# **Outer Dowsing Offshore Wind**

# **Environmental Statement**

Chapter 24 Hydrology and Flood Risk

Volume 3 Appendices

Appendix 24.3 Flood Risk

Assessment: Onshore Substation

(Part 2 of 2)

Date: February 2025

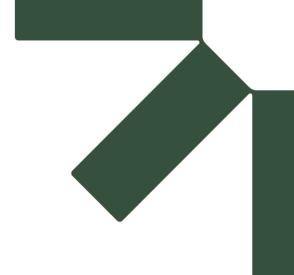
Document Reference: 6.3.24.3

Pursuant to APFP Regulation: 5(2)(a) and 5(2)(e

Rev: 4.0 (Tracked)

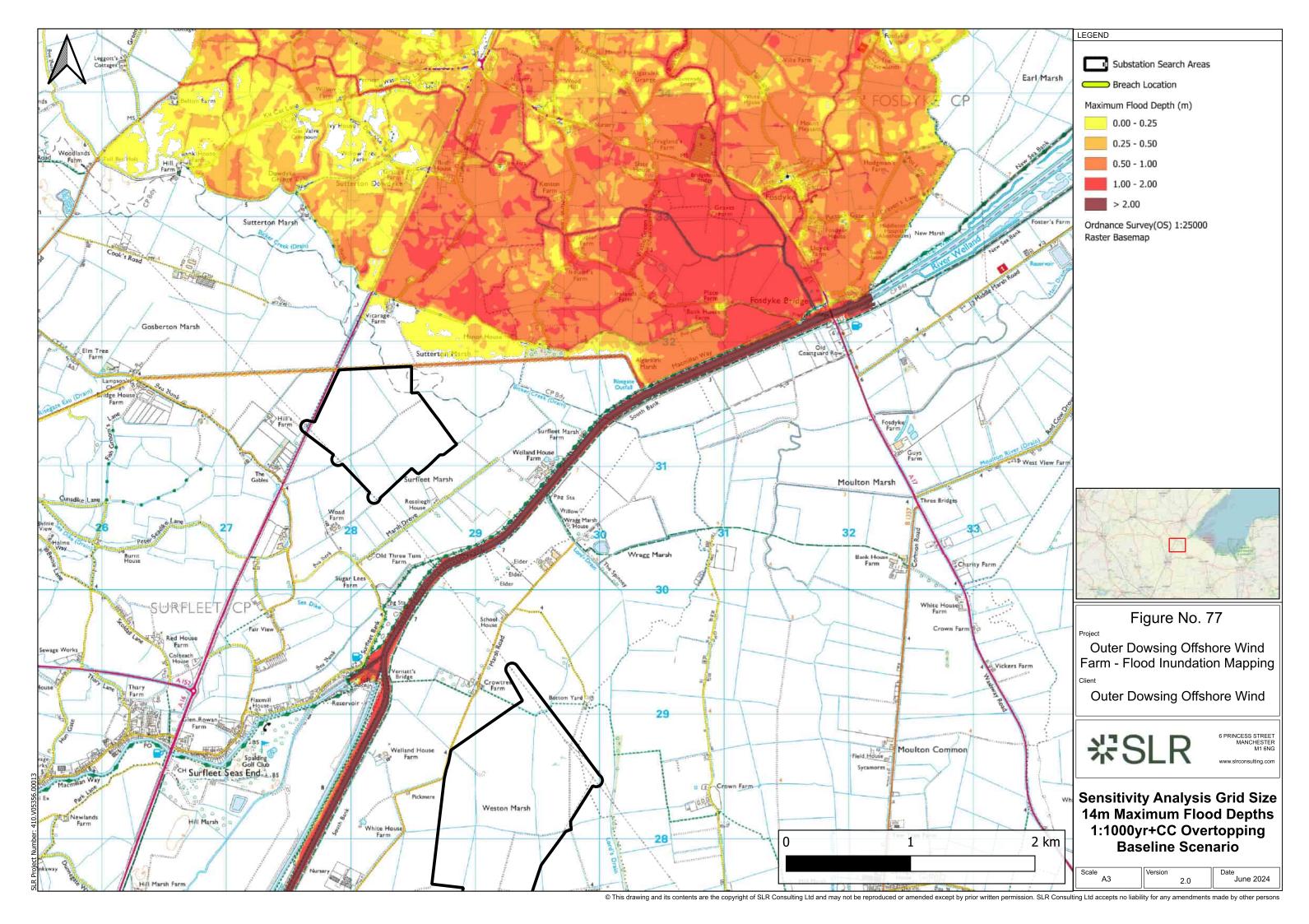


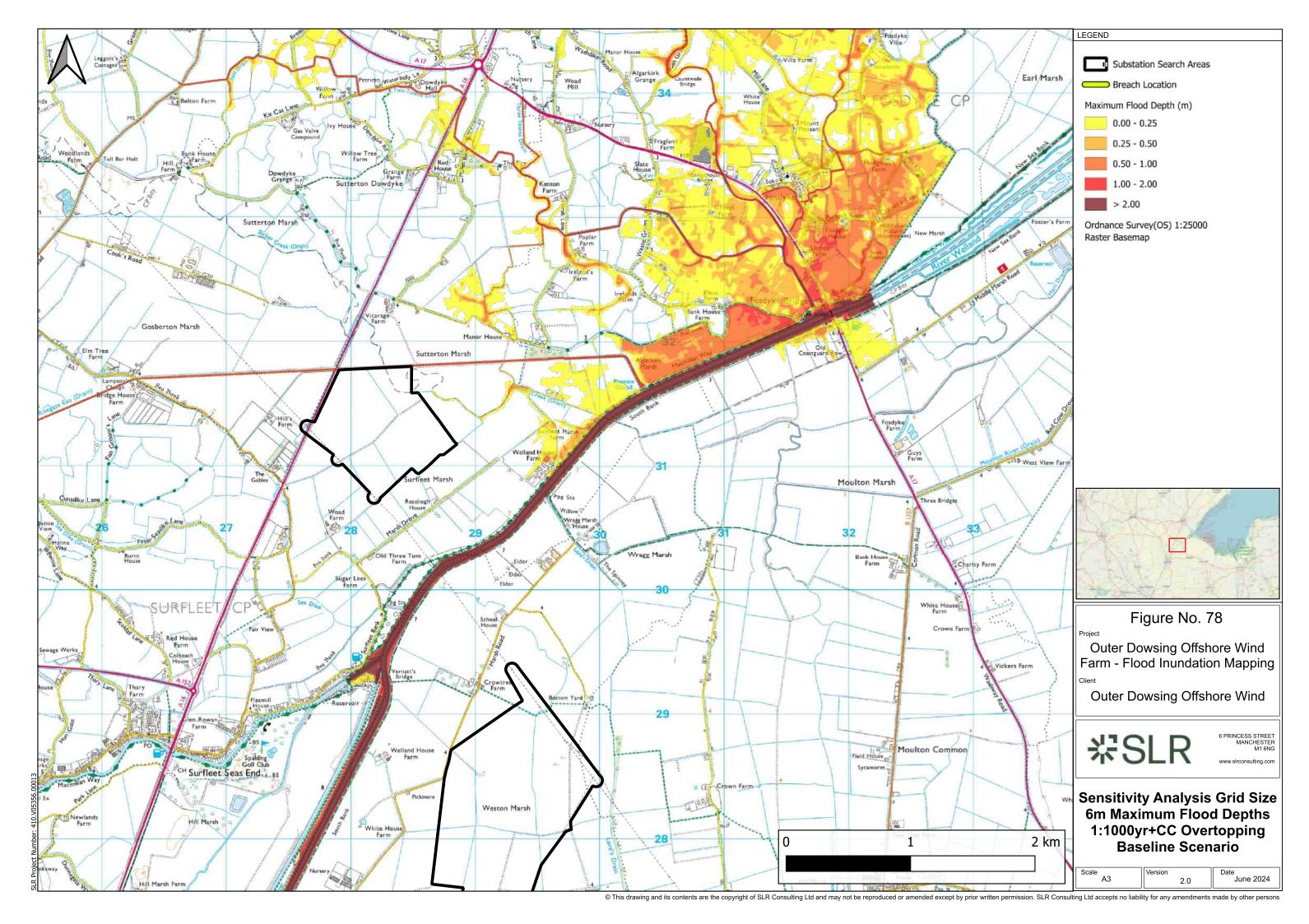
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1.0	March 2024		DCO Application	SLR	GoBe	•	nerd and lerburn	Outer Dowsing
2.0	June 202	4	Response to Section 51 Advice	SLR	Outer Dowsing	Shepherd and Wedderburn		Outer Dowsing
3.0	Septembo 2024	er	Procedural Deadline 19 <sup>th</sup> September	SLR	Outer Dowsing	•	nerd and lerburn	Outer Dowsing
4.0	February 2025		Examination Deadline 4	SLR	Outer Dowsing		nerd and lerburn	Outer Dowsing

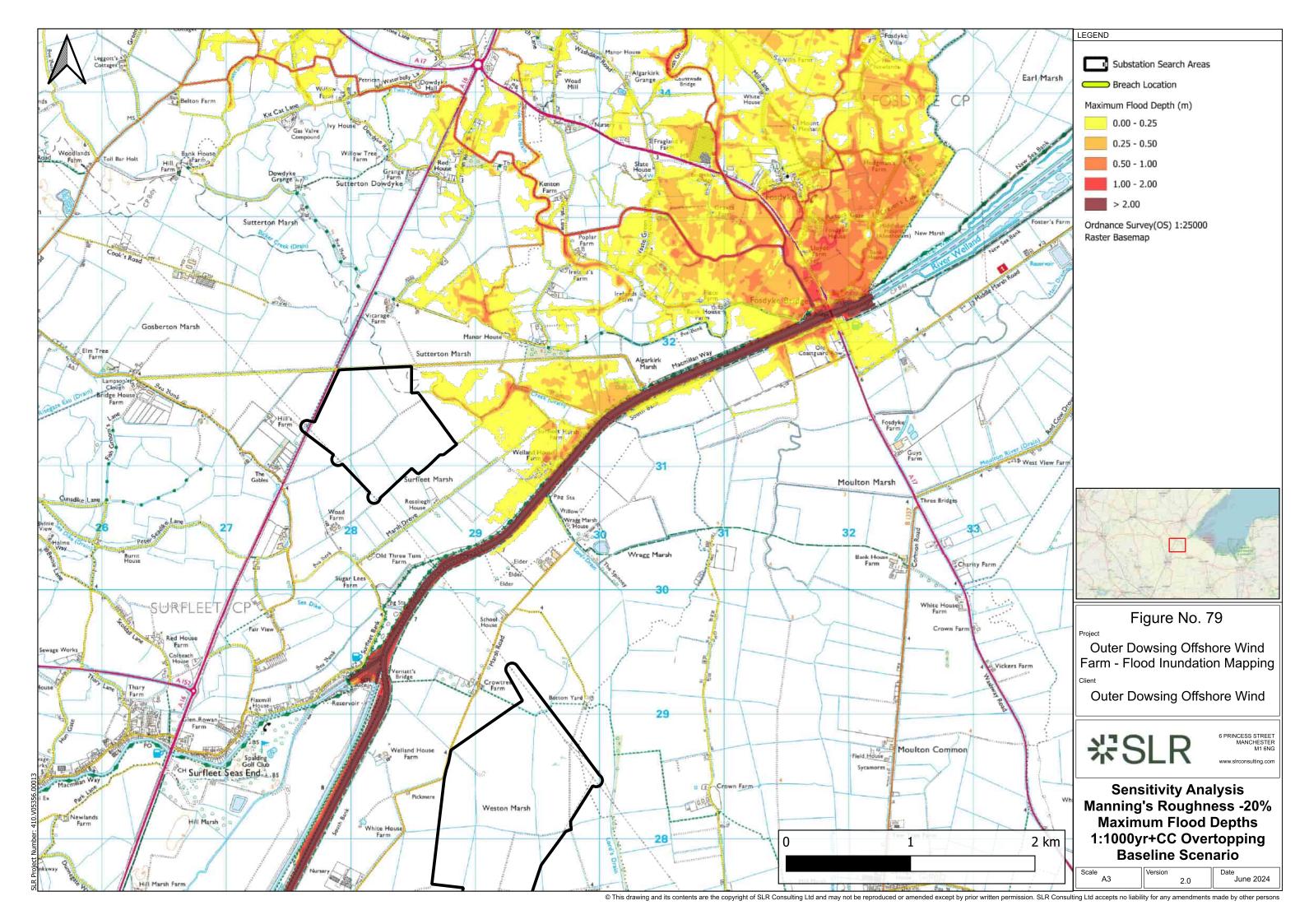


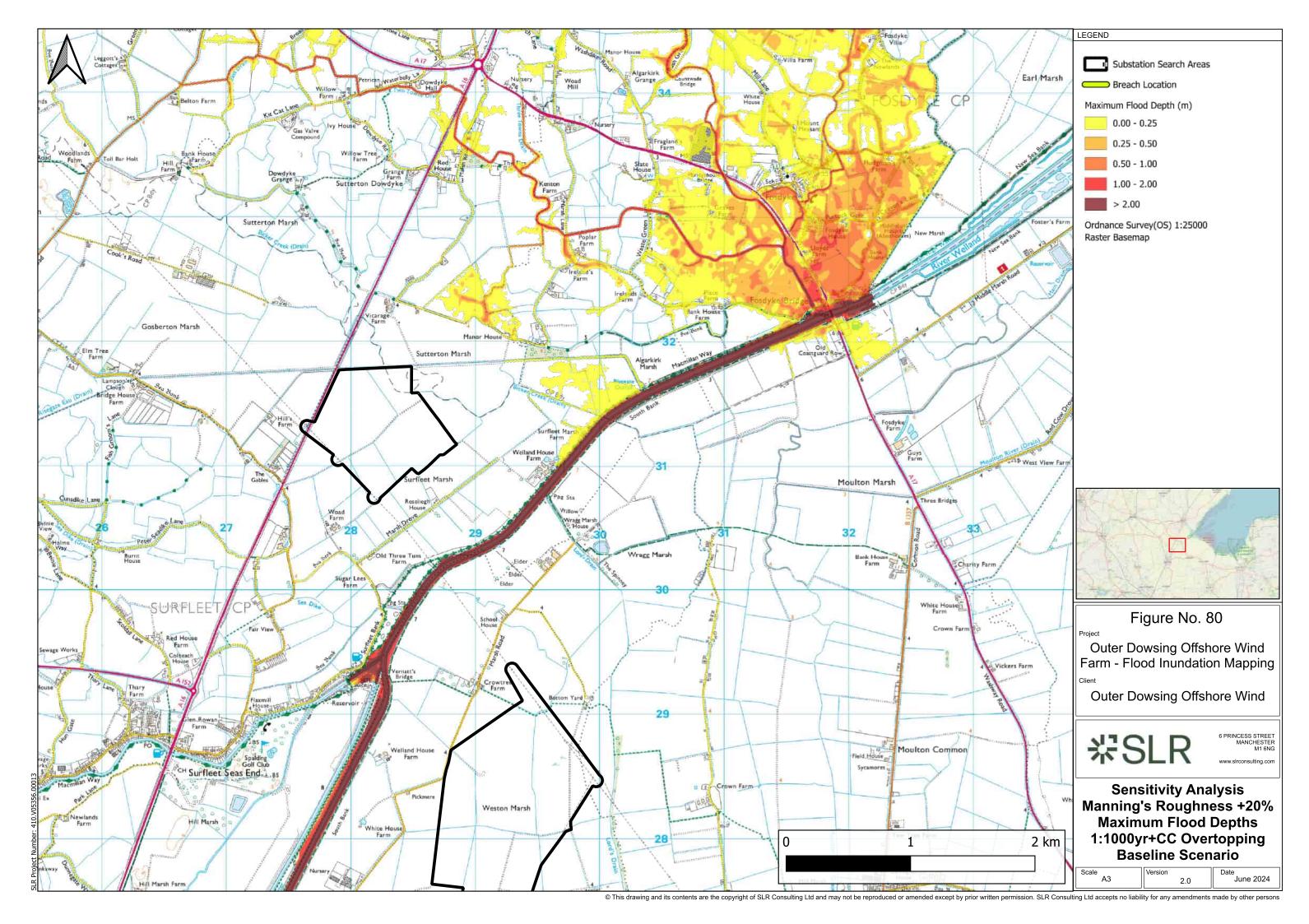
# Appendix B Sensitivity Analysis Maps – Peak Results

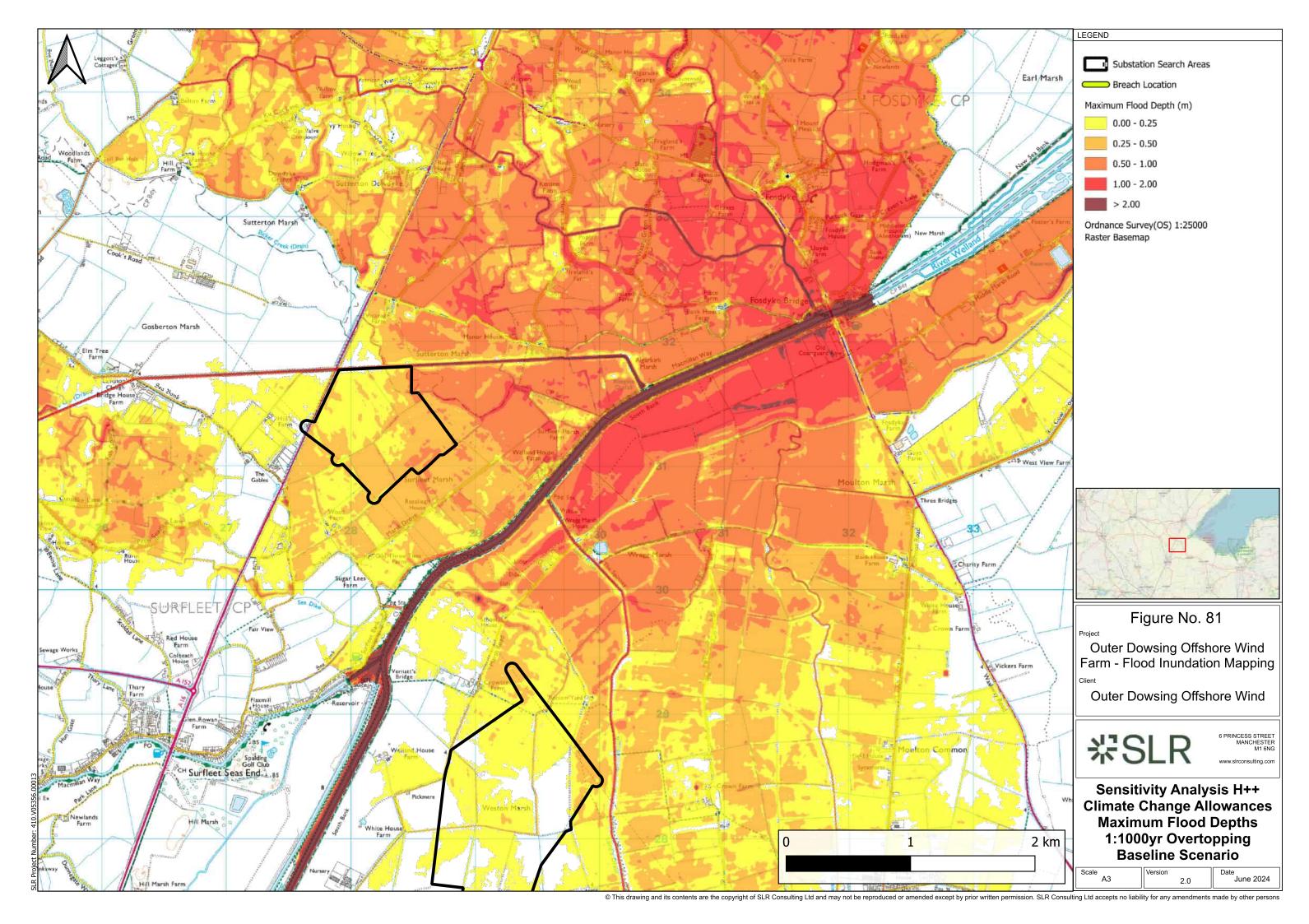


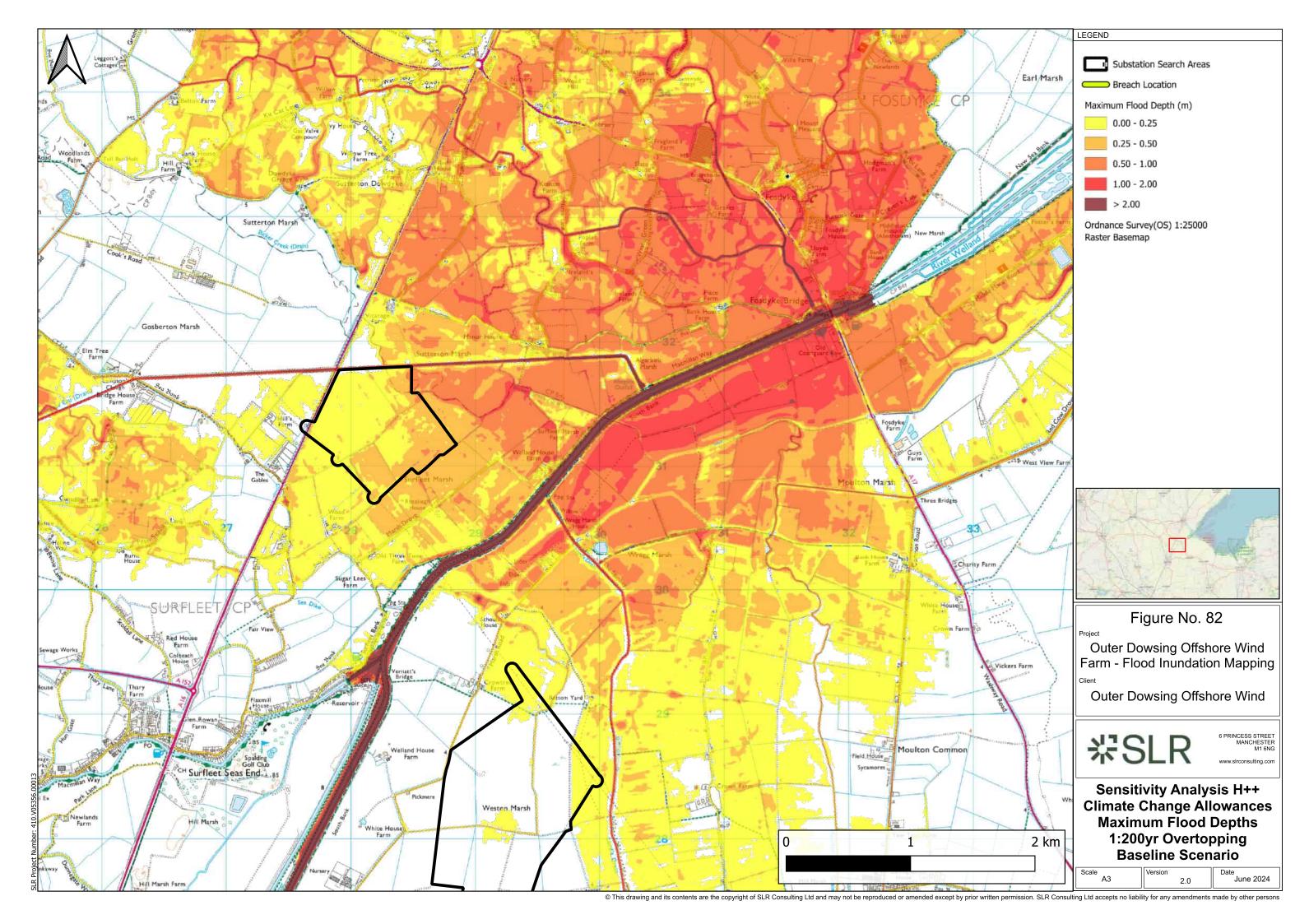


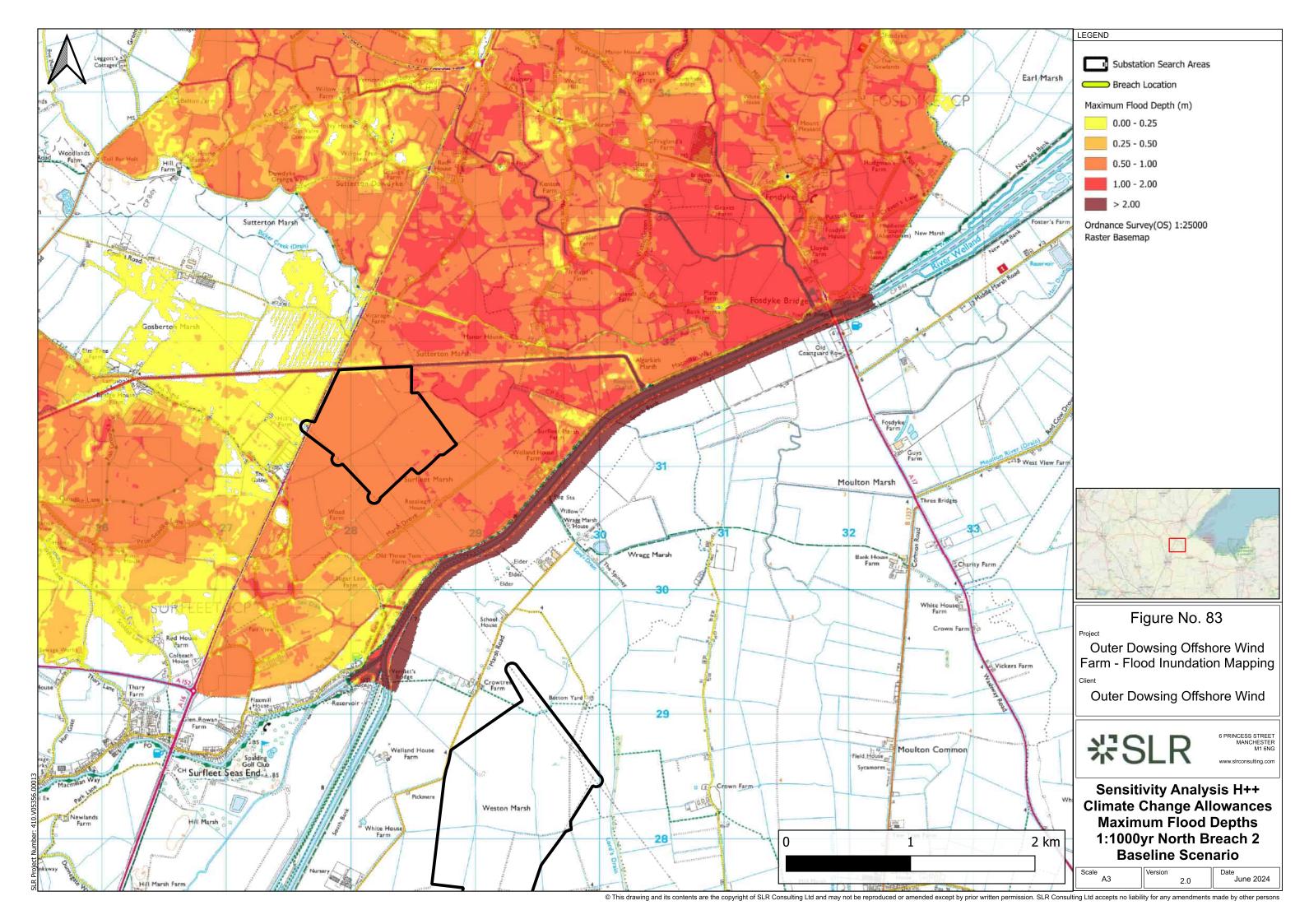


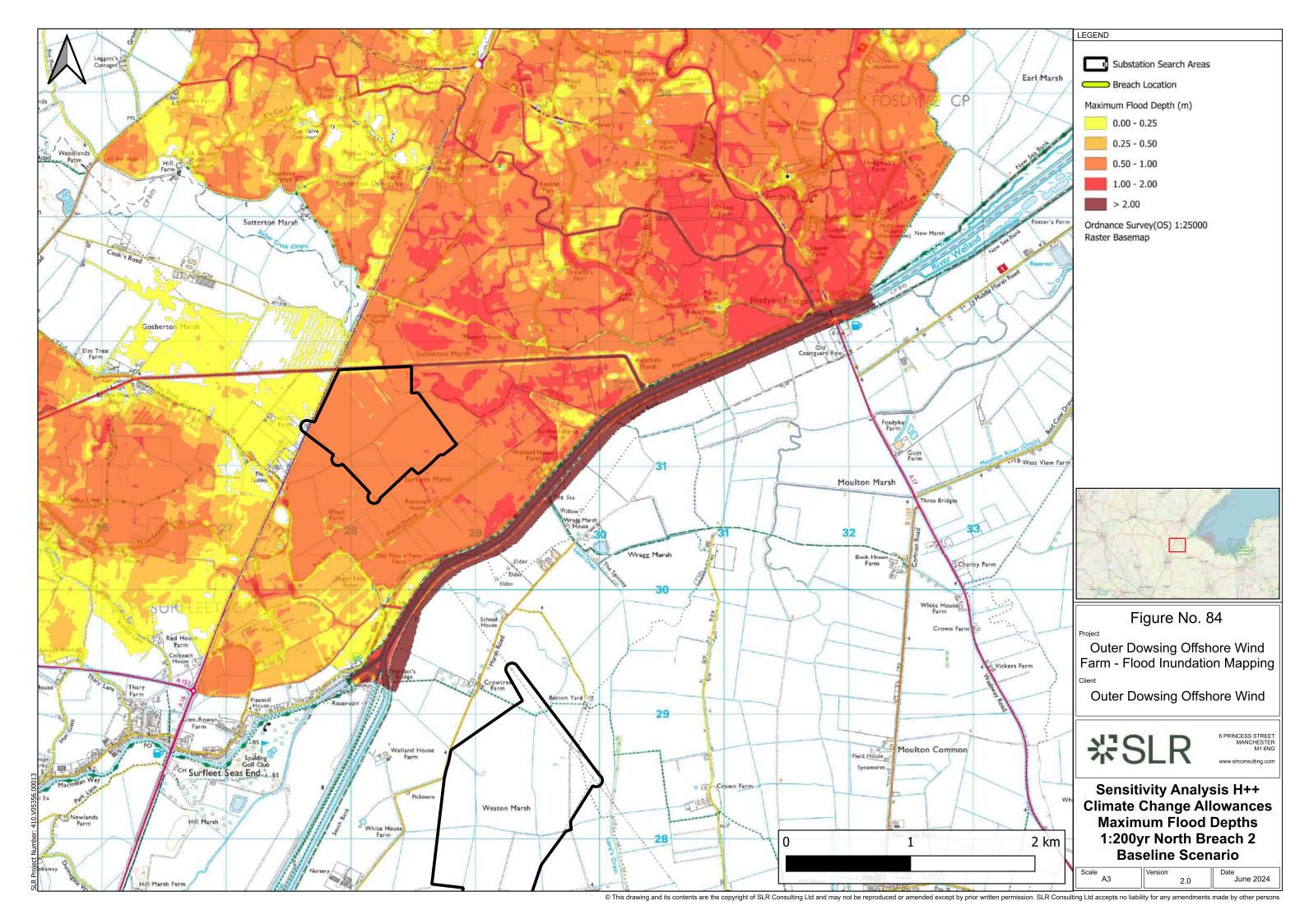














# **Appendix C** Technical Memorandum



# **Technical Memorandum**



To: Heather Tysoe From: Katrina Riches / George

Frisby

Company: Environment Agency SLR Consulting Limited

cc: Date: 21 August 2023

**Project No.** 410.V05356.00013

**RE: Outer Dowsing Offshore Windfarm Onshore Substation FRA** 

River Welland Breach Modelling

This technical note aims to outline the approach SLR propose to take with regard to breach and overtopping modelling for the Onshore Substation for Outer Dowsing Offshore Wind Farm.

A data request was submitted to the Environment Agency for model data relating to the proposed onshore cable route and substation search areas for Outer Dowsing Offshore Windfarm (ODOW). 2010 NTM Breach and Overtopping data was received with regard to scenarios for coastal areas and for the tidal reach of the River Welland.

Upon review it was evident that the data at the southern extent of the information provided, to the north and south of the River Welland, there were some issues and inconsistency in the data provided:

- north of the River Welland the flood model data is a lot coarser than the rest of the area provided, and interrogation of depth data only provides integer values such as '0', '1' or '2'; and
- south of the River Welland the 1 in 200\_CC2115\_Depth and 1 in 1000\_CC2115 Depth data seem to have the exact same extent and depths in certain areas.

The Environment Agency have reviewed these points and confirmed that they are aware of some issues in the modelling in certain locations, including the areas highlighted above. The Environment Agency are planning to update the existing modelling however no improvement on the data provided is currently available.

The Environment Agency have recommended that breach and overtopping analysis is carried out to ensure that the proposed design datums are sufficient to ensure that the proposed substation remains operational for the 0.1% annual exceedance probability scenario plus an allowance for climate change. Modelling completed by SLR will also ensure that breaches can be located at the critical locations.

The Environment Agency have provided guidelines for undertaking breach modelling which are appended to this note (Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping, Version 8, Jan 2014).

## 1.0 Proposed Breach Modelling Criteria

### 1.1 Hydrology

 The shape of the astronomical tidal curves to be used in the modelling were taken from Environment Agency Flood Risk Mapping and Data Management: Anglian



Region Report (2016). These have been scaled to fit gauged water levels at Fosdyke Bridge.

- These tidal curves have been scaled to fit the extreme water levels at Fosdyke Bridge (CFB conditions for the UK 2018 for 'Location: ESTURY\_RiverWELLAND Chainage: \_3992\_5).
- Climate change allowances for the sea level has been calculated from a base year of 2018 using the current guidance from EA for the Anglian Region for Upper End scenario (Flood risk assessments climate change allowances).
- Resultant Peak Tidal Levels at Fosdyke Bridge are summarised below:

AEP%	EA Report (m)	CFB (m)	CFB (97.5%confidence levels)
0.5%	5.99	5.98	6.38
0.1%	6.69	6.29	6.97
0.5%+CC	7.13	6.68	7.08
0.1%+CC	7.83	6.99	7.67

#### Climate change allowances

 $2018 - 2035 - 17yrs \times 7mm = 119mm$ 

2036 - 2065 = 339mm

2066 - 2080 - 15yrs x 15.8 = 237mm

Total sea level rise (2018-2080) = **695mm** 

Full head time (HT) boundary conditions can be found in the accompanying excel sheet.

### 1.2 Hydraulic Modelling

- Proposed southern and northern breach locations along the River Welland have been located at critical locations along the primary flood defences, which will allow for worst case flood events to the proposed sub station site option search areas. These locations have high levels of hydraulic connectivity to the sites due to proximity and existing watercourses, which also being downstream for the River Glen and Welland confluence and therefore close enough to the location of estuarine extreme water levels. (Fosdyke Bridge). The Breach locations are attached in the accompanying shapefiles and pdf.
- Modelling will be completed using 2D TUFLOW software with a grid size of 10m. Use of HPC and SGS to allow for underlying 1m LiDAR to be taken into account.
- LiDAR Composite DTM (1m 2022) will be used. (example tile: LIDAR-DTM-1m-2022-TF22nw)
- The heights of riverbank defenses in the River Welland study area are defined by a series of ZSH polylines in the TUFLOW 2D domain.
- A Head Time boundary on the River Welland will apply the coastal level in the watercourse channel.
- The flood plain model extent to extend significantly far from the site for no effects and all relevant flow paths to be modelled.



- 21 August 2023 SLR Project No: 410.V05356.00013
- The crest elevations used for the defences to be obtained from 'EA Spatial Flood Defences Including Standardised Attributes' layer and cross referenced against LiDAR.
- Breach of flood defences will be represented in TUFLOW using variable shape files.
- Breach criteria (as per EA guidance):
  - Ground level behind defence extracted to Lidar
  - Breach width = 50m
  - o Breach duration 70hr
- The 0.1%+CC event peak water level is higher than the current crest level of the embankment. Therefore, for this event the embankment will be raised in the model to a suitable height so that the peak water level in the River Welland does not overtop the flood embankment.
- Hazard, Depth and Velocity Mapping, along with Flood Depth Progression and Sensitivity Testing will be completed in line with the EA guidance.
- Results will be reported in a suitable modelling report.
- All events to be modelled with a base date of 2006 for present day.

### 2.0 Proposed Overtopping Modelling Criteria

In email correspondence with Heather Tysoe on 4<sup>th</sup> August 2023, the Environment Agency have stated that "With regards to overtopping, the Environment Agency will seek to raise flood defences in line with the climate change levels, however it is important to assess the potential depths which may occur from overtopping, should the defence heights remain unchanged".

It is therefore proposed that overtopping modelling will also be undertaken to address the effect of inundation with regard to finished floor levels of the substations. Only the 0.1% AEP+CC event has estimated levels higher than the current defence crest levels. Overtopping modelling can be completed for this event for the River Welland for the reach from the Fosdyke bridge to such a point upstream where the Flood Defence crest levels are higher than the peak water level. The overtopping would be simulated fully in the 2D domain with both north and south defence embankments being overtopped simultaneously.

## 3.0 Climate Change Allowances

As detailed in Section 1.1, the climate change allowances have been calculated using the guidance for the Anglian Region for the Upper End scenario.

In email correspondence with Heather Tysoe on the 4<sup>th</sup> August 2023, the Environment Agency have stated that "The following climate change guidance (section titled Assessing credible maximum scenarios for nationally significant infrastructure projects, new settlements or urban extensions) suggests that for an NSIP, the H++ climate change allowances should be applied."

It is understood that the H++ climate change allowances should be applied as a sensitivity test to "help assess how sensitive your proposal is to changes in the climate for different future scenarios. This will help to ensure your development can be adapted to large-scale climate change over its lifetime". It is therefore proposed that the Upper End scenario is used to assess the design level for the onshore substation, however a sensitivity test using the H++ climate change allowance will be included as part of the assessment. It would be grateful if we could receive clarity that this approach is correct.







# Appendix D Environment Agency Letter





Ms Katrina Riches Senior Hydrologist SLR Consulting Manchester House 86 (Third Floor) Princess Street Manchester M1 6NG Our ref: AN/2023/134856/04-L01 Your ref: EN010130-000032-220802

Date: 10 December 2024

#### Dear Katrina

# Construction of the Outer Dowsing Offshore Wind Farm River Welland Breach Model – 3rd Review Response

Thank you for submitting the updated River Welland breach analysis for review.

We have reviewed the information provided and we are satisfied that our previous comments have been addressed. The model is now considered to be fit for purpose in relation to assessing flood risk mitigation requirements for the Onshore Substation. Please see the attached Model Review Response sheet for further information.

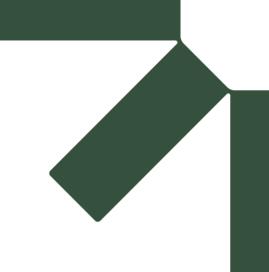
We look forward to receiving the additional modelling in relation to the potential 3<sup>rd</sup> party impacts, which you are undertaking to align with the national planning policy, 75-year timeframe requirement.

Should you require any additional information, or wish to discuss these matters further, please do not hesitate to contact me at the number below.

Yours sincerely

Annette Hewitson Principal Planning Adviser

Enc: Hydraulic Model Review 3rd Response spreadsheet



# Appendix E 75-year lifetime Technical Addendum



# Technical Addendum



Appendix E: Technical Addendum to Annex 1: River Welland Breach Modelling Report (document reference 6.3.24.3) - 75 year lifetime

Date: 17 December 20243 February 2025

**SLR Project No.:** 410.V05356.00013

Revision: V1.0

Prepared by: **SLR Consulting Limited** 

#### 1.0 Introduction

- 1. The purpose of this technical addendum is to present the hydraulic modelling results for the consideration of a 75--year lifetime for the proposed Outer Dowsing Offshore Wind (ODOW) Onshore Substation (OnSS). This additional modelling has been undertaken due to comments received from the Environment Agency requesting for the assessment of the scenario of the raised platform and OnSS remaining in place beyond 2065 and in particular the impact this couldwill have on 3rd parties in relation to flood hazard, following the additional years of allowances for climate change.
- 2. This document presents the adjustment of the hydraulic modelling boundaries, modelling results, and analysis to account for the consideration of the 75 year lifetime of development. The River Welland Breach Modelling Report (document reference 6.3.24.3 Appendix AAnnex 1) documents the modelling methodology and parameterisation and should be referred to for any other details of the model.

#### **Modelling Updates and Results** 2.0

#### 2.1 **Hydraulic Boundaries**

- 3. The boundary condition applied to the TUFLOW model was a Head-Time (HT) boundary placed across the River Welland at Fosdyke Bridge. This boundary is used to assign the tidal curves for the 1 in 200 annual chance (0.5% Annual Exceedance Probability (AEP)), 1 in 1,000 annual chance (0.1% AEP), 1 in 200 annual chance (0.5% AEP) plus an allowance for climate change and 1 in 1,000 annual chance (0.1% AEP) plus an allowance for climate change events.
- 4. Previous studies commissioned by the Environment Agency show coastal flooding to be the critical flood mechanism for this area of The Fens. This is considered mutually exclusive from fluvial flooding, as the same conditions that generate peak coastal flooding levels on this section of coastline are not thought to be linked with storm conditions which will generate large fluvial floods. Therefore, this study focuses solely on coastal / tidal flooding mechanisms.
- 5. The shape of the astronomical tidal curves used in the modelling were taken from the 2011 Hyder River Welland Hydraulic modelling report1. CFB 97.5% confidence levels have been selected to minimise the uncertainty. These tidal curves have then been

April 2011, Hyder/Environment Agency: Strategic Flood Risk Management Framework Tidal Nene and Tidal Welland Hazard Mapping Hydraulic Modelling Report



- scaled to fit the extreme water levels estimated at Fosdyke Bridge2 (CFB conditions for the UK 2018 for 'Location: ESTURY RiverWELLAND Chainage: 3992 5).
- 6. A normal depth boundary condition (HQ) has been used at the upstream end of the River Welland to avoid glass walling across the river. The location of the 2D boundary condition (2d\_bc) differs between overtopping and breach scenarios due to the different model boundaries (2d\_code) used in each scenario.
- 7. Climate change allowances for sea level rise have been calculated from a base year of 2018 using the current Guidance from the EA for the Anglian Region for the Upper End Scenario (Flood risk assessments climate change allowances). A lifetime of 75 years has been considered (from 2030) and therefore climate change allowances up to 2105 have been calculated.
- 8. Resultant peak tidal levels at Fosdyke Bridge for the 75 year lifetime are summarised below in Table 2-1 Table 21.

Table 2-1: Summary of Peak Tidal Levels at Fosdyke Bridge

AEP %	EA Report <sup>3</sup> (m)	CFB (m)	CFB (97.5% confidence levels)
1:200 (0.5% AEP)	5.99	5.98	6.38
1:200 (0.5% AEP) + CC UE	7.13	6.44	7.49
1:200 (0.5% AEP) + CC HC	-	-	7.22
1:1000 (0.1% AEP)	6.69	6.29	6.97
1:1000 (0.1% AEP) + CC UE	7.83	6.75	8.08
1:1000 (0.1% AEP) + CC HC	-	-	7.81

#### Climate change allowances:

(HC) Higher Central total cumulative sea level rise (2018-2105) = 838mm

(UE) Upper End total cumulative sea level rise (2018-2105) = 1113mm

#### 3.0 Model Results

9. Maximum flood extents and depths, and hazard rating results for the areas on and surrounding the site are presented in Appendix A of this Technical Addendum.

#### 3.1 Scenarios and Events

- 10. The peak flood extents for the overtopping baseline scenario show flood water reaches the site for all the scenarios presented in Table 2-1 with the exception of the (0.5% AEP) + CC Higher Central (HC) event. The flood extent for the (0.5% AEP) + CC HC event is contained within the channel immediately north of the site.
- 11. The peak flood extents for both breach events under baseline conditions show significant flooding at the site, which is summarised in Table 31 and <u>Table 3-3Table 33</u> below. The A16 road plays a significant role in controlling flood depths around the <u>site the site</u> area, acting as an obstruction to flow, holding water between the river and the road.

<sup>&</sup>lt;sup>3</sup> April 2011, Hyder/Environment Agency: Strategic Flood Risk Management Framework Tidal Nene and Tidal Welland Hazard Mapping Hydraulic Modelling Report



<sup>2 2018,</sup> Environment Agency: Coastal Flood Boundary Extreme Sea Levels

- 12. Under the proposed conditions, the OnSS remains free from flooding from all assessed scenarios for overtopping. For breach 1 and 2 all events show flooding of the OnSS, with the exception of the 0.5% AEP + CC HC scenario which remains flood free. The depth of flooding in the proposed scenarios range from 38mm to 149mm.
- 13. The peak flood levels and depths on site for baseline and proposed scenarios are provided in <u>Table 31Table 3-1</u> to Table 3-4 below.

Table 31: Baseline Peak Water Levels across the Site-

Maximum Flood Levels (m AOD)	Overtopping	Breach 1	Breach 2
1:200 (0.5% AEP) + CC UE	3.623	4.235	4.288
1:200 (0.5% AEP) + CC HC	-	4.141	4.197
1:1000 (0.1% AEP) + CC UE	3.847	4.289	4.328
1:1000 (0.1% AEP) + CC HC	3.704	4.236	4.290

Table 3-2: Proposed Peak Water Levels across the Site

Maximum Flood Levels (m AOD)	Overtopping	Breach 1	Breach 2
1:200 (0.5% AEP) + CC UE	-	4.238	4.315
1:200 (0.5% AEP) + CC HC	-	•	4.269
1:1000 (0.1% AEP) + CC UE	-	4.290	4.349
1:1000 (0.1% AEP) + CC HC	-	4.241	4.315

Table 3-3: Baseline Peak Water Depths across the Site

Maximum Flood Depths (m)	Overtopping	Breach 1	Breach 2
1:200 (0.5% AEP) + CC UE	0.062	0.842	0.884
1:200 (0.5% AEP) + CC HC	-	0.750	0.790
1:1000 (0.1% AEP) + CC UE	0.405	0.898	0.925
1:1000 (0.1% AEP) + CC HC	0.154	0.843	0.866

Table 3-4: Proposed Peak Water Depths across the Site

Maximum Flood Levels (m AOD)	Overtopping	Breach 1	Breach 2
1:200 (0.5% AEP) + CC UE	-	0.038	0.115
1:200 (0.5% AEP) + CC HC	-	-	0.069
1:1000 (0.1% AEP) + CC UE	-	0.090	0.149
1:1000 (0.1% AEP) + CC HC	-	0.041	0.115

- 14. The peak flood extents for the proposed and baseline conditions for all of the simulated events for overtopping and breach 1 & 2 are presented in Appendix A of this Technical Addendum. The hazard class change mapping, are also presented Appendix A.
- 15. The hazard class change maps show which receptors may potentially be affected by the development of the OnSS. The results demonstrate a limited change on hazard class for all simulated modelled events. The <u>results and</u> effect on receptors of the 75 year lifetime



scenario has been discussed further in the Onshore Substation Flood Risk Assessment (document reference 6.3.24.3 version 3) Appendix 24.3 (OnSS Flood Risk Assessment).



## Appendix A 75-year lifetime Figures



