



**WHITESTONE**  
solar farm

# WHITESTONE SOLAR FARM

## Volume 6: Environmental Statement

### 6.20 Appendix 10.2: Flood Risk Assessment

Application Document ref. EN0110020/APP/6.20  
Revision 01  
June 2026

**Planning Act (2008)**  
Infrastructure Planning (Applications:  
Prescribed Forms and Procedure)  
Regulations 2009  
Regulations 5(2)(a)

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## ENVIRONMENTAL STATEMENT

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Document Status					
Version	Purpose of Document	Authored by	Reviewed by	Approved by	Review Date
Rev01	DCO Submission	Wallingford HydroSolutions	ERM, TLT, Pershing, DWD, AECOM, Whitetone Net Zero Ltd	Whitestone Net Zero Ltd	01/06/2026

Approval for issue		
Whitestone Net Zero Ltd		1 June 2026

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### Glossary

Term	Meaning
<i>Cable Corridors</i>	Corridors within which the high voltage cables would be constructed.
<i>Environmental Statement (ES)</i>	The Environmental Statement which presents the environmental information relating to the Proposed Development. The ES has been prepared to present information for formal consultation in accordance with current EIA regulation.
<i>Order Limits</i>	Maximum extent of the Proposed Development comprising the Site and Cable Corridors.
<i>The Applicant</i>	Whitestone Net Zero Ltd.
<i>The Application</i>	The Application submitted to the Secretary of State for a Development Consent Order.
<i>The Proposed Development</i>	The proposed Whitestone Solar Farm.

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Term	Meaning
<i>The Site</i>	The land planned to be used for solar PV array and associated infrastructure, BESS, substation, landscaping and habitat enhancement. The Site is split into W1, W2, and W3.
<i>Whitestone 1 (W1)</i>	The northern parcels of the Whitestone Solar Farm.
<i>Whitestone 2 (W2)</i>	The middle parcels of the Whitestone Solar Farm.
<i>Whitestone 3 (W3)</i>	The southern parcels of the Whitestone Solar Farm.

### Acronyms

Acronym	Meaning
<i>AEP</i>	Annual Exceedance Probability
<i>AOD</i>	Above Ordnance Datum
<i>BESS</i>	Battery Energy Storage System
<i>CIRIA</i>	Construction Industry Research and Information Association
<i>DCLG</i>	Department of Communities and Local Government
<i>DMRB</i>	Design Manual for Roads and Bridges
<i>EA</i>	Environment Agency
<i>ES</i>	Environmental Statement
<i>FRA</i>	Flood Risk Assessment
<i>LLFA</i>	Lead Local Flood Authority
<i>LPA</i>	Local Planning Authority
<i>NGR</i>	National Grid Reference
<i>NPPF</i>	National Planning Policy Framework
<i>NPS</i>	National Policy Statement
<i>oCEMP</i>	Outline Construction Environmental Management Plan
<i>oSWDS</i>	Outline Surface Water Drainage Strategy
<i>PV</i>	Photovoltaic
<i>RMBC</i>	Rotherham Metropolitan Borough Council
<i>SFRA</i>	Strategic Flood Risk Assessment
<i>SuDS</i>	Sustainable Drainage System
<i>W1</i>	Whitestone 1
<i>W2</i>	Whitestone 2
<i>W3</i>	Whitestone 3

### Units

Units	Meaning
<i>ha</i>	Hectares
<i>km</i>	Kilometres
<i>kV</i>	Kilovolt

## ENVIRONMENTAL STATEMENT

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Units	Meaning
<i>m</i>	Metres
<i>mm</i>	Millimetres
<i>MW</i>	Megawatt

## 10.2 Flood Risk Assessment

### Introduction

- 10.2.1 This Flood Risk Assessment (FRA) has been prepared on behalf of Whitestone Net Zero Ltd ('The Applicant') in relation to the construction, operation, maintenance and decommissioning of Whitestone Solar Farm ('the Proposed Development'). This Appendix has been prepared to support **ES Volume 2, Chapter 10: Water Resources and Flood Risk [EN0110020/APP/6.10]** of the Environmental Statement (ES).

### Scope

- 10.2.2 This FRA evaluates the potential flood risk associated with the Proposed Development during the operation and maintenance of the Proposed Development.
- 10.2.3 The risks associated with flood risk during construction are assessed in detail in **ES Volume 2, Chapter 10: Water Resources and Flood Risk [EN0110020/APP/6.10]** and the mitigation needed is also set out within the Chapter and **the outline Construction Environment Management Plan (oCEMP) [EN0110020/APP/5.9]**. In summary, flood risk during construction will be managed through the implementation of appropriate construction drainage management. These will employ sustainable drainage system (SuDS) principals to attenuate runoff during the construction phase, so that there is no increase in flood risk. The Contractor will also monitor weather conditions to identify flood risk to the Proposed Development during construction, with an Incident Response Plan in place in the event of flooding during construction. An Outline Incident Response Plan has been included within the **oCEMP [EN0110020/APP/5.9]**.
- 10.2.4 This FRA outlines the relevant policy framework, describes the methodology employed and presents the existing baseline conditions and assesses the risk of flooding from a range of sources.

### Legislation, Policy and Guidance

- 10.2.5 The legislation, policy, and guidance related to water resources and flood risk as detailed in **ES Volume 3, Appendix 10.1: Legislation Policy and Guidance [EN0110020/APP/6.20]**, and relevant to the Proposed Development, are outlined below.
- 10.2.6 Legislation that has been considered includes:
- The Water Resources Act 1991<sup>1</sup> (as amended by the Water Act 2003<sup>2</sup>);
  - The Land Drainage Act 1991<sup>3</sup>;
  - Flood Directive 2007/60/EC<sup>4</sup>;
  - The Flood Risk (England and Wales) Regulations 2009<sup>5</sup> (which implemented the EC Flood Directive 2007/60/EC);
  - Flood and Water Management Act 2010<sup>6</sup>; and
  - Water Act 2014<sup>7</sup>.

- 10.2.7 National policy that has been considered includes:
- Overarching National Policy Statement (NPS) for Energy (EN-1) (2025)<sup>8</sup>;
  - NPS for Renewable Energy Infrastructure (EN-3) (2025)<sup>9</sup>;
  - NPS for Electricity Networks Infrastructure (EN-5) (2025)<sup>10</sup>; and
  - The National Planning Policy Framework (NPPF) (2025)<sup>11</sup>.
- 10.2.8 The following local policies, produced by the Lead Local Flood Authorities (LLFAs) and Local Planning Authorities (LPAs) which the Order Limits sits within the administrative boundaries of, has been considered:
- Doncaster Metropolitan Borough Council Level 1 Strategic Flood Risk Assessment<sup>12</sup>;
  - Derbyshire County Council Strategic Level 1 Strategic Flood Risk Assessment<sup>13</sup>; and
  - Rotherham Metropolitan Borough Council Strategic Flood Risk Assessment Level 1<sup>14</sup>.
- 10.2.9 Supporting guidance that has been considered includes:
- Construction Industry Research and Information Association (CIRIA) Development and flood risk: guidance to the construction industry, (C624D)<sup>15</sup>;
  - CIRIA The SuDS Manual (C753)<sup>16</sup>;
  - Department of Communities and Local Government (DCLG) Planning Practice Guidance: Flood risk and coastal change 2024<sup>17</sup>;
  - National Highways' Design Manual for Roads and Bridges (DMRB) LA 113 – Road drainage and the water environment, formerly HD45/09, Revision 1, 2020<sup>18</sup>;
  - National Flood and Coastal Erosion Risk Management Strategy 2022<sup>19</sup>;
  - Environment Agency (EA) Peak River flow climate change allowances by management catchment 2022<sup>20</sup>; and
  - EA Peak rainfall climate change allowances by management catchment 2022<sup>21</sup>.

## Site Information and Location

### Proposed Development

- 10.2.10 The Proposed Development involves the construction, operation and maintenance, and decommissioning of more than 100 megawatt (MW) of solar photovoltaic (PV) array, Battery Energy Storage System (BESS), onsite substations and supporting infrastructure, and grid connection infrastructure.
- 10.2.11 The grid connection infrastructure would connect the Proposed Development to the new 400 kilovolt (kV) National Grid substation proposed on land immediately east of Long Lane, Brinsworth, S60 4JJ (Long Lane 400kV Substation). National Grid has applied to Rotherham Metropolitan Borough Council (RMBC) for the development of this new substation which is intended by National Grid to be operational in time for the Proposed Development to connect in 2029. This substation is therefore not included in the Proposed Development and is subject to a separate planning application taken forward by National Grid.

10.2.12 The Proposed Development would be located within the Order Limits. The Order Limits encompass the total area of the Proposed Development comprising the Site and Cable Corridors. The Site is specifically the land that is planned to be used for solar PV array and associated infrastructure, BESS, substation, landscaping and habitat enhancement. The Site is split into Whitestone 1 (W1), Whitestone 2 (W2), and Whitestone 3 (W3) as described below. Solar PV Modules will be fixed and south-facing, with 8-25° angle and minimum height of 0.4m above ground level. The modules will be mounted on metal frames and surrounded by simple wooden post and wire fencing. Underground cables will also connect the three areas of the Site, shown as Cable Corridors.

### Location

10.2.13 The Proposed Development is located on land east of Sheffield, South Yorkshire. The Order Limits comprise a total area of approximately 1,488 hectares (ha), consisting of approximately 339ha proposed for the Cable Corridors and 1,149ha proposed for the Site. The Order Limits are centred around National Grid Reference (NGR) SK 485887. At their maximum extent, the Order Limits extend approximately 18.5km in a north-south direction, and approximately 8km in an east-west direction. The Site has been split into three distinct areas: W1, W2, and W3. These are shown in **ES Volume 3, Figure 3.1: Site Referencing [EN0110020/APP/6.19]**.

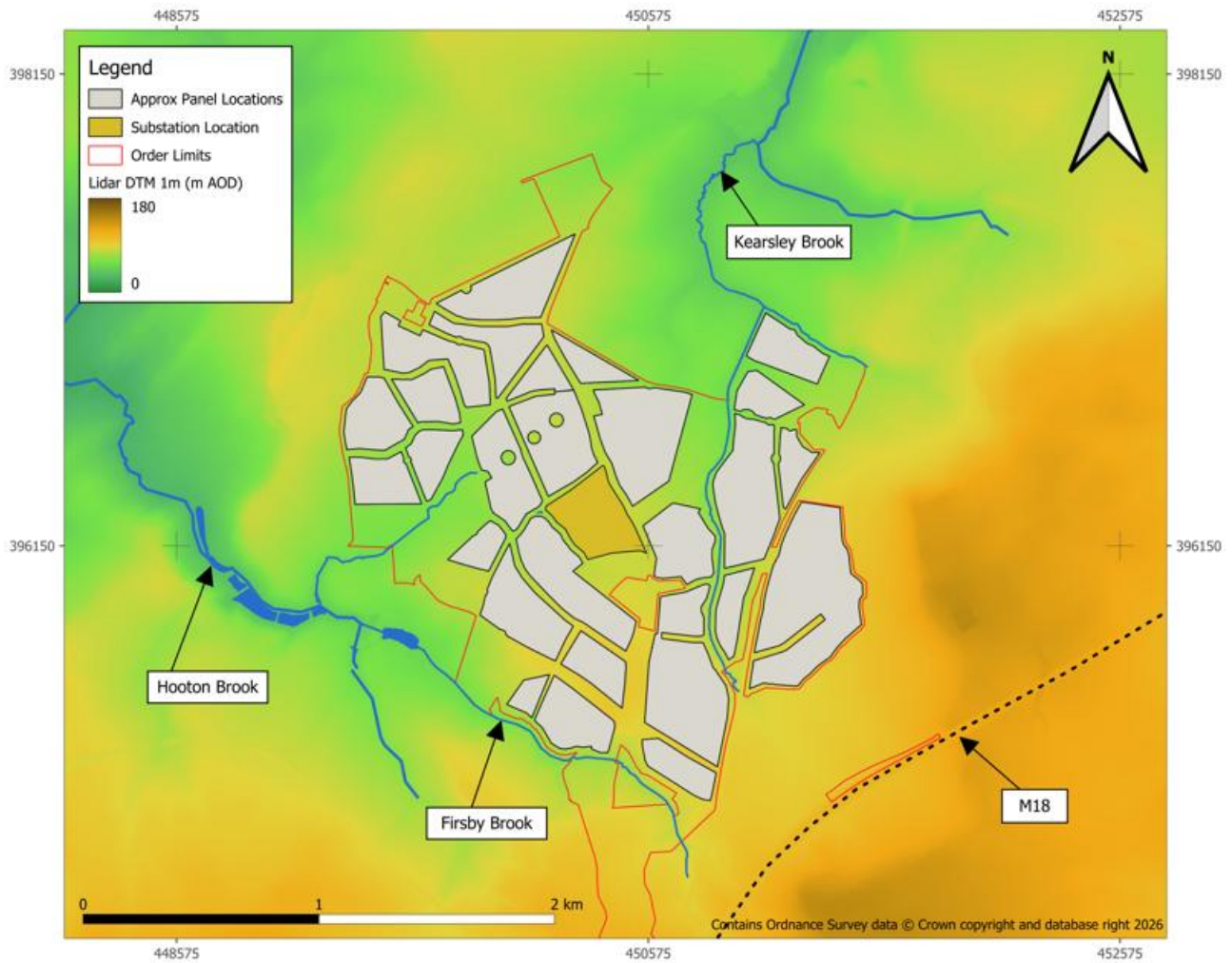
- W1 abuts the A630 to the north and is approximately 400m from the village of Clifton to the east and the M18 to the southeast. W1 is a broad open landscape set within a bowl (approximately 70m Above Ordnance Datum (AOD)) gently rising with small hills such as Beacon Hill (approximately 146m AOD) to the east. Centred around NGR SK 503962, W1 covers approximately 327ha;
- W2 is located within the administrative area of RMBC and comprises approximately 650ha of predominantly agricultural land. W2 is bisected by the M1 and centres around NGR SK477874. W2 is bordered by Wickersley to the north, Thurcroft and Dinnington to the east, North Anston to the southeast, Aston and Aughton in the southwest, and Treeton and Brinsworth in the west; and
- W3 is centred around NGR SK 485887 and covers an area of approximately 172ha. W3 abuts Harthill Reservoir and Hard Lane to the east, the A618 and the Derbyshire County border to the south and west and is approximately 500m south of Kiveton Park and the village of Wales.

10.2.14 The Order Limits are shown in **ES Volume 3, Figure 3.1: Order Limits [EN0110020/APP/6.19]**.

### Topography and Watercourses

10.2.15 The following Figure 1, Figure 2 and Figure 3 detail site topography and nearby watercourses for the Site areas.

10.2.16 The W1 Order Limits have a maximum elevation of 118m and minimum elevation of 87m AOD. The land is not flat, generally sloping to the northeast towards Kearsley Brook, or to the southwest towards Hooton Brook, with the highest ground found in the southeastern portion of the Site.



**Figure 1: Topography and Watercourses at W1**

10.2.17 The W2 Order Limits have a maximum elevation of 130m and minimum elevation of 28m AOD. Due to the areas large size, topography is varied across the Site, but generally areas west of the M1/M18 motorways slope down towards the River Rother including the large portion in the centre of the Site which is drained by the Ulley Brook. Meanwhile, areas east of the motorways generally slope to the east, towards watercourses including Kingsforth Brook and Anston Brook.

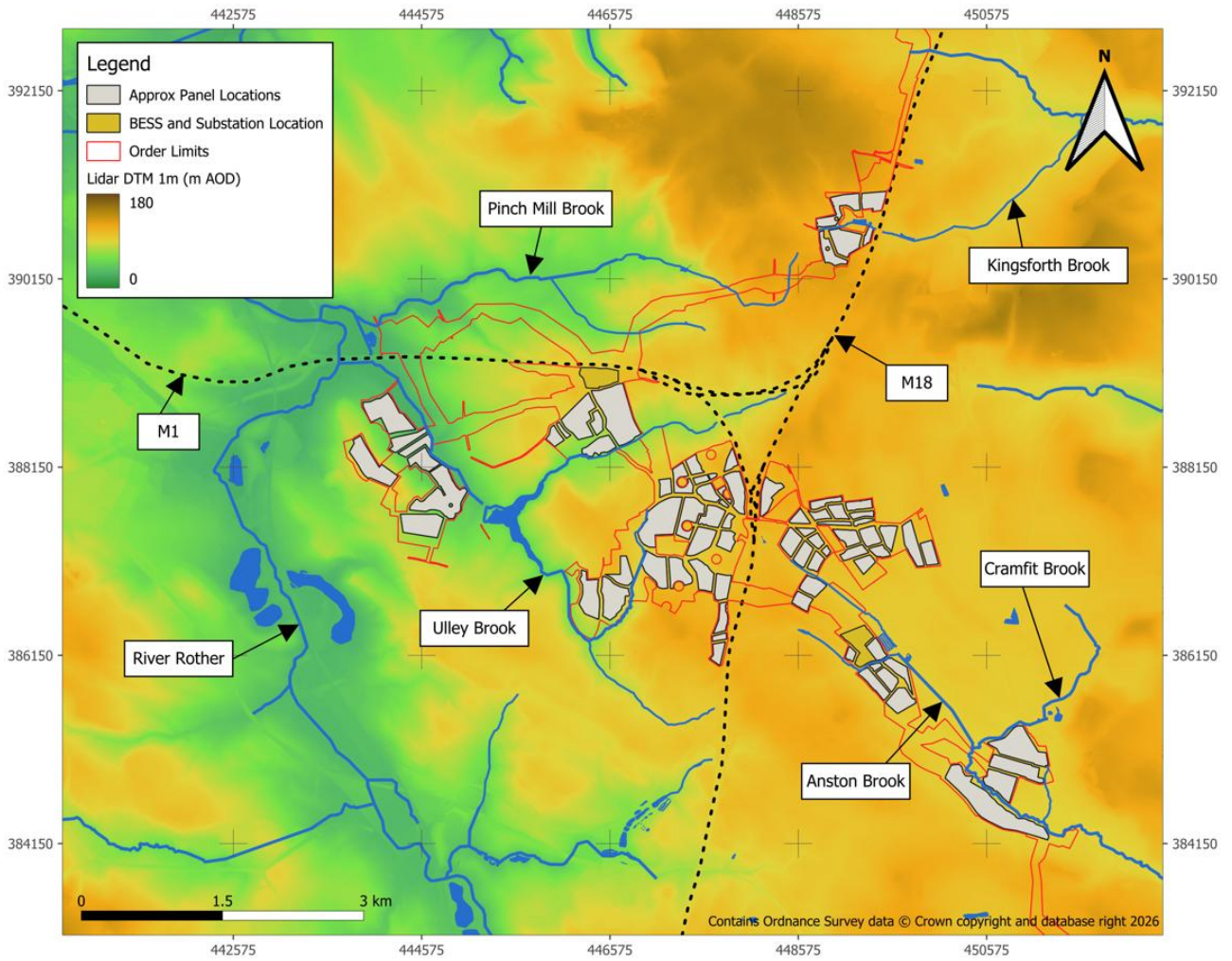


Figure 2: Topography and Watercourses at W2

10.2.18 The W3 Order Limits have a maximum elevation of 142m and minimum elevation of 78m AOD, with mean elevation higher than the other two site parcels. The Site is located close to Harthill and Pebley Reservoirs from which Broad Bridge Dyke arises, with land east of the M1 generally sloping to the northeast, and land west of the M1 generally sloping northwest.

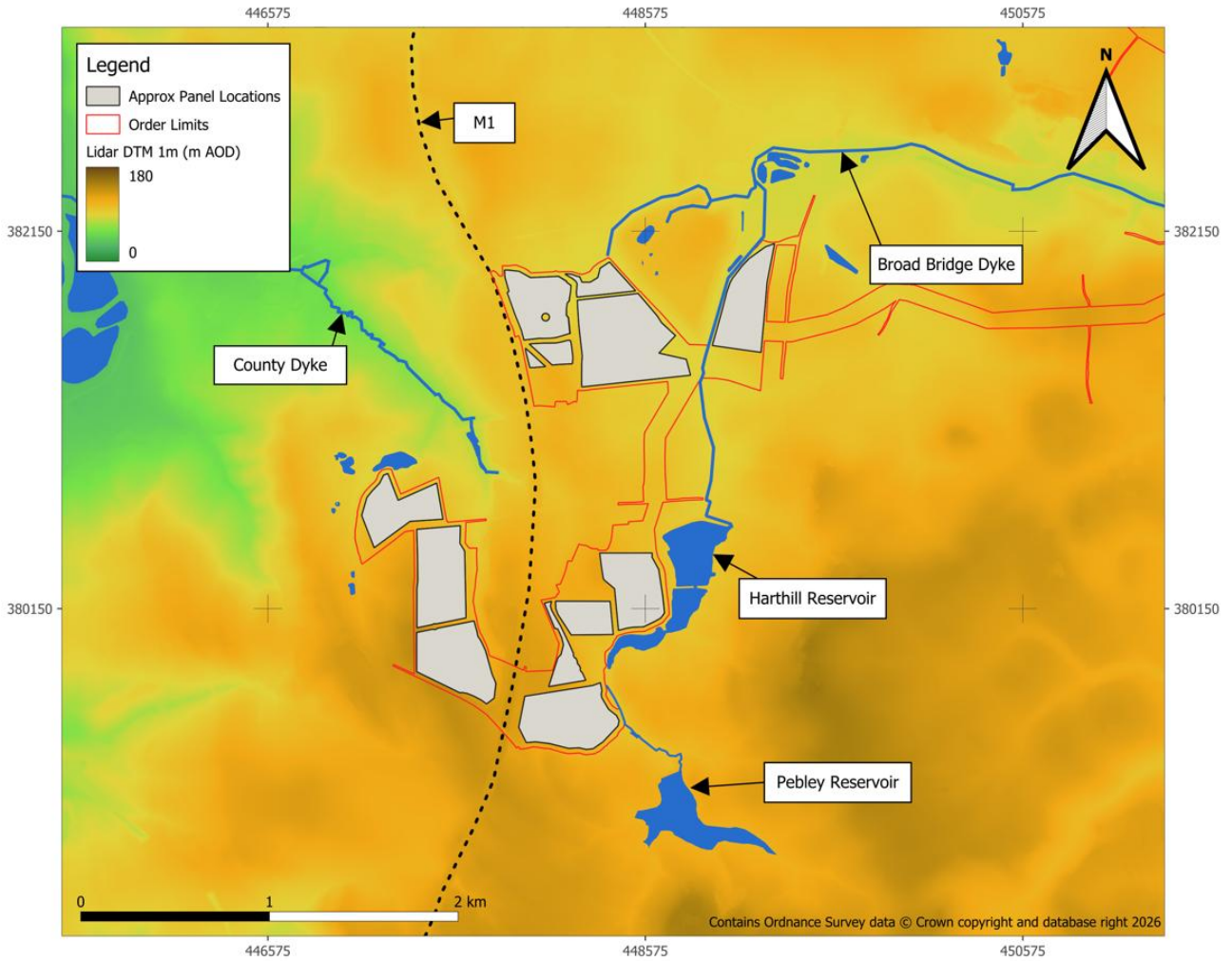
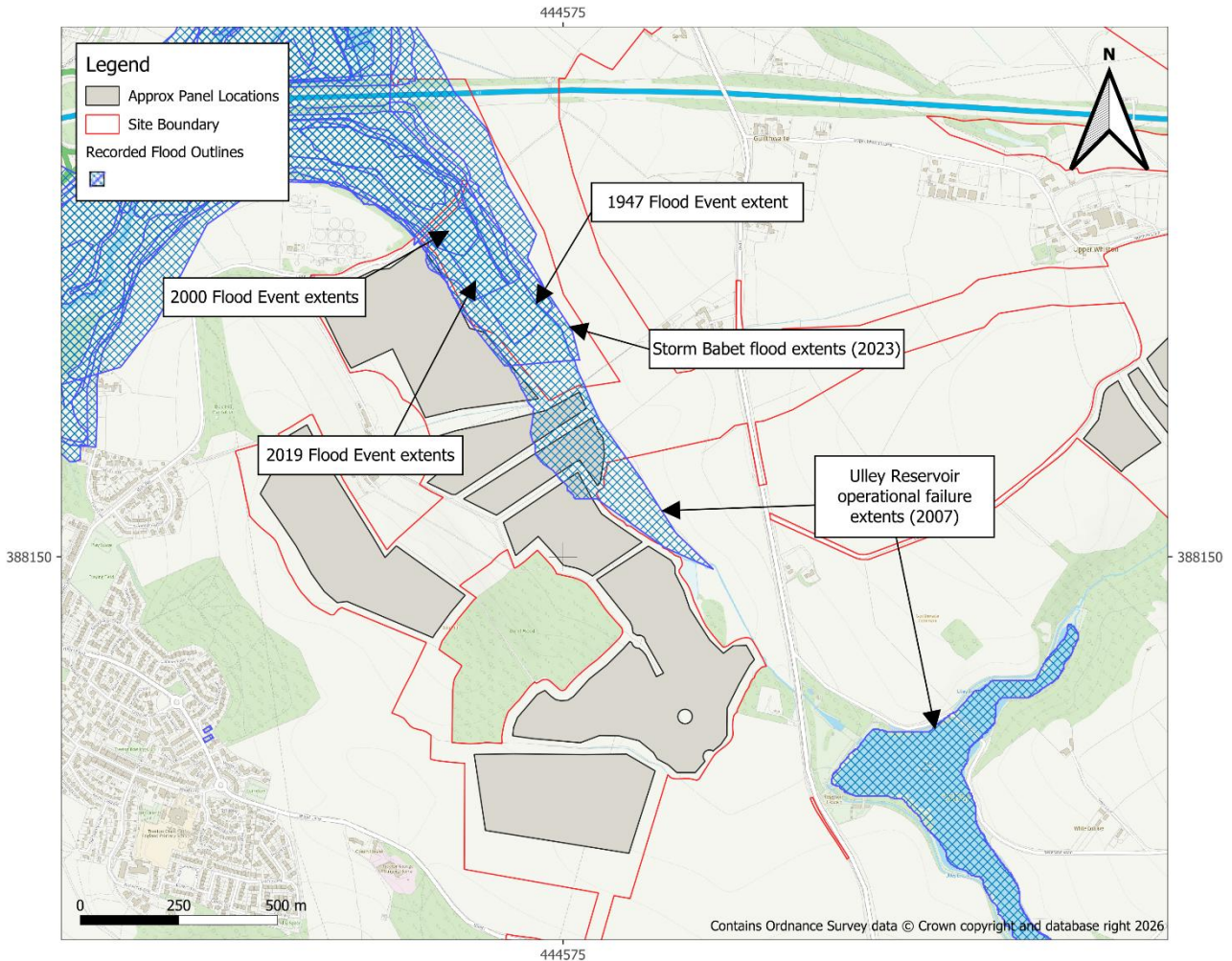


Figure 3: Topography and Watercourses at W3

## Flood Risk

### Historical Flooding

- 10.2.19 The only area of the Site included within the EA’s historic flooding dataset is at the Ulley Brook within W2. Recorded flood outlines show flood events along the Ulley Brook occurred in 1947, 2000, 2019 and 2023 caused by fluvial flooding. The 2023 event during Storm Babet was the most significant of these events.
- 10.2.20 Flooding also occurred in 2007, due to an operational failure/breach of defences at Ulley reservoir. The recorded flood outlines are illustrated below in **Figure 4**.



**Figure 4: Historical Flood Extents at Ulley Brook**

### Flood Defences

- 10.2.21 Similarly, the only area of the Site with formal flood defences is at Ulley Brook near its confluence with the River Rother. These defences are flood embankments, with some areas of naturally high ground along the River Rother, as well as abutments at road crossings. These are shown in **Figure 5**.

## Flood Warnings

- 10.2.22 There are no EA flood warning boundaries within the Site, with the closest flood warning areas to the Site located on Kearsley Brook at Conisbrough, Whiston Brook at Whiston, and the River Rother at Catcliffe.
- 10.2.23 These defences provide some protection to this part of the Site, however, during larger flood events they are overtopped.

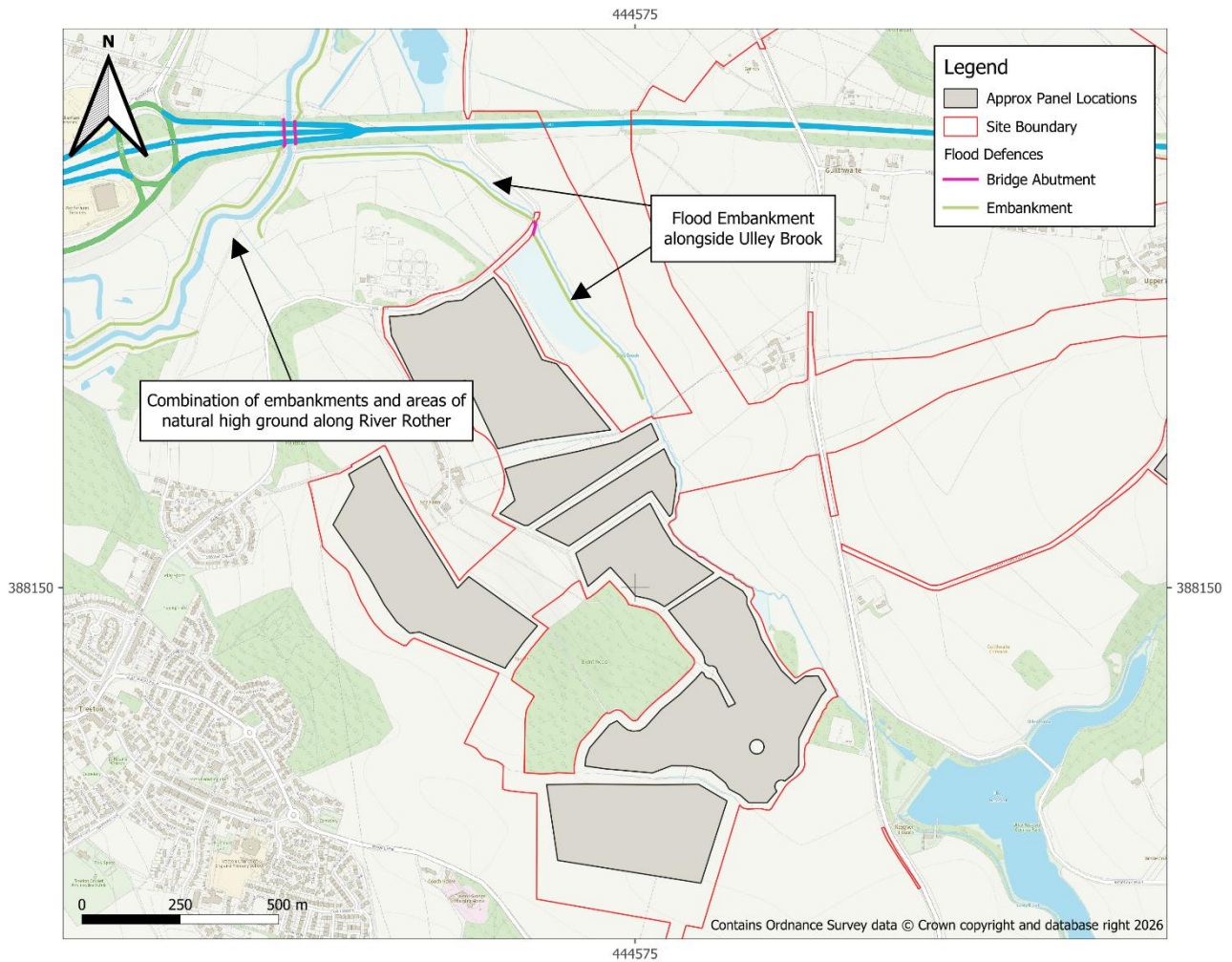


Figure 5: Flood Defences at Ulley Brook

### Fluvial Flood Risk

- 10.2.24 The EA Flood Map for Planning shows that most of the Site is located within Flood Zone 1. However, there are small areas of the Site within Flood Zones 2 and 3, located alongside watercourses at three distinct locations. These are:
- Ulley Brook (within W2);
  - Anston Brook (within W2); and
  - Broad Bridge Dyke (within W3).
- 10.2.25 **Figure 6, Figure 7 and Figure 8** show the EA Flood Map for Planning Flood Zones at these three locations.
- 10.2.26 Flood Zones 2 and 3 consider the flood risk associated with fluvial and tidal flood events during an undefended scenario, i.e. the presence of fluvial or tidal defences are not considered. Flood Zone 2 considers the extent of a 0.1% annual exceedance probability (AEP) flood event whilst Flood Zone 3 considers the extent of a 1% AEP event.
- 10.2.27 In comparison, Flood Zone 3b extents consider the defended scenario, where the presence and condition of flood defences are taken into consideration. Flood Zone 3b is defined as the functional floodplain and is assessed using the EA's Flood Map for Planning - 3.3% Rivers and Seas defended dataset<sup>22</sup>. Areas that are designed to flood, like flood storage areas, are also included within Flood Zone 3b.

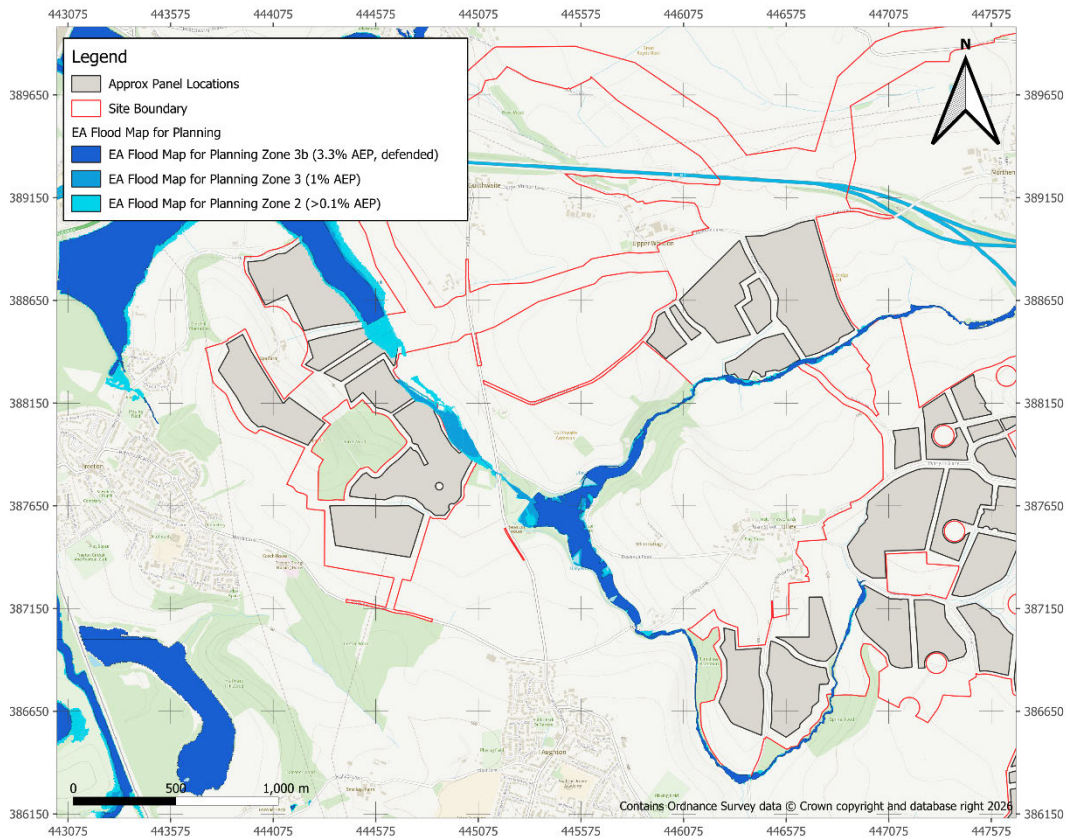


Figure 6: EA Flood Map for Planning at Ulley Brook

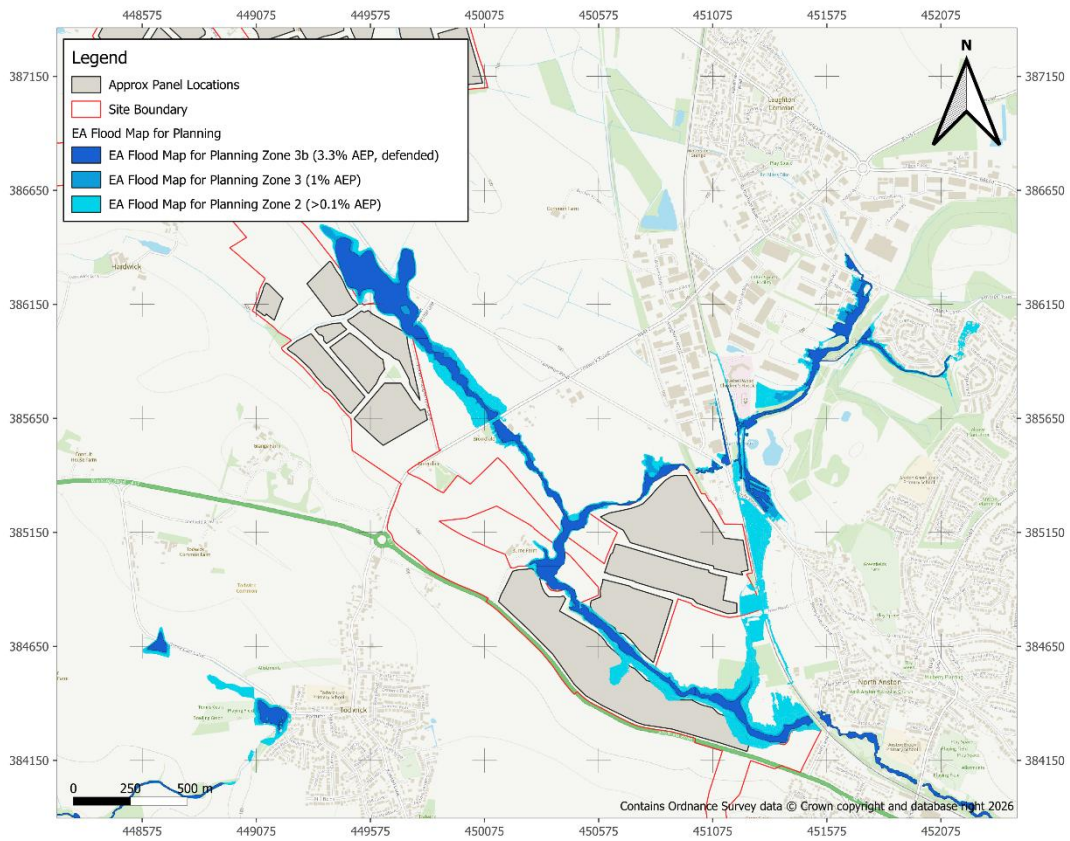
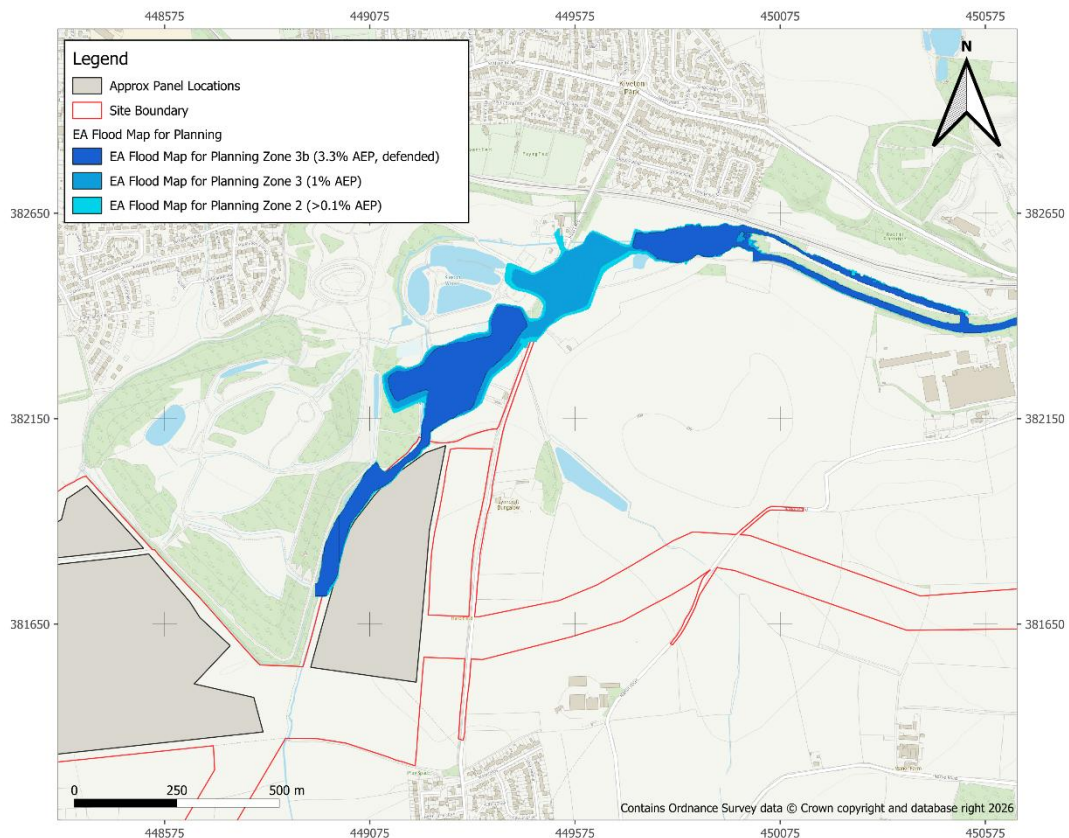


Figure 7: EA Flood Map for Planning at Anston Brook



**Figure 8: EA Flood Map for Planning at Broad Bridge Dyke**

- 10.2.28 It is evident from this data that without consideration of climate change, risk of fluvial flooding across the Site is very minimal. However, given the Proposed Development lifetime of approximately 60 years and the development classification of ‘Essential Infrastructure’, climate change must be considered, with the higher climate change allowance for the 2080s epoch used within this assessment.
- 10.2.29 The EA Flood Map for Planning plus climate change, only considers the central climate change allowance for the 2080s epoch, hence further investigation is required to determine flood extents associated with the higher climate change allowance (see section 4). However, as part of the initial assessment of flood risk at the Site, EA climate change floodmap extents (central climate change allowance) are presented in **Figure 9**, **Figure 10** and **Figure 11**.

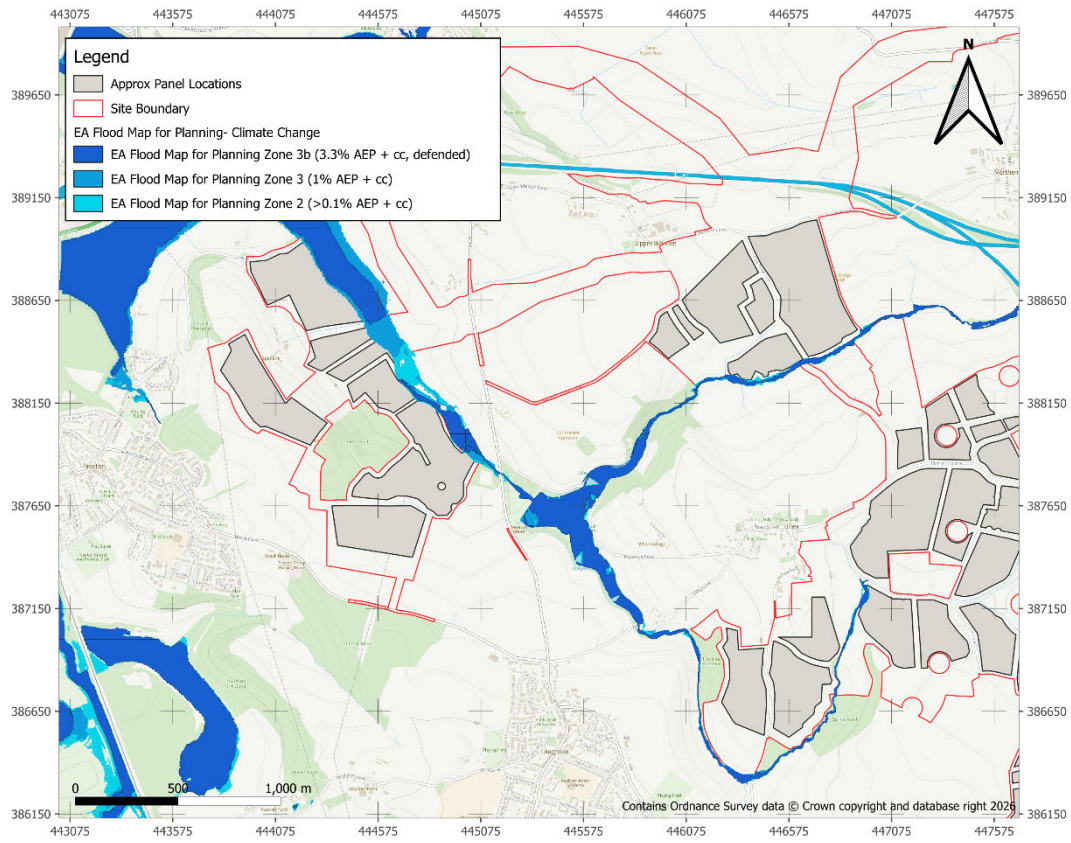


Figure 9: EA Flood Map for Planning- Climate Change at Ulley Brook

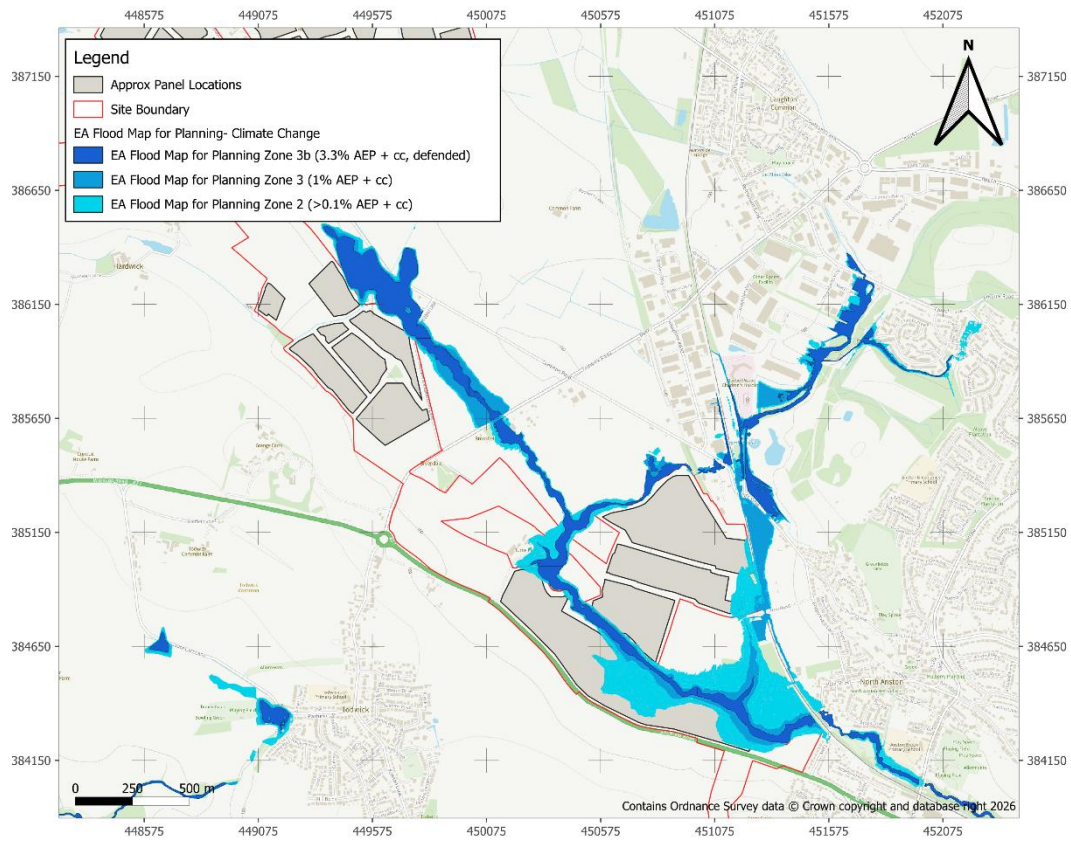
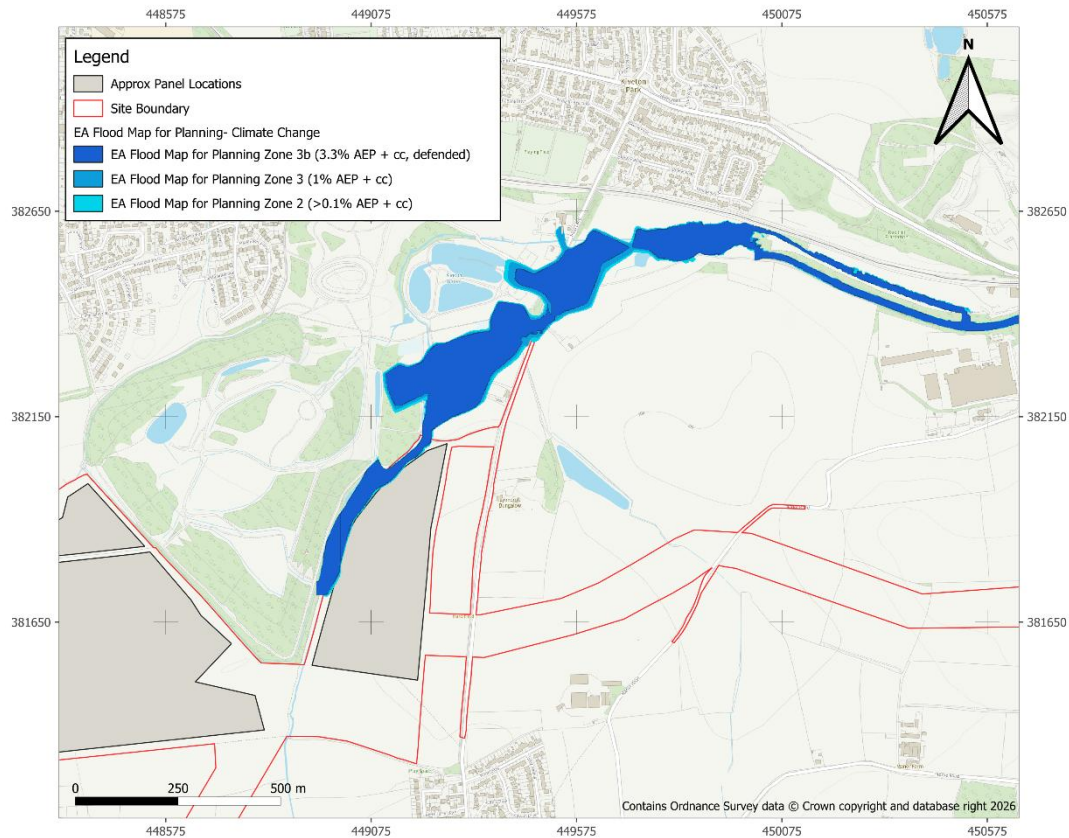


Figure 10: EA Flood Map for Planning - Climate Change at Anston Brook



**Figure 11: EA Flood Map for Planning- Climate Change at Broad Bridge Dyke**

**Surface Water Flood Risk**

- 10.2.30 The EA Risk of Flooding from Surface Water Map shows that the majority of the Order Limits is at very low risk of surface water flooding, meaning the annual chance of surface water flooding is less than 0.1%.
- 10.2.31 Isolated areas within the Site are defined as being at ‘Low’, ‘Medium’ and ‘High’ risk of surface water flooding, corresponding to an annual chance of flooding of between 0.1% and 1%, between 1% and 3.3% and greater than 3.3% respectively. The location of the areas at risk of surface water flooding generally coincide with topographical lows in the terrain and drainage ditches/ponds.
- 10.2.32 When considering climate change, the extent of surface water flood risk slightly increases, but is still limited to low points across the Site.
- 10.2.33 The extents of surface water flooding risk are shown in **Figure 12 to Figure 16** and extents including climate change are shown in **Figure 17 to Figure 20**.

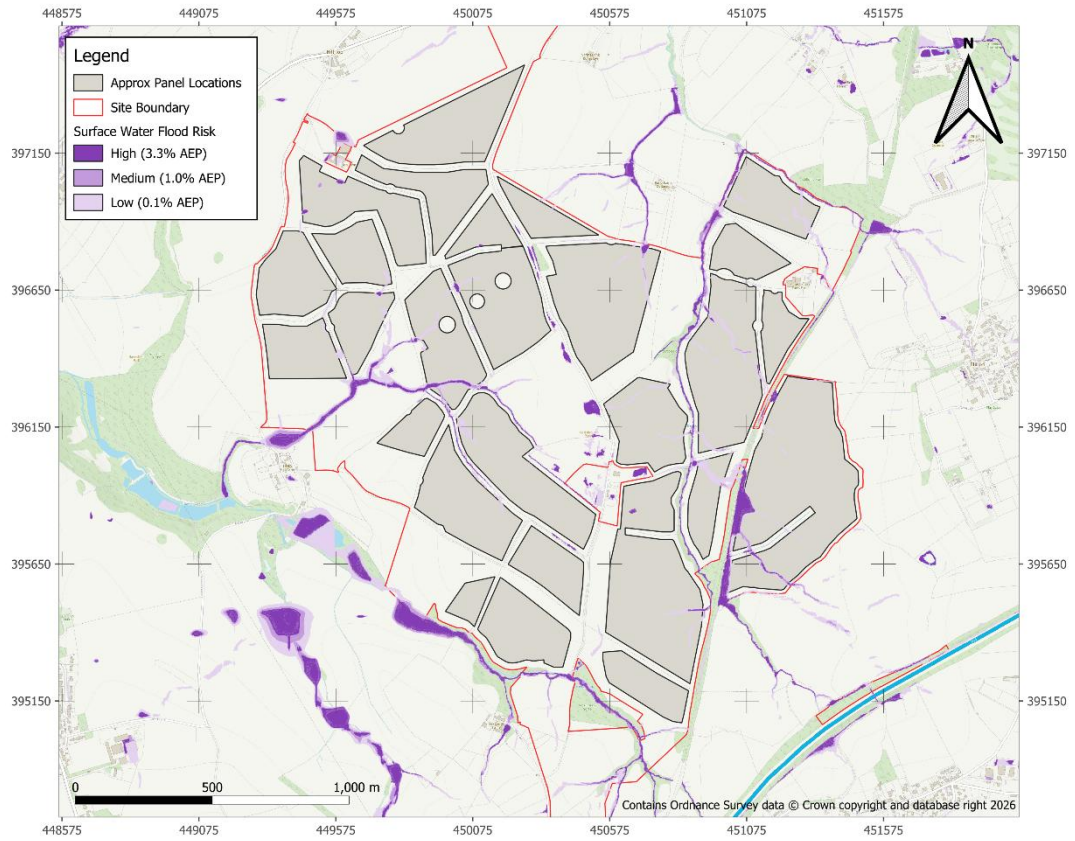
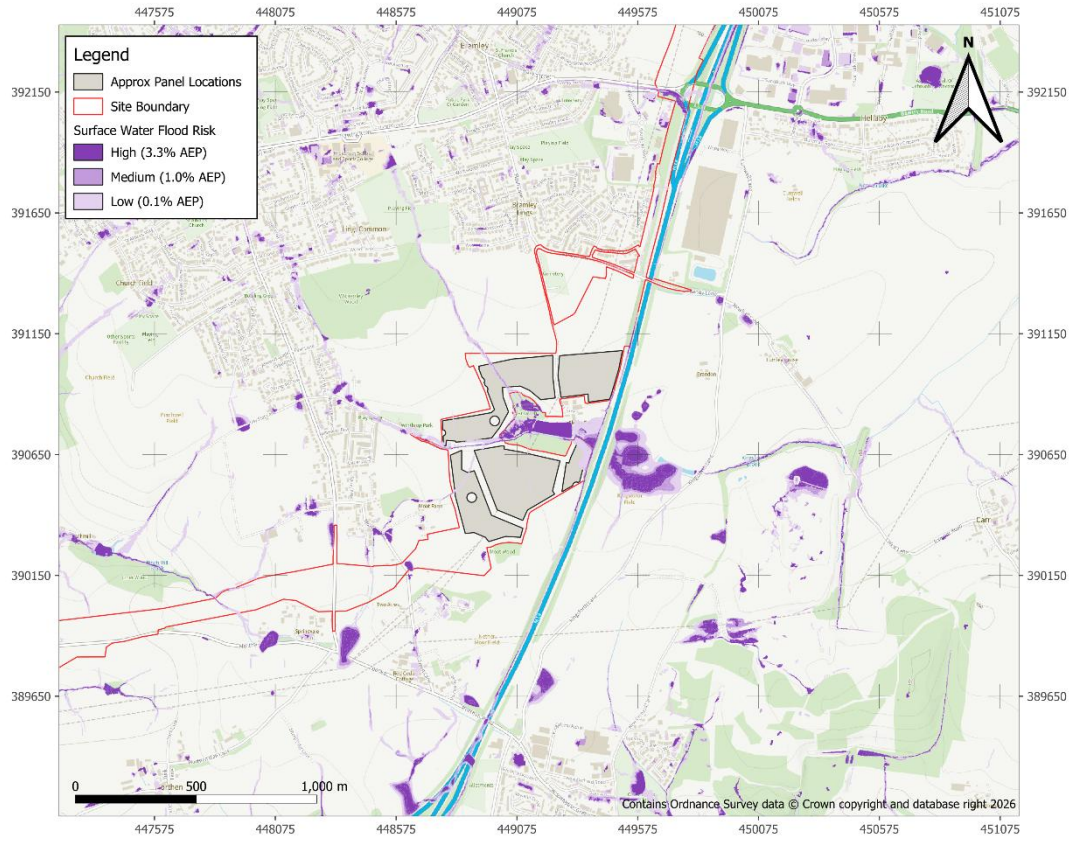


Figure 12 Surface Water Flood Map at W1

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**Figure 13 EA Surface Water Flood Map at W2 North**

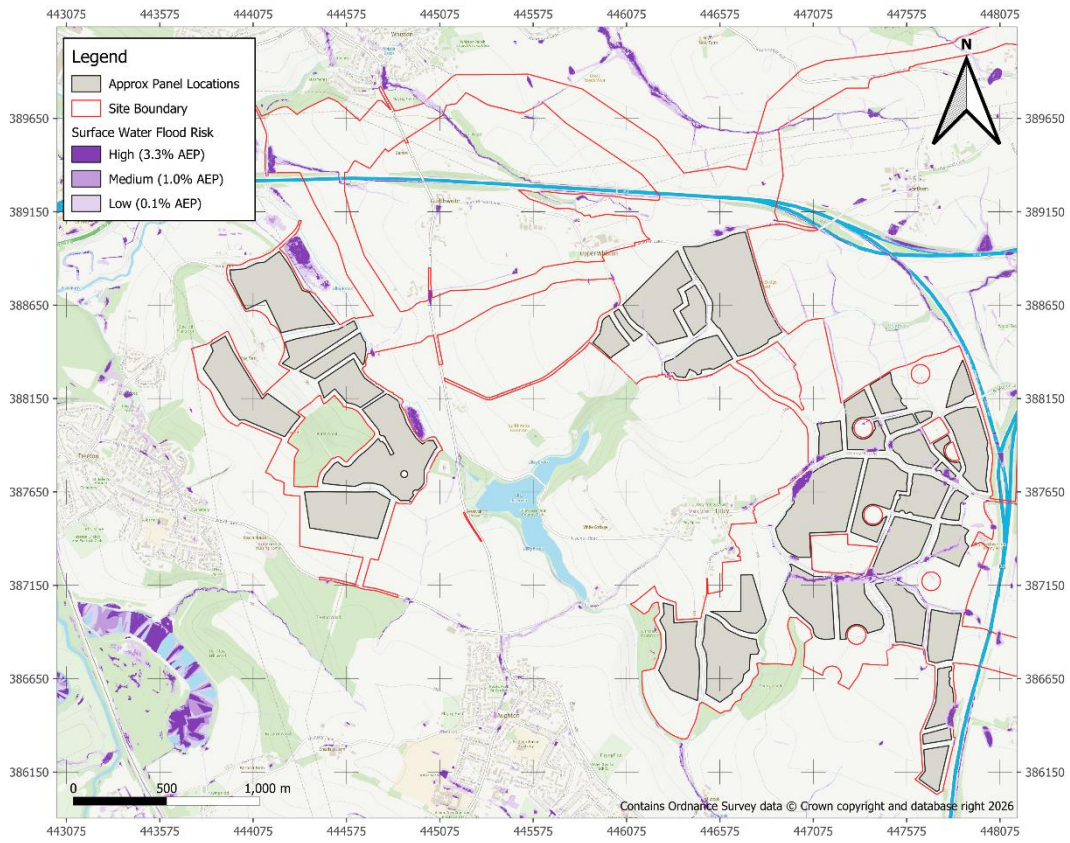


Figure 14: EA Surface Water Flood Map at W2 West

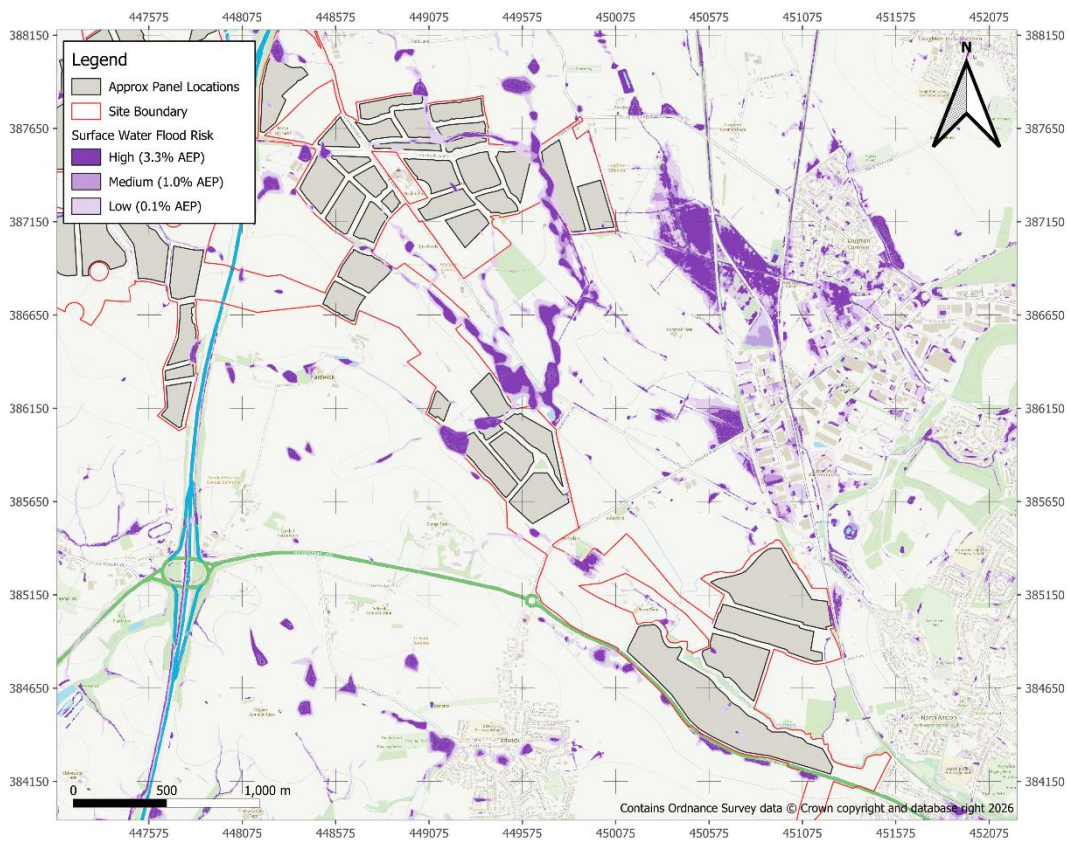


Figure 15: EA Surface Water Flood Map at W2 East

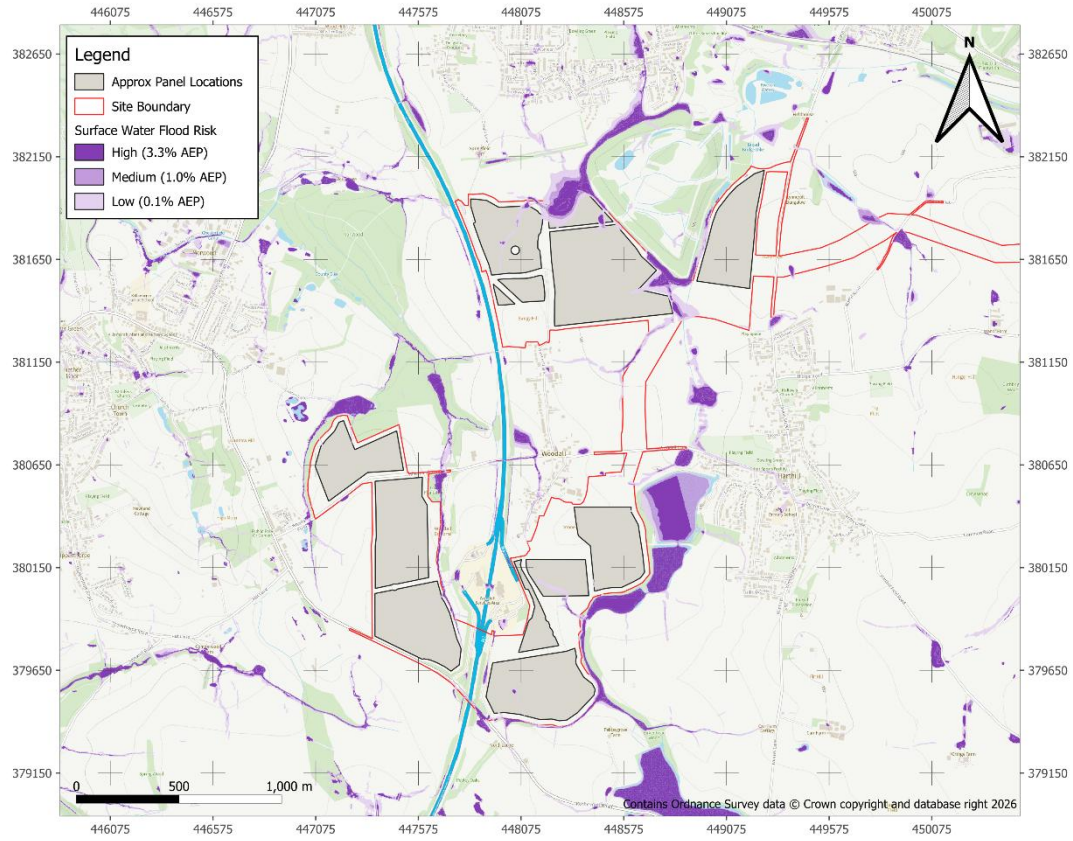


Figure 16: EA Surface Water Flood Map at W3

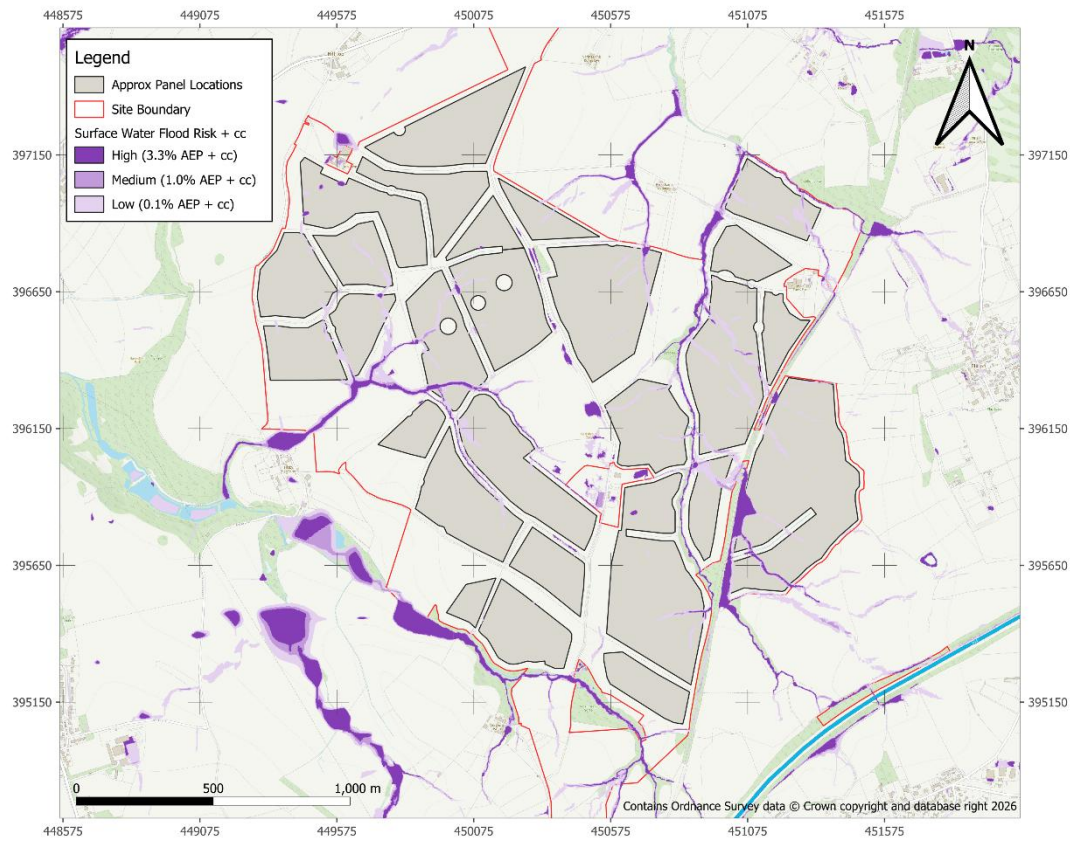


Figure 17: EA Surface Water Flood Map- Climate Change at W1

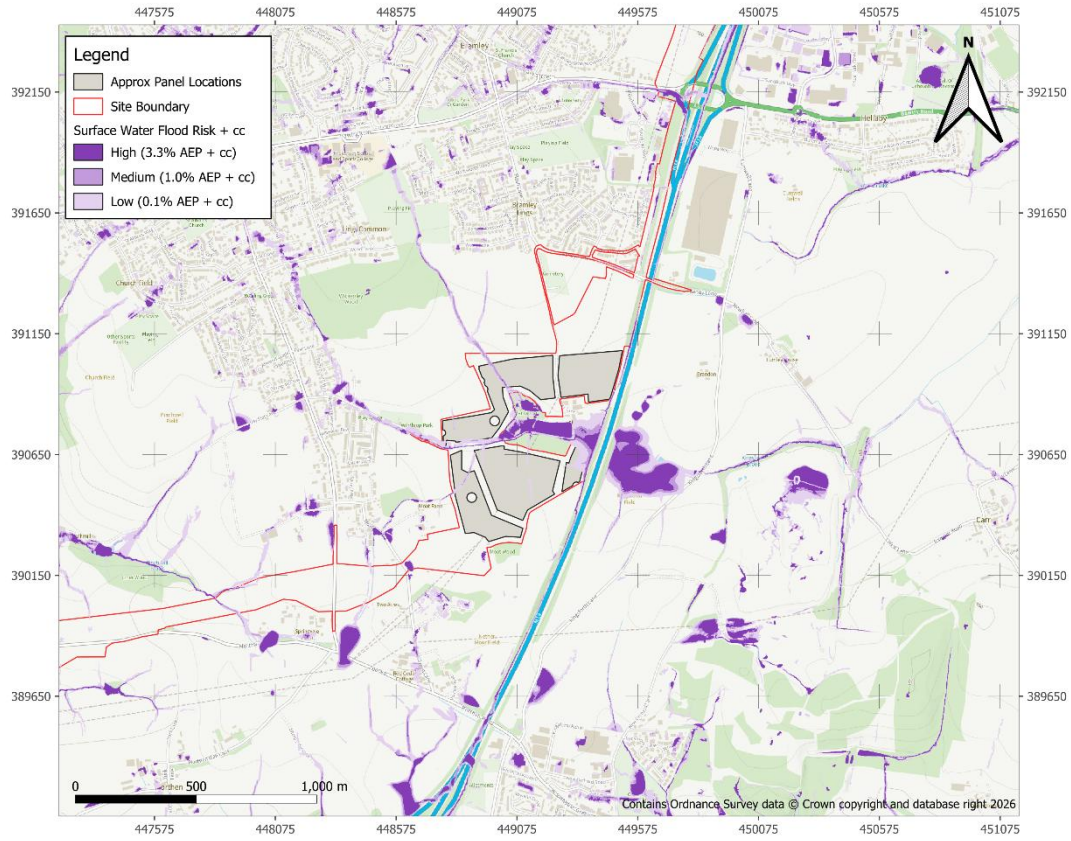


Figure 18: EA Surface Water Flood Map- Climate Change at W2 North

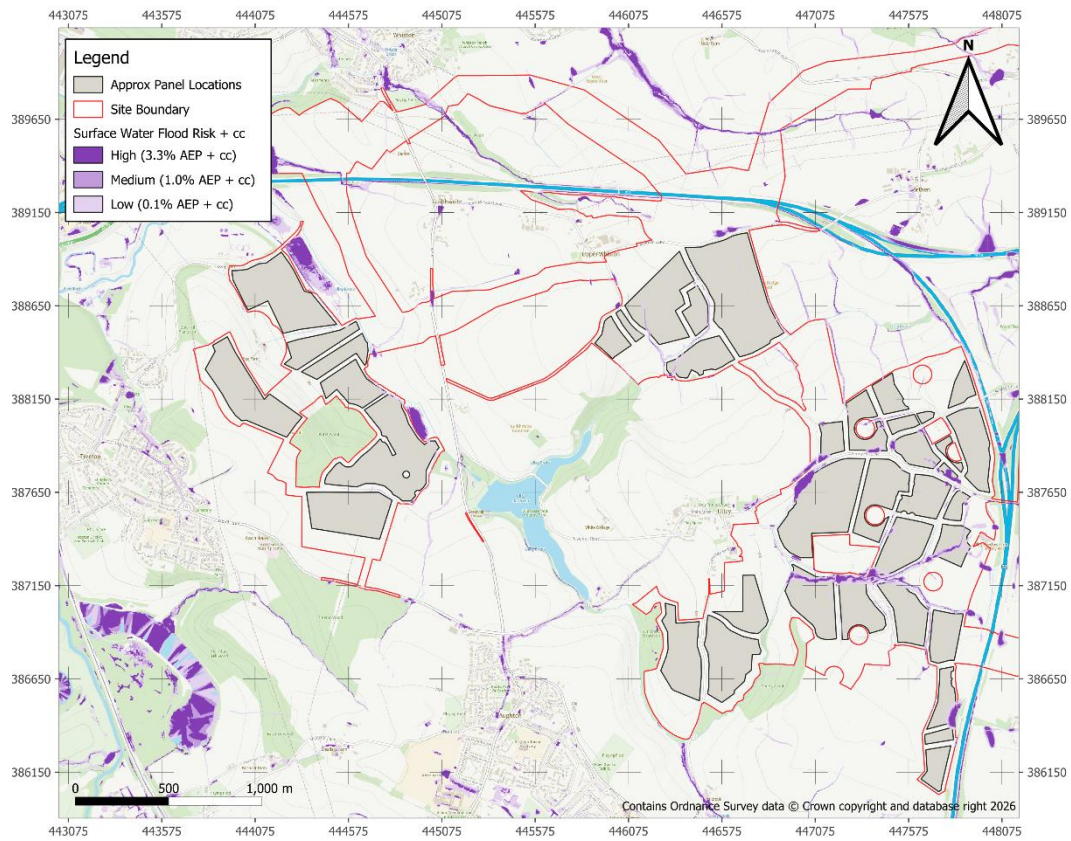


Figure 19: EA Surface Water Flood Map- Climate Change at W2 West

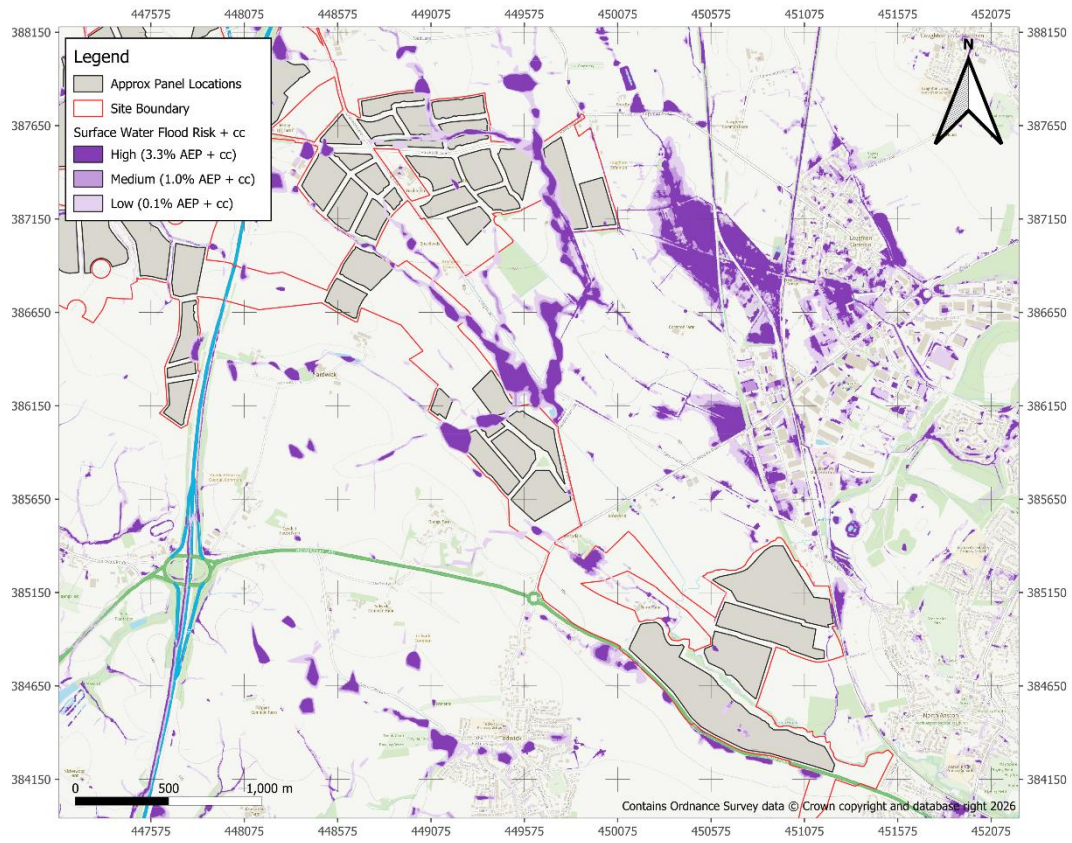


Figure 20: EA Surface Water Flood Map- Climate Change at W2 East

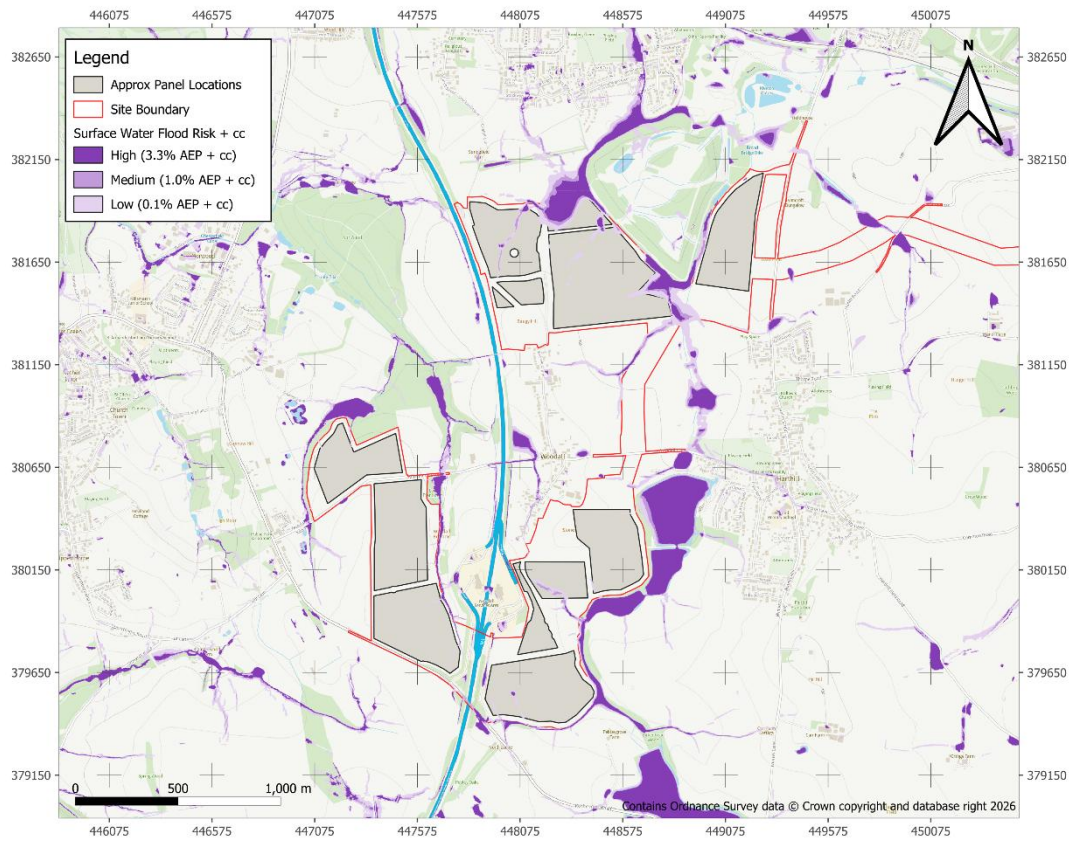


Figure 21: EA Surface Water Flood Map- Climate Change at W3

### Groundwater Flooding

- 10.2.34 The Site is underlain by a bedrock consisting of a combination of sandstone and mudstone, meaning the area is characterised as a moderately productive aquifer.<sup>23</sup>
- 10.2.35 Soils at the Site are mostly classed as slowly permeable seasonally wet acid loamy and clayey soils<sup>24</sup>. This soil is not highly permeable and therefore impedes drainage. Therefore, although the sandstone within the local bedrock allows for the development of aquifers in the area, the overlying soil should prevent groundwater flood risk from being Significant.

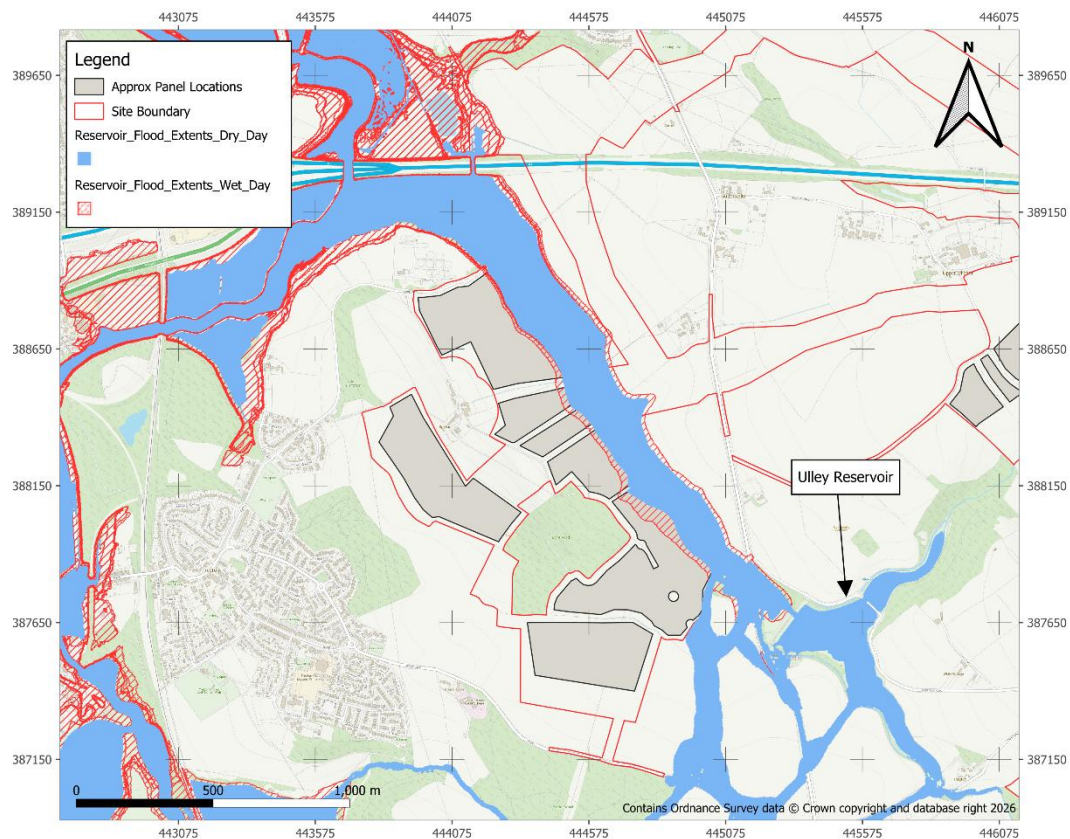
### Groundwater Flooding

- 10.2.36 The Site is underlain by a bedrock consisting of a combination of sandstone and mudstone, meaning the area is characterised as a moderately productive aquifer.
- 10.2.37 Soils at the Site are mostly classed as slowly permeable seasonally wet acid loamy and clayey soils. This soil is not highly permeable and therefore impedes drainage. Therefore, although the sandstone within the local bedrock allows for the development of aquifers in the area, the overlying soil should prevent groundwater flood risk from being Significant.
- 10.2.38 This is supported by the Rotherham Metropolitan Borough Council Strategic Flood Risk Assessment (SFRA) Level 1 (2008)<sup>14</sup>. The SFRA notes that there are no recorded incidents of groundwater flooding within the Borough and concludes that the regional risk of flooding from groundwater sources is considered to be particularly low. However, the SFRA also highlights that groundwater flood risk is highly variable and heavily dependent upon local conditions, advising that an FRA should assess this potential risk in a localised context.
- 10.2.39 In addition, the Doncaster Metropolitan Borough Council Level 1 Strategic Flood Risk Assessment (2026)<sup>13</sup> assesses groundwater risk using JBA's 5m Groundwater Emergence Map. A review of the Council's web-based mapping<sup>25</sup> for the Proposed Development confirms that while the vast majority of the W1 parcel is at no risk, there are very small areas on the edge of the Order Limits where solar panels intersect with Grid Codes 1 and 2:
- Grid Code 1: Groundwater levels are between 0.025m and 0.5m below the ground surface during a 100-year return period event. Within this zone, there is a risk of groundwater flooding to surface and subsurface assets, with the possibility of groundwater emerging at the surface locally; and
  - Grid Code 2: Groundwater levels are between 0.5m and 5m below the ground surface during a 100-year return period event. There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
- 10.2.40 In line with the recommendations of both SFRA's, a site-specific assessment has been undertaken for this FRA. The CDC groundwater risk map, the BGS Geology Viewer, and the LandIS Soils Scapes Viewer have been reviewed, and it has been identified that the risk of groundwater flooding occurring across the Order Limits is low.
- 10.2.41 Furthermore, as the solar panels will be raised above ground level, they are inherently protected from any potential localised shallow groundwater

emergence and the risk of groundwater flooding is considered to be **Low to Negligible** and **Not Significant**.

### Reservoir Flooding

- 10.2.42 The EA Reservoir Flood Risk extents show there are two areas of the Site at risk of potential reservoir flooding. These are on the Ulley Brook, downstream of Ulley reservoir (where historical flood records also show reservoir flooding occurred in 2007) and on Broad Bridge Dyke, downstream of Harthill Reservoir.
- 10.2.43 **Figure 22** and **Figure 23** show the location of reservoir flood risk related to the Site, where wet day flood extent is defined as where a reservoir breach occurs when watercourses are already in flood, whilst on for a dry day scenario the reservoir breach occurs without the addition of other flooding.



**Figure 22: Reservoir Flood Risk near Ulley Reservoir**

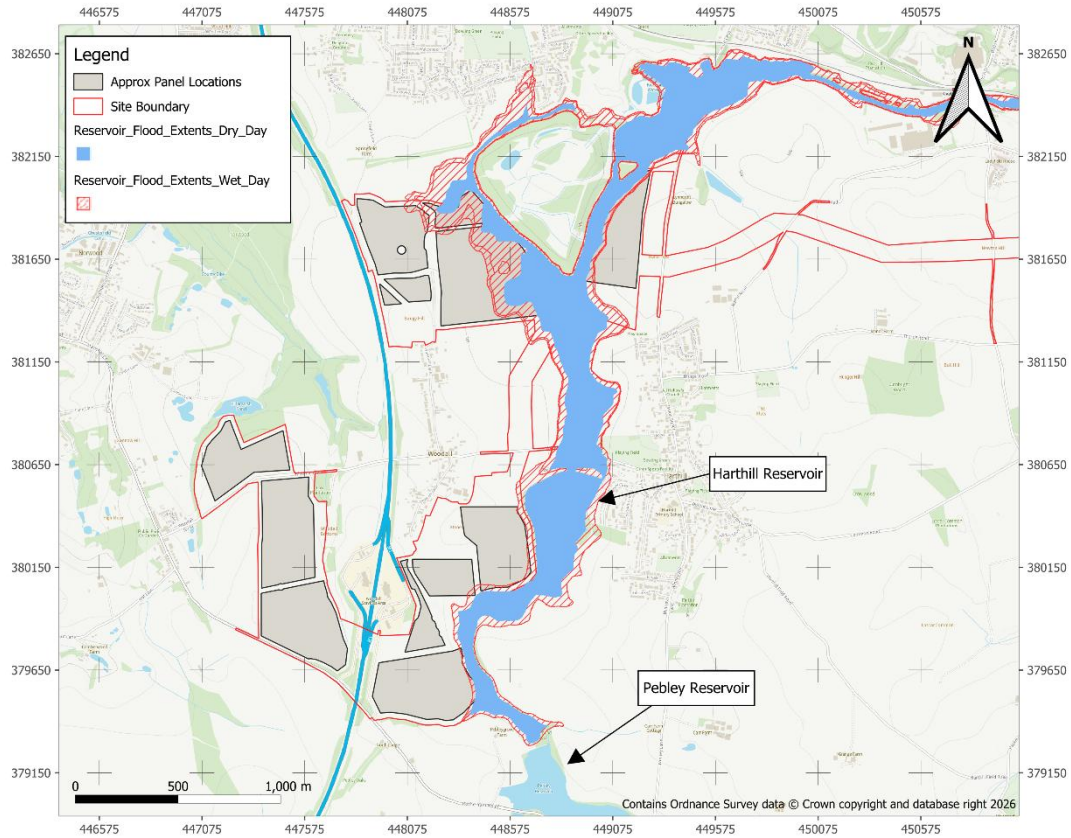


Figure 23: Reservoir Flood Risk near Harthill and Pebley Reservoirs

10.2.44 Despite some areas of reservoir flood risk across the Site, the likelihood of reservoir flooding is very low across the UK, due to strict safety regulations and the requirement for regular inspections, meaning reservoir failure is very uncommon and the risk of flooding from reservoirs is **Not Significant**.

### Flooding from Artificial Sources

- 10.2.45 The only artificial water body in the vicinity of the Proposed Development is the Chesterfield Canal, which although it crosses the Cable Corridor, is located approximately 400m away from the closest above ground part of the Proposed Development.
- 10.2.46 Flooding from canals can occur via two primary mechanisms: overtopping or an embankment breach.
- 10.2.47 The Chesterfield Canal is a heavily engineered and managed watercourse, therefore water levels are strictly controlled through a series of local locks, sluices, and overflow weirs. While canals can sometimes act as a conduit for broader fluvial flood risk, a review of the available flood mapping confirms that the Proposed Development is not at risk of inundation via the canal route. Consequently, the risk of overtopping under normal rainfall, extreme rainfall, or fluvial events is considered low.
- 10.2.48 LiDAR data shows that the highest canal level near the closest above-ground section of the Proposed Development is approximately 85mAOD. Whereas the PV panels at this closest location are approximately 89mAOD. The panels are elevated significantly above the maximum canal water level, therefore a breach would not naturally route water toward the infrastructure, and the Proposed Development is therefore not at risk from a breach of the canal.
- 10.2.49 The risk of flooding from artificial sources is therefore **Negligible** and **Not Significant**.

## Design Flood Levels

### Methodology

- 10.2.50 This Appendix first outlined the Proposed Development location and assessed baseline flood risk at the Site from all sources including fluvial, pluvial, groundwater and reservoir flooding.
- 10.2.51 Following the baseline assessment, it has been identified that the majority of the Site is located within Flood Zone 1. However, small areas of the proposed solar panels are located within Flood Zones 2 and 3. Therefore, fluvial design flood levels must be derived to ensure that any panels in these areas are raised to an appropriate elevation above the design flood level, allowing for safe operation of the Site throughout its lifetime, see paragraphs 10.2.97 to 10.2.102.
- 10.2.52 Furthermore, the assessment identified that some areas of the Site are at risk of pluvial flooding. Derivation of the design flood levels in these areas is also required, as it will be used to set PV panel heights where panels intersect the pluvial flood extent. This data will also inform broader mitigation measures, such as avoidance or raising, where there is a pluvial flood risk near other critical infrastructure, see paragraphs 10.2.109 to 10.2.113.
- 10.2.53 Given the Proposed Development has a vulnerability classification of 'Essential Infrastructure', and the lifetime of the development of 60 years, climate change allowances, guidance states that the higher CC allowance for the 2080s epoch should be applied for fluvial flooding, and the central CC allowance for the 2070s epoch should be applied for pluvial flooding. Flood risk data including these CC allowances is not readily available from the EA, hence these must be applied through modelling, or estimated using existing data.
- 10.2.54 The following sections outline the methodology to derive design floods for fluvial and pluvial flooding. In summary:
- Fluvial design levels are inferred using the EA's Flood Map for Planning dataset, LiDAR data and the latest climate change guidance, obtained from existing flood model data. This method has been discussed and agreed with the EA<sup>1</sup>; and
  - Pluvial design levels are derived from the EAs Risk of Surface Water Flooding dataset, including associated depth banding data.

### Design Fluvial Flood Levels

- 10.2.55 Fluvial Levels have been derived at the three key locations at risk of fluvial flooding, outlined in paragraphs 10.2.24 to 10.2.29.
- 10.2.56 The Site is located within the Idle and Torne and Don and Rother management catchments. The peak river flow allowances for each catchment are summarised in **Table 10.2 1**, with EA guidance advising that the higher climate change allowance should be used for 'Essential Infrastructure'.

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<sup>1</sup> The general approaches to assessing and mitigated flood risks arising from climate change impacts identified within the recent NaFRA2 flood mapping updates were discussed during a meeting on 24 February 2026. The approach was agreed by the EA in a letter dated 17 April 2026.

**Table 10.2 1 Peak River Flow Climate Change Allowances (2080s Epoch)**

Management Catchment	Central Allowance	Higher Allowance
Idle and Torne	27%	39%
Don and Rother	28%	38%

- 10.2.57 Therefore, the design flood event for the Site is the 1.0% AEP + 38% or 39% climate change allowance (2080s higher allowance), depending on the management catchment each exact location falls within.
- 10.2.58 For one location on the Site at the Ulley Brook, fluvial flood extents are included in the existing River Rother model (2023), where an area proposed to be filled with solar panels to the south of Long Lane is modelled as a 1D reservoir unit. Existing model results include the most up to date climate change allowances for the Don and Rother catchment and considers the defended scenario. Therefore, model results from the design event of 1.0% AEP + 38% climate change at this location will be used to identify fluvial flood levels from the Ulley Brook.
- 10.2.59 As these results are 1D and not 2D, spatial flooding will be assessed by determining the maximum flood level shown during the design event at the relevant reservoir node, then adding a freeboard of 0.3m and comparing this level to lidar to assess flood extents.
- 10.2.60 Upstream of the Rother model domain on the Ulley Brook, and on Anston Brook and Broad Bridge Dyke, there is no existing flood model available. Therefore flood extents and levels have been inferred using available LiDAR and EA Flood Map for Planning data.
- 10.2.61 Given all infrastructure other than solar panels is located within Flood Zone 1, and receptors at risk of fluvial flooding are limited to photovoltaic (PV) panels, the Proposed Development is considered to have a low vulnerability to flooding. Therefore, a proportionate assessment method has been adopted.
- 10.2.62 An example of the derivation method, which has been agreed with the EA, is provided below. This example determines the 0.1% AEP extents at Anston Brook.
- 10.2.63 At (E: 450763, N: 384551), on Anston Brook an area of panels is within the flood zone. Sections are drawn along the reach at risk, as shown in **Figure 24** and **Figure 25**. The locations where each cross section intersects the edge of the flood map extents can be identified.
- 10.2.64 Annex 1 also provides details on the calculations completed to derive fluvial design levels.

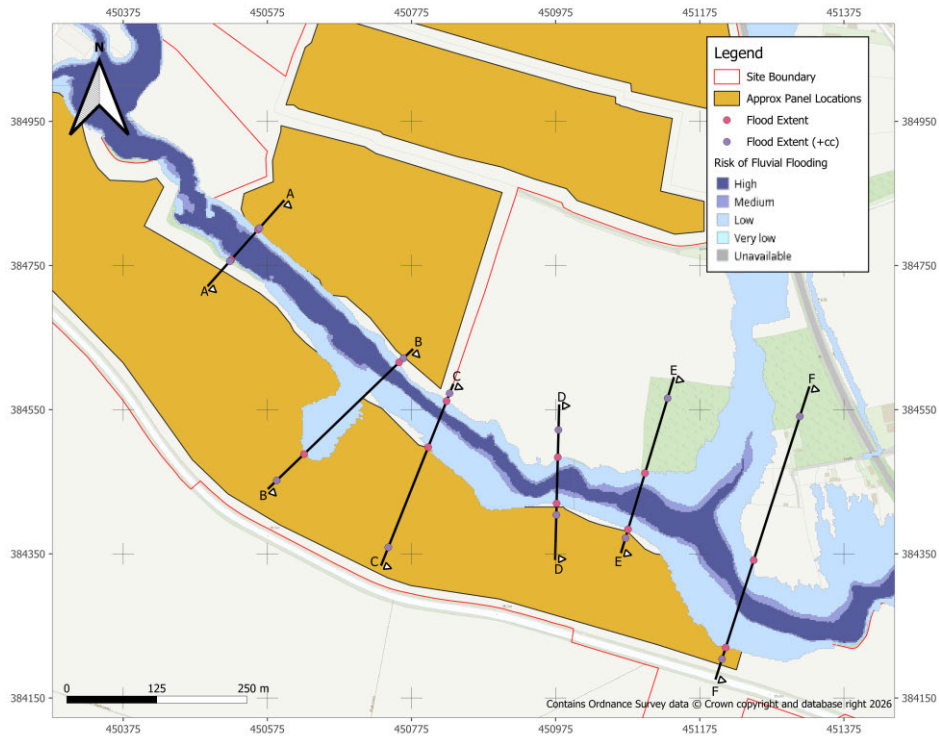


Figure 24: Example Flood Map Extents and Cross-Sections (0.1% AEP No CC)

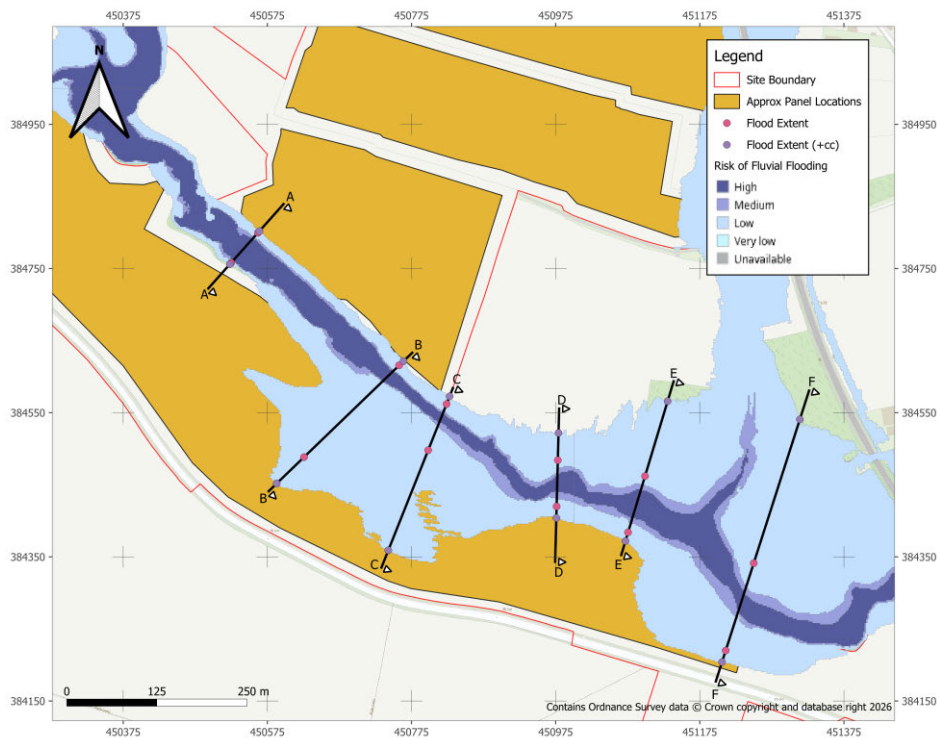
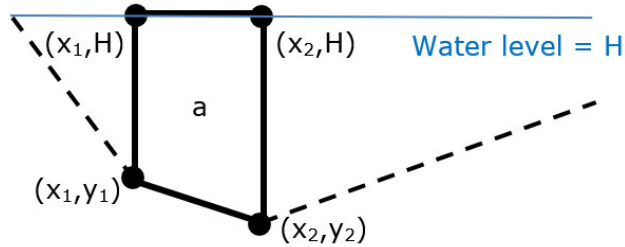


Figure 25: Example Flood Extents and Cross-Sections (0.1% AEP + Central CC)

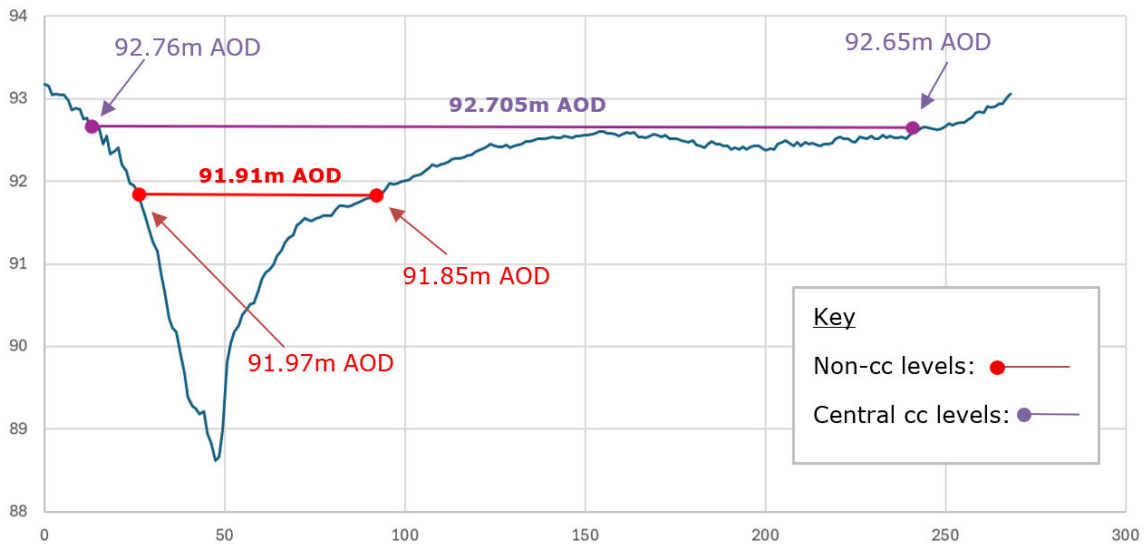
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- 10.2.65 Take section C-C, using LiDAR data, we can plot the cross-section and add corresponding points where the edge of the flood map extents intersect lidar, to identify flood levels for non-cc and central cc scenarios.
- 10.2.66 Assuming flat water level across the channel (i.e. no hydraulic gradient perpendicular to the direction of flow), take the average flood level across the section. Using this flood level, the cross-sectional area of flows can be calculated. Area can be calculated by splitting the cross-sections into trapeziums, and finding the sum of the areas of slices, using the formula:

$$A = \sum a \text{ where } a = (x_2 - x_1) \left( \frac{(H-y_1)+(H-y_2)}{2} \right) = \frac{1}{2} (x_2 - x_1) (2H - y_1 - y_2)$$



**Figure 26: Diagram of Generic Flood Cross-Section**



**Figure 27: Example Section C-C with labelled elevations**

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- 10.2.67 Then the area of flow during the higher climate change scenario will be estimated, by extrapolating from values for the other areas using peak river flow allowances for the 2080s epoch. For this stream, which lies in the Idle and Torne Management Catchment, the required higher climate change allowance is 39%, compared to the central allowance of 27%.
- 10.2.68 This can be used to calculate an increased flood level and identify maximum flood extent for the higher climate change scenario. For example:  $A_{hcc} = A_n + \frac{f_{hcc}}{f_{cc}}(A_{cc} - A_n)$  where  $A_{hcc}$  is the higher climate change area,  $A_{cc}$  is central climate change area,  $A_n$  is the no climate change area and  $f$  are the central and higher climate change allowances.
- 10.2.69 For this scenario,  $A_{hcc} = 75.44 + \frac{39}{27}(175.31 - 75.44) = 219.69\text{m}^2$ , which working backwards and using the known ground profile, gives a corresponding new flood level of 92.88m.

**Table 10.2 2 Calculation Table for Example Section C-C**

	CC Factor	H (m AOD)	Flow area, A (m <sup>2</sup> )
No CC	0%	91.91	75.44
Central CC Allowance	27%	92.71	175.31
Higher CC Allowance	39%	<b>92.88</b>	<b>219.69</b>

- 10.2.70 Once the new water level is calculated using this method, given no detailed modelling has been completed as part of this method, a freeboard of 600mm will be added to account for uncertainty, giving a final flood level of 93.48m at this section. It will be ensured that the lowest edge of the solar panels will be set to a height above this level.
- 10.2.71 Repeating this for all sections gives a distribution of flood levels along the length of the watercourse.
- 10.2.72 This method is acknowledged as a being conservative approach with a relatively high freeboard, resulting in a relatively high design flood level. As such, there is scope to refine these conservative estimates with hydraulic modelling.
- 10.2.73 Where these conservative estimates prove to be too conservative, this hydraulic modelling may be completed during detailed design to provide design flood levels with a greater degree of certainty. It is anticipated that this modelling will result in a lower design levels, which in some circumstances may enable a greater panel tilt and hence greater energy generation capacity.
- 10.2.74 Irrespective of the final approach used to define the design flood level, the design flood level will always be determined considering the 1.0% AEP event plus higher climate change allowance, and a suitable freeboard.
- 10.2.75 This FRA sets out an initial conservative estimate of this design level, leaving the opportunity open to reduce the uncertainty in these estimates should it be economically viable to do so at detailed design phase.

## Design Pluvial Flood Levels

- 10.2.77 To assess pluvial or surface water flood levels across the Order Limits, the EA's surface water flood mapping was used. The Design Flood Event for surface water flooding is also the 1.0% AEP event + central climate change allowance for the 2070s epoch.
- 10.2.78 Using a similar method to that for fluvial flooding was ultimately deemed inappropriate, considering pluvial flooding tends to occur in local depressions, where there is often no clear flow path and hence no obvious cross-section to analyse.
- 10.2.79 EA Surface Water Flood Risk Mapping - Climate Change flood map includes allowance for the central climate change factor for the 2050s epoch<sup>26</sup>. Considering the type and planned lifetime of the Proposed Development, the required climate change allowance for the design event at this site is the central climate change allowance for the 2070s epoch.
- 10.2.80 The peak rainfall climate change allowances for the Idle and Torne and Don and Rother management catchments are summarised in **Table 10.2 3**. It can be seen these allowances are both the same. Therefore, the required climate change allowance is a 25% uplift.

**Table 10.2 3 Peak Rainfall Climate Change Allowances**

Management Catchment	Central Allowance (2050s epoch)	Central Allowance (2070s epoch)
Idle and Torne	20%	25%
Don and Rother	20%	25%

- 10.2.81 To obtain a conservative estimate of the required climate change allowance, the 1000-year or 0.1% AEP event was used as a proxy for the 1% AEP + 25% climate change event.
- 10.2.82 This can be justified by peak rainfall data obtained from the FEH22 dataset from the Flood Estimation Handbook Web Service.
- 10.2.83 Point data was obtained at location (E: 448081, N: 387811) at the centre of the Whitestone Order Limits. For a 6 hour storm duration and 100 year return period event, a design rainfall of 67.15mm was calculated. Increasing this by 25% to include the 2070s climate change allowance gives a design rainfall of 83.94mm.
- 10.2.84 The design rainfall for the 1000 year without climate change event was calculated to be 106.13mm, which is greater than 83.94mm. Therefore, using the 0.1% AEP event mapping provides a conservative estimate for surface water flood depths across the Site.
- 10.2.85 The depth banding data included within the EAs Surface Water flooding dataset was used to assess depths. Any depths lower than 0.2m were excluded from consideration, as a minimum panel elevation of 0.4m above ground level provides at least 100% of flood depth in freeboard.
- 10.2.86 For all depths greater than 0.2m, an extra freeboard of 0.6m is applied to further ensure the depth estimates are conservative. This freeboard may be reduced if a more detailed assessment of pluvial flood risk is completed at the detailed design stage.
- 10.2.87 Similar to the fluvial flood levels, there is scope to improve pluvial depths with hydraulic modelling should it be economically beneficial to do so.

## Site Specific Assessment

### Development Vulnerability

- 10.2.88 The Proposed Development is categorised as ‘Essential Infrastructure’ as defined in Annex 3 of the NPPF. This development category is permissible in Flood Zones 1 and 2 without requiring an exception test. Essential Infrastructure may also be permissible within Flood Zone 3 or 3b if it can be shown to pass the exception test.
- 10.2.89 If within Flood Zone 3, essential infrastructure should be designed to remain operational and safe in times of flood, result in no net loss of floodplain storage, and not impede water flows or increase flood risk elsewhere.
- 10.2.90 The Site is mostly located within Flood Zone 1, with only some small areas of solar panels within Flood Zones 2 and 3. Within these areas, the Proposed Development has been designed to ensure safe operation up to the design flood event of 1.0% AEP + climate change (considering the 2080s epoch higher allowance for climate change in alignment with EA guidance). In essence, the minimum elevation of any panels within flood zones will be raised above the design flood level, which is set by the design flood level (inc. climate change) plus an appropriate freeboard allowance.

### Sequential Test

- 10.2.91 NPS EN-1 requires all new developments to undertake the Sequential Test in order to locate infrastructure in areas with the lowest risk of flooding. Furthermore paragraph 174 of the NPPF *states “the aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source”*.
- 10.2.92 The Applicant has demonstrated in detail, within Section 8.7 of the **Planning Statement [EN0110020/APP/5.5]**, submitted with the Application, the Applicant's compliance with the key policy tests and requirements from EN-1, notably paragraph 5.8.36, in relation to water resources and flood risk. It is considered that the Site selection process has passed the Sequential Test and that the design and layout has considered the flood risk characteristics of the Order Limits and taken a sequential approach.

### Exception Test

- 10.2.93 The exception test also applies to any Essential Infrastructure within Flood Zone 3.
- 10.2.94 To pass the Exception Test it must be demonstrated that;
- The development that has to be in a flood risk area will provide wider sustainability benefits to the community that outweigh flood risk; and
  - The development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.
- 10.2.95 In relation to the first bullet point, above, the Applicant considers that the significant benefits that the Proposed Development would deliver, as set out in Section 3 of the **Planning Statement [EN0110020/APP/5.5]**, submitted with the

Application, would clearly outweigh flood risk. These are considered to be 'sustainability benefits to the community' as specified in paragraph 178 of the NPPF for the following reasons:

- Significant renewable energy schemes at this scale are required to be able to meet the legally binding commitment to Net Zero and make energy more affordable and reliable for all;
- The Proposed Development delivers local community benefits through the proposed permissive paths, biodiversity net gain and environmental enhancements; and
- Socio-economic benefits are also anticipated to be available for the local communities through employment opportunities.

10.2.96 Point 2 of the Exception Test is passed as this FRA will demonstrate that the Proposed Development will be safe for its lifetime, without increasing flood risk elsewhere.

### Ensuring Safe Development – PV Panels

- 10.2.97 As discussed in paragraphs 10.2.55 to 10.2.75, fluvial design flood levels have been derived from the existing EA Flood Map for Planning dataset and available LiDAR data or extracted from available flood models, before a suitable freeboard is added.
- 10.2.98 Pluvial flood depths were also derived using the EAs Risk of Surface Water Maps and depth banding data.
- 10.2.99 Design fluvial flood levels are presented in **Figure 28** to **Figure 32** below. Consequent fluvial flood depths are shown in **Figure 33** to **Figure 39** alongside pluvial flood depths.
- 10.2.100 Annex 1 also provides details on the calculations completed to derive fluvial design levels.
- 10.2.101 For fluvial flooding, a design climate change allowance of 38/39% is used equating to the peak river flow higher allowance for the 2080s epoch.
- 10.2.102 For pluvial flooding, a design climate change allowance of 25% is used, equating to the peak rainfall central allowance for the 2070s epoch.

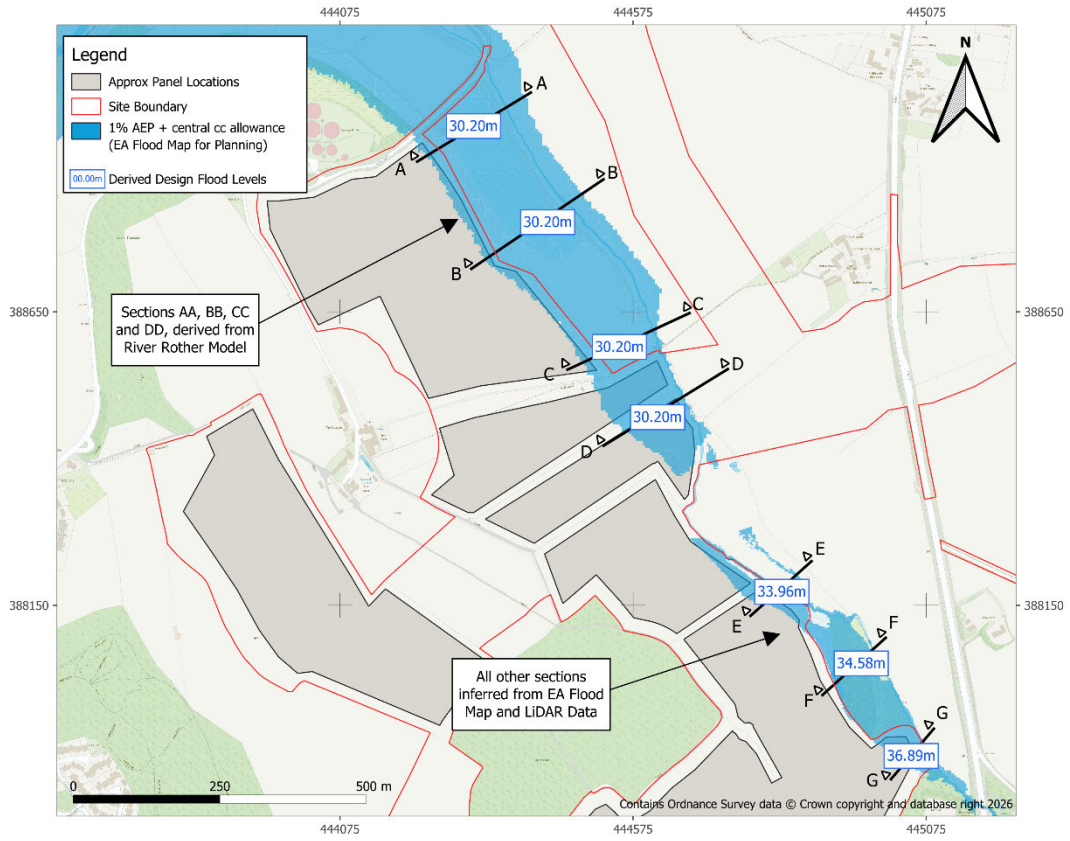


Figure 28: Design Fluvial Flood Levels at Ulley Brook (1)

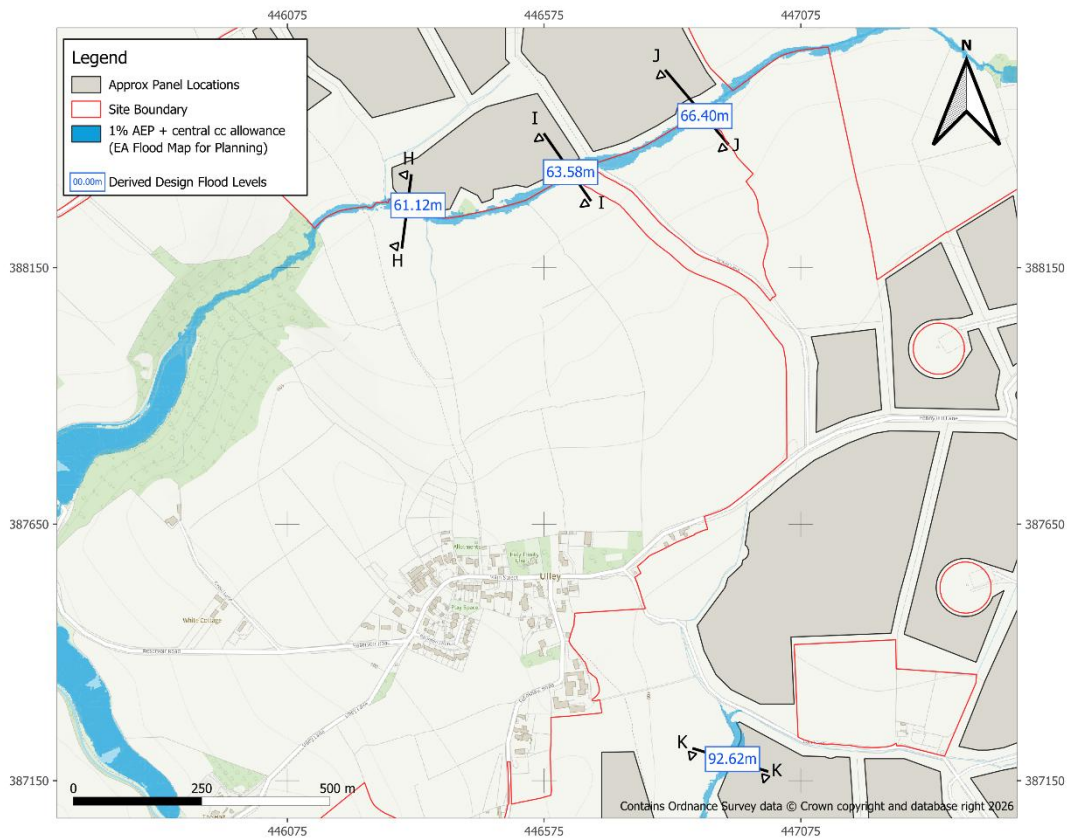
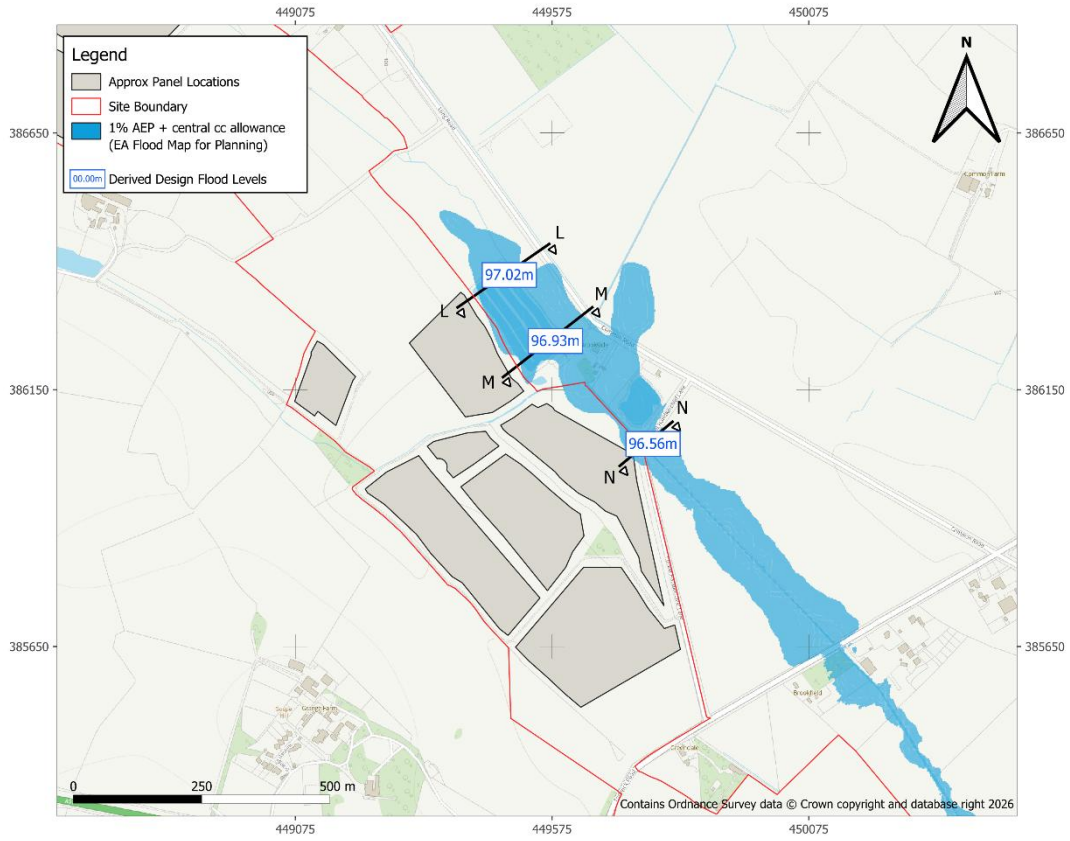
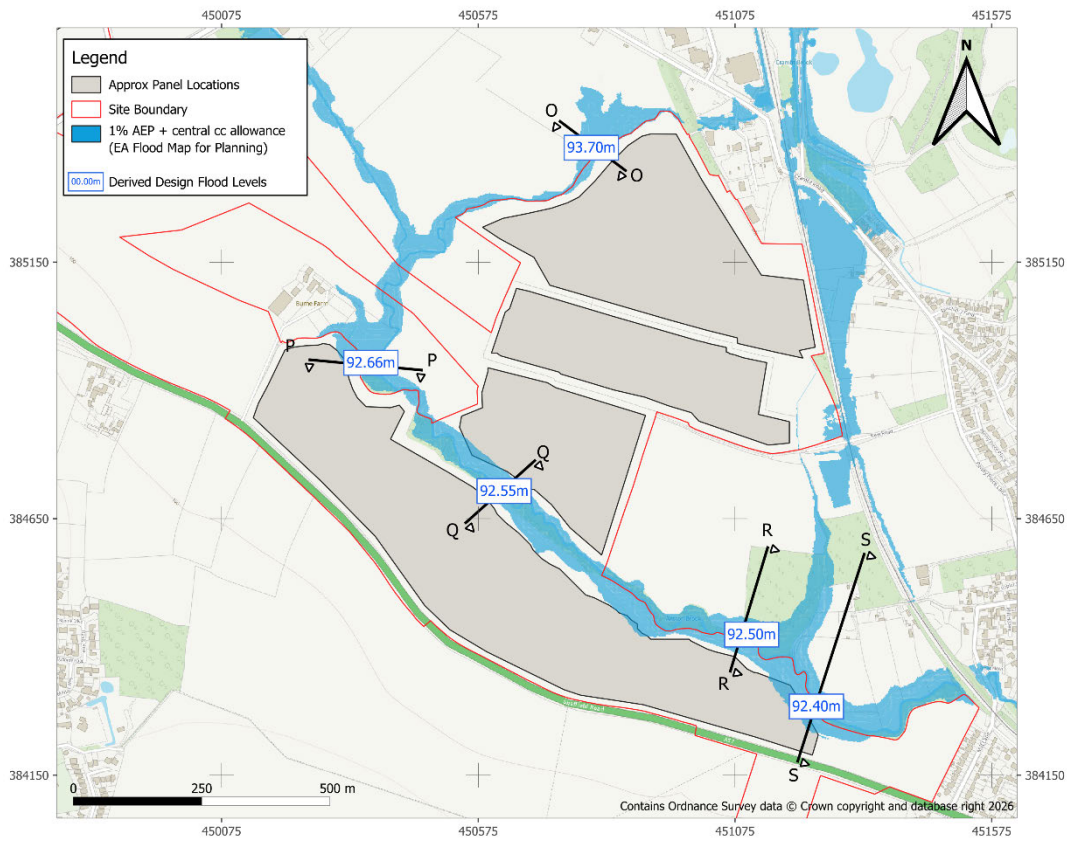


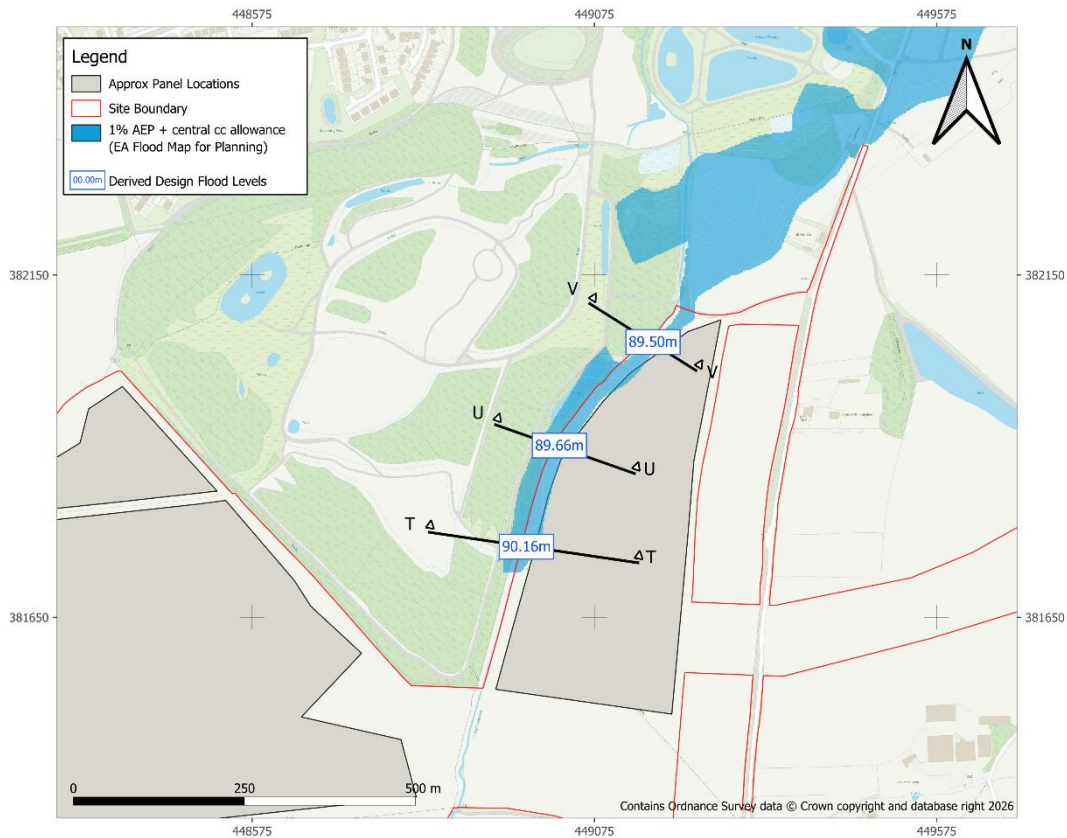
Figure 29: Design Fluvial Flood Levels at Ulley Brook (2)



**Figure 30: Design Fluvial Flood Levels at Anston Brook (1)**



**Figure 31: Design Fluvial Flood Levels at Anston Brook (2)**



**Figure 32: Design Fluvial Flood Levels at Broad Bridge Dyke**

- 10.2.103 All key infrastructure aside from solar arrays, including inverters, BESS and substations will be entirely located within Flood Zone 1, hence design levels are only relevant to solar panel elevations.
- 10.2.104 Once design flood levels and depths were determined, areas of panels were identified which may have to be raised to ensure safe operation of the Site is possible up to the 1.0% AEP + climate change design event.
- 10.2.105 **Figure 33 - Figure 39** illustrate zones where solar panels fall within the extents of fluvial or pluvial flooding during the design event and highlight required solar panel raising.
- 10.2.106 For fluvial flooding, in most areas the standard 0.4m minimum panel elevation above ground level is sufficient. In other areas, the panel elevation is below the estimated design flood level, meaning panels should be raised further.
- 10.2.107 In all panel areas within fluvial flood zones, where localised depressions in ground level occur, flood depths may increase. Here, local panel heights may increase, although the total level (AOD) of the panels will remain constant.
- 10.2.108 For pluvial flooding, areas of panels are to be raised to align with the zones of depth banding, where minimum panel elevation should be raised to the depth band plus 600mm freeboard. For example, for a panel within the 0.3m depth banding zone, minimum panel elevation should be at least 0.9m above ground level. This freeboard may be reduced if a more detailed assessment of pluvial flood risk is completed at the detailed design stage.

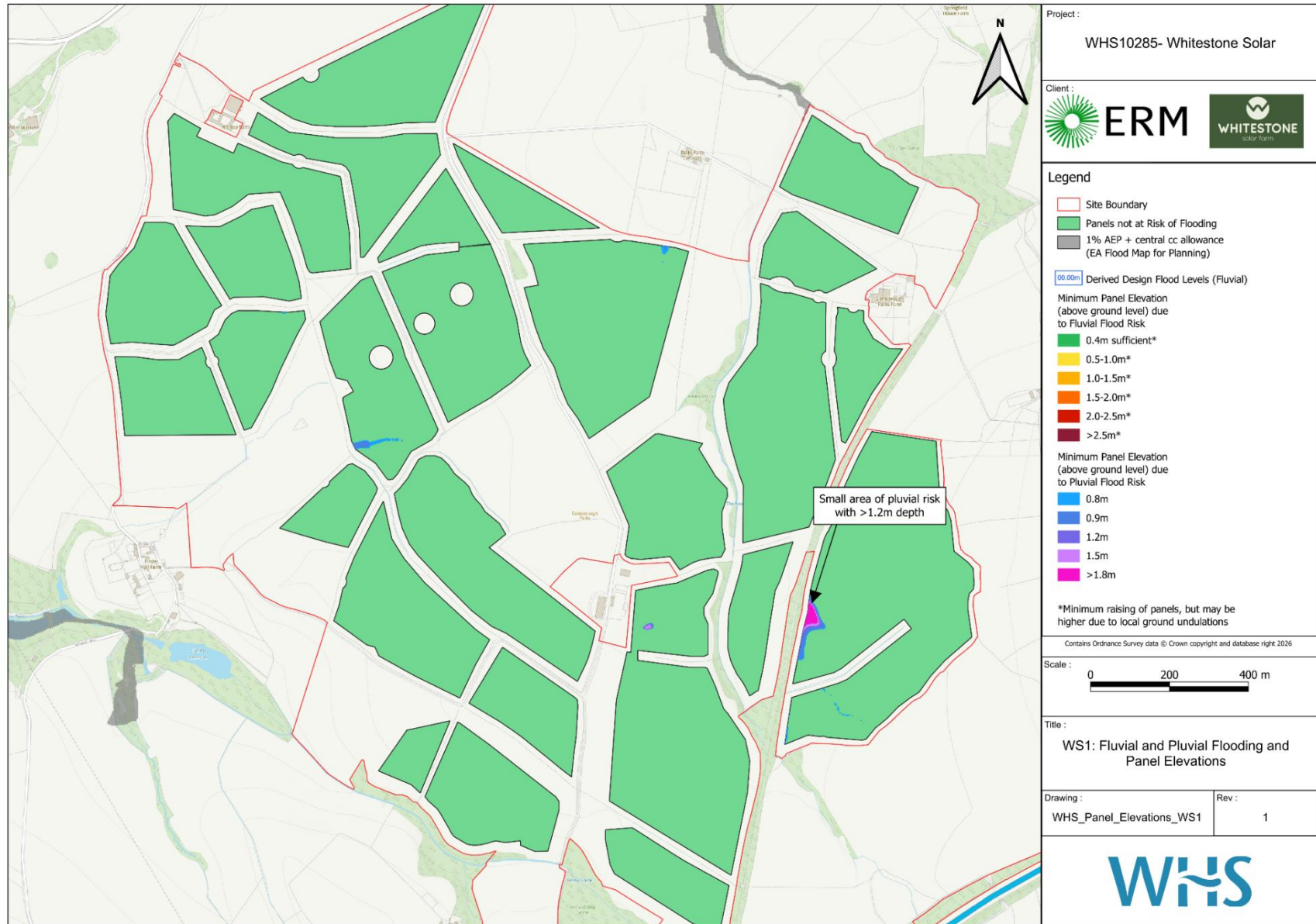


Figure 33: Fluvial and Pluvial Flooding and Panel Elevations, W1

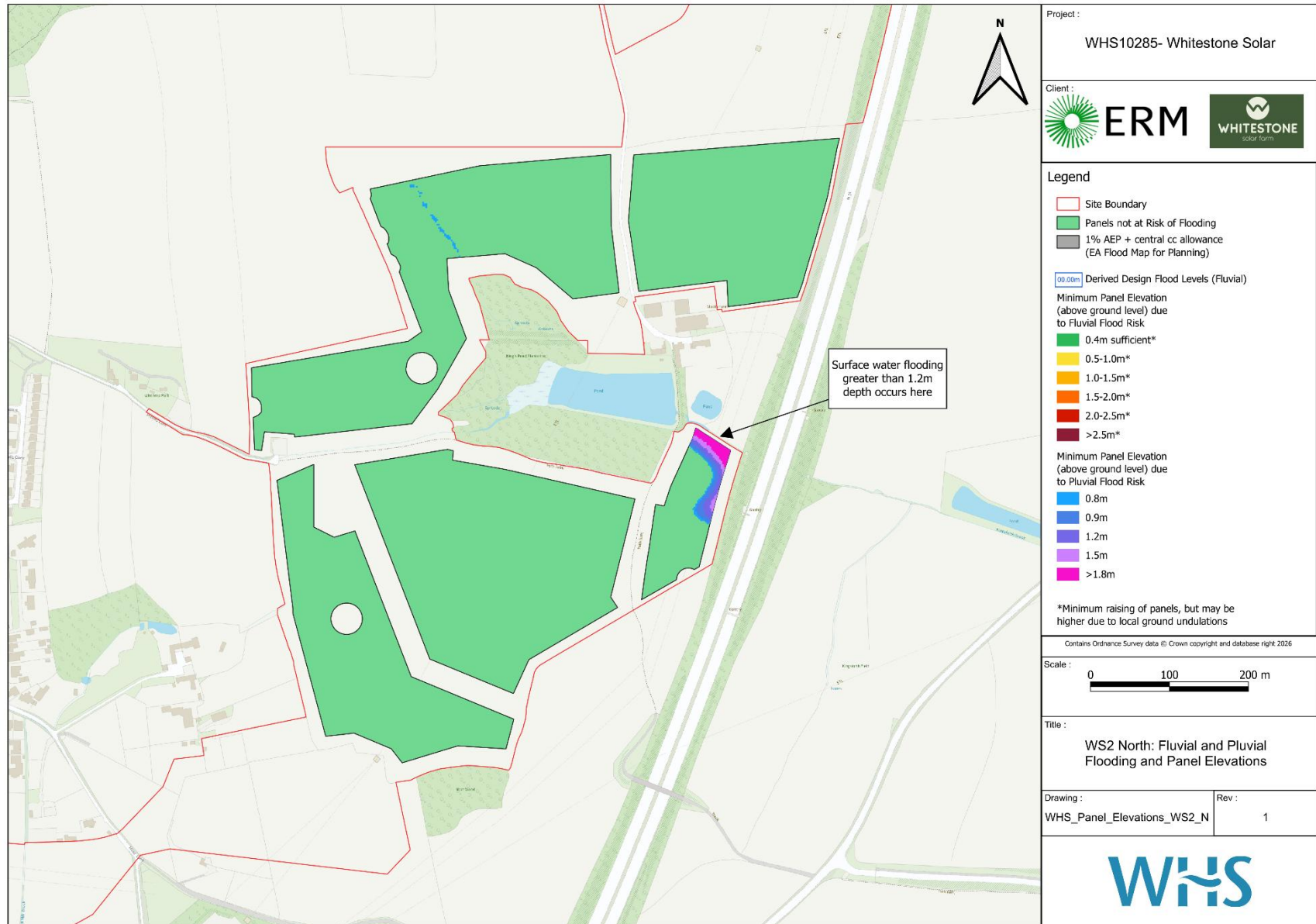


Figure 34: Fluvial and Pluvial Flooding and Panel Elevations, W2 North

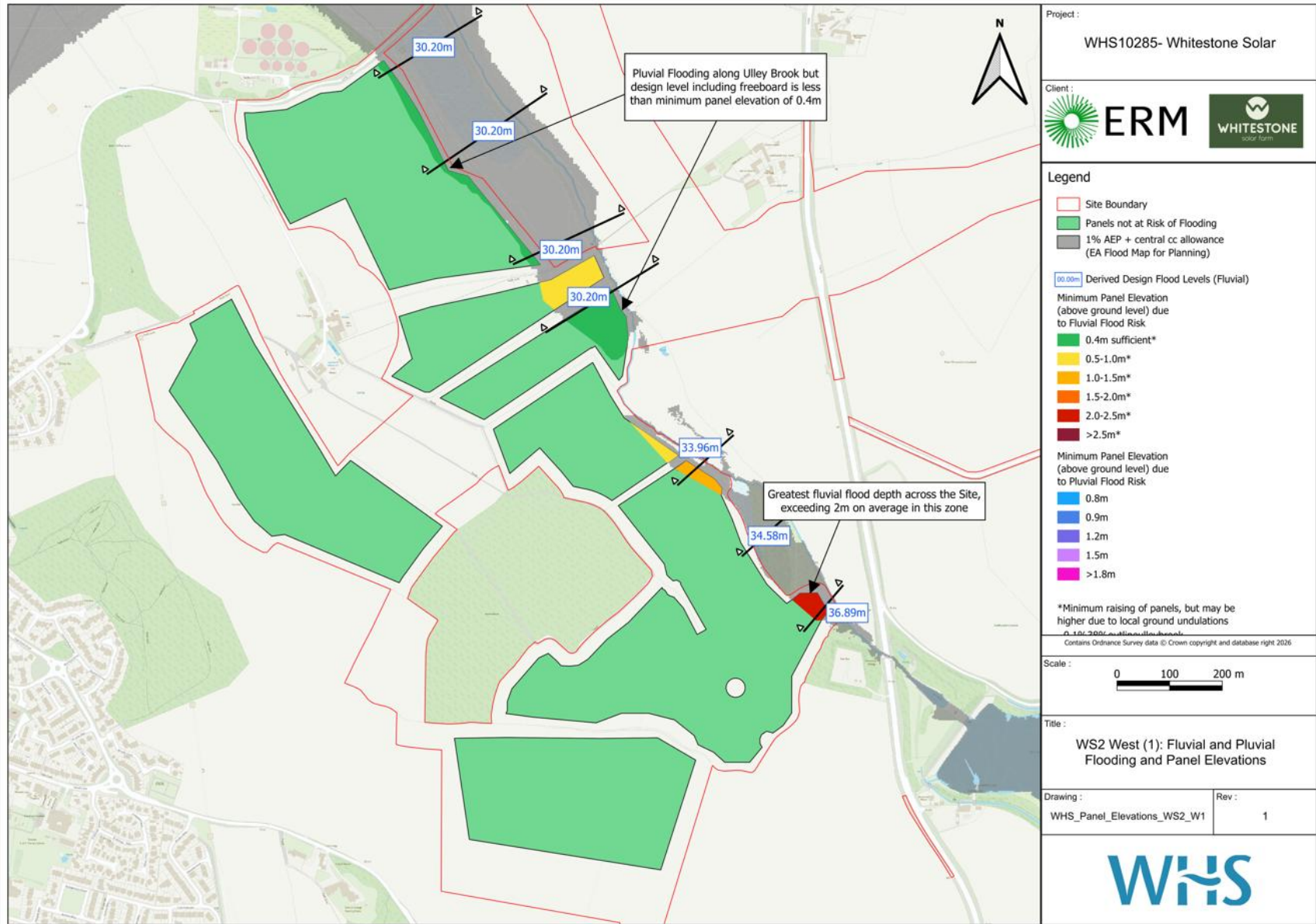


Figure 35: Fluvial and Pluvial Flooding and Panel Elevations, W2 West (1)

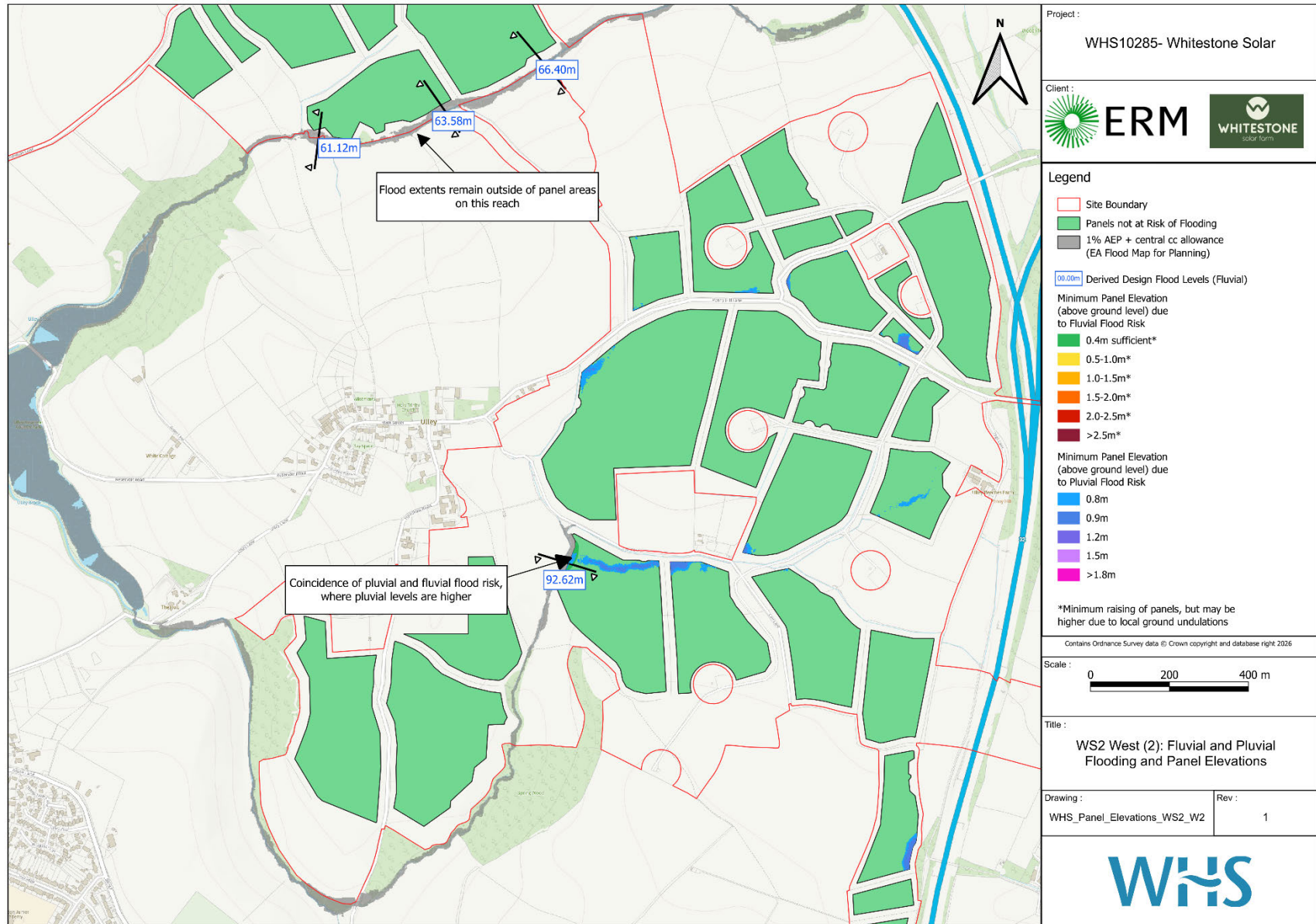
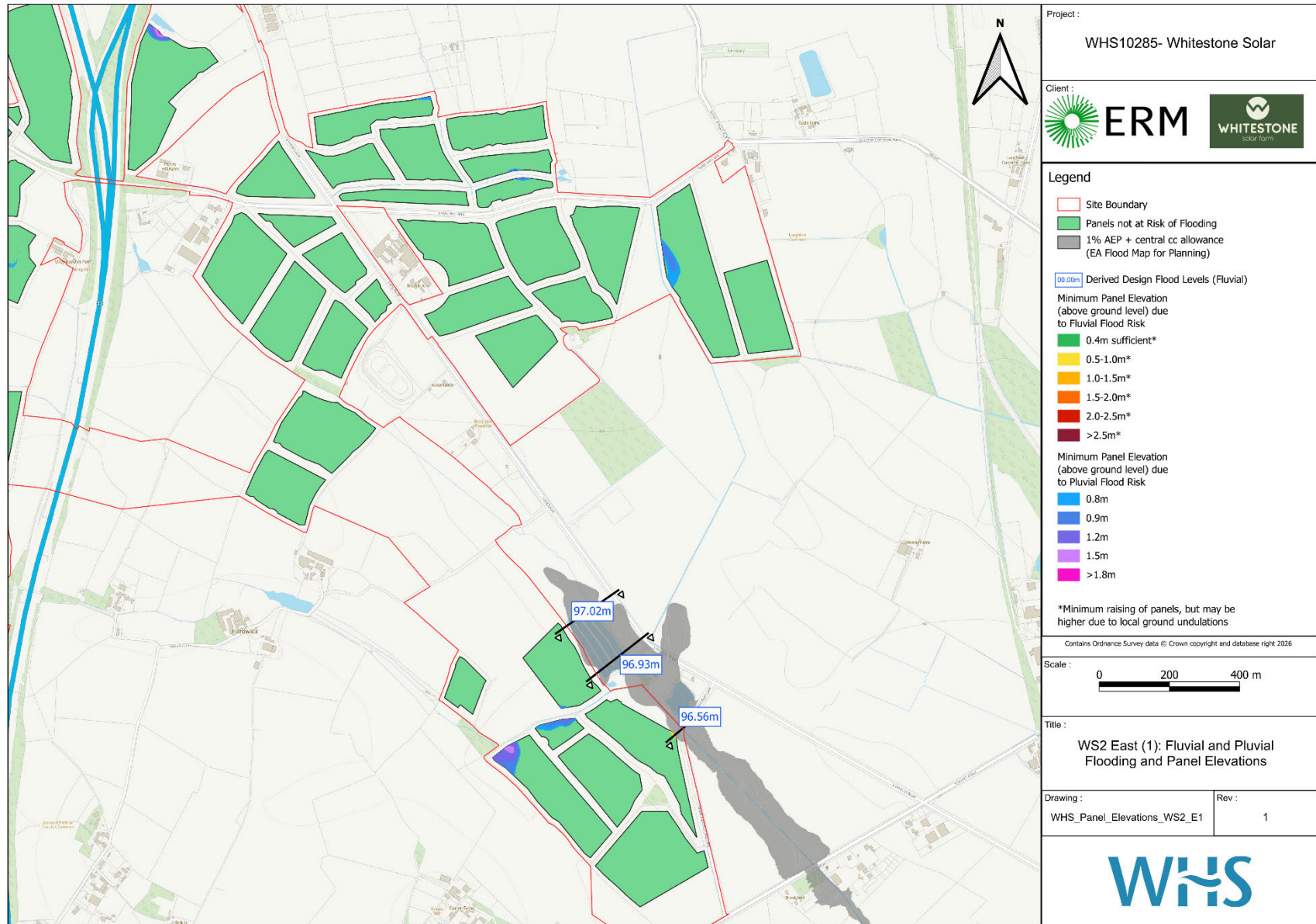


Figure 36: Fluvial and Pluvial Flooding and Panel Elevations, W2 West (2)

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**Figure 37: Fluvial and Pluvial Flooding and Panel Elevations, W2 East (1)**

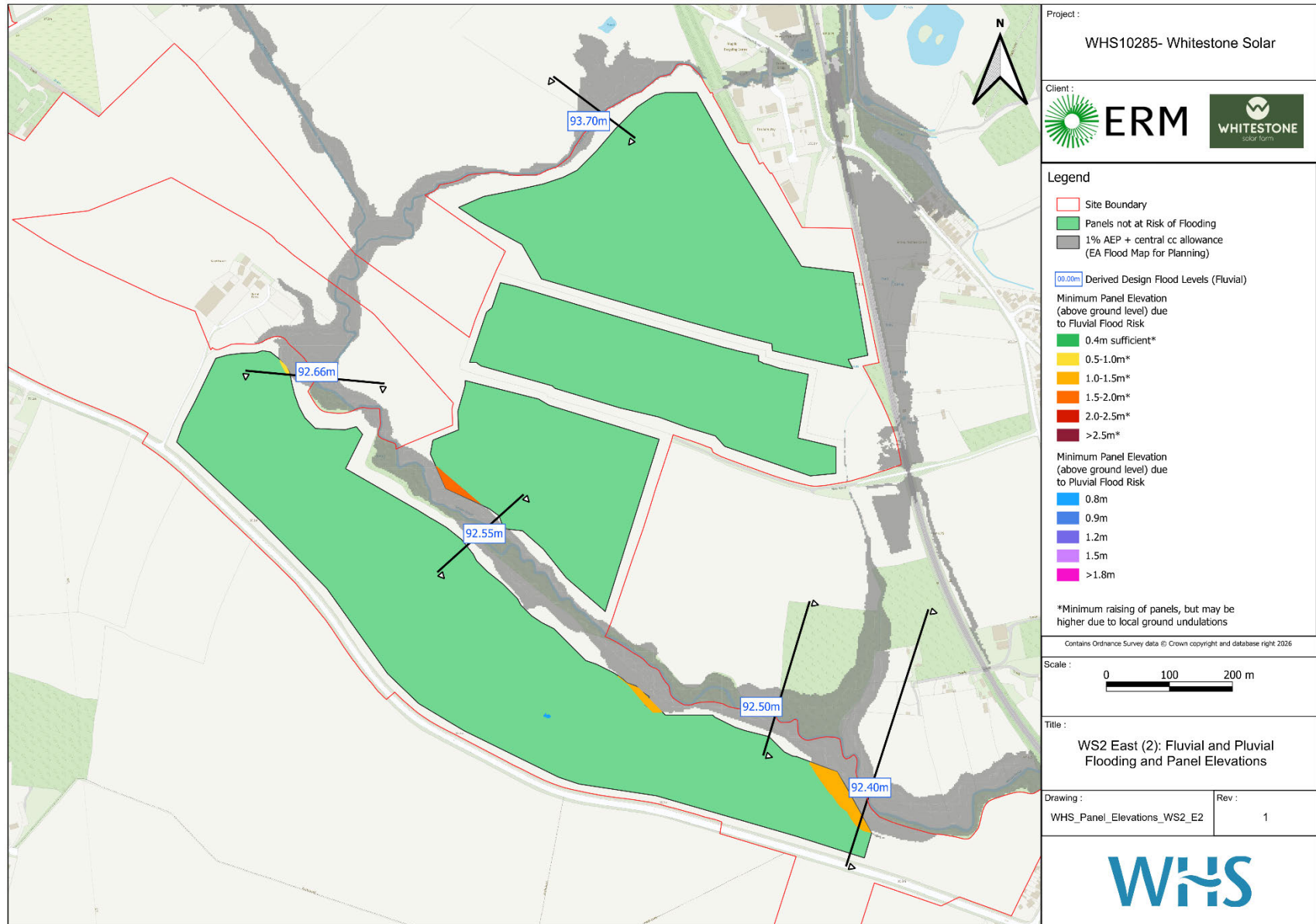


Figure 38: Fluvial and Pluvial Flooding and Panel Elevations, W2 East (2)

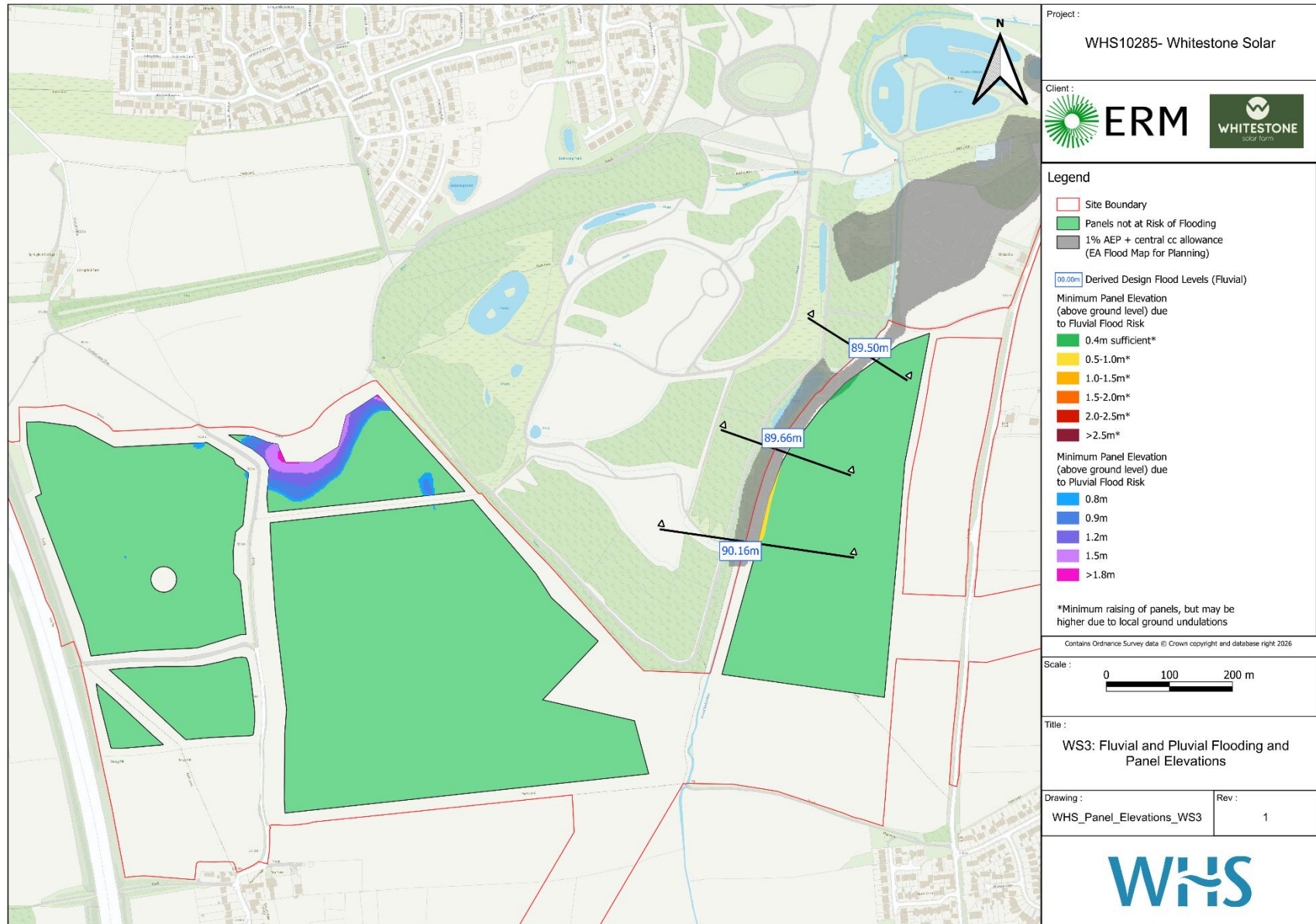


Figure 39: Fluvial and Pluvial Flooding and Panel Elevations, W3

## Ensuring Safe Development – Infrastructure

- 10.2.109 As part of the Proposed Development there are three locations that have been identified as being suitable for the supporting ancillary infrastructure, which predominantly includes substations and BESS.
- 10.2.110 The location of these three infrastructure parcels is shown in **Figure 40** to **Figure 42**. Within these parcels there is only pluvial flood risk, although some of this risk is thought to be fluvial in nature due to it coinciding with mapped watercourses/field drains.
- 10.2.111 Placement of infrastructure within these parcels will follow the mitigation hierarchy below:
- Option 1 – Locate all infrastructure in areas outside of the mapped climate change pluvial extents during post consent detailed design; and
  - Option 2 - Where Option 1 is not possible, infrastructure will be located within a pluvial risk area that is not associated with a defined surface water flow route. These areas are locations of pluvial ponding and can be managed as part of the **outline Surface Water Drainage Strategy (oSWDS) [EN0110020/APP/5.17]** for the Site. Infrastructure in these locations will not have any impact on flood risk as surface water run-off is controlled within the surface water drainage design. These locations are identified with a green hatch in **Figure 40** to **Figure 42**.
- 10.2.112 **Figure 40** and **Figure 41** shows the location of infrastructure parcels 1A and 2A respectively. Within these parcels there is only localised ponding, hence placement of infrastructure can be made anywhere within these parcels, provided the surface water drainage design, as part of the **oSWDS [EN0110020/APP/5.17]**, manages ponding within the identified localised depressions.
- 10.2.113 **Figure 42** shows the location of infrastructure parcel 2B. For the most part infrastructure can be located anywhere within the parcel boundary provided that a suitable surface water drainage is in place to manage run-off that currently ponds in the localised depressions, as part of the **oSWDS [EN0110020/APP/5.17]**. There is however some pluvial flood risk that is thought to be fluvial in nature, which is associated with the field drains on the southern border. In line with mitigation options 1 and 2 above, infrastructure will not be located in these areas (orange hatching on **Figure 42**).



Figure 40: Location of Substation 1A



Figure 41: Location of Substation and BESS 2A



Figure 42: Location of Substation 2B

### Management of Surface Water Run-off

- 10.2.114 An **oSWDS [EN0110020/APP/5.17]** has been developed to ensure the Proposed Development does not result in increased surface water runoff and hence increased surface water flood risk to nearby locations.
- 10.2.115 The installation of the PV panels is not expected to increase the total volume or rate of surface water run-off across the Site. The impervious surface of the panels will however result in localised concentration of rainwater falling from the lower edge of each array, known as the drip line. To effectively mitigate the areas between, under and surrounding the solar PV modules will be suitably planted with native grassland and wildflower mix (noting that planting types will be described within **the outline Landscape and Ecological Management Plan [EN0110020/APP/5.13]**). This planting will intercept and absorb rainfall running off the solar PV modules, preventing it from concentrating and potentially forming channels in the ground.
- 10.2.116 Strategic SuDS features, such as filter drains, swales, and basins / scrapes will be within the solar array areas. These features will promote ground infiltration and provide ecological and biodiversity benefits. Details are provided in the **oSWDS [EN0110020/APP/5.17]**.
- 10.2.117 Land under the PV Arrays will be allowed to naturally vegetate increasing infiltration and surface roughness, thereby reducing surface water runoff. Vegetative cover also provides a natural attenuation mechanism for sediment. Modelling work from Cook and McCuen (2013)<sup>27</sup> demonstrate that vegetated

ground cover beneath solar arrays plays a critical role in moderating runoff dynamics and reducing erosion risk when compared to unvegetated or gravel-covered substrates.

### **Impact on Flood Risk in Surrounding Areas**

#### **PV Panels**

- 10.2.118 To address the requirement for no net loss of floodplain storage, an embedded mitigation strategy has been adopted for the structural design. All PV panels located within flood risk areas will be mounted on solar PV frames and elevated completely above the design flood level. Furthermore, the use of above-ground raft foundations within these zones is not proposed. The panels are raised above the floodwaters, therefore only the legs will intersect the flood volume.
- 10.2.119 To assess the impact that placing PV legs within a flood risk area could have, a simple volumetric analysis has been completed, which is considered appropriate for this type of development.
- 10.2.120 This assessment has been completed at the location where flooding is deepest as this is the worst case scenario. All other locations where flooding is shallower will have lower impacts because the volume of the legs below the design flood level is also lower. Additionally, as the plan view leg density is constant, we do not need to consider absolute areas but instead consider it on a per m<sup>2</sup> basis. This is of course a conservative approach as impacts are unlikely to be constrained to just the panel areas and instead are likely to be distributed across the local flood cell.
- 10.2.121 Further measures to ensure that the volumetric calculation is conservative include the assumption that every PV panel unit has its own legs. In reality adjacent panel units share legs, meaning the number of panel legs here is overestimated. The legs themselves are also assumed to be solid rectangular sections, whereas in reality they are narrow C-section shaped, taking up significantly less space than the rectangular approximation.
- 10.2.122 The maximum flood depth within the Site is approximated to be 2.1m, and at this location the calculation of volumetric displacement corresponds to a flood level increase of approximately 3mm. When removing the assumption that the legs are solid, instead considering their true dimensions, this increase reduces to only 0.18mm.
- 10.2.123 This level of increase can be deemed negligible and will therefore not impact flood risk to areas surrounding the Site. This is because all areas of flooding across the Site are relatively constrained in terms of topography, meaning there will be no impacts beyond the developed area. There are no areas of panels within flood zone 3b, meaning panel legs are not removing capacity from areas of designated flood storage.

### Access Tracks

10.2.124 Where access tracks have to cross a fluvial or pluvial overland flow route they will be constructed such that the final level is at grade, meaning there will be no impact on flow routes and hence no impact on flood risk.

### Fences

10.2.125 The use of fences within the Proposed Development is unavoidable. Where fencing is required within a flood risk area, they will be for the most part be parallel to the direction of flow. This results in these fence lines having a negligible impact on flood risk as flow and debris will flow parallel to the fence and hence the risk of debris becoming caught is low.

10.2.126 Where fence lines are not parallel to the direction of flow they will introduce a small risk of blockage should debris become trapped in the fence openings. To mitigate this risk the open space within the fence will be as large as it can be, to allow water flow through the fence, without compromising the structural integrity of the fence or unnecessarily increasing security risk to the development.

10.2.127 In addition to the design of the fence being one that reduces the risk of blockage through design, in the event that a local blockage does occur the impacts will be very local and are unlikely to go beyond the Order Limits.

### Access/Egress

10.2.128 Due to the scale of the Site and the isolated risk of flooding from both fluvial and pluvial sources, access and egress constraints are not considered to be Significant issues.

10.2.129 The Proposed Development will be unmanned during standard operation, with access required solely for scheduled maintenance. Operational protocols will ensure that such maintenance activities are not completed during a flood event, fully mitigating this risk.

### Summary and Conclusion

10.2.130 The Proposed Development is categorised as 'Essential Infrastructure', consisting of a large solar farm of over 100MW and associated infrastructure.

10.2.131 The Site is located almost entirely within Flood Zone 1. Only a very small area of the proposed solar panels falls within Flood Zones 2 and 3, located at three specific areas: Ulley Brook, Anston Brook, and Broad Bridge Dyke.Site.

10.2.132 The Site is at some risk of surface water flooding, but risk is limited to areas around localised depressions.

10.2.133 There is some risk of reservoir flooding at two areas on the Site, although risk of reservoir flooding is very small due to high safety standards for reservoir maintenance in the UK and is therefore considered **Not Significant**.

10.2.134 The risk of flooding due to the Chesterfield Canal is **Negligible** and **Not Significant** because water levels are strictly managed and at this location the canal does not act as a conduit for river flooding, additionally the canal is located at a level below the nearest section of the Proposed Development and is therefore not a risk of flooding should the canal breach.

10.2.135 In the few areas where solar panels are at risk of fluvial or pluvial flooding, panels will be raised above the design flood level, defined as the 100yr + higher

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climate change allowance event, to ensure the Site can still operate safely during flooding. Therefore, no Significant effect.

- 10.2.136 In the one location where substation 2B infrastructure is potentially within areas of pluvial flooding linked to a fluvial source, any flood risk can be mitigated to not significant through avoidance of pluvial areas in detailed design. Therefore, no Significant effect.
- 10.2.137 The Proposed Development will have no impact on surrounding areas given proper implementation of the **oSWDS [EN0110020/APP/5.17]**, and that any loss in flood plain storage due to solar panel frames will not cause any detriment beyond the Order Limits. Therefore, no Significant effect.

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