EAST PARK ENERGY

East Park Energy

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Hydraulic Modelling Report

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East Park Energy Pluvial Modelling

Axis

East Park Energy Pluvial Modelling

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Contents

1 Introduction

1.1 Scope of Study

Wallingford HydroSolutions (WHS) has been commissioned by Axis to produce a 2D pluvial model to assess the surface water flood risk to the proposed East Park Energy development. This site-specific model has been requested by the Environment Agency as the national surface water depth mapping does not provide results for the 2070s climate change epoch.

The East Park Energy proposed development covers 773 ha of land to the north-west of St Neots comprising ground-mounted solar photovoltaic panels and an associated on-site battery energy storage system (BESS). The risk of flooding to the site from fluvial sources has been assessed in detail within the existing Flood Risk Assessment (FRA)[1] for the site using the detailed models from the 2015 Lower Great Ouse Flood Risk Mapping study[2].

1.2 Methodology

A 2D pluvial model of the two catchments covering the site has been developed to assess surface water flood risk across the whole panelled area.

The pluvial model has been produced using TUFLOW hydraulic modelling software with rainfall inputs derived using ReFH2. The 3.3% AEP (Annual Exceedance Probability), 1.0% AEP, 1.0% AEP + CC and 0.1% AEP events were assessed for several storm durations in line with the EA national scale RoFSW flood map, which include the 1hr, 3hr, 6hr, 9hr, 12hr and 18hr storm durations with a summer storm profile.

1.3 Data sources

The data sources used to inform this hydraulic modelling study are:

- LiDAR data from the National LiDAR Programme[3]
- Catchment data from the FEH web service[4]
- EA Risk of Flooding from Surface Water mapping[5]
- NaFRA2 New National Modelling Methodology Statement[6]
- Ordnance Survey Mapping Data.

1.4 Assumptions

The following assumptions have been made during this study:

- As detailed fluvial modelling has been assessed, it is sufficient to represent the watercourses within the catchments in the 2D domain only. A 1D domain is not required.

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[1] East Park Energy (2025) Environmental Statement Appendix 8-1: Flood Risk Assessment.
[2] Environment Agency (2015) Lower Great Ouse Flood Risk Mapping.
[3] Environment Agency (2023) *LIDAR Composite Digital Terrain Model (DTM) 1m.* Available at: https://environment.data.gov.uk/dataset/13787b9a-26a4-4775-8523-806d13af58fc
[4] UK CEH (2026) *Flood Estimation Handbook Web Service.* https://fehweb.ceh.ac.uk/Map
[5] Environment Agency (2025) Risk of Flooding from Surface Water. https://environment.data.gov.uk/dataset/b5aaa28d-6eb9-460e-8d6f-43caa71fbe0e
[6] Environment Agency (2025) *NaFRA2 New National Modelling Methodology Statement.*

2 Site Description

2.1 Site Location

The proposed development covers 773 ha of land to the northwest of St Neots. Although the site order limits extend further east the closest panelled area to St Neots is located approximately 2.5 km from the town. Four main areas of panels are located across the site boundary from east to west covering approximately 9-10 km, see Figure 1.

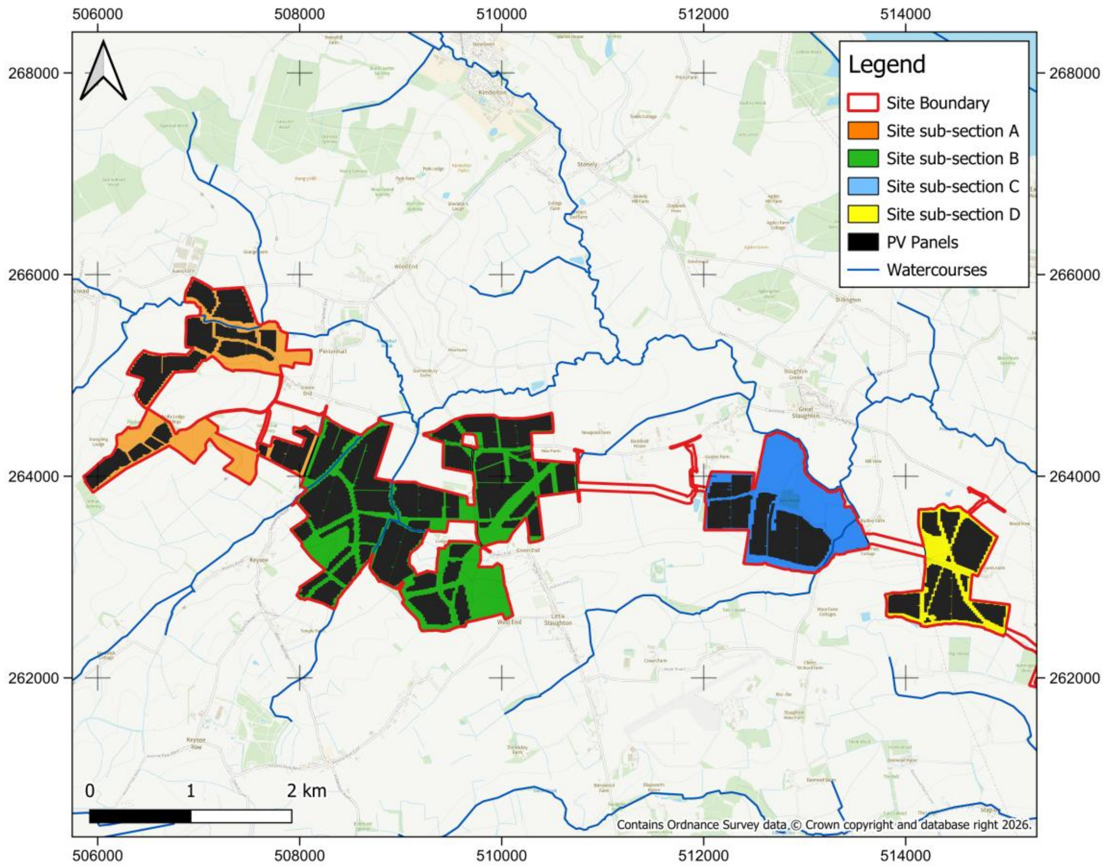


Figure 1 - Site Location

3 Hydrology Assessment

3.1 Catchments

Due to the scale of the proposed development, two catchments have been defined to cover panel areas A and B in the west, and areas C and D in the east, see Figure 2. As this is a pluvial flood model, rainfall hyetographs are required for both catchments as inputs to the 2D domain.

The catchments were predominantly defined using the EA detailed watersheds layer which is part of the overland flow pathways dataset[7]. These initial catchments were then updated to remove areas over 300 m downstream of the panelled area, and areas on the opposite bank of the Pertenhall Brook and River Kym to the proposed development. These areas were determined to not have an impact on pluvial flood risk to the site as they are represented within the fluvial modelling[2] and so were removed to reduce the computing power required to run the model as the catchment derived is also used to define the active area within the model domain. This approach still ensures that all the rainfall which may have an impact on the site is accounted for in the assessment. Figure 2 shows the final derived catchments with the AB catchment covering 28.8 km^2 and the CD catchment covering 10.5 km^2.

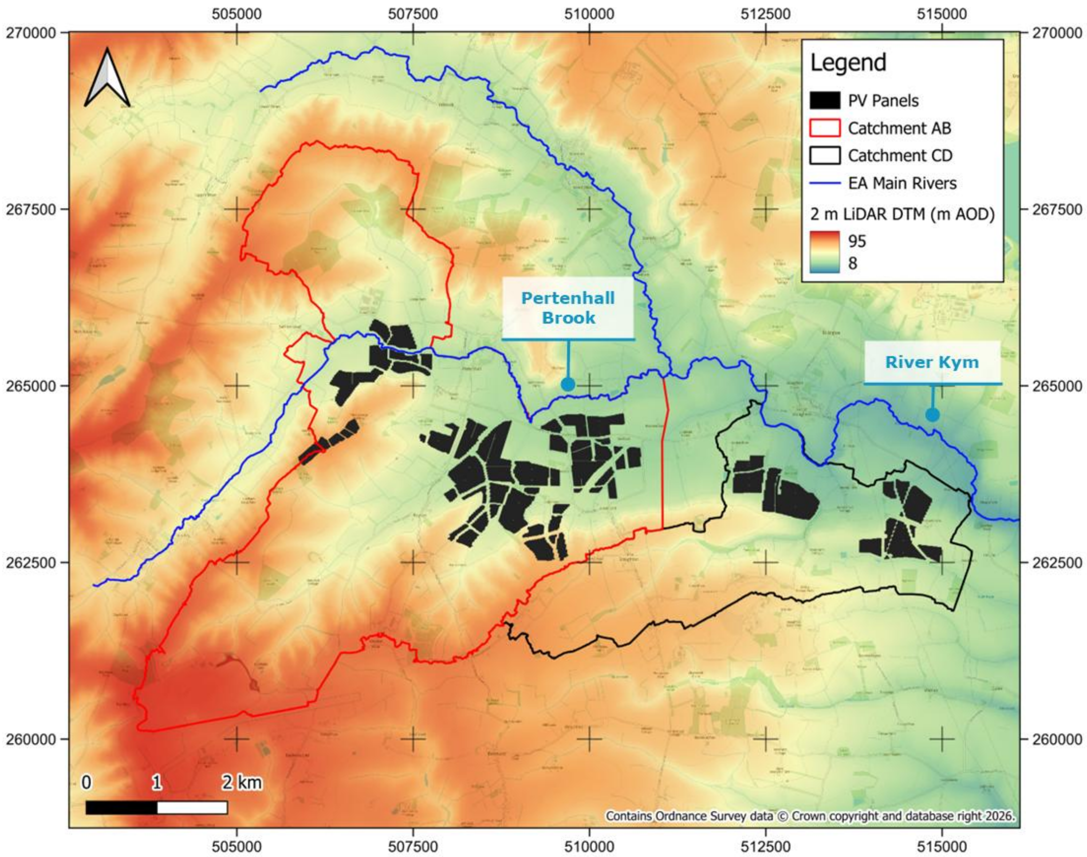


Figure 2 - Catchment Boundaries

[7] Environment Agency (2025) *Overland Flow Pathways.* https://www.data.gov.uk/dataset/c9dd994d-9649-4041-96d4-cdc0f1a53152/overland-flow-pathways

Appendix 1 details how rainfall hyetographs were generated for the two catchments. Catchment data was extracted from the FEH Web Service[4] for the two catchments which best represent the derived catchments and is displayed below in Table 1. The FEH22 DDF rainfall data from these catchments was used to determine the net rainfall inputs into the model, with infiltration losses modelled in ReFH2.3. This methodology is consistent with the EA's existing surface water flood map.

Table 1 - FEH Catchment Descriptors

Descriptor	AB Catchment	CD Catchment
BFIHOST19	0.305	0.314
PROPWET	0.24	0.24
SAAR6190 (mm)	588	559

3.2 Derivation of Rural and Urban Areas

OS MasterMap data was used to define the rural and urban areas within the catchment. Separate rural and urban hyetographs were then applied to the corresponding areas within the model domain. Given that urban rainfall will only be applied to impermeable surfaces, the Impervious Factor (IF) was set to 1.0 to indicate the entire cell is impermeable. A 4m cell size has been used within the model which was determined to represent land cover with a high enough resolution to allow this application of a higher IF given the large model active areas. Furthermore, the Impervious Runoff Factor (IRF) has been increased from the default value of 0.7 to 1.0, as the cell resolution of 4m is likely to explicitly represent localised depressions within the DTM.

3.3 Runoff Estimation

The ReFH2.3 software has been used to derive the hyetographs used in this model, whereby the FEH catchment descriptors (Table 1) are used to calculate the rainfall and loss parameters, which are then used to derive net rainfall. Three assumptions were adopted:

- Rainfall, infiltration and other losses are modelled in ReFH2
- The resulting Net rainfall (runoff) estimate by ReFH is applied to the 2D model domain
- Sewer losses are modelled in TUFLOW rather than ReFH2

Two separate hyetographs were derived for each storm duration (1, 3, 6, 9, 12, 18), representing net rural rainfall and net urban rainfall. Two storm profiles were also considered, the 75% winter profile and the 50% summer profile. The summer profile was used within the model runs as this resulted in the greatest peak rainfall for each duration event. Table 2 and Table 3 show the peak net rainfall for all durations and profiles for the 1000 yr event.

Table 2 - Catchment AB 1000yr event peak net rainfall

	1 Hour Peak Net Rainfall (mm)	3 Hour Peak Net Rainfall (mm)	6 Hour Peak Net Rainfall (mm)	9 Hour Peak Net Rainfall (mm)	12 Hour Peak Net Rainfall (mm)	18 Hour Peak Net Rainfall (mm)
	1000yr	1000yr	1000yr	1000yr	1000yr	1000yr
Urban Summer	16.29	22.60	27.40	30.02	31.68	33.66
Urban Winter	6.03	9.47	12.52	13.77	14.58	15.60
Rural Summer	8.53	12.92	16.66	18.85	20.29	22.06
Rural Winter	3.75	6.26	8.70	9.75	10.46	11.37

Table 3 - Catchment CD 1000yr event peak net rainfall

	1 Hour Peak Net Rainfall (mm)	3 Hour Peak Net Rainfall (mm)	6 Hour Peak Net Rainfall (mm)	9 Hour Peak Net Rainfall (mm)	12 Hour Peak Net Rainfall (mm)	18 Hour Peak Net Rainfall (mm)
	1000yr	1000yr	1000yr	1000yr	1000yr	1000yr
Urban Summer	17.27	23.59	28.13	30.54	32.03	33.79
Urban Winter	6.26	9.68	12.61	13.73	14.44	15.33
Rural Summer	8.67	12.95	16.39	18.34	19.59	21.11
Rural Winter	3.77	6.19	8.46	9.38	9.98	10.74

4 Hydraulic Model Build

The 2D domain is modelled using TUFLOW's 2025 release (2025.2.2), which runs on a Graphic Processing Unit (GPU) using the Heavily Parallelised Compute (HPC) solver.

4.1 Extent

The 2D domain covers a total area of 41.8 km^2 split across two active areas. These active areas were defined by creating a 100 m buffer around each of the two catchments shown in Figure 2. The method for deriving these catchments is described above within section 3.1. The 100 m buffer ensures all surface water flows are captured.

4.2 Grid Size and Orientation

A 4m grid size has been adopted as this is sufficient to represent major flow pathways across the large, predominantly rural, catchments. The computational area for both catchments is aligned west to east as this is the dominant flow direction across both catchments.

4.3 LiDAR data

The topography of the study area is represented by 1 m resolution LiDAR data flown in 2022. This is considered adequate to represent the key flow routes across the catchment areas.

4.4 DTM Modifications

Existing buildings within the model domain have been represented within the model as both an increase in Manning's n value and a direct change to the DTM. Buildings were added into the model as a Z shape which instructs TUFLOW to increase the DTM by 300 mm, to represent the floor slab through which no flow can occur.

4.5 Boundary Conditions

The inflow boundary conditions for the model are the rainfall hyetographs as discussed in section 3 and Appendix 1, with the rural and urban land cover extents defined using OS mapping.

Outflow boundaries have also been used to allow water to leave the model domain when it reaches the boundary of the active area. Multiple 2D HQ boundaries have been added to the hydraulic model where flood waters would otherwise accumulate. Due to the inclusion of a 100 m buffer around the derived catchments, downstream boundaries have only been included within the model where the existing watercourses or their floodplains leave the model boundary.

The gradient of terrain at these locations was determined using 1 m LiDAR data and was used to set the 'b' value in the 2D boundary. All areas where the terrain gradient was calculated and applied to the boundary line can be seen in Figure 3, Figure 4, and Table 4.

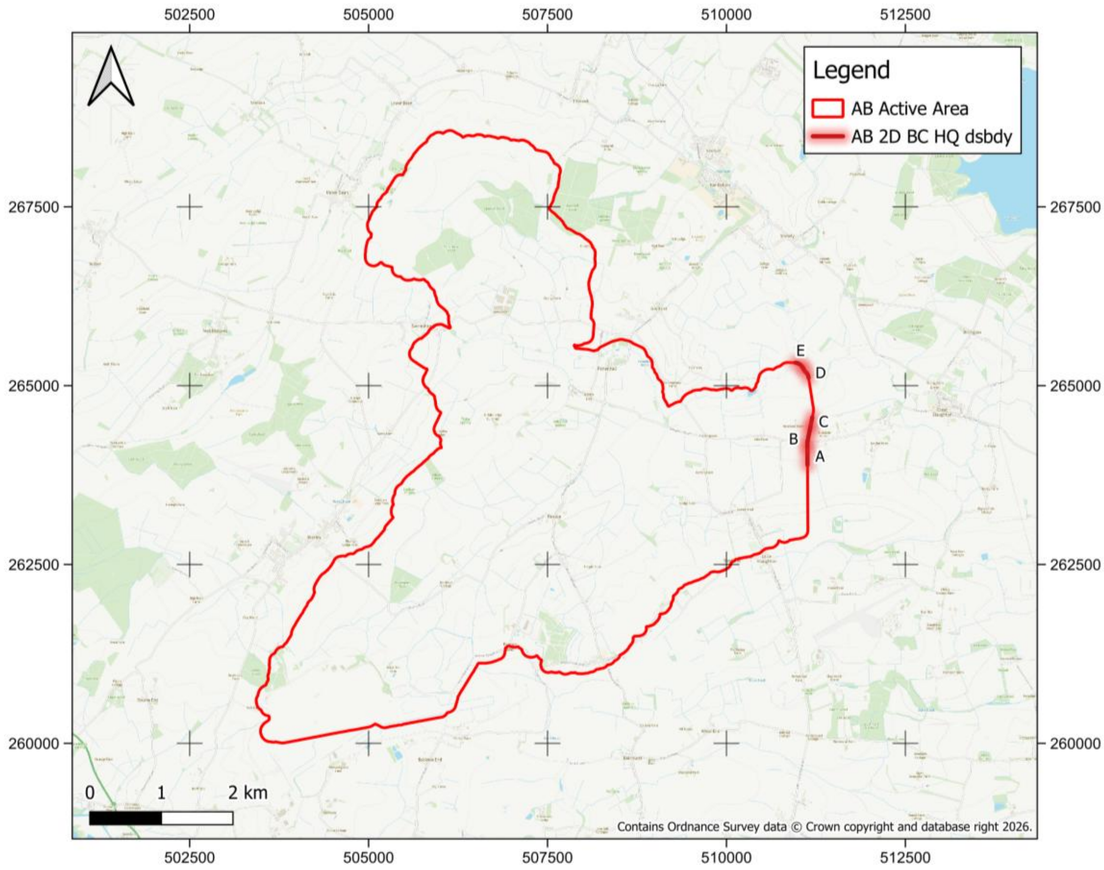


Figure 3 - 2D Downstream Boundaries – AB Catchment

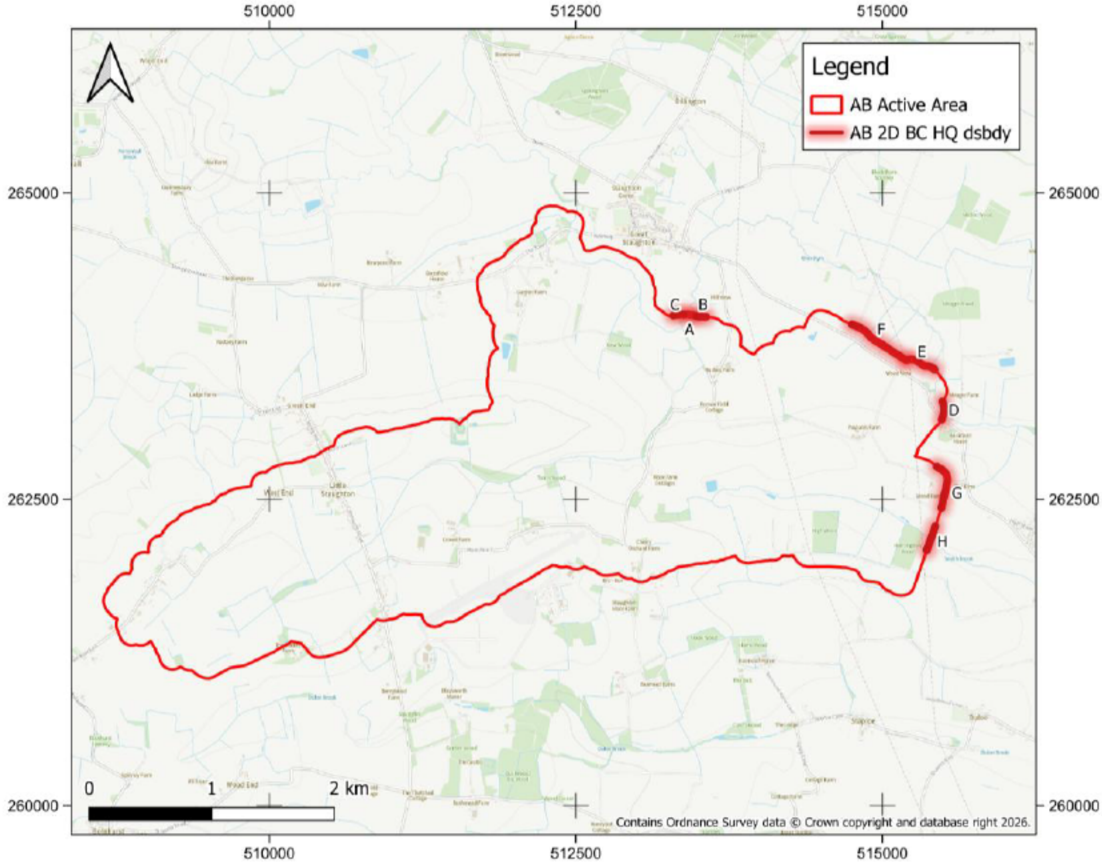


Figure 4 - 2D Downstream Boundaries – CD Catchment

Table 4 - Downstream Boundary Gradients

ID	Gradient (m/m)	
	AB Catchment	CD Catchment
A	0.0021	0.0071
B	0.0053	0.0500
C	0.0028	0.0057
D	0.0179	0.0070
E	0.0079	0.0067
F	-	0.0055
G	-	0.0917
H	-	0.0071

4.6 Sewer Losses

In line with the 2025 NaFRA2 New National Modelling[6], sewer losses have been applied at the default loss rate of 18 mm/hr. These losses have been applied to the model as a continuing loss of rainfall to urban surfaces. These sewer losses are defined in the .tmf file.

4.7 Surface Roughness

The floodplain roughness is defined using the Manning's n roughness coefficient, with the land use identified using OS mapping to define roads, buildings, forestry and grassland within the model domain.

2D material files contain an associated code which is referenced within a TUFLOW materials file, where they are assigned an appropriate roughness coefficient as detailed in Table 5.

With rural land cover the roughness value is known to be greater at shallow depths. As such, higher n values (n1) are specified when depths are below 100mm (y1). These are then linearly reduced (n2) as the flood depth increases (y2).

Table 5 - 2D Domain Surface Roughness Values

Mat_ID	Description	n	Initial losses	Continuing losses	y1	n1	y2	n2
1	Fields/Natural Land (pasture high grass)	0.035	0	0	0.1	0.4	0.4	0.035
2	Water Bodies	0.025						
3	Buildings	0.5	0	18				
4	Railway	0.04	0	18				
5	Roads	0.02	0	18				
6	Other Manmade Structures	0.5	0	18				
7	Woodland	0.1	0	0	0.1	0.4	0.4	0.100
8	Gardens	0.5	0	0	0.1	0.4	0.4	0.500
9	Stability	0.3						
10	Bushes	0.07	0	0	0.1	0.4	0.4	0.070
11	Driveways and paths	0.02	0	18				
12	Lawns	0.035	0	0	0.1	0.4	0.4	0.050

5 Design Runs

5.1 Summary of Design Runs

The pluvial model has been run for the following events:

- 3.3% AEP 1 hr, 3 hr, 6 hr, 9 hr, 12 hr, and 18hr (Summer)
- 1.0% AEP 1 hr, 3 hr, 6 hr, 9 hr, 12 hr, and 18hr (Summer)
- 1.0% AEP + climate change 1hr, 3 hr, 6 hr, 9 hr, 12 hr, and 18hr (Summer)
- 0.1% AEP 1 hr, 3 hr, 6 hr, 9 hr, 12 hr, and 18hr (Summer)

The climate change allowance has been applied based on the EA's guidance[8] for using peak rainfall intensity allowances to assess surface water flood risk. An upper end climate change allowance of 40% was applied for the Upper and Bedford Ouse Management Catchment.

Due to the size of the model domain, no single critical duration was identified for the design event (1.0% AEP +CC). Therefore, a model script was run within QGIS to create a maximum depth raster from all six durations for each design event.

5.2 Comparison of Modelled Results to EA Mapping

Figure 5 and Figure 6 show the modelled 1.0% AEP flood extents across the two model domains whilst Figure 7 and Figure 8 show the modelled 0.1% AEP flood extents. In all figures the results have been overlaid with the corresponding EA Risk of Flooding from Surface Water layer to provide a comparison between the two flood extents. To facilitate the comparison, the modelled extents have been filtered to remove all flood depths below 75 mm to mirror the national mapping[6].

Comparing the two mapped extents, shows close similarities in some locations and in others, the modelled extent is much larger. The areas where the modelled extent is much larger are predominantly associated with the watercourses in and around the site. Within the EA national surface water model significant watercourses which are modelled within the fluvial national model are removed through the addition of a drainage sump. This aims to reduce the overprediction of surface water flooding along fluvial floodplains[6]. Therefore, the areas within the model domain located in these drained areas, or those that are located downstream of them, are likely to show a greater area of inundation compared to the RoFSW mapping.

The greatest area of difference is located to the northeast of site sub-section D, see Figure 6 and Figure 8, associated with the convergence of multiple small watercourses.

[8] Flood Risk Assessments: Climate Change Allowances. Environment Agency. May 2022.

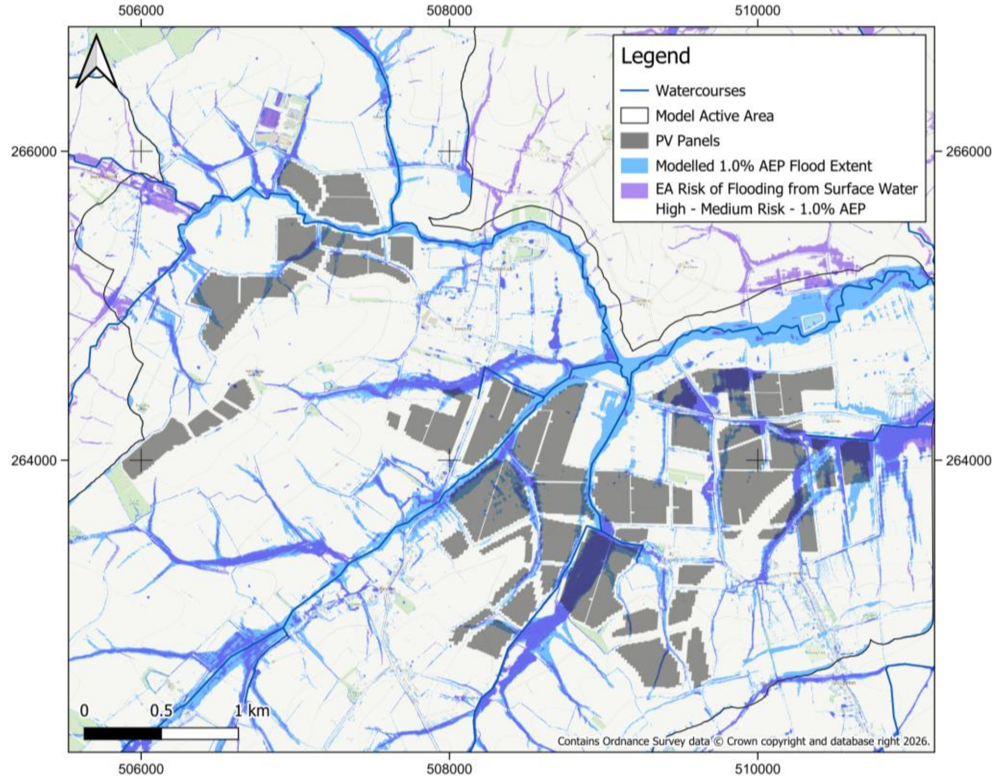


Figure 5 –1.0% AEP modelled results vs EA 1.0% AEP RoFSW extent – AB Model Area

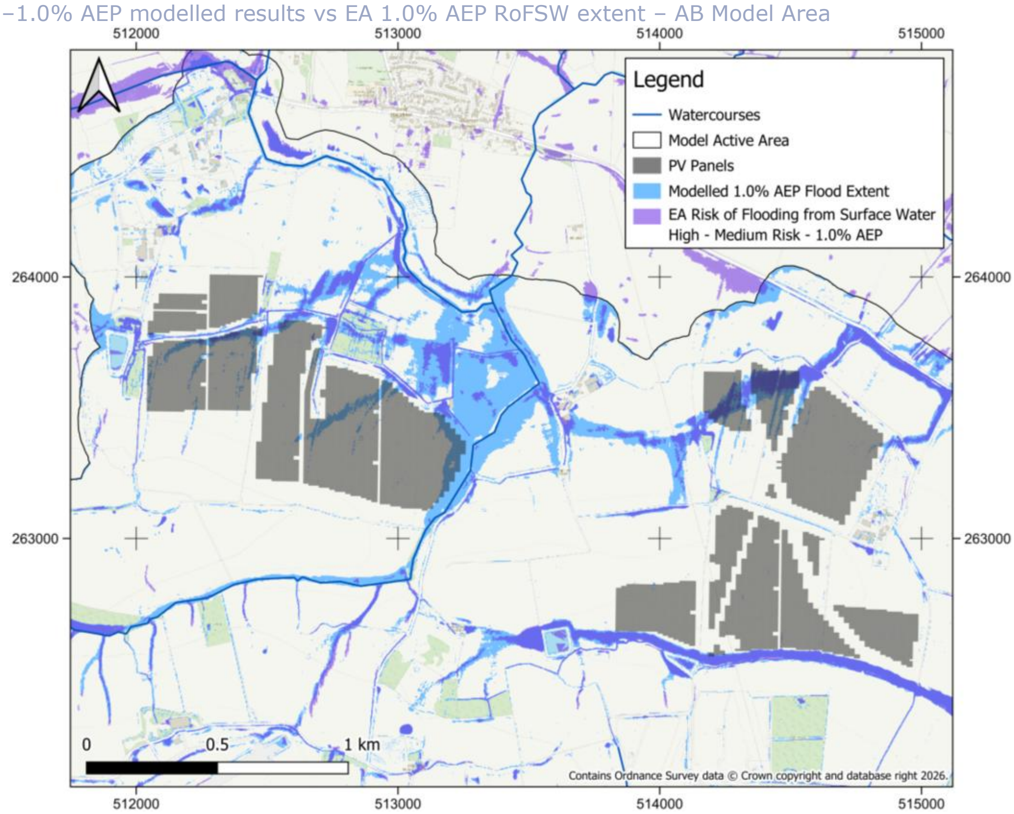


Figure 6 - 1.0% AEP modelled results vs EA 1.0% AEP RoFSW extent – CD Model Area

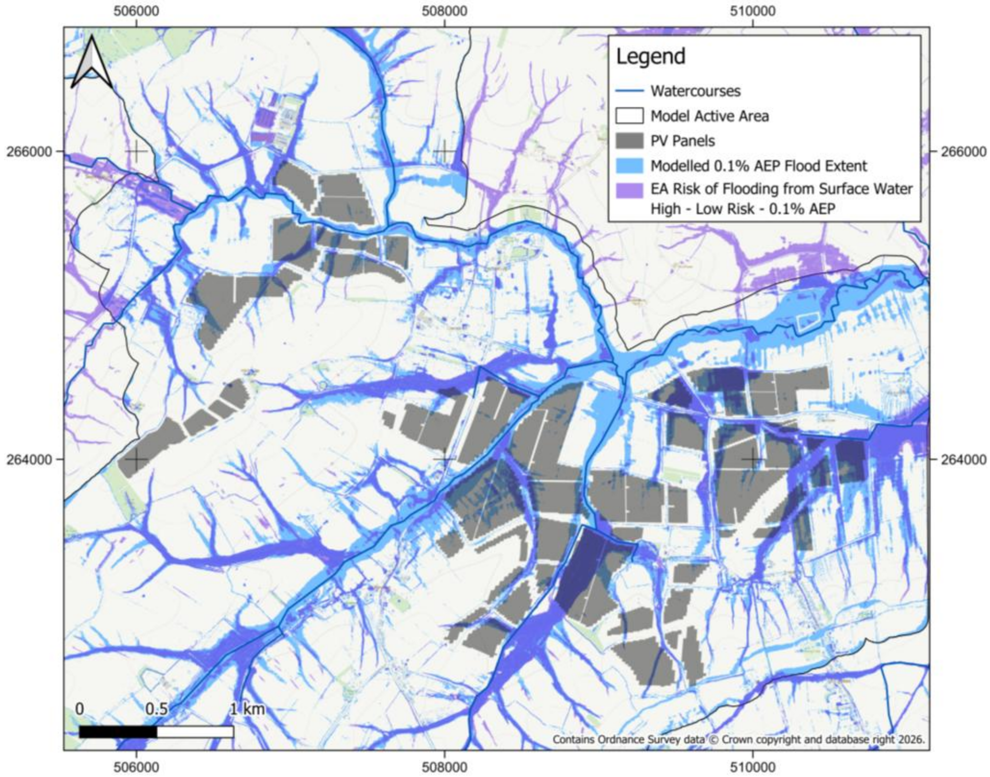


Figure 7 - 0.1% AEP modelled results vs EA 1.0% AEP RoFSW extent – AB Model Area

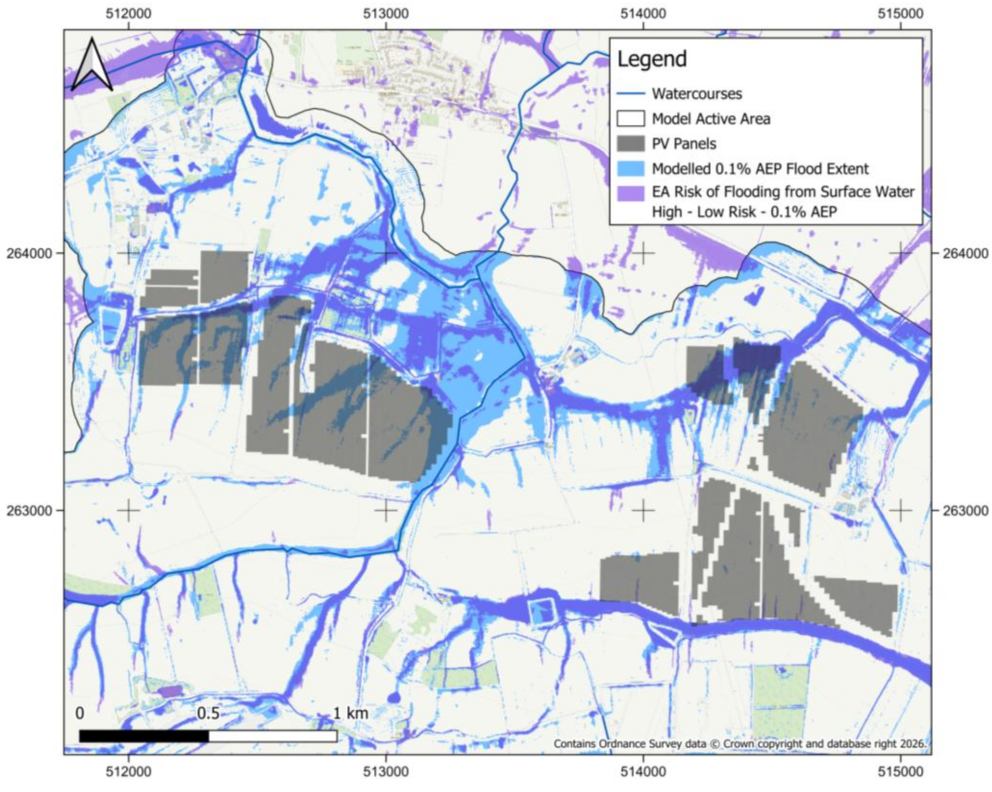


Figure 8 - 0.1% AEP modelled results vs EA 1.0% AEP RoFSW extent – CD Model Area

5.3 Maximum Modelled Flood Depths

Figure 9 and Figure 10 show the maximum modelled flood depths for model areas AB and CD respectively, for the 1.0% AEP event plus a 40% allowance for climate change. They show that flood depths outside of the watercourse channels and floodplains remain below 1 m. The maximum modelled flood depth within the panelled area is 0.9 m, associated with a depression in the topography bounded by higher land that results in flood waters building up over time. This area is located in the north of site sub-section B, between Great Staughton Road to the south and Little Staughton Road to the northeast (E: 509581, N: 264391). Within the area of the panels covered by the modelled flood extent, filtered by 75 mm, the average flood depth is 0.1 m.

The depth of flooding has been assessed at each solar array to identify any panels that require further raising above the standard 800 mm above ground level when considering a 300 mm freeboard, see Appendix 2. This was achieved by identifying the maximum modelled flood depth at each array and rounding the value up to one decimal place. For example, the maximum depth across the whole solar array is 0.903 m, therefore the depth value at those panels was rounded up to 1.0 m. A 300 mm freeboard was then applied to these values to produce the final required panel heights above ground level, with the maximum height being 1300 mm. Appendix 2 highlights that the majority of the proposed solar array achieves a 300 mm freeboard with the standard 800 mm height and that the panels requiring raising above this are concentrated within the northern section of site sub-section B.

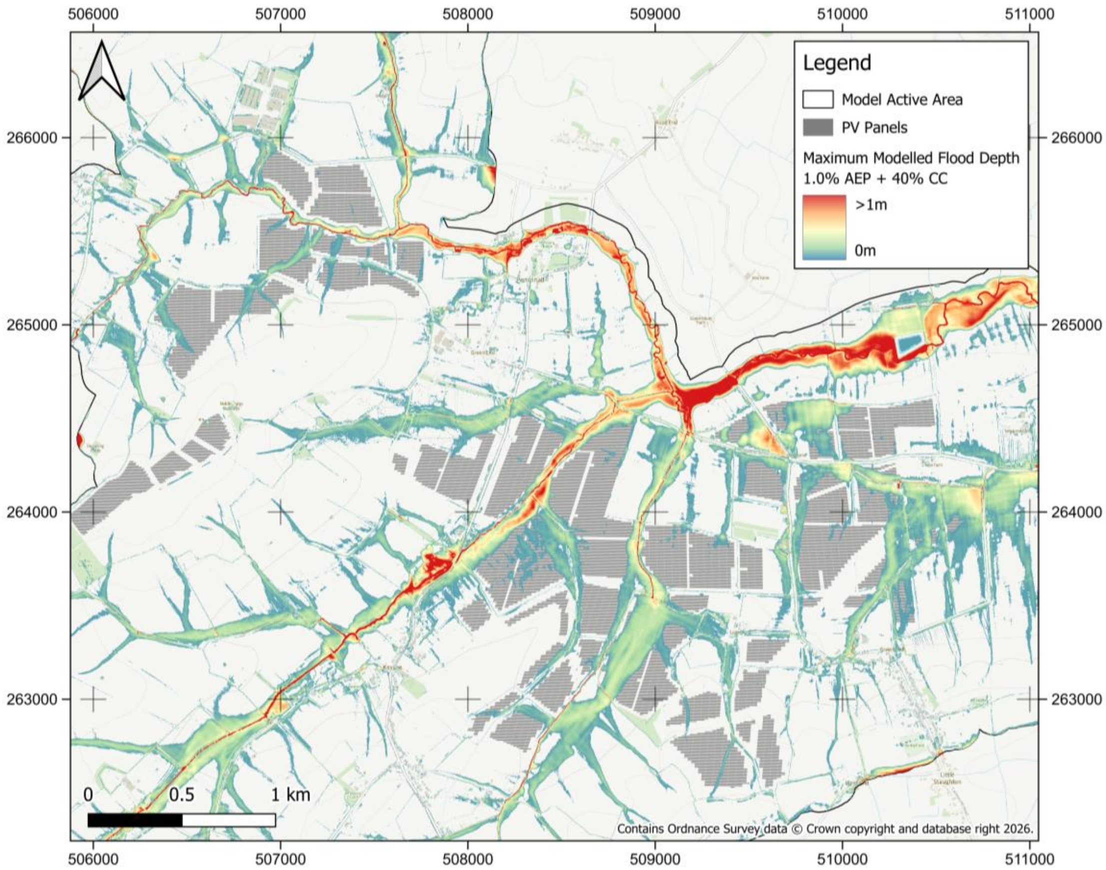


Figure 9 - 1.0% AEP +40% CC Maximum Modelled Flood Depth - AB Model Area

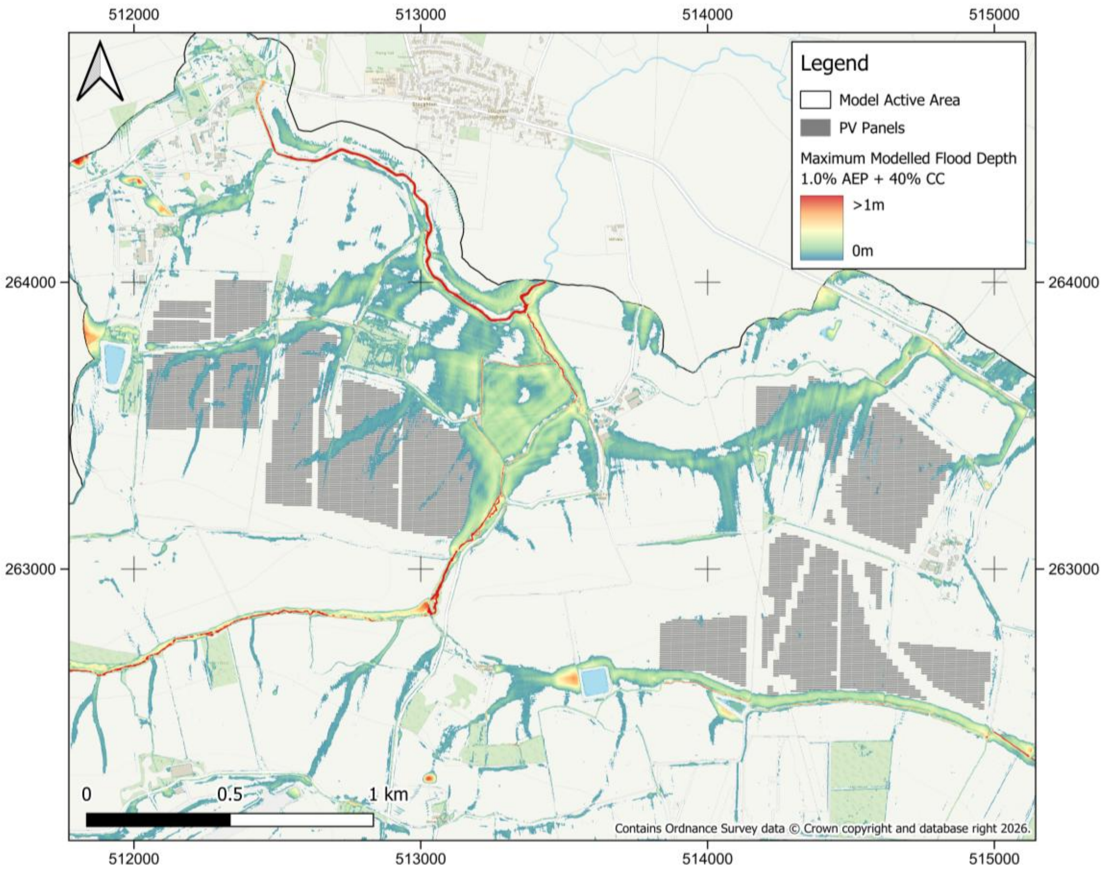


Figure 10 - 1.0% AEP +40% CC Maximum Modelled Flood Depth - CD Model Area

6 Post-Development

6.1 Model Build

The solar panels were implemented into the model as a post-development scenario. The panels will be raised on supports so that the lower edge of the panels are positioned at least 0.8m above the ground, meaning that flooding is only likely to be influenced by the panel legs and foundations.

6.1.1 Representation of panel supports using piled foundations

Within those areas where archaeological protection measures are not required (i.e. panel frames are supported by piled upright supports) the panel supports have been included in the model using a layered flow constriction layer (2d_lfcsh). Though consideration was given to modifying the underlying DTM to explicitly represent each support, this approach was deemed inappropriate due to the small size of the supports relative to the model grid resolution.

To represent the supports as a flow constriction layer, two key attributes are required – the Form Loss Coefficient (FLC) and Blockage Fraction (J) associated with the supports. The FLC used for the post-development scenario was derived using the method for applying losses from Hydraulics of Bridge and Waterways[9], which uses the width of the supports normal to the flow. Calculations of blockage were based on the number of supports in each block of solar panels. Each panel block was split longitudinally into two halves, one half represented the front supports and the other half represented the back supports. The procedure set out in Hydraulics of Bridge and Waterways applied to derive the FLC is outlined below:

1. The width of the supports was taken as 110mm, as this is the width of the longest side of the rectangular posts, the design of which was outlined in Figure 2-3a of the East Park Energy PEIR document.
2. The flow width was calculated based on the length of each panel block.
3. The blockage width of the supports (leg width multiplied by the number of legs in a panel block) and the flow width were used to calculate the blockage fraction (J value).
4. Using the Hydraulics of Bridge and Waterways chart (Figure 6) and assuming a series of square shape supports, the FLC (ΔKp) was determined.

Table 6 - Parameters to derive FLC

Parameter	Description	Value
b	Total flow assessed on a span-by-span approach/ total width per large panel block	5m/40m
W_p	Support width normal to flow single leg/support width normal to flow per panel block (8 legs)	0.11m/0.88m
J	Blockage fraction (b/W_p)	0.022 (2.2%)
Δkp	FLC (from graph based on J value)	0.0958

[9] Hydraulics of Bridge and Waterways. Hydraulics Design Series No. 1. Bradley, J. 1978.

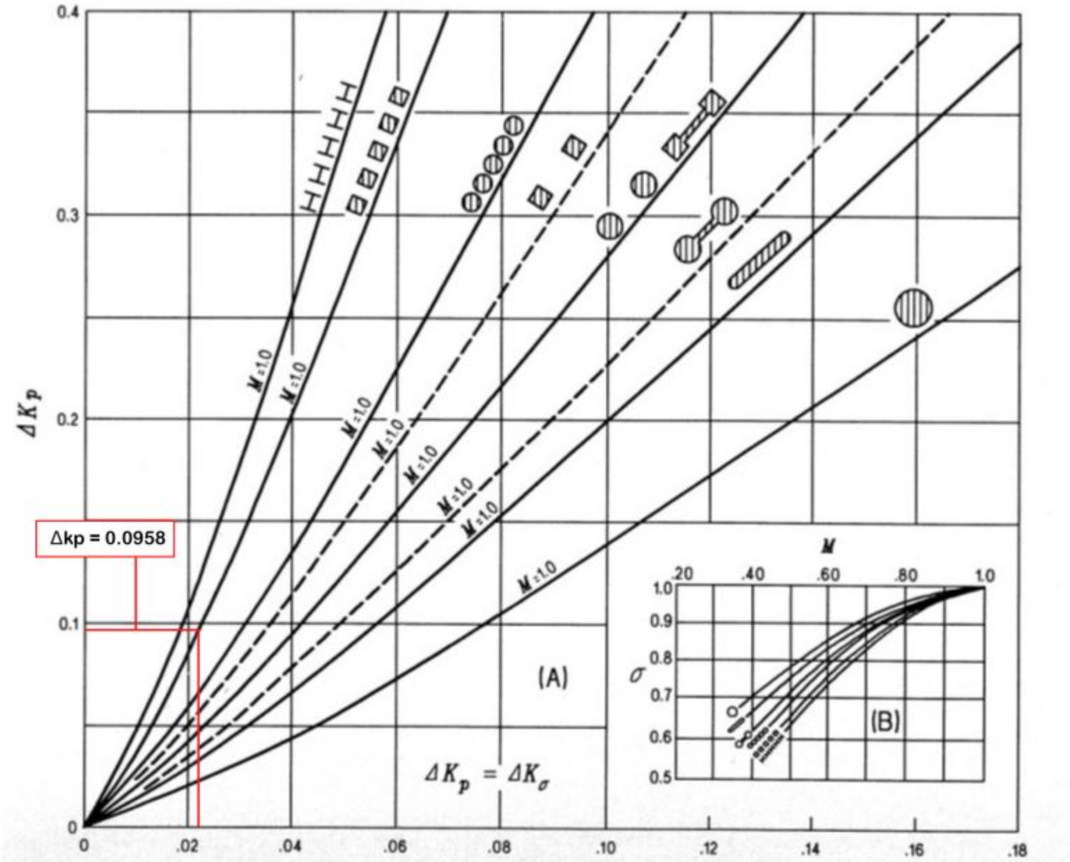


Figure 11 - Method to derive FLC, Hydraulics of Bridge and Waterways[9]

Only layer one of the flow constriction layer is used. The panels have been designed so that they are flood free for all events, therefore applying blockage to account for the panels using layer two is not necessary. The panels are designed to be positioned above the 100-year +CC with an additional 300mm freeboard, meaning flood waters will not reach the main panel body, and therefore the main panel body does not require representation in the model.

The cell size of the post-development model was also reduced from 4m to a maximum size of 2m, this allows for each row of supports to be represented independently in the model and allows for a more granular assessment of impacts. To ensure a like for like comparison the baseline was also re-run using a 2m grid.

Some uncertainties were encountered when deriving the FLC. The choice of a series of square shape supports used to derive Δkp is the most noteworthy uncertainty. Choosing this pier type is a conservative estimate of flow losses, any alternative appropriate pier type would result in a reduced Δkp value. Due to the conservative assumption made when defining Δkp, further refinement of the risk posed by the panels would likely result smaller impacts.

6.1.2 Representation of panels supported on concrete footings

Where panels are located within areas of archaeological constraints (see Table 1, also Figures 1 and 2 of the outline Archaeological Mitigation Strategy), non-intrusive surface-mounted pre-cast concrete ground anchors have been proposed. An indicative cross-section drawing of these is shown in ES Vol 3, Figure 2-2 (Indicative Engineering Drawings P01). Specification of these concrete footings will be confirmed during detailed design, however for the purposes of this hydraulic assessment, a conservative estimation of their size has been assumed, given in Table 7.

Table 7 Concrete footing dimensions

Length	Width	Height
2.5 m	0.5 m	0.4 m

As for the pilled supports, these footings are spaced 5 m apart under the panels. Because of the larger size of these features relative to the piled frame supports, it was considered appropriate to represent these features as topographical adjustments within the model DTM. In this way, their impacts upon both floodplain storage and conveyance can be assessed. This required cell sizes to be refined in these areas. This was achieved through use of a quadtree mesh, to reduce cell sizes from 2 m to 0.5 m (a quadtree mesh level of 4).

For areas where concrete footings were proposed, a thick z-line was then used in the post-development scenario to provide an elevation adjustment to the affected cells. Digitising a z-line length of 2.5 m and using the 'Thick' Tuflow command, resulted in a row of 0.5 m cells being raised 0.4 m above existing ground levels. The lines were spaced at 5 m intervals along the centreline of the panels. This representation of concrete footings in the post-development model is illustrated in Figure 12.

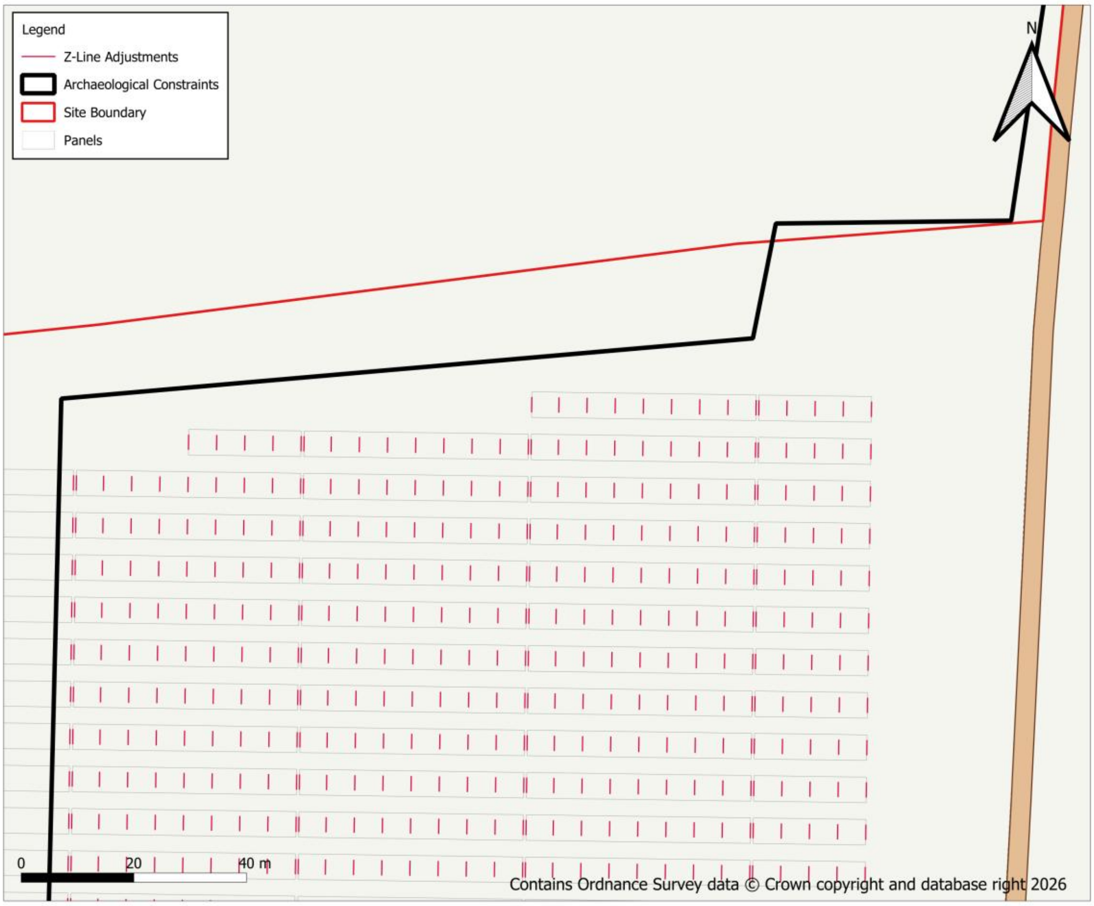


Figure 12 Representation of concrete footings by use of thick z-lines

6.2 Results

Figure 13 and Figure 14 show the modelled maximum flood depths for the 1.0% AEP plus climate change design event for the post-development scenario in the AB and CD model areas, respectively. These results show similar risks to the baseline, indicating that the panels are causing minimal impacts to the flood regime.

The depth change plots shown in Figure 15 and Figure 16 reflect this, they show that the vast majority of the site is not impacted by the proposed concrete footings and supporting legs. The only areas of detriment shown by the modelling are located:

- North of Site A (approximately E: 507077, N: 265318), which shows a very localised detriment around the upstream faces of the concrete footings used in this area. This detriment extends no further than 4 m from the panelled area and merely reflects the interruption of the shallow surface water flow path in this region. The detriment is at least 20 m from the Order Limits.
- West of Site B (approximately E:508220 N:263892), which shows a maximum of 42 mm detriment. This detriment likely occurs because of a flow route that runs below the panels in this location. It is expected that flow constriction has a more pronounced effect here because this flow route has a higher velocity compared to the other flow routes under the panels. Head loss is a

function of velocity and therefore in areas of higher velocity a greater head loss will occur. This detriment is acceptable as it remains wholly within the site boundary.

- North-east of Site B (approximately E: 509854, N: 264175), which shows minor areas of detriment up to 12 mm depth increase upstream of concrete footings.
- There are areas of scattered detriment within Site C, however these are limited to a only few cells (generally no more than 10 m for each cluster and affect only fields within the Order limits).
- North-west of Site D (approximately E: 514230, N: 263481.54), which shows a very localised area of detriment around the upstream faces of the concrete footings. This detriment extends no further than 7 m from the panelled area and merely reflects the interruption of a shallow surface water flow path in this region. The detriment is at least 40 m from the Order Limits.

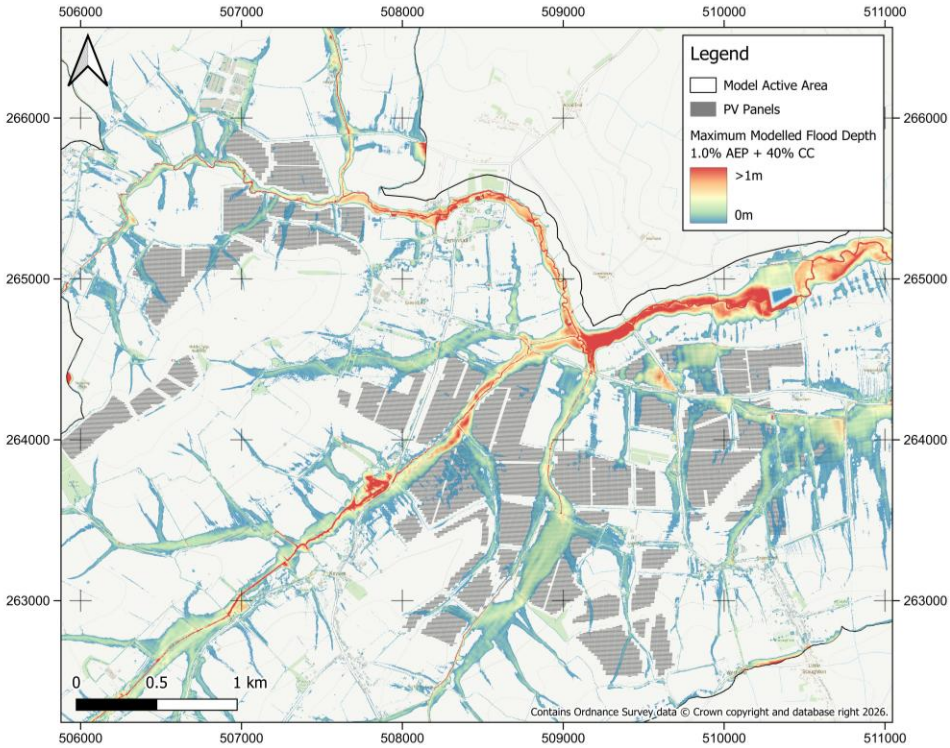


Figure 13 1.0% AEP +40% CC post-development model results - AB model area

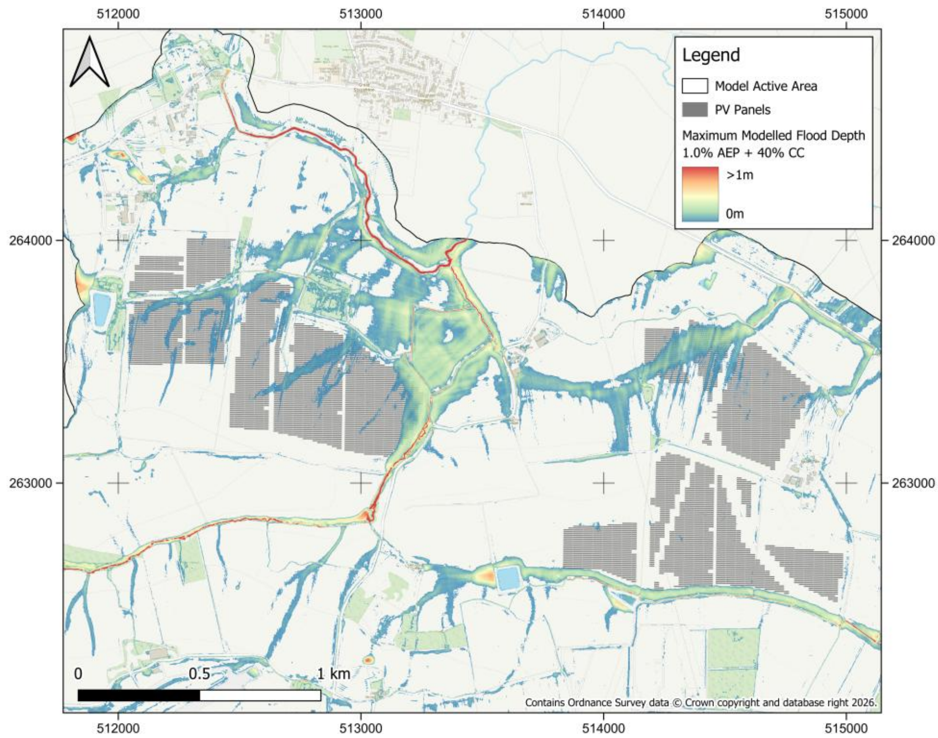


Figure 14 - 1.0% AEP +40% CC post-development model results - CD model area

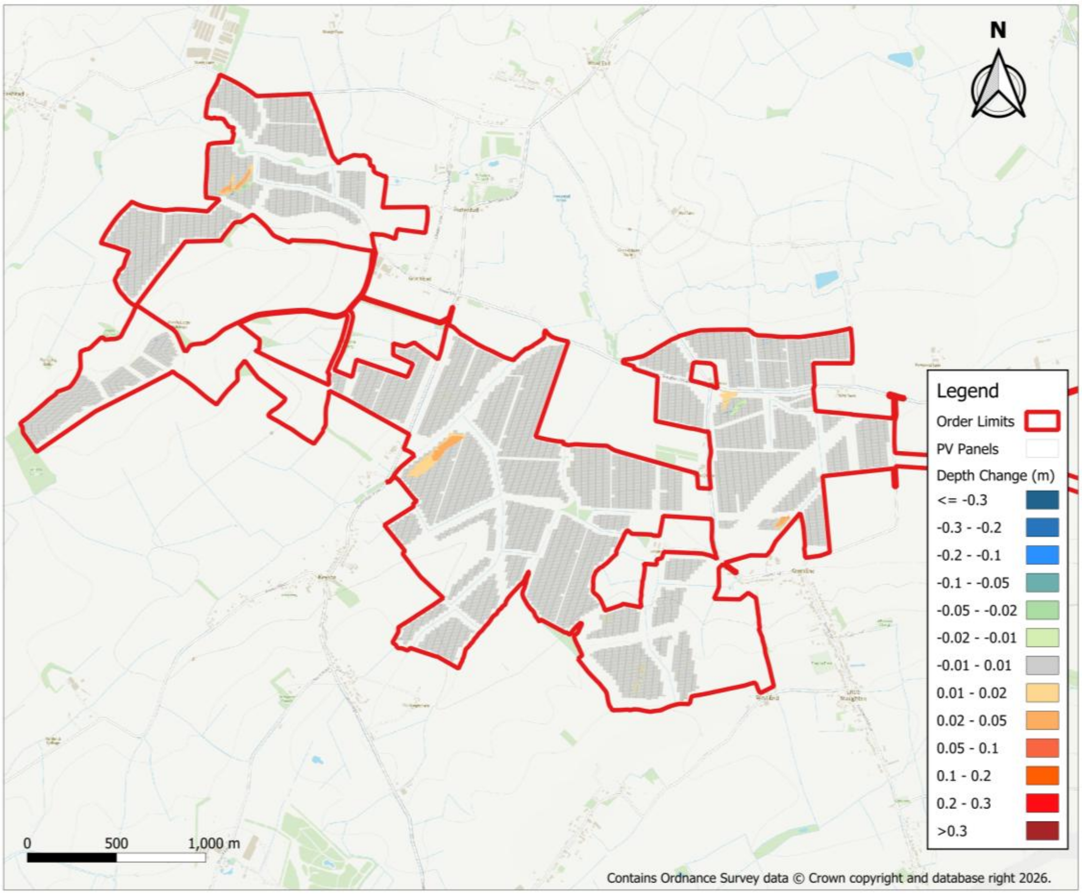


Figure 15 - 1.0% AEP +40% CC depth change analysis - AB model area

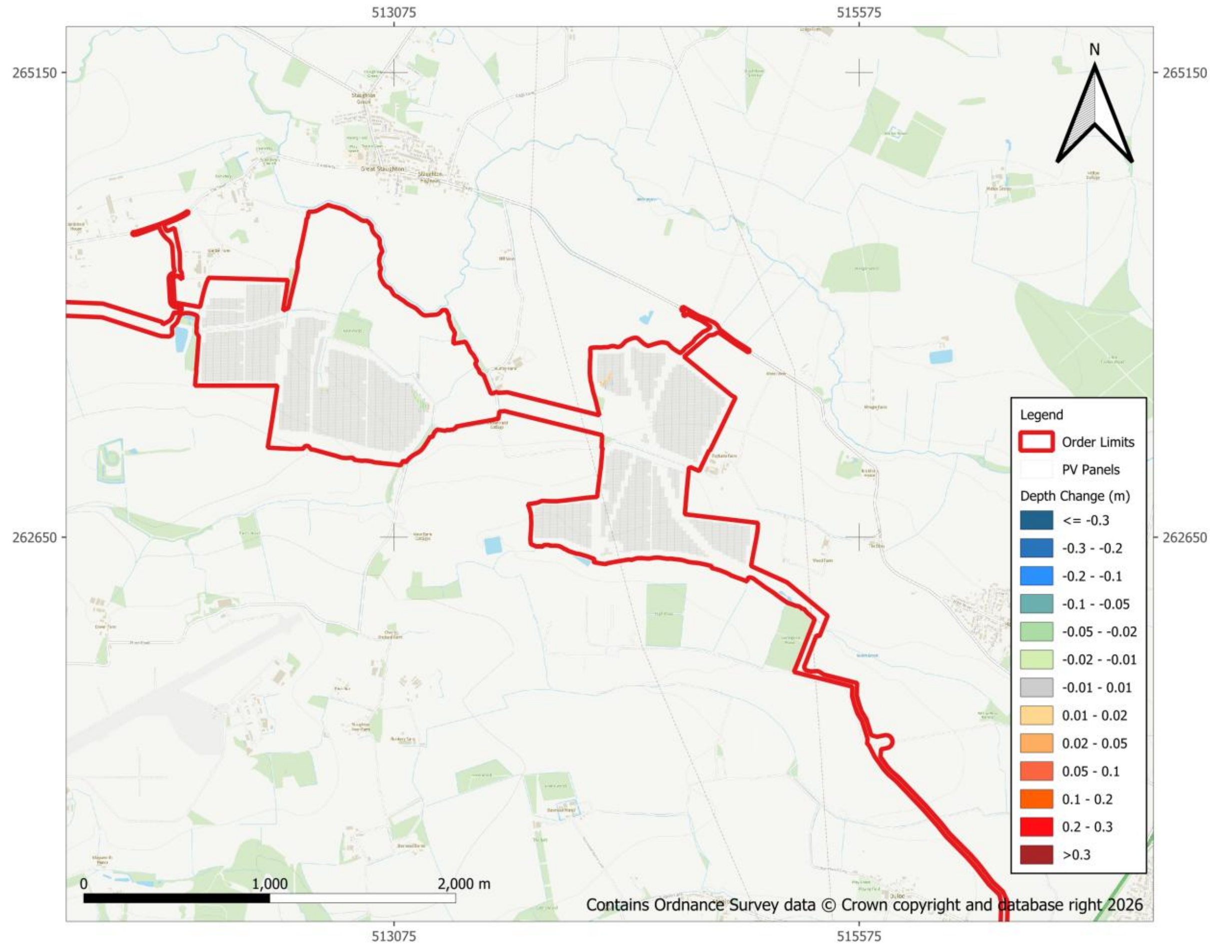


Figure 16 - 1.0% AEP +40% CC depth change analysis - CD model area

7 Sensitivity Analysis

Sensitivity analysis has been carried out on the 1.0% AEP +40% CC (6hr duration) event on the following parameters:

- *Manning's n value* – roughness coefficients for the floodplains have been increased and decreased by ± 20%.
- *Rainfall input* – the sensitivity of the model to changes in rainfall has been assessed by comparing modelled flood depths during the 1.0% AEP and 1.0% AEP +40% CC 6-hr duration events.

The results of the sensitivity analysis have been assessed at key points within the model domain. The sensitivity sample point locations are shown in Figure 17.

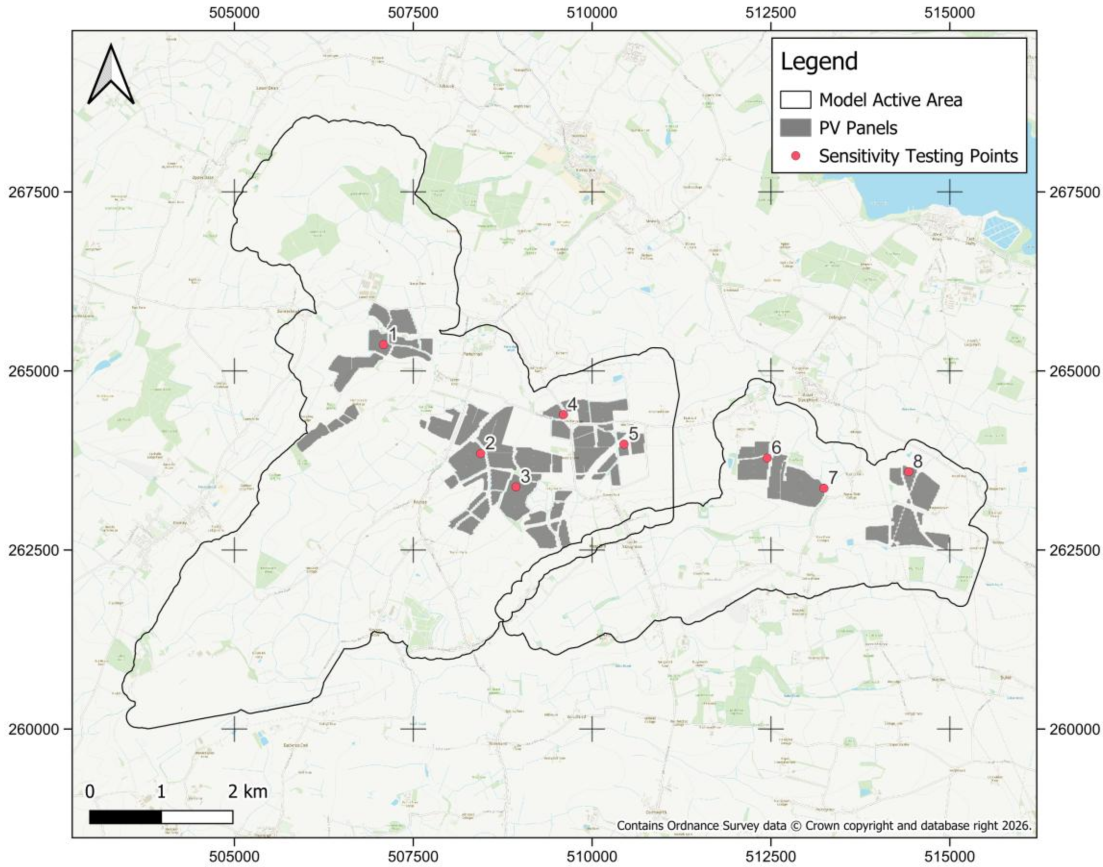


Figure 17 - Sensitivity Testing Points

7.2 Manning's N Value

The results of the sensitivity analysis on the roughness of the floodplains are shown in Table 8 below.

Table 8 - Manning's n value sensitivity analysis

Sensitivity Points	1.0% AEP +40% CC Depths (m)	SEN(N+) (m)	Difference (m)	SEN(N-) (m)	Difference (m)
1	0.203	0.210	+0.007	0.192	-0.011
2	0.166	0.171	+0.005	0.159	-0.007
3	0.334	0.342	+0.008	0.324	-0.010
4	0.893	0.892	-0.001	0.895	+0.002
5	0.206	0.212	+0.006	0.199	-0.007
6	0.197	0.203	+0.006	0.189	-0.008
7	0.327	0.331	+0.004	0.322	-0.005
8	0.223	0.229	+0.006	0.217	-0.006

As indicated above, there is generally a direct positive correlation between the modelled flood depths and the applied roughness coefficient for the floodplains and the structures, with flood depths increasing as the n values are increased and vice versa except at sensitivity point 4.

The observed deviation from the expected results at sensitivity point 4 is potentially because of the increased roughness forcing flows to seek alternate, lower-resistance flow paths. Similarly, the decreased floodplain roughness reduces resistance to flow, allowing water to move more directly to point 4 leading to higher flood depths. As point 4 is located within a depression in the topography it is likely to be impacted by these slight changes to flow routes. However, the general variations between the flood depths for the baseline and varied n value scenarios show acceptable sensitivity to changes in roughness.

7.3 Rainfall Input

The results of the rainfall sensitivity analysis are shown in Table 9 below.

Table 9 - Rainfall input sensitivity analysis

Sensitivity Points	1.0% AEP Depths (m)	1.0% AEP + CC Depths (m)	Difference (m)
1	0.165	0.203	+0.038
2	0.133	0.166	+0.033
3	0.284	0.334	+0.050
4	0.868	0.893	+0.025
5	0.158	0.206	+0.048
6	0.157	0.197	+0.040
7	0.270	0.327	+0.057
8	0.177	0.223	+0.046

The sensitivity analysis results show a direct positive correlation between the modelled flood depths and the applied rainfall depths, with flood depths increasing as the applied rainfall depth increases. The observed variation between the two events is within the expected range.

8 Model Stability and Limitations

8.1 2D Model Stability and Limitations

One of the main indicators of model stability with the HPC solver is the timestep selected by TuFLOW. This has been reviewed and plotted in Figure 18 for the 1.0% AEP plus climate change 18-hour duration event.

It is recommended that the timestep should not be less than one-tenth of the timestep that would have been used with the classic solver. For this model, a timestep of between 2.0 and 0.8 would have been selected for a grid resolution of 4m, hence a healthy HPC timestep would be between 0.2 and 0.08 seconds. The plot of the evolution of the 2d timestep (dtStar) indicates that the timestep does not drop below 0.08 for the duration of the simulation.

In addition to the 2d timestep, there are three control numbers which must be satisfied:

- A Nu value of 1.0 or greater indicates that the velocity is unusually high, or the cell size is too small or the modelled velocity.
- A Nc value of 1.0 or higher can be caused by large depths in relation to the cell size.
- A Nd value of 0.3 or higher could suggest there is a poor boundary setup or insufficient SX cells linked to the 1D structure, or the cell size is too small.

The Nu and Nd parameters lie within the acceptable values for the duration of the model run. The Nc value stays at 1.0 for the entire simulation and a review of the outputs shows this is likely due to the high depths at the centreline of the watercourses. To compensate for it reaching its limit, TuFLOW reduces the model time step. As the time step remains at an acceptable value throughout the simulation, the model is considered to be stable.

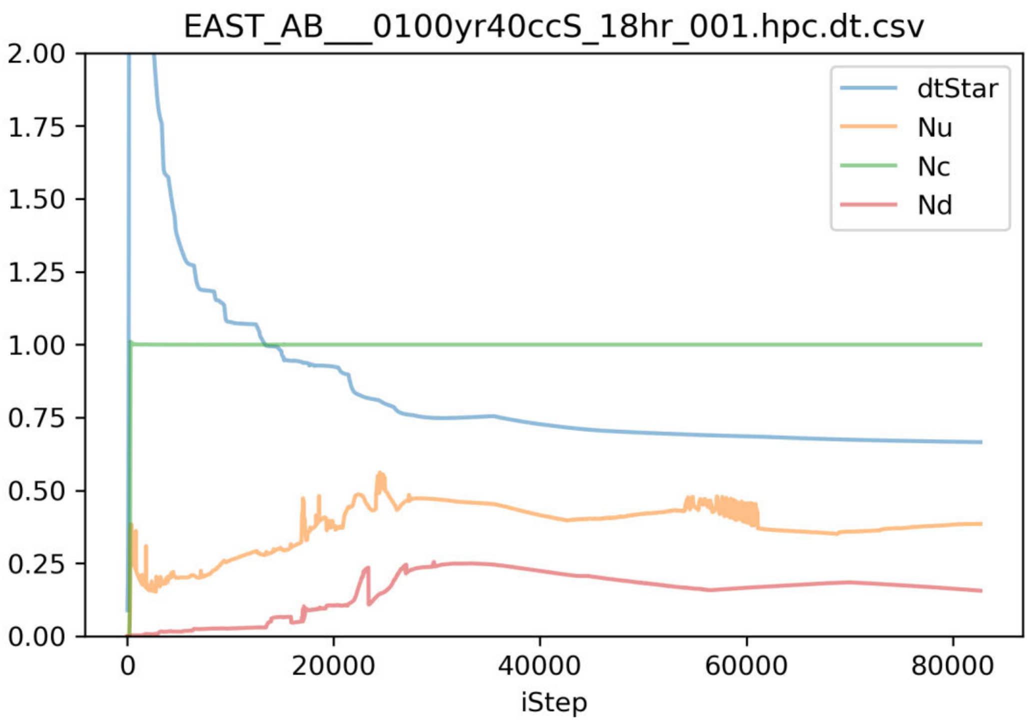


Figure 18 - Model Stability Indicators

8.2 Checks and Warning Messages

A number of Check and Warning messages are present in the TUFLOW log file upon completion of the model runs, which are summarised in Table 10. These have been reviewed, and they are all considered to be acceptable.

Table 10 - TuFLOW check and warning messages

ID	Count	Description	Comment
Check 2583	8	Material ID 1 contains a manning's n value (0.400) greater than Wu n limit (0.100) - n value will be limited in Wu formulation	Values have been reviewed and are considered acceptable.

9 Conclusion and Recommendations

This report has detailed the methodology used to produce a pluvial hydraulic model for the proposed East Park Energy Solar Farm with the aim to produce higher resolution depth maps for the panelled areas.

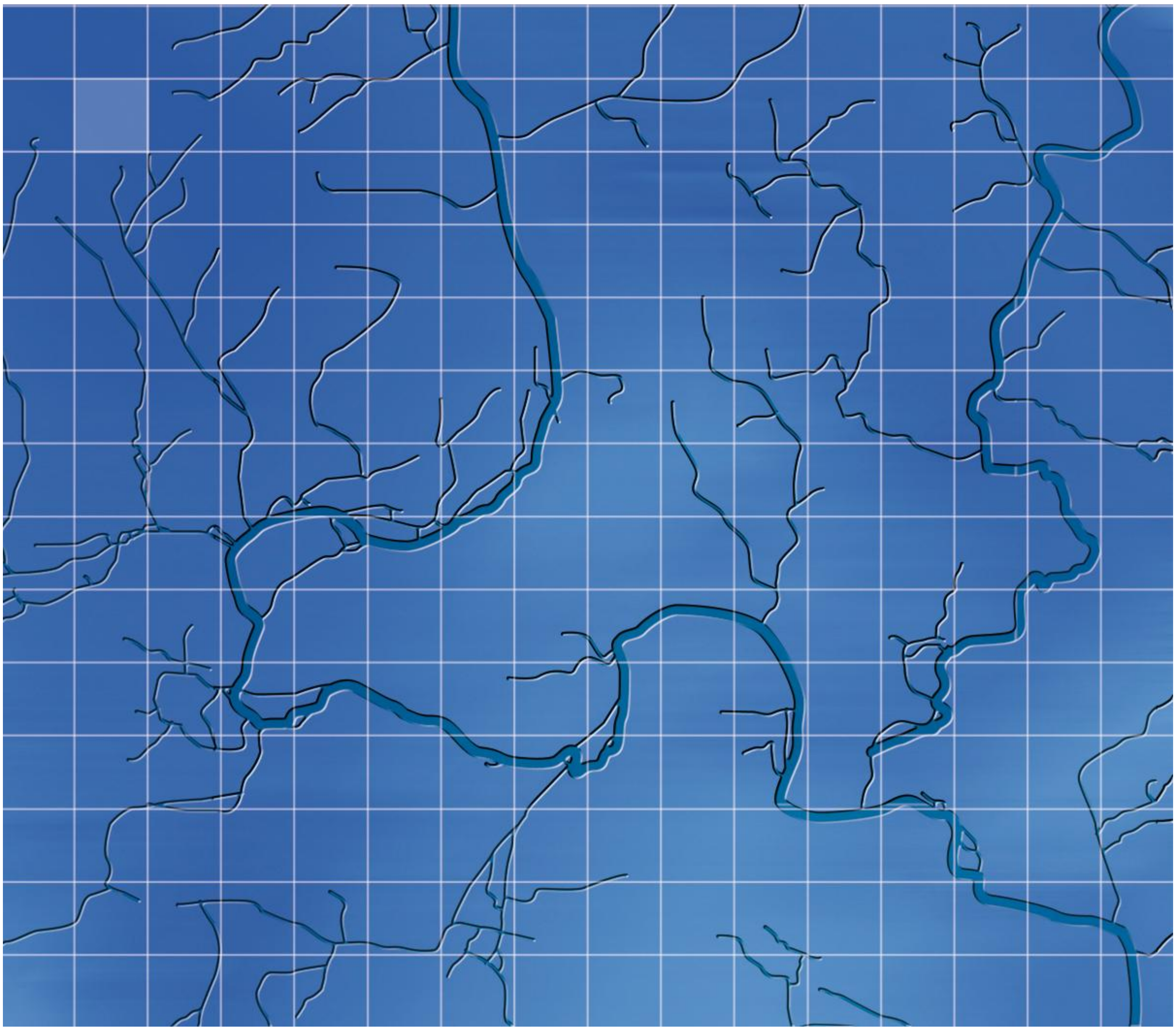
- Two model areas were defined to ensure that all the rainfall which may have an impact on the site is accounted for in the assessment. Rainfall estimates were produced for both catchments including a 40% allowance for climate change, relating to the upper end allowance for the 2070s epoch.
- The modelled results show a greater extent of flooding than the current EA mapping as the Risk of Flooding from Surface Water maps remove the impacts of main rivers with the use of a drainage sump. The maximum flood depth within the panelled area during the 1.0% AEP +40% CC design event is 0.9 m associated with a depression in the topography.
- A small number of panels will require raising above the standard 800 mm height to provide a 300 mm freeboard above the maximum modelled flood level. These panels are concentrated within the northern section of site sub-section B and are highlighted within Appendix 2. The maximum required panel height is 1300 mm.
- The post-development modelling scenario shows that the constriction caused by the panel legs and use of concrete footings in areas of archaeological constraint, has no impacts outside of the site boundary and minimal impacts within the site boundary.
- A sensitivity analysis completed on the baseline hydraulic model for manning's n and rainfall values, indicates that the model is acceptably sensitive to changes in these parameters. Therefore, the model is deemed suitable to inform flood depths within the site boundary.
- A review of the model stability and checks and warning messages indicates that the model is stable and suitable for use.

Appendix 1 – Pluvial Assessment for East Park Energy

Axis

February 2026

Pluvial Assessment for East Park Energy



Wallingford HydroSolutions Limited

www.hydrosolutions.co.uk

Axis

Pluvial Assessment for East Park Energy

Document issue details

WHS 1967

Version	Issue date	Issue status	Prepared By	Approved By
1.0	25/02/2026	Draft	[redacted]	[redacted]

For and on behalf of Wallingford HydroSolutions Ltd.

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Contents

1 Introduction

In order to refine the pluvial flood risk at the East Park Energy project (NGR: 511358, 263877), Wallingford HydroSolutions have been commissioned by Axis to undertake detailed pluvial modelling of the surrounding pluvial catchments to refine the assessment of pluvial flood risk to the proposed panel layout at the site.

2 The Catchments

The site lies near several watercourses including the River Kym, approximately 4 km upstream of its confluence with the River Great Ouse. Due to the scale of the proposed development, two catchments have been defined which cover site subdivisions A and B, and C and D respectively. As this is a pluvial flood model, rainfall hyetographs are required for both catchments as input into the 2d domain.

The catchments were predominantly defined using the EA detailed watersheds layer which is part of the overland flow pathways dataset[1]. These initial catchments were then updated to remove areas over 300 m downstream of the panelled area, and areas on the opposite bank of the Pertenhall Brook and River Kym to the proposed development. These areas were determined to not have an impact on pluvial flood risk to the site and so were removed to reduce the computing power required to run the model as the catchment derived is also used to define the active area within the model domain. This approach still ensures that all the rainfall which may have an impact on the site is included in the assessment. The overall size of the AB catchment was determined to be 28.8 km^2 and the CD catchment was determined to be 10.5 km^2, see Figure 1.

Using OS MasterMap data, the catchments are split into distinct urban and rural areas, with the rainfall calculated separately for each. Both catchments are underlain by a bedrock of mudstone (Oxford Clay Formation), however notable variations in the superficial deposits are present within both catchments with glacial till in the headwaters of the catchments, and alluvium and river terrace deposits close to the main river channels. Given these variations and the size of the catchments it was not considered appropriate to use point data from the catchment centroid. Instead FEH catchment data (from the closest matching available catchments) was extracted from the FEH Web Service[2]. The FEH catchments selected cover a similar extent to the pluvial catchments derived and are thought to better represent the geology (BFIHOST19), rainfall (SAAR) and soil wetness (PROPWET) used when estimating the rainfall hyetographs.

Table 1 provides information about the final descriptors used within the rainfall estimates, and the catchment areas are shown in Figure 1.

Table 1 – FEH Catchment descriptors

Descriptor	AB Catchment	CD Catchment
BFIHOST19	0.305	0.314
PROPWET	0.24	0.24
SAAR6190 (mm)	588	559

[1] Environment Agency (2025) *Overland Flow Pathways.* https://www.data.gov.uk/dataset/c9dd994d-9649-4041-96d4-cdc0f1a53152/overland-flow-pathways
[2] UK CEH (2026) *Flood Estimation Handbook Web Service.* https://fehweb.ceh.ac.uk/Map

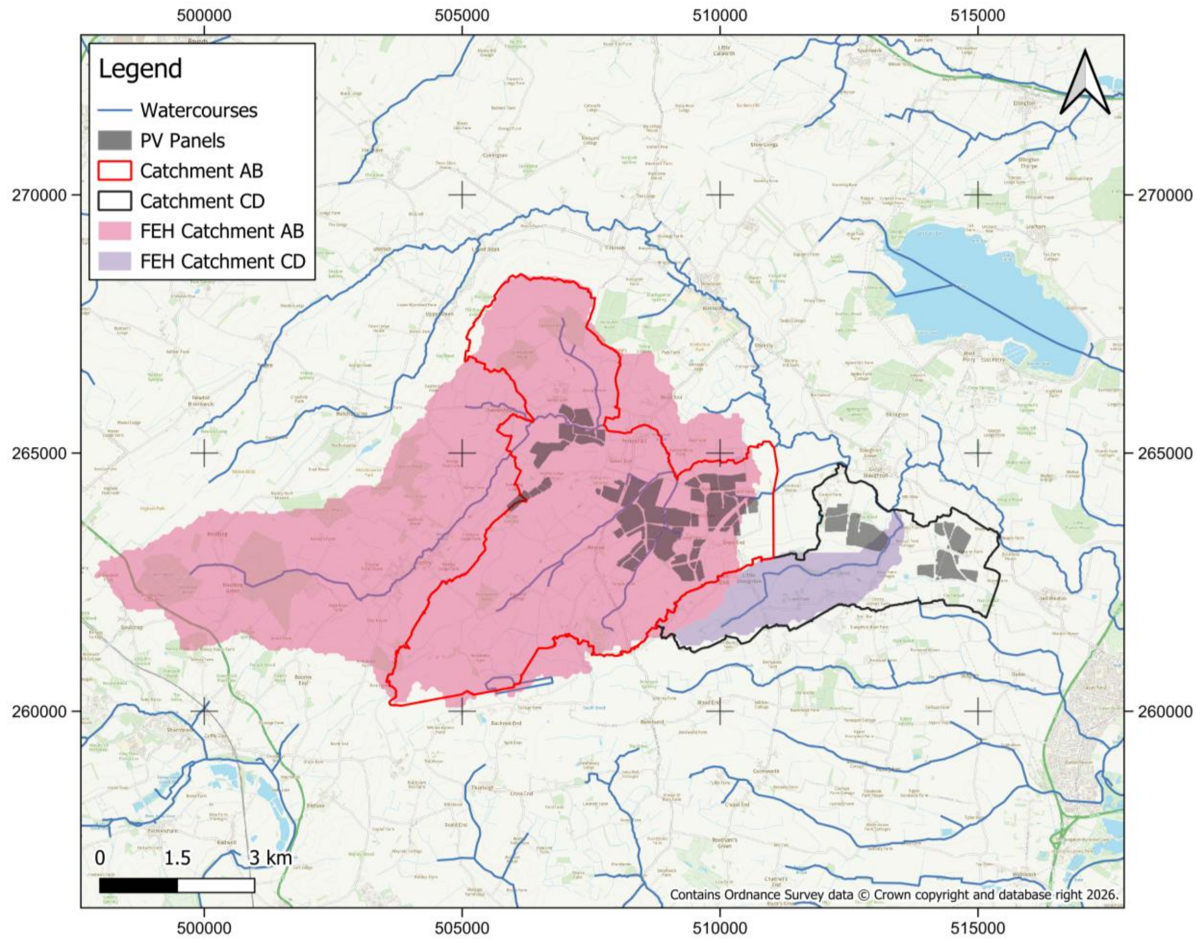

Figure 1 – Pluvial catchments

3 Outline Methodology

3.1 Rainfall Data

Catchment FEH22 DDF rainfall was obtained from the FEH Web Service at the same location as the catchment descriptor data. The rainfall model is produced at a 1km resolution.

3.2 Derivation of Net Urban & Rural Runoff

Separate parts of the model domain were defined as being urban or rural using OS MasterMap to allow separate urban and rural input rainfall hyetographs to the hydraulic model.

The ReFH2.3 software was used to derive the hyetographs. The rainfall-runoff methods underlying ReFH2.3 are those first published by Kjelsden[3], which were subsequently updated in 2015 and 2019 and implemented within the software as described in the WHS technical guidance[4].

ReFH2.3 uses the catchment descriptors to calculate loss parameters, which are used to derive net rainfall. Three assumptions were adopted:

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[3] Kjeldsen, T. R. 2007. The revitalised FSR/FEH rainfall-runoff method. Supplementary Report No.1. CEH.
[4] https://www.hydrosolutions.co.uk/software/refh-2/

- Rainfall, infiltration and other losses are modelled in ReFH2
- The resulting Net rainfall (runoff) estimate by ReFH is applied to the 2d model domain
- Sewer losses are modelled in TUFLOW rather than ReFH2

Two separate hyetographs were derived for each storm duration, representing net rural rainfall, and net urban rainfall. In terms of duration, hyetographs were derived for the following storms:

- Duration = 1hr, Timestep = 4min
- Duration = 3hr, Timestep = 12min
- Duration = 6hr, Timestep = 24min
- Duration = 9hr, Timestep = 36min
- Duration = 12hr, Timestep = 48min
- Duration = 18hr, Timestep = 72min

Two storm profiles were also considered, the 75% winter profile (generally recommended for rural catchments) and the 50% summer profile (recommended within urban catchments). These were applied to both the rural and urban analysis. Therefore, for each duration event there were a total of four separate hyetographs.

The hyetographs are defined over the area of the pluvial catchments (28.8 km^2 and 10.5 km^2). The Areal Reduction Factor (ARF) is set to 1 and the seasonal correction factor (SCF) is kept at its default values as defined for the catchment area and seasonality applied.

For the urban hyetographs, the impervious runoff factor (IRF) and impervious factor were both set at 1.0 to match the values used by the EA[5] in their latest national hazard mapping. All other urban parameters were maintained at their default values.

[5] Environment Agency (2025) *Risk of flooding from surface water – understanding and using the map.* https://www.gov.uk/government/publications/flood-risk-maps-for-surface-water-how-to-use-the-map/risk-of-flooding-from-surface-water-understanding-and-using-the-map

4 Results

The table below shows the peak rainfall across a timestep for each duration and season. The results are derived from the net rainfall values extracted from ReFH2.

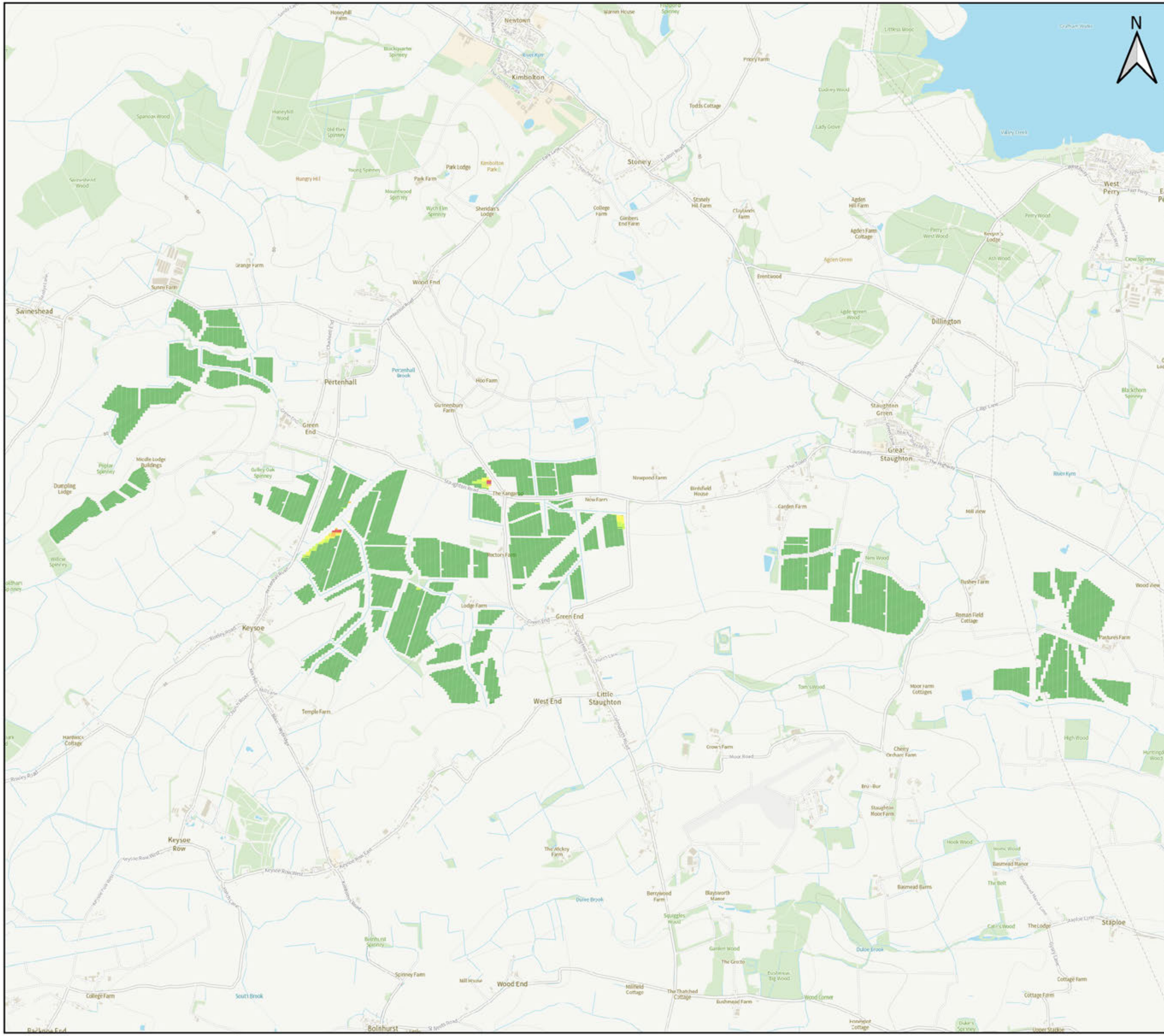
Table 2 – Catchment AB peak net rainfall

	1 Hour Peak Net Rainfall (mm) 1000yr	3 Hour Peak Net Rainfall (mm) 1000yr	6 Hour Peak Net Rainfall (mm) 1000yr	9 Hour Peak Net Rainfall (mm) 1000yr	12 Hour Peak Net Rainfall (mm) 1000yr	18 Hour Peak Net Rainfall (mm) 1000yr
Urban Summer	16.29	22.60	27.40	30.02	31.68	33.66
Urban Winter	6.03	9.47	12.52	13.77	14.58	15.60
Rural Summer	8.53	12.92	16.66	18.85	20.29	22.06
Rural Winter	3.75	6.26	8.70	9.75	10.46	11.37

Table 3 – Catchment CD peak net rainfall

	1 Hour Peak Net Rainfall (mm) 1000yr	3 Hour Peak Net Rainfall (mm) 1000yr	6 Hour Peak Net Rainfall (mm) 1000yr	9 Hour Peak Net Rainfall (mm) 1000yr	12 Hour Peak Net Rainfall (mm) 1000yr	18 Hour Peak Net Rainfall (mm) 1000yr
Urban Summer	17.27	23.59	28.13	30.54	32.03	33.79
Urban Winter	6.26	9.68	12.61	13.73	14.44	15.33
Rural Summer	8.67	12.95	16.39	18.34	19.59	21.11
Rural Winter	3.77	6.19	8.46	9.38	9.98	10.74

Appendix 2 - Panel Height Requirements



Project :

East Park Energy

Client :

axis

Legend :

Required Panel height above ground level to provide 300 mm freeboard (1.0% AEP +40% CC) (mm)

- 800
- 900
- 1000
- 1100
- 1200
- 1300

Scale :

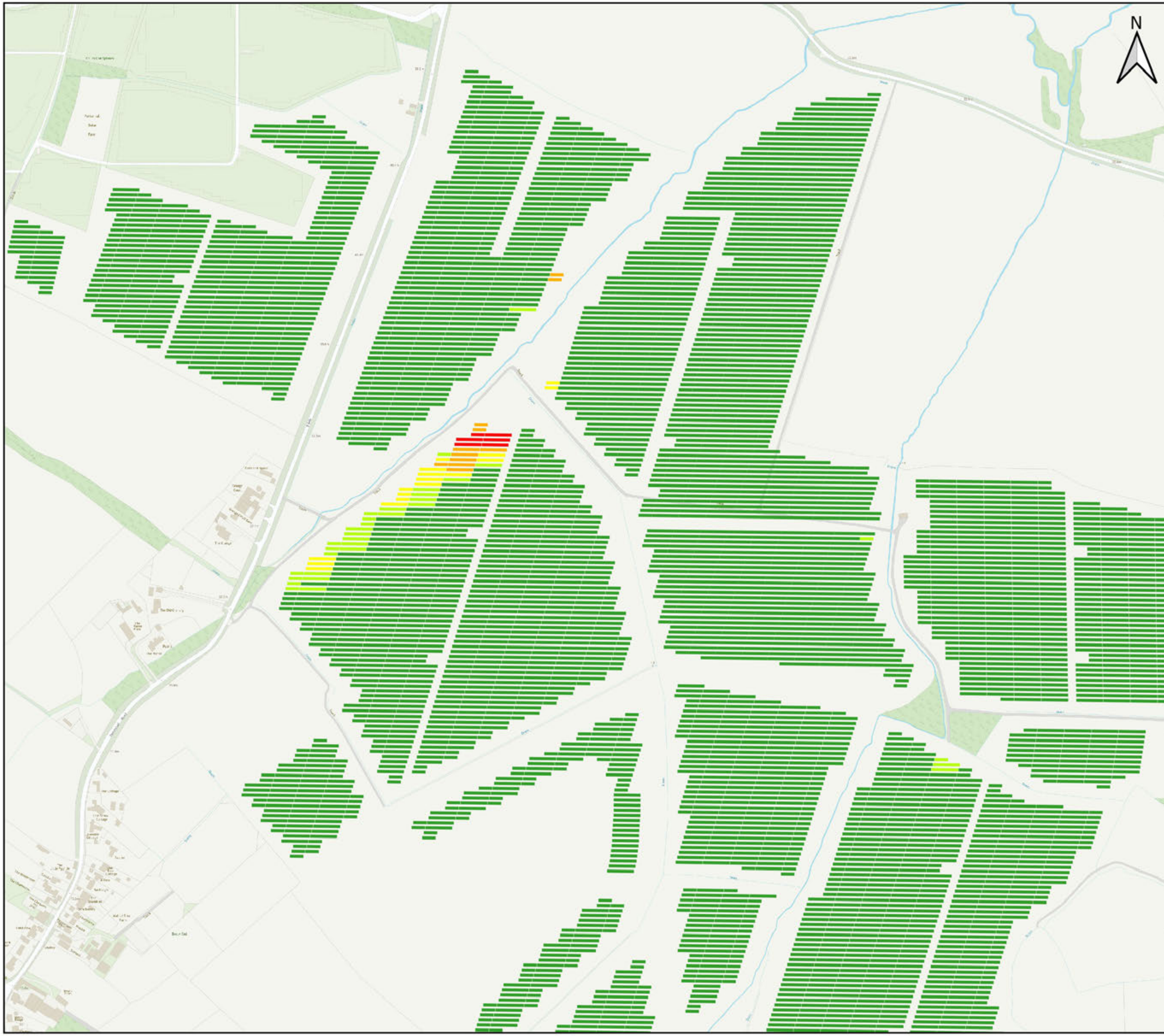
0 1 2 km

Title :

Appendix 2: Required Panel Heights (Full Site)

Drawing :	Rev :
WHS1967-T01-0001	1

WHS



Project :

East Park Energy

Client :

axis

Legend :

Required Panel height above ground level
to provide 300 mm freeboard
(1.0% AEP +40% CC) (mm)

- 800
- 900
- 1000
- 1100
- 1200
- 1300

Scale :

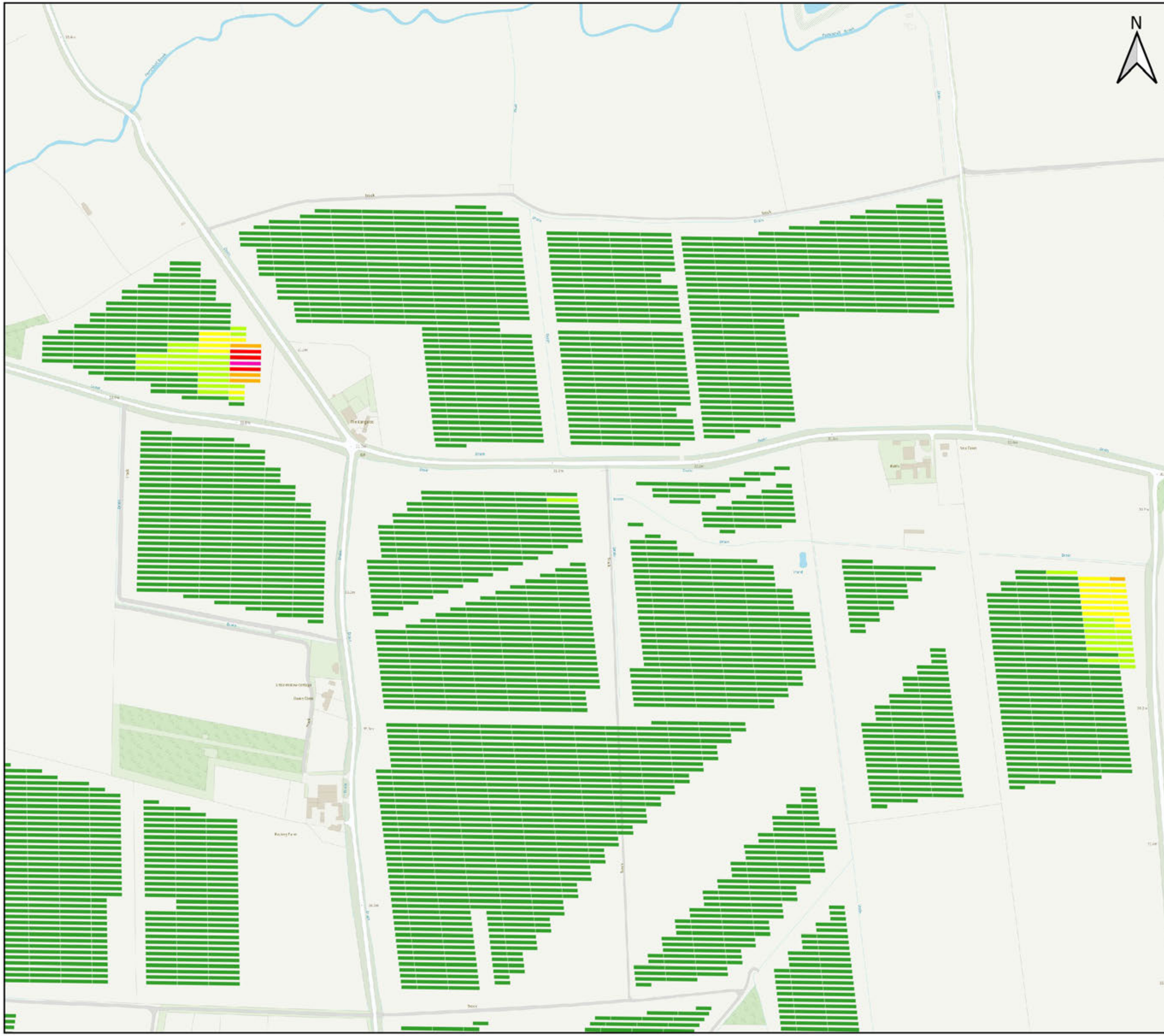
0 150 300 m

Title :

Appendix 2: Required Panel Heights
(Subsection B - West)

Drawing :	Rev :
WHS1967-T01-0002	1

WHS



Project :

East Park Energy

Client :

axis

Legend :

Required Panel height above ground level to provide 300 mm freeboard (1.0% AEP +40% CC) (mm)

- 800
- 900
- 1000
- 1100
- 1200
- 1300

Scale :

0 150 300 m

Title :

Appendix 2: Required Panel Heights (Subsection B - East)

Drawing :	Rev :
WHS1967-T01-0003	1

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