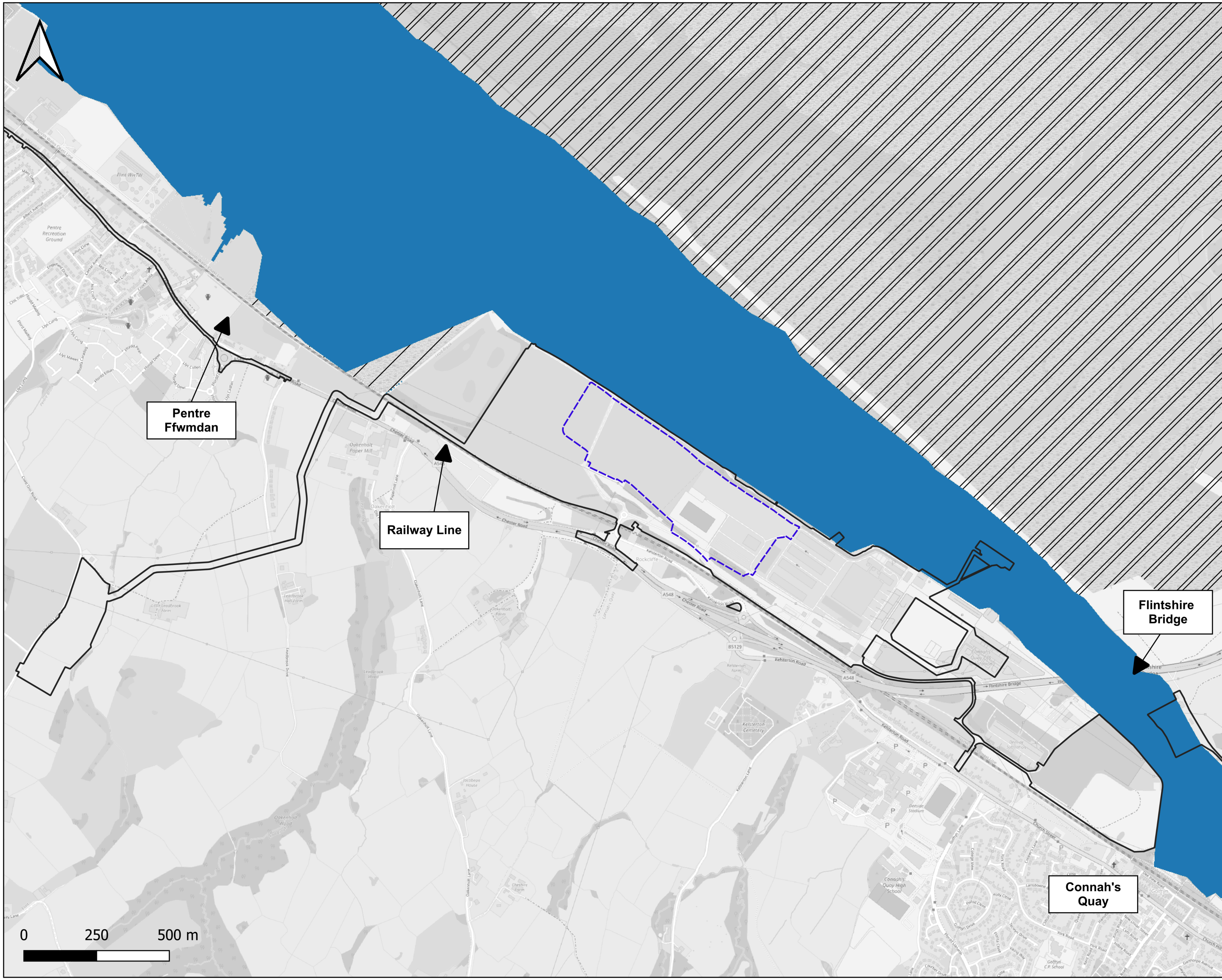


Figure 13F-22: Maximum Water Level through the River Dee

6.3.3 **Figure 13F-23** displays the maximum flood extents for the two fluvial AEP events simulated.

6.3.4 For both fluvial AEP events, all out of bank flooding is confined to the upper reaches of the River Dee and neither the Construction and Operation Area nor the Operational Footprint are impacted by floodwater. The maximum in-channel water level adjacent to the Operational Footprint is 5.05 mOD for both simulations which are dominated by the downstream MHWS tidal boundary.



THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT

LEGEND

- Operational Footprint
- Order limits
- Dee Estuary (1D Only)

Maximum Flood Extents

- 1% AEP + 45% Climate Change
- 0.1% AEP + 45% Climate Change

Project Title

CONNAH'S QUAY LOW CARBON POWER

Drawing Status

FINAL

Drawing Title

FLUVIAL SCENARIO MAXIMUM FLOOD EXTENTS

Client

UNIPER UK LTD

Scale at A3 1:12000

Drawn AH | Checker RC

Approver HJ | Date 30/07/2025

AECOM
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Bristol, BS1 6EW,
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AECOM

Drawing Number FIGURE 13F-23 Rev 1

6.4 Comparison with Previous Study

Overview

6.4.1 The baseline model results have been compared with the received NRW's 2020 River Dee Hydraulic Model. The maximum extents have been compared for the 2074 0.1% AEP event, with any key differences described below.

2074 0.1% AEP

6.4.2 **Figure 13F-24** displays an overlay of the maximum flood extents from the AECOM 2025 model compared to NRW's 2020 model. It should be noted that the epochs used for comparison are not equivalent, with NRW's 2020 model using an epoch of 2070 rather than 2074.

Figure 13F-24: Comparison with previous study (2074 0.1% AEP)

6.4.3 As displayed in **Figure 13F-24**, the maximum flood extents for both events show many similarities, with key areas of out of bank flooding occurring at Chester, Connah's Quay and at the Sealand Rifle Range (north of Deeside Industrial Park). Small differences between the maximum flood extents are, however, present in these areas.

6.4.4 The flood extent at Chester, Sealand Rifle Range and immediately upstream of Flintshire Bridge is slightly larger in the updated AECOM 2025 model, due to a higher in-channel water level. The flood extent surrounding Wepre Brook is shown to have reduced in the 2025 AECOM model, due to changes in the LiDAR DTM and improvements to the 1D-2D linking in this area.

Conclusion

6.4.5 It can be concluded that the maximum flood extents for the 2025 AECOM model are similar to NRW's 2020 model's maximum flood extent. Small disparities are seen within the flood extents, however the same key locations are inundated for both models, including Chester, Connah's Quay and the Sealand Rifle Range. As a result, this comparison adds validity to the updated model and subsequent outputs.

7. Sensitivity Analysis

7.1 Overview

7.1.1 Sensitivity testing of the model has been undertaken to assess the influence of parameter assumptions made during the model development on the assessment of flood risk at the Construction and Operation Area. Sensitivity testing is particularly important when calibration or verification data is not available or potentially unreliable. Sensitivity tests should be carried out on the design flood event and/or the event where the first out-of-bank flooding occurs, depending on the purpose of the project.

7.1.2 The following elements are considered standard sensitivity simulations suitable to assess the model sensitivity and therefore the potential impact on maximum flood depth:

- **Manning's roughness coefficients**: +/- 20% in 1D and 2D values for the 0.5% AEP 2074 tidal event;
- **Tidal event coinciding with fluvial flood event**: simulation of a 0.5% AEP 2074 tidal event with a 3.33% AEP fluvial event. 2no. scenarios have been tested, one using the same hydrograph/tidal profile as applied in their respective simulations, and one where the timings of the peaks of both events coincide; and
- **Climate change**: To assess the residual uncertainty within the estimation of the downstream tidal boundary the future tidal simulations have been run with the 0.5% AEP 2074 95th percentile and 0.1% AEP 2074 95th percentile events. Additional future resilience scenarios have been simulated using the 2100 0.5% AEP 70th percentile and 0.1% AEP 70th percentile simulations events.

7.1.3 It should be noted that the Method Statement originally shared with NRW stated a sensitivity test relating to the representation of buildings in the model maybe undertaken. No formal sensitivity test has been undertaken, however the Manning's n value of the buildings was updated from 0.3 to 0.5 following NRW's model review. A comparison of the flowpaths and flood extents between the two iterations of the model shows that the update results in no significant changes and therefore no further building sensitivity has been undertaken.

7.2 Manning's Roughness

7.2.1 It has been assumed that manning's n roughness coefficients applied to the model appropriately represent surface friction. Manning's roughness coefficient sensitivity was conducted by applying a +20% and -20% value to all 1D (open channel, bridges and culverts) and 2D (floodplain) 'n' parameters as specified in the 1D FMP DAT file and 2D materials layer respectively. This test also provides an indication of the sensitivity of flood risk to any change in watercourse condition or maintenance.

7.2.2 **Figure 13F-25** and **Figure 13F-26** present maximum water level difference maps comparing the present day 0.5% AEP tidal baseline with the +20% and -20% Manning's n roughness sensitivity results respectively.

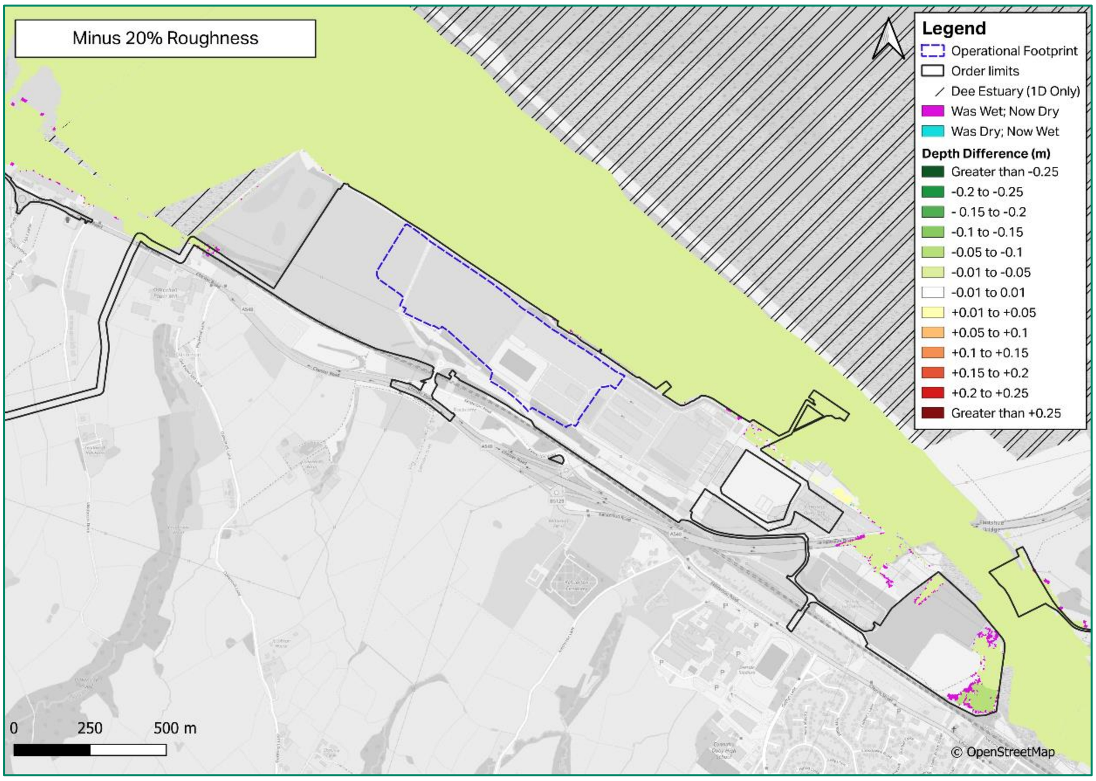

Figure 13F-25: Minus 20% Roughness Depth Difference Map

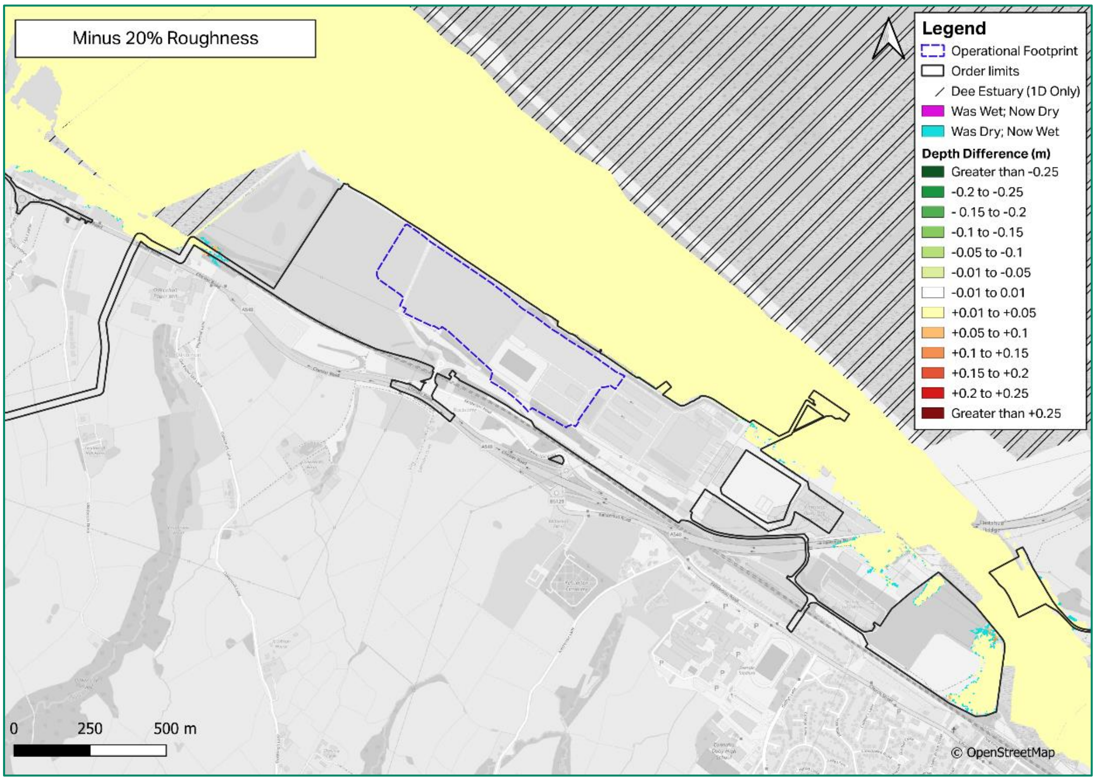

Figure 13F-26: Plus 20% Roughness Depth Difference Map

7.2.3 The two figures show that the modelled flood depths are not particularly sensitive to changes in manning's roughness, with a decrease in manning's roughness resulting in only slightly lower depths and vice versa when considering an increase in manning's roughness. Changes in flood depth are generally confined to the channel, and changes are more prominent further upstream. This is reversed from what would be expected in a fluvially dominated watercourse because the change in bed friction impacts the speed at which the tide propagates up the River Dee and this is the dominant mechanism at the Construction and Operation Area.

7.2.4 **Figure 13F-25** shows that applying a 20% decrease in roughness results in a decreased flood depth of up to -0.15 m adjacent to the Operational Footprint. **Figure 13F-26** shows that applying a 20% increase in roughness results in an increased flood depth of up to +0.01 m adjacent to the Operational Footprint. There is no significant change to the maximum flood extent adjacent to the Operational Footprint or the Construction and Operation Area.

7.2.5 These changes are generally proportionate to the increase or decrease in manning's roughness that has been applied and consistent with a tidally dominated system. Overall, the flood extents for the sensitivity runs and the baseline 0.5% AEP 2074 run show minimal differences.

7.3 Tidal Event Coinciding with Fluvial Flood Event

7.3.1 Two sensitivity tests have been undertaken where the 3.33% AEP fluvial event coincides with the 0.5% AEP 2074 tidal event. This has firstly been simulated using the same timings of peak flows as in the baseline models, and also with the peaks of both events aligned. In this sensitivity test, the tidal peak has been adjusted to align with the peak fluvial time adjacent to the Construction and Operation Area and the simulation time has been extended to 80 hours to ensure the peak of the fluvial event is entirely captured.

7.3.2 **Figure 13F-29** displays the maximum water level through the modelled River Dee for both sensitivity events, alongside the baseline tidal event. The water level impacts are more pronounced further upstream towards Chester. At the Operational Footprint (**Figure 13F-29**) the maximum water levels in the sensitivity tests align with the baseline scenario. The impacts at the Operational Footprint are also illustrated on **Figure 13F-30**. As illustrated, the water level at high tide aligns with the baseline for both events, with the only change seen at low tide where the sensitivity tests experience higher levels.

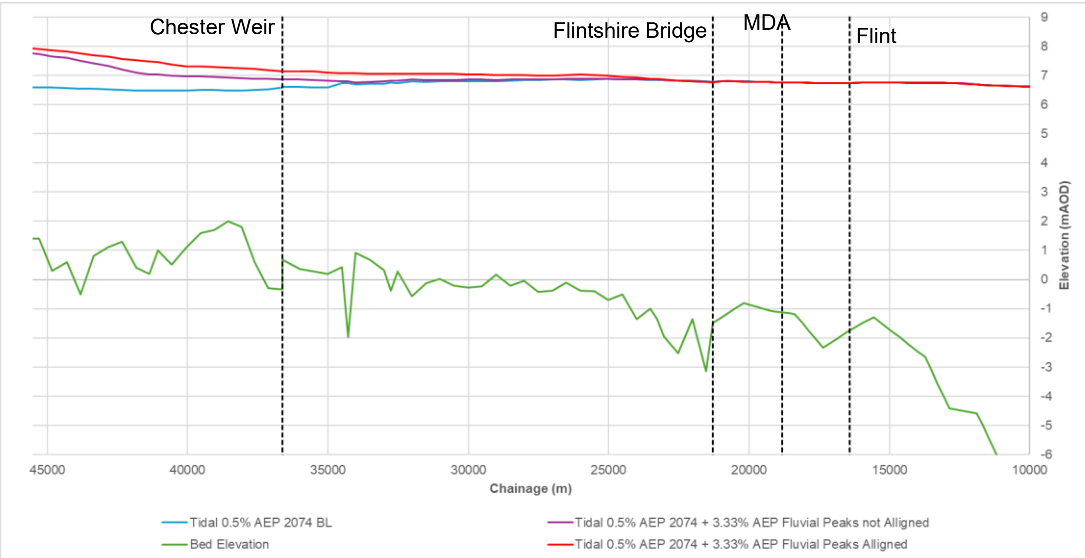

Figure 13F-27: Maximum Water Level through the River Dee for the sensitivity scenarios and the corresponding baseline event (0.5% AEP 074 tidal and 0.5% AEP 2074 tidal + 3.33% AEP fluvial with and without aligned peaks)

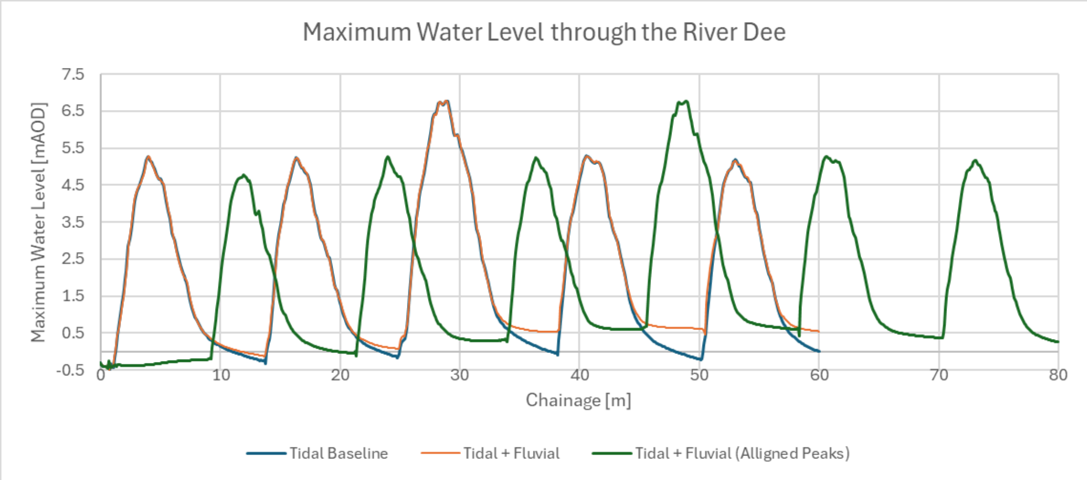

Figure 13F-28: Water Level adjacent to the Operational Footprint for the sensitivity scenarios and the corresponding baseline event (0.5% AEP 2074 tidal and 0.5% AEP 2074 tidal + 3.33% AEP fluvial)

7.3.3 **Figure 13F-29** and **Figure 13F-30** show depth difference maps for each event, compared with their respective tidal baseline events.

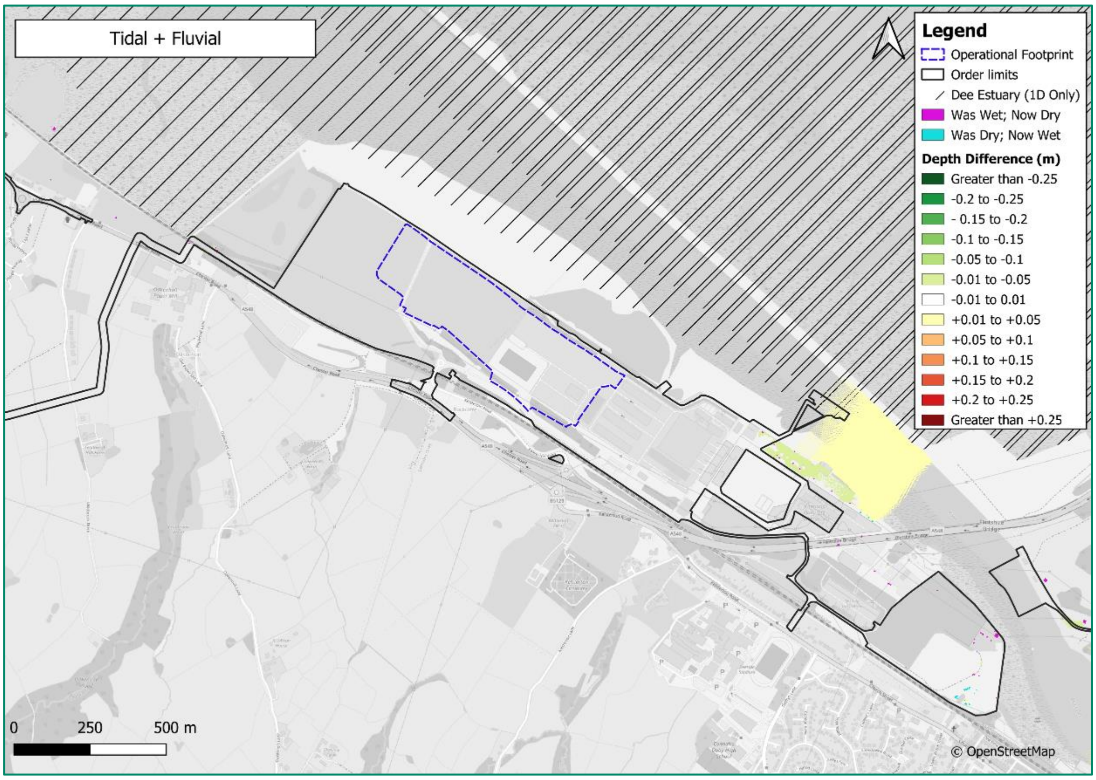

Figure 13F-29: Tidal + Fluvial Event (with timings of peaks retained from baseline models) compared to baseline tidal event

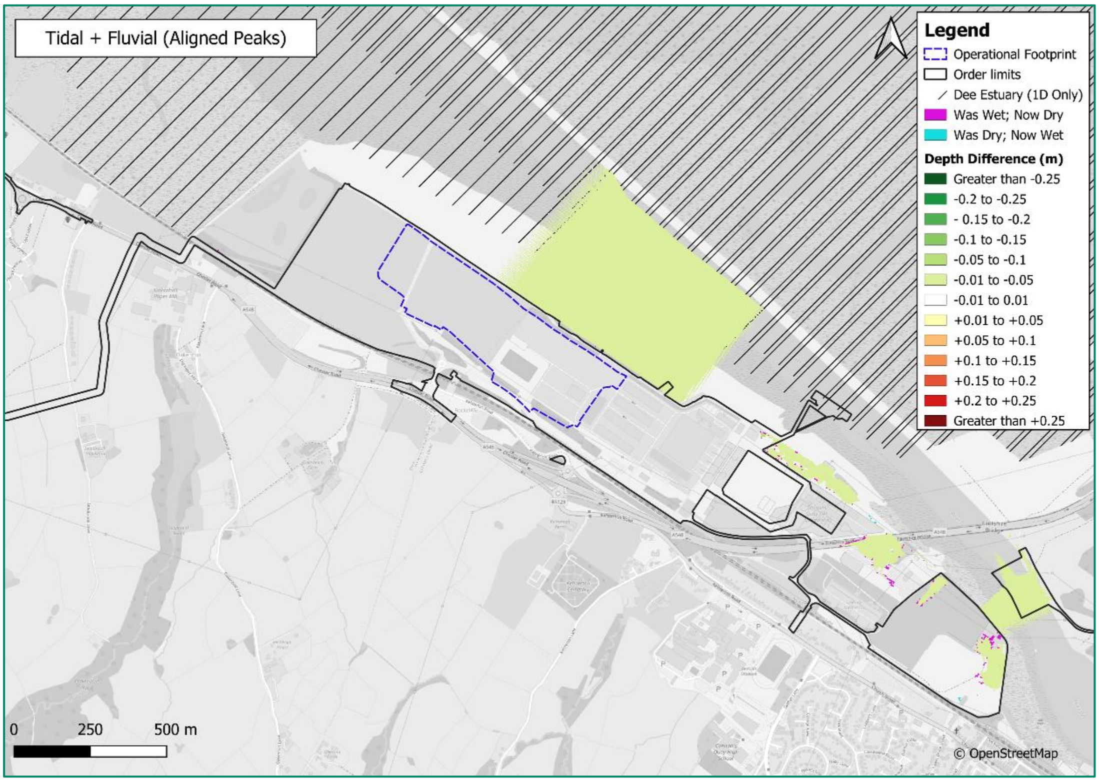

Figure 13F-30: Tidal + Fluvial Event (with timings of peaks aligned) compared to baseline tidal event

7.3.4 As shown above, and as illustrated in the water level plots, the two depth difference plots show similar impacts when compared to the baseline tidal event. Small areas of betterment are seen adjacent to the Operational Footprint and downstream of the Construction and Operation Area, however these are small depth changes seen (up to -0.01m).

7.3.5 The impacts of a tidal result coinciding with a fluvial result show minimal changes around the Operational Footprint. The Operational Footprint is not inundated for either event, thus providing additional confidence that the outcomes of this study are not sensitive to the joint probability of a fluvial and tidal event.

7.4 Climate Change

7.4.1 Four additional future climate change scenarios have been simulated for the 0.5% AEP (2074) and 0.1% AEP (2074) tidal events using 95th percentile from UKCP18 RCP 8.5 tidal boundary to assess the resilience of the Proposed Development to future sea level rise and uncertainty in the tide level estimations. A further two future climate change scenarios have been simulated for the 2100 epoch using the 0.5% AEP and 0.1% AEP 70th percentile tidal events to assess a longer design life of the development.

7.4.2 **Figure 13F-31** and **Figure 13F-32** show the maximum depth outputs from the 0.5% and 0.1% AEP (2074) 95th percentile scenarios. **Figure 13F-33** and **Figure 13F-34** show the maximum depth outputs from the 0.5% and 0.1% AEP (2100) 70th percentile scenarios. The results for each scenario will be discussed in detail below.

7.4.3 **Table 11** shows the maximum water levels adjacent to the Operational Footprint, at node Est_23500i.

Table 11: Maximum Water Level Outputs

Epoch	AEP (%)	70th Percentile Maximum Water Level (m AOD)	95th Percentile Maximum Water Level (m AOD)
Future (2074)	0.5	6.80	6.89
	0.1	6.97	7.12
Future (2100)	0.5	7.04	N/A
	0.1	7.27	N/A

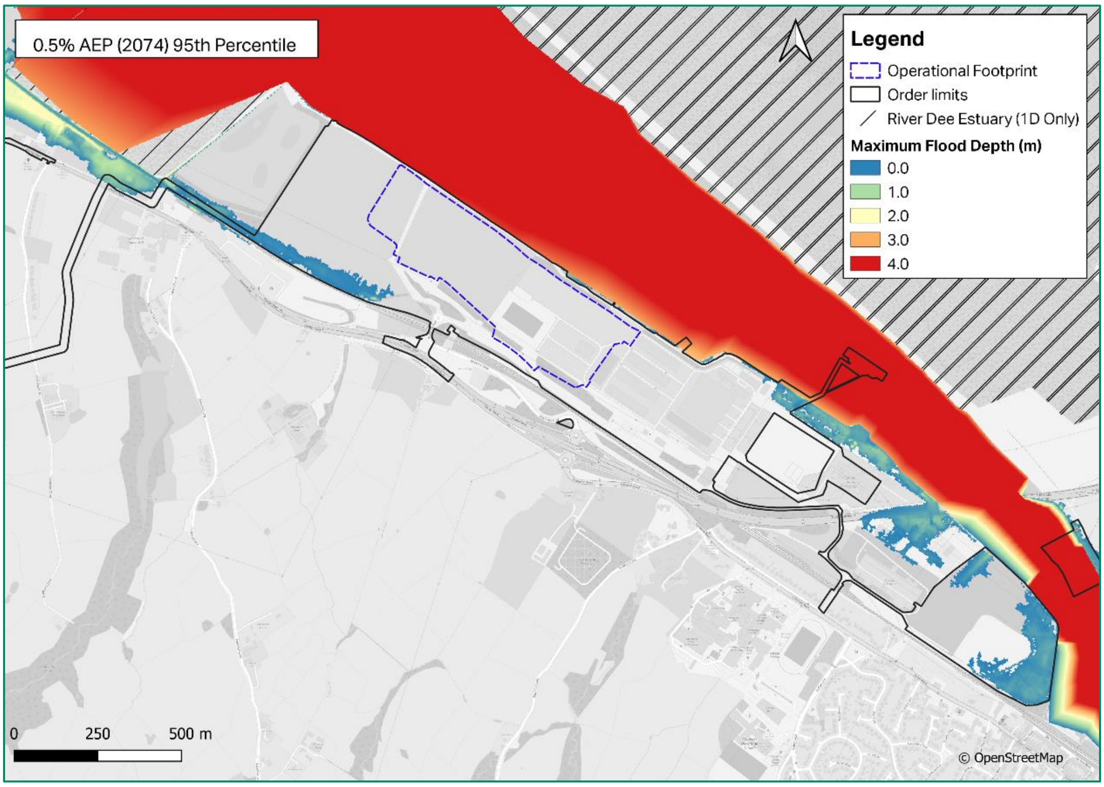

Figure 13F-31: 0.5% AEP (2074) 95th Percentile Data Maximum Flood Depth

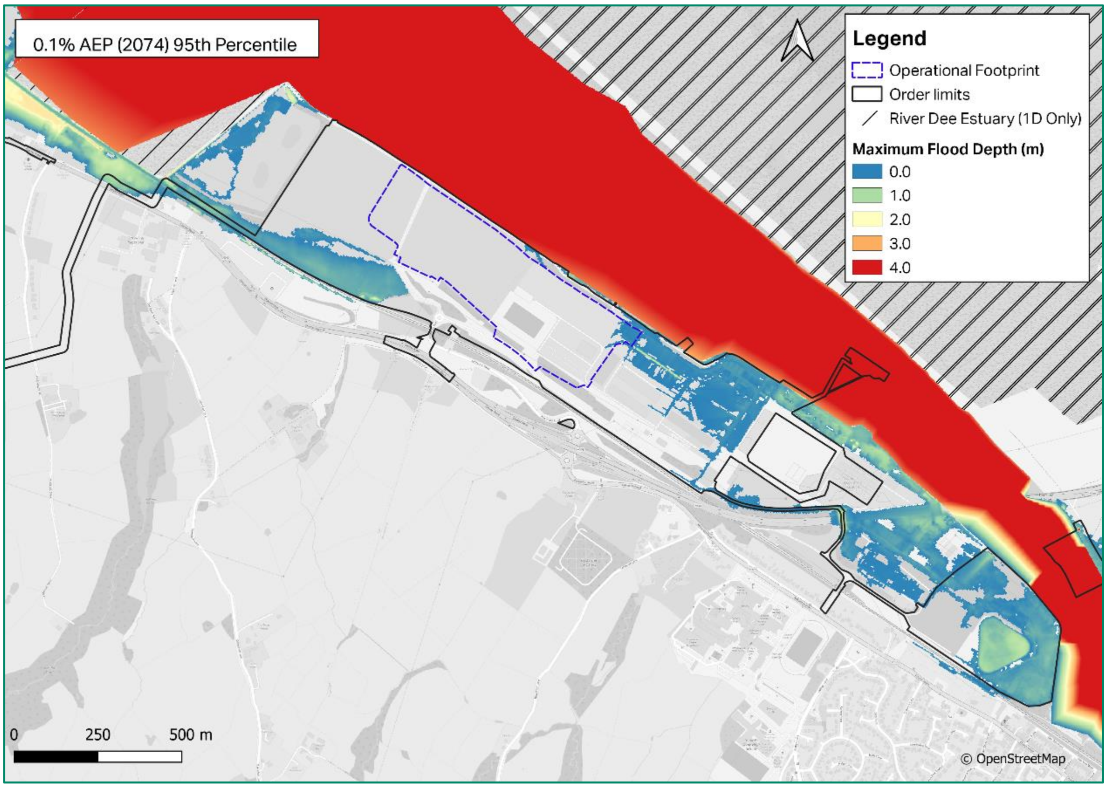

Figure 13F-32: 0.1% AEP (2074) 95th Percentile Data Maximum Flood Depth

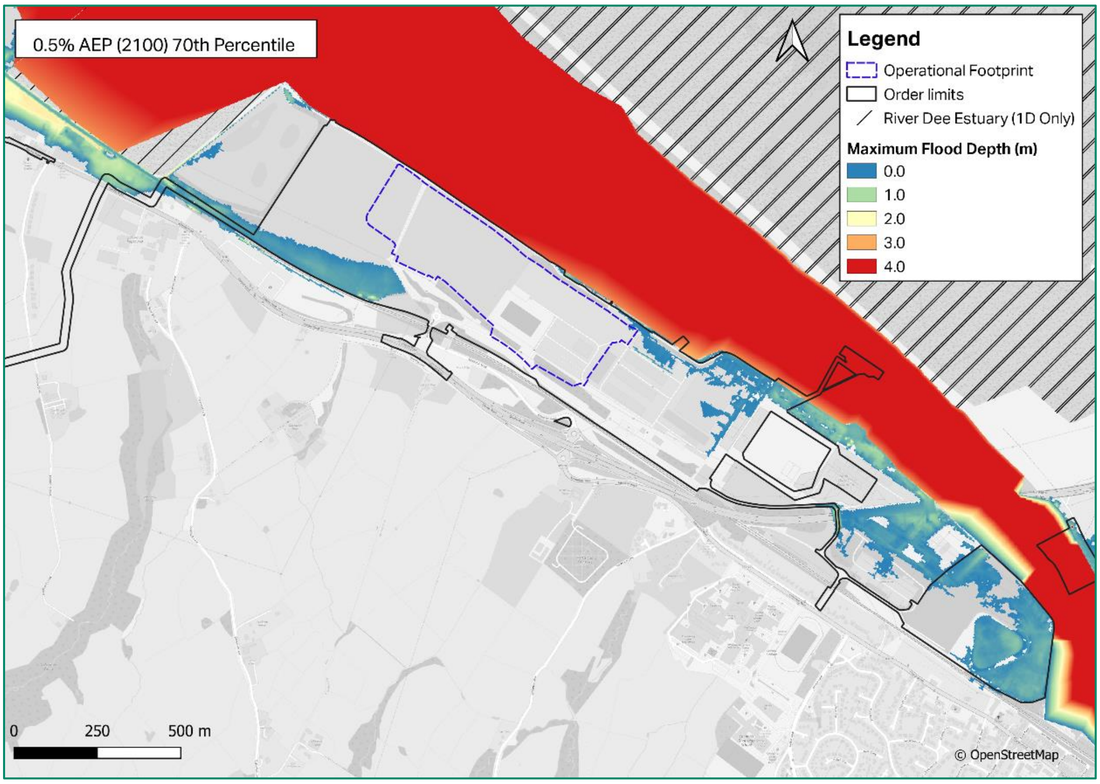

Figure 13F-33: 0.5% AEP (2100) 70th Percentile Data Maximum Depth

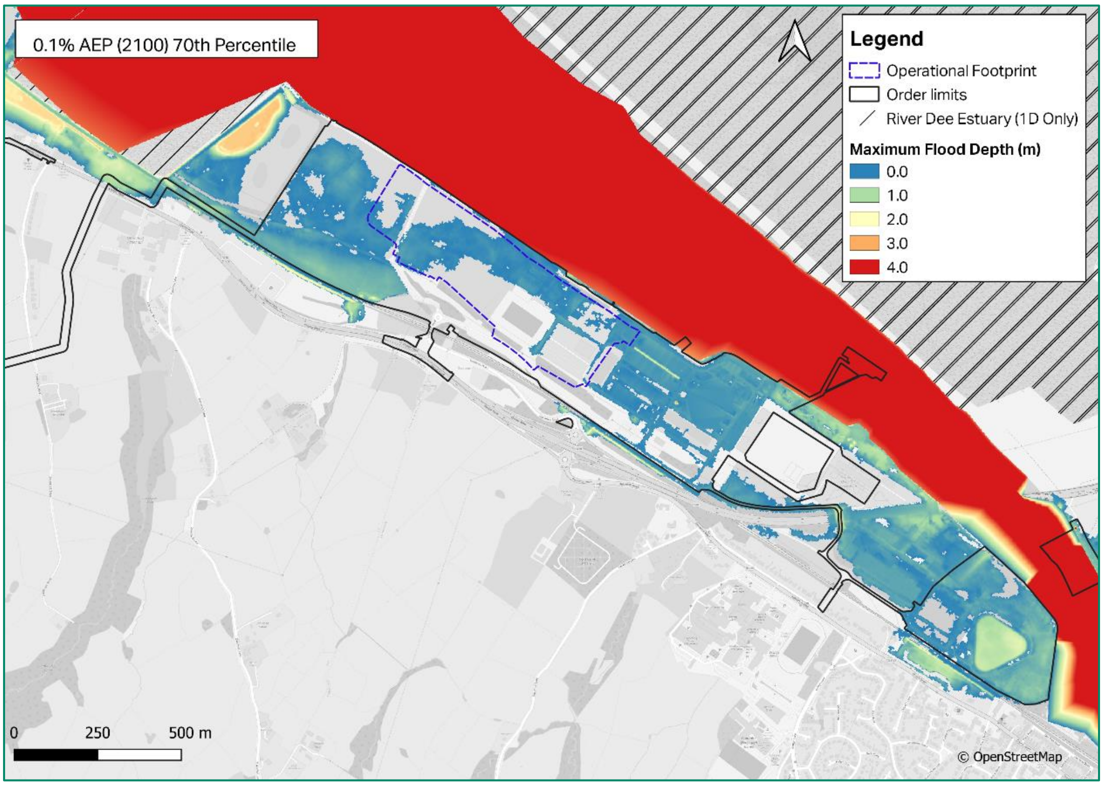

Figure 13F-34: 0.1% AEP (2100) 70th Percentile Data Maximum Depth

7.4.4 **Figure 13F-31** shows a maximum increase in flood depths within the channel adjacent to the Operational Footprint of +0.11 m when compared to the 70th percentile scenario. The flood extent is shown to increase slightly adjacent to the railway line located south of the Operational Footprint. The Operational

Footprint is not shown to be inundated during this event, however areas of the Construction and Operation Area are shown to be impacted.

7.4.5 **Figure 13F-32** shows a maximum increase in flood depth within the channel adjacent to the Operational Footprint of +0.17 m when compared to the 70th percentile scenario. Similarly to the lower AEP extent, this event shows an increase in flood extent along the railway line within the Construction and Operation Area, and flood depths within this area are shown to increase by +0.19 m compared to the baseline event. The Construction and Operation Area, including the existing Connah's Quay Power Station area are shown to be flooded during the 0.1% AEP event where they are not inundated during the baseline run. There is a small section of the Operational Footprint near the frontage that is shown to the flood as the maximum water level rises c.0.1 m above the raised ground levels. The area of inundation is small and remains at a depth of less than 0.15 m.

7.4.6 **Figure 13F-33** displays the Operational Footprint to not be flooded during the 0.5% AEP 2100 (70th percentile data) event. The Construction and Operation Area is shown to be inundated, however flood depths remain shallow. **Figure 13F-34** displays the maximum flood depth for the 0.1% AEP (2100) 70th percentile data event, where the Operational Footprint is shown to be inundated with floodwater. The maximum flood depth within the Operational Footprint is 0.43 m during this event. It should be noted that this event is the only modelled baseline event where the Operational Footprint is shown to be significantly flooded.

7.4.7 These changes are generally proportionate to the increase in tidal boundary that has been applied. The Operational Footprint is only inundated in the 0.1% AEP, 2074, 95th percentile event (maximum depth of 0.15 m) as well as the 0.1% AEP, 2100, 70th percentile event (maximum depth of 0.43 m). These are both extreme events and this indicates resilience to future sea level rise.

7.5 Summary

7.5.1 The results of the roughness and climate change sensitivity tests demonstrated that the modelled floodplain depths and maximum extents are not sensitive to variations in both roughness and tidal boundary levels and the changes are proportional to the parameter change. When the tidal event coincides with a fluvial flood event, the impacts are significant further upstream, however no impacts are seen surrounding the Construction and Operation Area. Floodplain depths remain low, and the Operational Footprint is not inundated for any of the sensitivity tests except the extreme 0.1% AEP, 2074,95th percentile event and the 0.1% AEP, 2100, 70th percentile event. In the 0.1% AEP, 2074, 95th percentile scenario only a small portion of the frontage is impacted to a depth of less than 0.15 m. In the 0.1% AEP, 2100, 70th percentile scenario the flooding through the Operational Footprint is more widespread, however flood depths remain relatively low, up to a maximum of 0.43 m. Consequently, there is confidence in the robustness of the baseline model results and it is concluded that no changes are considered necessary following these sensitivity runs.

8. Proposed Model

8.1 Overview

8.1.1 Following progression of the Operational Footprint design, it was decided that a proposed scenario would be simulated to assess the on-site and off-site impacts of land raising within the Operational Footprint. The model was set up with the same private defences removed as the baseline scenario (partially undefended scenario).

8.1.2 **Figure 13F-35** displays the area for proposed land raising (Operational Footprint), which has been raised out of the floodplain to a constant level of 7.4 m AOD. This level corresponds to the 2074 0.5% 70th percentile maximum water level at the Operational Footprint (6.8 m AOD), plus a 0.6 m freeboard. The buildings finished floor level within the proposed land raising area have all been raised to a constant value of 7.7 m AOD, corresponding to the 2100 0.5% 70th percentile maximum water level (7.1m AOD) plus a 0.6 m freeboard. It should be noted that **Figure 13F-35** uses a base map showing the existing Connah's Quay Power Station site and not the Proposed Development.

8.1.3 The Manning's roughness has been set to a uniform value of 0.02 throughout the area of proposed land raising. No other changes have been made to the baseline hydraulic model.

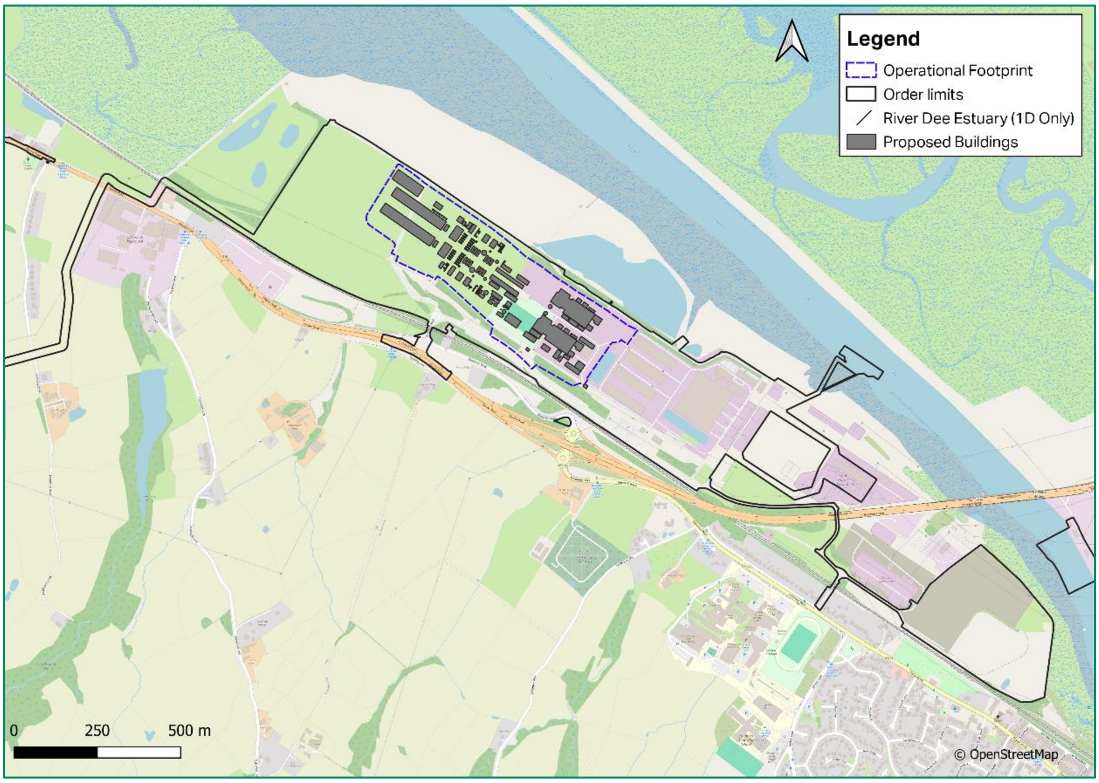

Figure 13F-35: Proposed Scenario Representation (Proposed Buildings representation is indicative)

8.1.4 The proposed model has been simulated for the following events, as the baseline models for these events show on-site flooding:

- 2100 0.5% AEP (70th percentile); and

- 2100 0.1% AEP (70th percentile).

8.1.5 The model was simulated for the 2074 epoch simulations but as there is no flooding of the Operational Footprint in the baseline model this has not been reported. Throughout this section, reporting will focus on the 0.1% AEP 2100 event, as this is the only baseline event that floods the Operational Footprint significantly.

8.2 Model Results

On-Site Impact

8.2.1 **Figure 13F-36** displays a depth difference plot between the baseline and proposed flood depths, for the 2100 0.1% AEP event (70th percentile data). All flooding is shown to be removed from the Operational Footprint due to the land raising. The area south-east of the proposed land raising area shows a slight benefit (up to -0.10 m), whilst the area immediately north-west shows a slight detriment (up to +0.05 m). There is also an increase of +0.1 m-+0.15 m on the access road along the Dee Estuary. All increases are contained within the Order limits.

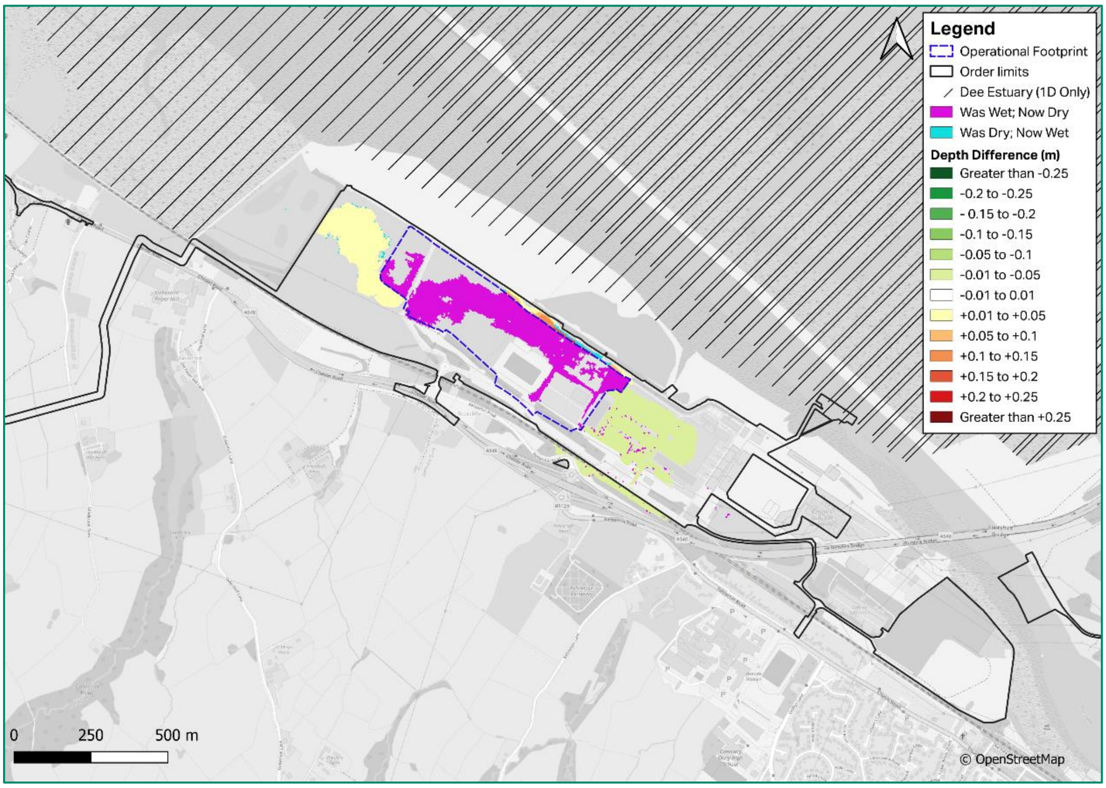

Figure 13F-36: Proposed Scenario Depth Difference (0.1% AEP 2100 70th Percentile Data)

Off-Site Impact

8.2.2 Small areas upstream of the Order limits show impacts as a result of the land raising during the 0.1% AEP 2100 70th percentile tidal event. These are mainly centred around Wepre Brook and the 1D culvert in this location and do not occur in any other simulation.

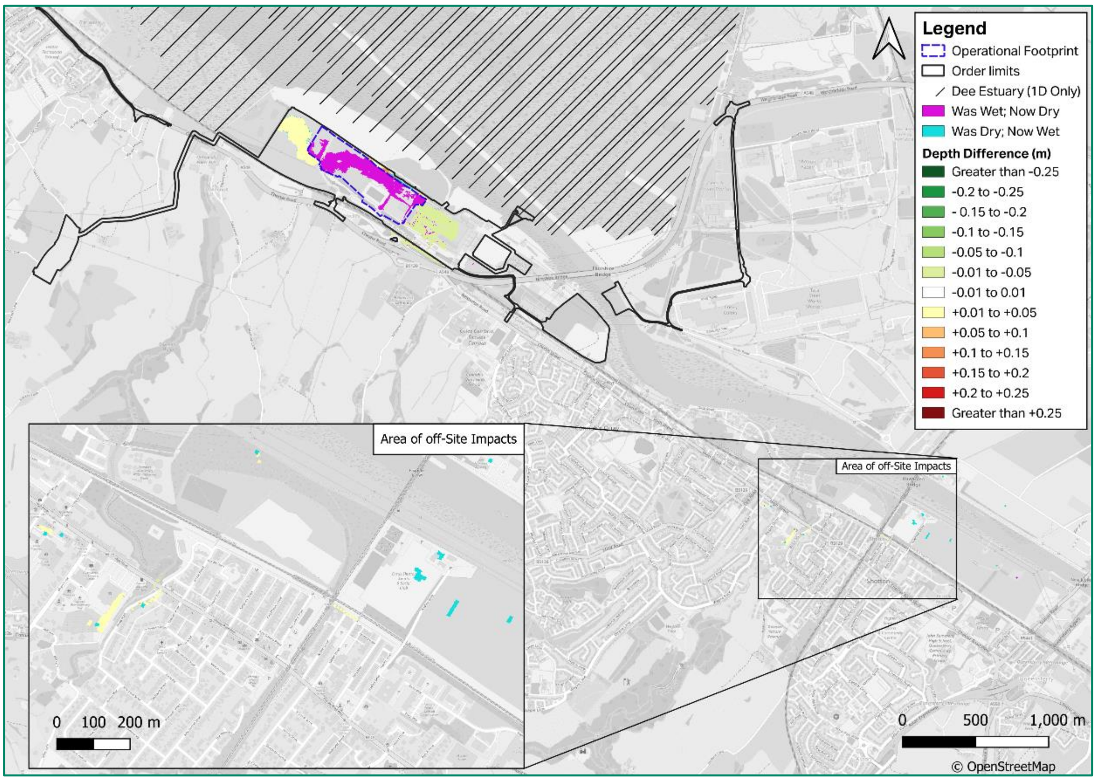

Figure 13F-37: Off-Site Impacts Depth Difference Plot (0.1% AEP 2100 70th Percentile Event)

8.2.3 A review of the hydrographs through the main channel in this location shows no change in flow, stage or timings as a result of the proposed land raising (<1 mm). It has therefore been concluded that the small changes in depth and flood extent are as a result of impacts to the simplification of the 1D culvert connecting the River Dee to Wepre Brook and model stability within the floodplain.

8.2.4 A check of this culvert in both the baseline and the land raising scenario indicates that both flow and stage through the culvert is the same in both scenarios. The flow is seen to oscillate through this culvert in both scenarios, and as a result the change to flood depths within this area is likely due to an instability in the 1D culvert, rather than any real impact of the land raising. Given the distance upstream of the Construction and Operation Area (c.2 km), small magnitude of change and the reasons presented above these increases in flood depth is not considered to be significant.

8.3 Conclusion

8.3.1 In conclusion, the area for proposed land raising (Operational Footprint) shows a complete reduction in flood extent, and minor impacts to flood depths are seen immediately adjacent to the land raising area. The on-site area south-east of the proposed land raising area shows a slight benefit (up to -0.10 m), whilst the area immediately north-west shows a slight detriment (up to +0.05 m). The land raising scenario shows no significant off-site impacts. Small changes are seen centred around Wepre Brook, however these are likely to be as a result of model stabilities.

9. Assumptions and Limitations

9.1.1 When considering the results and discussion throughout this report, it is important to understand the assumptions and limitations of the model and its outputs. These are as follows:

- 1D cross sections are derived from 2003 bathymetry data, which was used in the received NRW River Dee Hydraulic Model. The bed configuration of the Dee Estuary is likely to have undergone some changes since 2003 however, historic ariel photography indicates that the main tidal inlets have broadly remained the same. This is not expected to significantly impact model outputs;
- 1D cross section profile geometry is coarse, with elevations provided approximately every 50m along the bed profile;
- 1D cross sections have been georeferenced based solely on their chainage and as a result their locations may not be exact;
- fluvial hydrology has been retained from NRW's 2020 River Dee Hydraulic Model. Whilst this has been reviewed and considered suitable for use within this project, the hydrology data is from 2010 and as a result is outdated. The fluvial scenarios have been simulated with the upper end climate change allowance for the 2080s which is greater than that required for planning. The results show this does not impact the Construction and Operation Area and therefore the fluvial hydrology does not significantly change the conclusions of this study. Should this hydraulic model be used in the future for any purposes other than this project the suitability of the fluvial hydrology should be reviewed;
- a nested grid cell size of 4 m has been used within the Order limits and its surrounding areas. Any smaller flow paths may not be captured in detail, however this grid cell size is considered appropriate for a model of this scale;
- OSMM Data was not available for the entire study area, and OpenMap data was instead used for a small area north-west of the Construction and Operation Area. OS OpenMap data only shows key features, rather than assigning all land a feature code and as a result is a less detailed data source;
- there is a disparity between the two sources of OSMM used in the model. The Manning's value referenced for the general layer has been given as 0.03 for the updated dataset, whereas the dataset used in the previous study (and retained upstream of the Construction and Operation Area) uses a value of 0.05 for similar areas. Whilst this disparity is a limitation of the study, a review of 2D flow paths across the boundaries between datasets shows the change in roughness values to not have a significant impact on the conclusions;
- the flow through the 1D culverts connecting the River Dee to Wepre Brook is shown to oscillate throughout the model simulation. Whilst this has caused some model instabilities and some slight areas of impact in the proposed land raising scenario, this is of a large enough distance to the

Operational Footprint that it will not impact the conclusions of this assessment; and

- there is no observed data available to calibrate the model. As described in Section 7.3.4, observed data is required to verify the tide levels and timings. Based on predicted data, the model is overpredicting rather than underpredicting and hence showing a conservative representation of flood risk at Connah's Quay.

10. Summary and Conclusions

10.1 Summary

10.1.1 AECOM has been commissioned by the Applicant to undertake a hydraulic modelling assessment to better identify and understand the tidal and fluvial flood risk at the Proposed Development Site. In particular, the assessment is focused on the 'Operational Footprint' of the Proposed Development located within the Construction and Operation Area. In order to achieve this, a series of updates have been made to the existing NRW River Dee model, so that the nature and severity of flood risk to the Operational Footprint can be better understood. Key updates include extending the 1D-2D model to Flint, updating tidal boundaries and improving the floodplain representation.

10.1.2 A verification exercise has been undertaken, using data from the 2021 FCA and using predicted tide level data. The model showed good calibration at downstream of the Construction and Operation Area (Mostyn Docks) and upstream of the Construction and Operation Area (Chester) however it was possible to calibrate at Connah's Quay. In general, there was an overestimation of water level at Connah's Quay. It is recommended to collect observed tide data at Connah's Quay to validate the model at the Construction and Operation Area, as detailed in the **Framework CEMP (EN010166/APP/6.5)**.

10.1.3 The baseline model has been simulated for a range of AEP events, including the application of climate change allowances. Both tidal and fluvial scenarios have been simulated. The peak water level during the design event (0.5% AEP 2074) is 6.80 m AOD, and the 0.1% AEP 2074 tidal peak water level adjacent to the Operational Footprint is 6.97 m AOD.

10.1.4 As the Operational Footprint is expected to flood during the 0.1% AEP 2100 (70th percentile) event, proposed modelling of ground level raising has also been undertaken. The proposed model assumes a raised ground level of 7.4 m AOD for the Operational Footprint with all buildings raised to 7.7 m AOD. The model was simulated for the 0.5% and 0.1% AEP 2100 event (using 70th percentile data). The proposed model shows no significant off-site impacts as a result of the land raising. Small changes in depth and extent are seen around Wepre Brook, however this is thought to be an issue with model stability through a 1D culvert rather than as a direct result of the land raising.

10.1.5 A sensitivity analysis on various model parameters (Manning's roughness, climate change and the interaction between tidal and fluvial events) has shown that the conclusions of the report are robust and not impacted by variation in model parameters. Simulations for the 2100 epoch and for the 2074 epoch using 95th percentile data have been simulated to assess the future resilience of the Construction and Operation Area and Operational Footprint. The Operational Footprint is not shown to flood in any of the proposed scenario simulations.

10.2 Conclusions

10.2.1 The model results show that for all fluvial and tidal AEP events, including the 0.1% AEP 2074 tidal event, the Operational Footprint is not inundated by floodwater. Higher ground at the Operational Footprint prevents any inundation occurring and remains above the estimated flood level. Some areas of the Construction and Operation Area are shown to be inundated, however these are where no new development is proposed.

10.2.2 It is recommended that the model results are verified using observed tide data at Connah's Quay prior to detailed design, as detailed in the **Framework CEMP** (**EN010166/APP/6.5**). The calibration exercise indicates that the model is over predicting rather than under predicting water levels at Connah's Quay.

10.2.3 The sensitivity analysis undertaken shows that the assessment is still valid when key model parameters are changed and the conclusions at the Operational Footprint are robust against uncertainty in future sea level rise.

Annex A Key Correspondence with NRW

Minutes

Meeting name
Connah's Quay Hydraulic Modelling

Subject
Hydraulic Modelling requirements

Attendees
AECOM
NRW

Meeting date
07/05/2024

Time
1100

Location
Virtual

Project name
Connah's Quay

AECOM project number
60717119

Prepared by
AECOM

Ref	Item	Action / Responsible	Due by
01	Introductions	n/a	
02	Previous FCA Undertaken in 2021 – consultant extracted in-channel water level from 1D node in estuary (using Tidal Dee model) and compared this with ground levels on site to estimate flood level and depth for design flood event. Used to inform land raising level. No assessment of flood propagation or impact of land raising as Tidal Dee model not 1D-2D in area of site. As part of a new FCA, a more detailed assessment relating to tidal and fluvial risk is required.	n/a	
03	Use of existing modelling NRW confirmed that AECOM should be able to use the existing 1D-2D Tidal Dee model and extend it downstream to include all of the Proposed Development site. 1D-2D boundary currently at Flintshire Bridge and includes area upstream. NRW stated AECOM should review the existing hydrology and general model representation to confirm if they are appropriate or whether further updates are required.	n/a	
04	Modelling approach AECOM to review the existing 1D-2D Tidal Dee model (including hydrology), extend the model downstream to include the site and update with latest LIDAR. This will be documented within a method statement which will be provided to NRW for comment. Once the model has been updated, the baseline model will be issued to NRW for review. Likely 4-6 week turnaround time on reviews. Continue liaison with NRW's Senior Advisor (Development Planning)	AECOM to prepare method statement for NRW to review once scope of works have been agreed with client. AECOM to provide baseline model to NRW for review once this has been updated.	

Ref	Item	Action / Responsible	Due by
05	Design Flood Event Tidal likely to be dominant source of flood risk (River Dee) but fluvial sources also need to be considered (Kelsterton Brook). Design flood event: 0.5% AEP + climate change (tidal) and 1% AEP + climate change (fluvial). The 70th percentile for climate change allowances should be considered. Both defended and undefended scenarios should be considered as it is not currently known who maintains the defence. Undefended scenarios should be taken forward when assessing overall risk and mitigation measures. The 0.1% AEP + climate change also needs to be considered in relation to effects on flood risk elsewhere. Generally a 5mm threshold should be considered when assessing flood risk impacts to third parties. Further discussions may be required depending on what receptors are impacted and level of increase during all AEP events assessed.	n/a	
06	Mitigation NRW stated it was difficult to know the mitigation requirements until modelling had been undertaken due to the expansive estuary area. If land raising is proposed, compensatory storage may be required (on a like for like basis) depending on the local impact.	n/a	
07	AOB TAN15 (2004) confirmed as the latest version. Flood Map for Planning should have the latest flood risk information.	n/a	

Outlook

RE: Connah's Quay Hydraulic Modelling - minutes

From [redacted]@cyfoethnaturiolcymru.gov.uk>
Date Thu 2024-10-17 15:23
To [redacted]@aecom.com>
Cc [redacted]@cyfoethnaturiolcymru.gov.uk>; [redacted]@aecom.com>; [redacted]@cyfoethnaturiolcymru.gov.uk>; Development and Flood Risk, North & Mid <developmentandfloodrisk.northmid@cyfoethnaturiolcymru.gov.uk>

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Report Suspicious

[redacted]

In the absence of both [redacted] and [redacted] I've had a bit of a look into this today.

NRW does not hold any wave data/ information for the site or wider Dee Estuary which would be useful for the site. We are unaware of historic wave overtopping issues, nor do we hold any historic flood outlines related to wave overtopping in the site location. It's unlikely that wave overtopping is a significant risk at the site and that overtopping risk (and associated breach) from still water level is likely to be the dominant risk. This information should be sufficient to include in a FCA to show consideration has been given to wave overtopping.

Hope this helps
Regards
[redacted]

Dadansoddi Perygl Llifogydd - Cynghorydd Arbenigol / Flood Risk Analysis - Specialist Advisor
Perygl Llifogydd ar Rheoli Dŵr / Flood Risk and Water Management
[redacted]

Croesewir gohebiaeth yn Gymraeg a byddwn yn ymateb yn Gymraeg, heb i hynny arwain at oedi.
Correspondence in Welsh is welcomed, and we will respond in Welsh without it leading to a delay.

Cyfoeth Naturiol Cymru
Natural Resources Wales

Byd natur a phobl yn ffynnu gyda'n gilydd

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cyfoethnaturiol.cymru
naturalresources.wales

Connah’s Quay LCP – FCC Engagement Ecology

Meeting name	Subject	Attendees	Apologies
CQ PM Weekly Catchup	Connah's Quay Low Carbon Power Project	NRW Uniper AECOM	
Meeting date 26 January 2025	**Time** 11:00 – 12:00 BST		
Location Microsoft Teams	**Project name** Connah's Quay Low Carbon Power		
AECOM project number 60717119	**Prepared by** AECOM		

Please refer to the presentation slides

Ref	Item	Action
01	**Introduction** Introductions were given and AECOM provided an update on where the project is, in relation to hydraulic modelling, and agenda for this meeting: • Background to Hydraulic Modelling • NRW meeting 7th May 2024 • Method Statement shared for comment in September 2024 and finalised in October 2024 • Overview of Hydraulic Modelling approach – completed in accordance with Method Statement. AECOM presented the key updates to the model which included (1) 2D domain / model extension to Flint to include Main Development Area (2) 2D domain with 10m grid (as in the received model) and a new nested 4m grid for the areas of interest (3) new tidal curves using Hilbre Island for base level (4) fluvial boundary retained from existing model. • Areas of Discussion – Model Results – Model Calibration – Next Steps The aim is to present results and answer any questions/flag anything of note to address.	N/A
02	**Work to date** AECOM showed a figure displaying the Main Development Area (MDA), the resolution from the provided model, and the extension down to Flint.	N/A
03	**Outcomes of Modelling - Tidal** AECOM explained: • Model simulations – 0.5% and 0.1% AEP events (present day and future). Each tidal event modelled includes a small fluvial event i.e. a constant $30m^3$. • Future scenario uses 2070 epoch – All events were run undefended, removed all formal defences within the vicinity of the site. Defences remained further upstream along the River Dee.	N/A

Ref	Item	Action

- The model results show that for all modelled tidal AEP events, the MDA is not inundated by floodwater. Higher ground at the Site prevents any inundation occurring in the area.
- The cross section at the location of the MDA indicates a bank level of approximately 7.04m AOD. Table of results presented showing peak level for all tidal AEP events modelling demonstrating that these remain below the bank level.

AECOM showed a figure that illustrated the flood extents associated with each modelled event. No flooding at the MDA.

Outcomes of Modelling - Fluvial:

- Model simulations – 1% AEP + 45% CC and 0.1% AEP +45% Climate Change (CC) events. Each fluvial event modelled includes a small tidal event i.e. MHWS.
- For both AEP events, all out of bank flooding is confined to the upper reaches of the River Dee and neither the Site nor the MDA are impacted by floodwater. The maximum in-channel water level adjacent to the Site is 3.14m AOD for both simulations.
- **Main risk to the MDA is from tidal sources.**

NRW asked if it was only the [River] Dee was considered in the fluvial model. AECOM said yes, stating the other watercourses have justification for why they are not considered which will be discussed in the FCA.

NRW asked what the design lifetime of the project is. AECOM stated the design life is 30 years with a construction period of 8 years. Using 2025 as a base year this would take the development lifetime to 2063 which the modelling assessment considers by using a 2070 epoch. This allows for any delays with construction.

Model Calibration

AECOM explained the results of the calibration and verification:

Methodology Overview:

- An annual predicted tide curve was generated for 2024 at Hilbre Island using Admiralty Total Tide software.
- A 35 day period was then chosen between 25/02/2024 and 31/03/2024 to capture the Spring Tide and Neap tide cycle. This was applied as the downstream boundary.
- A constant fluvial inflow was applied at the upstream for the duration of the simulation.
- 1D only model was simulated for the 35 day period. A check was undertaken to see if there would be any significant out of bank flooding that could impact results. This indicated there was none and so the 1D only model was considered suitable to use.
- Predicted tide levels estimated at Mostyn Docks, Connah's Quay and Chester.
- Compared the modelled versus predicted tide at the three locations.

Mostyn docks:

- High Water Levels
  - Modelled HW level ranges within +/-0.3m of the predicted tide levels across the 35 day simulation.
  - Average difference of the modelled versus predicted HW level is –0.06m.
  - Model HW level calibrates well.
- Low Water Levels
  - Modelled LW level ranges between –0.6m to +0.02m of the predicted tide levels across the 35 day simulation.

Ref	Item	Action

- Average difference of the modelled versus predicted LW level is –0.29m.
- Model shows a general under estimation of LW level. This is not expected to impact the outcomes of this study because it is the peak water level that are important.

• Timing

- Average modelled Ebb and Flood duration within 5mins of predicted durations.
- Timing of the tide calibrates well.

• Conclusion

- **Model Calibrates well at Mostyn Docks**

Chester:

• High Water Levels

- Modelled HW level ranges within +/-0.25m of the predicted tide levels across the 8 day period above Chester Weir level. It is noted that the lowest modelled level is informed by Chester Weir therefore the HW has been compared above this level.
- Average difference of the modelled versus predicted HW level is –0.03m across the 8 day period above Chester Weir level.
- Model HW level calibrates well.

• Low Water Levels

- Predicted LW level not available at Chester. It is noted for Chester and Connah's Quay only the LW timing is documented. Figures will show only the time of the LW at a nominal elevation of -1mAOD.

• Timing

- Average modelled flood and ebb duration within 1hr of predicted flood duration across 8 day period.
- This is due to the impact of Chester Weir

• Conclusion

- **Model calibrates well at Chester**

Connah's Quay:

• High Water Levels

- Modelled HW level ranges within +0.3m to +1.16m of the predicted tide levels across the 35 day period.
- Average difference of the modelled versus predicted HW level is +0.75m across the 35 day period.
- Model HW level over estimating levels compared to the predicted tide level.

• Low Water Levels

- Predicted LW level not available at Connah's Quay

• Timing

- Average modelled flood and ebb duration within 10mins of predicted flood duration across 35 day period.

• Sensitivity

- Sensitivity on Manning's Roughness and Fluvial Inflows do not improve the modelled HW water level at Connah's Quay.
- Received model simulated with calibration event shows similar outputs.

Ref	Item	Action
	• Conclusion – **Model does not calibrate at Connah's Quay (overpredicting)** To summarise, it has been demonstrated through calibration that: • The model calibrates well at Mostyn Docks • The model calibrates well at Chester • The model cannot be calibrated at Connah's Quay The model cannot be calibrated at Connah's Quay therefore there is uncertainty in the modelled flood levels at this location. Given the model calibrates at Mostyn Docks and Chester and the calibration shows the model is overpredicting High Water levels at Connah's Quay the intention is to not calibrate further. NRW asked if the received model was also overpredicting. AECOM confirmed. Subject to NRW taking a look at the report, NRW explained that because it is an overprediction, it is unlikely NRW will raise concerns. NRW agreed, expanding on that point and mentioning that this represents a worst-case scenario. **Upstream Model Representation** • FMP 1D Only representation retained from received model. • No representation of the upstream floodplain. • Significant glass walling in fluvial climate change events through 1D only area (c.16km upstream of the Site). This is the same in the received model. • Fluvial impact is negligible at the Site because Tidally dominated. • Overestimating the volume reaching the Site therefore a conservative estimate and not expected to impact the conclusions. NRW mentioned this seems okay, as its overestimating, like the above.	
04	**Next Steps** • Model and report going through our internal Quality Assurance checks before being issued to Uniper for review. • Model and report to be issued to NRW for formal review AECOM asked how to upload the model. NRW mentioned their Senior Advisor (Development Planning) is the best person to coordinate with. NRW asked to send it through to the north planning email address, using the share file function if it is a large file.	Applicant to upload modelling information through to the north planning email address, using the share file function if it is a large file.
05	**AOB** N/A	N/A

Minutes

Meeting name	Subject	Attendees
Connahs Quay	Flood Modelling	AECOM NRW
Meeting date 21/05/25	**Time** 1500	
Location Virtual	**Project name** Connahs Quay	
AECOM project number 6017119	**Prepared by** AECOM	

Ref	Item	Action / Responsible
01	**Introduction** AECOM provided brief introduction and purpose of the meeting. This was essentially to discuss and agree a way forward with the red comments from NRW's model review provided on 8 May 2025 and a select number of amber comments. It was discussed that AECOM intend to use the 2074 epoch (higher end climate change estimate) as the design flood event with the 2100 epoch simulated as a sensitivity test. The events being simulated are mentioned below.	Formal response to model review to be issued to NRW for review.
02	**Climate Change Scenario** The modelling report states that estimates are calculated for 2074, however, the results are labelled as 2070. AECOM confirmed that this was a typo and that 2074 was being used.	To be updated in the modelling report so that 2074 is consistently referenced.
03	**Undefended Scenario** It was confirmed by NRW that there is less concern regarding the defences to the east of the A548 i.e. upstream of the site, where land is naturally raised. To the west of the A548 i.e. in the area of the site, NRW stated that two scenarios should be simulated (1) with the primary defence (embankment and rip rap defence) removed but with the secondary gabion wall retained and (2) with all defences including the gabion wall removed. AECOM were undertaking an approach whereby all defences including the gabion wall would be removed as part of the undefended scenario. NRW agreed with this approach.	AECOM to run the undefended scenario (with the primary and secondary defences removed) for the following events with the approach and results clearly documented within the modelling report: • 2074 0.5% AEP and 0.1% AEP, 70th and 95th percentile. • 2100 0.5% AEP and 0.1% AEP 70th percentile. A separate model run will be simulated whereby the primary defence (embankment and rip rap defence) will be removed with the secondary gabion wall retained. This will only be simulated for the design flood event i.e. the 2074 0.5% AEP 70th percentile.
04	**Breach Scenario** It was agreed with NRW that a breach scenario would not be required if the undefended scenario is removing the primary and secondary flood defences. However, justification would need to be provided in the report as to why no breach has been assessed.	AECOM to update modelling report to document why no breach analysis has been undertaken.

Ref	Item	Action / Responsible
05	**Levee Markers** Sensitivity run (1D only) undertaken by AECOM to test use of levee markers. The inclusion of levee markers caused inconsistent results which were lower than the baseline results. Also AECOM discussed how water would flow behind the area of the bund on the rising tide, through channels further downstream and therefore the inclusion of levee markers was not considered appropriate. Given the lower peak water level and mechanisms of flooding in the Dee Estuary it is not considered appropriate to include the levee markers. This was agreed by NRW although details should be included within the report.	AECOM to update modelling report to document why levee markers were not considered appropriate.
06	**Manning's Roughness** AECOM noted that the Manning's Roughness values have been retained from the received model. A sensitivity on the Manning's Roughness of the Dee Estuary has been undertaken using the 1D only model. Increasing the Manning's Roughness delays the time of the peak of the event. Whilst there is limited data for calibration the calibration event documented in the report showed a reasonable timing of the peak of the event. Without better data to verify the model there is limited justification to change the Manning's Roughness Values. This was agreed with NRW with some justification to be provided in the report.	Low Manning's Roughness values to be acknowledged in the modelling report and justification for not changing them to be included.
07	**Comparison with Previous Results** AECOM acknowledged the changes between AECOM's results and previous NRW results. This is thought to be primarily because of the difference in tidal boundaries. NRW agreed that it would not impact the outcomes but some explanation about the differences should be provided in the report. .	Commentary on differences of AECOM results versus previous NRW results to be provided in the modelling report.
08	**Climate Change Epoch** The issue around climate change epoch was discussed with NRW awaiting confirmation that the 2074 epoch has been agreed with PINS. However, PINS has indicated that this is not a matter on which the Inspectorate can advise. After the meeting, the policy was checked and according to NPS EN-1 (para 4.9.13): "*The Secretary of State should be satisfied that applicants for new energy infrastructure have taken into account the potential impacts of climate change using the latest UK Climate Projections and associated research and expert guidance (such as (such as the EA's Climate Change Allowances for Flood Risk Assessments or the Welsh Government's Climate change allowances and flood consequence assessments) available at the time the ES was prepared to ensure they have identified appropriate mitigation or adaptation measures. This should cover the*	NRW to provide comment on whether they agree with the approach to the assessment of climate change.

Ref	Item	Action / Responsible
	estimated lifetime of the new infrastructure, including any decommissioning period" This therefore provides justification as to why the 2074 epoch has been considered as it covers the estimated lifetime of the development (30 years) including the construction and decommissioning period (plus some contingency).	
09	**Post Meeting** Following the meeting, NRW provided some commentary on the queries raised about the climate change allowance epoch and land raising and assessment of the 0.1% AEP scenario (27 May 2025). These included: 1) Regarding Climate Change Allowance epoch: *"To confirm, we are not aware of a formal requirement for the Climate Change Allowance (CCA) to be agreed with the determining body in advance of the application being made. However, we strongly recommend that you do so, in order to avoid having to repeat any work at the application stage if they raise concerns. Current CCA guidance states that as a "rule of thumb…a lifetime of 75 years is assumed for all other developments". We are aware that the Connah's Quay Power Station project has an explicit lifetime of 35 years; however, the CCA guidance is currently being reviewed and is expected to be updated in the near future, so CCA may be subject to further change. Considering the status of power generating and distribution elements of power stations as Highly Vulnerable Development in the recently published TAN15 (2025), in addition to the location and scale of the project, we assume that a precautionary approach would be preferred by the applicant. We consider that the proposal to use the 2074 epoch, with assessment of the 2100 epoch used as a sensitivity test, could be acceptable. We would assume that upper end climate change estimates (95th percentile) will be assessed in the design event, as is required by TAN15 (para. 4.3)."* 2) Regarding land raising and assessment of 0.1% AEP scenario: *"When assessing the impacts of the 0.1% AEP scenario on the site, the site should be modelled as proposed, or by some proxy (i.e., raised to an arbitrary height), to show the effects of the proposed development, including any land raising, on flood water storage and flood risk elsewhere."*	Included for reference as a response from NRW to the climate change and land raising queries. AECOM note the advice provided with regards to land raising and the 0.1% AEP event. The land raising scenario will be simulated for the following events with results presented within the hydraulic modelling report. • 2074 0.5% AEP and 0.1% AEP, 70th and 95th percentile • 2100 0.5% AEP and 0.1% AEP 70th percentile.

Annex B Hydraulic Model Review[9]

Issue	Will this be addressed as part of the Study?	Required Model Update
Model Approach		
NRW's 1D-2D River Dee FMP-TUFLOW model downstream boundary is at the A548 bridge. The estuary downstream of the bridge is a 1D FMP model only. Currently the Construction and Operation Area is located in the 1D only area and the model in this area therefore requires updating to 2D in order to assess floodplain loss and off site impacts.	Y	NRW's River Dee model will be extended downstream to include 1D-2D representation of the Construction and Operation Area.
Model is based upon old bathymetry survey (2003) of the estuary. The geometry may have changed since 2003. Defences and floodplain features have been more recently updated into the model in 2020/2022 to ensure floodplain flow is captured.	N	New survey is not being commissioned as part of this study. The bathymetry data and latest LiDAR will be used to represent the estuary and 2D floodplain. This is considered suitable for the aims of this project.
Model simulated using: FMP - 4.5.1.6163 TUFLOW - 2018-03-AE-iSP-w64 Both versions of the software are out of date and have been developed further since 2020.	Y	The latest versions of FMP and TUFLOW will be used to simulate the updated model.
1D Model Build		

[9] This review was undertaken of a draft version of the hydraulic model and subsequent reporting. The required model updates have been made and the updated results are presented in this report.

Issue	Will this be addressed as part of the Study?	Required Model Update
Downstream of the A548 distance between cross sections is c. 460 m to 777 m. This should be improved especially in the area around the Construction and Operation Area.	Y	Distance between cross sections will be improved through the use of interpolates.
Currently areas of the model in 1D only are represented using panel markers. Latest versions of FMP allow for levee markers to ensure that overtopping only occurs when defence crests/embankments have been breached. In the estuary downstream of the A548, there is an embankment on the right bank where this could be applied. This may impact levels locally around the proposed development and could therefore be improved.	Y	The use of levee markers within the estuary will be reviewed and applied where necessary.
The 1D FMP nodes are not georeferenced downstream of the A548 bridge or upstream of Chester Weir.	Y	The 1D FMP nodes will be georeferenced.
Cross section profiles have been generated between a mixture of 2003 bathymetry survey and LiDAR DTM. Spot check of latest LiDAR DTM vs 2003 bathymetry + model cross section undertaken upstream of the A548 bridge which shows a good correlation. Spot check undertaken of bed elevation against bathymetry at nodes immediately downstream of A548 bridge compared to 1D cross section. Bed profile is very coarse with points every c. 50 m. This should be improved where possible to provide a similar resolution to upstream which this is more like every 20 m and 2 m through area of interest. This would ensure hydraulics are representative.	N	The cross sections of the estuary will be reviewed and improved where possible with regards to bed profile. Depending on the extent of the bathymetry data, the current representation of the cross sections may be retained. This will be determined during the model build stage.

Issue	Will this be addressed as part of the Study?	Required Model Update
Spot check conveyance shows many cross sections have large inflections upstream of the A548. This may be resulting in misrepresented flow at higher stage and should ideally be improved.	Y	Panel markers associated with all 1D FMP cross sections will be updated to improve conveyance.
Where extended cross sections are located, manning's roughness for the channel is the same as the floodplain. 0.010 is low but it is assumed that this has been previously agreed with NRW and not good reason to adjust it.	Y	Roughness values will be reviewed and updated where necessary.
1D Boundary Conditions		
Glass walling upstream of Chester Weir in the 1D only section of the model. This is far enough upstream that it will not impact result at the power station but should be explored further.	N	This is outside the modelling scope. Given the distance from the Construction and Operation Area, this is unlikely to impact results and will therefore not be addressed as part of the model updates.
Fluvial hydrology based upon 2010 fluvial hydrology. Significant changes in methodology since 2010. No intervening flows.	N	Given the location of the Construction and Operation Area, the predominant flood risk to the Construction and Operation Area is from tidal sources (River Dee). The tidal hydrology is therefore being updated. As fluvial flood risk is not considered the predominant risk, the fluvial hydrology is not proposed to be updated for the River Dee. However, fluvial model simulations for the River Dee will be undertaken based on the 1% and 0.1% AEPs (both including an allowance for climate change). This is considered a conservative approach through modelling the most extreme events and will provide an assessment of fluvial flood risk at the Construction and Operation Area.

Issue	Will this be addressed as part of the Study?	Required Model Update
Head-Time (HT) Boundary applied as downstream boundary condition. This boundary was updated in 2022 for breach modelling reflecting recent climate change guidance.	Y	The tidal boundaries are not considered correct for the model and will therefore be updated.
1D Structures		
Only structures represented are Chester Weir and Canal outfall road bridge. There are multiple crossings over the River Dee which have not been represented in the model. No documentation on why these have been omitted but presumably maintained from original modelling. These structures are large and likely only pier losses associated with them.	N	Given tidal influence and location/size of these structures in relation to the Construction and Operation Area, the current approach is considered acceptable and structures will therefore not be updated in the model.
Multiple floodplain culverts have been included as 1d_nwk culverts and bridges. Around 50 were added during the 2020 update and are based upon estimated elevations using LiDAR. Culverts have not been reviewed in full but appears to cover the main routes upstream of the Construction and Operation Area. Review of floodplain flowpaths particularly through embankments recommended with specific checks on any features within close proximity to the Construction and Operation Area.	Y	Structures which are located within close proximity to the Construction and Operation Area and have the potential to impact flood flowpaths will be reviewed and updated where survey is available. Where survey is not available, these will be updated using the latest LiDAR and from observations from the site visit.
2D Model Build		
LiDAR applied to the received model was flown in 2017. More recent LiDAR available flown in 2022.	Y	The latest LiDAR data (2022) will be applied to the model.

Issue	Will this be addressed as part of the Study?	Required Model Update
Model grid size is 10 m. This is relatively coarse for a site specific model. This is appropriate for strategic scale but should be reduced or improved in the area of interest.	Y	Either the grid resolution will be improved to 4 m (for the entire model) or a separate domain will be created for the area of the Construction and Operation Area which will use a 4 m grid size.
North Wales Tidal Defence Survey is included all the way to the Estuary mouth. Cannot check survey as not received. It appears that this was added 2015/16. NRW should provide this data so that it can be checked.	Y	This survey data will be requested from NRW so that the defence representation can be checked within the model.
2D Boundaries and Roughness		
OS MasterMap data applied throughout the model. This has not been updated as part of the 2020 or 2022 updates indicating it is >5yrs old. This should therefore be reviewed and updated.	Y	The latest OS MasterMap data will be used where available.
Linked 1D-2D		
Along the River Dee the CN connections appear to be away from where the cross section has been surveyed. This means the water is being conveyed at the incorrect location. This should be consistent with where the cross section is located.	Y	The representation of the cross sections and CN connections will be reviewed and improved.
The 1D cross section widths have been compared with the 2D cross section widths. These are c. 1-4 grid cells width difference in 1D and 2D. Ideally these should be updated and cross section linking made consistent with location of the extracted cross sections.	N	The scope does not include for review and update of cross section widths. Where this is unlikely to impact model stability, updates will be made but generally the current cross section representation will be retained.

Issue	Will this be addressed as part of the Study?	Required Model Update
Inconsistencies identified between the 1D and 2D bank levels throughout the model. Having consistent 1D and 2D cross sections bank heights is important for correct hydraulic representation and should therefore be improved.	Y	Bank levels in the 2D model will be updated so that they reflect the bank levels specified within the 1D model.
Run Parameters		
The 1D timestep is 20 seconds. This is 2x the grid resolution and 4x the 2D timestep. This is much larger than expected. This should be amended to be half the 2D timestep i.e. 2.5 seconds.	Y	The timestep will be revised so that it is half the 2D timestep (which in turn will be half the 2D grid size).
Model Sensitivity		
No model sensitivities or any form of model calibration, validation or verification has been applied.	Y	Model sensitivities will be undertaken on the updated model. There will also be a calibration check where high water level and timing of low water within the River Dee estuary will be compared against tidal data at Connah's Quay and Chester.

Annex C Tidal Boundary Technical Note

Project:	**Tidal River Investigations**	Job No:	**60655537**
Subject:	**Connah's Quay Tidal Boundaries**		
Prepared by:	**ZC**	Revision:	
Checked by:	**BT**	Date:	**02nd July 2025**
Lead Verified by:	**AF**		

Updated Tidal Boundaries

Tidal boundaries are required for the downstream boundary of a hydraulic model of the Dee Estuary to be used for the Connah's Quay assessment. This technical note describes the method, outputs and assumptions made in derivation of the tidal boundaries. This text will be incorporated into the modelling report for the project.

Method

New tidal boundary conditions for the hydraulic model of the River Dee Downstream of Connah's Quay have been created to include storm surge and sea level rise to achieve the extreme water levels predicted by the Coastal Flood Boundaries (CFB) data (Environment Agency, 2018). The water levels for five epochs have been determined: 2024, 2044, 2074, 2100 and 2124, for return periods of 2, 10, 20, 25, 50, 100, 200 and 1000 years. Levels for MHWS for each epoch were also calculated.

The UK Hydrographic Office (UKHO) publishes tidal data for stations around the UK. The closest tidal station to the downstream boundary is Hilbre Island (UKHO, 2022) (Figure 1).

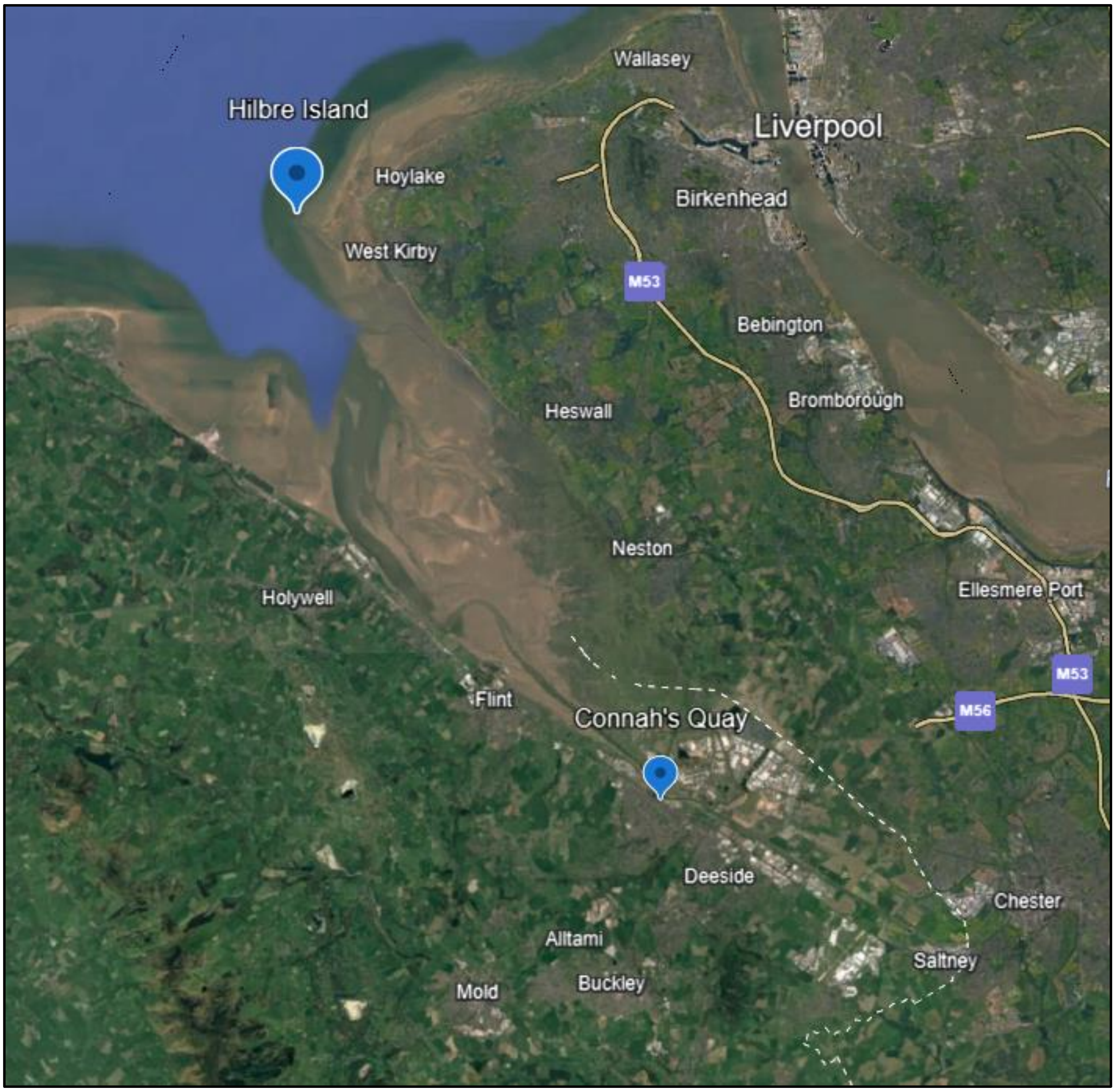

Figure 1: Hilbre Island (England) and Connah's Quay (Wales) (Source: Google Earth, accessed October 2024)

Base tide

TotalTide software (UKHO, 2022) was used to predict the base tidal curve for Hilbre Island. The levels were adjusted to Ordnance Datum using 0 mCD = -4.93 mOD from the 2022 Admiralty Tide Tables (ATT) (UKHO, 2022).

Coastal Flood Boundary Dataset

The CFB chainage that was used along the Dee Estuary was 1150_1. The position of this chainage location is highlighted in Figure 2. It is the chainage point closest to Hilbre Island and the downstream boundary of the model (the position of the downstream boundary is at label 1000 in Figure 3).

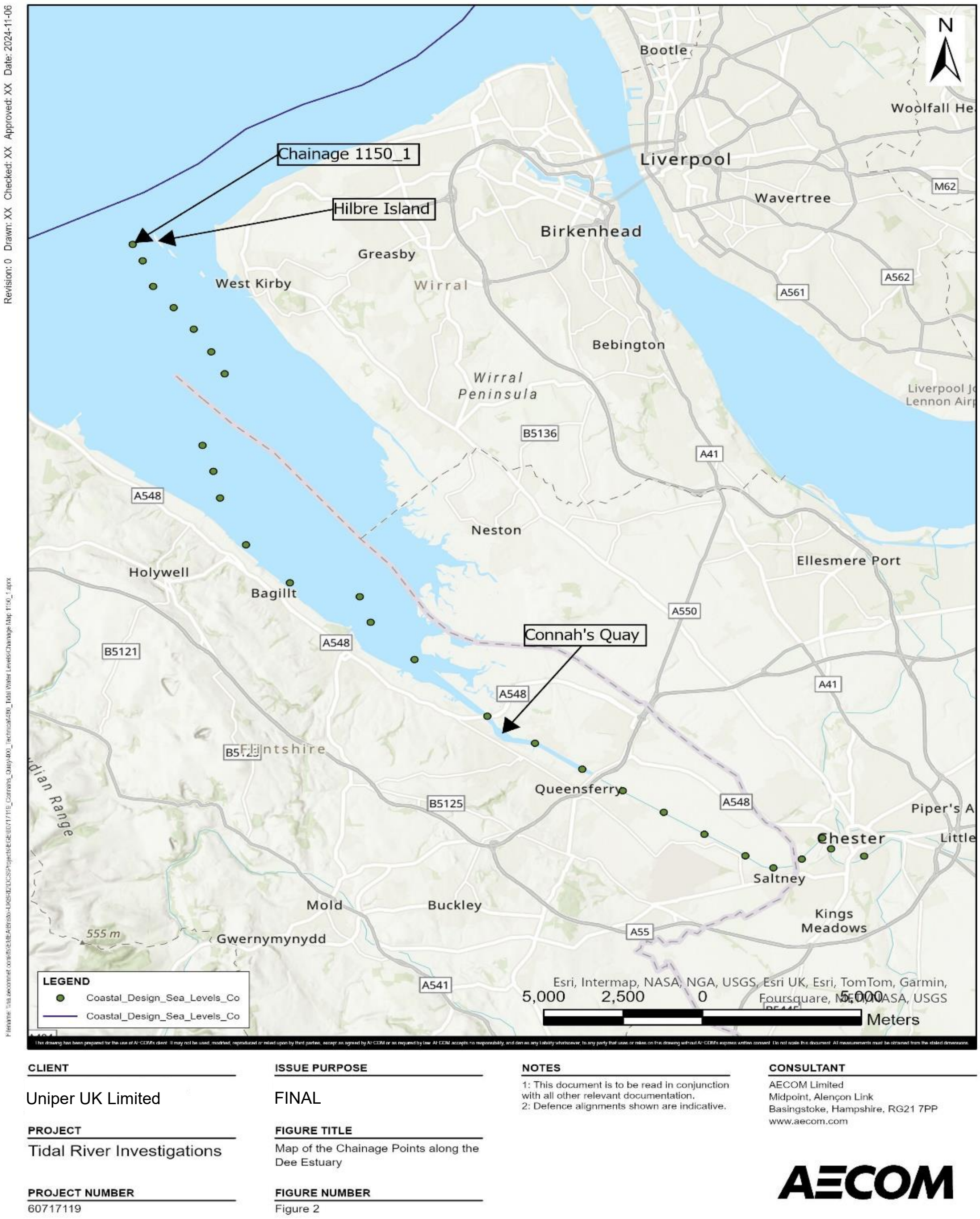

Figure 2: Map of the Chainage Points along the Dee Estuary, with chainage 1150_1 highlighted as the chosen chainage point for this project

Figure 3: Model downstream boundary located at the Mouth of the Dee (''1000'' has been used for the boundary location) (Source: Google Earth, accessed October 2024)

Climate Change

The Environment Agency guidance on climate change (Environment Agency, 2022) provides three options for use in FCERM projects:

- Design: the higher central (70th percentile from UKCP18 RCP 8.5);
- Sensitivity tests and assessment of mitigation: upper end allowance (95th percentile from UKCP18 RCP 8.5); and
- More extreme climate change and for critical infrastructure: H++.

For the purposes of this project the time series of water levels for all three scenarios have been calculated for each epoch and return period. The sea level rise projections using UKCP18 data sets have been obtained from the online tool (UKMO, 2022) for the nearest point in the database at the mouth of the Dee Estuary (dark blue box highlighted in Figure 4).

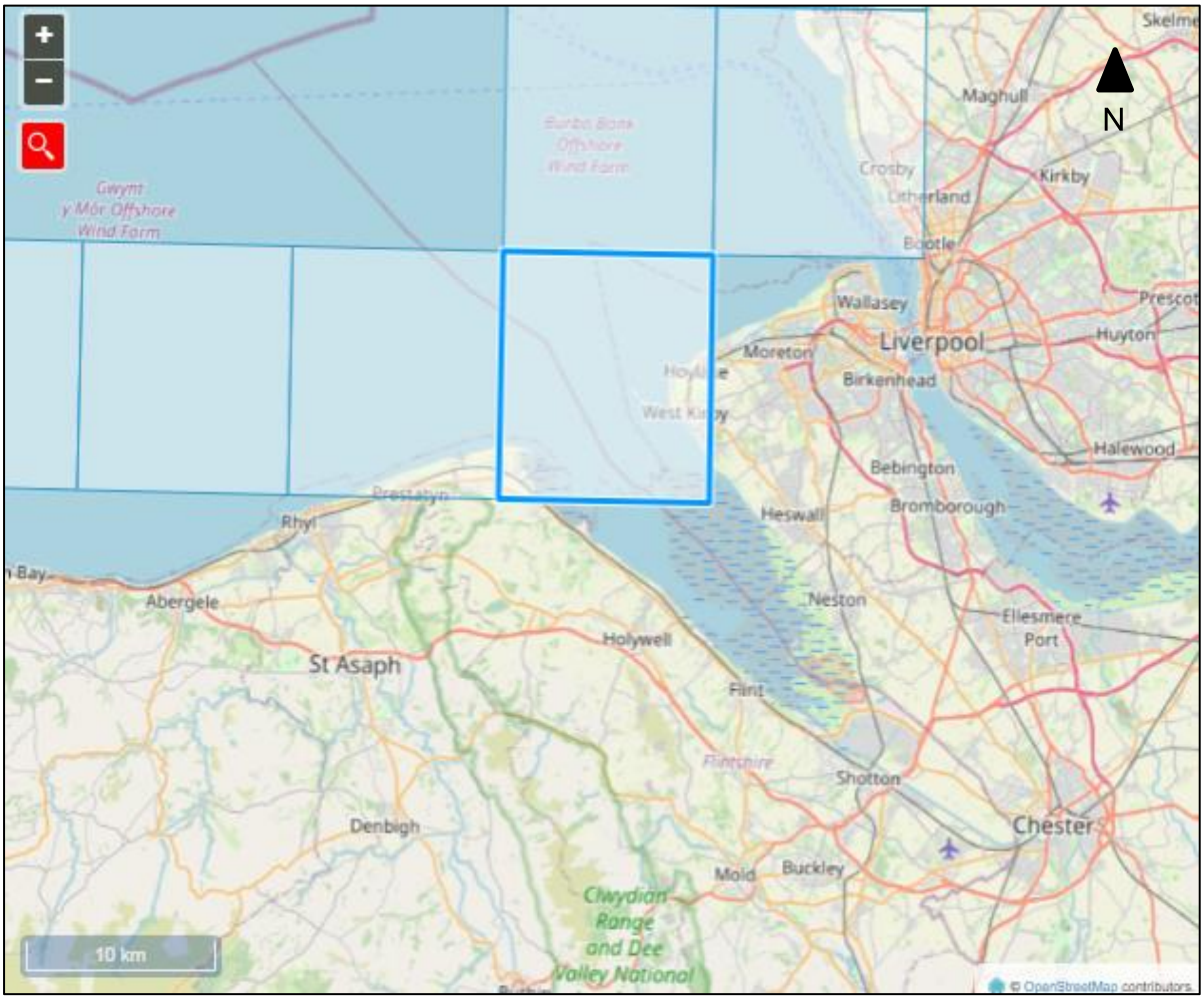

Figure 4: Location of the sea level rise projections (UKMO, 2022)

Results

A summary of the extreme water levels for each return period, epoch and sea level rise scenario is provided in Table 1, Table 2 and Table 3.

Table 1: Summary of extreme water levels for each epoch and return period for the RCP8.5 70 percentile scenario.

Climate Emissions Scenario: RCP8.5 70 percentile					
	Epoch				
	2024	**2044**	**2074**	**2100**	**2124**
Sea level Rise [m] from 2017 base date	**0.033**	**0.154**	**0.415**	**0.699**	**0.980**
Return Period [years]					
MHWS	4.103	4.224	4.485	4.769	5.050
2	5.363	5.484	5.745	6.029	6.310
10	5.553	5.674	5.935	6.219	6.500
20	5.643	5.764	6.025	6.309	6.590
25	5.663	5.784	6.045	6.329	6.610
50	5.783	5.904	6.165	6.449	6.730
75	5.813	5.934	6.195	6.479	6.760
100	5.843	5.964	6.225	6.509	6.790
200	5.933	6.054	6.315	6.599	6.880
1000	6.153	6.274	6.535	6.819	7.100

Table 2: Summary of extreme water levels for each epoch and return period for the RCP8.5 95 percentile scenario.

Climate Emissions Scenario: RCP8.5 95 percentile					
	Epoch				
	2024	2044	2074	2100	2124
Sea level Rise [m] from 2017 base date	0.041	0.196	0.549	0.952	1.356
Return Period [years]					
MHWS	4.111	4.266	4.619	5.022	5.426
2	5.371	5.526	5.879	6.282	6.686
10	5.561	5.716	6.069	6.472	6.876
20	5.651	5.806	6.159	6.562	6.966
25	5.671	5.826	6.179	6.582	6.986
50	5.791	5.946	6.299	6.702	7.106
75	5.821	5.976	6.329	6.732	7.136
100	5.851	6.006	6.359	6.762	7.166
200	5.941	6.096	6.449	6.852	7.256
1000	6.161	6.316	6.669	7.072	7.476

Table 3: Summary of extreme water levels for each epoch and return period for the H++ scenario.

Climate Emissions Scenario: H++					
	Epoch				
	2024	2044	2074	2100	2124
Sea level Rise [m] from 2017 base date	0.174	0.672	1.419	2.066	2.114
Return Period [years]					
MHWS	4.244	4.742	5.489	6.136	6.184
2	5.504	6.002	6.749	7.396	7.444
10	5.694	6.192	6.939	7.586	7.634
20	5.784	6.282	7.029	7.676	7.724
25	5.804	6.302	7.049	7.696	7.744
50	5.924	6.422	7.169	7.816	7.864
75	5.954	6.452	7.199	7.846	7.894
100	5.984	6.482	7.229	7.876	7.924
200	6.074	6.572	7.319	7.966	8.014
1000	6.294	6.792	7.539	8.186	8.234

Figure 5 displays tidal curve for the base tide and MHWS over the following time periods 2024, 2044, 2074 and 2124 for the RCP 8.5 70th percentile sea level rise scenario. The graph highlights the effect of Sea Level Rise (SLR) on future high tides.

Figure 6 shows the 2124 1:200 yr event tidal curves with different sea level rise projections; the RCP 8.5 70th percentile, RCP 8.5 95th percentile and H++ RCP 8.5 scenario.

Figure 7 is a graph displaying the different components of the 2124 200yr event using the RCP 8.5 70th percentile sea level rise scenario. The graph shows the base tide, sea level rise and surge components to create the final curve.

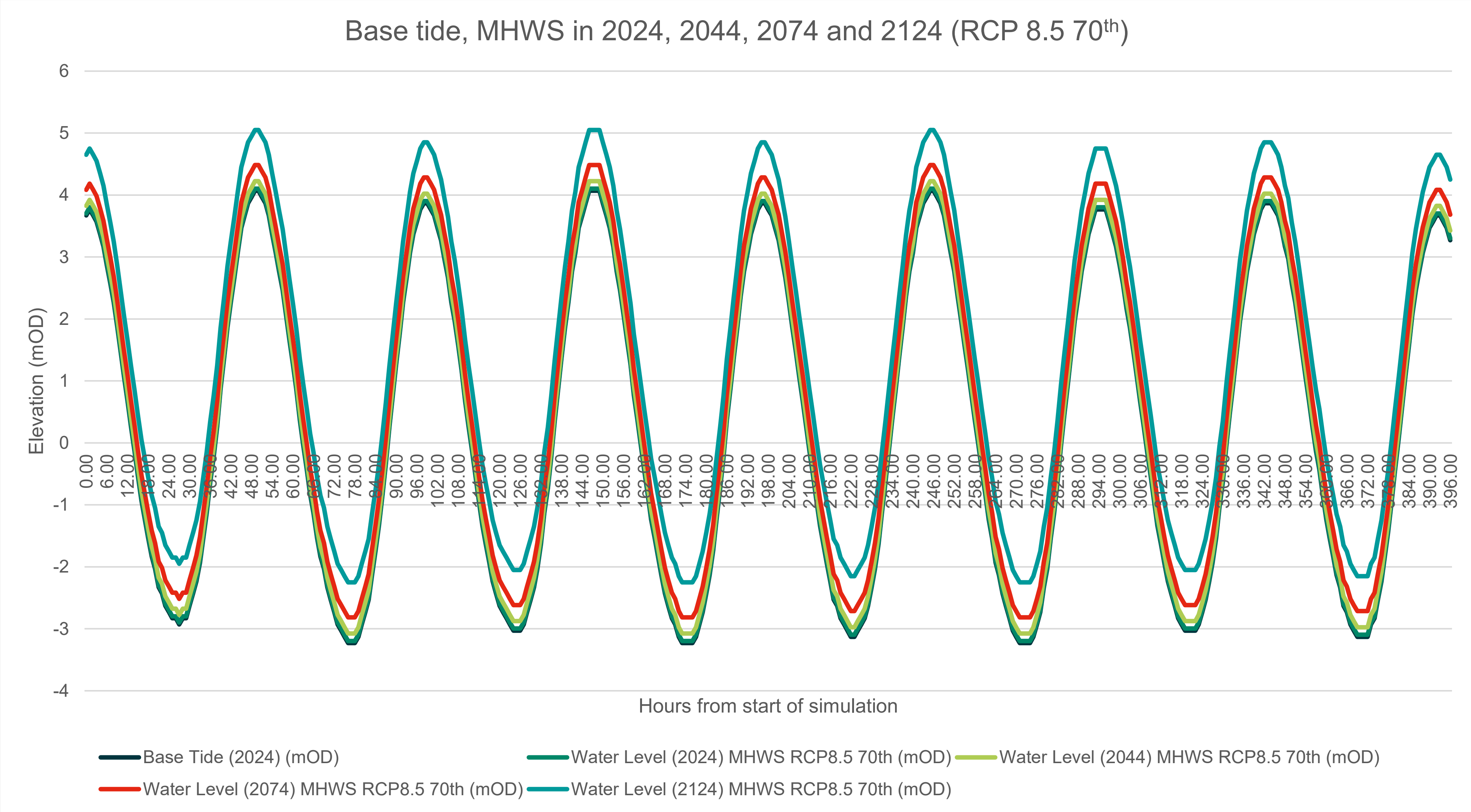

Figure 5: Base tide, MHWS in 2024, 2044, 2074 and 2124 (RCP 8.5 70th percentile)

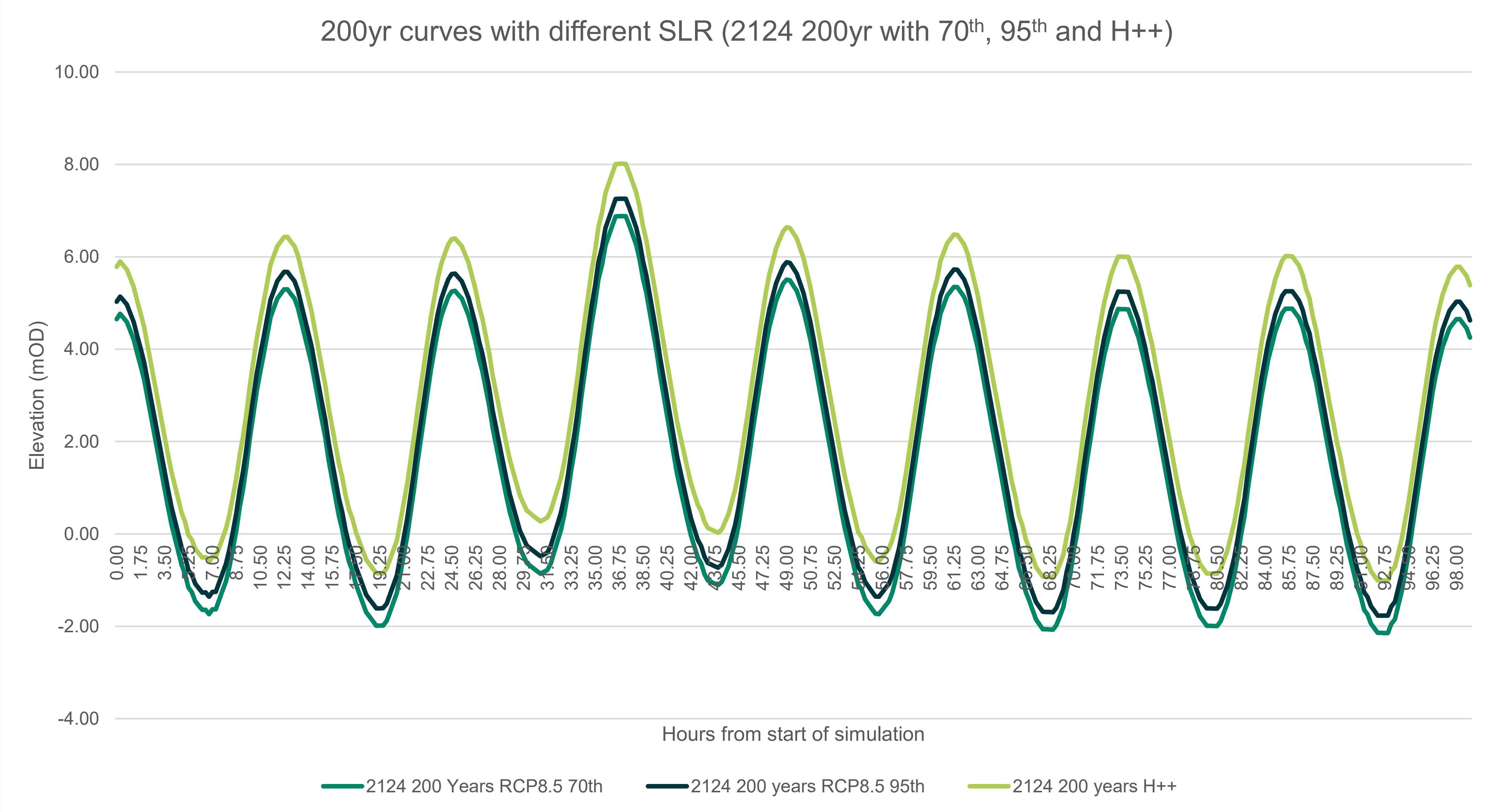

Figure 6: 2124 1:200yr event with different SLR projections (RCP 8.5 70th , RCP 8.5 95th and H++ scenario)

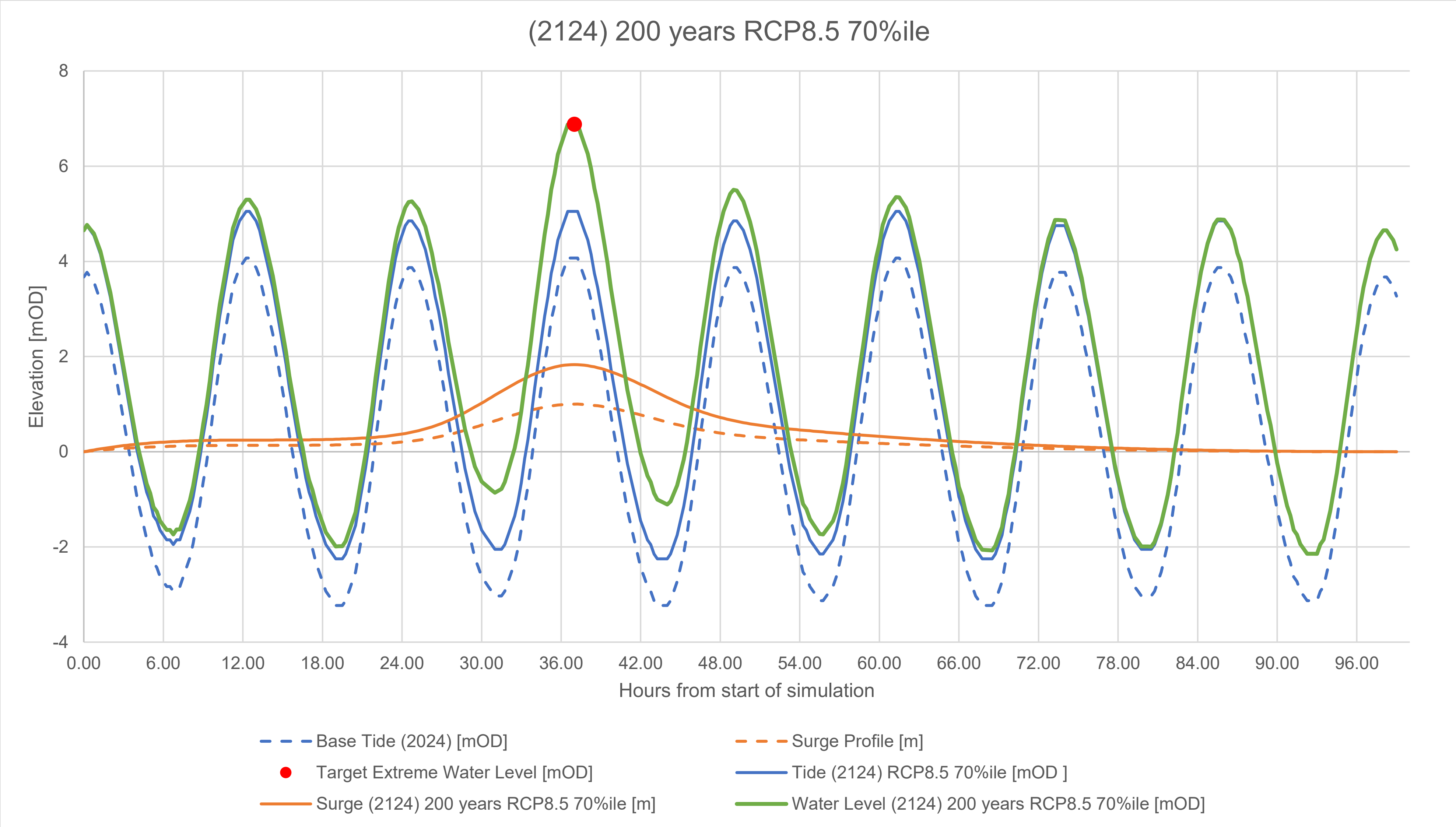

Figure 7: 200yr 2124 (RCP 8.5 70th percentile) scenario showing the different components (e.g. sea level rise, surge etc.)

References

Environment Agency, 2022, Flood and coastal risk projects, schemes and strategies: climate change allowances https://www.gov.uk/guidance/flood-and-coastal-risk-projects-schemes-and-strategies-climate-change-allowances accessed 9th May 2023

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UKMO, 2022, UK Climate Projections User Interface, https://ukclimateprojections-ui.metoffice.gov.uk/ui/home accessed 9th May 2023

UKHO, 2022, Admiralty Tide Tables Volume 1A

Annex D Maximum Depth Figures

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LEGEND

- Operational Footprint
- Order limits
- Dee Estuary (1D Only)

Maximum Depth (m)

- 0.0
- 1.0
- 2.0
- 3.0
- 4.0

Model Run File: TidalDee_UNDEF_2024_70pc_T0200_ACM_020_d_Max

Project Title

CONNAH'S QUAY LOW CARBON POWER

Copyright

Drawing Status

FINAL

Drawing Title

TIDAL SCENARIO 0.5% AEP (2024) MAXIMUM FLOOD DEPTH

Client

UNIPER UK LTD

Scale at A3 1:12000

Drawn AH | Checker RC

Approver HJ | Date 31/07/2025

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LEGEND

Operational Footprint

Order limits

Dee Estuary (1D Only)

Maximum Depth (m)

0.0

1.0

2.0

3.0

4.0

Model Run File: TidalDee_UNDEF_2024_70pc_T1000_ACM_020

Project Title

CONNAH'S QUAY LOW CARBON POWER

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Drawing Status

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Drawing Title

TIDAL SCENARIO 0.1% AEP (2024) MAXIMUM FLOOD DEPTH

Client

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Approver HJ	Date 31/07/2025

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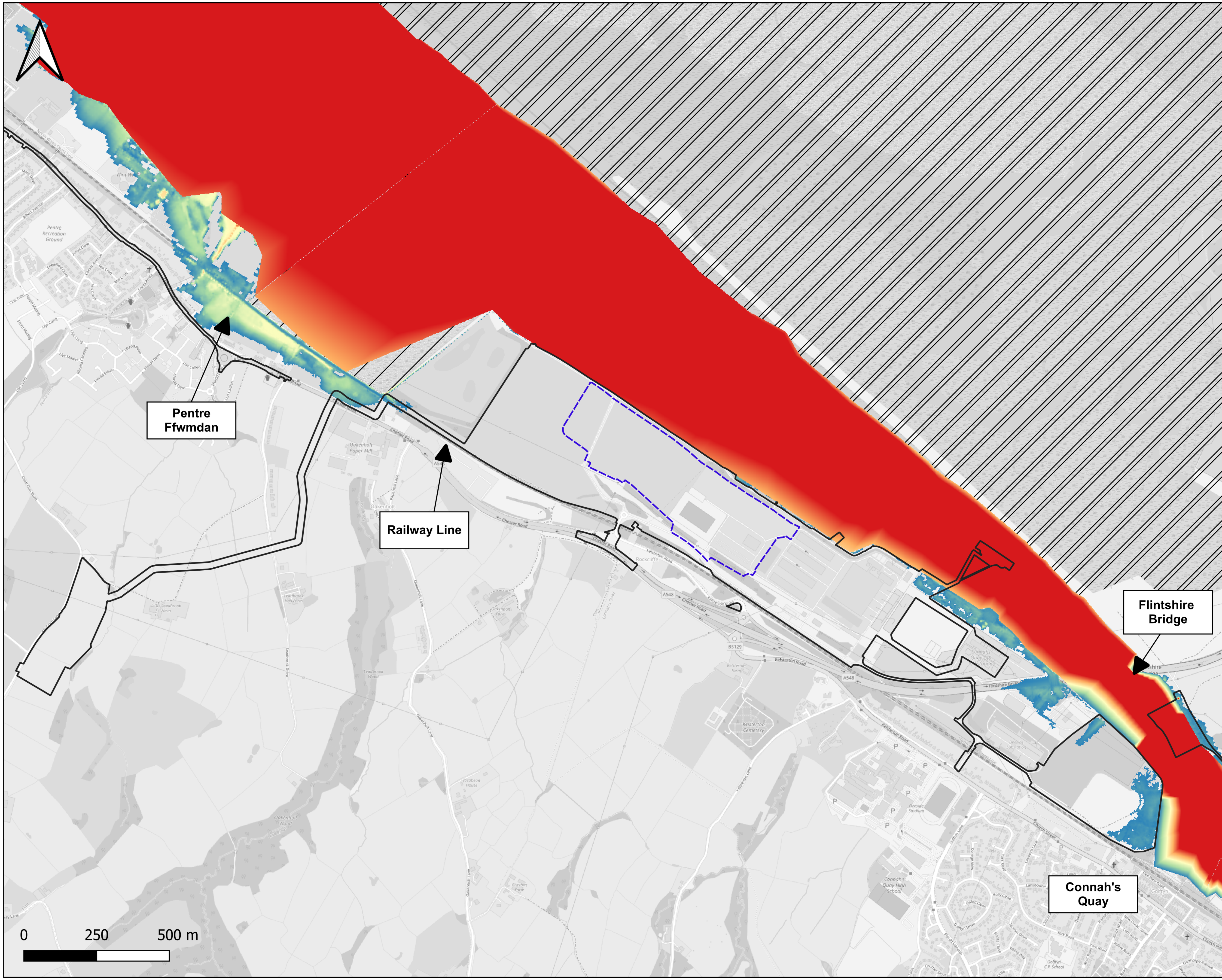

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LEGEND

Operational Footprint

Order limits

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Maximum Depth (m)

0.0

1.0

2.0

3.0

4.0

Model Run File:
TidalDee_UNDEF_2074_70pc_T0200_ACM_020

Project Title

CONNAH'S QUAY LOW CARBON POWER

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Drawing Status

FINAL

Drawing Title

TIDAL SCENARIO
0.5% AEP (2074)
MAXIMUM FLOOD DEPTH

Client

UNIPER UK LTD

Scale at A3 1:12000

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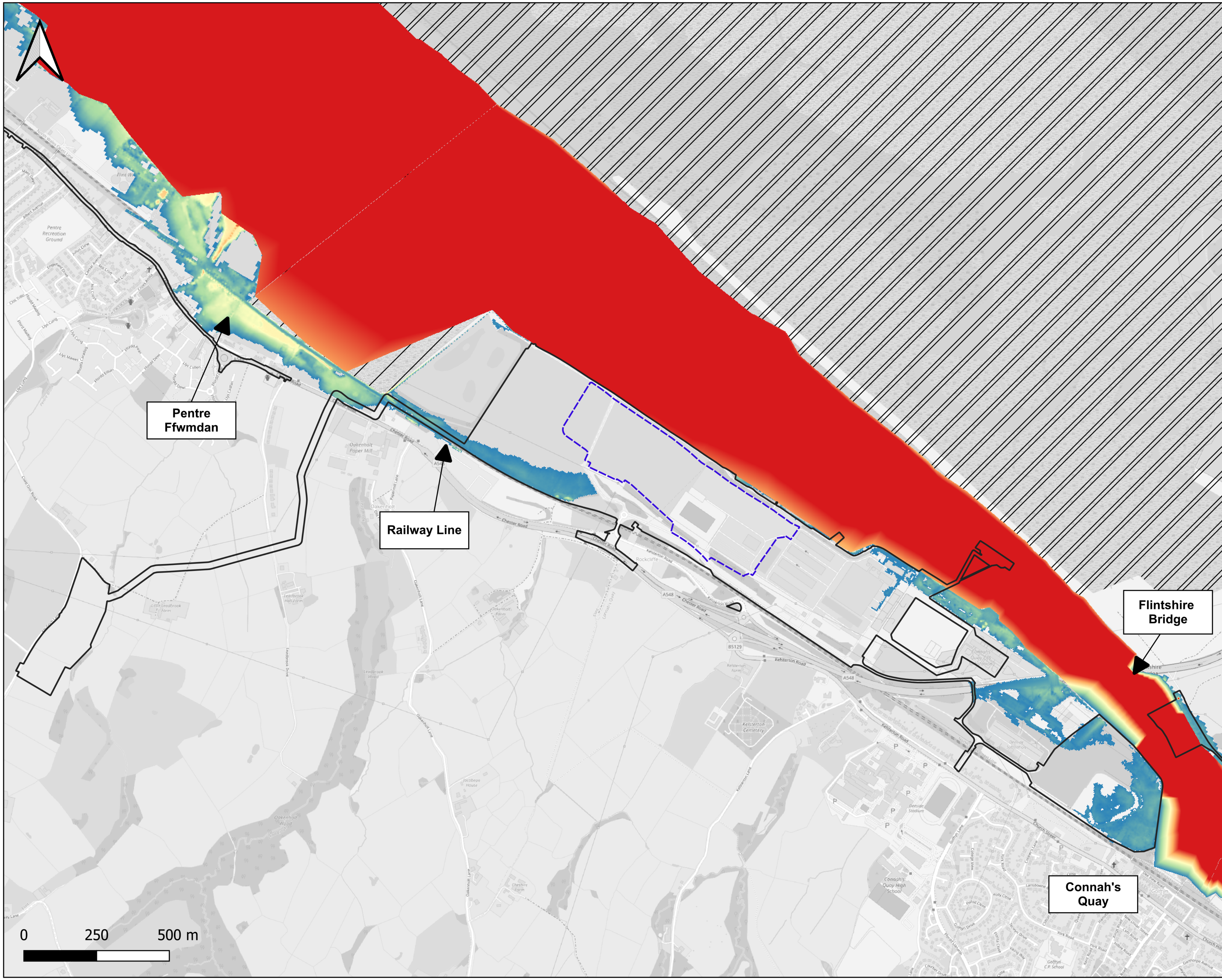

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LEGEND

- Operational Footprint
- Order limits
- Dee Estuary (1D Only)

Maximum Depth (m)

- 0.0
- 1.0
- 2.0
- 3.0
- 4.0

Model Run File:
TidalDee_UNDEF_2074_70pc_T1000_ACM_020

Project Title

CONNAH'S QUAY
LOW CARBON
POWER

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Drawing Status

FINAL

Drawing Title

TIDAL SCENARIO
0.1% AEP (2074)
MAXIMUM FLOOD DEPTH

Client

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Scale at A3	1:12000
Drawn AH	Checker RC
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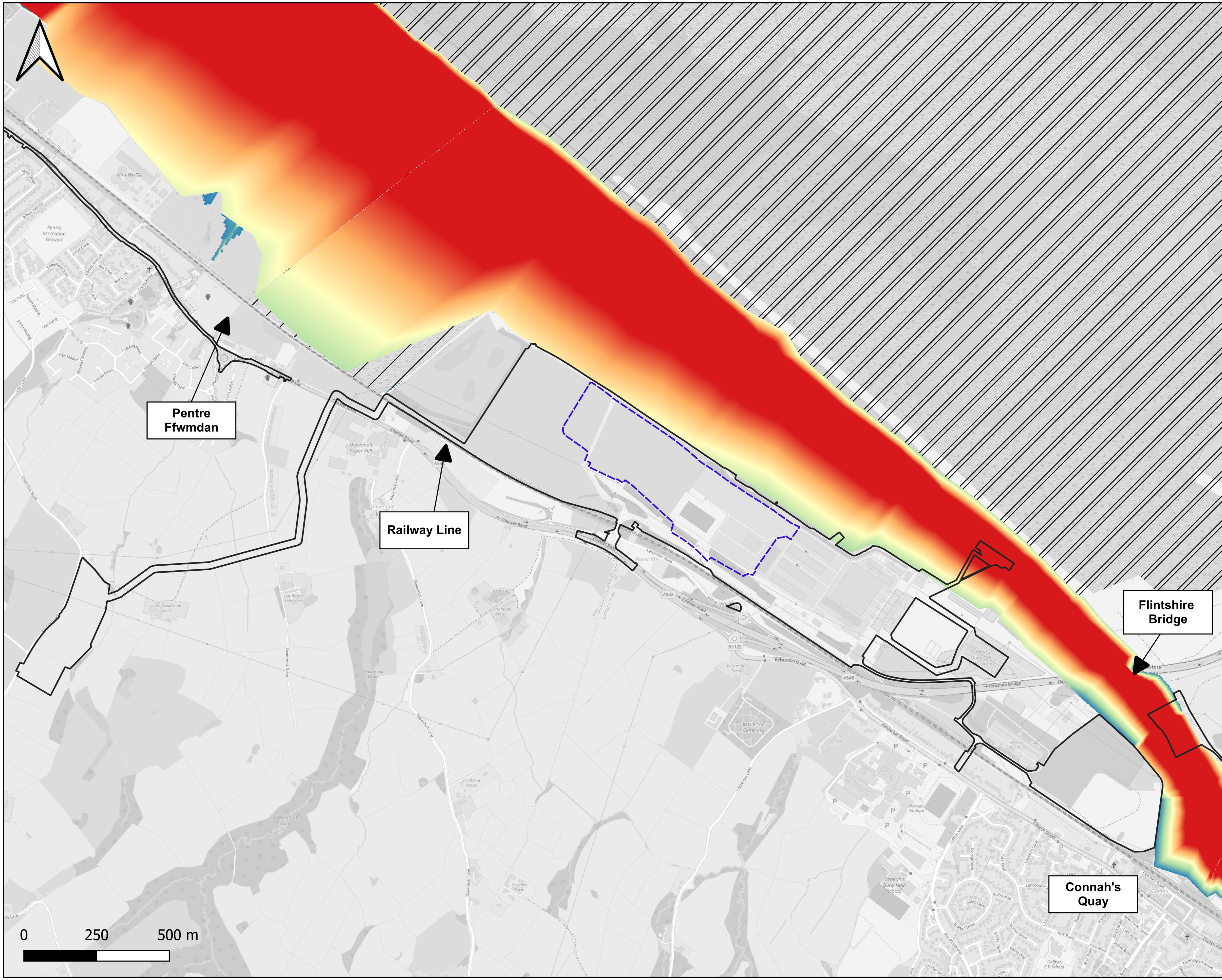

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LEGEND

Operational Footprint
Order limits
Dee Estuary (1D Only)

Maximum Depth (m)

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2.0
3.0
4.0

Model Run File:
TidalDee_UNDEF_UCC_Q0100_ACM_020A

Project Title
CONNAH'S QUAY LOW CARBON POWER

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Drawing Status
FINAL

Drawing Title
FLUVIAL SCENARIO 1% AEP + 45% CLIMATE CHANGE MAXIMUM FLOOD DEPTH

Client
UNIPER UK LTD

Scale at A3	1:12000
Drawn AH	Checker RC
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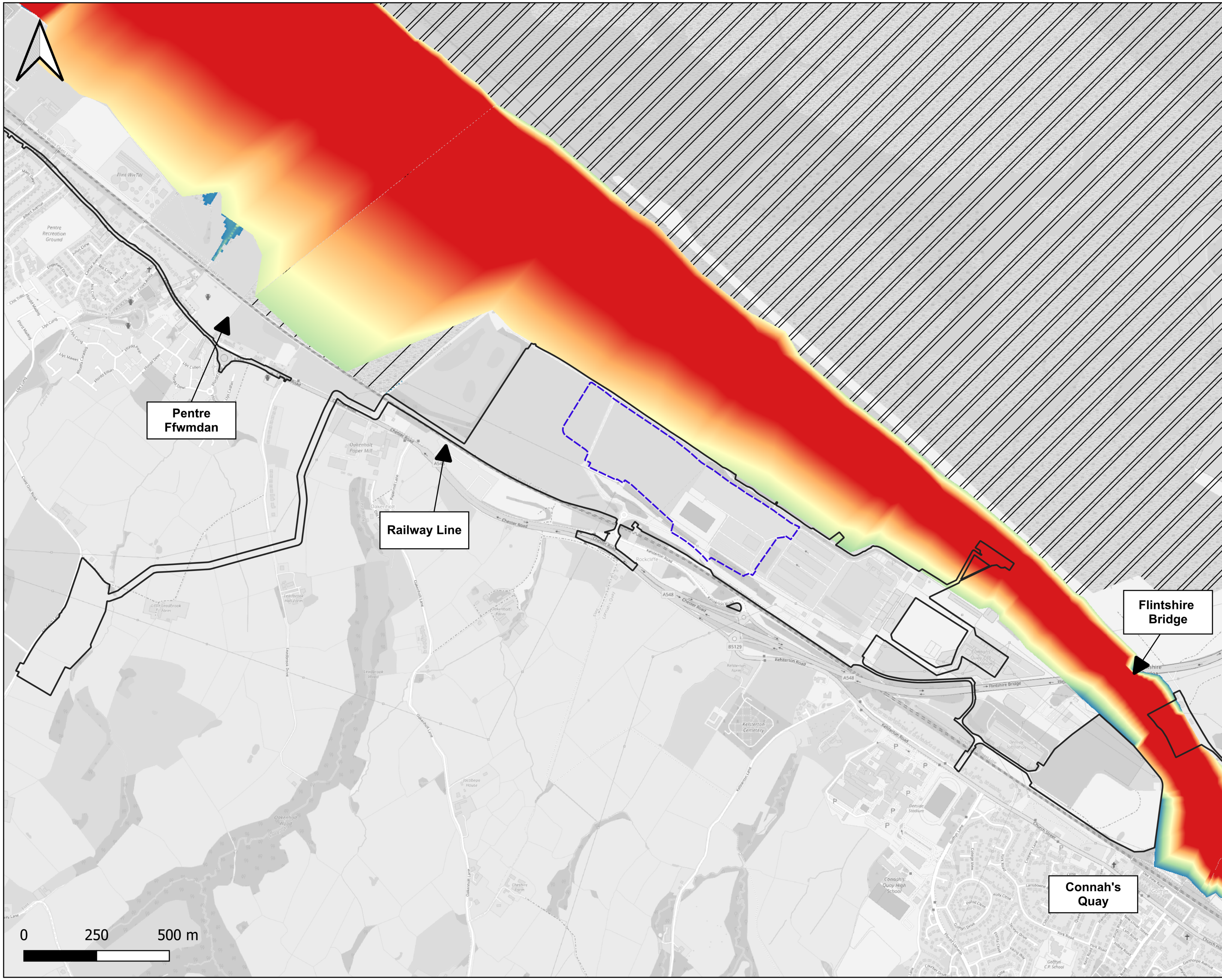

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LEGEND

Operational Footprint

Order limits

Dee Estuary (1D Only)

Maximum Depth (m)

0.0

1.0

2.0

3.0

4.0

Model Run File:
TidalDee_UNDEF_UCC_Q1000_ACM_020A

Project Title

CONNAH'S QUAY LOW CARBON POWER

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Drawing Status

FINAL

Drawing Title

FLUVIAL SCENARIO 0.1% AEP + 45% CLIMATE CHANGE MAXIMUM FLOOD DEPTH

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