HELIOS RENEWABLE ENERGY PROJECT

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Flood Risk Assessment

April 2025

HELIOS RENEWABLE ENERGY PROJECT

FLOOD RISK ASSESSMENT

ENSO GREEN HOLDINGS D LIMITED

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PART 4 OF 6

APPENDICES 10 - 18

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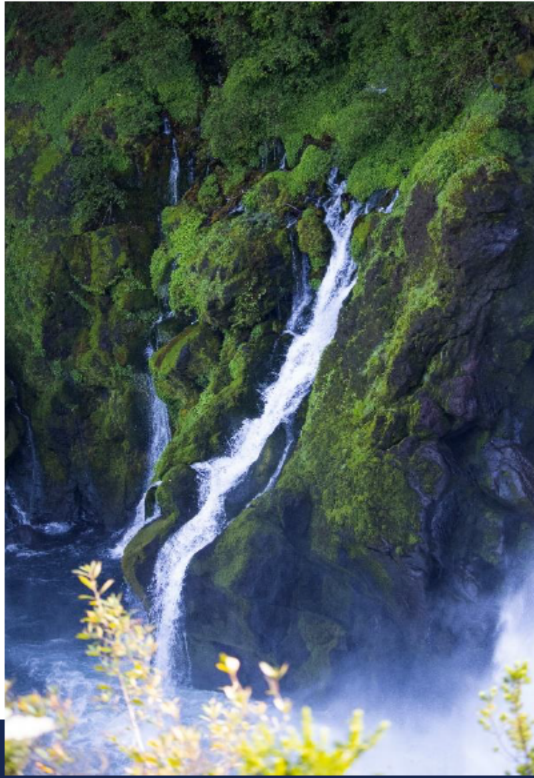
Appendix 10



aegaea

Flood risk, water and environment

Hydraulic Model Technical Note
AEG0851_YO8_EnsoEnergy_03

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aegaea

Flood risk, water and environment

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Please Note:

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1. Introduction

1.1. Aegaea have been commissioned by Enso Energy to undertake a hydraulic modelling exercise to better understand flood risk at the proposed location of the Renewable Energy development (comprising of a solar scheme) north of Snaith and west of Camblesforth at the approximate postcode YO8 8QL. The purpose of the study is to identify the potential risk to the site from the watercourses and tidal impacts from downstream, in the vicinity of the site, and to inform emerging design proposals.

Site Overview

1.2. The site is located to the southwest of Drax Power Station, and West of Camblesforth. The site location is shown within Figure 1 below.

1.3. The site is approximately 60ha and consists of greenfield land. It is surrounded by predominantly agricultural land. to the northwest and by greenfield land to the south, east and west. The East Coast Main Line and Selby Up/Down railway lines are located west of the site. The site is located between the River Ouse (to the north) and the River Aire (to the south). Selby Road borders the site to the north.

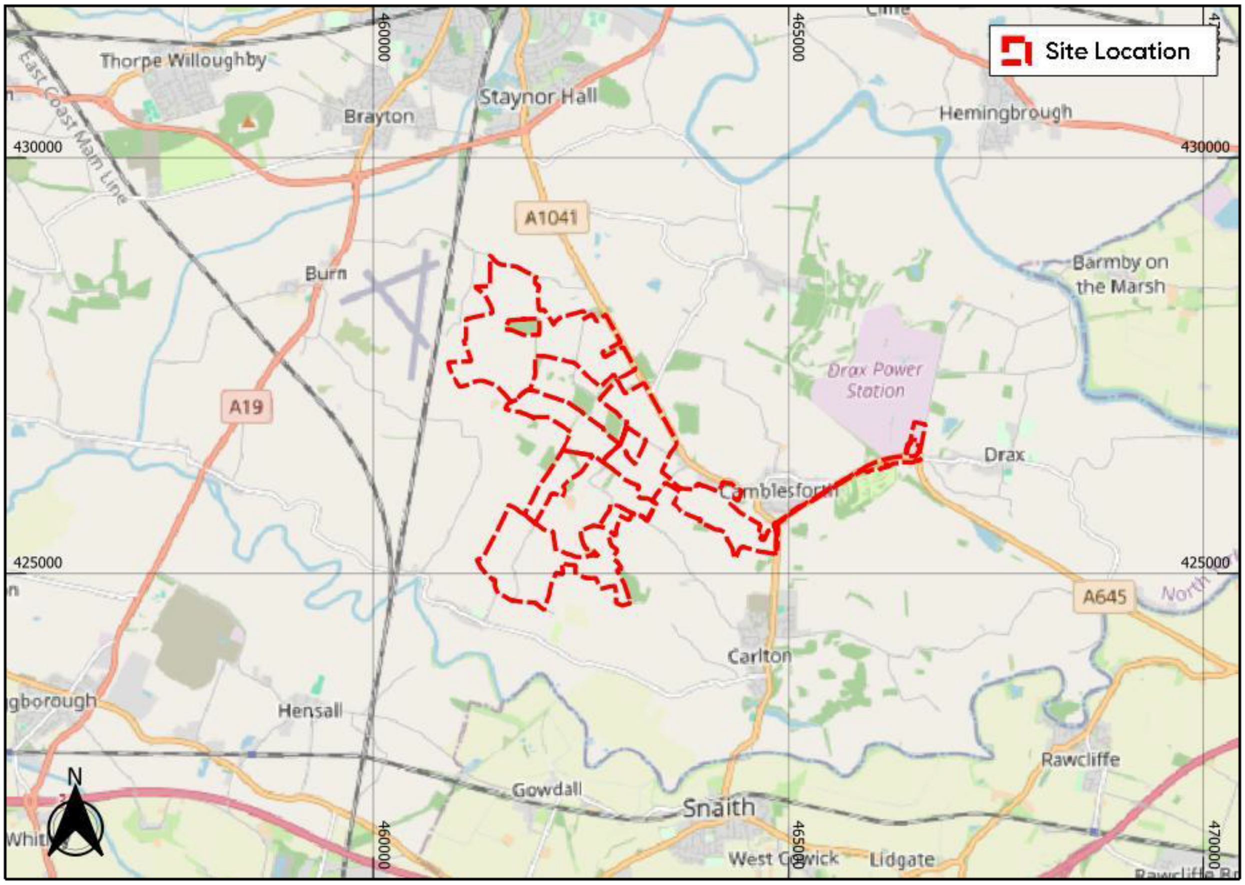


Figure 1: Site location (Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors)

Aims and Objectives

1.4. The aim of this exercise is to establish a good hydraulic representation of the fluvial and tidal flooding mechanisms and magnitude within the study area.

1.5. To achieve this aim, the following objectives have been identified:

- Obtain existing Environment Agency hydraulic model data and convert model files to Estry-TUFLOW.
- Construct a linked 1D-2D model representing the identified watercourses and floodplains within the site and in its immediate vicinity, utilising the converted EA model data.
- Undertake a hydrological assessment, following Environment Agency Flood Estimation Guidance, of the catchment for key return periods.

- Simulate fluvial events to establish a set of baseline conditions, including climate change allowances.
- Simulate tidal events to establish a set of baseline conditions, including climate change allowances.
- Simulate sensitivity tests within the model to test the key physical parameters and any assumptions.

2. Available Data

Flood Map for Planning

2.1. The Flood Map for Planning (Figure 2) identifies the site as being affected by Flood Zone 2 and 3. Flood Zone 2 is defined as land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. Flood Zone 3 is defined as land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.

2.2. The flood zones within the site boundary are associated with the River Ouse to the North and River Aire to the South. The site is located west of the confluence between these two main rivers at Goole. Flood extents indicate flow may back tidally locked, spilling out of bank onto the floodplains and inundating the site.

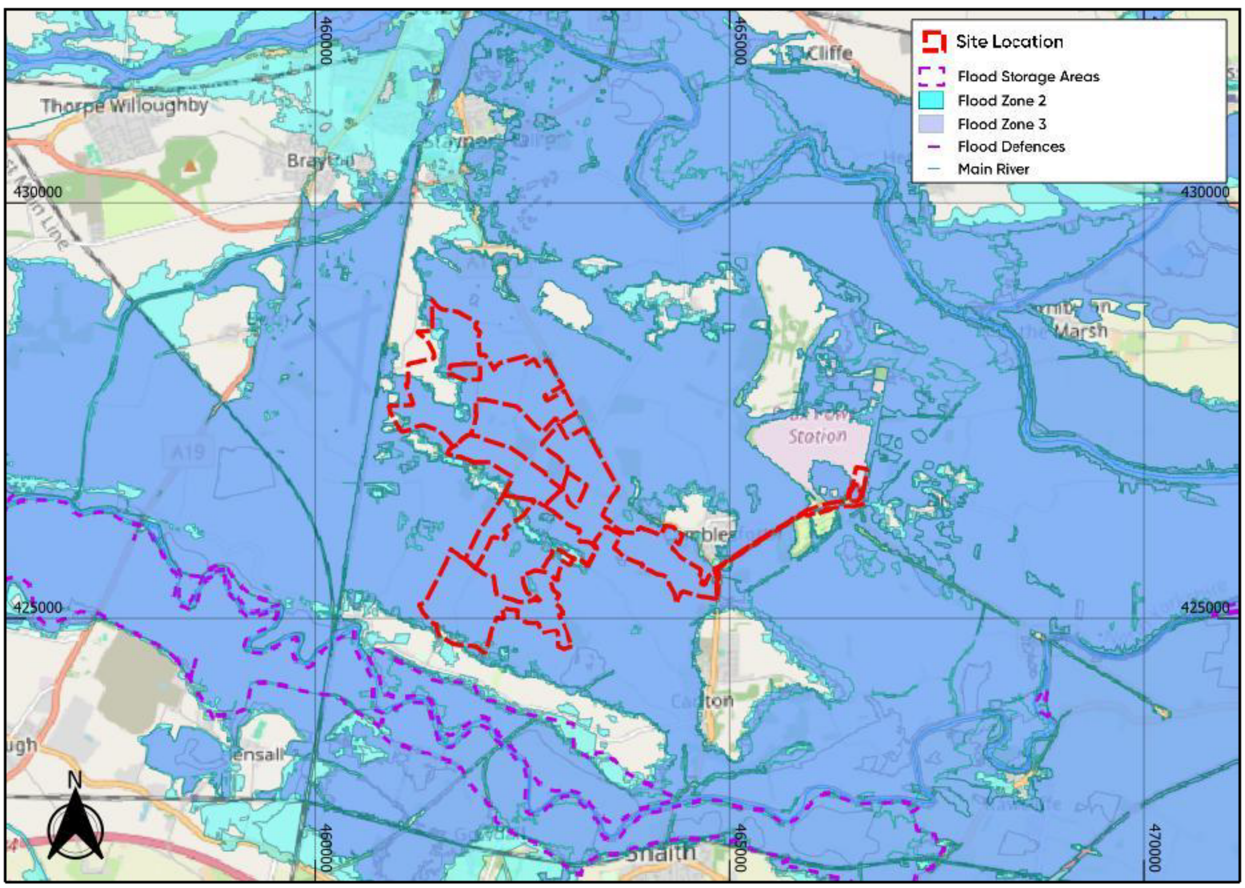


Figure 2: Flood Map for Planning (Sources: Environment Agency copyright and / or database rights 2022. All rights reserved. © Crown Copyright and database right 2022. Ordnance Survey licence number 100024198.)

2.3. It is not clear what model composition makes up the floodmap for planning or whether this has been supplemented by historic flood information.

2.4. Fluvial hydraulic simulations have been undertaken to assess the site-specific risk of flooding from watercourses in more detail. A tidal scenario was also undertaken to assess the risk from this source.

Environment Agency Product 7 data

Lower Aire (2017)

2.5. EA Product 7 data (hydraulic model build) was obtained for the Lower Aire (EA designated Main River) to the South of the site. This river was modelled in 2017 as part of the Northern Forecasting Package produced by JBA Consulting.

2.6. The River Aire was represented by a linked 1D-2D model, constructed in ISIS/Flood Modeller, linked to TUFLOW. Cross sections were based on new and existing surveyed data, interpolate sections were also used. A large number of structures were identified, surveyed and included in the hydraulic model build, including bridges under the railway line near the north.

2.7. The model was calibrated and verified against four flood events (including December 2015) and the resulting calibrated model demonstrated a good fit with most of the observed data from the two most extreme events that were evaluated.

2.8. The 1D hydraulic model provided by the EA was converted to ESTRY and linked to a 2D domain (TUFLOW). The model was also trimmed and updated where appropriate to provide a better representation of flood mechanisms in the vicinity of the site. This is described in more detail in section 4 of this report.

Lower Ouse and Wharfe Washlands (2018)

2.9. EA Product 7 data (hydraulic model build) was obtained for the Lower Ouse and Wharfe Washlands (EA designated Main River) to the north of the site. This river was originally modelled in 2018 by Mott MacDonald.

2.10. The Lower Ouse and Wharfe Washlands was represented by a linked 1D-2D model, constructed in ISIS/Flood Modeller – TUFLOW. Cross sections were based on new and existing surveyed data, interpolate sections were also used. A large number of structures were identified, surveyed and included in the hydraulic model build.

2.11. The 1D hydraulic model provided by the EA was converted to ESTRY and linked to a 2D domain (TUFLOW). The model was also trimmed and updated where appropriate to provide a better representation of flood mechanisms in the vicinity of the site. This is described in more detail in section 4 of this report.

Upper Humber

2.12. EA Product 7 data (hydraulic model build) was obtained for the Upper Humber (EA designated Main River) to the east of the site. This river was originally modelled between 2016 and 2018 by JBA.

2.13. The Upper Humber was represented by a linked 1D-2D model, constructed in ISIS/Flood Modeller – TUFLOW. Cross sections were based on new and existing surveyed data, interpolate sections were also used. A large number of structures were identified, surveyed and included in the hydraulic model build.

2.14. The hydraulic model provided by the EA was converted to ESTRY and linked to a 2D domain (TUFLOW). The model was also trimmed and updated where appropriate to provide a better representation of flood mechanisms in the vicinity of the site. This is described in more detail in section 4 of this report.

Summary

2.15. EA Product 7 data was obtained for the Lower Aire, Lower Ouse and Upper Humber watercourses. The models used calibrated and verified flow data and incorporate defended scenarios. The site of interest sits in the vicinity of all three of these existing hydraulic models and is not exclusively at risk from one specific source (Figure 3). Therefore, the decision was made to convert the three existing models to the same format (ESTRY-TUFLOW), then subsequently trim and merge the model files to one new hydraulic model build, retaining as much of the original calibrated modelling as possible (Figure 4). This includes the hydrological boundaries resulting from the calibration

2.16. Where multiple scenarios were originally modelled, only the defended scenario was taken forward into the converted model build.

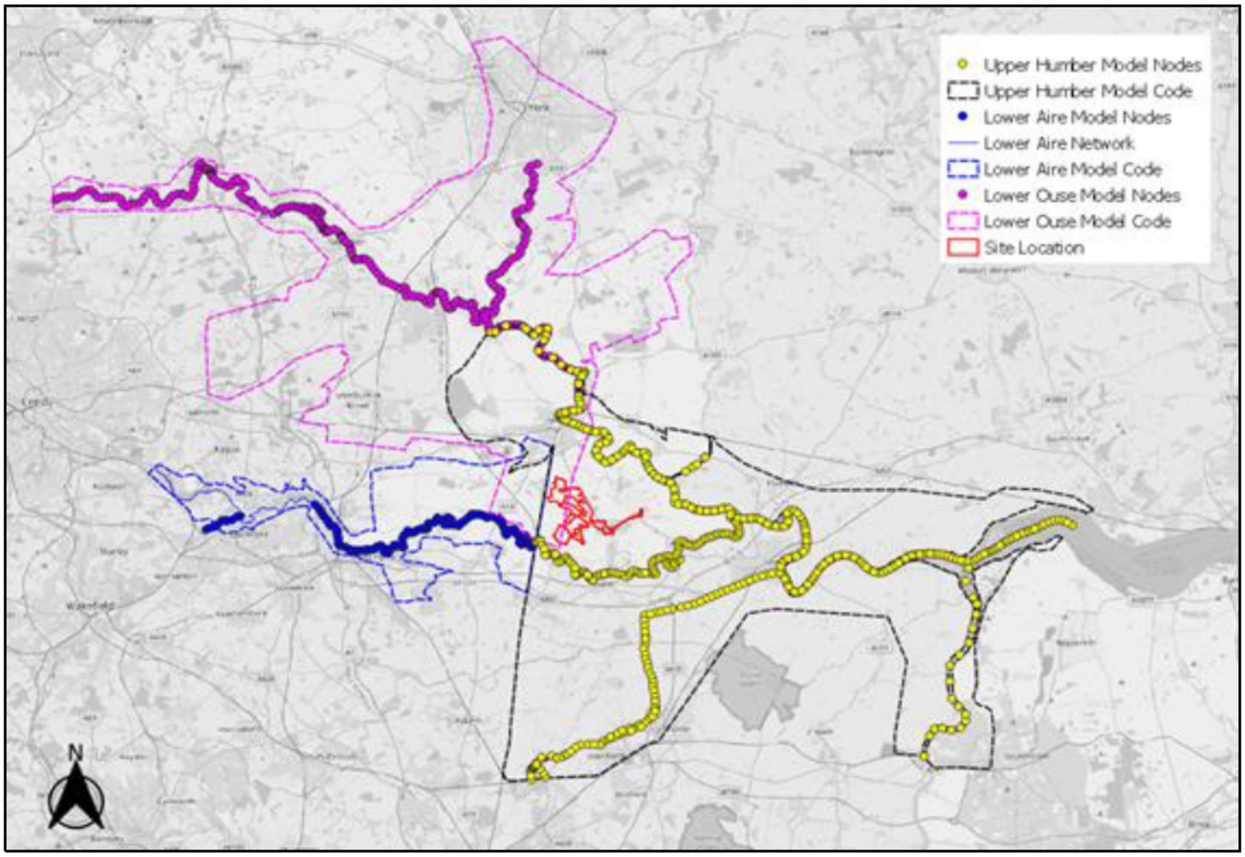


Figure 3: Existing EA Product 7 Data Extent (Sources: Environment Agency copyright and / or database rights 2022. All rights reserved. © Crown Copyright and database right 2022. Ordnance Survey licence number 100024198.)

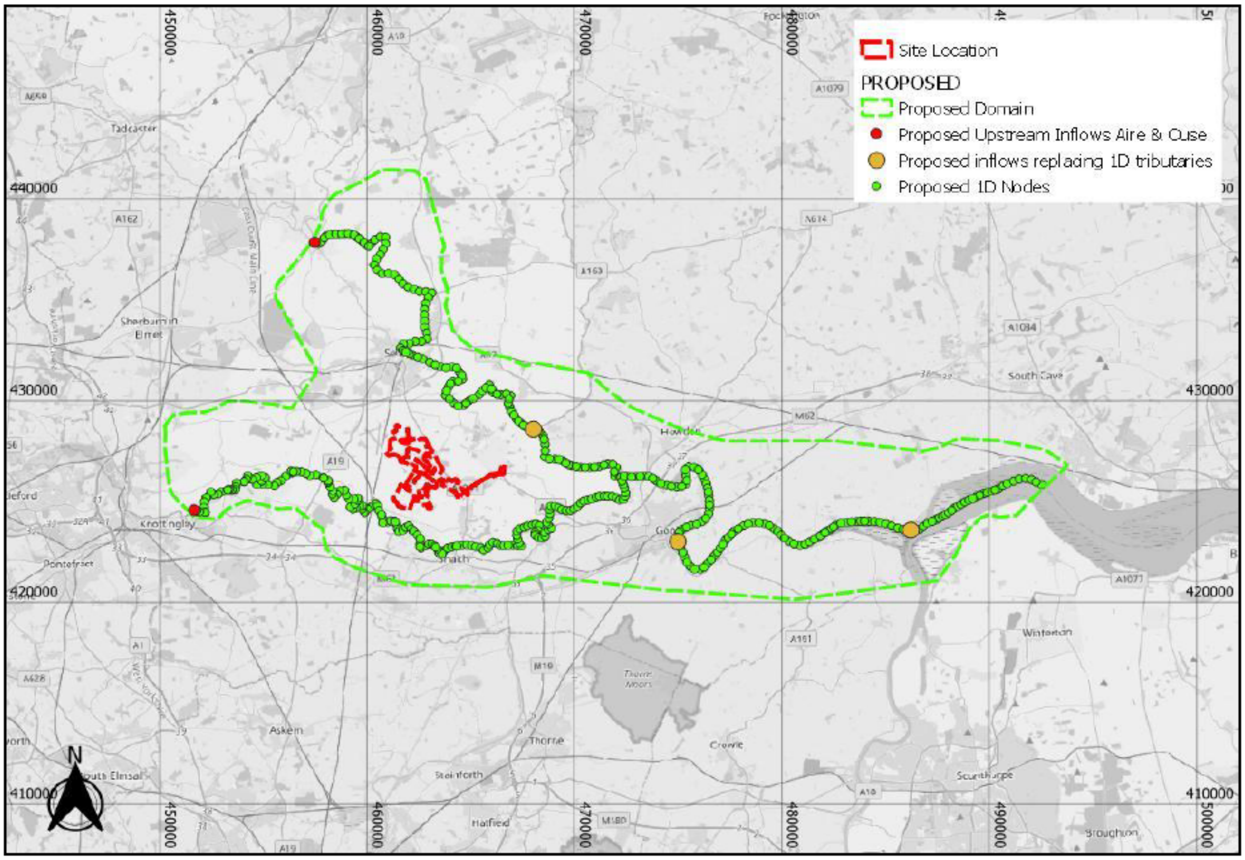


Figure 4: Proposed new model extent (Sources: Environment Agency copyright and / or database rights 2022. All rights reserved. © Crown Copyright and database right 2022. Ordnance Survey licence number 100024198.)

Terrain Data

2.17. EA Light Detection and Ranging (LiDAR) data is available for the local area. This is in the format of a Digital Terrain Model (DTM) at 1m resolution. Environment Agency National LiDAR Programme LiDAR data, published in 2022 (**Error! Reference source not found.**), was used to inform the model build. The latest EA LiDAR data obtained as part of the new hydraulic modelling works superseded any previous LiDAR data used in the original model builds.

Survey Data

2.18. The Lower Aire, Lower Ouse, and Upper Humber models all contained representations of in channel and floodplain structures. This includes bridges, weirs, and culverts. Original structures were converted and retained from the three EA models.

2.19. However, to improve the representation of flood risk in the vicinity of the site, additional survey requirements were identified. Storm Geomatics attended the site and provided survey information at the locations identified in Figure 5. The new round of surveying focussed on floodplain structures in the vicinity of the site that could allow flow to be conveyed beneath railway lines and highways.

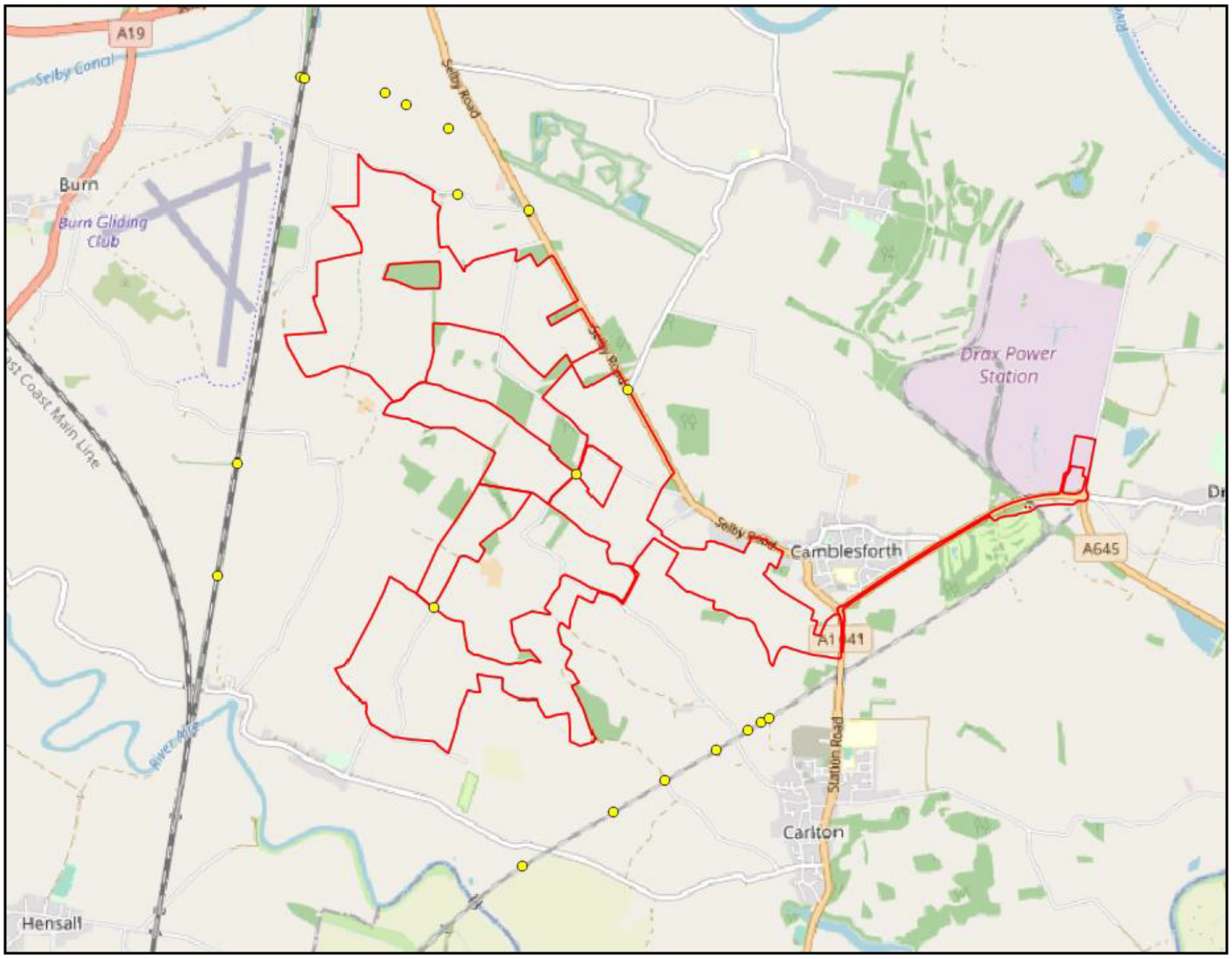


Figure 5: Storm Geomatics new survey locations (Sources: © Crown Copyright and database right 2022. Ordnance Survey licence number 100024198.)

Roughness Data

2.20. The model roughness values were retained from the original model builds. A desktop review was undertaken, utilising aerial imagery and the original roughness '2d_mat' areas were deemed to be appropriate and accurate.

3. Hydrological Assessment

Overview

3.1. The Lower Aire, Lower Ouse and Wharfe Washlands and Upper Humber models utilise calibrated and verified inflow data. The original models are recent, being published in 2017, 2018 and 2018 respectively.

3.2. A hydrological assessment has been undertaken, following the latest Environment Agency Flood Estimation Guidance, to establish peak flows at key return periods and storm durations.

3.3. Ultimately, the purpose of the hydrological assessment was to understand the impact of the additional years of peak flow data available since the original models were constructed, to inform a decision as to whether the calibrated and verified flow data is not fit for purpose anymore.

3.4. An Aegaea Letter dated 17th August 2023 previously formed the basis for a "terms of reference" for future modelling works for the site. It intended to be prescriptive in overall scope, while acknowledging that there will be a need for some flexibility and pragmatism in the modelling arrangements. With regards to the hydrology associated with the updated modelling works, it was stated:

> *"Significant updates to the model hydrology of both the Humber and River Aire were undertaken as part of the incoming modelling. Although it would perhaps be standard practice to update the hydrology given the age of the modelling (5 years old), it is suggested that given the nature of the model and calibration that this is not going to be necessary."*

3.5. The objective of the hydrological assessment is to assess the impact of the extension to the NRFA Peak Flows Dataset from Version 5 (2017) to Version 12 (2023). This facilitated the decision of whether an update to the hydrological modelling is required.

Methods

3.6. Historic and contemporary peak flows were quantified for the River Aire and River Ouse, at upstream inflow locations for the updated hydraulic model.

3.7. To quantify the impact of the record extension, WINFAP-FEH-derived modelled peak flows were compared for a historic and contemporary dataset:

1. For the contemporary derivation of flood peak flows, all data was used;
2. For the historic (2017) derivation, data from stations used to derive QMED and those within the pooling groups for 2016 onwards was manually rejected.

3.8. Default estimates of QMED were derived, and subsequently default donor adjustments using the standard number of six donors were applied. The same pooling group members were used to allow as direct a comparison as possible. Stations within the pooling groups had their records manually shortened to achieve the limitations to the periods of record.

3.9. An iteration was then undertaken to assess the total number of station-years with the limited record lengths. The minimum 500 station-years required for the historic analysis pooling group is retained and the contemporary pooling group is then also updated to remove stations in excess of the historic pooling groups.

3.10. This method enables the same pooling groups to be used for both growth curve assessments, whilst retaining the minimum 500 station years for the limited record length (historic) assessment. This may mean that excess stations are in the standard (contemporary) assessment, but it is considered that comparative method is critical.

3.11. Importantly, the record extension includes a major flood in the region during November 2019. This will not have a major impact on the derivation of the index flood, QMED, as this is the median annual average flood. However, the growth curve, which is a multiplier for larger return periods, is expected to be influenced by this.

3.12. The full Technical Note is included as Appendix A, which includes a more detailed description of the methodology for undertaking the comparison between historic and contemporary flows.

Results

Aire

3.13. There is a consistent decrease in flood peak for the historic periods of record method. The difference increases in magnitude and percentage for larger return periods. For the 100-year return period design event – a key measure that is subject to climate change allowances within the Planning process – the extension of the record has resulted in a flood peak that is 2.8% greater. A maximum impact of 4.6% is identified for the 1,000-year event.

Table 1 – Aire Contemporary vs Historic Peak Flows

	Historic (2016) m³/s			Contemporary (2022) m³/s			Difference	
Return Period	GL	GEV	KAP3	GL	GEV	KAP3	m³/s	%
2	352.17	352.17	352.17	352.17	352.17	352.17	0.00	0.00%
5	429.59	437.98	433.40	432.56	441.18	436.45	2.97	0.69%
10	481.20	490.65	485.99	486.79	496.75	491.79	5.59	1.16%
20	533.38	538.29	536.70	542.09	547.66	545.73	8.71	1.63%
25	550.68	552.84	552.91	560.52	563.34	563.09	9.84	1.79%
30	565.05	564.48	566.16	575.87	575.93	577.31	10.82	1.91%
50	606.62	596.01	603.36	620.43	610.26	617.46	13.82	2.28%
75	641.16	620.02	633.08	657.66	636.60	649.75	16.50	2.57%
100	666.60	636.53	654.30	685.18	654.84	672.92	18.58	2.79%
200	731.35	674.71	705.99	755.62	697.37	729.75	24.27	3.32%
500	825.27	721.94	775.72	858.70	750.74	807.30	33.43	4.05%
1,000	903.36	755.40	829.62	945.16	789.09	867.93	41.81	4.63%

Ouse

3.14. The effect of the record extension is similar, with the polarity of change the same as for the River Aire results, above. The maximum change is of a similar magnitude, for the 100-year return period design event the extension of the record has resulted in a flood peak that is 2.4% greater. A maximum impact of 3.6% is identified for the 1,000-year event.

Table 2 - Ouse Contemporary vs Historic Peak Flows

	Historic (2016) m³/s			Contemporary (2022) m³/s			Difference	
Return Period	GL	GEV	KAP3	GL	GEV	KAP3	m³/s	%
2	421.12	421.12	421.12	421.12	421.12	421.12	0.00	0.00%
5	521.85	532.48	526.60	525.49	536.45	530.37	3.64	0.70%
10	590.98	603.69	597.29	597.55	610.82	604.11	6.57	1.11%
20	662.37	670.18	667.25	672.30	680.71	677.48	9.93	1.50%
25	686.34	690.91	689.99	697.46	702.58	701.40	11.12	1.62%
30	706.37	707.64	708.70	718.52	720.28	721.12	12.14	1.72%
50	764.88	753.67	761.91	780.14	769.10	777.34	15.25	1.99%
75	814.13	789.41	805.09	832.13	807.17	823.12	18.01	2.21%
100	850.73	814.38	836.31	870.86	833.85	856.29	20.13	2.37%
200	945.18	873.34	913.67	971.06	897.12	938.78	25.88	2.74%
500	1085.21	948.86	1020.99	1120.30	978.73	1053.88	35.09	3.23%
1,000	1204.18	1004.26	1106.28	1247.65	1039.03	1145.88	43.48	3.61%

Climate Change Context

3.15. The 2050s epoch used to assess the peak river flow allowances covers the period 2040-2069. It is proposed the 'Design Flood' would be the 'Higher Central' allowance for the 2050s epoch. The percentage allowances will be taken from the Wharfe and Lower Ouse, or Aire and Calder (in brackets) and applied to the relevant watercourses:

Table 3 - Climate Change Percentage Allowances

Epoch	Central	Higher	Upper
2020s	11 (11)	14 (15)	22 (24)
2050s	13 (13)	18 (18)	29(31)
2080s	23(23)	31 (31)	48 (51)

3.16. With the climate changes allowances for this project of 18% for the development site, this is greater than the increase in flow resulting from the period of record limitations of around 3 to 4%.

Upstream inflows

3.17. Inflows to the trimmed domain have been extracted from the existing Aire, Ouse and Humber models at the upstream extent of the new model.

3.18. These locations have been chosen so that capturing routed flows from existing models was possible and representative of flow upstream of the site.

3.19. This method ensures that hydraulic representations of the floodplain and floodplain storage are accounted for and that calibration work undertaken as part of previous modelling is not lost.

Summary

3.20. Historic and contemporary peak flows were quantified for the River Aire and River Ouse, at upstream inflow locations for the updated hydraulic model to determine the impact of the NRFA Peak Flow Dataset record extension since the original hydrological assessment was undertaken in 2017.

3.21. This document and the Technical Note included in Appendix A demonstrate that the impact of the record extension compared to the historic record is small. For the 100-year return period design event – a key measure that is subject to climate change allowances within the Planning process – the extension of the record has resulted in a flood peak that is 2.8% greater at the Aire inflow and 2.4% greater at the Ouse inflow.

3.22. Aegaea recognise the inherent limitations on confidence with hydrological assessments, particularly when there is a lack of calibration. The existing hydrological boundary conditions are from 'calibrated and verified' modelling undertaken previously. The increase in peak flow resulting from the record extension is less than 5% during the 1000year return period. It is not considered necessary to generate new hydrological inflows to supersede the existing calibrated and verified inflows given the relatively small difference in peak flows resulting from the record extension.

3.23. It is proposed to re-use the existing hydrological assessment flows, of which there is greater confidence due to the verification and calibration previously undertaken. Sensitivity tests, including variations in flow, were undertaken.

3.24. Refer to Appendix B for the Hydrological Assessment Technical Note.

4. Baseline Hydraulic Modelling

Model Build

4.1. A 1D-2D modelling approach was adopted using TUFLOW Heavily Parallelised Compute (HPC) (version 2023-03-AA-iSP-w64).

4.2. All parameters were retained as default and a nominative timestep of 5 seconds was adopted for the 2D domain and a timestep of 2.5 seconds was adopted for the 1D domain.

1D Domain

Aire

4.3. The Lower Aire 1D-2D Hydraulic Model provided by the EA was converted to ESTRY-TUFLOW. The FM-to-ESTRY conversion tool was used to generate ESTRY specific 1D model files that retained key hydraulic properties and dimensions such as channel and structure geometry. Cross sections were converted to csv and 1d_xs format at their original location. '1d_xs' and '1d_nwk' lines were manually georeferenced based on the 1d ISIS node link layer if they were found to not be georeferenced originally. Height-Width tables were generated for irregular culvert and bridge structures in addition to spill cross section geometry.

4.4. The converted 1D domain was trimmed upstream, primarily to improve model efficiency. The trim location was selected at hydraulic bottlenecks in the original EA model, with distinct flow mechanisms that are not significantly influenced by upstream and downstream flood mechanisms.

4.5. A new '1d_bc' QT type inflow was applied to the trimmed upstream 1D domain. Flows were extracted from the results of the original Lower Aire model, retaining flows as described in Section 3. The flows were extracted for the Aire 100-year / Calder 40-year scenario from an upstream bottleneck (FM cross-section 02671003552C) and applied at the start of the model domain. This represents a precautionary approach. The upstream extent of the Aire 1D domain is at 451652.0, 424546.9, the downstream extent of the 1D domain converted from the Lower Aire model is at 460215.0, 424729.4.

4.6. Converted cross sections, network lines, boundary conditions and links within the trimmed 1D domain were reviewed and updated where appropriate. Most significantly, the converted cross sections (1d_xs and .csv files) were trimmed to left and right bank where anomalies were identified, based on the section data and a review of LiDAR elevations at the cross-section locations. At the left and right banks water spills into the 2D domain via HX type boundary conditions.

4.7. Structure dimensions and geometry were retained as far as possible from the existing Lower Aire model provided by the EA.

Ouse

4.8. The Lower Aire 1D-2D Hydraulic Model provided by the EA was converted to ESTRY-TUFLOW. The FM-to-ESTRY conversion tool was used to generate ESTRY specific 1D model files that retained key hydraulic properties and dimensions such as channel and structure geometry. Height-Width tables were generated for irregular culvert and bridge structures in addition to spill cross section geometry.

4.9. The converted 1D domain was trimmed upstream, primarily to improve model efficiency. The trim location was selected at hydraulic bottlenecks in the original EA model, with distinct flow mechanisms that are not significantly influenced by upstream and downstream flood mechanisms. The upstream extent of the Ouse 1D domain is at 457489.2, 437829.4, the downstream extent of the 1D domain converted from the Lower Ouse model is at 463521.8, 431681.0.

4.10. A new '1d_bc' QT type inflow was applied to the trimmed upstream 1D domain. The inflow applied is the same as that used within the Upper Humber model, as extracted from IED file Ouse_F_100.ied.

4.11. All converted cross sections, network lines, boundary conditions and links within the trimmed 1D domain were reviewed and updated where appropriate. Most significantly, the original EA model cross sections were sometimes found to extend into the floodplain. However, these extended cross sections we're not considered appropriate as a 2D representation of floodplain elevations is preferred. Therefore, the converted cross sections (1d_xs and .csv files) were trimmed to left and right bank, based on the section data and a review of LiDAR elevations at the cross-section locations. This results in a more targeted 1D domain that specifically represents the channel geometry. At the left and right banks water spills into the 2D domain via HX type boundary conditions.

4.12. Structure dimensions and geometry were retained as far as possible from the existing Lower Aire model provided by the EA.

Upper Humber

4.13. The Upper Humber 1D-2D Hydraulic Model provided by the EA was converted to ESTRY-TUFLOW. The FM-to-ESTRY conversion tool was used to generate ESTRY specific 1D model files that retained key hydraulic properties and dimensions such as channel and structure geometry. Cross sections were converted to csv and 1d_xs format at their original location. Cross sections were converted to csv and 1d_xs format at their original location. '1d_xs' and '1d_nwk' lines were manually georeferenced based on the 1d ISIS node link layer if they were found to not be georeferenced originally. Height-Width tables were generated for irregular culvert and bridge structures in addition to spill cross section geometry.

4.14. The converted 1D domain was trimmed upstream, primarily to improve model efficiency. The trim location was selected at hydraulic bottlenecks in the original EA model, with distinct flow mechanisms that are not significantly influenced by upstream and downstream flood mechanisms. The Upper Humber upstream trim locations matched the Lower Aire and Lower Ouse downstream trim locations. This therefore allowed for a seamless joining of the Aire, Ouse and Humber watercourses into a single 1D domain.

4.15. Tributary inflows were extracted from the results of the original Lower Aire model, retaining flows as described in Section 3.

4.16. An 'HT' type '1d_bc' was applied to the downstream extent of the 1D domain, and the model in general. At this downstream boundary, a tidal stage / time series was applied.

4.17. All converted cross sections, network lines, boundary conditions and links within the trimmed 1D domain were reviewed and updated where appropriate. The original EA model cross sections were found to extend into the floodplain in some locations. These extended cross sections we're not considered appropriate as a 2D representation of floodplain elevations is preferred. Therefore, some of the converted cross sections (1d_xs and .csv files) were trimmed to left and right bank, based on the section data and a review of LiDAR elevations at the cross-section locations. This results in a more targeted 1D domain that specifically represents the channel geometry. At the left and right banks water spills into the 2D domain via HX type boundary conditions.

2D Domain

4.18. A base 40.0m resolution grid was adopted for the TUFLOW domain. Quadtree nesting was utilised to refine the grid resolution at key areas around the 1D domain and structures. The base resolution (quadtree nest level 1) was retained for the majority of the model domain to improve model efficiency. After quadtree nest levels were applied, the minimum grid resolution was refined to 5.0m (nest level 4). This approach is considered to be sufficient to provide a good representation of topography at general floodplain areas whilst not losing topographic detail at watercourses and key areas in the vicinity of the site.

4.19. EA 1m resolution LiDAR DTM (2022 National LiDAR Programme) data was used as the basis for the 2D floodplain.

4.20. Bank elevations were reinforced using 'thick z-shape' layers retained from the original EA models. Additional '2d_zsh' and '2d_zln' layers were retained from the original models which represented railways, roads, underpasses, and flood defences.

4.21. A review of the hydraulic model identified that bank levels within the vicinity of Haddlesey Flood Gate on the left bank of the River Aire were underestimated. This was corrected by extracting the Lowest_2D_ZC elevation from the 1D_to_2D check file and creating a 2D Z-Shape to apply this to the bank in this location.

4.22. There are various hydraulic structures within the vicinity of the site, which were represented in the model primarily within the 1D domain as described previously. Structures out with the 1D domain have been embedded into the 2D domain, linked via '2d_bc' SX type links. Structure dimensions were informed by survey information where available. Where not available, assumptions were made in regard to their size, material and invert levels.

4.23. Structures within the floodplain are summarised in Table 4 below.

Table : Modelled Floodplain Culverts

Node Label	UNK01_00011_B1
Unit Type	I
Upstream Invert (m AOD)	1.928

Downstream Invert (m AOD)	1.928
Dimensions	Set by Height-Width table
Comments	Inverts and dimensions from survey
Node Label	UNK01_00011_B2
Unit Type	I
Upstream Invert (m AOD)	1.942
Downstream Invert (m AOD)	1.942
Dimensions	Set by Height-Width table
Comments	Inverts and dimensions from survey
Node Label	UNK01_00658_B1
Unit Type	I
Upstream Invert (m AOD)	2.194
Downstream Invert (m AOD)	2.194
Dimensions	Set by Height-Width table
Comments	Inverts and dimensions from survey
Node Label	UNK01_01290_C1
Unit Type	C
Upstream Invert (m AOD)	2.327
Downstream Invert (m AOD)	2.320
Dimensions	0.9m diameter
Comments	Inverts and dimensions from survey

Node Label	UNK01_02509_B1
Unit Type	I
Upstream Invert (m AOD)	3.499
Downstream Invert (m AOD)	3.499
Dimensions	Set by Height-Width table
Comments	Inverts and dimensions from survey
Node Label	UNK01_02539_B1
Unit Type	I
Upstream Invert (m AOD)	3.687
Downstream Invert (m AOD)	3.687
Dimensions	Set by Height-Width table
Comments	Inverts and dimensions from survey
Node Label	UNK02_00010_C1
Unit Type	C
Upstream Invert (m AOD)	4.042
Downstream Invert (m AOD)	4.023
Dimensions	0.92m diameter
Comments	Inverts and dimensions from survey
Node Label	UNK03_00013_C1
Unit Type	C

Upstream Invert (m AOD)	3.821
Downstream Invert (m AOD)	3.587
Dimensions	1.2m diameter
Comments	Inverts and dimensions from survey
Node Label	UNK04_00010_C1
Unit Type	C
Upstream Invert (m AOD)	2.380
Downstream Invert (m AOD)	2.476
Dimensions	0.6m diameter
Comments	Inverts and dimensions from survey
Node Label	UNK05_00007_C1
Unit Type	C
Upstream Invert (m AOD)	3.258
Downstream Invert (m AOD)	3.276
Dimensions	0.6m diameter
Comments	Inverts and dimensions from survey
Node Label	UNK06_00017_C1
Unit Type	C
Upstream Invert (m AOD)	2.039
Downstream Invert (m AOD)	2.005
Dimensions	1.2m diameter

Comments	Inverts and dimensions from survey
Node Label	UNK07_00020_C1
Unit Type	C
Upstream Invert (m AOD)	1.890
Downstream Invert (m AOD)	1.890
Dimensions	1.38m diameter
Comments	Inverts and dimensions from survey
Node Label	UNK08_00021_B1
Unit Type	I
Upstream Invert (m AOD)	3.853
Downstream Invert (m AOD)	3.853
Dimensions	Set by Height-Width table
Comments	Inverts and dimensions from survey
Node Label	UNK09_00009_B1
Unit Type	I
Upstream Invert (m AOD)	2.589
Downstream Invert (m AOD)	2.589
Dimensions	Set by Height-Width table
Comments	Inverts and dimensions from survey
Node Label	UNK10_00009_B1

Unit Type	I
Upstream Invert (m AOD)	0.995
Downstream Invert (m AOD)	0.995
Dimensions	Set by Height-Width table
Comments	Inverts and dimensions from survey
Node Label	UNK11_00018_C1
Unit Type	C
Upstream Invert (m AOD)	2.881
Downstream Invert (m AOD)	2.726
Dimensions	0.68m diameter
Comments	Inverts and dimensions from survey
Node Label	UNK12_00020_C1
Unit Type	C
Upstream Invert (m AOD)	2.559
Downstream Invert (m AOD)	2.629
Dimensions	0.56m diameter
Comments	Inverts and dimensions from survey
Node Label	UNK13_00142_C1
Unit Type	C
Upstream Invert (m AOD)	0.61
Downstream Invert (m AOD)	0.499

Dimensions	01.53m diameter
Comments	Inverts and dimensions from survey
Node Label	FC1
Unit Type	C
Upstream Invert (m AOD)	4.1
Downstream Invert (m AOD)	3.95
Dimensions	0.92m diameter
Comments	Inverts based on LiDAR, dimensions based on nearby downstream surveyed culvert
Node Label	FC2
Unit Type	C
Upstream Invert (m AOD)	3.5
Downstream Invert (m AOD)	3.6
Dimensions	1.2m diameter
Comments	Inverts based on LiDAR, dimensions based on nearby downstream surveyed culvert

Boundary Conditions

4.24. '1D_bc' QT type inflows were applied directly to the watercourses, either using flows extracted from appropriate cross-sections or using inflows from the available hydraulic models,

4.25. A tidal 'Stage-Time' (HT) boundary was applied to the 1D and 2D domain, at the downstream extent of the model. The original Upper Humber downstream boundary was retained. The T2 peak stage was adjusted to fit the Humber 2100+ Strategy Extreme Water Level (2020), extracted from the node located at the downstream extent of the model.

4.26. The following maximum stages for the downstream boundaries were used for the hydraulic model simulations:

- T2 (2070's, Middle) – 5.54m AOD (utilised for fluvial events)
- T2 (2070's, Upper) – 5.58m AOD (utilised for fluvial 100-year + upper end climate change allowance only as a sensitivity test)
- T200 (2070's) – 6.17m AOD
- T200 (2070's, H++) – 6.36m AOD

4.27. The downstream boundary (DSB) is located approximately 25km downstream of the site. However, it is important to consider the tidal influences on flood mechanisms at the site.

Schematisation

4.28. The linked 1D-2D hydraulic model schematic within the vicinity of the site is presented in Figure 6.

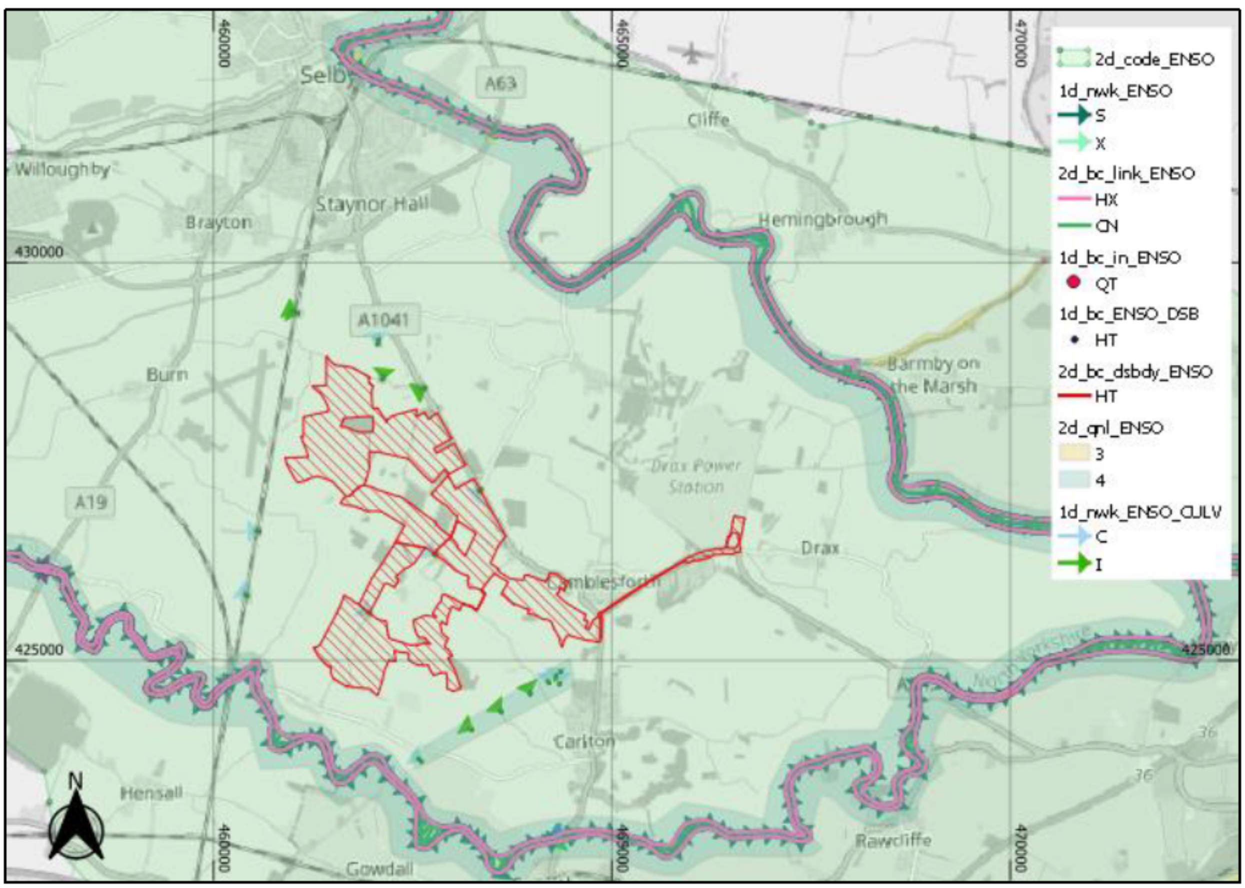


Figure 6: Model Schematic site specific (Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors)

Design Events

Fluvial

4.29. The fluvial portion of each model (Ouse and Aire) were simulated against the following key design flood events:

- 1 in 30-year
- 1 in 100-year
- 1 in 100-year + 18% allowance for climate change (2050's higher allowance)
- 1 in 100-year + 29% (Ouse) / 31% (Aire) allowance for climate change (2050's upper allowance)

Coastal

4.30. The model was simulated against the following key design flood events:

- 1 in 200-year (2070's epoch climate change uplift) for tidally driven scenarios.
- 1 in 2 year (2070s epoch Medium Higher Central climate change uplift) was also calculated as a downstream boundary for fluvial dominant scenarios.
- 1 in 2 year (2070s epoch High Upper End climate change uplift) was run as a sensitivity for the fluvial 1 in 100-year + upper end allowance.
- 1 in 200-year (2070s epoch H++ uplift) was run as a sensitivity along with the 1 in 30-year fluvial flows.

5. Model Results

Fluvial

5.1. The baseline modelled fluvial flood extents within and in the vicinity of the site are included within Figure 7 below.

5.2. The hydraulic model showed that the site is at risk of fluvial flooding for the Q0100_CC_HIGHER and Q0100_CC_UPPER return periods.

5.3. The sensitivity test of the 1 in 100-year Upper End event with the T2 2070s epoch High Upper End climate change uplift showed there to be notable difference in extent or depth within the site.

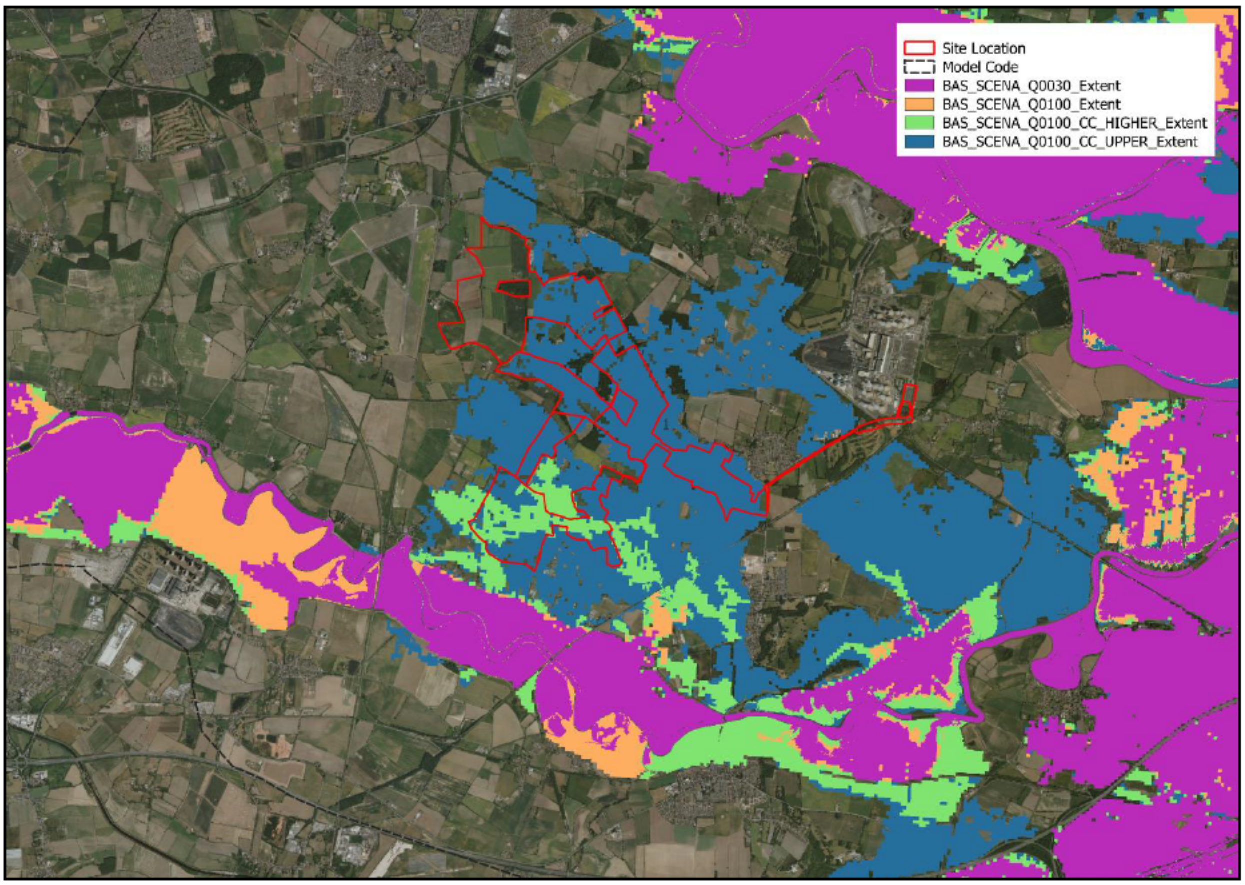


Figure 7: Baseline Fluvial Model Floodplain Extent (OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors). Results filtered.

5.4. The baseline flood depths are included within Figure 8 to Figure 10.

5.5. Figure 10 shows the impact of the combined 100 year plus 18% climate change applied to both the Aire and Ouse at the same time, with a tidal boundary of 2 years (2070s epoch).

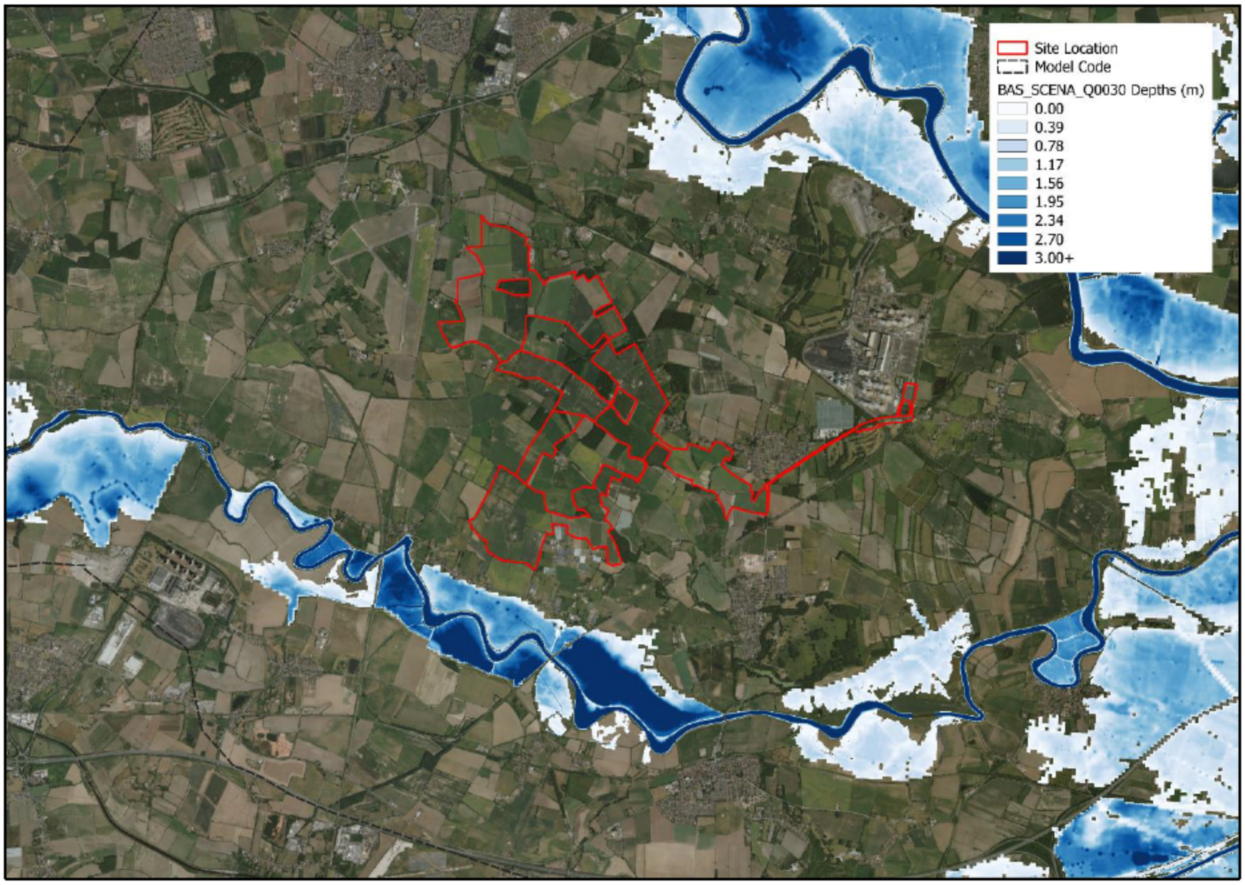


Figure 8: Baseline modelled fluvial flood depths for the 30yr return period (Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors).

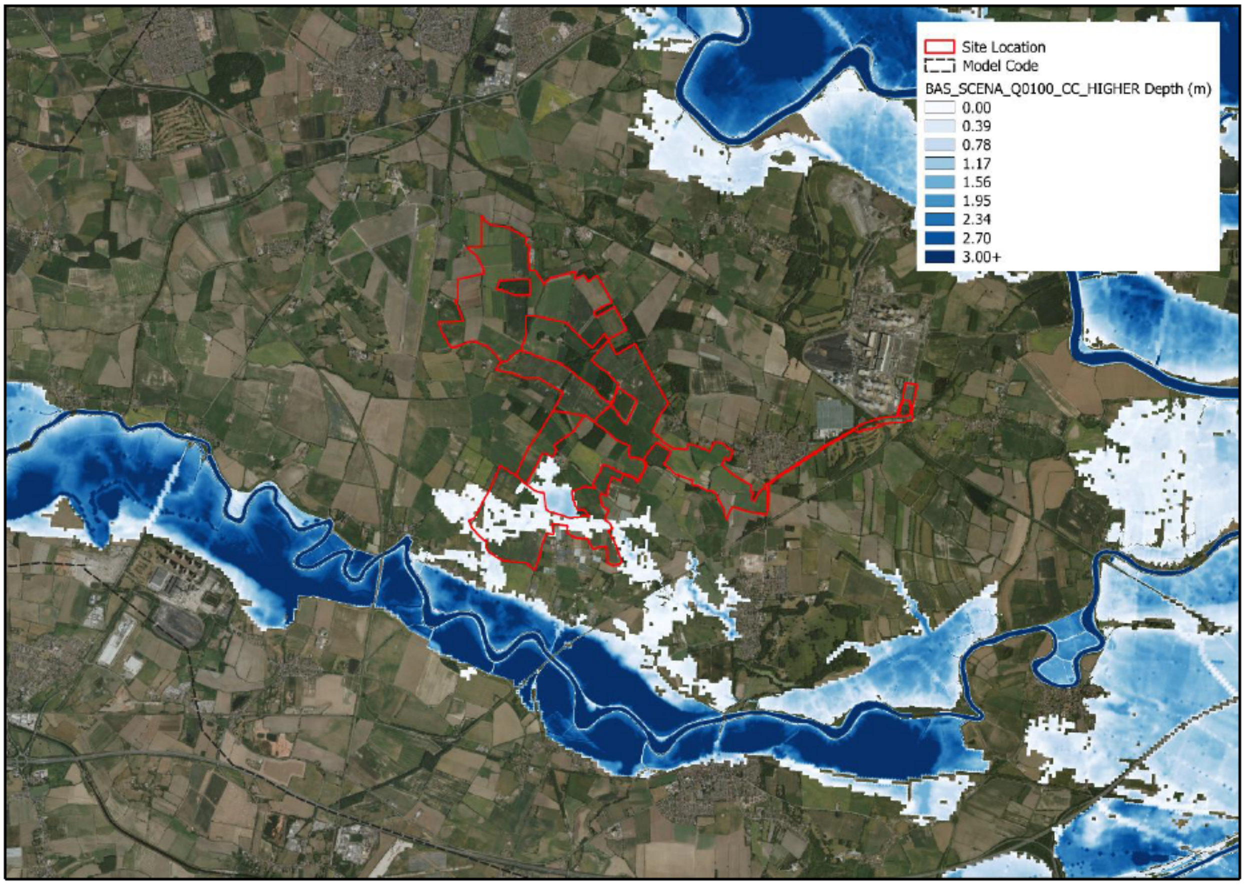


Figure 9: Baseline modelled fluvial flood depths for the 100yr return period + Higher climate change allowance (2050's) (Base map from OpenStreetMap and OS Map Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors).

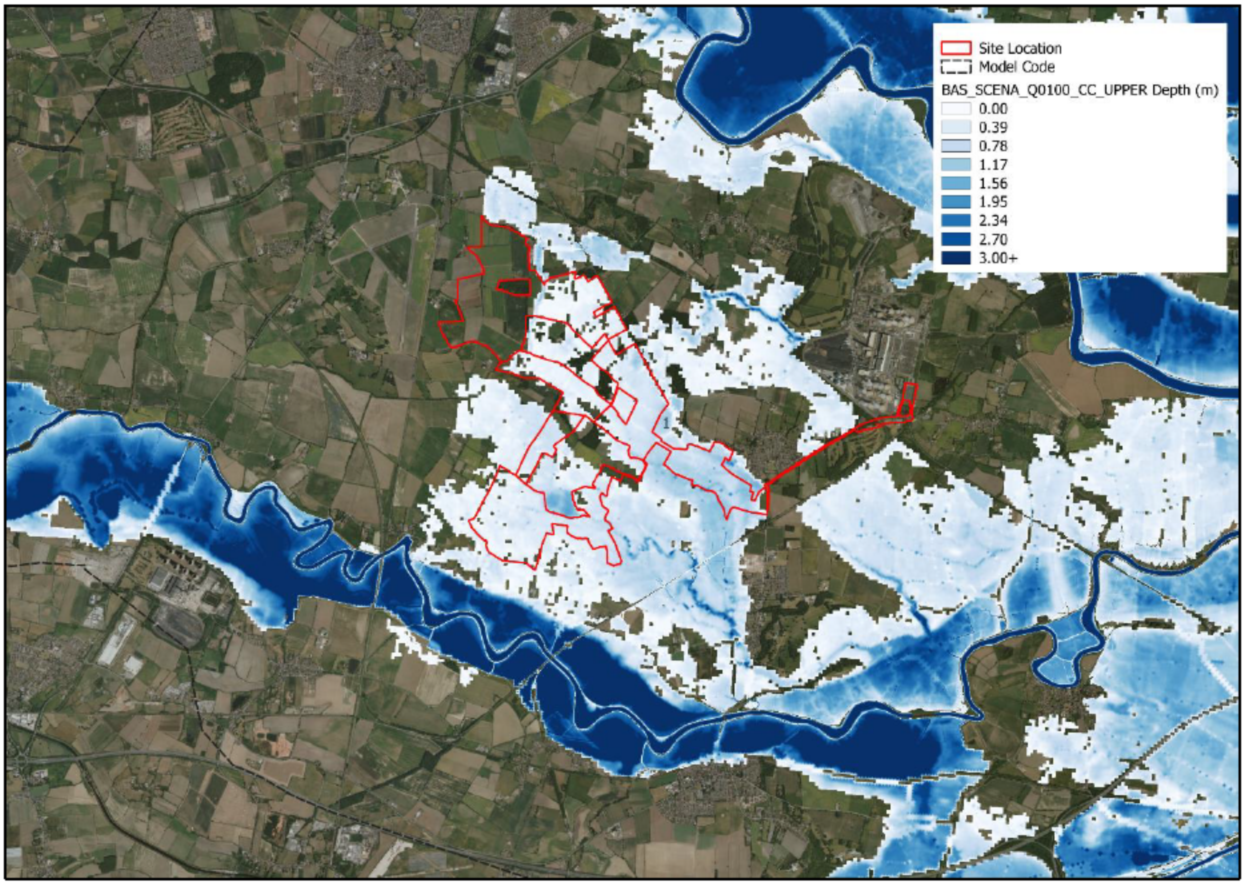


Figure 10: Baseline modelled fluvial flood depths for the 100yr return period + Upper climate change allowance (2050's) (Base map and data from OS Map and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors).

Tidal

5.6. The baseline modelled tidal flood extents within and in the vicinity of the site are included within below.

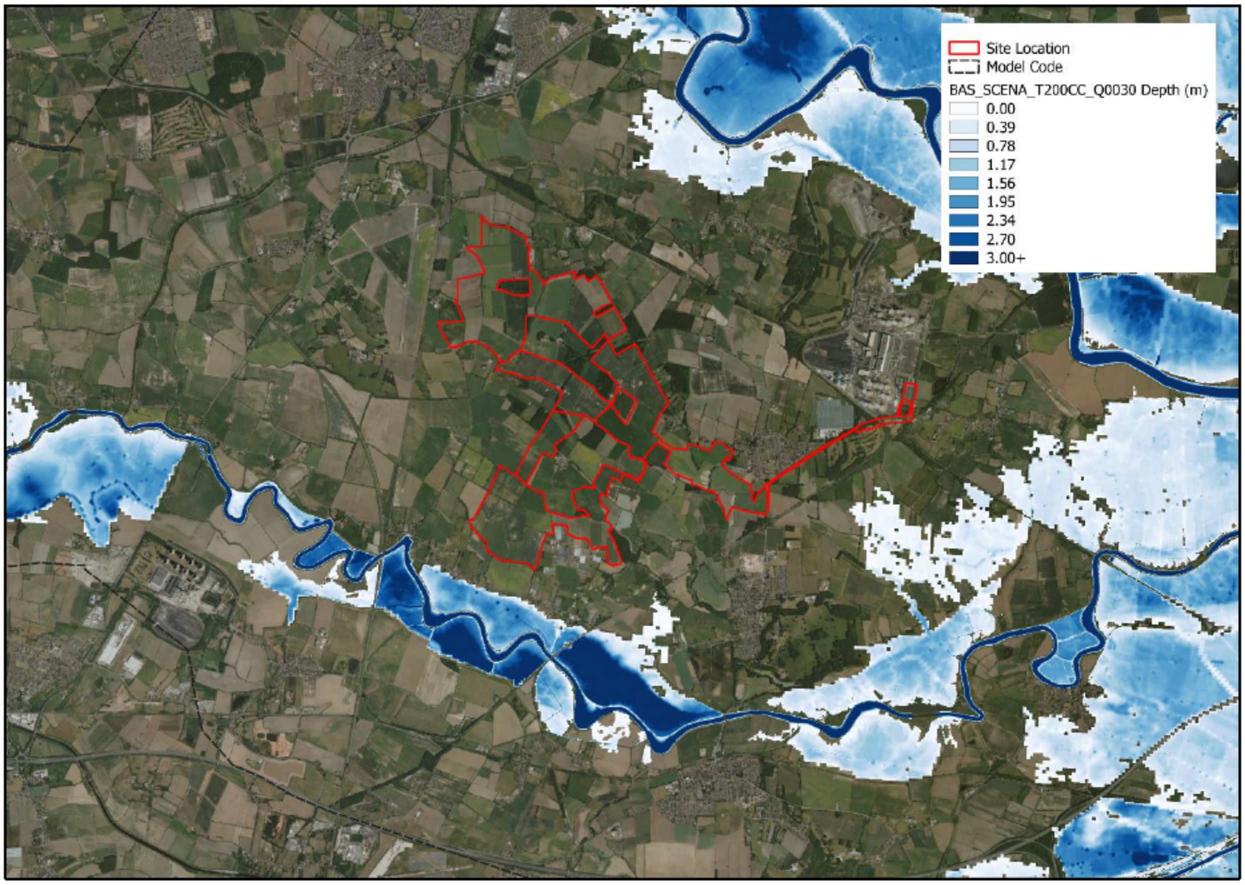


Figure 11: Baseline modelled tidal flood depths for the 200yr return period (2070's) (Base map and data from OS Map and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors).

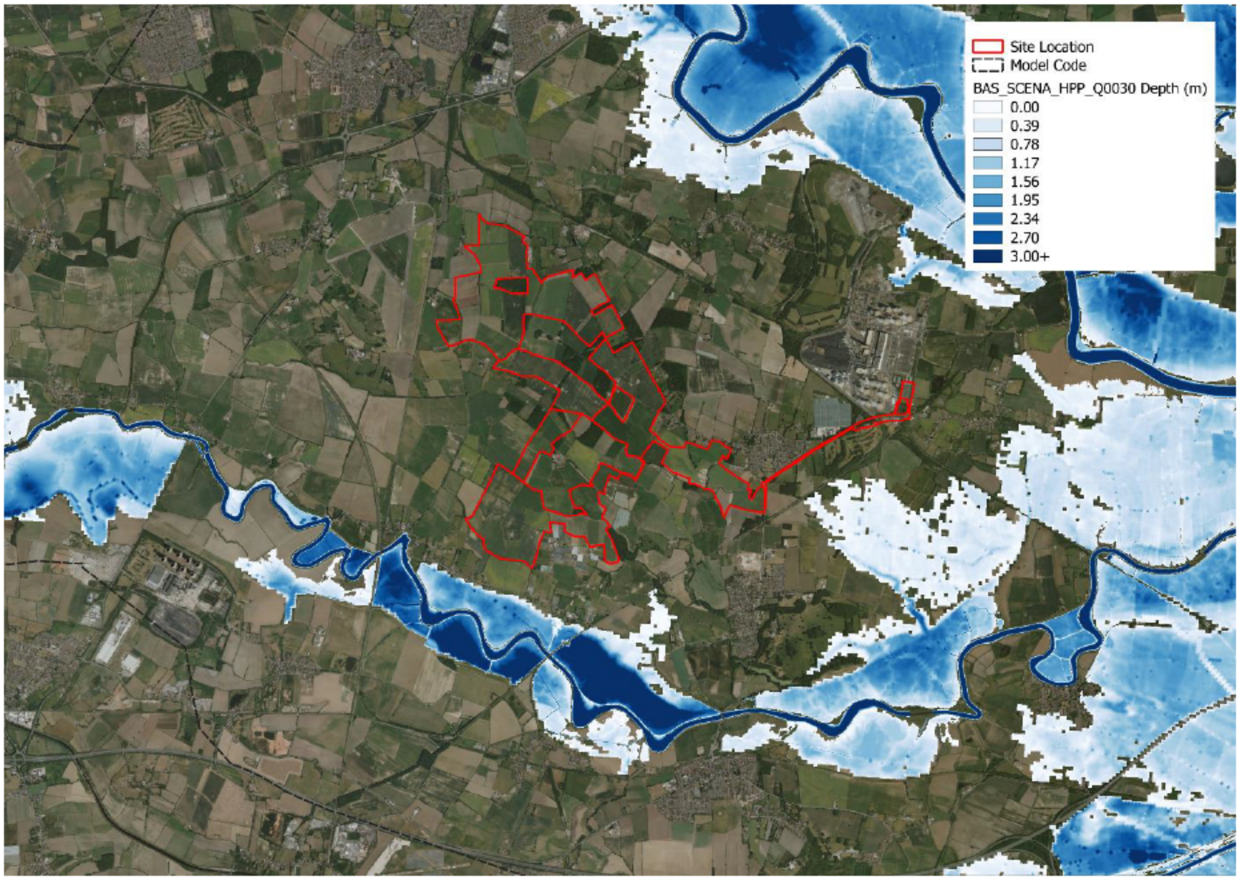


Figure 12: Baseline modelled tidal flood depths for the 200yr return period (2070's, H++) (Base map and data from OS Map and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors).

6. Sensitivity Testing

6.1. Sensitivity tests were undertaken for the following parameters:

- Aire Inflow
- Ouse Inflow
- Roughness -/+ 20%

6.2. It was not considered necessary to undertake sensitivity testing on the downstream boundary given the range of tidal events simulated.

Aire Inflow

6.3. Flood risk to the site is shown to be largely driven by the River Aire. As a sensitivity test, the Aire 40-year / Calder 100-year scenario (A40C100) was utilised to inform the Aire inflows. This was derived by rerunning the Lower Aire model for the A40C100 event to derive a new 100-year inflow. The higher climate change allowance was then applied.

6.4. Flood extents within the site are shown to increase as a result of the sensitivity test, with an increase in flood level of up to ~0.070m within the site.

Ouse Inflow

6.5. To account for any uncertainty in the derivation of the inflow for the River Ouse, an increase of 20% was applied to the 100-year + higher climate change allowance event.

6.6. Flood extents within the site are shown to marginally increase as a result of the sensitivity test, with an increase in flood level of up to ~0.035m within the site, though the increase is mostly limited to 0.003m.

6.7. It is recommended that sufficient freeboard is provided to accommodate for this variation in peak flood level.

Roughness

6.8. To account for variations in seasonal vegetation, sensitivity tests were undertaken on the 100-year + higher climate change allowance event. Roughness was varied by -/+ 20% in the 2D domain. It was not considered necessary to vary the roughness of the 1D domain given the large size of the watercourses and limited vegetation present within the channel.

6.9. An increase of 20% is shown to result in an increase in flood level of up to ~0.020m within the site.

6.10. A decrease of 20% is shown to result in flood level increasing and decreasing in different areas of the site. The maximum increase was 0.050m.

6.11. It is recommended that sufficient freeboard is provided to accommodate for this variation in peak flood level.

7. Model Stability & Limitations

Simulation Parameters

7.1. TUFLOW version 2023-03-AE-iSP-w64 Heavily Parallelised Compute (HPC) was used in all simulations.

7.2. All parameters were retained as default.

7.3. A nominative timestep of 5 seconds was adopted for the 2D domain and a timestep of 2.5 second was adopted for the 1D domain. The timestep variation occurs as part of the stability mechanism of the TUFLOW software and timestep decreases relative to the depth of flooding occurring at the smallest cell size.

Model Stability

7.4. 28 occurrences of negative depths were reported in the 1D domain for the baseline simulations. A negative depth can be indicative of an instability, particularly if the negative depth is persistent.

7.5. In this instance, on a model with an extensive 1D domain, the negative depths are relatively isolated and non-persistent, indicating minimal to no impact on the model outcomes.

7.6. Additional interpolate sections were introduced to help reduce the instances of negative depths, which had a positive impact. It's possible that additional channel survey and new cross section data could provide a more accurate representation of channel geometry and remove negative depths. However, the negative depth occurrences are not considered to be significant in the context of a 200hour simulation.

7.7. No repeated timesteps were reported in the HPC (2D) domain for the baseline simulations.

7.8. Cumulative ass error was reported at -0.004% and -0.02% for the baseline simulations, which is considered to be an indicator of stability.

7.9. For a HPC model to be considered stable, three parameters should be maintained: Nu (Courant number relates to velocity relative to the cell size), Nc (Celerity Control number relates to water depth relative to cell size) and Nd (Diffusion control relates diffusion of momentum relating to the sub grid viscosity). Generally, for a stable model these values should be: Nu<1, Nc<1 and Nd<0.3.

Table 5: HPC solver stability outputs

	Maximum allowance indicating a healthy model performance	Max Model outputs - 100yr_CC_HIGHER return period	Average Model outputs - 100yr_CC_HIGHER return period
Nu (Courant number)	1	1.08	0.74
Nc (Celerity Control number)	1	0.87	0.56
Nd (Diffusion control number)	0.3	0.33	0.29

7.10. Based on the values in Table 5, the model's Nu max and Nd max value is slightly above the limit for healthy performance. Given the large depths and relatively small cell size, such occurrences close to the limits are expected. However, the average values are within the healthy range and considering the simulation time of 200hours, the average is considered to be more representative.

Limitations

7.11. The modelling exercise has made best use of the available data at the time of construction and simulation.

7.12. The model was informed by the EA publicly available LiDAR (RMSE of +/- 150mm), and existing cross sections from the Lower Ouse, Lower Aire, and Upper Humber hydraulic models.

7.13. Flows were extracted from the Lower Ouse, Lower Aire, and Upper Humber hydraulic models and were subsequently applied to the new hydraulic model build.

7.14. It is assumed that any difference in inflows to the original models and the extracted results is due to out of bank flooding upstream of the 1D cross section location. Results were extracted at hydraulic bottlenecks so as to limit any out of bank flooding not being captured by the 1D results extraction.

7.15. There are various hydraulic structures within the vicinity of the site, which were represented in the model primarily within the 1D domain as described previously. Structure dimensions were informed by survey information where available. Where not available, assumptions were made in regard to their size, material and invert levels. As a result of the conversion from Flood

Modeller, there is not always a like for like equivalent of a structure in Estry. Therefore, some structure representations are not direct copies of the original models.

7.16. The hydraulic model build retains any inherent limitations from the three original model studies. This includes any unsurveyed structures in the 1D domain. It is noted that some large downstream structures are not formally represented in the model, which is a limitation. Additional channel/structure surveying could be undertaken, however the structures that are not surveyed are generally considered to be topo far away from the site to be of material consideration.

7.17. Tidal volume not represented formally in the downstream boundary condition (1d_bc / 2d_bc). The Upper Humber downstream boundary was extracted and the peak adjusted to match the Humber 2100+ Strategy Extreme Water Level (2020), extracted from the node located at the downstream extent of the model.

7.18. Discrepancies between the incoming data for multiple watercourses indicates that some of the hydrological inputs to the design model could need to be refined. This is because the area lies in an area at the broad confluence of five major rivers (Ouse, Aire, Don, Derwent and Trent). The representation of the hydrology from those five watercourses is assumed to be accurate for the assessment of risk to the site.

7.19. This model was used to assess flood risk at the site location and should not be used to assess flood risk in the wider catchment.

8. Conclusions

8.1. Three separate hydraulic models (Lower Aire, Lower Ouse and Wharfe Washlands, Upper Humber) were obtained and converted to a single Estry-TUFLOW model.

8.2. Overall, the modelling exercise show significant parts of the site to be affected by fluvial flooding. Mitigations measures will be required to ensure the safety of any future development, to both property and its users.

8.3. Outcomes of the modelling suggest lower design depths than previous modelling. This is attributed to the combination of events used for joint probability modelling, as well as the application of sub grid sampling and updated LiDAR.

Appendix A - Topographical survey

aegaea

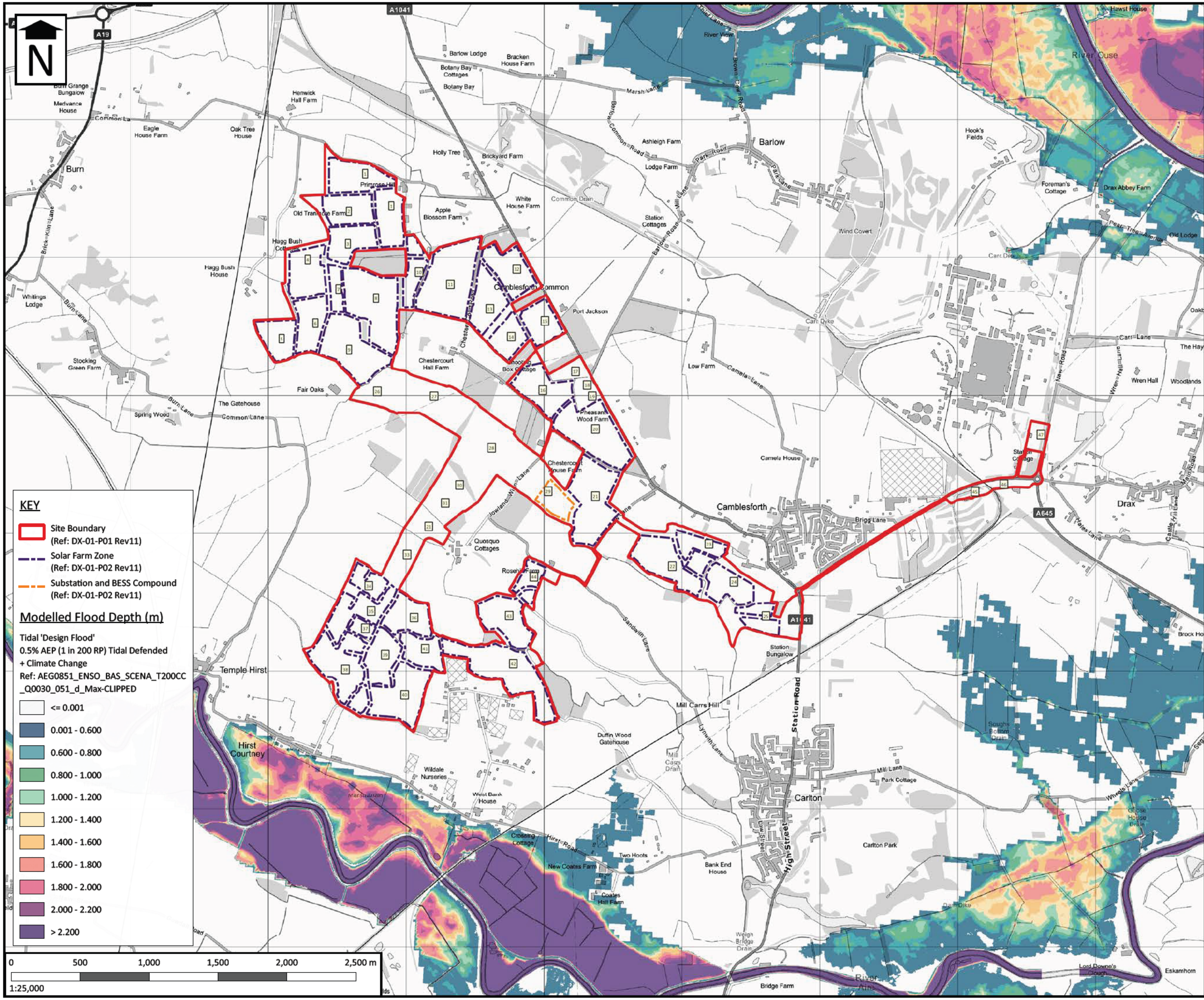
Flood risk, water and environment

Appendix B - Hydrology Report

aegaea

Flood risk, water and environment

Appendix 11



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2. Drawing is based upon Parameter Plan, Enso Energy Drawing No. DX-01-P02 Rev 11 dated 15/04/2024.

3. Field Numbers based upon Field Boundaries Plan, Enso Energy Drawing No. DX-01-P44 Rev 04 dated 15/04/2024.

4. Flood risk data based on the results from the site-specific flood model produced by Aegaea. Details contained in Hydraulic Model Technical Note (Document Ref: AEG0851_YO8_EnsoEnergy_03 Rev A dated 16/05/2024).

5. Drawing should be read in conjunction with Flood Risk Assessment produced by PFA Consulting (Document Ref: E216-DOC01-FRA-Issue 1, June 2024).

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	04.06.24	First issue.	BF	SAM

Status
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Client
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Project **Helios Renweable Energy Project**

Drawing Title **Tidal 'Design Flood' Flood Depths**

Drawing No. **E216/150** REV #

Date: June 2024 | Scale: As Shown

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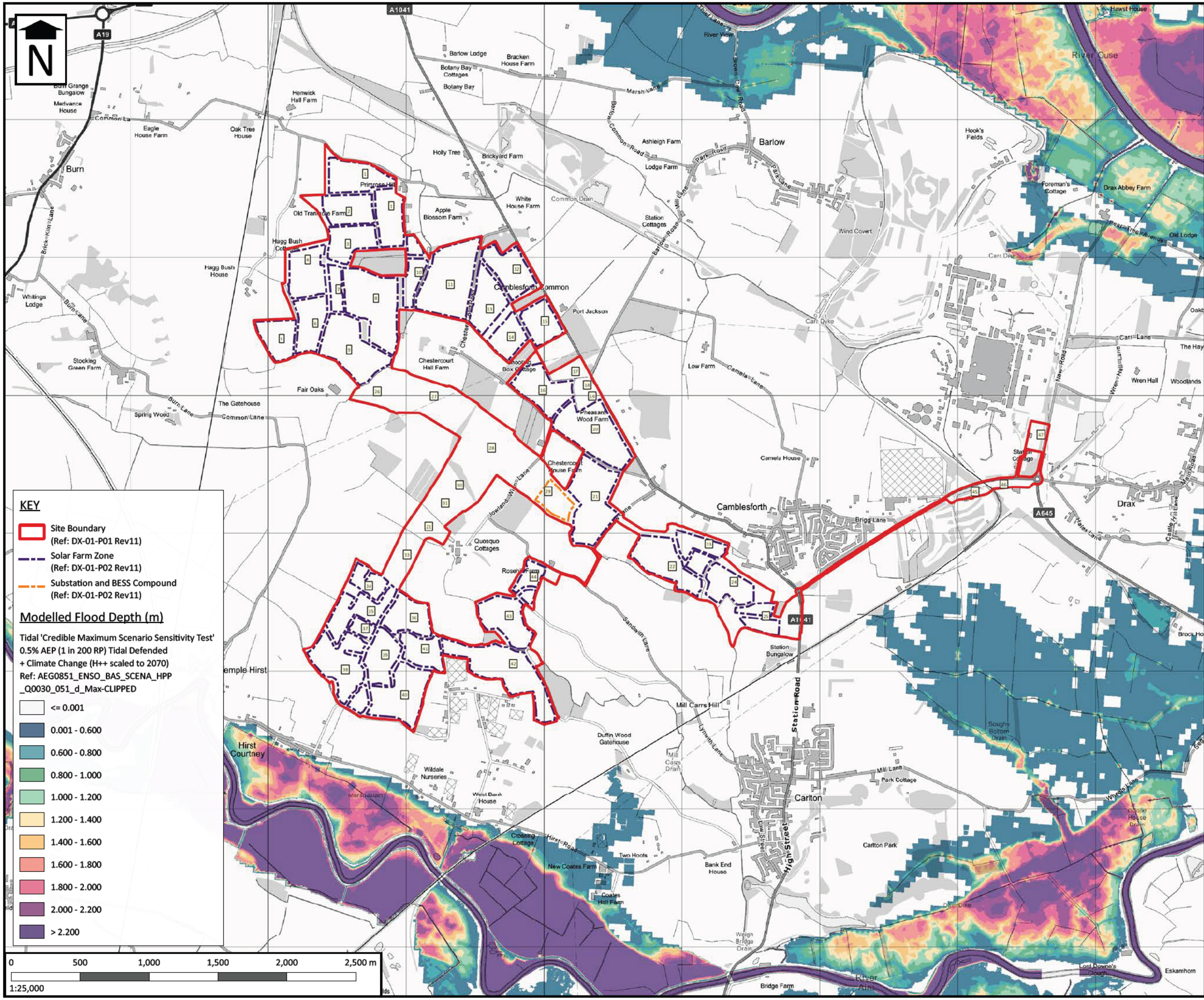
Appendix 12



KEY

Site Boundary (Ref: DX-01-P01 Rev11)

Solar Farm Zone (Ref: DX-01-P02 Rev11)

Substation and BESS Compound (Ref: DX-01-P02 Rev11)

Modelled Flood Depth (m)

Tidal 'Credible Maximum Scenario Sensitivity Test' 0.5% AEP (1 in 200 RP) Tidal Defended + Climate Change (H++ scaled to 2070)
Ref: AEG0851_ENSO_BAS_SCENA_HPP _Q0030_051_d_Max-CLIPPED

- <= 0.001
- 0.001 - 0.600
- 0.600 - 0.800
- 0.800 - 1.000
- 1.000 - 1.200
- 1.200 - 1.400
- 1.400 - 1.600
- 1.600 - 1.800
- 1.800 - 2.000
- 2.000 - 2.200
- > 2.200

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Drawing Title **Tidal 'Credible Maximum Scenario Sensitivity Test' Flood Depths**

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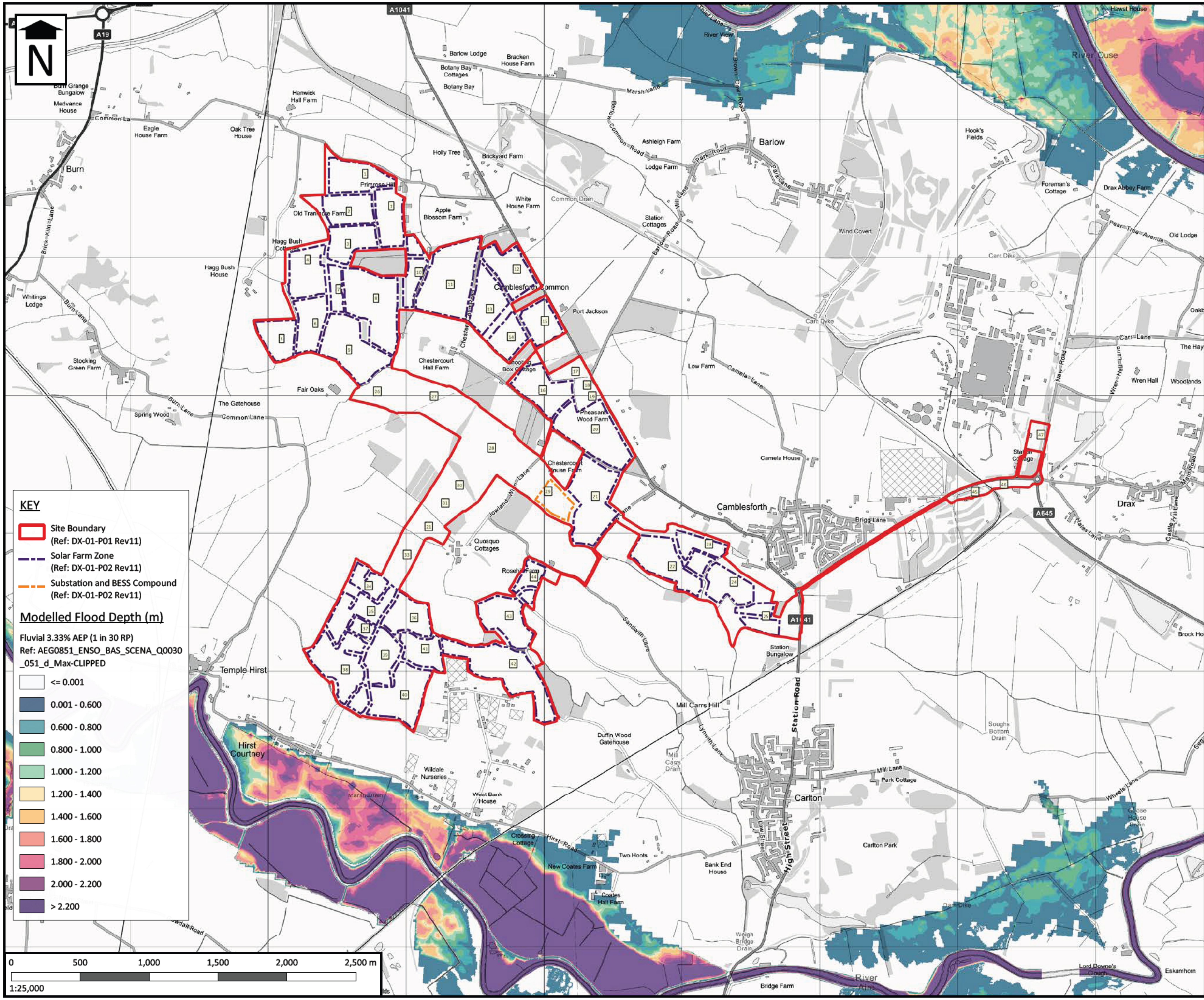
Appendix 13



KEY

- Site Boundary (Ref: DX-01-P01 Rev11)
- Solar Farm Zone (Ref: DX-01-P02 Rev11)
- Substation and BESS Compound (Ref: DX-01-P02 Rev11)

Modelled Flood Depth (m)

Fluvial 3.33% AEP (1 in 30 RP)
Ref: AEG0851_ENSO_BAS_SCENA_Q0030_051_d_Max-CLIPPED

- <= 0.001
- 0.001 - 0.600
- 0.600 - 0.800
- 0.800 - 1.000
- 1.000 - 1.200
- 1.200 - 1.400
- 1.400 - 1.600
- 1.600 - 1.800
- 1.800 - 2.000
- 2.000 - 2.200
- > 2.200

0 500 1,000 1,500 2,000 2,500 m
1:25,000

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Drawing Title
Fluvial 3.33% AEP (1 in 30 RP) Flood Depths

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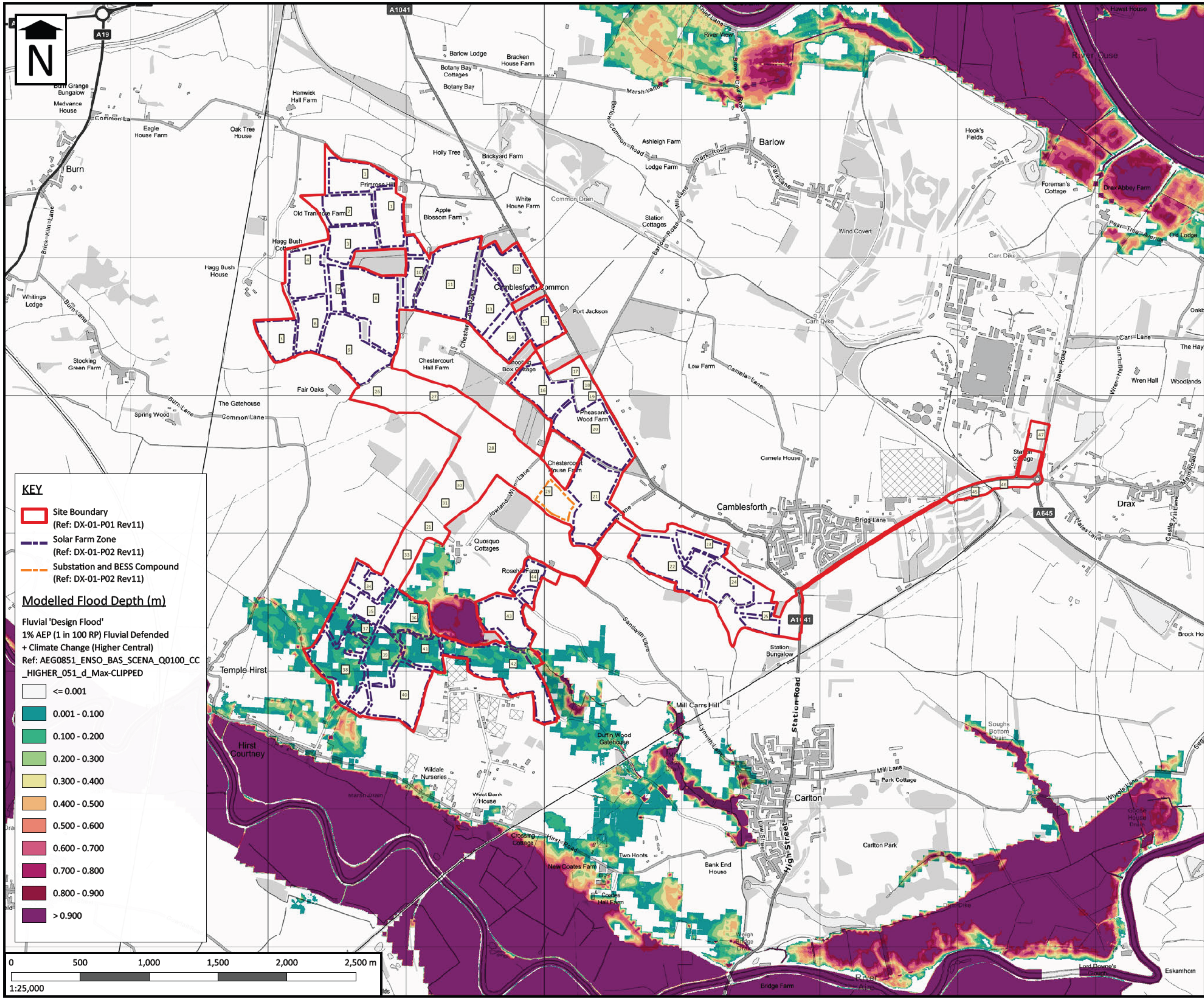
Appendix 14



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Drawing Title **Fluvial 'Design Flood' Flood Depths**

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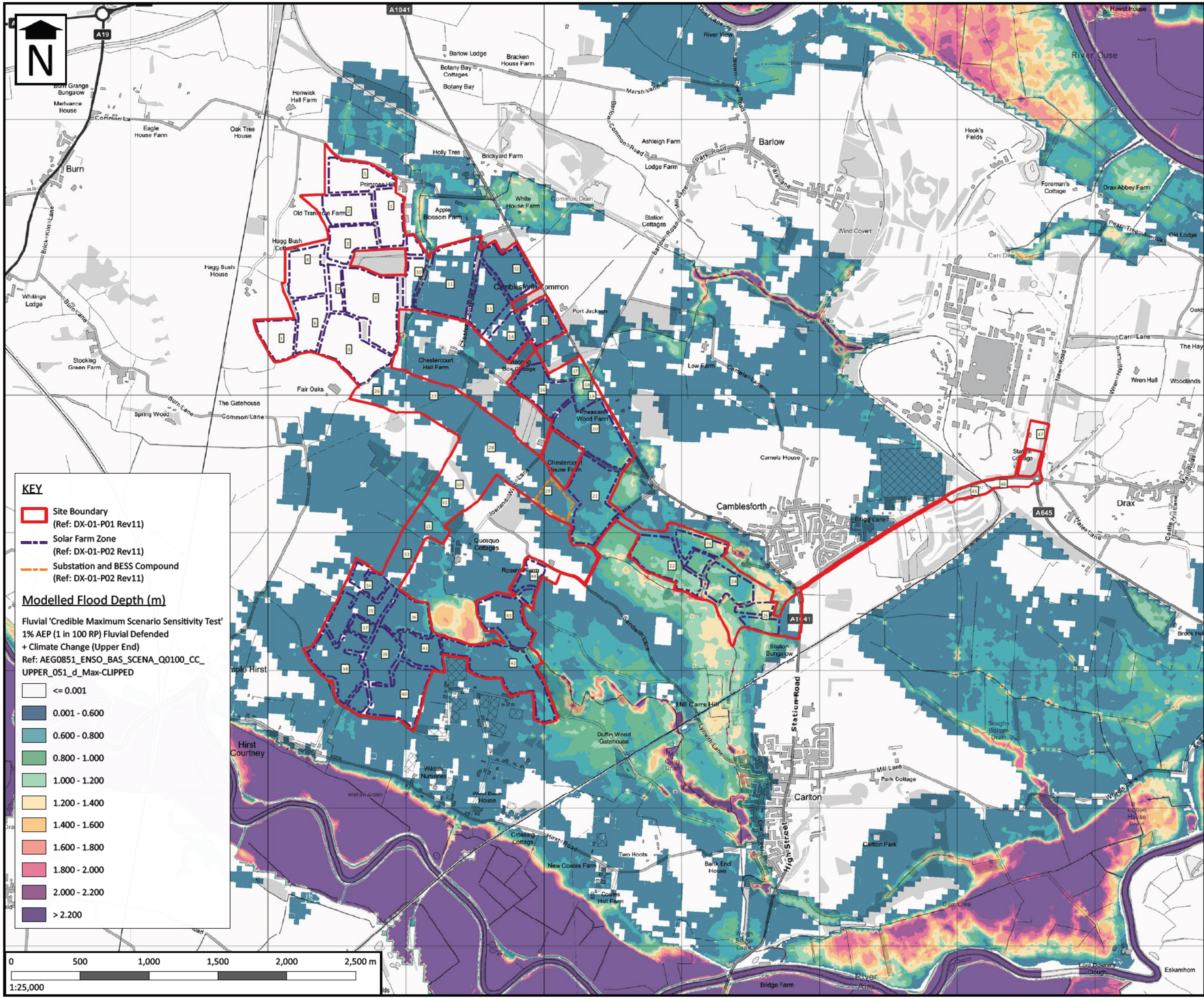
Appendix 15



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2. Drawing is based upon Parameter Plan, Enso Energy Drawing No. DX-01-P02 Rev 11 dated 15/04/2024.
3. Field Numbers based upon Field Boundaries Plan, Enso Energy Drawing No. DX-01-P44 Rev 04 dated 15/04/2024.
4. Flood risk data based on the results from the site-specific flood model produced by Aegaea. Details contained in Hydraulic Model Technical Note (Document Ref: AEG0851_YO8_EnsoEnergy_03 Rev A dated 16/05/2024).
5. Drawing should be read in conjunction with Flood Risk Assessment produced by PFA Consulting (Document Ref: E216-DOC01-FRA-Issue 1, June 2024).
6. May contain Ordnance Survey data © Crown copyright 2020 Ordnance Survey 10024198.
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Rev	Date	Description	Drawn	Check
#	04.06.24	First issue.	BF	SAM

Status
FOR PLANNING

Client
Enso Green Holdings D Limited

Project
Helios Renweable Energy Project

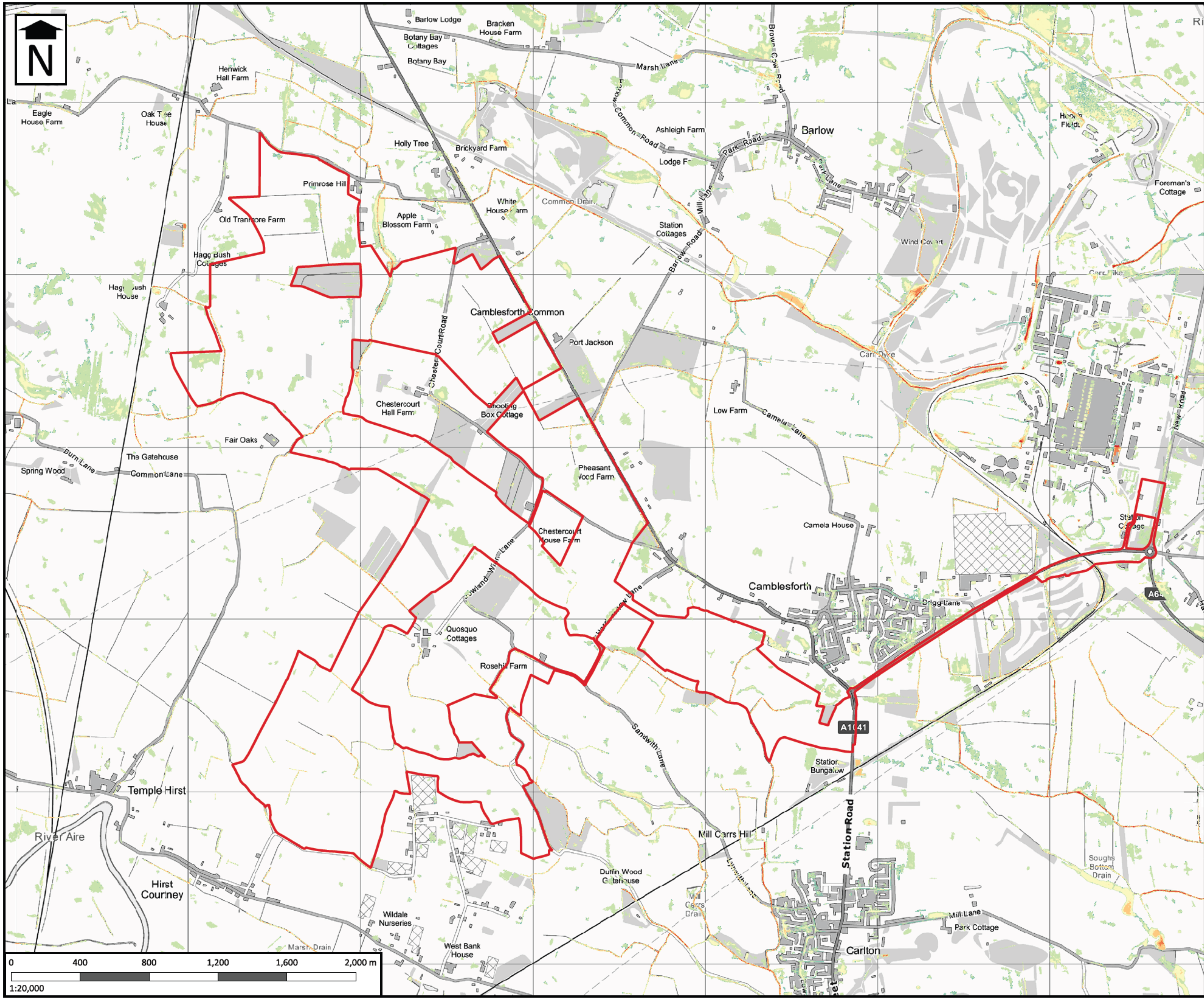
Drawing Title
Fluvial 'Credible Maximum Scenario Sensitivity Test' Flood Depths

Drawing No. E216/154 REV #

Date: June 2024 Scale: As Shown

Email: bfox@pfaplc.com

Appendix 16



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For Planning
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KEY

Site Boundary

Risk of Flooding from Surface Water
Low Risk Modelled Flood Depth (m)
Ref: RoFSW_SE62_Depth_1in1000

- 0.00 - 0.15
- 0.15 - 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

NOTES

1. Drawing is based upon drawing number DX-01-P01 Rev10 Site Boundary by Enso Energy dated 07/02/2024.

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Rev	Date	Description	Drawn	Check
#	NI	First issue.	RS	BF
A	31.05.23	Site boundary updated.	RS	BF
B	22/08/23	Update to Red Line Boundary	JS	BF
C	14/02/24	Update to Red Line Boundary	JS	BF

Status
FOR PLANNING

Client
Enso Green Holidings D Limited

Project **Helios Renewable Energy Project**

Drawing Title **Risk of Flooding from Surface Water (1 in 1000 yr)**

Drawing No. **E216/02** REV C

Date: May 2023 | Scale: As Shown

Email: rsmith@pfaplc.com

Appendix 17

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NOTES

1. Site Boundary based upon Order Limits Location Plan, Enso Energy Drawing No. DX–01–P01 Rev 11, dated 15/02/24.
2. Drawing based upon Parameter Plan, Enso Energy Drawing No. DX–01–P02 Rev 11, dated 15/04/24.
3. Flood risk data based on the results from the site–specific flood model produced by Aegaea. Details contained in Hydraulic Model Technical Note (Document Ref: AEG0851_Y08_EnsoEnergy_03 Rev A dated 16/05/24.
4. Drawing should be read in conjunction with Flood Risk Assessment produced by PFA Consulting (Document Ref; E216–DOC01–FRA–Issue 1, June 2024).
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7. Contains third party information.
8. Minimum equipment levels subject to detailed design and will be informed by an Environment Agency approved site–specific flood model.
9. Minimum equipment levels rounded to nearest 0.005m.

Summary of Flood Mitigation Measures

The Proposed Development extends into areas of elevated flood risk from the fluvial 'design flood'. The Proposed Development would be designed to appropriately safe in the fluvial 'design flood' without increasing flood risk elsewhere. The Proposed Development would be designed to be resilient to the fluvial 'credible maximum scenario sensitivity test' flood event with the implementation of adaptation measures where necessary at the appropriate time.

The following design flood mitigation and adaptation measures are proposed:

- A flood warning and evacuation plan for the relevant phase of the Proposed Development would be contained in the detailed CEMP, OEMP or DEMP and the construction contractor and operating staff would register to receive flood alerts / warnings from the EA and follow site evacuation procedures during periods of elevated flood risk;
- During times of elevated tidal and fluvial flood risk the solar arrays within the areas of elevated flood risk would be rotated to the horizontal stow position which would be a minimum of a 0.3m above the fluvial 'design flood' level or the stow position set above the fluvial 'credible maximum scenario sensitivity test' level, whichever is greater;
- Panel supports and security fencing in flood risk areas would be securely piled into the ground and designed to allow for the effect of flowing water pressures and to be resistant to inundation during a flood event;
- Security fencing mesh size in flood risk areas (fluvial 'design flood') would be increased to 0.15m square to minimise the risk of it collecting debris;
- Ancillary control equipment will be preferentially located in areas of very low surface water flood risk and very low fluvial flood risk in the fluvial 'design flood' and in areas affected by flood depths <0.6m in the fluvial 'credible maximum scenario sensitivity test' flood event.
- Substation and BESS Compound will be preferentially located in areas of very low surface water flood risk and very low fluvial flood risk in the fluvial 'design flood'.
- The level of ancillary control equipment will be raised at least 0.3m (and up to 0.6m) above existing ground level to manage residual risk.
- As an adaptation measures the Substation and BESS Compound would be protected by a suitably designed earth flood defence bund. The height of the proposed earth flood defence bund would be raised at least +0.6m above the fluvial 'credible maximum scenario sensitivity test' flood level to protect the equipment from inundation;
- The Flood Management Strategy for the Site will keep under review the need to implement a level for level floodplain compensation scheme for the Substation and BESS Compound to mitigate the effect of the earth flood defence bund. A preliminary floodplain compensation scheme within the DCO limits has been shown to be feasible;
- Onsite watercourses are retained and existing watercourse crossings are utilised where possible within the Proposed Development;
- Where possible all development (including security fencing) is at least 7m from the onsite ordinary watercourses in accordance with Selby Area IDB byelaws. Additional consents may be required for watercourse crossings (site access or services) and landscape planting where this is not achieved.

Key

- Site Boundary
- Solar Farm Zone
- Substation and BESS Compound
- Watercourse
- Contours

Modelled Flood Levels (mAOD)
Fluvial 'Credible Maximum Scenario Sensitivity Test'
1% AEP (1 in 100 RP) Fluvial Defended
+ Climate Change (Upper End)

Ref: AEG0851_ENSO_BAS_SCENA_Q0100_CC_UPPER_051_h_Max–CLIPPED

- 4.10 – 4.20
- 4.20 – 4.30
- 4.30 – 4.40
- 4.40 – 4.50
- 4.50 – 4.60
- 4.60 – 4.70
- 4.70 – 4.80
- 4.80 – 4.90
- 4.90 – 5.00
- 5.00 – 5.10
- 5.10 – 5.20
- 5.20 – 5.40
- 5.40 – 5.50

Note: Modelled flood levels to be reviewed following Environment Agency approval of the site–specific flood model.

Rev	Date	Description	Drawn	Check
#	13/02/24	First Issue.	JS	BF
A	04/06/24	Flood mitigation and adaptation measures updated to reflect s te-specific flood modelling (May 2024).	BF	SAM

Status
FOR PLANNING

Client
Enso Green Holdings D Ltd

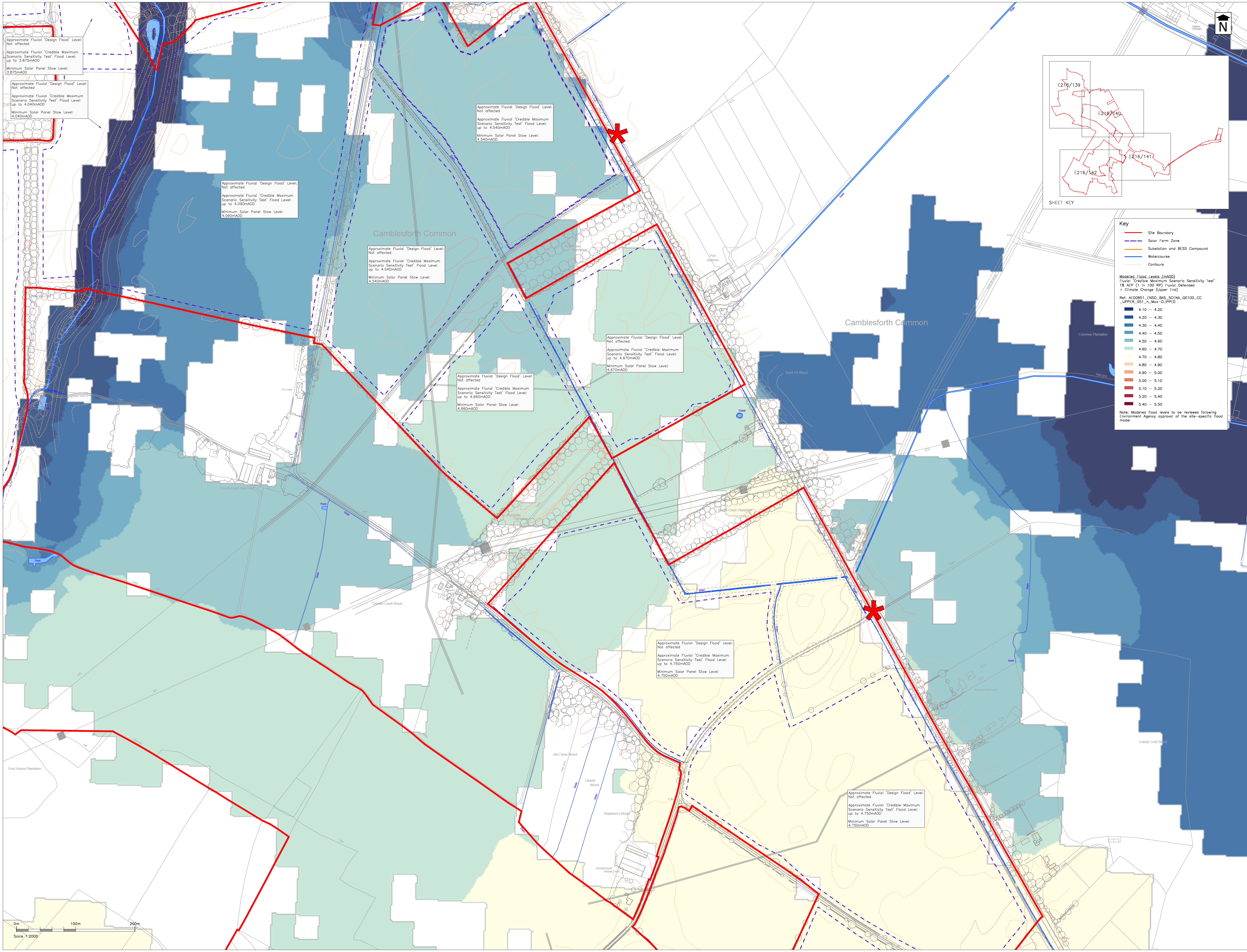
Project
Helios Renewable Energy Project

Drawing Title
Minimum Equipment Levels Sheet 1 of 4

Drawing No. **E216/139** Rev A

Date: Februrary 2024 | Scale: 1:2000 @ A0

E-Mail: [redacted]@pfaplc.com



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NOTES

1. Site Boundary based upon Order Limits Location Plan, Enso Energy Drawing No. DX–01–P01 Rev 11, dated 15/02/24.
2. Drawing based upon Parameter Plan, Enso Energy Drawing No. DX–01–P02 Rev 11, dated 15/04/24.
3. Flood risk data based on the results from the site–specific flood model produced by Aegaea. Details contained in Hydraulic Model Technical Note (Document Ref: AEG0851_Y08_EnsoEnergy_03 Rev A dated 16/05/24.
4. Drawing should be read in conjunction with Flood Risk Assessment produced by PFA Consulting (Document Ref; E216–DOC01–FRA–Issue 1, June 2024).
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7. Contains third party information.
8. Minimum equipment levels subject to detailed design and will be informed by an Environment Agency approved site–specific flood model.
9. Minimum equipment levels rounded to nearest 0.005m.

Summary of Flood Mitigation Measures

The Proposed Development extends into areas of elevated flood risk from the fluvial 'design flood'. The Proposed Development would be designed to appropriately safe in the fluvial 'design flood' without increasing flood risk elsewhere. The Proposed Development would be designed to be resilient to the fluvial 'credible maximum scenario sensitivity test' flood event with the implementation of adaptation measures where necessary at the appropriate time.

The following design flood mitigation and adaptation measures are proposed:

- A flood warning and evacuation plan for the relevant phase of the Proposed Development would be contained in the detailed CEMP, OEMP or DEMP and the construction contractor and operating staff would register to receive flood alerts / warnings from the EA and follow site evacuation procedures during periods of elevated flood risk;
- During times of elevated tidal and fluvial flood risk the solar arrays within the areas of elevated flood risk would be rotated to the horizontal stow position which would be a minimum of a 0.3m above the fluvial 'design flood' level or the stow position set above the fluvial 'credible maximum scenario sensitivity test' level, whichever is greater;
- Panel supports and security fencing in flood risk areas would be securely piled into the ground and designed to allow for the effect of flowing water pressures and to be resistant to inundation during a flood event;
- Security fencing mesh size in flood risk areas (fluvial 'design flood') would be increased to 0.15m square to minimise the risk of it collecting debris;
- Ancillary control equipment will be preferentially located in areas of very low surface water flood risk and very low fluvial flood risk in the fluvial 'design flood' and in areas affected by flood depths <0.6m in the fluvial 'credible maximum scenario sensitivity test' flood event.
- Substation and BESS Compound will be preferentially located in areas of very low surface water flood risk and very low fluvial flood risk in the fluvial 'design flood'.
- The level of ancillary control equipment will be raised at least 0.3m (and up to 0.6m) above existing ground level to manage residual risk.
- As an adaptation measures the Substation and BESS Compound would be protected by a suitably designed earth flood defence bund. The height of the proposed earth flood defence bund would be raised at least +0.6m above the fluvial 'credible maximum scenario sensitivity test' flood level to protect the equipment from inundation;
- The Flood Management Strategy for the Site will keep under review the need to implement a level for level floodplain compensation scheme for the Substation and BESS Compound to mitigate the effect of the earth flood defence bund. A preliminary floodplain compensation scheme within the DCO limits has been shown to be feasible;
- Onsite watercourses are retained and existing watercourse crossings are utilised where possible within the Proposed Development;
- Where possible all development (including security fencing) is at least 7m from the onsite ordinary watercourses in accordance with Selby Area IDB byelaws. Additional consents may be required for watercourse crossings (site access or services) and landscape planting where this is not achieved.

Rev	Date	Description	Drawn	Check
#	13/02/24	First Issue.	JS	BF
A	04/06/24	Flood mitigation and adaptation measures updated to reflect site-specific flood modelling (May 2024).	BF	SAM

Status
FOR PLANNING

Client
Enso Green Holdings D Ltd

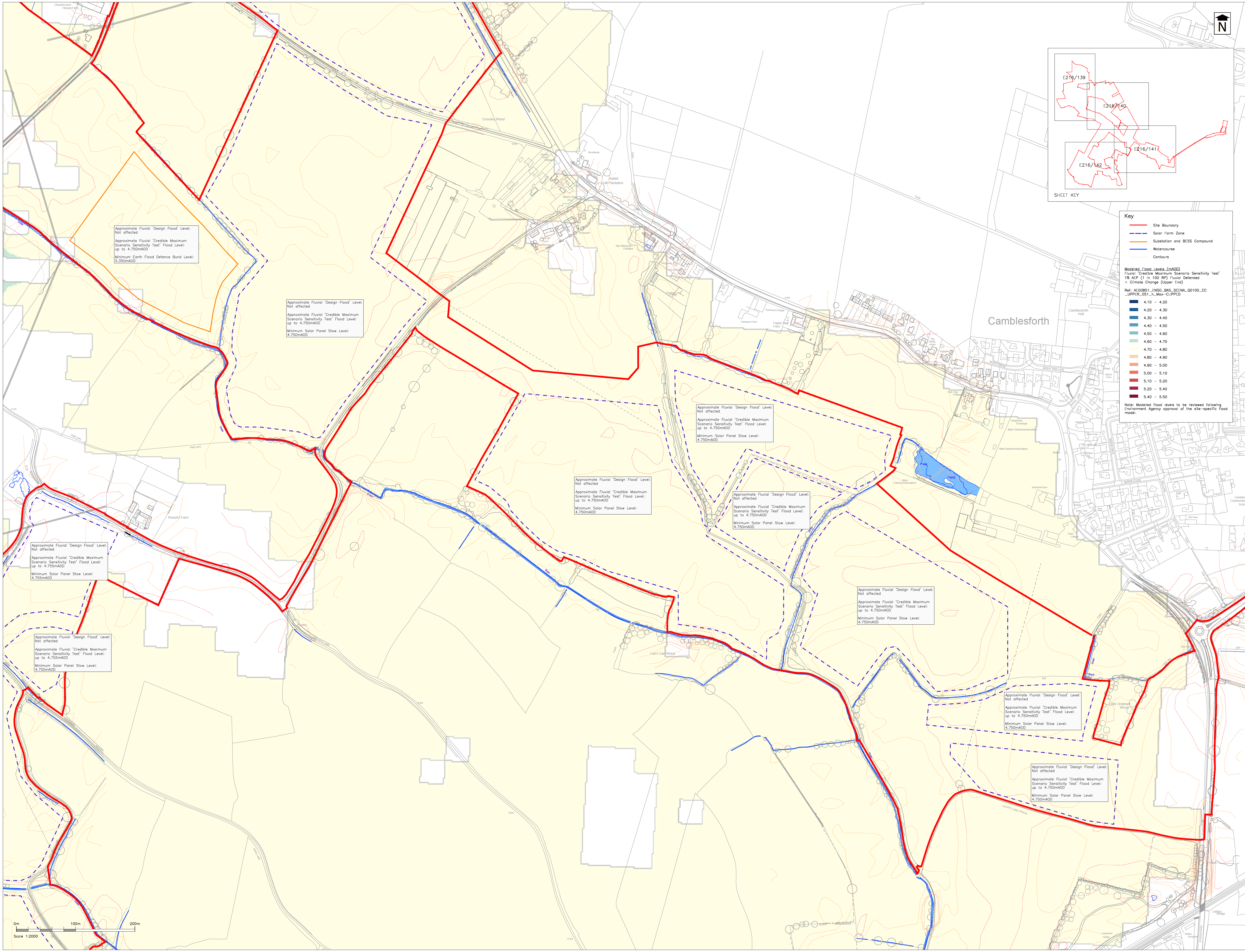
Project
Helios Renewable Energy Project

Drawing Title
Minimum Equipment Levels Sheet 2 of 4

Drawing No. **E216/140** Rev A

Date: Februrary 2024 | Scale: 1:2000 @ A0

E-Mail: [redacted]@pfaplc.com



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NOTES

1. Site Boundary based upon Order Limits Location Plan, Enso Energy Drawing No. DX-01-P01 Rev 11, dated 15/02/24.
2. Drawing based upon Parameter Plan, Enso Energy Drawing No. DX-01-P02 Rev 11, dated 15/04/24.
3. Flood risk data based on the results from the site-specific flood model produced by Aegaea. Details contained in Hydraulic Model Technical Note (Document Ref: AEG0851_Y08_EnsoEnergy_03 Rev A dated 16/05/24.
4. Drawing should be read in conjunction with Flood Risk Assessment produced by PFA Consulting (Document Ref; E216-DOC01-FRA-Issue 1, June 2024).
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7. Contains third party information.
8. Minimum equipment levels subject to detailed design and will be informed by an Environment Agency approved site-specific flood model.
9. Minimum equipment levels rounded to nearest 0.005m.

Summary of Flood Mitigation Measures

The Proposed Development extends into areas of elevated flood risk from the fluvial 'design flood'. The Proposed Development would be designed to appropriately safe in the fluvial 'design flood' without increasing flood risk elsewhere. The Proposed Development would be designed to be resilient to the fluvial 'credible maximum scenario sensitivity test' flood event with the implementation of adaptation measures where necessary at the appropriate time.

The following design flood mitigation and adaptation measures are proposed:

- A flood warning and evacuation plan for the relevant phase of the Proposed Development would be contained in the detailed CEMP, OEMP or DEMP and the construction contractor and operating staff would register to receive flood alerts / warnings from the EA and follow site evacuation procedures during periods of elevated flood risk;
- During times of elevated tidal and fluvial flood risk the solar arrays within the areas of elevated flood risk would be rotated to the horizontal stow position which would be a minimum of a 0.3m above the fluvial 'design flood' level or the stow position set above the fluvial 'credible maximum scenario sensitivity test' level, whichever is greater;
- Panel supports and security fencing in flood risk areas would be securely piled into the ground and designed to allow for the effect of flowing water pressures and to be resistant to inundation during a flood event;
- Security fencing mesh size in flood risk areas (fluvial 'design flood') would be increased to 0.15m square to minimise the risk of it collecting debris;
- Ancillary control equipment will be preferentially located in areas of very low surface water flood risk and very low fluvial flood risk in the fluvial 'design flood' and in areas affected by flood depths <0.6m in the fluvial 'credible maximum scenario sensitivity test' flood event.
- Substation and BESS Compound will be preferentially located in areas of very low surface water flood risk and very low fluvial flood risk in the fluvial 'design flood'.
- The level of ancillary control equipment will be raised at least 0.3m (and up to 0.6m) above existing ground level to manage residual risk.
- As an adaptation measures the Substation and BESS Compound would be protected by a suitably designed earth flood defence bund. The height of the proposed earth flood defence bund would be raised at least +0.6m above the fluvial 'credible maximum scenario sensitivity test' flood level to protect the equipment from inundation;
- The Flood Management Strategy for the Site will keep under review the need to implement a level for level floodplain compensation scheme for the Substation and BESS Compound to mitigate the effect of the earth flood defence bund. A preliminary floodplain compensation scheme within the DCO limits has been shown to be feasible;
- Onsite watercourses are retained and existing watercourse crossings are utilised where possible within the Proposed Development;
- Where possible all development (including security fencing) is at least 7m from the onsite ordinary watercourses in accordance with Selby Area IDB byelaws. Additional consents may be required for watercourse crossings (site access or services) and landscape planting where this is not achieved.

Rev	Date	Description	Drawn	Check
#	13/02/24	First Issue.	JS	BF
A	04/06/24	Flood mitigation and adaptation measures updated to reflect site-specific flood modelling (May 2024).	BF	SAM

Status
FOR PLANNING

Client
Enso Green Holdings D Ltd

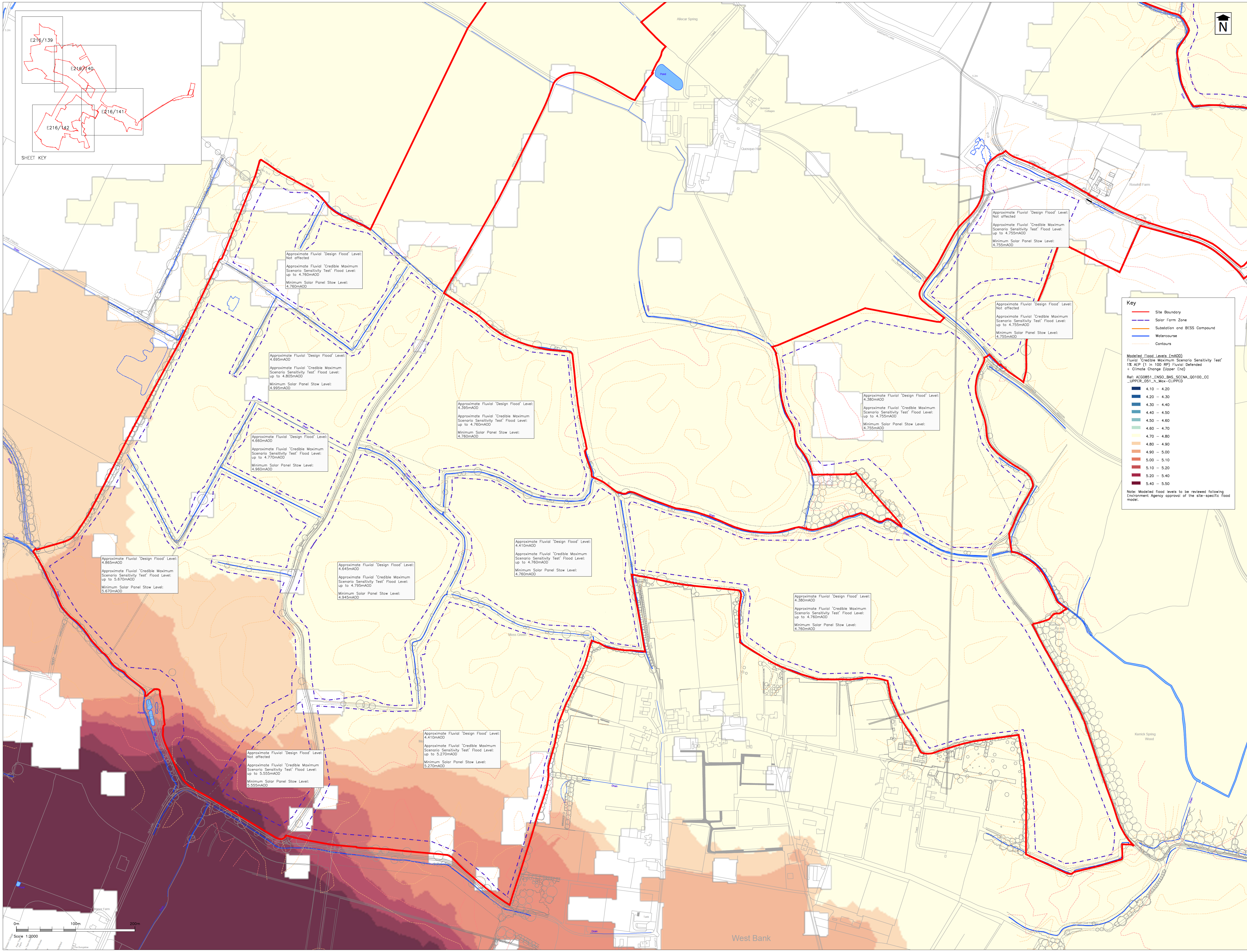
Project
Helios Renewable Energy Project

Drawing Title
Minimum Equipment Levels Sheet 3 of 4

Drawing No. **E216/141** Rev A

Date: Februrary 2024 | Scale: 1:2000 @ A0

E-Mail: [redacted]@pfaplc.com



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NOTES

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2. Drawing based upon Parameter Plan, Enso Energy Drawing No. DX–01–P02 Rev 11, dated 15/04/24.
3. Flood risk data based on the results from the site–specific flood model produced by Aegaea. Details contained in Hydraulic Model Technical Note (Document Ref: AEG0851_Y08_EnsoEnergy_03 Rev A dated 16/05/24.
4. Drawing should be read in conjunction with Flood Risk Assessment produced by PFA Consulting (Document Ref; E216–DOC01–FRA–Issue 1, June 2024).
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8. Minimum equipment levels subject to detailed design and will be informed by an Environment Agency approved site–specific flood model.
9. Minimum equipment levels rounded to nearest 0.005m.

Summary of Flood Mitigation Measures

The Proposed Development extends into areas of elevated flood risk from the fluvial 'design flood'. The Proposed Development would be designed to appropriately safe in the fluvial 'design flood' without increasing flood risk elsewhere. The Proposed Development would be designed to be resilient to the fluvial 'credible maximum scenario sensitivity test' flood event with the implementation of adaptation measures where necessary at the appropriate time.

The following design flood mitigation and adaptation measures are proposed:

- A flood warning and evacuation plan for the relevant phase of the Proposed Development would be contained in the detailed CEMP, OEMP or DEMP and the construction contractor and operating staff would register to receive flood alerts / warnings from the EA and follow site evacuation procedures during periods of elevated flood risk;
- During times of elevated tidal and fluvial flood risk the solar arrays within the areas of elevated flood risk would be rotated to the horizontal stow position which would be a minimum of a 0.3m above the fluvial 'design flood' level or the stow position set above the fluvial 'credible maximum scenario sensitivity test' level, whichever is greater;
- Panel supports and security fencing in flood risk areas would be securely piled into the ground and designed to allow for the effect of flowing water pressures and to be resistant to inundation during a flood event;
- Security fencing mesh size in flood risk areas (fluvial 'design flood') would be increased to 0.15m square to minimise the risk of it collecting debris;
- Ancillary control equipment will be preferentially located in areas of very low surface water flood risk and very low fluvial flood risk in the fluvial 'design flood' and in areas affected by flood depths <0.6m in the fluvial 'credible maximum scenario sensitivity test' flood event.
- Substation and BESS Compound will be preferentially located in areas of very low surface water flood risk and very low fluvial flood risk in the fluvial 'design flood'.
- The level of ancillary control equipment will be raised at least 0.3m (and up to 0.6m) above existing ground level to manage residual risk.
- As an adaptation measures the Substation and BESS Compound would be protected by a suitably designed earth flood defence bund. The height of the proposed earth flood defence bund would be raised at least +0.6m above the fluvial 'credible maximum scenario sensitivity test' flood level to protect the equipment from inundation;
- The Flood Management Strategy for the Site will keep under review the need to implement a level for level floodplain compensation scheme for the Substation and BESS Compound to mitigate the effect of the earth flood defence bund. A preliminary floodplain compensation scheme within the DCO limits has been shown to be feasible;
- Onsite watercourses are retained and existing watercourse crossings are utilised where possible within the Proposed Development;
- Where possible all development (including security fencing) is at least 7m from the onsite ordinary watercourses in accordance with Selby Area IDB byelaws. Additional consents may be required for watercourse crossings (site access or services) and landscape planting where this is not achieved.

Rev	Date	Description	Drawn	Check
#	13/02/24	First Issue.	JS	BF
A	04/06/24	Flood mitigation and adaptation measures updated to reflect site-specific flood modelling (May 2024).	BF	SAM

Status
FOR PLANNING

Client
Enso Green Holdings D Ltd

Project
Helios Renewable Energy Project

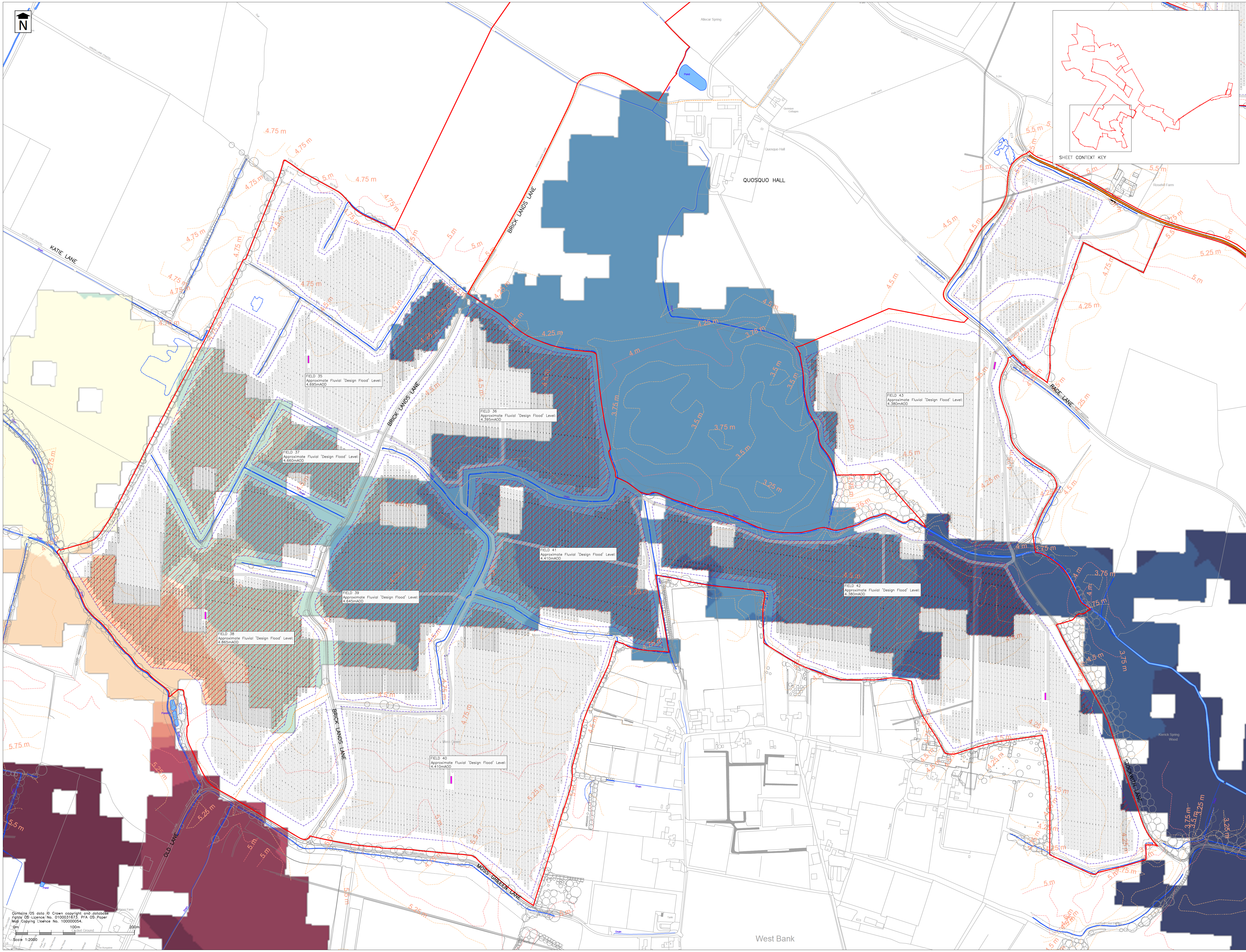
Drawing Title
Minimum Equipment Levels Sheet 4 of 4

Drawing No. **E216/142** Rev A

Date: Februrary 2024 | Scale: 1:2000 @ A0

E-Mail: [redacted]@pfaplc.com

Appendix 18



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Website
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For Planning
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NOTES

1. Site Boundary based upon Order Limits Location Plan, Enso Energy Drawing No. DX-01-P01 Rev 11, dated 15/02/24.
2. Drawing based upon Indicative Design, Enso Energy Drawing No. DX-01-P47 Rev 08, dated 15/04/24.
3. Flood risk data based on the results from the site-specific flood model produced by Aegaea. Details contained in Hydraulic Model Technical Note (Document Ref: AEG0851_Y08_EnsoEnergy_03 Rev B dated 25/06/24.
4. Drawing should be read in conjunction with Flood Risk Assessment produced by PFA Consulting (Document Ref: E216-DOC01-FRA-Issue 1, June 2024) and Water Environment Supplementary Assessment produced by PFA Consulting (Document Ref: E216-DOC02-Issue 1, January 2024)
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8. Minimum equipment levels subject to detailed design and will be informed by the Environment Agency approved site-specific flood model produced by Aegaea.
9. Minimum equipment levels rounded to nearest 0.005m.

Key

Site Boundary
Solar Farm Zone
Watercourse
Contours
Operational Area of the Site affected by Fluvial 'Design Flood' 356,963.50 m^2 / 35.696 Ha

Modelled Flood Levels (mAOD)
Fluvial 'Design Flood'
1% AEP (1 in 100 RP) Fluvial Defended
+ Climate Change (Higher Central)

Ref: AEG0851_ENSO_BAS_SCENA_Q0100_CC_HIGHER_051_h_Max-CLIPPED

4.10 – 4.20
4.20 – 4.30
4.30 – 4.40
4.40 – 4.50
4.50 – 4.60
4.60 – 4.70
4.70 – 4.80
4.80 – 4.90
4.90 – 5.00
5.00 – 5.10
5.10 – 5.20
5.20 – 5.40
5.40 – 5.50

Rev	Date	Description	Drawn	Check
#	20/12/24	First Issue.	BF	MWS

Status
FOR PLANNING

Client
Enso Green Holdings D Ltd

Project
Helios Renewable Energy Project

Drawing Title
Preliminary Solar Array Support Flood Volume Displacement Assessment Flood Extents

Drawing No. **E216/164**

Date: December 2024 Scale: 1:2000 @ A0
E-Mail: [redacted]@pfaplc.com