Fosse Green Energy

EN010154

6.3 Environmental Statement Appendices

Appendix 9-C: Flood Risk Assessment (Tracked)

VOLUME

6

Planning Act 2008 (as amended)

Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

20 March 2026

Planning Act 2008

The Infrastructure Planning

(Applications: Prescribed Forms and Procedure) Regulations

2009 (as amended)

Fosse Green Energy

Development Consent Order 202[ ]

6.3 Environmental Statement Appendices

Appendix 9-C: Flood Risk Assessment

Regulation Reference	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	EN010154
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Version	Date	Issue Purpose
Rev 1	18 July 2025	DCO Submission
Rev 2	20 January 2026	Deadline 1
Rev 3	20 March 2026	Deadline 3

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Executive Summary

ES 1 This Flood Risk Assessment (FRA) forms a technical appendix to **Chapter 9: Water Environment** of the Environmental Statement (ES) **[EN010154/APP/6.1]** for Fosse Green Energy (hereafter referred to as the 'Proposed Development').

ES 2 The infrastructure for the Proposed Development will comprise the construction, operation and maintenance, and decommissioning of a solar photovoltaic (PV) electricity generating facility, with an on-site Battery Energy Storage System (BESS) and other associated infrastructure, with a total capacity exceeding 50 megawatts (MW), along with an import and export connection to the national transmission network at the proposed National Grid substation near Navenby.

ES 3 A full description of the Proposed Development is included in **Chapter 3: The Proposed Development** of this ES **[EN010154/APP/6.1]**.

ES 4 The design life of the Proposed Development is anticipated to be 60 years, and decommissioning is expected to commence thereafter. The National Planning Practice Guidance (Ref. 5, paragraph 006) suggests that for non-residential development, an assessment period of 75 years can be used to form a starting point for assessment. However, as the operational design life is stated as 60 years, it is considered appropriate to assess the design life for 60 years.

ES 5 The DCO Site is located approximately 9km south and south west of Lincoln City centre, located within the North Kesteven District of Lincolnshire. The area within and surrounding the Proposed Development is a primarily rural setting, comprising of open agricultural fields, individual trees, woodlands, hedgerows, linear tree belts, farm access tracks, local transport roads and villages.

ES 6 In this FRA and throughout the ES, the following definitions are used to describe the key areas of the Proposed Development shown in **Figure 1-1: Proposed Development Location [EN010154/APP/6.3]**.

a. **The DCO Site** – the maximum extent of land required for the construction, operation (including maintenance), and decommissioning of the Proposed Development. The DCO Site comprises the Principal Site and the Cable Corridor. The boundary of the DCO Site is referred to as the DCO Site Boundary. The total area of the DCO Site is approximately 1,368 hectares (ha); 351ha for the Cable Route Corridor and 1,070ha for the Principal Site.

b. **Principal Site** – the area of the DCO Site covered by the ground-mounted solar photovoltaic (PV) panels, Solar Stations, Battery Energy Storage System (BESS), Onsite Substation, planting and mitigation areas, interconnecting cables between solar PV areas, and associated infrastructure. The Principal Site includes interconnecting cable corridors, solar PV array areas, and areas of habitat enhancement and mitigation planting. The total area of the Principal Site is approximately 1,070ha.

c. **Cable Corridor** – the area of the Site in which the 400 kilovolt (kV) and associated cables (the Grid Connection Cables) will be installed between the Onsite Substation and the proposed National Grid substation near Navenby. The proposed National Grid substation near Navenby is subject to a separate application and does not form part of the Proposed Development. The Cable Corridor partially overlaps the Principal Site and is approximately 351ha.

ES 7 This FRA primarily relates to the Principal Site during the operational phase of the Proposed Development, as works within the Cable Corridor are proposed to be installed below ground and therefore not anticipated to have any impact on long term flood risk (i.e. there will be no permanent above ground-built development). The underground cabling is inherently flood protected. Flood risk during the construction of the Proposed Development is to be managed by the onsite contractors through the final Construction Environment Management Plan (CEMP), to be developed post DCO Consent. A **Framework Construction Environment Management Plan (CEMP)** is submitted with the DCO application **[EN010154/APP/7.7]**.

ES 8 The Proposed Development within the Principal Site will consist of the following infrastructure:

a. Solar PV panels (also known as ‘modules’);
b. PV module mounting structures;
c. BESS;
d. Inverters;
e. transformers;
f. Switchgear;
g. An Onsite Substation and control buildings;
h. Onsite cabling;
i. Ancillary infrastructure (e.g. combiner boxes, weather stations);
j. Electricity export via high-voltage cable and connection to the National Electricity Transmission System;
k. Fencing and security;
l. Access tracks; and
m. Landscaping, permissive paths and biodiversity mitigation and enhancement areas.

ES 9 The physical infrastructure proposed across the DCO Site is described in further detail in **Chapter 3: The Proposed Development [EN010154/APP/6.1]**.

ES 10 This FRA has been prepared in accordance with the requirements of the Overarching National Policy Statement (NPS) for Energy (EN-1) (Ref. 1), the NPS for Renewable Energy Infrastructure (EN-3) (Ref. 2), and Electricity Networks Infrastructure (EN-5) (Ref. 3), and the National Planning Policy Framework (NPPF) (Ref. 4). The proposed use of the Proposed Development would be classed as ‘Essential Infrastructure’ in accordance with Annex 3 of NPPF (Ref. 4).

ES 11 The vast majority of the Principal Site lies within Flood Zone 1. Small areas of Flood Zone 2 and 3 associated with Main Rivers are present in areas near the boundary of the Principal Site, including the Witham Washlands Flood Storage Area. The Principal Site also has flood plain associated with Ordinary Watercourses (Mill Dam Dyke) and along field boundaries.

ES 12 Areas where the extents of Flood Zone 2 overlap with solar PV Panels in the Principal Site have been identified within this FRA and are referred to as “interaction zones”. No other permanent built development is located within Flood Zone 2 or 3.

ES 13 Voluntary enhancement is provided in the form of proposed edge swales located in the western extents of solar PV Fields 25, ~~30 and 34~~43, and the field between the solar PV Fields 25 and 33, which has no proposed electrical infrastructure (see **Annex ~~C~~D: ~~Environmental Agency Correspondence [EN010154/APP/6.3]~~** for field numbers referred to in this document), which will be provided to reduce surface water flood risk to properties along the Avenue in Morton, where surface water mapping (Ref. 6) shows a risk of ponding at the low spot where the properties lie. These edge swales will capture the majority of the runoff from Solar Station Compounds and runoff from the solar PV panel fields, reducing peak runoff rates during storm events, for up to and including the 1 in 100 year plus 40% climate change event (for where new impermeable surfaces are introduced). Field 25 is discussed further within **Appendix 9-D: Framework Surface Water Drainage Strategy [EN010154/APP/6.3]** as ~~these are~~this is proposed to utilise infiltration swales, which will capture runoff and infiltrate to ground with no discharges to a watercourse. Refer to **Annex D: Framework Surface Water Drainage Strategy ~~/ Layout~~/ Layout [EN010154/APP/6.3]** of this FRA for the Framework Surface Water Drainage Strategy overview and Principal Site layout drawing (**Annex C: Environmental Agency Correspondence [EN010154/APP/6.3**~~])~~]) for field numbers. The enhancement is secured within the **Design Approach Document (Appendix A: Design Commitments) [EN010154/APP/7.3]**).

ES 14 Small sections of the Cable Corridor lie within Flood Zone 2 and 3 extents, including the Witham Washlands Flood Storage Area; however, the cable route will have no permanent above ground, built development during the operational phase of the Proposed Development within these areas.

ES 15 This FRA assesses the Proposed Development in more detail relative to each flood risk area.

ES 16 The flood risk summary presented in **Table 1~~Table 1Table 1~~** indicates the overall flood risk across the Proposed Development.

Table 1: Proposed Development Flood Risk Summary

Flood Risk Source	Pre-Proposed Development Flood Risk Level	Post-Proposed Development Flood Risk Level	Comment
Fluvial	**Low–High** Low (majority of Principal Site	**Low–High** Low (Principal Site and majority	Solar PV Panel infrastructure within Flood Zones 2 and 3. “interaction zones” are not envisaged to alter

Flood Risk Source	Pre-Proposed Development Flood Risk Level	Post-Proposed Development Flood Risk Level	Comment
	and majority of Cable Corridor) – High (small area of Cable Corridor where crossing the River Brant and Witham Washlands Flood Storage Area).	of Cable Corridor) – High (small area of Cable Corridor where crossing the River Brant and Witham Washlands Flood Storage Area).	the existing flood extents, topography and are proposed to be installed to enable sufficient freeboard to remain operational in times of flood. No change to flood risk level.
Tidal	**Low** (Residual)	**Low** (Residual)	Tidal sea level assessment undertaken, Principal Site at low risk from River Witham and River Brant due to site levels, except for Field 54, where sea level rise may impact the DCO Site during the H++ scenario. However, residual risk is Low as tidal defences at Boston designed for beyond 300 years including climate change and, in addition, embedded mitigation for the credible maximum scenario exceed mitigation requirements for potential sea level rise. No change to flood risk level.
Pluvial	**Low–Medium**	**Low–Medium**	Increased surface water runoff is proposed to be managed on-site to mimic the pre-Proposed Development conditions for up to and including the 1 in 100 + 40% climate change (CC) event, with discharge rates limited to existing Greenfield rates. No change to flood risk level.
Groundwater	**Medium**	**Medium**	North Kesteven District Council's Strategic Flood Risk Assessment (SFRA) indicates the area the DCO Site is located within is deemed not to be at risk of groundwater flooding, with no recorded groundwater flood events. No Change to flood risk level
Sewers	**Low**	**Low**	No records of sewer flooding in the Principal Site within the North Kesteven District Council SFRA. No proposed connection to public foul or surface water sewers.

Flood Risk Source	Pre-Proposed Development Flood Risk Level	Post-Proposed Development Flood Risk Level	Comment
			No change to flood risk level.
Artificial Sources	**Low**	**Low**	Environment Agency online mapping shows the maximum extent of flooding from artificial sources are not located within the vicinity of the DCO Site Boundary. No change to flood risk level.

ES 17 When considered within the context of national, regional and local planning policy in respect of development and flood risk, this FRA concludes that the area of the Proposed Development remains safe for its lifetime, does not increase flood risk elsewhere, and fulfils the Government’s wider criteria for sustainable development.

1. Introduction

1.1 Background

1.1.1 This Flood Risk Assessment (FRA) forms a technical appendix to **Chapter 9: Water Environment** of this ES **[EN010154/APP/6.1]** for Fosse Green Energy (hereafter referred to as the 'Proposed Development').

1.1.2 The area within and surrounding the Proposed Development is primarily rural, comprising open agricultural fields, individual trees, woodlands, hedgerows, linear tree belts, farm access tracks, local transport roads and villages. The area within and surrounding the Proposed Development is described in more detail in **Chapter 2: The Site and Surroundings [EN010154/APP/6.1].**

1.1.3 This FRA primarily relates to the Principal Site during the operational phase of the Proposed Development, as permanent infrastructure associated with the Cable Corridor will all be underground with no permanent above ground-built development. The Cable Corridor is therefore considered to not have an impact on long term flood risk during the operation of the Proposed Development as there will be no change to contributing areas or changes to the existing runoff and drainage regime.

1.1.4 Flood risk during construction and decommissioning of the Proposed Development across the Principal Site and Cable Corridor is to be managed in-situ for the duration of works via flood risk and pollution management mitigation measures documented within the Construction Environmental Management Plan (CEMP), to be developed post DCO consent. A **Framework CEMP** is submitted with the DCO application **[EN010154/APP/7.7]** and is secured via a Requirement in the DCO.

1.2 FRA Objectives

1.2.1 The minimum requirements for FRAs, as outlined in the Overarching National Policy Statement (NPS) for Energy (NPS EN-1) (paragraph 5.8.15) (Ref. 1) are to:

a. *"Be proportionate to the risk and appropriate to the scale, nature, and location of the project;*

b. *Consider the risk of flooding arising from the project in addition to the risk of flooding to the project;*

c. *Take the impacts of climate change into account, across a range of climate scenarios, clearly stating the development lifetime over which the assessment has been made;*

d. *Be undertaken by competent people, as early as possible in the process of preparing the proposal;*

e. *Consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels,* *flood storage areas and other artificial features, together with the consequences of their failure and exceedance;*

f. *Consider the vulnerability of those using the site, including arrangements for safe access;*

g. *Consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and include information on flood likelihood, speed-of-onset, depth, velocity, hazard and duration;*

h. *Identify and secure opportunities to reduce the causes and impacts of flooding overall, making as much use of natural flood management techniques as part of an integrated approach to flood risk management;*

i. *Consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;*

j. *Include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that these risks can be safely managed, ensuring people will not be exposed to hazardous flooding;*

k. *Consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems, Information should include:*

   i. *Describe the existing surface water drainage arrangements for the site.*

   ii. *Set out (approximately) the existing rates and volumes of surface water run-off generated by the site. Detail the proposals for restricting discharge rates.*

   iii. *Set out proposals for managing and discharging surface water from the site using sustainable drainage systems an accounting for the predicted impacts of climate change. If sustainable drainage systems have been rejected, present clear evidence of why their including would be inappropriate.*

   iv. *Demonstrate how the hierarchy of drainage options has been followed*

   v. *Explain and justify why the types of SuDS and method of discharge have been selected and why they are considered appropriate. Where cost is a reason for not including SuDS, provide information to enable comparison with the lifetime costs of a conventional public sewer connection.*

   vi. *Explain how sustainable drainage systems have been integrated with other aspects of the development such as open space or green infrastructure, so as to ensure an efficient use of the site.*

   vii. *Describe the multifunctional benefits the sustainable drainage system will provide.*

viii. *Set out which opportunities to reduce the causes and impacts of flooding have been identified and included as a part of the proposed sustainable drainage system.*

ix. *Explain how run-off from the completed development will be prevented from causing an impact elsewhere.*

x. *Explain how the sustainable drainage system been designed to facilitate maintenance and, where relevant, adoption. Set out plans for ensuring and acceptable standard of operation and maintenance throughout the lifetime of the development.*

l. *Detail those measurements that will be included to ensure the development will be safe and remain operational during a flooding event throughout the development's lifetime without increasing flood risk elsewhere.*

m. *Identify and secure opportunities to reduce the causes and impacts if flooding overall during the period of construction, and*

n. *Be supported by appropriate data and information, including historical information on previous events."*

1.2.2 The principal objectives of the FRA, accounting for the above, are to:

a. Identify potential forms of flooding, including rivers, watercourses, surface water flooding, groundwater flooding, flooding from sewer systems and other forms of flooding, relevant to the Proposed Development;

b. Establish the risk of flooding in relation to the Proposed Development;

c. Determine the effects of the Proposed Development on flooding elsewhere either through displacement of floodwaters or increased runoff; and

d. Suggest appropriate flood mitigation measures for the Proposed Development, including a strategy for disposal of surface water run-off following the principles of Sustainable Drainage Systems (SuDS).

1.3 Scope of Work

1.3.1 In preparing this FRA, the Applicant has:

a. Obtained relevant data and information from statutory and other authorities;

b. Considered the potential sources of flooding;

c. Assessed the risk of flooding to the Proposed Development;

d. Assessed the impact of off-site flooding (displaced water) on third parties;

e. Considered the impact of climate change; and

f. Considered mitigation requirements for the design and any residual risk.

1.4 Proposed Development Description

1.4.1 The Proposed Development comprises the construction, operation (including maintenance), and decommissioning of ground mounted solar PV panel arrays to generate solar electricity and store the energy within a Battery Energy Storage System (BESS) for import and export to the national electricity transmission network.

1.4.2 **Chapter 3: Proposed Development** of this ES **[EN010154/APP/6.1]** provides further details of the Proposed Development and programme for site preparation, construction, and decommissioning works.

1.5 Proposed Development Extent

1.5.1 The DCO Site Boundary is made up of two main elements:

a. 'The Principal Site', covering approximately 1,070ha, which is the location where ground mounted solar photovoltaic (PV) panel arrays, BESS and an Onsite Substation will be installed; and

b. The 'Cable Corridor', covering approximately 351ha, which will comprise the underground electrical cables required to connect the Principal Site to the National Electricity Transmission System.

1.5.2 As discussed in **Section 1.1**, this FRA is focused primarily on assessing flood risk to and from the Proposed Development within the Principal Site. The development infrastructure within the Cable Corridor is inherently protected from flood risk to the Proposed Development and increasing flood risk elsewhere, as all infrastructure is buried below ground during the operational phase, i.e. there is no permanent above ground infrastructure proposed along the Cable Corridor.

1.6 Existing Land Use

1.6.1 The Principal Site consists of mostly greenfield agricultural land, with some local roads connecting rural dwellings to villages adjacent to the DCO Site Boundary.

1.6.2 The Principal Site has been set to only occupy natural landscape, avoiding existing developments and buildings. It is estimated to cover less than 1% existing impermeable area. Therefore, existing land within the Principal Site is considered 100% permeable (0% impermeable) for the purposes of this assessment. This represents a worst-case approach to the existing catchment surface water greenfield runoff rates.

1.6.3 **Table 2~~Table 2Table 2~~** provides a summary of the existing Principal Site permeable and impermeable areas.

Table 2: Principal Site Boundary Existing Contributing Areas

	Permeable Area (ha)	Impermeable Area (ha)	Percentage Impermeable
Principal Site Boundary	1,065	0%	0%

1.6.4 The Cable Corridor consists of similar land use to the Principal Site, with the additional feature near Fen Lane, where the Route overlaps with the Witham Washlands Flood Storage Area (FSA) associated with the Main Rivers Brant and Witham. It is anticipated that any of the Proposed Development infrastructure within the Cable Corridor boundary will not impose a change to permeable/impermeable areas following construction. Therefore, only the Principal Site has been assessed in detail to ensure the Proposed Development remains safe from future flood risk, does not increase flood risk elsewhere, and fulfils the Government's wider criteria for sustainable development.

1.7 Development Proposals

1.7.1 The Proposed Development within the Principal Site will consist of the following infrastructure:

a. Solar PV panels (also known as 'modules');
b. PV panel mounting structures;
c. BESS;
d. Inverters;
e. Transformers;
f. Switchgear;
g. An Onsite Substation and control buildings;
h. Onsite cabling;
i. Ancillary infrastructure (e.g. combiner boxes, weather stations);
j. Electricity export and import via high-voltage Grid Connection Cable and connection to the National Electricity Transmission System;
k. Fencing and security;
l. Access tracks; and
m. Landscaping, permissive paths and biodiversity mitigation and enhancement areas.

1.7.2 **Chapter 3: The Proposed Development [EN010154/APP/6.1]** provides further details of the components of the Proposed Development.

1.7.3 The Indicative Site Layout Plans for the Proposed Development are shown in **Figure 3-2A** and **Figure 3-2B [EN010154/APP/6.2]**.

1.8 Consultees

1.8.1 The following stakeholders have been consulted during the Statutory Consultation for the Proposed Development and during preparation of the ES. This FRA takes into account any comments made, particularly the following key stakeholders:

a. Lead Local Flood Authority – Lincolnshire County Council;

b. The Environment Agency;

c. Upper Witham Internal Drainage Board; and

d. Trent Valley Internal Drainage Board.

2. Legislation and Planning Policy

2.1.1 Legislation, planning policy, and guidance relating to flood risk and pertinent to the Proposed Development is set out in the following sections.

2.2 National Planning Policy

2.2.1 National Policy Statements (NPS) set out the Government's national policy for energy infrastructure. They have effect in relation to the decisions by the Secretary of State on applications for energy developments that are nationally significant under the Planning Act 2008.

2.2.2 Since the first publication of the NPS for Energy in 2011, reviews have been undertaken by the Government to ensure the policies are updated to align with the policies set out in the Governments Energy White Paper: Powering our Net Zero Future (Ref. 26), setting out how the UK will clean up its energy system and reach net zero emissions by 2050, which was published in 2020.

2.2.3 This FRA considers the in force NPS documents from January 2024 as follows:

a. NPS for Energy EN-1 (Ref. 1);

b. NPS for Renewable Energy Infrastructure EN-3 (Ref. 2); and

c. NPS for Electricity Networks EN-5 (Ref. 3).

Overarching National Policy Statement (NPS) for Energy (EN-1)

2.2.4 NPS EN-1 (Ref. 1) sets out the Government's policy for delivery of major energy infrastructure.

2.2.5 The objectives of this FRA are in line with paragraph 5.8.15 of NPS EN-1.

2.2.6 Paragraph 5.8.13 of NPS EN-1 states:

"a site-specific flood risk assessment should be provided for all energy projects in Flood Zones 2 and 3 in England or Zones B and C in Wales. In Flood Zone 1 in England or Zone A in Wales, an assessment should accompany all proposals involving:

a. Sites of 1 hectare or more;

b. Land which has been identified by the Environment Agency (EA) or National Resources Wales (NRW) as having critical drainage problems;

c. Land identified (for example in a local authority strategic flood risk assessment) as being at increased flood risk in future;

d. Land that may be subject to other sources of flooding (for example surface water), and;

e. Where the EA or NRW, Lead Local Flood Authority, Internal Drainage Board or other body have indicated that there may be drainage problems".

2.2.7 Paragraph 5.8.14 states the assessment should

"identify and assess the risks of all forms of flooding to and from the project and demonstrate how these flood risks will be managed, taking climate change into account".

2.2.8 Paragraph 5.8.18 NPS EN-1 recommends that applicants should arrange:

"pre-application discussions before the official pre-application stage of the NSIP process with the EA or NRW, and, where relevant, other bodies such as Lead Local Flood Authorities, Internal Drainage Boards, sewerage undertakers, navigation authorities, highways authorities and reservoir owners and operators".

2.2.9 Paragraphs 5.8.25 NPS EN-1 explains the range of sustainable approaches to surface water drainage management.

2.2.10 Paragraph 5.8.26 of NPS EN-1 states:

"Site layout and surface water drainage systems should cope with events that exceed the design capacity of the system, so that excess water can be safely stored on or conveyed from the site without adverse impacts".

2.2.11 Paragraph 5.8.27 NPS EN-1 states:

"The surface water drainage arrangements for any project should, accounting for the predicted impacts of climate change throughout the development's lifetime, be such that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior to the proposed project, unless specific off-site arrangements are made and result in the same net effect".

2.2.12 Paragraph 5.8.28 of NPS EN-1 states:

"It may be necessary to provide surface water storage and infiltration to limit and reduce both the peak rate of discharge from the site and the total volume

discharged from the site. There may be circumstances where it is appropriate for infiltration facilities or attenuation storage to be provided outside the project site, if necessary, through the use of a planning obligation".

2.2.13 Paragraph 5.8.29 of NPS EN-1 requires

"a sequential approach to be to be applied to the layout and design of projects with more vulnerable uses being located on parts of the site at lower probability and residual risk of flooding by using Sustainable Urban Drainage Systems (SuDS)."

2.2.14 Paragraph 5.8.30 of NPS-EN-1 states

"where a development may result in an increase in flood risk, on-site level-for-level compensatory storage, accounting for the predicted impacts of climate change over the lifetime of the development, should be provided."

2.2.15 Paragraph 5.8.32 of NPS EN-1 states

"where development may contribute to a cumulative increase in flood risk elsewhere, the provision of multifunctional sustainable drainage systems, natural flood management and green infrastructure can also make a valuable contribution to mitigating this risk whilst providing wider benefits."

2.2.16 Paragraph 5.8.33 of NPS EN-1 also requires flood warning and evacuation plans for areas of development identified to be at risk of flooding.

2.2.17 Paragraph 5.8.36 of NPS EN-1 states that:

"in determining an application for development consent, the Secretary of State should be satisfied that where relevant:

"the application is supported by an appropriate FRA".

2.2.18 Paragraph 5.8.41 of NPS EN-1 states that:

"Energy projects should not normally be consented within Flood Zone 3b, or Zone C2 in Wales, or on land expected to fall within these zones within its predicted lifetime. This may also apply where land is subject to other sources of flooding (for example surface water). However, where essential energy infrastructure has to be located in such areas, for operational reasons, they should only be consented if the development will not result in a net loss of floodplain storage and will not impede water flows".

2.2.19 Paragraph 5.8.42 of NPS EN-1 states:

"Exceptionally, where an increase in flood risk elsewhere cannot be avoided or wholly mitigated, the Secretary of State may grant consent if they are satisfied that the increase in present and future flood risk can be mitigated to an acceptable and safe level and taking account of the benefits of, including the need for, nationally significant energy infrastructure as set out in Part 3 above. In any such case the Secretary of State should make clear how, in reaching their decision, they have weighed up the increased flood risk against the benefits of the project, taking account of the nature and degree of the risk,

the future impacts on climate change, and advice provided by the EA or NRW or other relevant bodies".

National Policy Statement for Renewable Energy NPS EN-3

2.2.20 The NPS for Renewable Energy (EN-3), taken together with the Overarching NPS for Energy (EN-1), provides the primary policy for decisions by the Secretary of State on applications they receive for nationally significant renewable energy infrastructure.

2.2.21 Paragraph 2.4.11 of NPS EN-3 (Ref. 2) notes that:

"Solar photovoltaic (PV) sites may also be proposed in low lying exposed sites. For these proposals, applicants should consider, in particular, how plant will be resilient to:

a. Increased risk of flooding; and

b. Impact of higher temperature."

2.2.22 While NPS EN-3 does not mention a need for an FRA or implications for drainage, paragraph 2.10.84 of NPS EN-3 does state:

"Where a Flood Risk Assessment has been carried out this must be submitted alongside the applicant's ES. This will need to consider the impact of drainage. As solar PV panels will drain to the existing ground, the impact will not, in general, be significant."

2.2.23 Paragraph 2.10.84 NPS EN-3 states

"where a Flood Risk Assessment has been carried out this must be submitted alongside the applicant's ES and will need to consider the impact of drainage."

2.2.24 Paragraph 2.10.85 of NPS EN-3 states,

"Where access tracks need to be provided, permeable tracks should be used, and localised Sustainable Drainage Systems (SuDS), such as swales and infiltration trenches, should be used to control any run-off where recommended."

2.2.25 Paragraph 2.10.87 of NPS EN-3 states:

"Culverting existing watercourses/drainage ditches should be avoided."

2.2.26 The Proposed Development has a design principle to utilise existing water crossing locations to avoid the need for new culverts, therefore having less impact on both flood risk and biodiversity . Should a new crossing, requiring a culvert to be proposed, it is expected that the least impacting design be utilised, (e.g. arch rather than box or pipes) to mitigate impact to flood risk levels.

National Policy Statement for Electricity Networks Infrastructure (EN-5)

2.2.27 The NPS for Electricity Networks Infrastructure (EN-5) (Ref. 3) principally concerns high voltage transmission systems and distribution systems in addition to associated infrastructure.

2.2.28 Paragraph 2.3.2 of NPS EN-5 explains that:

"as climate change is likely to increase risks to the resilience of electrical infrastructure it requires applicants to "set out to what extent the Proposed Development is expected to be vulnerable, and, as appropriate, how it has been designed to be resilient to:

a. flooding, particularly for substations that are vital to the network; and especially in light of changes to groundwater levels resulting from climate change;"

b. the effects of wind and storms on overhead lines;

c. higher average temperatures leading to increased transmission losses;

d. earth movement or subsidence caused by flooding or drought (for underground cables); and

e. coastal erosion – for the landfall of offshore transmission cables and their associated substations in the inshore and coastal locations respectively."

2.2.29 Paragraph 2.3.3 of NPS EN-5 reiterates the requirements set out in NPS EN-1 (Ref. 1) that *"future increased risk of flooding would be covered in any flood risk assessment".*

2.2.30 The infrastructure for the Onsite Substation and either the 'centralised BESS' (a single BESS compound) or 'distributed BESS' (approximately 328 batteries distributed throughout the Principal Site, located at Solar Station Compounds) arrangements are all located within Flood Zone 1 and at low risk from other sources of flooding, ensuring the infrastructure will remain operational in times of flood. The Solar Station Compounds include BESS containers under the distributed BESS' arrangement. The proposed solar infrastructure is explained in further detail in **Chapter 3: The Proposed Development** of this ES **[EN010154/APP/6.1]**.

2.2.31 For PV Panels located in Flood Zone 2 and 3, these will have mitigation in the form of raised mounting heights to ensure they remain operational in times of flood with suitable freeboard above the predicted flood levels (fluvial flood risk to PV panels is discussed further in **Section 4.3**).

National Planning Policy Framework

2.2.32 The NPPF (Ref. 4) was first published in March 2012, superseding previous national planning policy statements and guidance, The NPPF was subsequently revised in July 2021, September 2023, December 2023 and most recently in December 2024. This FRA complies with the latest revised version of the NPPF.

2.2.33 Flood Risk and Coastal Change Planning Practice Guidance (PPG) (Ref. 5) was also published in 2014 to support the implementation of the NPPF. The PPG was last updated in August 2022; this FRA complies with this and all other current national and local policy.

2.2.34 Section 14 of the NPPF, entitled "*Meeting the challenge of Climate Change, Flooding and Coastal Change*" (paragraphs 161-186), sets out the requirements to assess flood risk and climate change for developments.

2.2.35 Paragraph 182 notes

"applications which could affect drainage on or around the site should incorporate sustainable drainage systems to control flow rates and reduce volumes of runoff, and which are proportionate to the nature and scale of the proposal. These should provide multifunctional benefits wherever possible, through facilitating improvements in water quality and biodiversity, as well as benefits for amenity. Sustainable drainage systems provided as part of proposals for major development should:

a) take account of advice from the Lead Local Flood Authority;

b) have appropriate proposed minimum operational standards; and

c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development."

2.2.36 The assessment of flood risk is based on the definitions in as extracted from the PPG in Table 3~~Table 3Table 3~~.

Table 3: Flood Zones – Reproduced from Table 1 of the PPG 2014 (Ref. 5)

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic FRAs areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

2.2.37 Annex 3: "*Flood Risk vulnerability classification*" of the NPPF, classifies the Flood Risk Vulnerability of various land uses as extracted in Table 4Table 4Table 4.

Table 4: Development Type and Vulnerability Classification – Reproduced from Annex 3 of the NPPF (Ref. 4)

Development Type	Definition
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines. • Solar farms.
Highly Vulnerable	• Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as "essential infrastructure")
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in "more vulnerable", and assembly and leisure.

Development Type	Definition
	• Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place). • Car Parks
Water-compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in his category, subject to a specific warning and evacuation plan.

2.2.38 The Proposed Development falls within the definition of ‘Essential Infrastructure’. The overall aim of the sequential approach is to steer new development to areas of lowest flood risk, i.e., Flood Zone 1 and low surface water flood risk (Sequential Test, see section below). Where there are no reasonable sites available outside areas at risk of flooding, Flood Zones 2 and 3 may be considered, subject to passing the Exception Test, as required and set out in Table 5~~Table 5Table 5~~ below.

2.2.39 Surface water flood risk has been reviewed alongside the EA published Updated Flood Map for Surface Water (EA uFMfSW (Ref. 6) which now includes climate change (i.e. for the period 2040-2060).

2.2.40 The EA uFMfSW (Ref. 6) shows where areas could be potentially susceptible to surface water flooding in an extreme rainfall event.

2.2.41 The latest mapping assesses flooding resulting from severe rainfall events based on the following three scenarios:

a. High Risk: 1 in 30 year (0.33%) annual probability event;

b. Medium Risk: 1 in 100 year (1%) annual probability event; and

c. Low Risk: 1 in 1000 year (0.1%) annual probability event.

2.2.42 Land at lower than a 1 in 1000 (0.1%) annual probability of flooding is considered to be a "Very Low" risk.

The Sequential Test and Exception Test

2.2.43 NPS EN-1 (Ref. 1) and the NPPF (Ref. 4) set out the requirements of the Sequential Test, which is a risk-based test that should be applied at all stages of development.

2.2.44 All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by:

a. Applying the sequential test and then, if necessary, the exception test as set out below;

b. Safeguarding land from development that is required, or likely to be required, for current or future flood management;

c. Using opportunities provided by new development and improvements in green and other infrastructure to reduce the causes and impacts of flooding, (making as much use as possible of natural flood management techniques); and

d. Where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations.

2.2.45 The aim of the Sequential Test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the development in areas with a lower risk of flooding. A Strategic FRA will provide the basis for applying this test. The sequential test approach should be used in areas known to be at risk now or in the future from any forms of flooding.

2.2.46 If it is not possible for development to be located within areas of lower risk of flooding (taking into account wider sustainable development objectives), the Exception Test may have to be applied. The need for the Exception Test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3: *"Flood Risk vulnerability classification"* of the NPPF.

2.2.47 Table 5~~Table 5Table 5~~ below reproduces the flood risk vulnerability and flood zone compatibility, as set out in Table 2 of the PPG (Ref. 5).

Table 5: Flood Risk Vulnerability and Flood Zone 'Compatibility' – Reproduced from Table 2 of the PPG 2022 (Ref. 5)

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test Required	✓	✓	✓
Zone 3a	Exception Test Required	×	Exception Test Required	✓	✓
Zone 3b (functional Floodplain)	Exception Test Required	×	×	×	✓

✓	Development is appropriate
×	Development should not be permitted
	Flood Zones that the Proposed Development sits within

2.2.48 The NPPF (Ref. 4) states in paragraph 178 that, for the Exception Test to be passed, it should be demonstrated that both of the following elements should be satisfied for development to be allocated or permitted:

a. The development would provide wider sustainability benefits to the community that outweigh the flood risk; and

b. 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.

2.2.49 Both elements of the Exception Test should be satisfied for development to be allocated or permitted.

2.2.50 The sequential approach to the design and layout of the Proposed Development complies with paragraph 5.8.29 of NPS EN-1 (Ref. 1) in relation to the layout of the Proposed Development's infrastructure.

2.2.51 Paragraph 2.3.9 of NPS EN-3 (Ref. 2) states:

"As most renewable energy resources can only be developed where the resource exists and where economically feasible, and because there are no limits on the need established in Part 3 of EN-1, the Secretary of State should not use a sequential approach in the consideration of renewable energy projects (for example, by giving priority to the re-use of previously developed land for renewable technology developments)."

2.2.52 The sequential approach in selecting the location of the DCO Site for the Proposed Development is set out in **Chapter 4: Alternatives and Design**

Evolution [EN010154/APP/.6.1] and the **Planning Statement [EN010154/APP/7.2]**, which are submitted as part of the DCO application.

2.3 Local Planning Policy

2.3.1 The DCO Site is located within the administrative areas of North Kesteven District Council and Lincolnshire County Council.

2.3.2 Lincolnshire County Council will consider the FRA (through consultation with the EA and North Kesteven District Council as necessary) as the DCO Site is predominately located within Flood Zone 1.

2.3.3 The following key planning documents and salient polices have been considered to inform this FRA:

a. Lincolnshire County Council:

   i. Preliminary FRA (2011) (Ref. 7)

   ii. Second Cycle Preliminary FRA for Lincolnshire (2017) (Ref. 8)

   iii. Central Lincolnshire Local Plan (2023) (Ref. 9)

   iv. Joint Flood Risk and Water Management Strategy 2019-2050 (Ref. 10)

b. North Kesteven District Council:

   i. North Kesteven Strategic Flood Risk Assessment (2009) (Ref. 11)

2.4 Internal Drainage Boards

2.4.1 Internal Drainage Boards (IDB) are local public authorities that manage water levels within areas of special drainage need (Internal Drainage Districts) in England and Wales. Works relating to watercourses within these designated areas of the DCO Site must seek consent from the relevant IDB.

2.4.2 The DCO Site is located across two IDBs, Upper Witham and Trent Valley.

2.4.3 The following documents have been considered to inform this FRA:

a. Upper Witham Internal Drainage Board;

   i. Policy Statement on Water Level and Flood Risk Management Asset List (Ref. 12), and

   ii. Upper Witham Internal Drainage Board Byelaws (Ref. 13)

b. Trent Valley Internal Drainage Board;

   i. Planning and Byelaw Policy (Ref. 14), and

   ii. Advice Note, AN06: Surface Water (Ref. 15).

3. Supporting Information

3.1 Contributing Areas

3.1.1 Within hydrology, it is generally understood that permeable surfaces absorb rainfall whilst impermeable surfaces repel rainfall leading to surface water runoff. For a site, the total impermeable area is often referred to as the DCO Site's Contributing Area. The Contributing Area is used as part of the calculation to determine the volume of surface water runoff generated within the DCO Site. Developing greenfield sites (typically entirely permeable land) often increases the DCO Site's Contributing Area as natural permeable surfaces are sealed by impermeable surfaces.

3.1.2 For the Proposed Development across the Principal Site, some existing permeable surfaces will be replaced by proposed impermeable surfaces.

3.1.3 The solar PV panels are assumed to not contribute to the total post-Development impermeable area as the mounting structures holding the solar PV panels are usually supported by galvanised steel legs driven into the ground, therefore mitigating the need for concrete footings. This assumption is compliant with Paragraph 2.10.84 of NPS EN-3 (Ref. 2). The ground beneath the solar PV panels remains permeable, where runoff from the panels can drain at source for the majority of rainfall events.

3.1.4 It is noted that, in potentially archaeologically sensitive areas, PV panels may require concrete footings instead of being piled.

3.1.5 It is considered that interception of rainfall by the solar PV panels will impose negligible impact on the with-Proposed Development surface water runoff rates as the ground below and surrounding the solar PV panels is proposed to consist of suitable planting such as native grassland and wildflower mix, which will provide a permeable surface area and reduce the risk of erosion of soils.

3.1.6 A comparison of the proposed and existing Principal Site has been undertaken to demonstrate how the with-development Contributing Area will be affected compared to the pre-development scenario.

3.1.7 Table 6~~Table 6Table 6~~ below presents this overall comparison refer to **Appendix 9-D: Framework Surface Water Drainage Strategy [EN010154/APP/6.3]** for detailed breakdowns of impermeable areas within the DCO Site).

Table 6: Pre- and Post-Development Contributing Areas within Principal Site

	Total Area (ha)	Pre-Development contributing area (ha)	Post-development contributing area (ha)	Pre-development PIMP*	Post-development PIMP*
Principal Site	1065	0	10.01	0%	0.94%**

*- Percentage Impermeable Area (PIMP) – percentage of an area that is impermeable.
**- Assumed operational buildings/compound areas are 100% PIMP. Photovoltaic (PV) panel areas assumed to have effective 0% PIMP.

3.2 Existing Drainage

3.2.1 The area within the Principal Site is largely greenfield. LiDAR data has been utilised to assess topography. It is unknown if formal piped drainage systems are present across the DCO Site, although it is likely there is historical sub-surface field drainage across the fields proposed for PV panels; however, this is not typically mapped data.

3.2.2 The Principal Site is located across two River Basin Districts; the majority of the DCO Site is located with the Anglian River Basin District and a small portion on the western side of the DCO Site is within the Humber River Basin District. Plate 1~~Plate 1Plate 1~~ below presents the boundary between the two districts with a black line and labels indicating the extents of the operational catchment's waterbody extents.

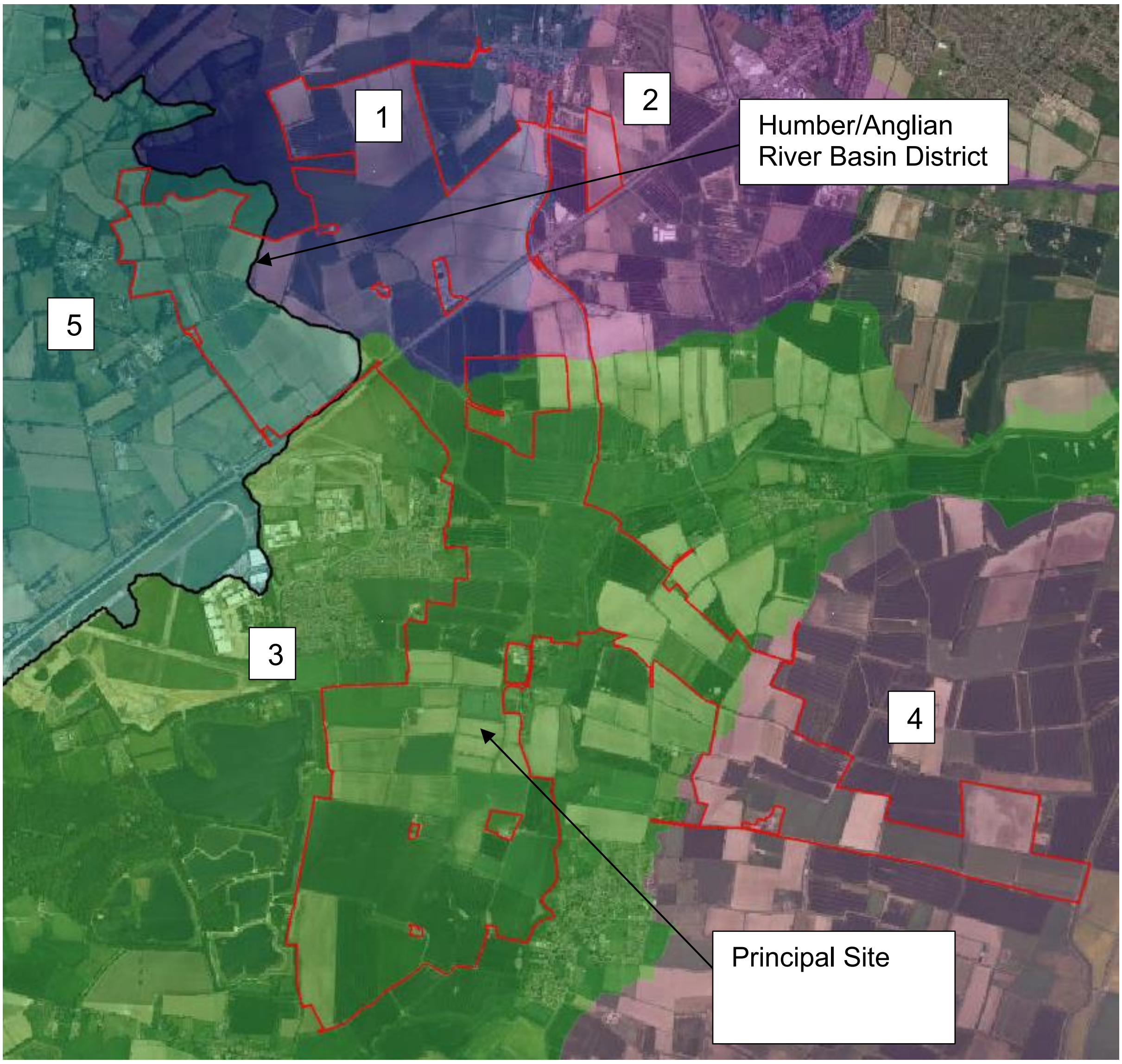


Plate 1: River Basin Districts

Label	River Bain District	Operational Catchment	Waterbody
1	Anglian	Witham Upper	Boultham Catchwater Drain
2	Anglian	Witham Upper	South Hykeham Catchwater
3	Anglian	Witham Upper	Witham - conf Cringle Bk to conf Brant
4	Anglian	Witham Upper	Brant - Lower
5	Humber	Trent and Trib	The Fleet Lower

3.2.3 The majority of the Principal Site is drained east of the black line shown in Plate 1~~Plate 1Plate 1~~ via Ordinary Watercourses which are located within four waterbody catchments belonging to the Anglian River Basin District, labelled 1–4 in Plate 1~~Plate 1Plate 1~~. These catchments convey flows to the River Witham (a Main River), either via the River Brant or Ordinary

Watercourses. The River Witham is located adjacent to the Eastern boundary of the Principal Site, flowing north towards Lincoln. There is a fluvial flood risk model available of the two Main Rivers (Brant and Witham), provided by the EA (last updated in 2015).

3.2.4 The remaining area lies within land designated as the Humber River basin district and labelled as no. 5 in Plate 1~~Plate 1Plate 1~~. This area is associated with the Fleet Lower Catchment which serves an Ordinary Watercourse, Mill Dam Dyke, a tributary of the River Trent. The Mill Dam Dyke becomes a designated Main River approximately 3.3km from the closest point of the Principal Site Boundary. There is no EA Fluvial Model available for this Main River, following a Product 6 data request in April 2023.

3.2.5 In general, it is assumed that for low intensity rainfall events, rainfall is collected within the waterbody catchments across the Principal Site, naturally draining to ground or to Ordinary Watercourses located along the field boundaries identified by LiDAR data before discharging to larger Main Rivers downstream.

3.2.6 For rainfall events where rainfall exceeds the infiltration capacity of the ground or the maximum discharge rates of the Ordinary Watercourses within the two catchments, it is assumed that any excess runoff would flow overland and pond in lower lying areas and surrounding watercourses before naturally draining / evaporating after the event has occurred.

3.3 Existing Flood Risk from All Sources

3.3.1 Table 7~~Table 7Table 7~~ summarises the Pre-Development flood risk across the DCO Site. Note the DCO Site Boundary have been marked indicatively on the maps within this FRA to represent the perspective of the Principal Site and Cable Corridor and surroundings in the context of the recently published flood map for planning (25 March 2025) (Ref. 28) (refer to **Figure 1-2: DCO Site [EN010154/APP/6.2]** for the detailed extent of the DCO Site Boundary).

Table 7: Pre-Development Flood Risk Mapping

Flood Risk Source	Flood Risk Level	Mapping and Comments
Fluvial	Low to High	

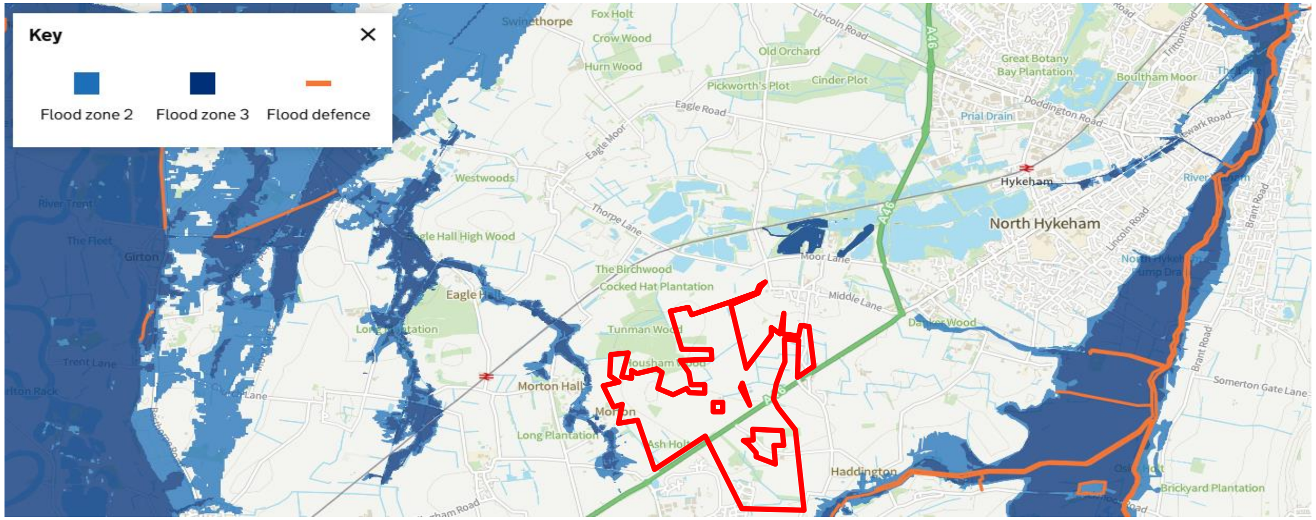


Plate 2: Flood Map for Planning (28 March 2025) (Ref. 28)[1]

[1] DCO Site boundary is indicative on Plates 2-15

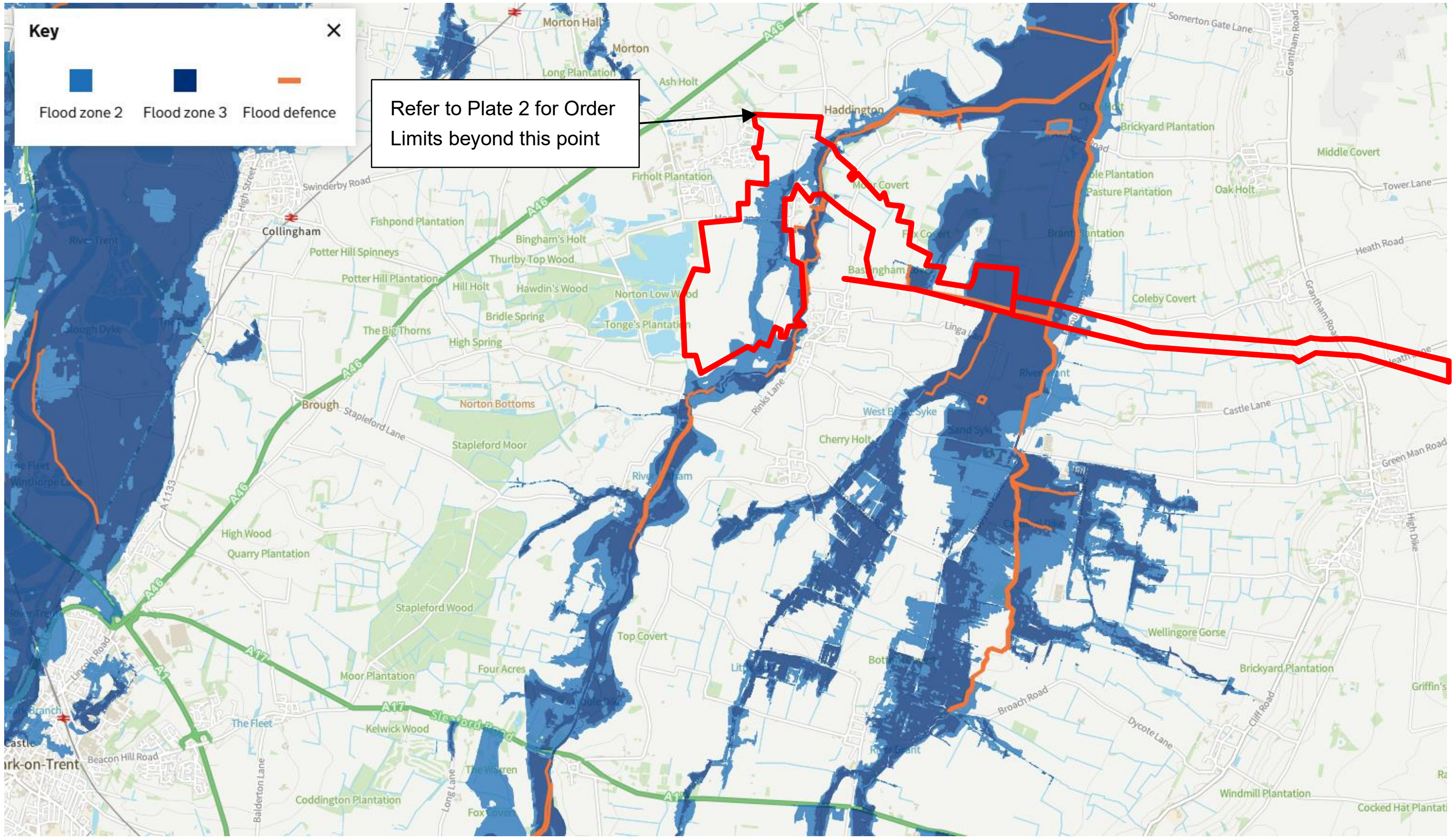


Plate 3: Flood Map for Planning (28 March 2025) (Ref. 28)

Flood Risk Source	Flood Risk Level	Mapping and Comments

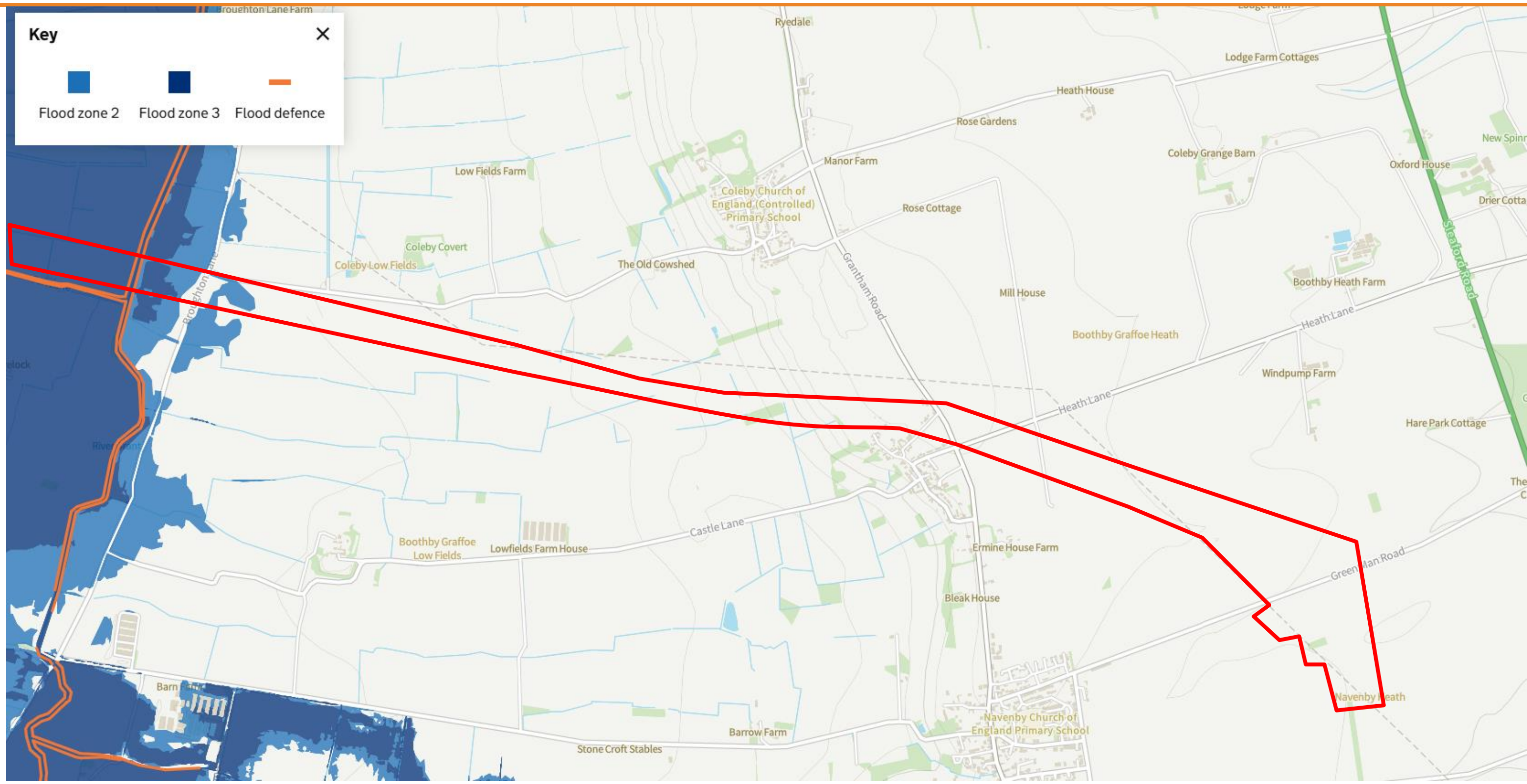
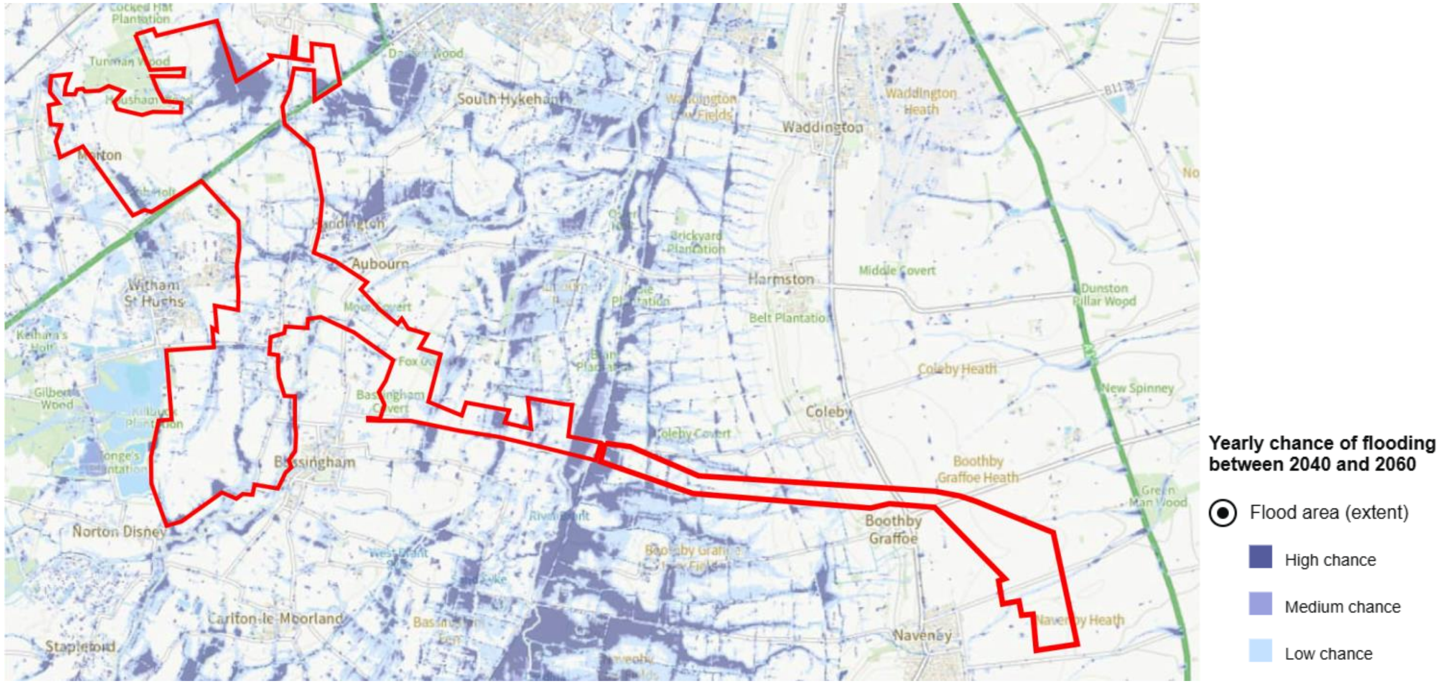


Plate 4: Flood Map for Planning (28 March 2025) (Ref. 28)

The mapping indicates that the majority of the Principal Site is located within Flood Zone 1, however there are significant areas designated as Flood Zone 2 and 3 associated with a flood storage area west of the river Witham (Witham Washlands Flood Storage Area). The mapping above does not take into account flood defences, although shown on the online mapping.

Flood Risk Source	Flood Risk Level	Mapping and Comments
Tidal	Low (Residual) - Medium	The majority of the DCO Site (east of the A46) is considered to be at a low residual risk of tidal flooding as the River Witham and Brant is protected for up to the 300 year event with an allowance for climate change by the Grand Sluice tidal defence in Boston, approximately 45km from the centre of the Principal Site. Mill Dam Dyke, an Ordinary Watercourse in the vicinity of the Proposed Development, located approximately 3.6km north west of the Principal Site (Morton Hall area) is subject to tidal influence, this may impose a tidal risk to the Principal Site as an Ordinary Watercourse that is a tributary to Mill Dam Dyke runs parallel with part of the DCO Site. The Mill Dam Dyke discharges into the River Trent via tidal sluice; however, the Mill Dam Dyke can become tide locked impacting flood risk upstream. This is discussed in the North Kesteven Strategic Flood Risk Assessment, in Section 4 (Ref. 11). Appendix C of the North Kesteven SFRA (Ref. 11) notes EA modelling suggests peak levels in the Mill Dam Dyke would reach approximately 7.74m AOD, before overtopping and flooding low lying areas. With lowest ground levels at the north west extent of the Principal Site being approximately 14m AOD, tidal risk is considered low.

Flood Risk Source	Flood Risk Level	Mapping and Comments
Surface Water	Low to High	 **Plate 5: Online Maps for Long Term Surface Water Risk (Ref. 6)** The risk of surface water flooding across the DCO Site varies from very low to high. The areas of higher risk are likely associated with fluvial flood risk and areas of low topography where surface water sits and pools rather than draining away, or show areas at risk from flooding from smaller Ordinary Watercourses and/or local land drains.
Groundwater	Low	North Kesteven District Council's SFRA indicates the area the DCO Site is located within is deemed not to be at risk of groundwater flooding, with no recorded groundwater flood events. No site-specific ground investigation information has been undertaken, however, a review of selected BGS borehole records available indicate shallow groundwater at depths of 2 to 3m below ground level (bgl) is likely to present in the DCO Site, particularly in the river valleys and where the permeable superficial deposits are encountered. The depth to groundwater in the underlying bedrocks is currently unknown.

Flood Risk Source	Flood Risk Level	Mapping and Comments
Sewers	Low	The DCO Site is located predominantly within rural agricultural land. However, where the Boundary crosses roads and in closer proximity to settlements there is a risk of flooding from sewers, specifically nearer to sewerage treatment plants located to the south, adjacent to the Principal Site.

Artificial Sources **Low**

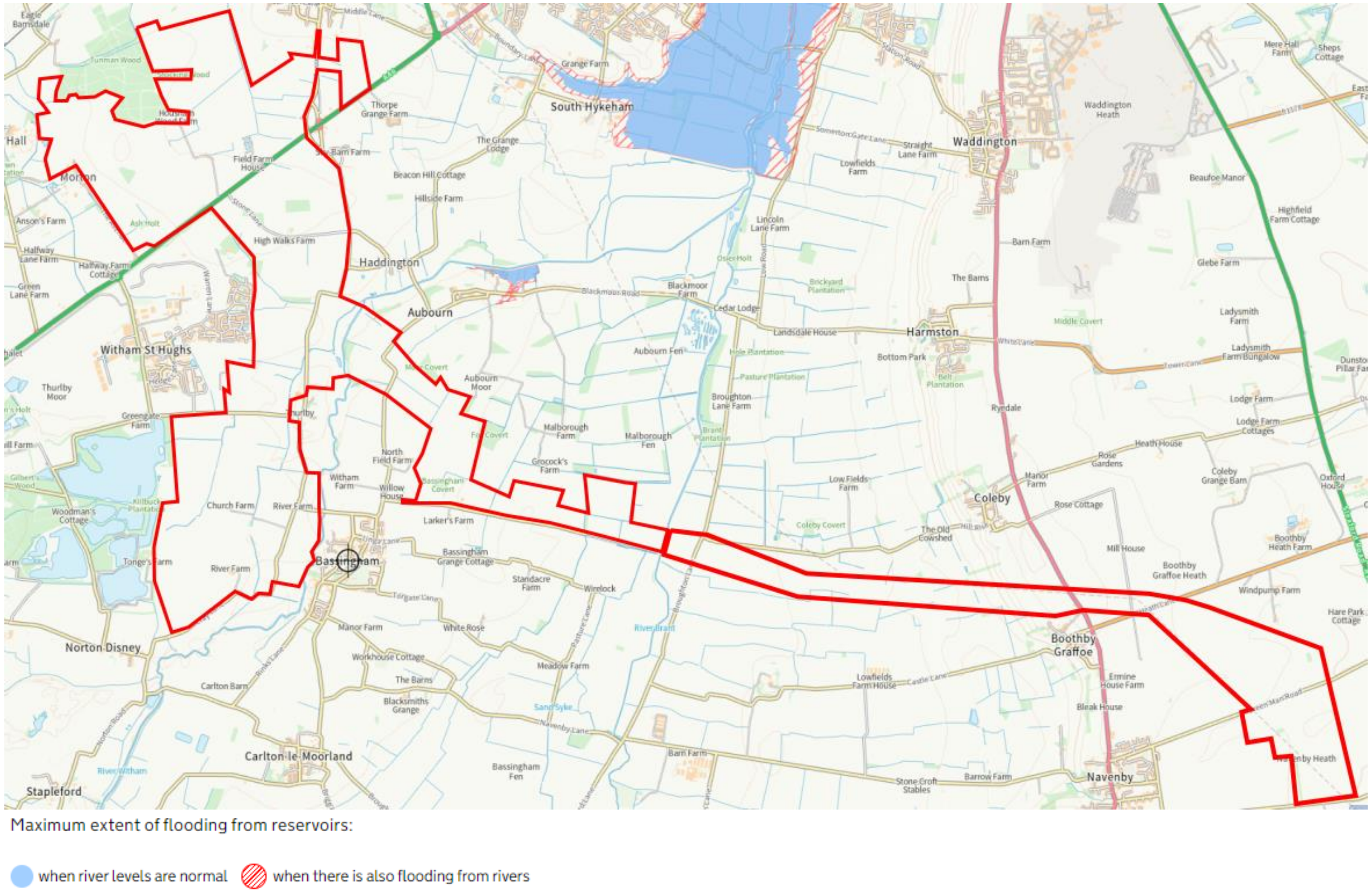


Plate 6: Online Flood Maps for Planning Artificial Sources

Environment Agency online mapping shows the maximum extent of flooding from artificial sources are not located within the vicinity of the DCO Site.

3.4 Watercourses

3.4.1 Watercourses are designated as Main Rivers or Ordinary Watercourses. Main Rivers are identified on the Statutory Main River Map (Ref. 16) and are maintained by the EA, whereas Ordinary Watercourses are maintained by the Lead Local Flood Authority (Lincolnshire County Council).

3.4.2 The following watercourses lie within the DCO Site:

a. Main River:
   i. The River Witham
   ii. The River Brant
   iii. West Brant Syke (running along Fen Lane into the River Brant
b. Ordinary Watercourses:
   i. Mill Dam Dyke (becomes Main River approximately 3.6km downstream, at North Scarle)
   ii. Numerous LLFA/IDB field drains

3.4.3 Figure 9-1: Surface Water Bodies and Their Attributes [EN011054/APP/6.2] shows the locations of the watercourses within the DCO Site.

3.5 Geology and Hydrology

3.5.1 A desk top assessment has been completed to determine bedrock and superficial geology within the DCO Site. These maps indicate there is an approximately north-south geological boundary separating the DCO Site.

3.5.2 Scunthorpe Mudstone (Mudstone and Limestone interbedded) Formation Group, which is designated a Secondary B aquifer and Charmouth Mudstone Formation Group, also a Secondary B aquifer to the west, and Lincolnshire Limestone, a Principal aquifer to the east.

3.5.3 A desktop assessment has been completed using the British Geological Society online mapping (Ref. 17) (finding bedrock and superficial geology within the DCO Site Boundary. These maps indicate there is an approximately north-south geological boundary separating the DCO Site.

Bedrock

3.5.4 Bedrock: Scunthorpe Mudstone (Mudstone and Limestone interbedded) Formation Group, which is designated a Secondary B aquifer and Charmouth Mudstone Formation Group, also a Secondary B aquifer to the west of Bassingham, and Lincolnshire Limestone, a Principal aquifer to the east of Bassingham.

Superficial Deposits

3.5.5 Alluvium - Clay, silt, sand and gravel, is found surrounding the River Witham. Fulbeck Sand and Gravel Member - Sand and gravel, and

Balderton Sand and Gravel Member - Sand and gravel is also found in the vicinity of the Main Rivers within the Principal Site.

3.5.6 The online “Soilscape" map viewer (Ref. 18), describes the soils beneath the Principal Site as ‘Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils’ with ‘Impeded drainage’ properties, and ‘Naturally wet very acidic sandy and loamy soils’ with ‘Naturally wet’ drainage properties.

4. Assessment of Existing Flood Risk (Principal Site)

4.1 Flood Risk from all Sources

4.1.1 This Section assesses the flood risk from the following sources against the Indicative Site Layout Plan as shown within **Figure 3-2A** and **3-2B** of this ES **[EN010154/APP/6.2]** during the operational phase of the Proposed Development:

a. Fluvial (Rivers and the Sea);

b. Surface Water;

c. Sewers;

d. Groundwater; and

e. Artificial waterbodies.

4.1.2 The methodology used to assess the flood risk is detailed below:

a. **Low**: where little risk is identified or any theoretical risk identified is classified as low within Local Authority SFRAs and/or EA flood risk mapping extents, with low probability of flooding occurring.

b. **Medium**: where risk is identified within Local Authority SFRA and/or EA flood risk mapping extents indicating a medium probability, but manageable flood risk with little to no mitigation required; and

c. **High**: where modelled levels within Local Authority SFRA and/or EA flood risk mapping extents show risk to the DCO Site Boundary as a high probability of flood risk and where mitigation needs to be considered and residual risks controlled.

4.1.3 In line with the sequential approach, all proposed buildings/compound areas, substation / transformers stations and BESS and the majority of the solar PV panels will be located outside of Flood Zones 2 and 3 i.e., in Flood Zone 1.

4.1.4 The Main Rivers and other Ordinary Watercourses within and surrounding the DCO Site will not be impacted by a change in flood risk level within the Cable Corridor as no permanent above ground installations are proposed for the operational phase of the Proposed Development.

4.1.5 PV infrastructure shown to be at flood risk in the Principal Site is to be mitigated as set out in **Section 8.**

4.1.6 Table 8~~Table 8Table 8~~ provides a summary of flood risk as a result of the Proposed Development. Each source of flood risk is discussed in further detail in the sections below.

Table 8: With-Development Flood Risk Summary (Operational Phase)

Flood Risk Source	Flood Risk Level	Comments
Fluvial	(Principal Site) Low– with areas of Medium to High risk associated with Rivers Brant and Witham watercourses.	Generally, the majority of Principal Site is situated in areas classified as Flood Zone 1 (Low Risk). As also shown in **Figure 9-3: Fluvial Flood Risk [EN010154/APP/6.2]** and Plate 7Plate 7Plate 7 below; there are areas of flood risk located within the Principal Site associated with the River Brant, West Brant Syke and River Witham that have been assessed using the 2015 EA fluvial modelling extents that interact with some areas of proposed PV Panel fields. There is also an area adjacent to the Principal Site to the north west associated with an Ordinary Watercourse that is a tributary to a Main River (Mill Dam Dyke) which do not interact with the proposed infrastructure, where there is no fluvial model available. The area of overlap is hereby referred to in this FRA as the “Interaction Zone”.

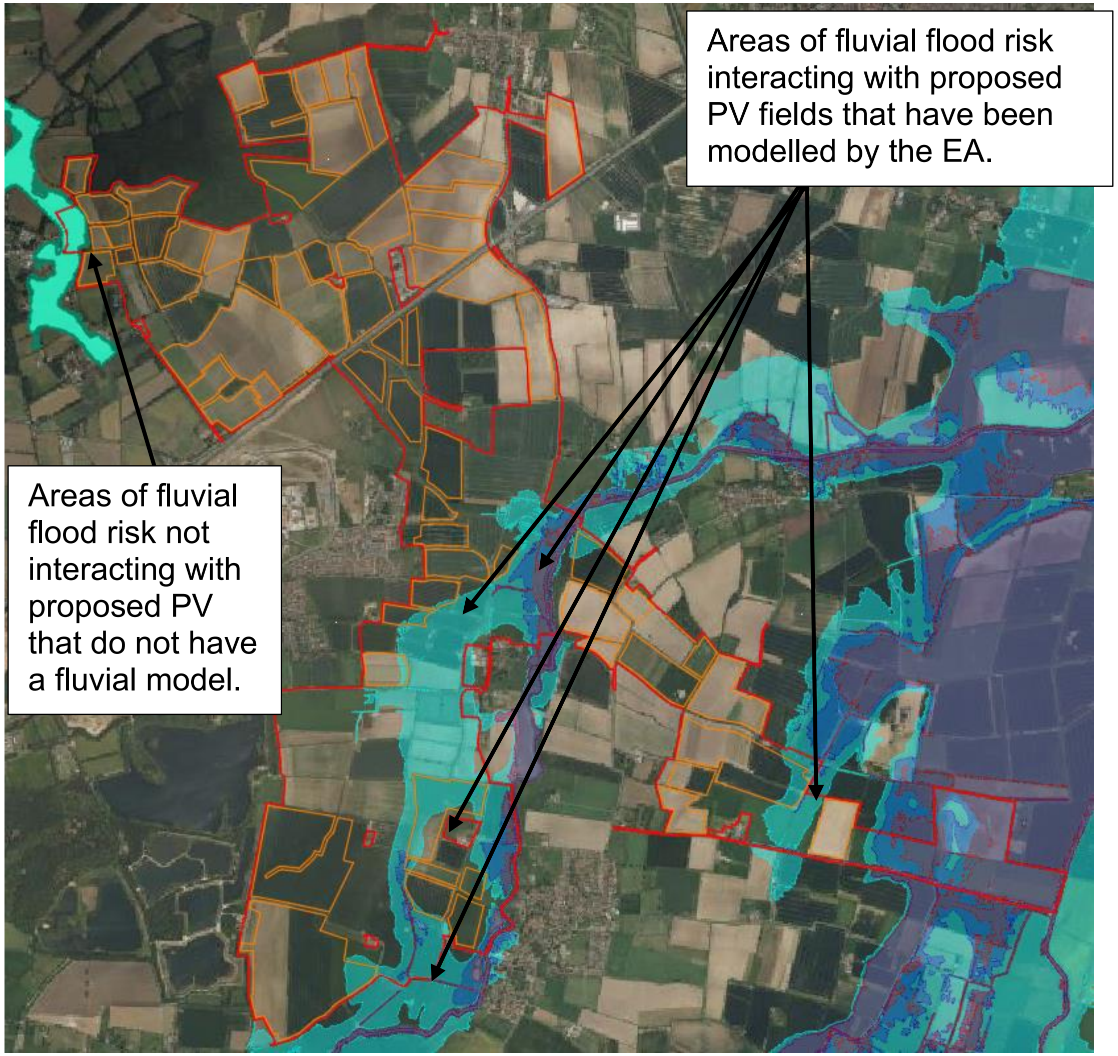


Plate 7: Fluvial Flood Risk overview

Flood Risk Source	Flood Risk Level	Comments
		Source: DEFRA online Flood Zone 2 Dataset (Ref. 22) (2025), DEFRA online Flood Zone 3 Dataset (Ref. 23) (2025). Copyright and database right 2025. Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community The Proposed Development does not propose any above ground infrastructure other than PV panels within the flood risk areas above. Where there are PV panels overlapping with flood risk areas (called interaction zones), these has been limited to the current day 1 in 1000 year flood extents (Flood Zone 2) and the 1 in 100 year plus climate change extents (Flood Zone 3a). There is no permanent above ground infrastructure, other than PV panels, proposed for the operational phase within the 1 in 100 year + Climate Change Flood Zone 3a extents ~~or~~ and no proposed infrastructure within the 1 in 30 year Flood Zone 3b extent (functional floodplain). No change to pre-Proposed Development flood risk level.
Tidal	Low (residual)	No change to flood risk level as a result of the Proposed Development.
Surface Water	Medium	Surface water flood risk is generally low across the Principal Site, with some areas of Medium risk associated with natural topography. Solar PV panels and mounting structures will not increase surface water flood risk as they are not considered to alter the existing drainage regime. Any increased surface water runoff from impermeable areas is proposed to be managed to mimic the pre-Proposed Development conditions for up to and including the 1 in 100 + 40% Climate Change event as detailed in **Appendix 9-D: Framework Surface Water Drainage Strategy [EN010154/APP/6.3]**. Flood Risk will not increase elsewhere as a result and, therefore, remains Medium.
Groundwater	Low	**Appendix 9-D: Framework Surface Water Drainage Strategy [EN010154/APP/6.3]** does not propose to utilise infiltration techniques to discharge increased surface water runoff. No change to flood risk level.
Sewers	Low	The Proposed Development does not impact any existing sewage infrastructure, and no new infrastructure is proposed. No change to pre-Proposed Development flood risk level.

Flood Risk Source	Flood Risk Level	Comments
Artificial Sources	Very Low	The Proposed Development does not impact artificial sources of flood risk and does not propose above ground infrastructure located within the vicinity of an existing artificial flood risk source. No change to pre-Proposed Development flood risk level.

4.2 Climate Change

4.2.1 As of July 2021, the climate change allowances used in FRAs have changed, and now propose peak river flow allowances based on Water Framework Directive catchment areas, instead of nationwide allowances in previous iterations of guidance.

4.2.2 The DEFRA mapping website '*Climate change allowances for peak river flow in England*' (Ref. 19) has been reviewed to confirm the revised climate change allowances for the catchment areas that cover the DCO Site; these are the Lower Trent and Erewash and the Witham catchments. These values have been used in this assessment.

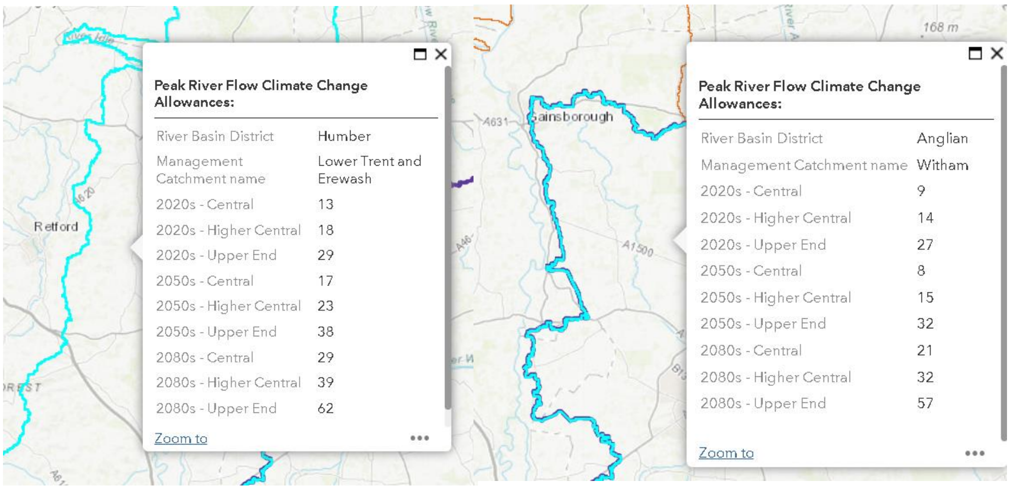


Plate 8: DEFRA Climate Change Allowances for Peak River Flow in England (accessed January 2025)

4.2.3 Climate change allowances relate to predicted percentage increase in peak river flows as a result of the effects of climate change, which development projects like the Proposed Development must take into account in their design.

4.2.4 The current allowance for design purposes for the Proposed Development are the Higher Central allowance of 39% and 32% (for Essential Infrastructure), for the Lower Trent and Erewash Management Catchment and Witham Management Catchment, respectively.

4.2.5 An additional assessment for Essential Infrastructure projects is the application of the H++ Scenario climate change allowance for sea level rise; a sensitivity assessment to ensure infrastructure can operate in extreme events involving a tidal influence. Previously, the H++ Scenario would be applied to Infrastructure projects of this scale. The H++ scenario provides an estimate of sea level rise and river flood flow change beyond the likely range (i.e. an extreme event beyond expected climate change allowances) but within physical plausibility. It is useful for contingency planning to understand what might be required if climate change were to happen much more rapidly than expected.

4.2.6 **Section 4.4** discusses the H++ Scenario for the Proposed Development.

Credible Maximum Scenario (CMS)

4.2.7 Nationally significant infrastructure projects (NSIPs) are major infrastructure projects which include solar farms with an output greater than 50MW, such as the Proposed Development.

4.2.8 The online EA guidance ("Flood risk assessments: climate change allowances") (Ref. 20) indicates that for "*Assessing credible maximum scenarios for nationally significant infrastructure projects, new settlements or urban extensions*":

"If you develop NSIPs you may need to assess the flood risk from a credible maximum climate change scenario" (CMS).

4.2.9 The test should be treated as a 'sensitivity test', to help assess how sensitive a proposal is to changes in the climate for different future scenarios. This will ensure the Proposed Development can be adapted to large-scale climate change over its lifetime.

4.2.10 As the Principal Site is almost entirely within the Witham Management Catchment, the CMS allowance to be referred to in this assessment is the Upper End for the 2080s Epoch, from Plate 8~~Plate 8Plate 8~~ this value is 57%. This is considered a reasonable approach to the assessment of flood risk to the Proposed Development.

4.3 With-Proposed Development Fluvial Flood Risk

4.3.1 The following section provides an assessment of the fluvial flood risk level to and from the Principal Site. The assessment demonstrates that the Proposed Development will not result in an increase to existing flood risk within and surrounding the DCO Site through the implementation of the Drainage Strategy and identifies any areas within the Principal Site where mitigation measures may be required to protect the Proposed Development, to on-site infrastructure and off site, from future fluvial flood events when taking climate change into consideration.

Fluvial Flood Risk as a result of the Proposed Development Infrastructure

4.3.2 **Appendix 9-D: Framework Surface Water Drainage Strategy** of this ES **[EN010154/APP/6.3]** proposes that increased surface water flows from the Proposed Development as a result of new impermeable areas, within the Principal Site, will be managed and discharged to watercourses (or to ground via "Rural SuDS" (RSuDS) techniques where watercourses are not in close proximity). Surface water discharge will be limited to existing greenfield rates via sustainable drainage techniques.

4.3.3 The strategy to control the with-Proposed Development discharge rates to mimic the pre-Proposed Development run-off conditions, mitigates any increases to peak river flow rates within the watercourses utilised for outfall locations within the Principal Site boundary. This strategy will result in no increase to fluvial flood risk levels within vicinity of the Principal Site throughout the design life of the Proposed Development.

Fluvial Flood Risk to the Proposed Development Infrastructure

4.3.4 In general, the majority of the Principal Site is located within Flood Zone 1, with three areas of Flood Zone 2 and 3 extents located within proximity to the above ground infrastructure proposed to be located within PV panel fields.

4.3.5 **Plate 9~~Plate 9Plate 9~~** below presents the Flood Risk Extents utilised in assessing flood risk for the Principal Site.

4.3.6 The light and dark blue flood risk extents shown on **Plate 9~~Plate 9Plate 9~~** have been extracted from the EA's 2015 Fluvial Model of the River Witham and River Brant whilst the green flood risk extents for the Mill Dam Dyke have been extracted from the Environment Agency's Online Flood Map for Planning datasets (Ref. 21 and Ref. 22). There is no detail fluvial hydraulic model for the Mill Dam Dyke and the green flood extents shown do not account for climate change.

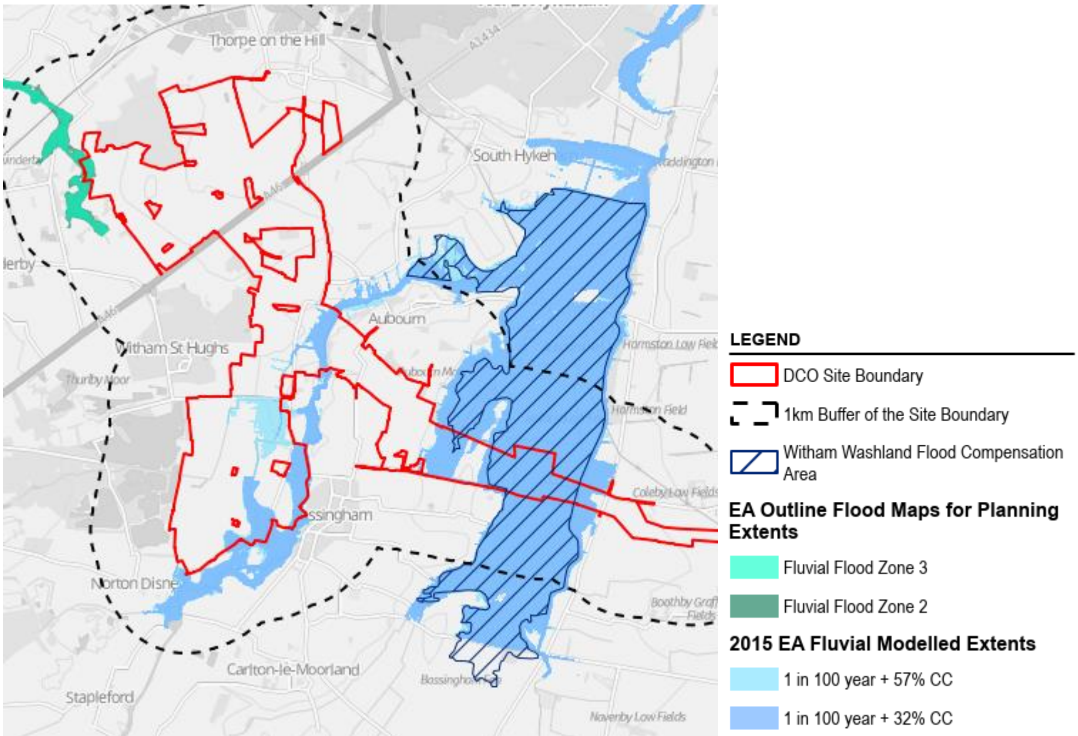


Plate 9: Extract of Figure 9-3 Fluvial Flood Risk of this ES [EN010154/APP/6.2]

4.3.7 There are two separate flood risk datasets available within DCO Site: Mill Dam Dyke catchment and the River Brant and Witham. The Mill Dam Dyke catchment lies within the Lower Trent and Erewash Management Catchment whilst the Upper Witham Catchment lies with the Witham Management Catchment. The proposed method of fluvial flood risk assessment for each of the two catchments is discussed in detail in the following section. A summary of these methods is provided follows:

a. Mill Dam Dyke:

   i. The fluvial flood risk within this catchment was assessed by analysing the hydraulic catchment and performing a watercourse capacity check to estimate flood depths across the solar PV fields along the Mill Dam Dyke and any residual flood risk and mitigation requirements.

   ii. As the location of the solar PV fields are very near the top of the Mill Dam Dyke catchment, with a small catchment, it is considered there is no fluvial interaction, with just a pluvial runoff relationship with the watercourse.

b. River Brant and Witham:

Flood Zone 3a

   i. The fluvial flood risk model for the Upper Witham fluvial catchment (including the River Witham and Brant), referred to as the Upper Witham Lincoln hydraulic model, was published by the EA in 2015 and includes climate change allowances for 20% for the 1 in 100 year event.

   ii. During correspondence with the EA during a meeting in November 2023, the EA confirmed in the meeting (included in the correspondence in **Annex C: Environmental Agency Correspondence [EN010154/APP/6.3]**) that the Upper Witham Lincoln hydraulic model would be updated in 2024 to account for current climate change allowances. The EA confirmed in a letter on 21 December 2023 that this FRA can utilise the 2015 model data to assess the current climate change allowances, uplifting the climate change allowances to 32% for design and 57% for sensitivity. This updated modelling was completed in September 2024 - see **Annex F: Hydraulic Modelling with climate change allowances technical note** of this FRA **[EN010154/APP/6.3]** for a technical note detailing the modelling approach.

   iii. Updates to the 2015 Upper Witham Lincoln hydraulic model to account for current climate change allowance performed by the EA have not yet been published.

   iv. For this Flood Risk Assessment, the 1 in 100 year plus 32% climate change extent has been used for the assessment and potential mitigation.

Flood Zone 3b

i. The 2015 hydraulic model provides the 1 in 30-year extent for Flood Zone 3b (Functional Floodplain).

ii. No permanent above ground infrastructure is located within Flood Zone 3b.

Floodplain Compensation for PV Panels

4.3.8 With any proposed scheme that has potential flood risk and consequential floodplain loss, an assessment of compensation should be provided. As discussed in this FRA, there is no permanent above ground infrastructure, other than solar PV panels, that will be located with Flood Zone 2 and 3a extents. All other permanent above ground infrastructure and operational phase site compounds within the Principal Site will be located in Flood Zone 1.

4.3.9 As discussed in this FRA, the modelling carried out using the 2015 model, ~~using~~ uses the current climate change allowances (Refer to **Annex F: Hydraulic Modelling with climate change allowances technical note** of this FRA **[EN010154/APP/6.3]**)~~, as agreed with the EA, indicated a maximum flood depth in all scenarios of 500mm across the principal site within PV panel areas. As PV panels are set 800mm above the ground level, flood risk does not impact the panels.~~ .

4.3.10 Solar PV panel~~ legs~~ ls ~~do, however,~~ sit within the River Witham and River Brant flood extents.

4.3.11 Each Solar PV panel has a minimum height above ground of 800mm, and is supported by adjustable steel legs. The proposed density of the panels is approximately 1,500 panels per hectare. Each panel is support by two I beams and a Sigma Beam (for non-tracking panels; fixed panels will have thinner legs due to less weight to support; therefore, a conservative approach has been taken to assess floodplain volume impacts for tracker panels).

4.3.12 A volumetric floodplain compensation calculation, assessing all ~~three~~ eleven of the identified fields has been undertaken to determine if floodplain compensation is required.

4.3.13 Of the PV panel fields at risk of flooding, only ~~3~~ 5 are within the Flood Zone 3a climate change extent (~~for the~~ 1 in 100 year plus ~~57~~32% ~~CMS flood extent or the 1 in 1000 year extent, whichever is greater~~climate change); Fields ~~45~~53, ~~54 and~~ 57, 59, 60 and 62. **Table 9~~Table 9Table 9~~** provides the cumulative results of the volumes occupied by the PV mounting structure leg within the design fluvial flood depth extents. See **Annex ~~F~~G~~: Hydraulic Modelling with climate change allowances technical note [EN010154/APP/6.3]~~** included within this FRA for full calculations.

Table 9: Total Volumes of PV Mounting Structures in Flood Depth Extents

PV field No.	Total PV field area within design flood depth extents (ha)	Total mounting structure leg cross sectional area within design flood depth extents (m^2)	Average depth within design flood depth extents (mm)	Total leg volume within design flood depth extents (m^3)
5345	3.001.34	26.7111.93	550300	14.693.58
5754	0.081.76	0.7115.67	100300	0.074.70
5957	0.360.08	3.210.71	400300	1.280.21
60	0.46	4.1	250	1.02
62	1.95	17.36	25	0.43
TOTAL	**5.853.18**	-	-	17.508.49

4.3.14 The results indicate that total of 8.4917.50m^3 of floodplain volume is lost as a result of the solar PV panel infrastructure within the CMS flood depth extents. Across a totaln area of 3.185.85 ha, this results in an average maximum depth increase of 0.3024mm, with a maximum increase in the flood depth of approximately 1.570.49mm in solar PV Field 53.

4.3.15 From practical experience, it is considered current fluvial modelling outputs can predict approximate flood depths within model cells to +/-10mm in tolerance. With LiDAR and drone survey tolerances between +/- 150mm and +/- 20-30mm respectively, it is considered a hydraulic model would not feasibly assess the floodplain loss at this scale of floodplain loss within a tolerance less than +/- 10mm.

4.3.16 Therefore, it is considered, with the estimated average flood depth increase of 1.570.3224mm, there will be no material increase in flood risk on the DCO Site or elsewhere. With the lack of receptors downstream of the interaction zone (open greenfield space) floodplain compensation is not required for the Proposed Development.

4.3.17 In summaryconclusion, fluvial flood risk is not increased as a result of the Proposed Development, to the Proposed Development or elsewhere.

Fluvial Flood Risk for Mill Dam Dyke

4.3.18 In order to assess the fluvial flood risk to the fields containing solar PV in the vicinity of the fluvial flood risk area of the Mill Dam Dyke, a catchment runoff approach has been undertaken to estimate potential flood depths, including allowances for climate change.

4.3.19 The assessment is based on the contributing pluvial runoff catchment area and the peak runoff rates that it can feasibly generate, related to the channel capacity and predicted flood risk as a result of exceeded channel capacity.

4.3.20 The minimum assessment parameters to base the assessment on and to assess suitability in addressing flood risk are set out below:

a. Flood Estimation Handbook (FEH 2022) web service data has been used to assess the flood risk runoff rates;

b. Predicted flood level assessment undertaken using climate change allowances for the 2080's Epoch for both the Higher Central and Upper End in lieu of a hydraulic model of the Mill Dam Dyke;

c. Design Climate Change Allowance: 39%;

d. Credible Maximum Scenario / Sensitivity Test: 57%;

e. Minimum Design Freeboard of 300mm; and

f. Credible Maximum Scenario depths shall not submerge the PV panels but can utilise the freeboard allowance.

4.3.21 As there is no detailed hydraulic model to assess the climate change values above, a conservative assessment of climate change based on excess catchment flows has been undertaken to provide an appropriate assessment of flood risk to the solar PV panels in the Principal Site where they are at potential risk of flooding. Further detail is set out in the Technical Note which is included in **Annex E: Fluvial Flood Risk Technical Note** of this FRA **[EN010154/APP/6.3]**.

4.3.22 The Technical Note sets out the methodology, analysis, findings and proposes mitigation measures

4.3.23 The fluvial flood risk area identified by the green flood risk extents in **Plate 9~~Plate 9Plate 9~~** have been taken from the EA's Online Flood Maps for Planning data download service (Ref. 21 and Ref. 22).

4.3.24 These extents provide the present-day Flood Zone 2 and 3 extents associated with the Mill Dam Dyke watercourse located in the north western boundary of the Principal Site located within the Humber River Basin District.

4.3.25 Assessing climate change, for the 2080's epoch; the Higher Central (design) allowance requires an additional 39% for fluvial modelling and the Upper End (sensitivity) allowance requires an additional 57% for climate change allowances.

4.3.26 In lieu of a detailed hydraulic model to assess the 39% and 57% allowances, and to provide a robust approach to the analysis, a conservative overestimate of the potential discharge rates that the Mill Dam Dyke may become subject to have been applied. The design discharge rate for the Mill Dam Dyke has been taken as the greenfield 1 in 100 year rate increased by 50% instead of 39% (1.5 x 1 in 100 year rate), and the sensitivity check discharge rate has taken as the greenfield 1 in 100 year rate increased by 100% instead of 57% (2 x 1 in 100 year rate).

4.3.27 **Table 10~~Table 10Table 10~~** below provides the assessed maximum flood depths, i.e. the design flood depth and the CMS flood depth.

Table 10: Predicted flood levels (1 in 100 year + Climate Change)

Flood Event	Max Flood Depth Above Bank (m)	Top of Bank Level (m AOD)	Max Flood Depth Above Bank (m AOD)
1 in 100 year + 50% Higher Central Allowance (Design)	0.207	12.50	**12.707**
1 in 100 year + 100% Upper End Allowance (Sensitivity)	0.250	12.50	**12.750**

4.3.28 The findings of the above analysis, indicate that during the design and sensitivity scenarios, the flood depth would not extend out from the Mill Dam Dyke into the flood channel far enough to impact the PV fields as the fields have a higher topography, with the lowest point of 12.90m AOD in Field 8. The analysis, therefore, concludes that there is no residual fluvial flood risk to the Proposed Development infrastructure in this area for the duration of its lifespan and there is no mitigation required in this area, incorporating the impacts of climate change.

Summary

4.3.29 An analysis has been undertaken to predict the flood levels surrounding the Mill Dam Dyke Ordinary Watercourse for the 1 in 100 year + CC events, applying a very conservative approach to the climate change allowances.

4.3.30 The flood depth when taking into account both the Higher and Upper climate change allowances, does not reach the topographical height of the adjacent fields proposed to contain solar PV.

4.3.31 Therefore no mitigation, such as raising panel mounting height is required in this area of the Proposed Development from the Mill Dam Dyke.

Fluvial Flood Risk for River Brant, West Brant Syke and Witham

4.3.32 For the River Brant and Witham Main River watercourses, the EA has undertaken detailed hydraulic modelling in 2015.~~,~~ Following further discussion with the EA this modelling has been updated to include the current climate change allowances of 32% and 57% to the 1 in 100 year event – see **Annex F: Hydraulic Modelling with climate change allowances technical note** of this FRA **[EN010154/APP/6.3]**. The extents of which are identified in **Figure 9-3: Fluvial Flood Risk** of this ES **[EN010154/APP/6.2]**.

4.3.33 Other than solar PV panels, the Proposed Development design does not propose any permanent above ground infrastructure within Flood Zone 2 or~~,~~ 3a, with no infrastructure of any sort proposed in ~~or~~ Flood Zone 3b.

4.3.34 The plates below show the following fluvial extents from the 2015 hydraulic model:

a. Purple - Flood Zone 3b (1 in 30 year);

b. Light Blue - Flood Zone 3a (1 in 100 year plus 32% climate change);

c. Dark Blue - Flood Zone 3a (1 in 100 year plus 57% climate change); and

d. Cyan - Flood Zone 2 (1 in 1000 year).

4.3.35 **Figure 9-3: Fluvial Flood Risk** of this ES **[EN010154/APP/6.2]** and the plates below indicate there are ~~two~~ five fields ~~with~~ where solar PV panels ~~that~~ are located within the Flood Zone ~~3b or Flood Zone~~ 3a plus climate change extents.

Table 11: Predicted Flood Depths including climate change

Field No.	Maximum predicted flood level within Flood Zone 3 (100 yr + 32% CC) (m AOD)	Lowest topographical field level within flood extent Interaction Zone (m AOD)	Maximum flood depth within Flood Zone 3 (100 yr + 32% CC) Interaction Zone (m)
534	8.30	7.2090	0.401.10
57	8.20	8.00	0.20
59	10.60	9.8	0.80
60	10.50	10	0.50
62	10.55	10.5	0.05

Panel height does not provide **300mm freeboard**

Panel height provides min 300mm freeboard

4.3.36 The standard solar PV panel heights are to be a minimum 800mm above ground. Within the design scenario (100 yr + 32% CC) a minimum freeboard depth of 300mm should be provided below the bottom of the panel. Fields 57, 60 and 62 have a maximum flood depth less or equal to 0.5m; therefore, the minimum freeboard is provided.

4.3.37 Within Fields 53 and 59 the floods depths do not allow the required freeboard of 300mm to be met; therefore, mitigation is required by raising the solar PV panels above the floodplain to ensure a 300mm freeboard is maintained. Within the flood extents of Field 53, solar PV panel heights will be raised by a maximum of 0.6m to provide 300mm freeboard. Within Field 59, the height of the base of the solar PV panels will be raised by a maximum of 0.3m respectively to provide the required 300mm freeboard.

4.3.36 By providing the mitigation within solar PV fields 53 and 59, fluvial flood risk during the design storm event for the Proposed Development (1in 100year + 32% CC) is suitably managed, ensuring panels will remain operational in times of flood. Whilst Fields 54 and 57 lie partially within Flood Zone 3 (100 yr + 32% CC), the maximum flood depth does exceed 0.4m. As such, all panels within these field will achieve a minimum freeboard depth of 300mm below the bottom of the panel. Therefore, for the design storm event including climate change, there is no mitigation required to raise solar PV panels above the floodplain to ensure a 300mm freeboard is maintained.

4.3.38

Credible Maximum Scenario

4.3.374.3.39 To demonstrate the Proposed Development will remain operational in times of flood, The model assessed the Credible Maximum Scenario (CMS) based on both the 1 in 100 year + 57% climate change scenario within the updated 2015 Upper Witham Lincoln hydraulic model and the 2015 modelled Flood Zone 2 extent (1 in 1000 year event). Both flood extent outlines have been used to assess the CMS, as the 57% allowance extends over the 1 in 1000 year extent in places.

4.3.384.3.40 Fields proposed to contain solar PV panels where the flood extents interact with the PV Arrays include fields: 44, 45, 5448, 51, 53, 55, 57, 59, 60, 61 and 62 and 57 as shown on the figures below.

Plate 10: 2015 Model Fluvial Flood Extents Field 44

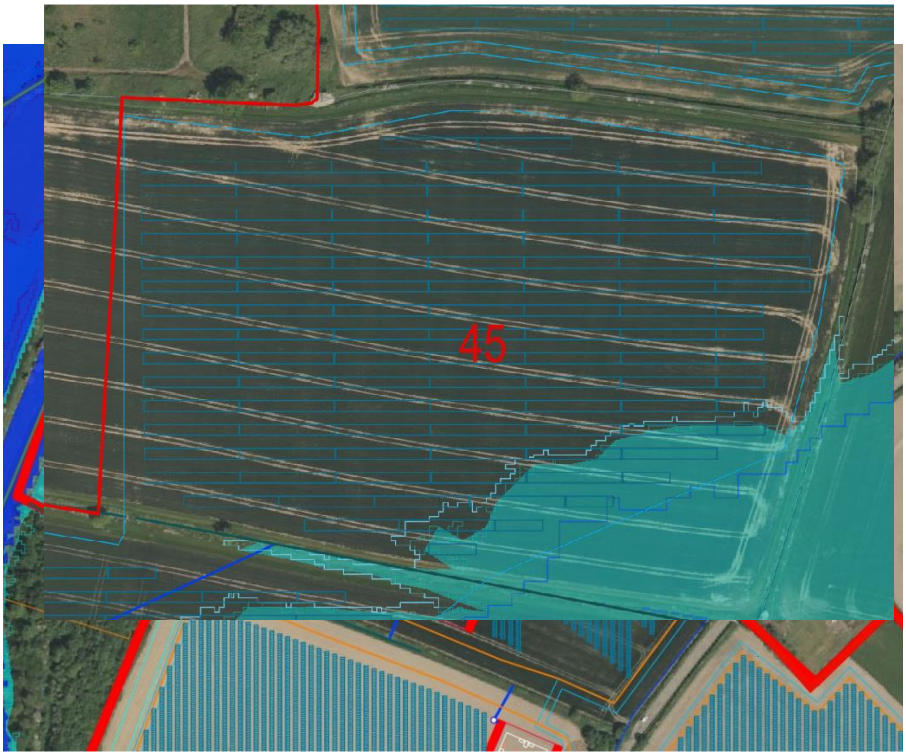


Plate 10: 2015 Model Fluvial Flood Extents Field 45

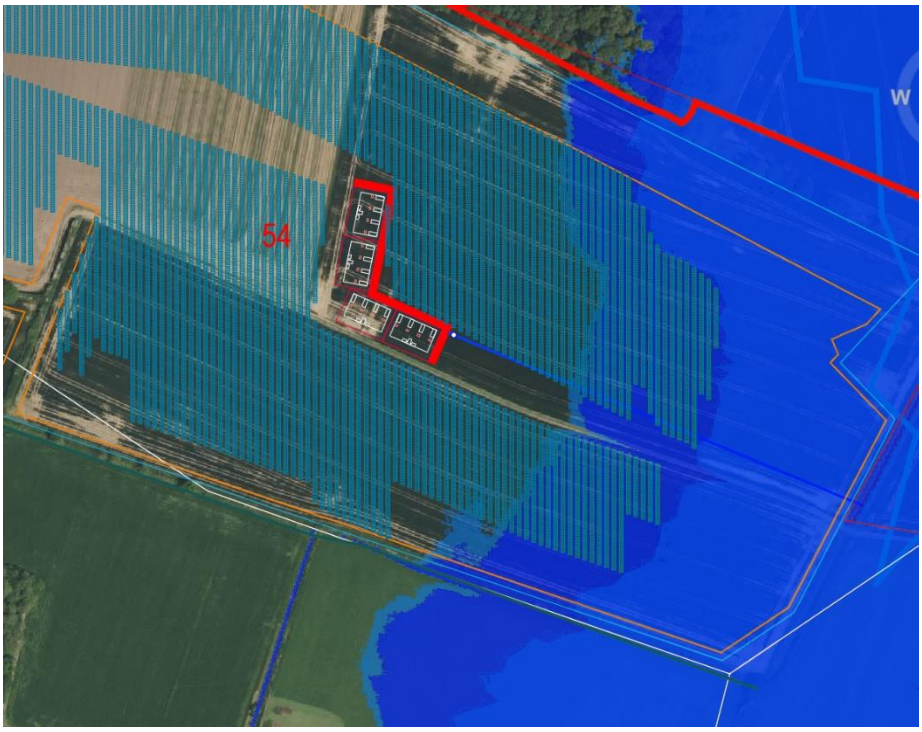


Plate 11: 2015 Model Fluvial Flood Extents Field 45

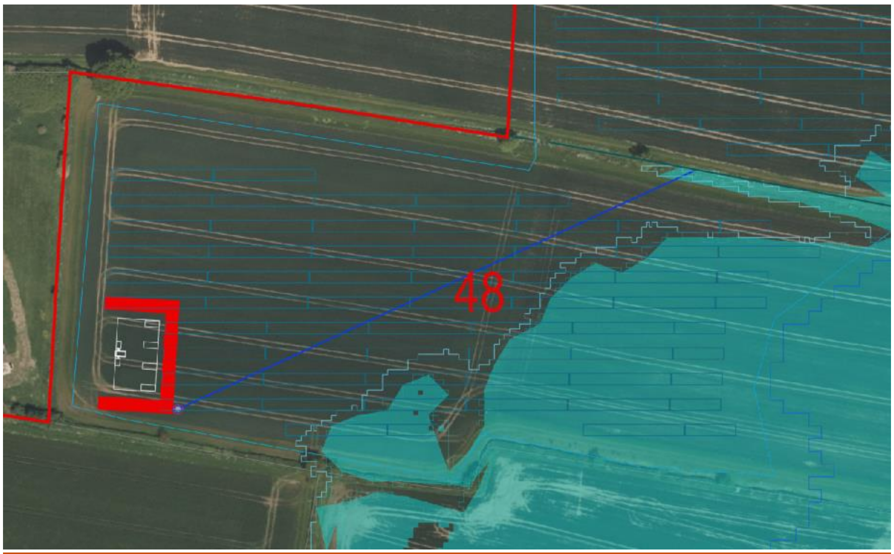
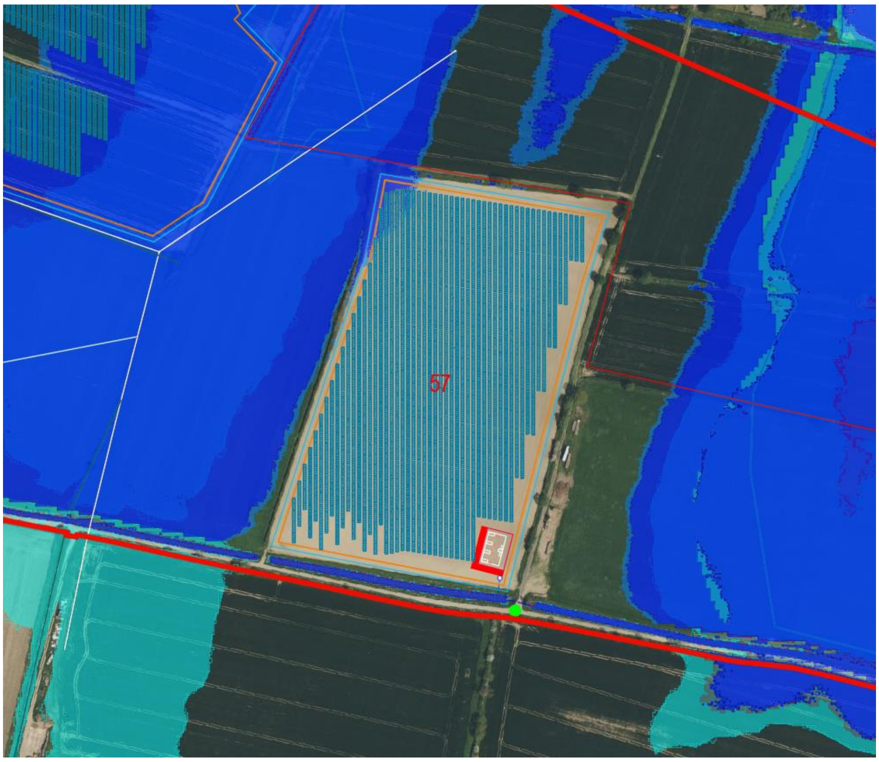


Plate 12121211: 2015 Model Fluvial Flood Extents Field 4854



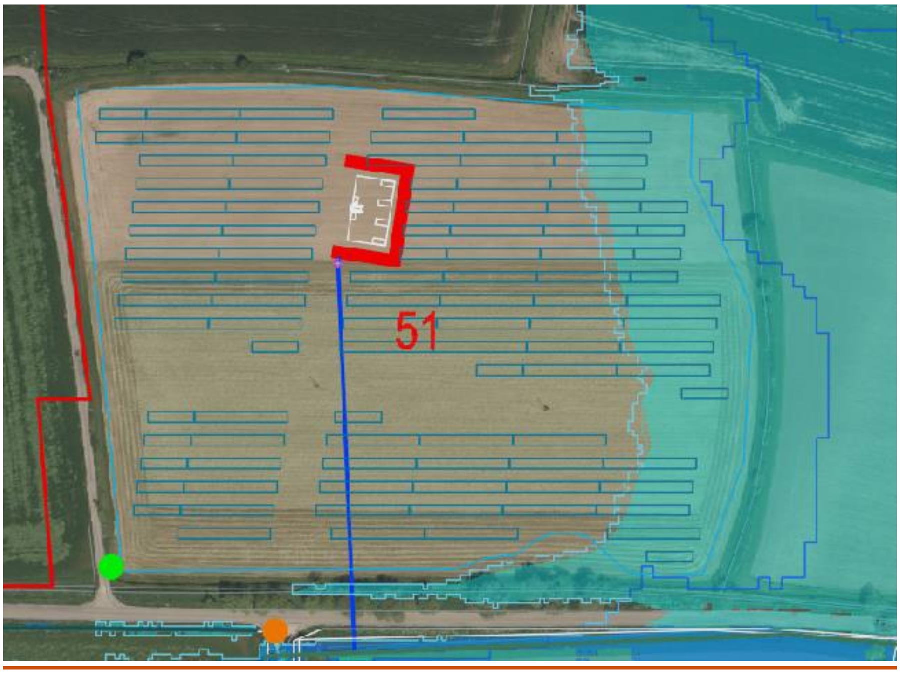


Plate 131312: 2015 Model Fluvial Flood Extents Field 5751

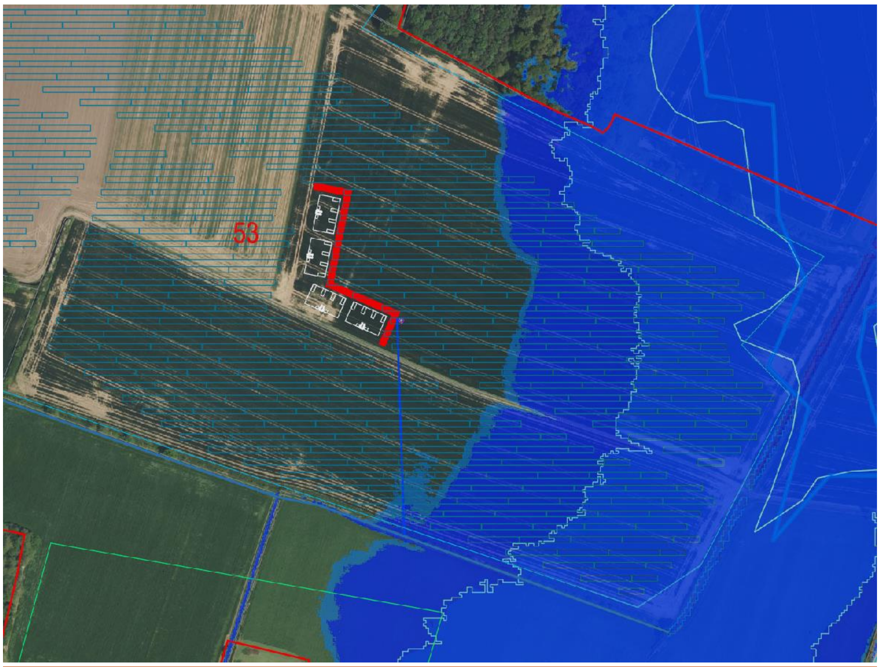


Plate 14: 2015 Model Fluvial Flood Extents Field 53

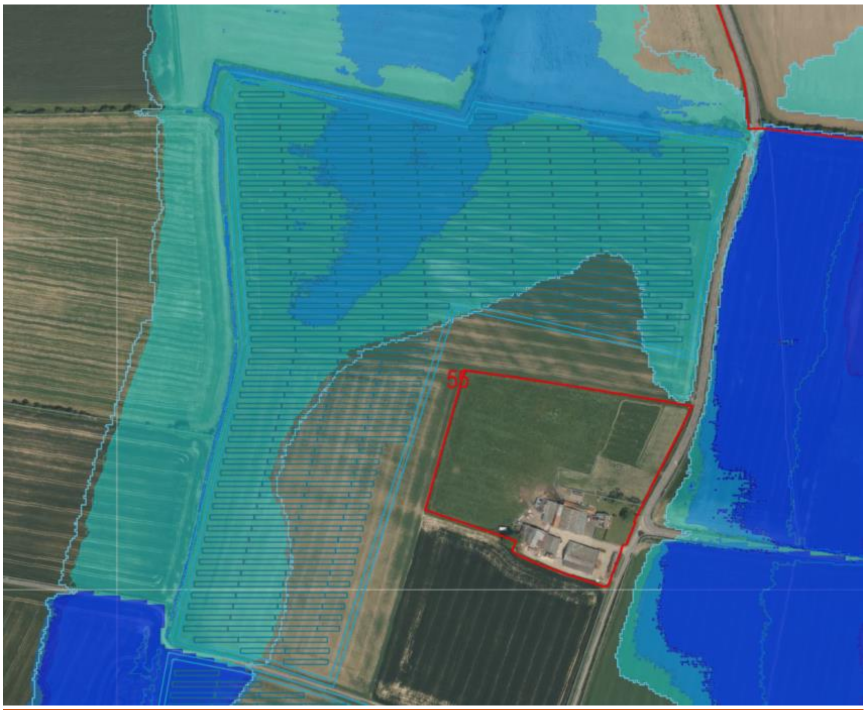


Plate 15: 2015 Model Fluvial Flood Extents Field 55

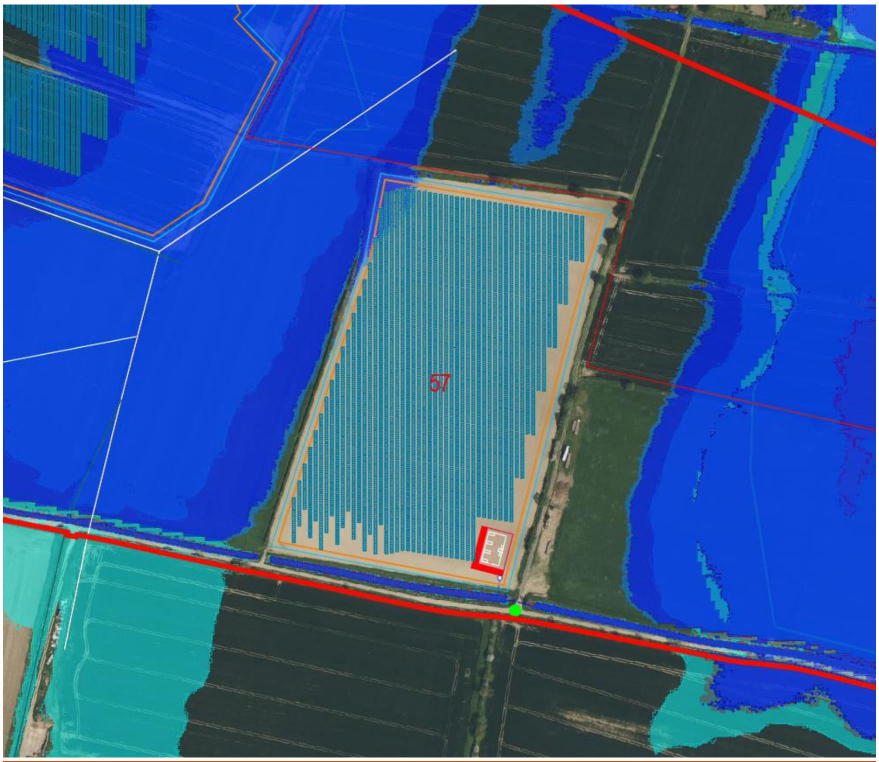


Plate 16: 2015 Model Fluvial Flood Extents Field 57

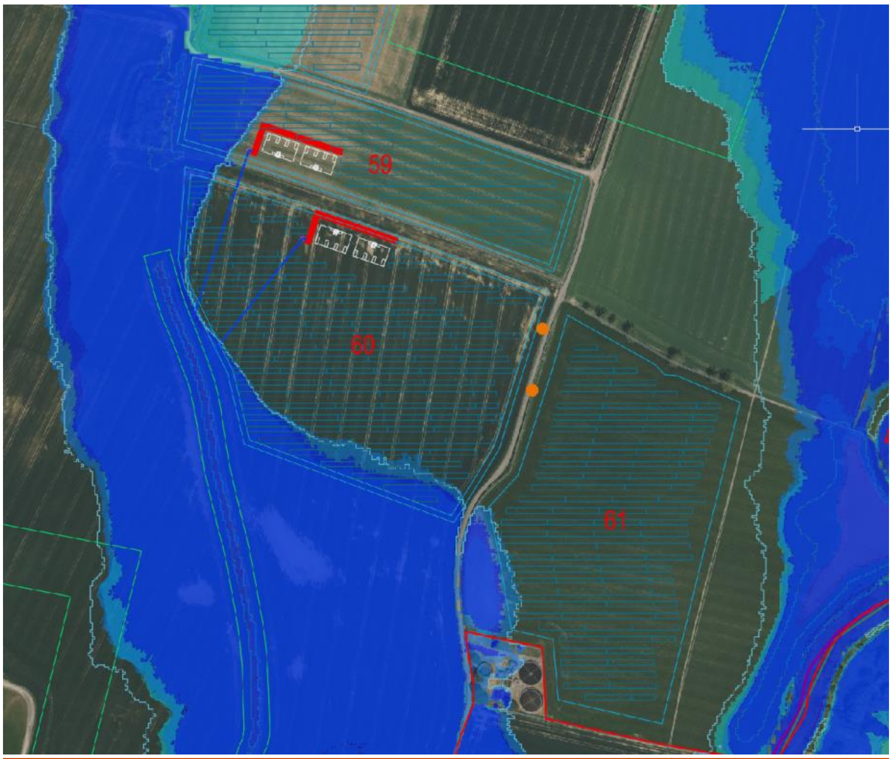


Plate 17: 2015 Model Fluvial Flood Extents Field 59, 60 and 61

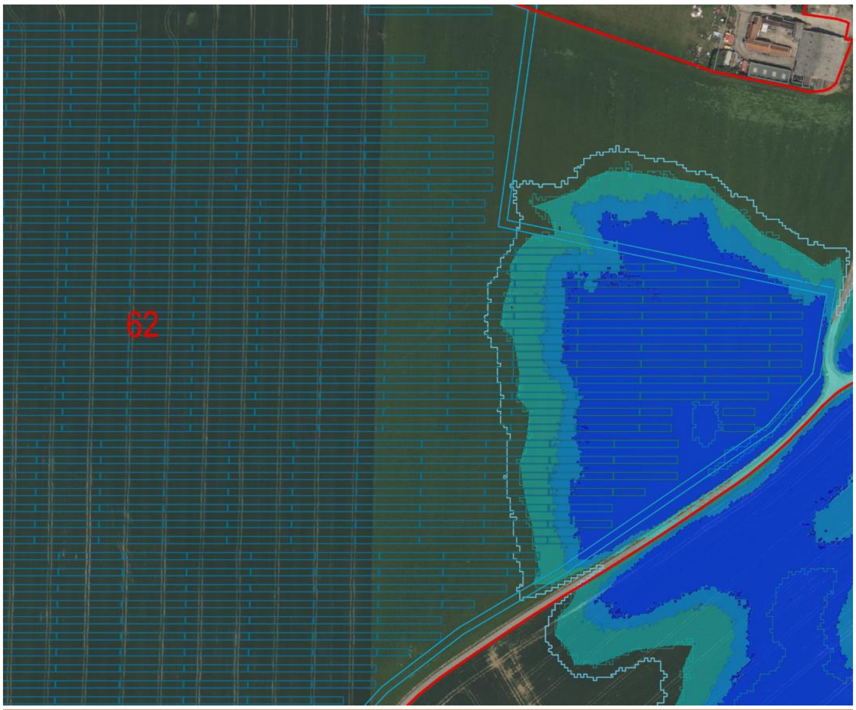


Plate 18: 2015 Model Fluvial Flood Extents Field 62

~~4.3.39~~4.3.41 Table 12~~Table 12Table 12~~ below includes the ~~highest~~ maximum estimated flood levels, of either the 2015 hydraulic model data Flood Zone 2 extent or the updated 1 in 100 year + 57% climate change extent, whichever is ~~higher~~greater, and an analysis of the topographical levels taken from LiDAR data (Ref. 23), within each of the Flood extent interaction zones, to confirm if the solar PV panels are safely above the flood level, during the credible maximum scenario event, and will remain operational in times of flood.

Table 12: Flood Extent Interaction Zone Depths

Field No.	Maximum predicted flood level (m AOD)	Lowest topographical field level within flood extent Interaction Zone (m AOD)	Maximum flood depth within Flood Interaction Zone(m)	Panel Height (including design event mitigation) (m)	Flood Extent
44	8.80	8.50	0.30	0.80	Flood Zone 2
45	9.44~~8.75~~	9.15~~8.74~~	0.29~~0.01~~	0.80	Flood Zone 2
44	8.80	8.50	0.30	0.80	Flood Zone 2
45	9.44	9.15	0.29	0.80	Flood Zone 2
48	9.5	9.10	0.40	0.80	Flood Zone 2
51	9.7	9.40	0.30	0.80	Flood Zone 2
53~~4~~	8.40	7.90	0.50	1.40	1 in 100 yr + 57% CC
55	10.00	9.10	0.90	0.80	Flood Zone 2
57	8.30	8.00	0.30	0.80	1 in 100 yr + 57% CC
59	10.70	9.80	0.90	1.10	1 in 100 yr + 57% CC
60	10.70	10.00	0.70	0.80	1 in 100 yr + 57% CC

Field No.	Maximum predicted flood level (m AOD)	Lowest topographical field level within flood extent Interaction Zone (m AOD)	Maximum flood depth within Flood Interaction Zone(m)	Panel Height (including design event mitigation) (m)	Flood Extent
61	10.70	10.60	0.10	0.80	1 in 100 yr + 57% CC
62	10.95	10.50	0.45	0.80	Flood Zone 2

	Panel height not sufficient to satisfy CMS
	Panel height sufficient to satisfy CMS

4.3.42 As shown in Table 12Table 12Table 12, with the embedded mitigation for the design flood event (1 in 100 year + 57% climate change extent, or 1in 1000 year extent, whichever is greater1 in 100 year + 32% CC) in place, solar PV panels are not at risk of fluvial flooding when taking into account the credible maximum scenario, except for solar PV Field 55, where the maximum flood depth during the CMS is 0.90m. The PV panels in Field 55 will be raised by up to 200mm to 1.0m height above ground, to provide 100mm freeboard during the CMS; therefore, with the additional mitigation in place for Field 55, it is demonstrated that the solar PV infrastructure will remain operation in times of flood during extreme storm events.

4.3.40 there are only three solar PV fields where panels are located in the flood extents. The maximum flood depth was assessed to be approximately 0.5m in Field 54. As solar PV panel heights are to be a minimum 0.8m above ground, all of the solar PV panels are not at risk of fluvial flooding, taking into account the credible maximum scenario; this demonstrates the solar PV infrastructure will remain operation in times of flood.

4.3.414.3.43 In conclusion, with the embedded mitigation proposed, the Proposed Development fluvial flood risk for both the Mill Dam Dyke and the River Brant and Witham is considered to have been appropriately assessed, ensuring the Proposed Development will remain operational in times of flood.

Flood Defence Breach

4.3.424.3.44 The proposed solar PV fields also benefit from flood defences along the River Witham and River Brant, either from natural high ground or embankments. Plate 19Plate 19Plate 13 below indicates the flood defences along the rivers Witham and Brant, taken from the Defra online spatial data download service for flood defences (Ref. 24), along with the standard of protection (SoP) and the defence type where they pass within the Principal Site. The River Witham SoP differs depending on the river bank and natural ground level. The EA 2015 hydraulic model takes these flood defences into account within the published model extents.

4.3.434.3.45 These flood defences are operated and maintained by the EA to a high standard, such that the flood risk up to and including the return periods noted is considered a low residual risk.

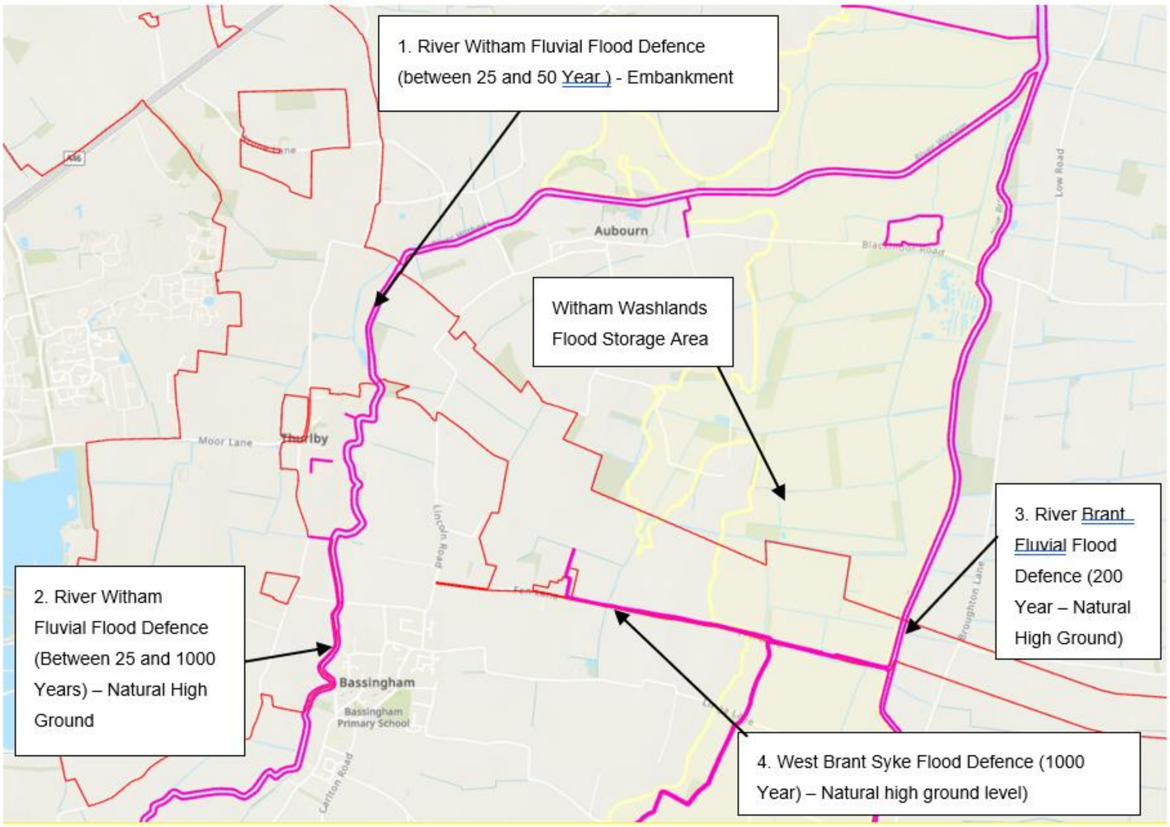


Plate 191913: Environment Agency Fluvial Flood Defence Locations

4.3.444.3.46 The spatial flood defence data (Ref. 24) notes the defences, shown for item 2, 3 and 4 in Plate 19Plate 19Plate 13, benefit from natural high ground to form the flood defences. A flood defence breach is associated with a failure of above ground man-made raised defences. As these defences are in areas of natural high ground, a breach of these defences is considered unlikely.

4.3.454.3.47 The reach of the River Witham (item 1 in Plate 19Plate 19Plate 139) benefits from raised man-made embankments, between Fields 43, 44, 44 and 487. Only solar PV fields 54 and 57 lie within the 1 in 100 year plus climate change extent, and only Field 45 lies partially within the 1 in 1000 year extent.

4.3.464.3.48 The 2015 hydraulic model, updated for the current climate allowance, considers flood defences; however, the flood defences only provide up to a 1 in 50 year storm event. It is reasonable to consider that a breach during a 1 in 100 year event would not extend further than the modelled fluvial 1 in 100 year plus 32% climate change extent as the embankment would be overtopped in any case.

~~4.3.47 Fields 54 and 57 could, in theory, be impacted by an embankment breach but maximum flood depth for the CMS (noted in **Table 12**) is approximately 0.5m, the solar PV panels are afforded at least 0.3m freeboard above this level, providing sufficient protection from a potential breach.~~

4.3.49 Given the lifetime of the Proposed Development is proposed to be 60 years, it is considered that a breach event within the Principal Site is a low residual risk, and taking into account the embankments will be inspected as part of the Environment Agency monitoring regime for flood defence assets.

4.4 With-Proposed Development Tidal Flood Risk

4.4.1 Tidal flooding occurs when an exceptionally high tide, almost always accompanied by a storm tide surge, overtops and/or breaches the tidal defences along a coastline or tidal estuary.

4.4.2 Although North Kesteven does not lie along a coastline or does not have a tidal river flowing through the District, a small area around North Scarle falls within the River Trent's tidal floodplain.

4.4.3 The Mill Dam Dyke, which runs through North Scarle is considered a significant tidal flood risk source. The Mill Dam Dyke (or Girton Fleet downstream of Baxter Bridge) flows through the village of North Scarle and discharges into the River Trent via a modern tidal outfall sluice. The watercourse can become tide locked impacting on water levels within the channel at North Scarle.

4.4.4 The village of North Scarle is approximately 3.6km from the Proposed Development boundary, at a level of between approximately 9m AOD and 10m AOD. The tidal influence is not considered to pose a risk to the DCO Site with minimum ground levels of PV panel fields approximately 13m AOD.

4.4.5 The Mill Dam Dyke discharges into the River Trent via tidal sluice; however, the Mill Dam Dyke can become tide locked impacting flood risk upstream. This is discussed in the North Kesteven Strategic Flood Risk Assessment, in Section 4 (Ref. 11). Appendix C of the North Kesteven SFRA (Ref. 11notes Environment Agency modelling suggests peak levels in the Mill Dam Dyke would reach approximately 7.74m AOD, before overtopping and flooding low lying areas. With lowest ground levels at the north west extent of the Principal Site boundary being approximately 14m AOD, tidal risk is considered low.

4.4.6 Another potential tidal influence within North Kesteven is determined by the ability of the River Witham to discharge via its tidal outfall at Boston (Grand Sluice). The River Witham's discharge can be restricted for significant periods of time when there is a high tide which has implications for fluvial flood risk as far upstream as North Kesteven.

4.4.7 Tidal flood risk to the DCO Site generally is considered to be low. However, for a Proposed Development of this nature, an assessment of future sea level rise is required.

Sea Level Rise

4.4.8 Sea level rise allowances account for slow land movement. This is due to glacial isostatic adjustment from the release of pressure at the end of the last ice age. The northern part of the UK is slowly rising, and the southern part is slowly sinking. This is why net sea level rise is predicted to be less for the north west and north east than the rest of the country.

4.4.9 Sea level rise and the H++ scenario have been considered in this FRA. An assessment of the impacts of future sea level rise has been undertaken to demonstrate the Principal Site is not at risk during its expected operational design life, taking into consideration the Boston Barrier Tidal Flood Defence Scheme.

4.4.10 The H++ is required to assess a site as part of a sensitivity test for NSIP, to ensure a proposed NSIP scheme is safe from flood risk for its lifetime.

4.4.11 There are a range of allowances for each river basin district and epoch for sea level rise, **Plate 20~~Plate 20Plate 14Plate 14~~** presents the boundaries of the two river basin catchments.

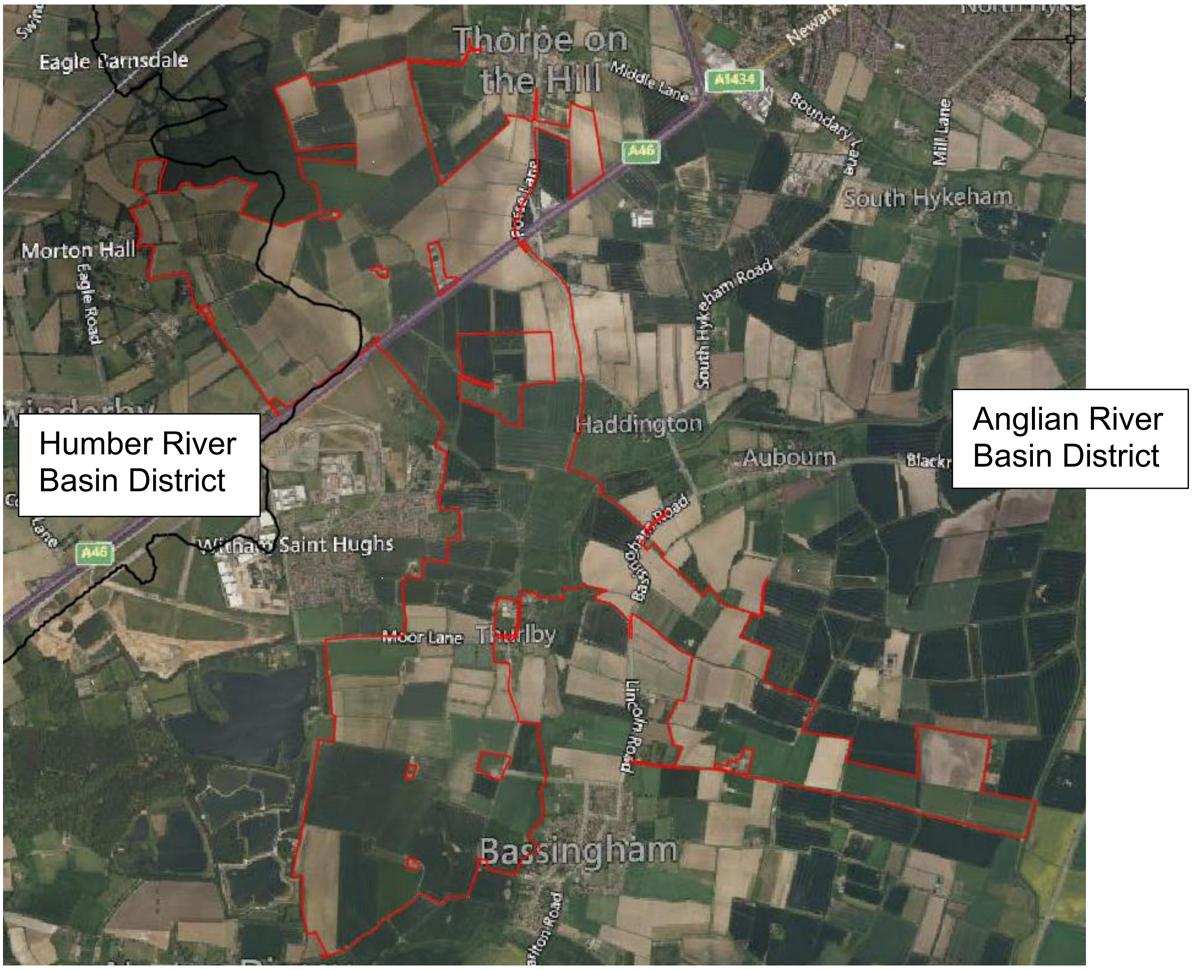


Plate 202014: River Basin District Map, Environment Agency (online)

4.4.12 The climate change allowances are set out in Table 2 of the EA online Climate Change Assessment guidance (Ref. 25) and are based on percentiles. A percentile describes the proportion of possible scenarios that fall below an allowance level. Table 13Table 13Table 13 below indicates the sea level rise estimate, for the epochs for the Humber and Anglian River basin catchments.

Table 13: Extract from Table 2 of Environment Agency Sea Level Rise Tables (Online)

River Basin District	Allowance	2036 to 2065 (mm/yr)	2036 to 2065 (mm/yr) – Cumulative Total	2066 to 2095 (mm/yr)	2066 to 2095 (mm/yr) – Cumulative Total	2095 to 2125 (mm/yr)	2095 to 2125 (mm/yr)– Cumulative Total
Humber	Higher Central	8.4	252	11.1	333	12.4	372
Humber	Upper End	11	330	15.3	459	17.6	528

River Basin District	Allowance	2036 to 2065 (mm/yr)	2036 to 2065 (mm/yr) – Cumulative Total	2066 to 2095 (mm/yr)	2066 to 2095 (mm/yr) – Cumulative Total	2095 to 2125 (mm/yr)	2095 to 2125 (mm/yr)– Cumulative Total
Anglian	Higher Central	8.7	261	11.6	348	13.0	390
Anglian	Upper end	11.3	339	15.8	474	18.1	543

4.4.13 The design life of the Proposed Development is anticipated to be up to 60 years from 2033, as set out in **Chapter 3: The Proposed Development** of this ES **[EN010154/APP/6.1]**, and decommissioning is expected to commence thereafter.

4.4.14 For the sea level rise assessment, an additional year has been included to the 60-year design life to provide a conservative approach to the Proposed Development; therefore, the design life of the Proposed Development is assessed up to 2094.

Anglian River Basin District

4.4.15 For the Anglian River Basin District (River Witham and Brant catchment) Sea level rise poses a potential risk to Principal Site. It has been estimated, using the Environment Agency's online sea level rise data for the Anglian River basin management area, sea level could rise by approximately 1026.4mm by the year 2094. Refer to calculations in **Annex A: Sea Level Rise Calculation** of this appendix **[EN010154/APP/6.3]** for more detail.

4.4.16 A rise of 1026.4mm would provide a predicted peak flood level of 7.07m AOD.

4.4.17 Applying the H++ analysis as a sensitivity test, i.e. applying a maximum 1.9m rise, the tidal level could theoretically reach 7.94m by 2100.

4.4.18 The lowest site level with infrastructure proposed to be located within areas proposed for solar PV panels in the Principal Site is 7.90m AOD, associated with Field number 543, north of Fen Lane and west of the Witham Washlands Flood Storage Area (from LiDAR data review). This level is below the H++ scenario level. This area is a concise low spot with the vast majority of the Principal Site being above 8.5m AOD.

4.4.19 The lowest level within the Principal Site, within Field number 534 is located within an area associated with the River Witham Catchment; the land within this catchment is fundamentally protected by the Boston Tidal Barrier (opened in 2020). The tidal barrier is designed to protect the River Witham catchment against tidal flooding for the 1 in 300 year event for the next 100 years, (up to the year 2120) which exceeds the design life for the Proposed Development. Therefore, sea level rise is unlikely to impact the Principal Site and is considered a low residual risk.

4.4.20 However, ~~whilst the base of the panels within Field number 54 are set at 7.9m,~~ as the PV panels will situated at least 0.8m above ground level, in solar PV Field 53, the panels themselves will be situated above the theoretical maximum tidal level. ~~As such, it is understood than the~~Therefore, solar PV panels will be able to the remain operational in times of severe flood, ~~with~~ during potential failure of the Boston Tidal defences, or prolonged operation of the barrier which could potentially cause upstream levels to increase ~~taken into account~~.

4.4.21 Therefore, sea level rise does not provide a material flood risk to the Principal Site and is considered a low residual risk when taking into account the already proposed mitigation measures.

Humber River Basin District

4.4.22 For the Humber River Basin District (Mill Dam Dyke catchment) Sea level rise poses a potential risk to Principal Site. It has been estimated, using the Environment Agency's online sea level rise data (Ref. 25) for the Anglian River basin management area, sea level could rise by up to approximately 978.1mm by the year 2094 (with a 60 year design life plus one year for a cautionary approach); assessed by accumulating the mm/yr increase in sea level depth in each epoch up to the year 2094. Refer to Calculations in **Annex A: Sea Level Rise Calculation** of this appendix **[EN010154/APP/6.3]** for more detail.

4.4.23 A rise of 978.1mm would provide a predicted peak flood level of 6.09m AOD.

4.4.24 Applying the H++ analysis as a sensitivity test, i.e. applying a maximum 1.9m rise, the tidal level could theoretically reach 7.01m by 2100.

4.4.25 The lowest point of the Principal Site surrounding the Mill Dam Dyke at Morton Hall is 13.5m AOD; therefore, it is considered the area of the Principal Site relating to the Mill Dam Dyke catchment is not at risk of sea level rise.

4.4.26 There is no permanent above ground infrastructure proposed along the Cable Corridor. As such, mitigation is not considered to be required to protect finished levels of proposed infrastructure due to sea level rise.

4.4.27 In summary, the flood risk to permanent above ground infrastructure (Principal Site) and the risk to people associated with sea level rise is considered a low residual risk, with no further mitigation required, in both the Humber and Anglian River Basin Districts.

4.5 With-Proposed Development Surface Water Flood Risk

4.5.1 As the Principal Site covers a large area, the surface water flood risk level varies from low to high across the Principal Site for the pre-Proposed Development scenario with areas of higher risk associated with topographical low spots and/or areas immediately surrounding watercourses.

4.5.2 **Appendix 9-D: Framework Surface Water Drainage Strategy** of this ES **[EN010154/APP/6.3]** sets out how increases in surface water runoff as a result of the Proposed Development are proposed to be managed via SuDS techniques to ensure the existing surface water drainage regime is mimicked, mitigating the risk of increased surface run off from and to the Proposed Development.

4.5.3 The increases to impermeable areas are envisaged to be a result of localised runoff from; the Solar Station Compounds located across the PV panel fields (in the case of a 'distributed BESS' arrangement), the single BESS compound (in the case of the 'centralised BESS' arrangement) and the Onsite Substation. The increase in surface water runoff from these areas is proposed to be managed via sustainable drainage techniques to temporarily attenuate the increased surface water flows before discharging to surrounding watercourses at restricted rates to mimic the pre-Proposed Development conditions for up to and including the 1 in 100 year + 40% climate change event.

4.5.4 It is considered that total impermeable areas where solar PV panels are proposed for the with-Proposed Development scenario will remain consistent to the pre-Proposed Development state. Therefore, the proposed PV panel areas are considered to not impact the post-Proposed Development surface water flood risk level associated specially in relation to PV panel areas adjacent to field drains (Ordinary Watercourses).

4.5.5 As part of the non-statutory consultation for the Proposed Development, properties along The Avenue in Morton, adjacent to solar PV fields 25 and 33~~, 30 and 34~~, are known to experience surface water flooding from natural overland runoff from these fields. The online flood map for surface water (Ref. 6) indicates a medium flood risk to these properties.

4.5.6 Surface water runoff and mitigation is discussed in **Section 7.** Mitigation includes edge swales. Edge swales are proposed within the principles of the Framework Surface Water Drainage Strategy, discussed in more detail within **Appendix 9-D: Framework Surface Water Drainage Strategy** of this ES **[EN010154/APP/6.3],** to capture excess runoff from the PV fields. These edge swales will capture the peak runoff from Solar Station Compounds and runoff from the solar PV panel fields, reducing peak runoff rates during storm events, for up to and including the 1 in 100 year plus 40% climate change event (for the where new impermeable surfaces are introduced). The voluntary enhancement swales in Fields 25 and 33~~, 30 and 34~~ and the swales located in the field between solar PV Fields 25 and 33 will be sized accordingly to capture overland surface water runoff; therefore, reducing the existing surface water flood risk to properties along The Avenue, providing betterment.

4.5.7 It is therefore envisaged that there will be no material increase to surface water flood risk on or surrounding the Principal Site for the with-Proposed

Development scenario meaning surface water risk will therefore remain as existing.

4.6 With-Proposed Development Other Sources of Flood Risk

Groundwater

4.6.1 Groundwater flood risk is anticipated to remain unchanged, as there are no proposals for discharging surface water runoff via infiltration methods due to the underlying ground conditions not being suitable for such techniques except in areas where discharge to a watercourse is unachievable.

Sewers

4.6.2 The Proposed Development scenario does not propose to interact or alter any existing sewer infrastructure and therefore will result in no change to flood risk from such sources. Construction risk of exposing or damaging sewers during the construction phase of the Proposed Development will be included and managed within the **Framework CEMP [EN010154/APP/7.7]**.

Artificial Sources

4.6.3 There are no Artificial Sources of flood risk within the Principal Site; therefore, flood risk remains low from Artificial Sources.

4.7 Temporary Construction Compounds (Principal Site)

4.7.1 During the construction phase of the Principal Site, one main construction compound and several secondary construction compounds are proposed within the Principal Site, the locations and maximum footprint of the compounds are shown in **Figure 3-1: Construction Compounds and Access Locations [EN010154/APP/6.2].**

4.7.2 All temporary construction compounds are located within Flood Zone 1 and are in areas of very low surface water flood risk and low risk from groundwater, sewers and other artificial sources.

4.7.3 The temporary construction compounds are proposed to be in place for up to 30 months during the Construction Phase, being gradually built out and replaced with solar PV panels by the commencement of the Operational Phase, where located within the Principal Site.

4.7.4 The assessment of solar PV panels during the Operational Phase where temporary construction compounds are proposed within the Principal Site conclude that no mitigation measures will be required within construction compound locations.

4.7.5 Therefore, it is considered the temporary construction compounds within the Principal Site are considered to be at low risk of flooding from all sources.

4.8 Principal Site Flood Risk Summary

4.8.1 The increase in surface water runoff rates as a result of the with-Proposed Development scenario will be managed via sustainable drainage techniques proposed to mimic the pre-Proposed Development conditions detailed within the **Framework Surface Water Drainage Strategy** (**Appendix 9-D** of this ES **[EN010154/APP/6.3]**).

4.8.2 In the small areas where Flood Zone 3 extends into PV Panel areas, mitigation of fluvial flood risk to Proposed Development infrastructure is not required.

4.8.3 In summary, it is considered that flood risk levels from all sources within and surrounding the DCO Site Boundary will remain unchanged, i.e. no increase in flood risk to the Proposed Development or elsewhere, with the embedded mitigation proposed, and the Proposed Development will remain operational in times of severe flooding.

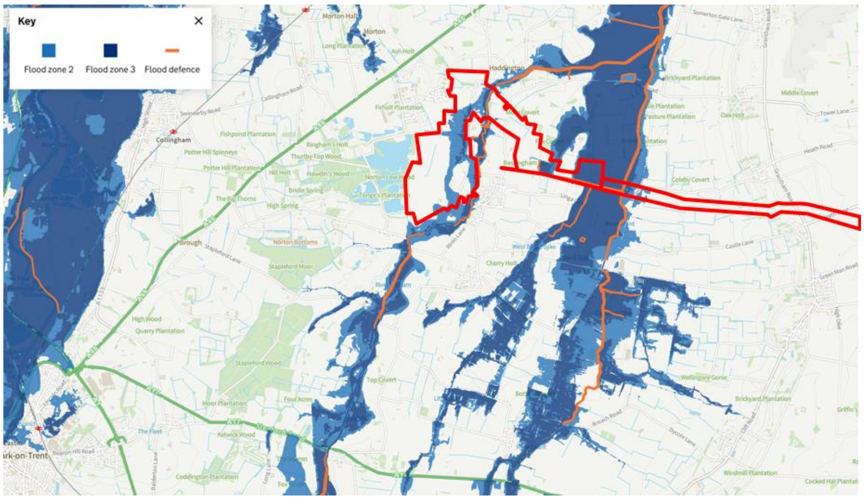
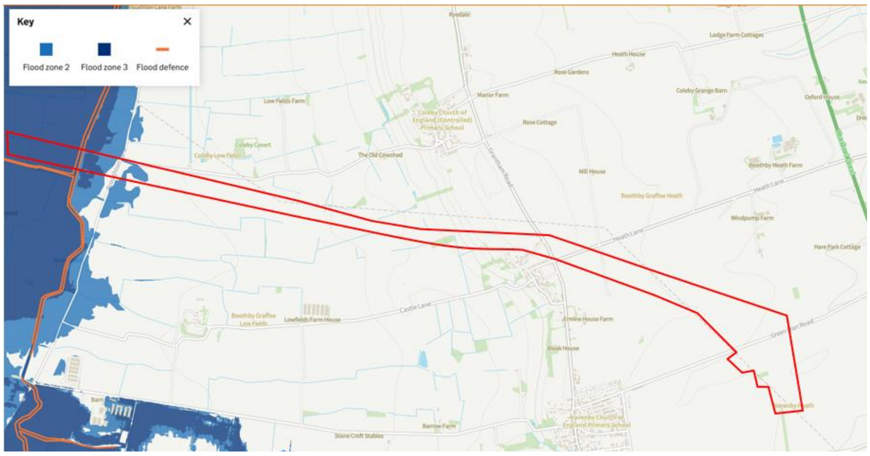
5. Assessment of Flood Risk (Cable Corridor)

5.1 Flood Risk from all Sources

5.1.1 Long term flood risk resulting from the Cable Corridor is considered to be as existing for the operational phase, as the infrastructure will be buried throughout the corridor with no permanent above ground-built development.

5.1.2 **Table 14~~Table 14Table 14~~** below sets out the flood risk from all sources for the Cable Corridor only.

Table 14: Flood Risk Summary (Cable Corridor)

Flood Risk Source	Flood Risk Level	Mapping and Comments
Fluvial	Low to Very High	 **Plate 21~~2115~~: Flood Map for Planning (28 March 2025)**  **Plate 22~~2216~~: Flood Map for Planning (28 March 2025)** The Cable Corridor extends into an area of Flood Zones 2 and 3 associated with the River Witham. However, as no above ground infrastructure is proposed to be located within the Cable Corridor during the operational phase of the Proposed Development, the long term flood risk is expected to remain as existing, with no mitigation measured required as there will be no change to the floodplain. As the Principal Site is located west of the River Witham, in order to connect power into the Grid near Navenby, there is no alternative cable corridor that would avoid Flood Zones 2/3.
Tidal	Low	The Cable Corridor is not located within an area susceptible to tidal flood risk. No change to pre-Proposed Development flood risk level.
Surface Water	Low to High	No change to flood risk level and no increase in flood risk. No mitigation required for below ground cables. Any interaction with existing below ground drainage (land drains) will be managed and reinstated during construction and decommissioning and set out in the **Framework CEMP[EN010154/APP/7.7]**.

Flood Risk Source	Flood Risk Level	Mapping and Comments
Groundwater	Low-Medium	No historical groundwater flooding events are mentioned specifically within the North Kesteven SFRA. However, where the Cable Corridor crosses the River Witham, groundwater may be elevated within the alluvial deposits. There is no risk mapping for groundwater in this area, but as soils are largely impermeable the risk is considered medium, as the bedrock geology would not support large amounts of water storage, such as an aquifer. There may be a risk of groundwater ingress to excavations during the laying and potential removal of cables during the construction and decommissioning phases, the management of any water ingress to the excavations will be included in the **Framework CEMP [EN010154/APP/7.7]** and **Framework DEMP [EN010154/APP/7.9]**
Sewers	Low	There are no confirmed sewers in the vicinity of the Cable Corridor. As there is no proposed connection to public sewers along the Cable Corridor, there will be no increase in sewer flood risk as a result of the Proposed Development. Construction and decommissioning risk of exposing or damaging sewers will be included and managed via the **Framework CEMP [EN010154/APP/7.7]** and **Framework DEMP [EN010154/APP/7.9]**.
Artificial Sources	Low (residual)	No change to flood risk level and no mitigation required.

5.2 Temporary Construction Compounds (Cable Corridor)

5.2.1 There will be a maximum of seven temporary construction compounds during the construction phase located along the Cable Corridor. These are illustrated on **Figure 3-1: Construction Compounds and Access Locations [EN010154/APP/6.2]**.

5.2.2 The locations of these compounds are proposed in locations outside of Flood Zone 2 and 3 extents (including the impacts of climate change) and are within areas of low risk from other sources e.g. surface water flood risk.

5.2.3 In addition to the seven construction compounds, there are two proposed Horizontal Directional Drilling (HDD) camp areas, to facilitate the drilling of cables beneath the flood defences along the River Brant and under the River Brant itself. These Camps are illustrated indicatively on **Figure 3-1: Construction Compounds and Access Locations [EN010154/APP/6.2]**; with one camp to be located within the eastern extent of the Witham Washlands Flood Storage Area and the other on the opposite bank of the River Brant, outside of the Witham Washlands Flood Storage Area.

5.2.4 The HDD camps will be located around 20 – 40m from the main HDD entry and exit points and will be specifically for the HDD activities; they will be much smaller in size than the construction compounds and shorter in duration (set up, used and demobilised again within 2-4 days).

5.2.5 The main HDD entry and exit locations are discussed in Table 4 of the **Framework Construction Management Plan**, in Volume 7 of the ES **[EN010154/APP/7.7]** and will be set back from flood defences. The flood defences along the River Brant in this location are at natural ground level with no embankment or raised structural feature, as shown in Plate 19Plate 19Plate 13. HDD entry and exit points will be set back at least 16m from the outer face of flood defences, in this case top of bank, and located at a depth of at least 5m under Main Rivers.

5.2.6 One of the HDD camps will be located in Flood Zone 3b (land with a 3.33% chance of flooding each year) and the other in Flood Zone 3a (land with a 1% probability of flooding each year, including the impacts of climate change). The camp in Flood Zone 3b is associated with the Witham Washlands Flood Storage area.

5.2.7 Table 4 of the **Framework Construction Environmental Management Plan**, in Volume 7 of the ES **[EN010154/APP/7.7],** details the HDD camps and Contractor requirements to mitigate flood risk.

5.2.8 Additionally where trenching for cable installation is required within the Witham Washlands Flood Storage Area, plant can be demobilised and removed immediately in the event of a flood, as with the HDD Camps discussed above. No soil from trenching will be kept within the extents of the Witham Washlands Flood Storage Area during the works. This is also discussed within Table 4 of the **Framework Construction Environmental Management Plan**, in Volume 7 of the ES **[EN010154/APP/7.7**.

5.2.9 To mitigate flood risk impacts from the HDD camps, the Contractor will check the ground conditions onsite, the water levels in the watercourses, and weather forecasts daily and postpone the HDD works if the HDD camp locations are already flooded or if heavy rain is forecast in the few days before or during the HDD camp setup. Cleanup and demobilisation typically takes half a day to 1 day for a HDD camp and, therefore, in the unlikely event that heavy rainfall occurs with a camp in place, it should be possible to remove the camp entirely before the location floods, to ensure the Witham Washlands Flood Storage area retains full capacity in times of flood, with no loss of floodplain.

5.2.10 In summary, although the two HDD camps are in areas at risk of flooding, due to the short duration of each camp being in place (typically 2-4 days), the Contractor will avoid this activity coinciding with a flood event.

6. The Sequential Test and the Exception Test

6.1.1 The Sequential and Exception Tests have been considered to satisfy both the National Policy Statements, and NPPF requirements.

6.1.2 The Sequential and Exception Tests have been undertaken to satisfy both NPS EN-1 (Ref. 1) and NPPF (Ref. 4) requirements, as set out in **Section 2.2** of this FRA.

6.1.3 The Principal Site includes areas of high risk of flooding although is predominantly within Flood Zone 1.

6.1.4 The location of the Principal Site was dictated in part by the availability of a grid connection point at the proposed National Grid substation near Navenby. **Chapter 4: Alternatives and Design Evolution [EN010154/APP/6.1]** provides an explanation of site selection process along with how the Proposed Development had considered alternatives taking into account wider environmental and planning considerations.

6.1.5 As set out in **Chapter 4: Alternatives and Design Evolution [EN010154/APP/6.1],** the location of the Principal Site was informed by the considerations outlined in the NPS EN-3 (Ref. 2) in relation to the siting of solar PV infrastructure.

6.1.6 A sequential approach has been applied to the layout and design of the Principal Site whereby the on-site substation, BESS and the majority of the solar PV arrays located in areas with the lowest risk of flooding from any source. As discussed in **Section 4.3** above, there are areas where Solar PV panels are located within Flood Zone 2 extents. Where required, embedded mitigation within the design has been included to remain operation in times of flood. East-west tracking panels may be used enabling them to be tilted and as such provide greater resilience to instances of flooding in these areas. However, the FRA has assessed a worst case scenario of fixed south facing panels with a minimum 800mm height above ground level. The Sequential Test is therefore considered passed for the Principal Site due to flood risk from any source to be low following the embedded mitigation.

6.1.7 In terms of the Exception Test and the provision of wider sustainability benefits, the Proposed Development will include habitat creation and enhancement as set out in **Chapter 8: Ecology and Nature Conservation** of this ES **[EN010154/APP/6.1].** This will contribute to the Proposed Development providing biodiversity net gain in line with the Environment Act 2021 (Ref. 27). There are some areas of high-risk flooding within the Principal Site which are excluded from solar panels and are proposed to be used for ecological enhancement. Safeguarding these flood risk areas for ecological enhancement will secure these areas from future development, mitigating potential future increases to flood risk.

6.1.8 As detailed within **Section 8** of this FRA, embedded mitigation measures and an **Framework Surface Water Drainage Strategy** (**Appendix 9-D** of this ES **[EN010154/APP/6.3]**) will be secured by a requirement in the DCO to be implemented, in order to ensure that the Proposed Development is safe for its lifetime and that there will be no increases in flooding elsewhere. Thus, the Proposed Development satisfies the second requirement of the Exception Test and will remain safe throughout its lifetime without increasing flood risk to third party land.

6.1.9 Therefore, as demonstrated above the Principal Site is considered to pass the Sequential and Exception Test.

7. Drainage Strategy

7.1 Drainage Strategy Principles

7.1.1 The **Framework Surface Water Drainage Strategy** included in **Appendix 9-D** of this ES **[EN010154/APP/6.3]** proposes a system for new impermeable areas during the with-Proposed Development scenario designed to accommodate the 1 in 100-year storm, plus a 40% allowance for an increase in peak rainfall intensity due to climate change.

7.1.2 The Drainage Strategy assumes:

a. The solar PV panels and permeable access tracks will not lead to an increase in impermeable area within the DCO Site.; and

b. 100% of the runoff from the BESS areas and substation areas will contribute to runoff managed by a new drainage system.

7.1.3 The **Framework Surface Water Drainage Strategy** proposes to attenuate runoff via sustainable drainage techniques (excluding infiltration to ground due to assumed geological conditions) and restrict at greenfield rates to watercourses within the DCO Site Boundary as per the existing conditions.

7.1.4 Foul drainage is not considered within the drainage strategy as no connection to the public sewer is proposed, drainage will be dealt with via a sealed cesspit arrangement or similar sealed system for the compound areas, emptied and maintained to recommended manufacturer advice. This will be collected/emptied by specialist licensed contractors.

7.1.5 Further details including contributing areas, runoff rates, water quality assessment and maintenance requirements are included within **Appendix 9-D** of this ES **[EN010154/APP/6.3]**.

7.1.6 The solar PV panels will be mounted above the ground, allowing rainfall/runoff to infiltrate into the ground beneath the panels. Existing research by Cook and McCuen and Pennsylvania State University, supports the conclusion that the impact of solar panels and vegetated ground cover on runoff characteristics is non-significant. Both studies found that maintaining healthy vegetation beneath the panels mitigates potential changes to runoff with no significant increase in runoff, time to peak, peak volume or runoff rates. The proposed use of a native grassland and wildflower mix, and engineered stormwater controls, such as edge swales, is therefore considered adequate to manage the flood risk to and from solar PV panel areas. The drainage regime of the solar PV panel areas is therefore assumed to remain consistent with its pre-developed state. For further information relating to the research, refer to Annex H of this FRA.

8. Residual Risks and Mitigation

8.1 Residual Risks to the Proposed Development

8.1.1 Solar panels may either be fixed south facing or single axis tracker panels, which the latter can tilt to track the sun's movement throughout the day. The single axis tracker panels can be fitted with sensors to detect flood water and can tilt the panels to raise the panels above predicted flood levels. However, the assessment of flood risk has been based on a worst case fixed south facing panel which has a fixed height of 800mm above the ground, the lowest height of any proposed PV panel as presented in **Chapter 3: The Proposed Development** of this ES **[EN010154/APP/6.1]**.

8.1.2 Embedded mitigation has been provided within solar PV fields 53 and 59 to provide a minimum 300mm freeboard during the design storm event (1in 10 year +32% CC). Embedded mitigation also provides sufficient freeboard during the credible maximum scenario event.

~~8.1.1~~8.1.3 Two HDD camps are located in areas at risk of flooding. These camps are short duration camps (2-4 days from setup to demobilising from site). Mitigation proposed in paragraph 5.2.7 will ensure the camps are not present during flood events, with no impact to operation of the Witham Washlands flood storage area, or loss of floodplain during an event. No soil from trenching will be kept within the extents of the Witham Washlands Flood Storage Area during the works

~~8.1.2~~8.1.4 Residual flood risk from all sources to and from the Proposed Development is considered to be low.

8.2 Safe Access

8.2.1 Through the Sequential Test process and design iterations, there are no buildings located within the floodplain. The only structures within the floodplain are solar PV panels. All compounds for site staff, Solar Station Compounds, Onsite Substation and BESS Compound have been located out of flood zones and it is envisaged access to solar PV panels within Flood Zone 2 and 3a would not be undertaken during flooding conditions.

8.2.2 During a flood event, any affected infrastructure will not be accessed or manned until flood waters recede.

9. Conclusions

9.1.1 This FRA has been prepared to support the ES, submitted with the DCO application for the Proposed Development.

9.1.2 The FRA demonstrates flood risk, from all sources, will not increase as a result of the Proposed Development, within the DCO Site or elsewhere, with the proposed embedded mitigation in place.

9.1.3 A separate **Framework Surface Water Drainage Strategy** (**Appendix 9-D** of this ES **[EN010154/APP/6.3]**) demonstrates surface water drainage will be manged effectively to ensure there is no increase in surface water runoff form the Proposed Development above the existing regime.

10. References

Ref. 1 Overarching National Policy Statement for Energy (EN-1) (2023). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf

Ref. 2 National Policy Statement for Renewable Energy Infrastructure (EN-3). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf

Ref. 3 National Policy Statement for Electricity Networks Infrastructure (EN-5). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47858/1942-national-policy-statement-electricity-networks.pdf

Ref. 4 National Planning Policy Framework (March 2012, updated December 2023). Available at: https://assets.publishing.service.gov.uk/media/669a25e9a3c2a28abb50d2b4/NPPF_December_2023.pdf

Ref. 5 Department of Communities and Local Government (2014, updated August 2022) National Planning Practice Guidance: Flood Risk and Coastal Change. Available online: https://www.gov.uk/guidance/flood-risk-and-coastal-change

Ref. 6 Environment Agency (Gov.uk) published Updated Flood Map for Surface Water (uFMfSW). Available online: https://www.gov.uk/check-long-term-flood-risk

Ref. 7 Lincolnshire County Council Preliminary Flood Risk Assessment. (2011). Available at: https://www.lincolnshire.gov.uk/flood-risk-management/preliminary-flood-risk-assessment/1

Ref. 8 Second Cycle Preliminary Flood Risk Assessment for Lincolnshire (2017). Available at: https://www.lincolnshire.gov.uk/flood-risk-management/preliminary-flood-risk-assessment/1

Ref. 9 Central Lincolnshire Local Plan (2023). Available at: https://www.n-kesteven.gov.uk/central-lincolnshire

Ref. 10 Lincolnshire County Council Joint Flood Risk and Water Management Strategy 2019-2050. Available at: https://www.lincolnshire.gov.uk/directory-record/63754/flood-risk-and-water-management-strategy

Ref. 11 North Kesteven Strategic Flood Risk Assessment (2009). Available at: https://www.n-kesteven.gov.uk/sites/default/files/2023-01/Strategic%20Flood%20Risk%20Assessment%20Report.pdf

Ref. 12 Upper Witham Internal Drainage Board Policy Statement on Water Level and Flood Risk Management Asset List (2018). Available at: https://witham3idb.gov.uk/wp-content/uploads/2020/12/UW-Policy-Statement-2018.pdf

Ref. 13 Upper Witham Internal Drainage Board Byelaws. Available at: https://witham3idb.gov.uk/wp-content/uploads/2020/12/Upper-Witham-Internal-Drainage-Board-Byelaws.pdf

Ref. 14 Water Management Consortium, Planning and Byelaw Policy (2021). Available at: https://ioaann.wmc-idbs.org.uk/download/DocumentType/policies/20210518PlanningAndByelawPolicyRev6_2.pdf

Ref. 15 Water Management Consortium Advice Note, AN06: Surface Water (2021). Available at: https://tvidb.wmc-idbs.org.uk/download/DocumentType/policies/20210518-AN06SurfaceWaterRev4_3.pdf

Ref. 16 Environment Agency Statutory Main River Map (Online).

Ref. 17 British Geological Society (BGS) Online.

Ref. 18 Land Information Systems Soilscapes soil types viewer (online). Available at: https://www.landis.org.uk/soilscapes/

Ref. 19 DEFRA climate change allowances for peak river flow in England (online). Available at: available at: https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow

Ref. 20 Environment Agency online Climate Change Assessment guidance (online). Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Ref. 21 Defra online Flood Zone 2 Dataset (2024) DEFRA Spatial Data Download. Available at: Flood Map for Planning (Rivers and Sea) - Flood Zone 2

Ref. 22 Defra online Flood Zone 3 Dataset (2024) DEFRA Spatial Data Download. Available at: Flood Map for Planning (Rivers and Sea) - Flood Zone 3

Ref. 23 Defra Survey Data Download service (2024). Available at: https://environment.data.gov.uk/survey

Ref. 24 Defra AIMS Spatial Flood Defences data download service.(inc. standardised attributes) Available at: https://environment.data.gov.uk/explore/8e5be50f-d465-11e4-ba9a-f0def148f590?download=true

Ref. 25 Extract from Table 2 of Environment Agency Sea Level Rise Tables (Online). Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Ref. 26 HMSO (2020). Energy White Paper: Powering our net future. Avalable at: https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future

Ref. 27 HMSO (2021) Environment Act 2021. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents

Ref. 28 Flood Map for Planning
Flood map for planning - GOV.UK

Ref. 29 BRE Agricultural Good Practice Guidance for Solar Farms

Ref. 30 Cook, D. D., & McCuen, R. H. (2013). Hydrologic Response of Solar Farms. Journal of Hydrologic Engineering, 18(5), 538-543.

Ref. 31 Pennsylvania State University, 2024

Annex A Sea Level Rise Calculation

Assessed using Environment Agency OnlineSea Level Rise calulation Table 2; https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

The following maps will help you find out which river basin district you are in:

River basin district map

River basin district map that zooms in so you can find places close to river basin district boundaries

For places in:

*- Thames river basin district use 'south east' sea level rise allowances
*- Severn river basin district use 'south west' sea level rise allowances
*- parts of Solway Tweed river basin district on the west coast and Dee river basin district that are in England, use 'north west' sea level rise allowances
*- parts of Solway Tweed river basin district on the east coast that are in England, use 'Northumbria' sea level rise allowances

The allowances in table 1 account for slow land movement. This is due to 'glacial isostatic adjustment' from the release of pressure at the end of the last ice age. The northern part of the UK is slowly rising and the southern part is slowly sinking. This is why net sea level rise is less for the north-west and north-east than the rest of th country.

Notes:

*- To calculate sea level using table 1, add the allowances for the appropriate one of the 6 geographical areas:
*- up to 2035, use the mm for each year rates for the appropriate geographical area, starting from the present day extreme sea levels from Coastal design sea levels – coastal flood boundary extreme sea levels (2018)
*- from 2036 to 2065, get the increase in sea level by adding the number of years on from 2035 (to 2065), multiplied by the respective rate shown in table 1 for the appropriate geographical area – if the whole time period applies use the cumulative total
*- treat time periods 2066 to 2095 and 2096 to 2125 as you would 2036 to 2065

Where it is appropriate to apply a credible maximum scenario, use the H++ allowance. There is no H++ value for sea level rise beyond 2100.

H++ (Sensitivity)

*- For the change to relative mean sea level use the H++ scenario of 1.9m for the total sea level rise to 2100.

Table 1: sea level allowances by river basin district for each epoch in mm for each year (based on a 1981 to 2000 baseline) – the total sea level rise for each epoch is in brackets

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Anglian	Higher central	5.8 (203)	8.7 (261)	11.6 (348)	13 (390)	1.20
Anglian	Upper end	7 (245)	11.3 (339)	15.8 (474)	18.1 (543)	1.60
South east	Higher central	5.7 (200)	8.7 (261)	11.6 (348)	13.1 (393)	1.20
South east	Upper end	6.9 (242)	11.3 (339)	15.8 (474)	18.2 (546)	1.60
South west	Higher central	5.8 (203)	8.8 (264)	11.7 (351)	13.1 (393)	1.21
South west	Upper end	7 (245)	11.4 (342)	16 (480)	18.4 (552)	1.62
Northumbria	Higher central	4.6 (161)	7.5 (225)	10.1 (303)	11.2 (336)	1.03
Northumbria	Upper end	5.8 (203)	10 (300)	14.3 (429)	16.5 (495)	1.43
Humber	Higher central	5.5 (193)	8.4 (252)	11.1 (333)	12.4 (372)	1.15
Humber	Upper end	6.7 (235)	11 (330)	15.3 (459)	17.6 (528)	1.55
North west	Higher central	4.5 (158)	7.3 (219)	10 (300)	11.2 (336)	1.01
North west	Upper end	5.7 (200)	9.9 (297)	14.2 (426)	16.3 (489)	1.41

Area of England	Allowance	2000 to 2035 (mm/yr)	2000 to 2035 (mm) - Total	2036 to 2065 (mm/yr)	2036 to 2065 (mm) - cumulative	2066 to 2095 (mm/yr)	2066 to 2095 (mm) - cumulative	2096 to 2125 (mm/yr)	2096 to 2125 (mm) - cumulative	Cumulative rise 2000 to 2125 (metres)
Anglian	Higher central	5.8	203	8.7	261	11.6	348	13	390	1.2
Anglian	Upper end	7	245	11.3	339	15.8	474	18.1	543	1.6
South east	Higher central	5.7	200	8.7	261	11.6	348	13.1	393	1.2
South east	Upper end	6.9	212	11.3	339	15.8	474	18.2	546	1.6
South west	Higher central	5.8	203	8.8	264	11.7	351	13.1	393	1.21
South west	Upper end	7	245	11.4	342	16	480	18.4	552	1.62
Northumbria	Higher central	4.6	161	7.5	225	10.1	303	11.2	336	1.03
Northumbria	Upper end	5.8	203	10	300	14.3	429	16.5	495	1.43
Humber	Higher central	5.5	193	8.4	252	11.1	333	12.4	372	1.15
Humber	Upper end	6.7	235	11	330	15.3	459	17.6	528	1.55
North west	Higher central	4.5	158	7.3	219	10	300	11.2	336	1.01
North west	Upper end	5.7	200	9.9	297	14.2	426	16.3	489	1.41

Location	Design Life (yrs)	Estimated Year of First Operation	End Life (Worst Case)	RBMP	Higher Central 2000-2035 Total (mm)	Upper 2000-2035 Total (mm)	Higher Central 2036-2065 Total (mm)	Upper 2036-2065 Total (mm)	Higher Central 2066-2095 mm/yr	Upper 2066-2095 mm/yr	Years from 2066 to end life
Fosse Green Solar (Chainage _3994, FID 6 Coastal Node)	60	2033	2094	Anglian	203	245	261	339	11.6	15.8	28
(Highest Level Near Site)											
Sea Level (mAOD) (1 in 200 year 97.5% Percentile - C2_T100 - Worst Case											
6.28											
Lowest Site Level - Fosse Green Solar (mAOD)											
7.05											

		Total Adjusted to mAOD
SUB_TOTAL Higher Central	324.8	
TOTAL Rise (mm) Higher Central	788.8	7.07
SUB-TOTAL Upper	442.4	
TOTAL Rise (mm) Upper	1026.4	7.31
H++ Scenario (mm)	1900	8.18
	Design Site Level Not at Risk	Fail
	Sensitivity Test	Fail

Location	Design Life (yrs)	Estimated Year of First Operation	End Life (Worst Case)	RBMP	Higher Central 2000-2035 Total (mm)	Upper 2000-2035 Total (mm)	Higher Central 2036-2065 Total (mm)	Upper 2036-2065 Total (mm)	Higher Central 2066-2095 mm/yr	Upper 2066-2095 mm/yr	Years from 2066 to end life
Fosse Green Solar (Chainage _3888, FID 26 Coastal Node) (Highest Level Near Site)	60	2033	2093	Humber	193	235	252	330	11.1	15.3	27
Sea Level (mAOD) (1 in 200 year 97.5% Percentile - C2_T100 - Worst Case 5.32											
Lowest Site Level - Fosse Green Solar (mAOD) 13.50											

		Total Adjusted to mAOD
SUB_TOTAL Higher Central	299.7	
TOTAL Rise (mm) Higher Central	744.7	6.06
SUB-TOTAL Upper	413.1	
TOTAL Rise (mm) Upper	978.1	6.30
H++ Scenario (mm)	1900	7.22
	Design Site Level Not at Risk	Pass
	Sensitivity Test	Pass

Annex B Fluvial Analysis Calculations (Ordinary Watercourse)

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	[redacted]
Site name:	Fosse Green
Site location:	Morton Ditch Catchment

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	53.17015° N
Longitude:	0.68229° W
Reference:	3461239725
Date:	Jul 09 2024 15:10

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha):	437.4919615

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.613
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	580	577
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		400.93
1 in 1 year (l/s):		348.81
1 in 30 years (l/s):		982.29
1 in 100 year (l/s):		1427.32
1 in 200 years (l/s):		1687.93

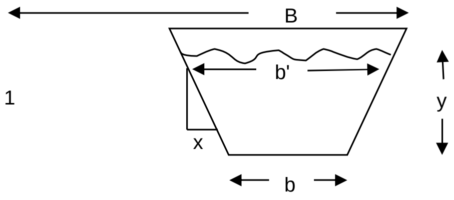
AECOM

OPEN CHANNEL FLOW CALCULATIONS

Project: *Fosse Green Solar* **Job No:**
Section: *Morton Ordinary Watercourse Flood Channel (Higher Allowance: 1.86 Cu)* **Date:** *09.07.2024*
Sheet No: *1* **of** *2*
Made By: *PM* **Checked By:** CB

				Cover	Pipe	Depth	side slope	half trench width
Free Board	0.00	m						
Width of channel base, b=	4.50	m						
Channel side slope, 1 in x=	327.0							
Max. water depth, y=	0.22	m						

Existing ground level=	14.000	m
Invert level of channel=	11.750	m
Top channel width, B=	1352.00	m



area, A=	16.8168
wetted perimeter,P=	148.3807
top width at top water level, b'=	148.38
hydraulic radius, R=	0.113336
hydraulic mean depth, Dm=	0.113336
Velocity, m/s=	**0.111445**

Bed slope 1 in 690
Manning's, n= 0.08

Harpswell Flood Channel (Higher Allowance: 9.7Cu)

Q= 1.8741579 cumecs or 1874.16 l/s

Existing ground level=		m	Channel length=		m
Proposed freeboard=		m (300mm recommended)	Starting invert=		m
Proposed MIN invert level=		m	End Invert=		m

ROUGHNESS VALUES

Type of channel	Condition	Manning's n
Grass channel, regularly maintained	Average, good	0.050
Grass channel, not maintained with dense weeds	Good Average Poor	0.050 0.080 0.120
Concrete	Average Poor	0.013 0.016
Black top	Average Poor	0.017 0.021

SIDE SLOPES

Material	Side Slope (H:V)
Rock	Nearly vertical
Muck and peat soils	¼:1
Stiff clay or earth with concrete lining	½:1 to 1:1
Earth with stone lining or earth for large channels	1:1
Firm clay or earth for small ditches	1½:1
Loose, sandy earth	2:1
Sandy loam or porous clay	3:1

OPEN CHANNEL FLOW CALCULATIONS

Project: *Fosse Green Solar* **Job No:**

Section: *Morton Ordinary Watercourse Capacity* **Date:** *28.11.22*

Sheet No: *1* **of** *1*

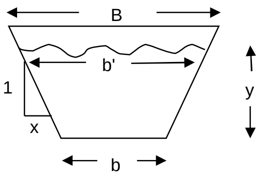
Made By: *PM* **Checked By:** CB

			Cover	Pipe	Depth	side slope
Free Board	0.00	m				
Width of channel base, b=	1.50	m			0.50	
Channel side slope, 1 in x=	2.0					
Max. water depth, y=	0.50	m				

Existing ground level= 12.500 m

Invert level of channel= 12.000 m

Top channel width, B= 4.50 m



area, A=	1.2500
wetted perimeter,P=	3.736068
top width at top water level, b'=	3.5
hydraulic radius, R=	0.334576
hydraulic mean depth, Dm=	0.357143
Velocity, m/s=	**0.229341**

Bed slope 1 in 690

Manning's, n= 0.08

Q= 0.2866766 cumecs or 286.68 l/s

Existing ground level= m Channel length= m

Proposed freeboard= m (300mm recommended) Starting invert= m

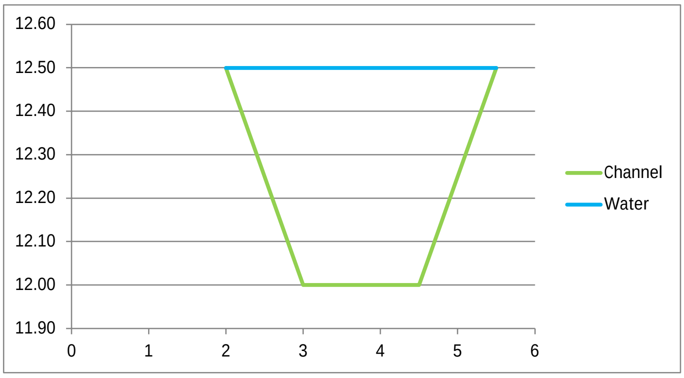
Proposed MIN invert level= m End Invert= m

ROUGHNESS VALUES

Type of channel	Condition	Manning's n
Grass channel, regularly maintained	Average, good	0.050
Grass channel, not maintained with dense weeds	Good Average Poor	0.050 0.080 0.120
Concrete	Average Poor	0.013 0.016
Black top	Average Poor	0.017 0.021

SIDE SLOPES

Material	Side Slope (H:V)
Rock	Nearly vertical
Muck and peat soils	¼:1
Stiff clay or earth with concrete lining	½:1 to 1:1
Earth with stone lining or earth for large channels	1:1
Firm clay or earth for small ditches	1½:1
Loose, sandy earth	2:1
Sandy loam or porous clay	3:1



Annex C Environment Agency Correspondence

[redacted]

To: [redacted]
Subject: [redacted]rgy NSIP - flood risk advice
Attachments: Fosse Green Energy Solar Farm - Discretionary Advice Service Request

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This message came from outside your organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Report Suspicious

H[redacted]

As you will be aware, AECOM have accepted our offer for charged planning advice, which is being set up by our finance team.

As we can now proceed, please can you let me know if you would like us to review and respond directly to the following flood risk enquiry in your initial email (attached) to inform your FRA methodology, or are you going to provide a document on the proposed approach to the FRA which will cover these elements instead?

- *Fluvial Modelling: Model extents were provided for the 2015 hydraulic model of the Upper Witham. We were not issued with the actual model files due to the current one being updated and due to be published in 2024. We have shown on the layout the climate change extents (20%) for the 1in 100 and 1 in 1000 year events. We do not expect the current climate change allowance of 1 in 100 year plus 32% for the Higher Central to extend beyond the 1 in 1000 year plus 20% climate change though. The Credible Maximum Scenario (CMS), (Upper End allowance of 57%), sensitivity assessment would be worth discussing as well as to how we can assess this in lieu of the model update.*
    - *Design Assumption – 300mm freeboard to be provided during the design event (1 in 100 year plus 32% cc). CMS Sensitivity test to ensure PV panels are not flooded during the Upper end Scenario (1 in 100 year plus 57% cc).*
    - *Key queries:*
        - *Can we use the existing model to assess the new climate change allowances as it is not certain the revised model will be published by the time of the DCO. As it is only solar PV panels potentially at risk with a minimum ground clearance of 600mm which can be raised in flood risk areas, could this be a rational approach to the DCO.*
        - *Flood Zone 3b – current requirement is 1 in 30 year now; 2015 model extents show all built development is outside of the current 1 in 100 plus 20% cc extents, can it be agreed we are effectively not developing within the 1 in 30 year extent.*

Kind regards,

[redacted]

Please accept my thanks for your email in advance, I have made a commitment to stop sending e-mails that just say thank you. This will help me to reduce my carbon footprint https://carbonliteracy.com/the-carbon-cost-of-an-email/

Creating a better place for people and wildlife

creating a better place
for people and wildlife

Environment Agency

[redacted]

Our ref: XA/2023/100051/01-L01
Your ref: 60700987
Date: 21 December 2023

Dea [redacted]

Nationally Significant Infrastructure Project (NSIP): Fosse Green Energy

Proposed solar and energy storage park with associated grid connection infrastructure, land 9km south west of Lincoln, North Kesteven, Lincolnshire

Flood risk advice – review of technical approach to fluvial flood risk

Thank you for seeking our cost recoverable advice on your proposed technical approach to fluvial flood risk in connection with the above development.

We are pleased to provide our advice to you under cost recovery agreement no. ENVPAC/1/NIT/00013 as set out below.

We have reviewed the flood risk enquiry element of your email dated 25 October 2023 and the accompanying site layout plan (Fosse Green South Installation Version 6 – Sheet 1 – Site Overview; dated 18 October 2023), along with the supporting flood risk technical note (ref. 60700987-ACM-FGEXX-TN-CIV-000001, dated 12 December 2023).

It is worth noting that the Upper Witham model is an Infoworks RS 1d-2d linked model developed by Mott Macdonald in 2015. AECOM are currently in the process of updating the 2015 model to a Flood Modeller-TUFLOW model, with the current programme for completion being the end of March 2024, although this will likely be delayed due to additional ongoing work to calibrate the model with the Storm Babet event of October 2023.

AECOM should already have a copy of the existing 2015 Infoworks RS model as part of the works they are undertaking for the EA to update the model. We would have no issue with this modelling being shared internally within AECOM so the applicant has access to it.

Please see below our comments on your flood risk enquiry detailed in your email (dated 25 October 2023):

1. **AECOM's proposed design assumption:** *"300mm freeboard to be provided during the design event (1 in 100 year + 32% CC). CMS Sensitivity test to ensure PV panels are not flooded during the Upper End Scenario (1 in 100 year + 57% CC)".*
   EA response: This appears to be a sensible assumption and aligns with the freeboard used for other solar farms.

2. **Question from AECOM:** *Can we use the existing model to assess the new climate change allowances as it is not certain the revised model will be published by the time of the DCO. As it is only solar PV panels potentially at risk within a minimum ground clearance of 600mm which can be raised in flood risk areas, could this be a rational approach to the DCO?*
   EA response: This seems like a reasonable way forward in the absence of the current updated hydraulic modelling. However, we would expect the applicant to still cross-check the flood extents from the 2015 model with the updated FM-TUFLOW model outputs if this becomes available before the DCO submission.

3. **Question from AECOM:** *Flood Zone 3b – current requirement is 1 in 30 year now; 2015 model extents show all built development is outside of the current 1 in 100 + 20% CC extents, can it be agreed we are effectively not developing within the 1 in 30 year extent?*
   EA response: This is considered a reasonable and pragmatic assumption.

Comments on the technical approach document:

Document name: Fluvial Flood Risk Technical Approach
Document ref: 60700987-ACM-FGEXX-TN-CIV-000001
Document date: 12/12/2023
Produced by: AECOM

Issue ref.	**Doc ref.**	**EA Comments**	
001	**Section 1.5,**	**Issue**	Other than the photovoltaic (PV) panels, the paragraph makes reference to there being no

	page 1		other permanent built infrastructure above ground during operation, so no further flood risk concerns. However, it is unclear what above ground structures, or ground raising works, may be required during the construction phases of the development.
		Impact	It is not clear from the technical note whether there will be any additional flood risk considerations necessary during the construction phases of the development. It is essential that the scheme does not result in an increase in flood risk elsewhere at any point during the construction or operation of the scheme.
		Suggested solution	Please can further information be provided on the construction phases of the works, including any temporary infrastructure or ground raising that may be required, and where this is expected to be situated. It is recommended that a sequential approach be taken, even for the construction stages, ensuring all works are located within Flood Zone 1, where possible. Should any structures or ground raising be required within Flood Zones 2 or 3 then it should be demonstrated that they will not result in an increase in flood risk elsewhere.
002	**Section 3.1.1, page 4**	**Issue**	How are you planning on determining the flood levels for the 1% annual probability (1 in 100 year), 0.1% annual probability (1 in 1000 year) and climate change scenarios? Have you been provided with these results as part of your product 6 dataset or were you planning on using the flood extent outlines and LiDAR data (e.g. where the flood outlines intersect the LiDAR)?
		Impact	It is not completely clear from the technical note how flood levels will be obtained and therefore how they will affect the development proposals.
		Suggested solution	Please add this detail to the technical note for clarity.

003	**Section 3.1.1, page 4**	**Issue**	It is not clear what is meant by the following statement: *"Assessing LiDAR topographic data to assess the potential impact on flood levels at the 1 in 100 and 1 in 1000 year climate change extents, in order to propose sufficient mitigation for the solar panel areas within the impacted areas."*
		Impact	It is not completely clear from the technical note what this statement is referring to. Is this in respect to understanding the impact (flood risk detriment) of the PV mounting structures?
		Suggested solution	Please clarify in the technical note what specifically is meant by this statement and how any flood risk determent associated with the PV mounting structures will be determined.
004	**Section 3.1.1, page 4**	**Issue**	Calculating flood levels for the plus 32% and plus 57% climate change scenarios by extrapolating the rate of increase from the plus 20% scenarios.
		Impact	This approach could over and potentially underestimate flood risk increases in some locations.
		Suggested solution	We appreciate you may not have been provided with a copy of the 2015 Infoworks RS model but scaling the 1% annual probability (1 in 100 year) inflows boundaries in the existing model by 32% and 57% would be the better approach here and allow for a more robust assessment. This approach would be reliant of having an Infoworks RS licence.

<u>Additional comments/advice</u>

1. With regards to estimating the 1% annual probability (1 in 100 year) plus 32% and plus 57% flood levels, how exactly are you intending on determining flood levels and extents? Do you have an Infoworks RS licence? Would it be easier to just re-run the model with scalings of 32% and 57% applied to the 1% annual probability (1 in 100 year) design flows? AECOM are currently working on the model update for the Upper Witham, converting the existing Infoworks RS 2015

model into a Flood Modeller-TUFLOW model hence you may already have a copy of this.

2. The washland in this area (Witham Washland) fills to a level of around 7.65 metres above Ordnance Datum. Near to the site boundary, the existing 2015 Infoworks RS model is 1d only with floodplain flooding represented using a series of 1d storage units.
3. A portion of the red line boundary intersects Flood Zone 2 and 3 (XY coordinates: 488120, 364380) for a non-main river watercourse, which drains into the Mill Dam Dyke catchment and the tidal River Trent. The Environment Agency do not hold any detailed hydraulic modelling for this watercourse. This will also need to be considered.
4. If any of the development is located within the 1% annual probability (1 in 100 year) plus 32% climate change extent then an assessment of floodplain loss should be made, and floodplain compensation provided where required to ensure no impacts on flood risk elsewhere.

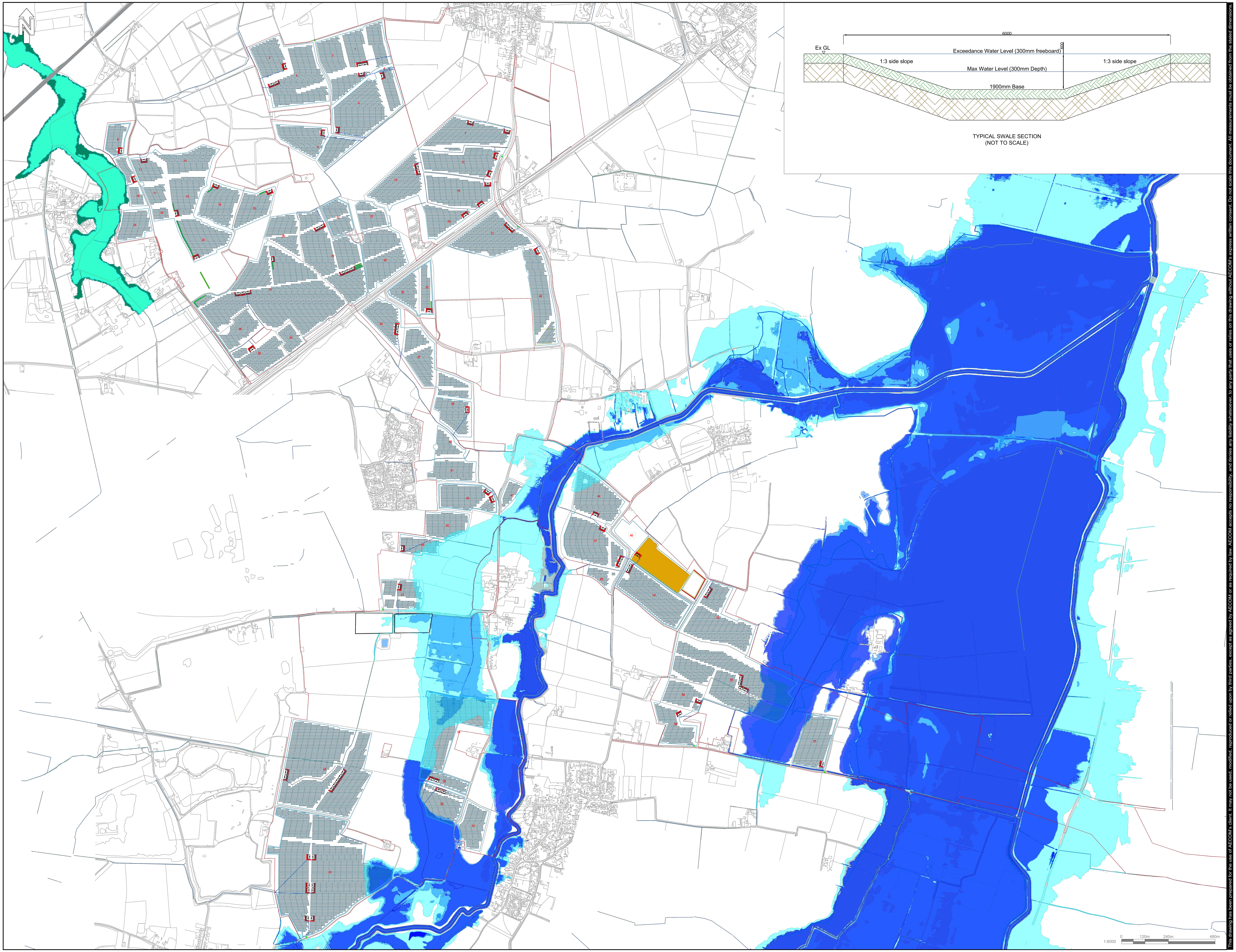
We trust the above is helpful. Should you require any additional information, or wish to discuss these matters further, please do not hesitate to contact me using the details below.

Yours sincerely

[redacted]

Annex D Framework Drainage Strategy / Scheme Layout

60700987-ACM-ZZ-XX-DR-CE-000001



Project Management Initials: Designer: MT Checked: IH Approved: NT

AECOM

PROJECT

Fosse Green Solar

CLIENT

Fosse Green Solar Ltd

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www.aecom.com

NOTES

1. DO NOT SCALE FROM THIS DRAWING
2. ALL LEVELS SHOWN ARE IN METERS ABOVE ORDNANCE DATUM (AOD) UNLESS STATED OTHERWISE
3. SITE LEVELS BASED ON LiDAR SURVEY IN ABSENCE OF TOPOGRAPHIC SURVEY.
4. SITE BACKGROUND TAKEN FROM OS BASE MAP DATASET AND SHOULD NOT BE USED FOR DETAILED DESIGN PURPOSES
5. SITE LAYOUT BASED ON 'FOSSE GREEN MASTERPLAN V8.2' WITH SOLAR PV FIELD NUMBERING FROM V9.2
6. THE INFORMATION ON THIS PLAN IS GIVEN WITHOUT OBLIGATION OR WARRANTY. NO LIABILITY OF ANY KIND WHATSOEVER IS ACCEPTED BY AECOM FOR ANY ERRORS OR OMISSIONS. DRAINAGE STRATEGY DESIGN INDICATIVE AND SUBJECT TO CHANGE.
7. SOLAR PV PANEL HEIGHT MIN 800mm ABOVE GROUND LEVEL

LEGEND

- 2015 Model: 1:30 yr (Flood Zone 3b)
- 2015 Model: 1:100yr + 32% CC (Flood Zone 3a)
- 2015 Model: 1:100yr + 57% CC (Flood Zone 3a)
- 2015 Model: 1:1000 yr
- DC COUPLED SOLAR STATION COMPOUND OPTION
- PV MODULES / FIELD NUMBER
- SITE BOUNDARY
- BESS ATTENUATION SWALE
- INFILTRATION SWALE
- PIPED CONNECTION FROM SWALE TO WATERCOURSE
- AC COUPLED BESS OPTION
- TEMPORARY CONSTRUCTION COMPOUND
- ONLINE FLOOD MAPS FOR PLANNING FLOOD ZONE 2
- ONLINE FLOOD MAPS FOR PLANNING FLOOD ZONE 3
- ORDINARY WATERCOURSE
- MAIN RIVER
- SUBSTATION

SUITABILITY

S2 FOR INFORMATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P03	30/01/26	THIRD ISSUE
P02	17/04/25	SECOND ISSUE
P01	10/04/25	FIRST ISSUE

PROJECT NUMBER

60700987

SHEET TITLE

FOSSE GREEN ENERGY SOLAR FARM
OUTLINE DRAINAGE STRATEGY

SHEET NUMBER

60700987-ACM-ZZ-XX-DR-CE-000001

Annex E Fluvial Flood Risk Technical Note

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Project name:
Fosse Green Energy

Project ref:
60700987

From:
AECOM Limited

Date:
February 2025

Annex E
Technical Note: Fluvial Flood Level Analysis

Mill Dam Dyke Catchment

Background

AECOM was commissioned to prepare a Preliminary Flood Risk Assessment (PFRA) as an Appendix to the PEIR stage in relation to the Development Consent Order (DCO) application for the construction, operation and decommissioning of the Fosse Green Energy solar farm (the Scheme) located approximately 11km south of the city of Lincoln, near Bassingham, Lincolnshire, UK.

The PFRA appended to the PEIR identified one surface water watercourse within close proximity to the DCO Site Boundary with associated Environment Agency Flood Zone 2 and 3 extents that lie in relatively close proximity to the proposed Solar photovoltaic panel (PV) fields where above ground Solar PV Modules are proposed to be mounted. It should be noted that the Flood Zone extents do not encroach on any of the proposed infrastructure, however an assessment of climate change is not included within these extents. The surface water watercourse is an ordinary watercourse (Mill Dam Dyke), flowing south to north in the village of Morton.

Figure 1 identifies the arrangement of the ordinary watercourse, its associated Flood Zone 2 and 3 extents, its upstream catchment, the proposed layout of the DCO Site and the catchment outlet / analysis location for where the assessment of flood risk, including climate change, has been based upon for the solar PV panels in the vicinity.

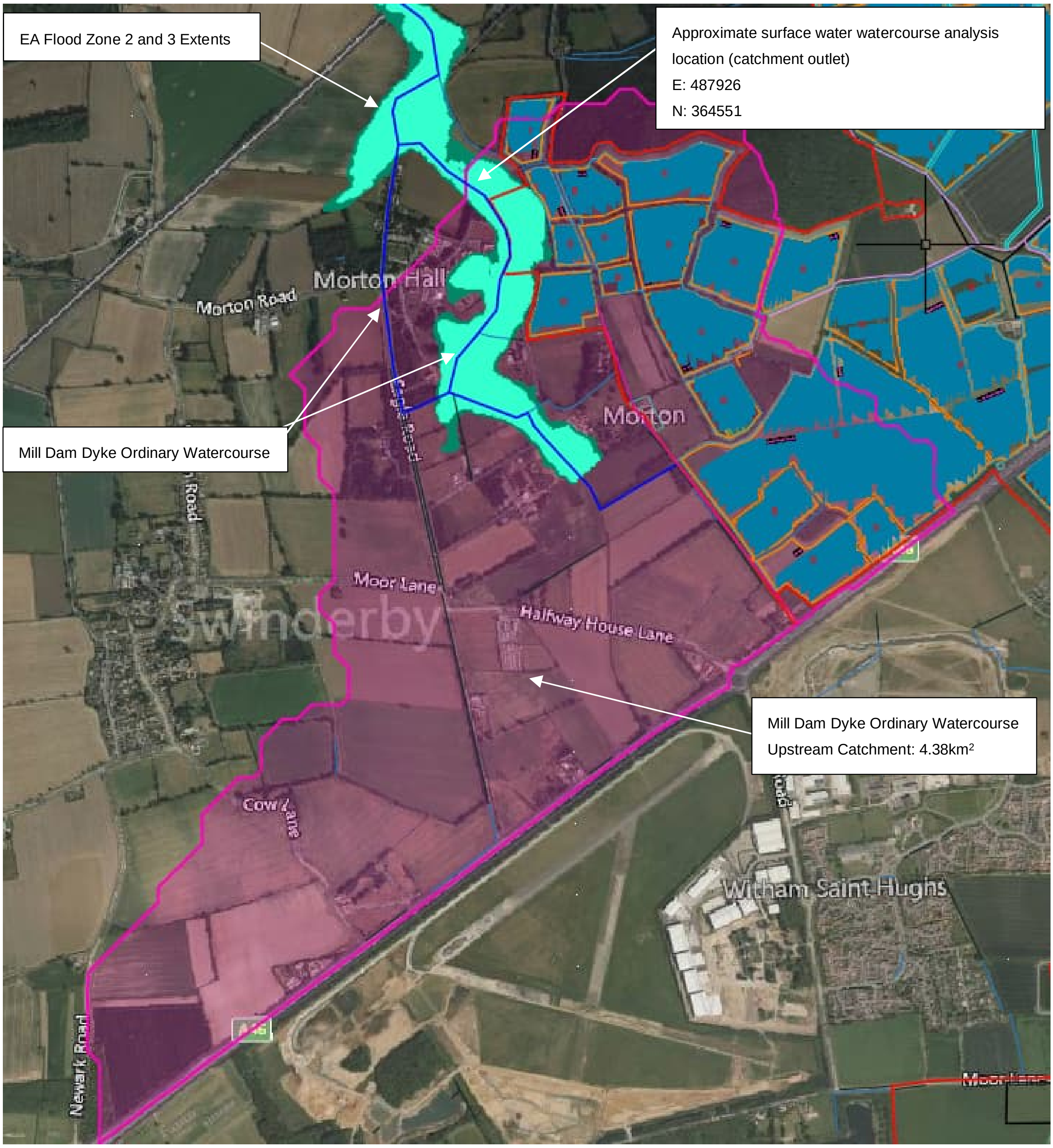


Figure 1 - Site Location Plan (Red: DCO Site Boundary, Orange: Solar PV Fields, Cyan/Teal: EA Flood Zone 2/3 Extents, Pink: Mill Dam Dyke Upstream Catchment)

A detailed hydraulic model of the Mill Dam Dyke ordinary watercourse is not available. As such an alternative analysis to detailed hydraulic modelling was undertaken in the PFRA, to assess the future risk of fluvial flooding to the proposed Solar PV modules adjacent the FZ 2 and 3 extents, including a conservative assessment of climate change.

Consultation undertaken prior to the PFRA submission for the PEIR stage, with the Environment Agency, Internal Drainage Boards (IDBs) and Lead Local Flood Authorities (LLFA) during a meeting held on 04.09.2023 resulted in the proposed analysis methodology outlined in the PFRA being recognised by all parties as appropriate for the relatively small scale of fluvial flood risk. Appendix 10-5 of the ES provides the minutes from this meeting.

The Environment Agency have since provided a further consultation in response to the PFRA submission with the PEIR via a letter dated 02.12.2024.

Appendix A11, A12 and A13 of the 02.12.2024 consultation response letter from the Environment Agency requests further information relating to fully appraise the findings of the fluvial flood level analysis undertaken on the Mill Dam Dyke near to the Scheme Boundary.

This Technical Note, therefore, provides additional detail of the analysis method and its findings predicting the estimated flood levels of the Mill Dam Dyke associated with Flood Zone 2 and 3 extents, when taking into account climate change. The revised assessment provides sufficient evidence to demonstrate the predicted flood levels will not cause additional flood risk to the PV Panel infrastructure for the design life of the Scheme, as requested by the Environment Agency.

Analysis Method of Mill Dam Dyke

In lieu of detailed hydraulic modelling, the anaylsis methodology detailed within this technical note provides a conservative estimated flood depth above the bank level of the Mill Dam Dyke for the 2080's Epoch using open channel flow calculations for both the "Higher" (design) allowance and the "Upper" (sensitivity) allowances. This enables an estimation of how far the flood extents could reach within the DCO site, using LiDAR topography as a reference level, and if flood risk encroaches on the proposed PV panel areas, and how deep the flood water would be surrounding the PV panels.

In order to carry out this assessment, the following methodology has been carried out to predict the expected flood level during the design and sensitivity fluvial flood events:

1) The contributing catchment area upstream of the Mill Dam Dyke analysis location.
2) The existing greenfield run-off rates expected to enter the watercourse at the analysis location for the design and sensitivity scenarios (taking into account increased flows for climate change).
3) The existing capacity of the Mill Dam Dyke at the analysis location.
4) The excess discharge during the design and sensitivity scenarios, including climate change) that cannot be conveyed within the existing channel capacity at the analysis location which may cause flooding out towards the DCO site.
5) The expected depth the excess discharge would rise to above the watercourse bank level in relation to the surrounding topography to determine if the flooding would encroach on the proposed PV panel areas.

Assessment

1) The contributing catchment area upstream of the Mill Dam Dyke watercourse analysis location.

LiDAR Map data and FEH catchment data covering Morton Hall and the mill Dam Dyke and its surrounding area has been used to develop a 3D surface with watershed lines using Autodesk Civil 3D software. The watershed lines provide a defined catchment outline for the Mill Dam Dyke, as shown in Figure 1. The catchment outlet, defined as the point where the watercourse leaves the catchment, is also confirmed in Figure 1 with a grid reference. The catchment outlet is also the point where the analysis has been undertaken as this is the worst case location as it is the most downstream point on the catchment that serves the solar PV fields in this area, and also adjacent to the lowest PV field.

2) The greenfield run-off rates expected to enter the Mill Dam Dyke at the analysis location for the design and sensitivity scenarios (taking into account increased flows for climate change).

The Mill Dam Dyke is an ordinary watercourse, located within the Trent Lower and Erewash Management Catchment. The Environment Agency Climate Change Allowances for peak river flow in England and have been incorporated into the greenfield runoff rate calculations in line with statutory guidance.

The greenfield runoff discharge rate contributing to the surface water watercourse upstream of the analysis location has been calculated by the HR Wallingford Greenfield Runoff Rate Estimation Tool (using FEH Data), see Appendix A for calculations.

As shown in Figure 2 below, for the 2080's Epoch; the "Higher" (design) allowance requires an additional 39% peak river flow for fluvial modelling and the "Upper" (sensitivity) allowance requires an additional 62% peak river flow for fluvial modelling.

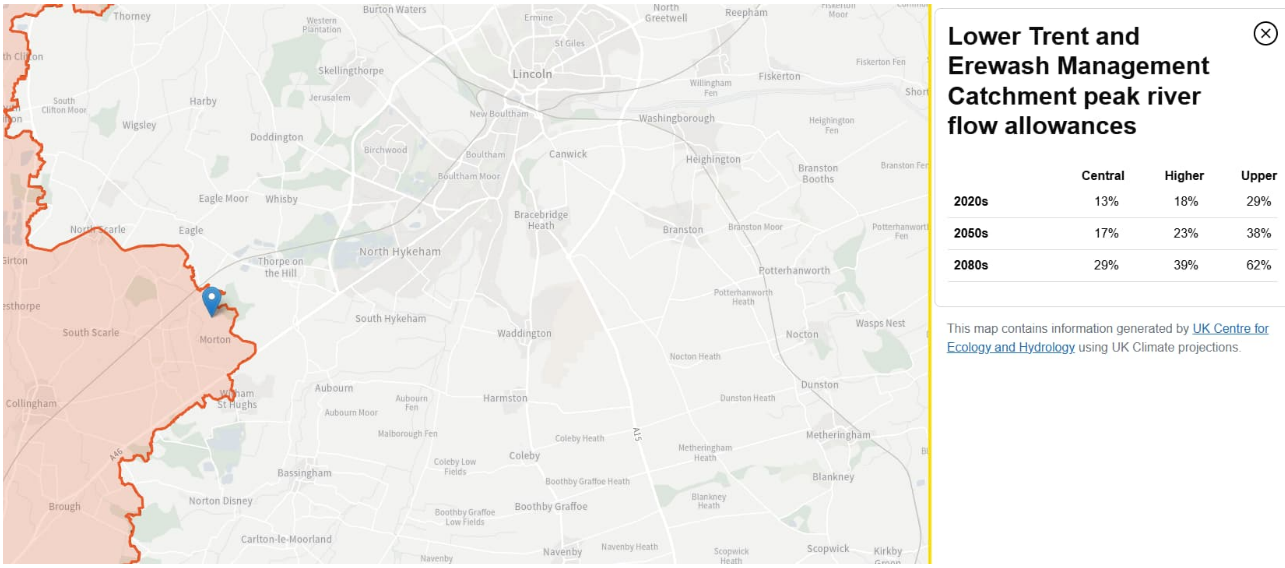


Figure 2 - DEFRA Peak River Flow Climate Change Allowances

In order to ensure a robust approach to the analysis, a conservative overestimate of the potential discharge rates that the ordinary watercourse may become subject to have been used. The Higher (design) discharge rate for the surface water watercourse has been taken as the greenfield 1 in 100 year rate increased by 50% (1.5 x 1 in 100 year rate), and the Upper (sensitivity) check discharge rate has taken as the greenfield 1 in 100 year rate increased by 100% (2 x 1 in 100 year rate).

Table 1 provides the estimated Greenfield Runoff rates using the FEH method and the increased design and sensitivity discharge rates to be used in this analysis. (Refer to Appendix A for Greenfield Runoff Rate Calculations)

Table 1 – Greenfield Runoff Rates (Using FEH Data)

Watercourse	Catchment Area (km^2)	Qbar (Cumecs)	1 in 1 year (Cumecs)	1 in 30 year (Cumecs)	1 in 100 year (Cumecs)	1 in 100 year + 50% (Cumecs) Higher Allowance (Design)	1 in 100 year + 100% (Cumecs) Upper Allowance (Sensitivity)
Mill Dam Dyke	4.38	0.40	0.35	0.98	1.43	**2.145**	**2.86**

3) The existing capacity of the watercourse at the analysis location.

An open channel flow calculation undertaken to estimate the existing capacity of the ordinary watercourse utilised 0.25m contours produced in ArcGIS software from LiDAR map data obtained from the DEFRA website to estimate the cross sectional profile of the existing watercourse at the analysis location (shown in Figure 4). The top of bank level was also taken as 12.5mAOD.

The 3D surface extracted from the LiDAR data provides level data to estimate a gradient of the long profile of the watercourse bed from the analysis location to approximately 400m upstream(1:389) to be used in calculating the existing watercourse capacity, see Appendix B for existing watercourse capacity calculations.

As the watercourse is not accessible at the analysis location, Google Maps street view imagery approximately 290m downstream of the analysis location on Eagle Road has been used to estimate a Manning's n value of 0.08 (grass channel, not maintained with dense weeds in average condition) has been used for the roughness value in the open channel calculation, to demonstrate a conservative approach.

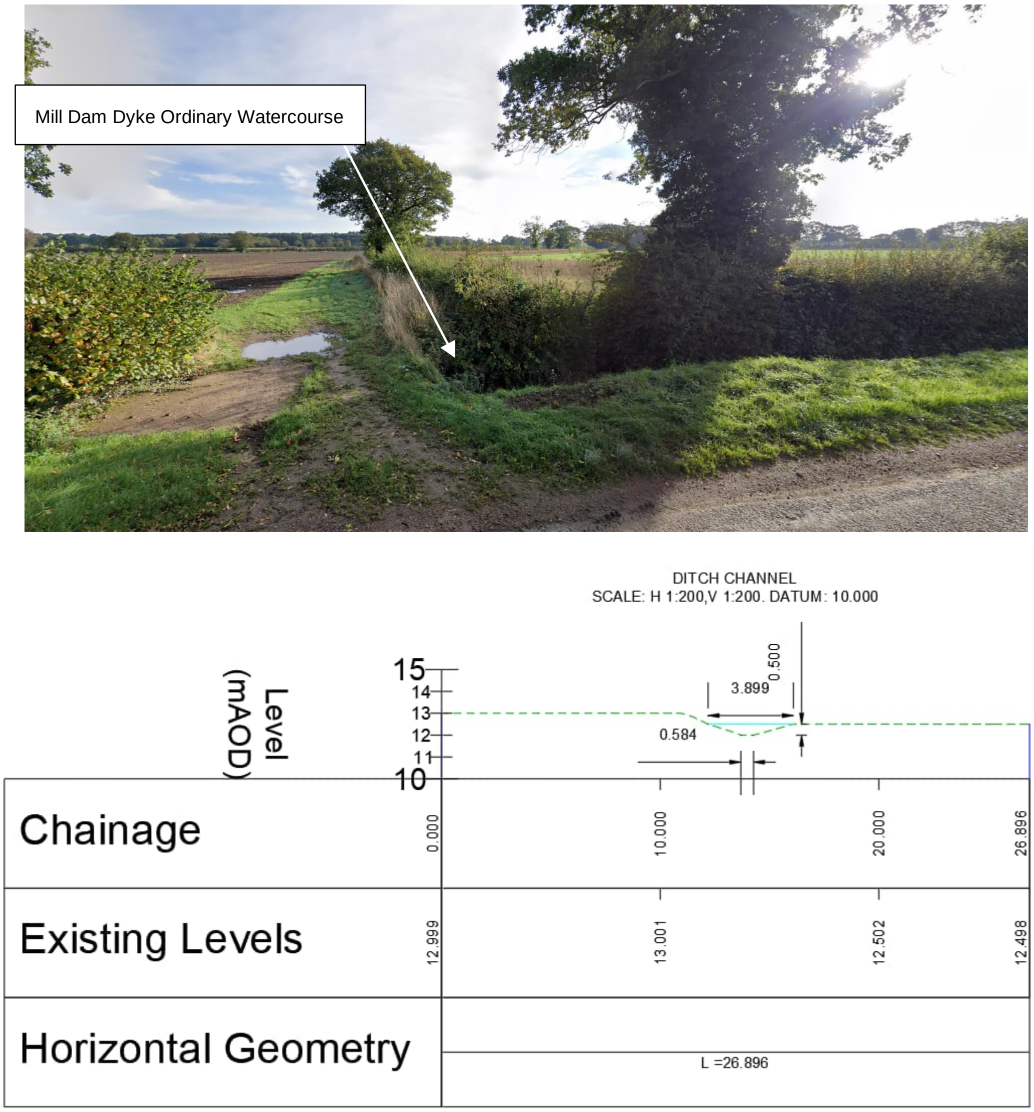


Figure 3 - Watercourse Cross-section

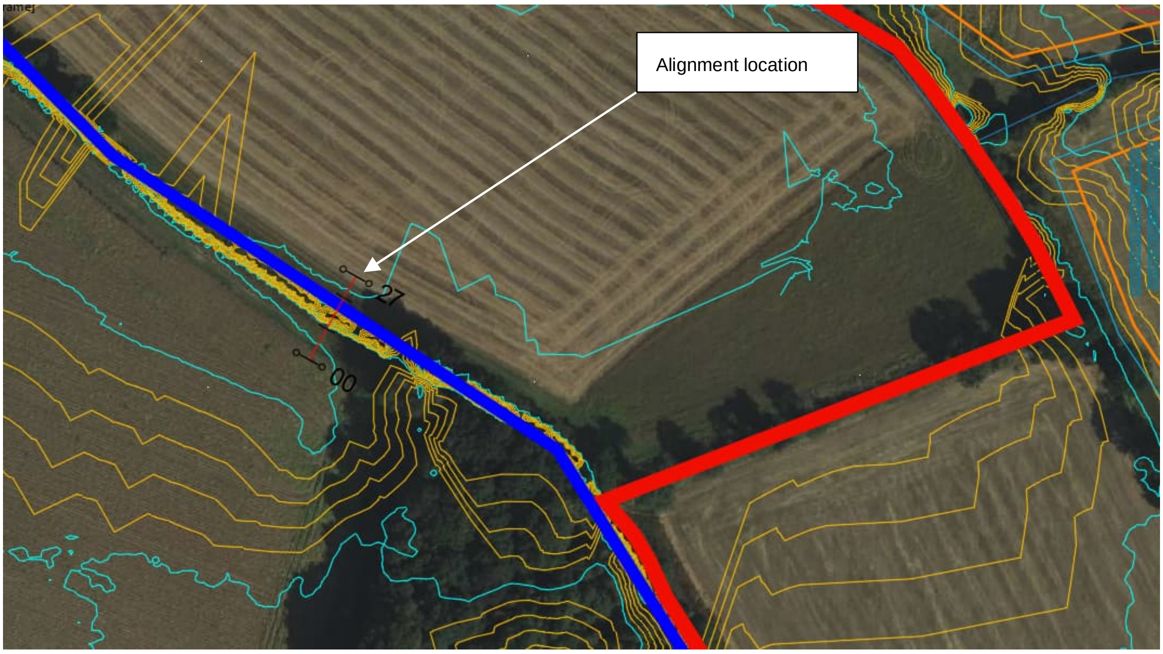


Figure 4 – Ordinary Watercourse Cross-Section Alignment

The open channel flow calculation provides the maximum discharge rate of the watercourse at the analysis location. (See Appendix B for calculations including details cross section geometry)

Table 2 – Existing Watercourse Capacity

Watercourse	Capacity (Cumecs)
Mill Dam Dyke	**0.29**

4) The excess discharge during the design and sensitivity scenarios, including climate change) that cannot be conveyed within the existing channel capacity at the analysis location which may cause flooding out towards the DCO site.

The excess discharge rate that cannot be contained and conveyed within the exiting surface water watercourse profile during the flood events is calculated by comparing the difference between the 1 in 100 year + CC (Cumecs) Higher / Upper Sensitivity Allowance discharge rates (Table 1) with the Existing Watercourse Capacity (Table 2).

Table 3 - Excess Discharge Rates

Flood Event	Expected Greenfield rate entering surface water watercourse (Cumecs)	Existing Watercourse capacity (Cumecs)	Excess discharge rate (Cumecs)
1 in 100 year + 50% (Cumecs) Higher Allowance (Design)	2.15	0.29	**1.86**
1 in 100 year + 100% (Cumecs) Upper Allowance (Sensitivity)	2.86	0.29	**2.57**

5) The expected depth the excess discharge would rise to above the watercourse bank level in relation to the surrounding topography to determine if the flooding would encroach on the proposed PV panel areas.

A further open channel flow calculation uses the following parameters to determine the expected flood depth at the analysis location:

- The geometry of the adjacent land (flood channel) to the surface water watercourse analysis location provided by the topographical drone survey to determine the cross sectional profile of the flood channel predicted to be partially filled with greenfield runoff during flood events; and,
- The excess discharge rates during the flood events to calculate the expected flood depth above the bank level of the surface water watercourse.

Figure 5 provides a schematic diagram of the cross section at the analysis during a flood event. The flood depth above bank has been calculated by determining the profile of the flood plain above the top of bank level. Open flow calculations have then been used to determine the depth of water above the top of bank level required to convey the additional discharge. Figures 6, and 7 show the profile of the floodplain. Based on an assessment of the profile of the floodplain the average slope from the eastern bank of the watercourse to Field 8 was determined to be 1 in 327. Using this gradient and the top of bank width of 3.9m the depth of water required to discharge the excess discharge rates was calculated. (See Appendix C for calculations of the Flood Channel capacity)

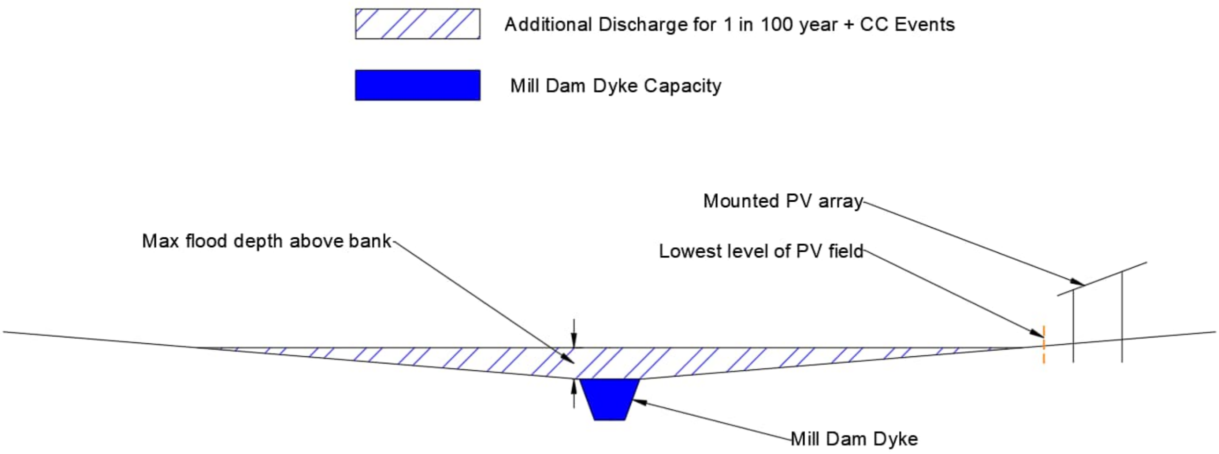


Figure 5 - Example Analysis Cross- Section (not to scale)

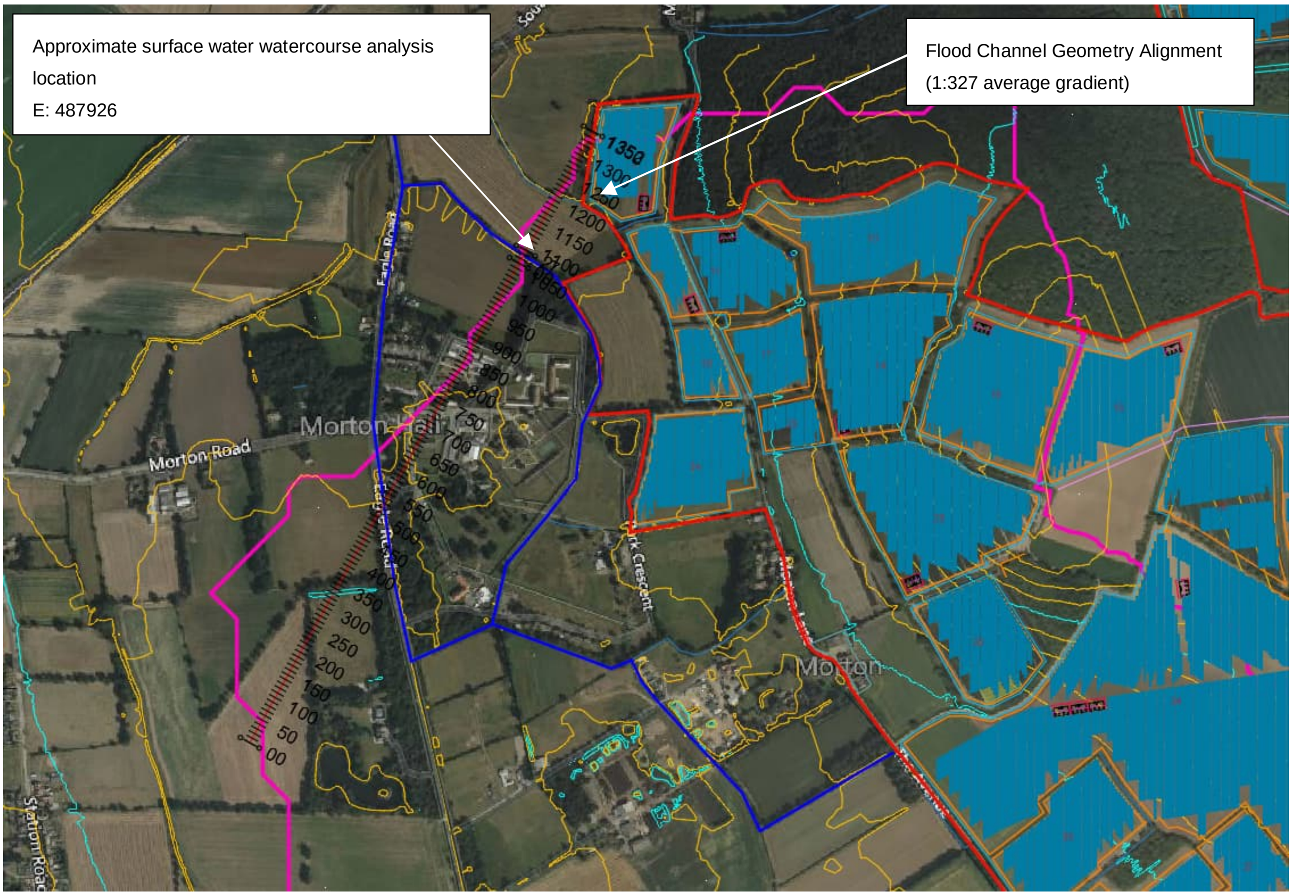


Figure 6 - Floodplain Alignment

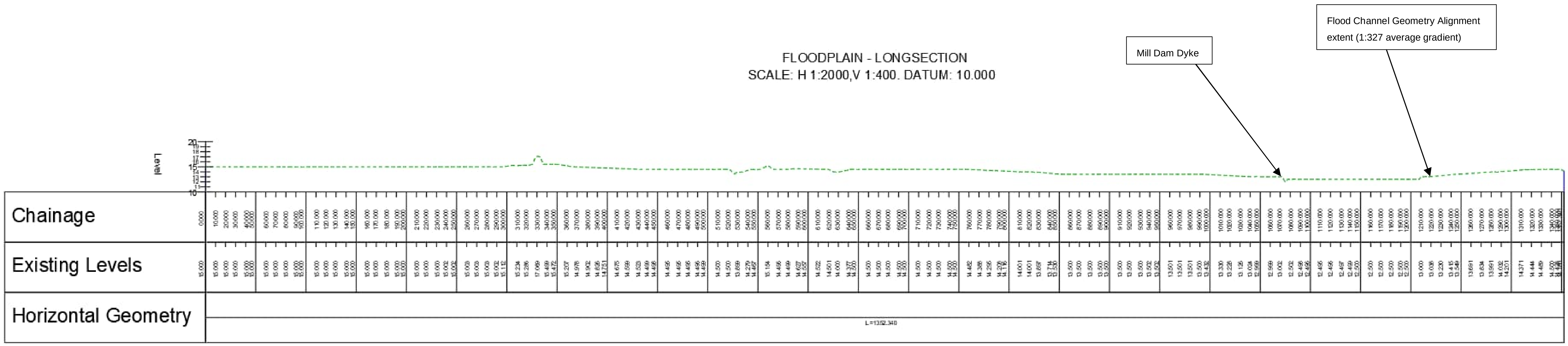


Figure 7 - Flood Plain Geometry

Table 4 provides the expected flood depth levels above the surface water watercourse bank level at the analysis location for the higher and upper flood event scenarios.

Table 4 – Predicted flood levels (1 in 100 year + CC Higher Central Allowance)

Flood Event	Max Flood Depth Above Bank (m)	Top of Bank Level (m AOD)	Flood Level (m AOD)
1 in 100 year + 50% Higher Central Allowance (Design)	0.207	12.50	**12.707**
1 in 100 year + 100% Upper End Allowance (Sensitivity)	0.250	12.50	**12.750**

Figure 8 below provides spot levels of the lowest points of each of the PV fields adjacent to the Flood Zone 2 and 3 extents.

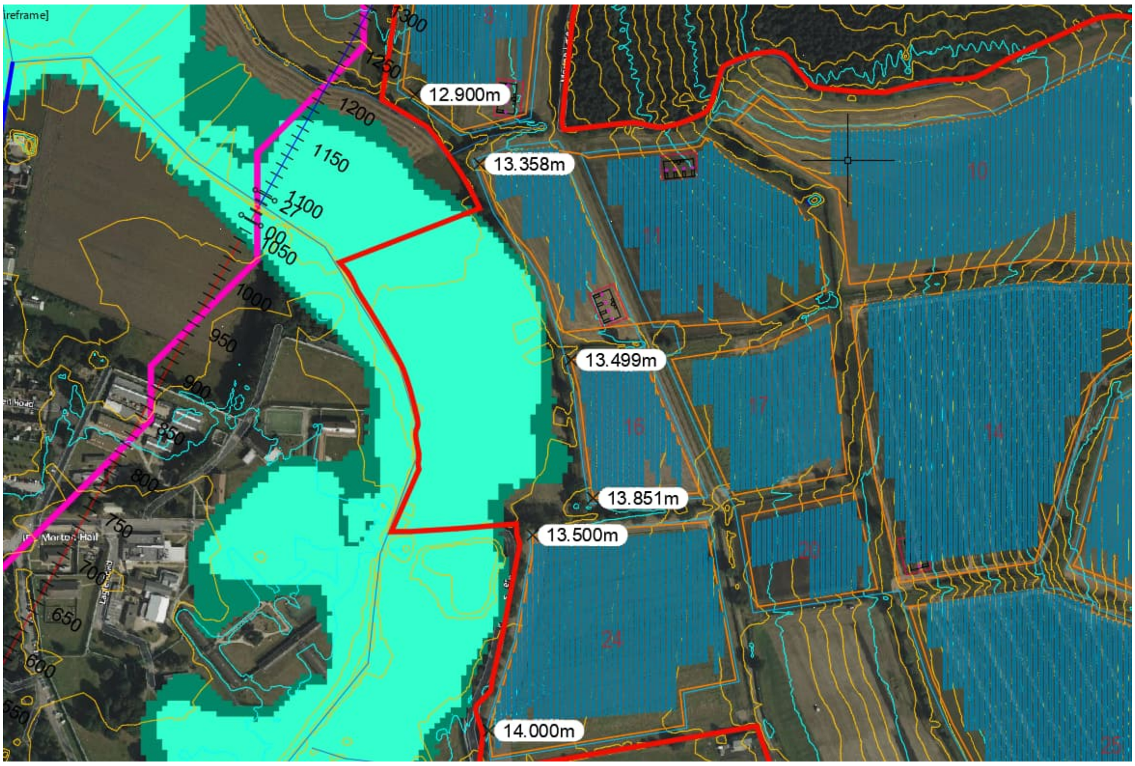


Figure 8: PV Field Topography

Table 5 shows the lowest ground level within the DCO Site adjacent to the Mill Dam Dyke ordinary Watercourse (Field no. 8), and therefore the expected lowest level of a typically mounted PV Module (600mm above ground) within the Interaction Zone.

The expected flood depth of 12.707m AOD and 12.750m AOD are, therefore, not expected to be within the reaches of the lowest PV field location, at 12.90m AOD. In conclusion, the PV panels are considered to not be at risk of future fluvial flood risk.

Summary

An analysis has been undertaken to predict the flood levels surrounding the Mill Dam Dyke Ordinary Watercourse for the 1 in 100 year + CC events, applying a very conservative approach to the climate change allowances.

The flood depth when taking into account both the Higher and Upper climate change allowances, does not reach the topographical height of the adjacent PV Fields.

Therefore no mitigation, such as raising panel mounting height is required in this area of the Scheme.

Appendix A – Greenfield Calculations

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	[redacted]
Site name:	Fosse Green
Site location:	Morton Ditch Catchment

Site Details

Latitude:	53.17015° N
Longitude:	0.68229° W
Reference:	3461239725
Date:	Jul 09 2024 15:10

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha):	437.4919615

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.613
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	580	577
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		400.93
1 in 1 year (l/s):		348.81
1 in 30 years (l/s):		982.29
1 in 100 year (l/s):		1427.32
1 in 200 years (l/s):		1687.93

Appendix B – Existing Watercourse Capacity Calculations

AECOM

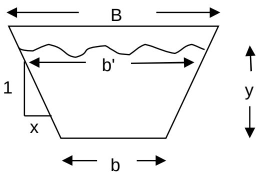
<u>OPEN CHANNEL FLOW CALCULATIONS</u>

Project: *Fosse Green Solar* **Job No:**
Section: *Mill Dam Dyke Ordinary Watercourse Capacity* **Date:** *17.01.2024*
Sheet No: *1* **of** *1*
Made By: *PM* **Checked By:** CB

Free Board	0.00	m
Width of channel base, b=	0.584	m
Channel side slope, 1 in x=	3.246	
Max. water depth, y=	0.50	m

Cover	Pipe	Depth	side slope
		0.50	

Existing ground level=	12.500	m
Invert level of channel=	12.000	m
Top channel width, B=	3.899	m



area, A=	1.1035
wetted perimeter,P=	3.980545
top width at top water level, b'=	3.83
hydraulic radius, R=	0.277223
hydraulic mean depth, Dm=	0.28812
Velocity, m/s=	**0.269456**

Bed slope 1 in	389
Manning's, n=	0.08

Q= 0.2973451 cumecs or 297.35 l/s

Existing ground level=		m	Channel length=		m
Proposed freeboard=		m (300mm recommended)	Starting invert=		m
Proposed MIN invert level=		m	End Invert=		m

<u>ROUGHNESS VALUES</u>

Type of channel	Condition	Manning's n
Grass channel, regularly maintained	Average, good	0.050
Grass channel, not maintained with dense weeds	Good Average Poor	0.050 0.080 0.120
Concrete	Average Poor	0.013 0.016
Black top	Average Poor	0.017 0.021

<u>SIDE SLOPES</u>

Material	Side Slope (H:V)
Rock	Nearly vertical
Muck and peat soils	¼:1
Stiff clay or earth with concrete lining	½:1 to 1:1
Earth with stone lining or earth for large channels	1:1
Firm clay or earth for small ditches	1½:1
Loose, sandy earth	2:1
Sandy loam or porous clay	3:1

Appendix C – Flood Chanel Calculations

OPEN CHANNEL FLOW CALCULATIONS

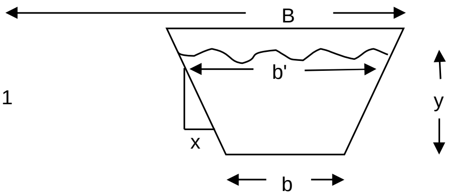
Project: *Fosse Green Solar* **Job No:**
Section: *Morton Ordinary Watercourse Flood Channel (Higher Allowance: 1.86 Cu)* **Date:** *17.01.2025*
Sheet No: *1* **of** *2*
Made By: *PM* **Checked By:** CB

Free Board	0.00	m
Width of channel base, b=	3.90	m
Channel side slope, 1 in x=	389.0	
Max. water depth, y=	0.207	m

Cover Pipe Depth side slope half trench width B

Existing ground level=	14.000	m
Invert level of channel=	11.750	m
Top channel width, B=	1352.00	m

area, A=	17.4754
wetted perimeter,P=	164.9455
top width at top water level, b'=	164.945
hydraulic radius, R=	0.105946
hydraulic mean depth, Dm=	0.105947
Velocity, m/s=	**0.106547**



Bed slope 1 in 690
Manning's, n= 0.08

Harpswell Flood Channel (Higher Allowance: 9.7Cu)

Q= 1.8619517 cumecs or 1861.95 l/s

Existing ground level= m
Proposed freeboard= m (300mm recommended)
Proposed MIN invert level= m

Channel length= m
Starting invert= m
End Invert= m

ROUGHNESS VALUES

Type of channel	Condition	Manning's n
Grass channel, regularly maintained	Average, good	0.050
Grass channel, not maintained with dense weeds	Good Average Poor	0.050 0.080 0.120
Concrete	Average Poor	0.013 0.016
Black top	Average Poor	0.017 0.021

SIDE SLOPES

Material	Side Slope (H:V)
Rock	Nearly vertical
Muck and peat soils	¼:1
Stiff clay or earth with concrete lining	½:1 to 1:1
Earth with stone lining or earth for large channels	1:1
Firm clay or earth for small ditches	1½:1
Loose, sandy earth	2:1
Sandy loam or porous clay	3:1

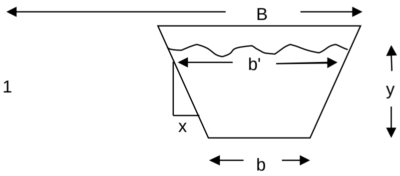
OPEN CHANNEL FLOW CALCULATIONS

Project: *Fosse GreenSolar* **Job No:**
Section: *Morton Ordinary Watercourse Flood Channel (Upper Allowance: 2.57 Cu)* **Date:** *17.01.2025*
Sheet No: *2* **of** *2*
Made By: *PM* **Checked By:** CB

Free Board	0.00	m
Width of channel base, b=	3.90	m
Channel side slope, 1 in x=	389.0	
Max. water depth, y=	0.250	m

Cover Pipe Depth side slope half trench width B

Existing ground level=	12.500	m
Invert level of channel=	11.750	m
Top channel width, B=	1352.00	m



area, A=	25.2875
wetted perimeter,P=	198.4006
top width at top water level, b'=	198.4
hydraulic radius, R=	0.127457
hydraulic mean depth, Dm=	0.127457
Velocity, m/s=	**0.102176**

C

Bed slope 1 in 960
Manning's, n= 0.08

Q= 2.5837798 cumecs or 2583.78 l/s

Existing ground level= m
Proposed freeboard= m (300mm recommended)
Proposed MIN invert level= m

Channel length= m
Starting invert= m
End Invert= m

ROUGHNESS VALUES

Type of channel	Condition	Manning's n
Grass channel, regularly maintained	Average, good	0.050
Grass channel, not maintained with dense weeds	Good Average Poor	0.050 0.080 0.120
Concrete	Average Poor	0.013 0.016
Black top	Average Poor	0.017 0.021

SIDE SLOPES

Material	Side Slope (H:V)
Rock	Nearly vertical
Muck and peat soils	¼:1
Stiff clay or earth with concrete lining	½:1 to 1:1
Earth with stone lining or earth for large channels	1:1
Firm clay or earth for small ditches	1½:1
Loose, sandy earth	2:1
Sandy loam or porous clay	3:1

Annex F Hydraulic Modelling with climate change allowances technical note

Table of Contents

Figures

1. Introduction

1.1 Purpose of Document

This report outlines the hydraulic modelling carried out to support the Fosse Green Energy Solar Farm Flood Risk Assessment (FRA) with regards to demonstrating the baseline flood risk to the proposed solar farm. The document aims to summarise how the existing hydraulic model of the Upper Witham has been used to generate flood extent mapping for the 1% AEP event with the latest climate change allowances.

1.2 Study Objectives

AECOM were provided with the 2015 Upper Witham Lincoln hydraulic model (produced as part of the Environment Agency's Upper Witham Model Improvement Study[1]), which was created/modified in InfoWorks RS modelling software (a modelling software that has since been retired by the developers). Following wider AECOM discussions with the Environment Agency (EA), the 2015 Upper Witham Lincoln hydraulic model was deemed suitable for assessing the baseline flood risk to the proposed solar farm, however AECOM were required to assess the baseline flood risk with the updated climate change allowances.

The objectives of this study are as follows:

- Update the 2015 Upper Witham Lincoln InfoWorks RS baseline model to include "*Flood Compartments*" (a feature of InfoWorks RS required to export flood mapping in a GIS format) which correspond to "(*1D) Storage Areas*" that represented the River Witham's floodplain near the proposed solar farm.
- Develop revised 1% Annual Exceedance Probability (AEP) event plus climate change hydrology based on the latest allowances[2]. The 1% AEP plus 32% and 57% climate change uplifts were required, which are the current catchment area climate change allowances that cover the Principal Site.
- Run the updated 2015 Upper Witham InfoWorks RS baseline model with the revised 1% AEP event plus climate change uplifts.
- Post process and analyse the hydraulic models baseline results to understand the flood risk to the proposed solar farm.

1.3 Proposed Development

The proposed solar farm is located approximately 10 km south of Lincoln (NGR 491230, 362409) and covers approximately 14 km^2, Figure 1-1. The proposed solar farm intersects with parts of the River Witham's floodplain near Witham St Hughs / Bassingham and the River Brant's floodplain to the north-east of Bassingham (including a segment of the Brant Washland). The solar panels have been designed to sit 0.8 m above existing ground elevations across the site, i.e. at the lowest panel angle the lowest edge of the panel will be 0.8m above ground level.

[1] Environment Agency (July 2015) Upper Witham Model Improvement Study. Mott MacDonald
[2] DEFRA (2023) Climate Change Allowances for Peak River Flow. Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk) Accessed 16/07/2024

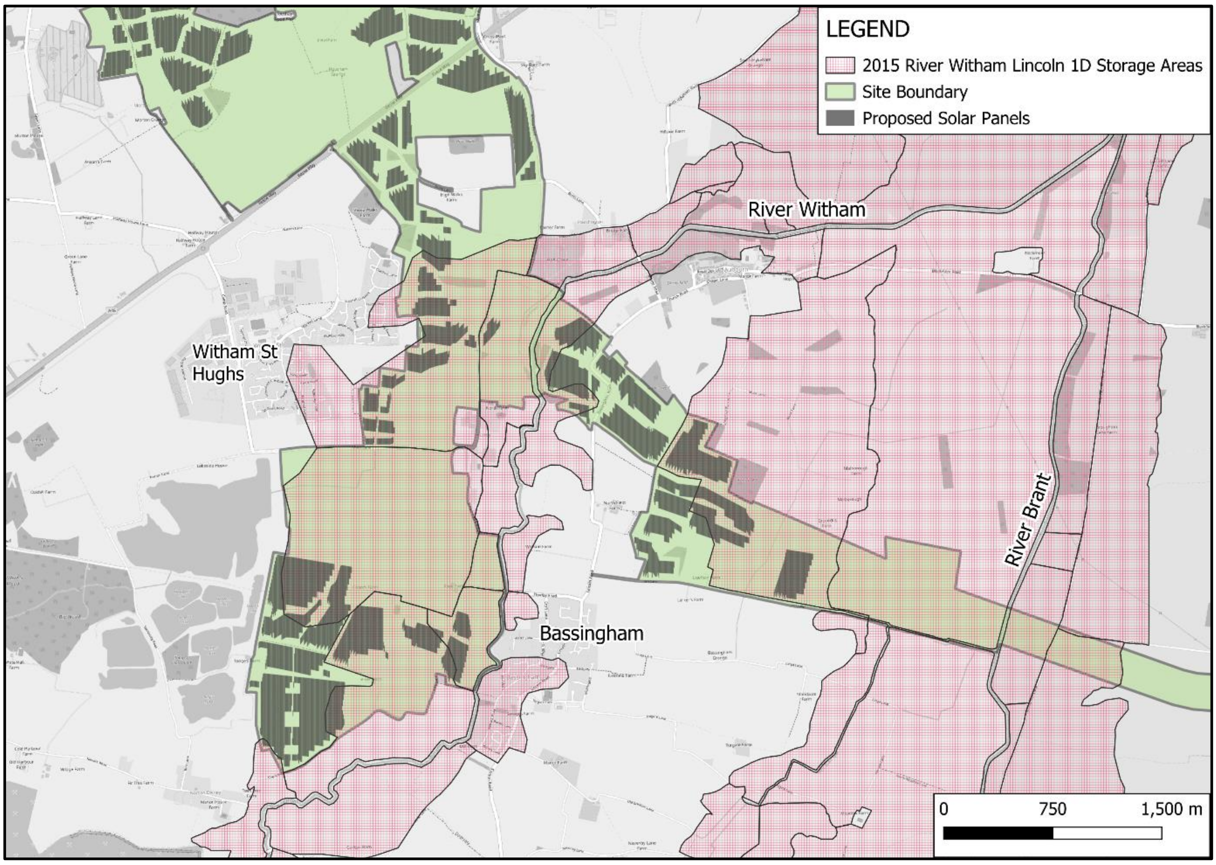


Figure 1-1 Overview of the proposed solar farm site

2. Data Sources and Review

2.1 Original Hydraulic Model

The EA provided AECOM with the 2015 Upper Witham Lincoln hydraulic model, which was built/modified in InfoWorks RS (a now superseded modelling software).

The 2015 Upper Witham Lincoln hydraulic model has been used as part of this study. It is a 1D-2D hydraulic model, built in InfoWorks RS (version 12.5). Further information on the model build can be found in the original reporting for the model upon request.

2.2 Ground Model

The 2015 Upper Witham Lincoln hydraulic model used 2 m resolution LiDAR DTM data obtained in 2014 as part of the associated study. This LiDAR dataset was not provided to AECOM and could not be obtained for this study. As a result, the 2020 1 m resolution LiDAR DTM composite was downloaded from DEFRA[3] and used for flood mapping in the InfoWorks RS run dialog.

Using the 2020 1 m resolution LiDAR DTM will have limited impact on the hydraulic models results as the 2015 Upper Witham hydraulic model's 2D domain was previously 'meshed' (InfoWorks RS's method of pre-processing the 2D domain) using the 2014 LiDAR DTM, and no changes were made to the 2D model which required the model to be re-meshed using the 2020 LiDAR DTM composite. The hydraulic model's 1D storage areas were also already previously defined using the 2014 LiDAR DTM and were not updated with the 2020 LiDAR DTM composite dataset.

However, the use of the 2020 1 m LiDAR DTM composite will impact the output of flood compartments which have been created as part of this study. The "*Flood Compartments*" superimpose the calculated peak water level of their corresponding "(1D) storage area" onto the ground model (in this case, the 2020 LiDAR DTM composite) to produce a flood depth outline. Any significant developments in the River Witham's or River Brant's floodplain since 2014 will be picked up in the flood depth outline, however the change in floodplain would not have been originally used when defining the original 1D storage area relationship, hence has a potential floodplain volume discrepancy.

[3] DEFRA Survey Data Download. https://environment.data.gov.uk/survey Last accessed 15/07/2024.

3. Model Build

3.1 Model Software

Modelling carried out for the current study continued to use InfoWorks RS v12.5 to avoid discrepancies due to software versions as the model was developed using this version.

3.2 Model Overview

The hydraulic model represents the majority of watercourses and their floodplains in 1D-only, although parts of the model domain, essentially around Lincoln, are represented in1D-2D. Where the hydraulic model was represented in 1D-only, the watercourses are modelled by either extended cross-sections, or cross-sections connected to a series of interconnected 1D storage areas (via 1D spill units) representing the floodplain.

The ‘*UW_Lincoln_Defended_>1pAEP*’ InfoWorks RS ‘network’ file, *‘Design_1p_40H*‘ InfoWorks RS ‘event file’, and ‘*UW_Lincoln_Defended*’ InfoWorks RS ‘logical rules’ file were used as a starting point for this study. The ’network’ was modified for flood mapping purposes and ‘event file’ was modified to reflect updated climate change allowances; however, the ‘logical rules’ were retained as supplied. Downstream boundary conditions were also unchanged from the 2015 study.

3.3 Climate Change Allowances

To account for the effects of climate change on fluvial flooding at the proposed site, two new InfoWorks RS ‘event’ files were prepared to increase hydrology inputs associated with the 1% AEP design event by 32% and 57%, in accordance with the allowances provided by DEFRA[4]. This was done by applying scaling factors of 1.32 and 1.57 to the rainfall-runoff boundaries and Claypole inflow boundary for the 1% AEP, 40-hour duration design event. The 40-hour duration event is the worst-case duration.

3.4 Run Parameters & Setup

All InfoWorks RS run parameters were retained from the 2015 run dialog.

The InfoWorks RS run dialogues were setup to use the modified hydraulic model ‘network’ file, the new 1% plus climate change ’event’ files, and the 1 m 2020 DTM composite ground model. The ‘logical rule’ file was unchanged.

The ‘network’ file, design ‘event’ files, and ‘logical rules’ file - as well as the event ‘simulation’ files generated to run the new simulations - were as follows:

- Network: *‘UW_Lincoln_Defended>1pAEP – Flood Comp_V4’*
- Design Events: *‘Design_1p_40H_32%CC*, and *‘Design_1p_40H_57%CC’*
- Logical Rules: ‘*UW_Lincoln_Defended*’
- Event Simulations: *‘Defended Runs 40H>1pAEP _32%CC_V3’*, and *‘Defended Runs 40H>1pAEP_57%CC_V2’*

3.5 Flood Mapping Outputs

The proposed solar farm boundary intersects the floodplains of the River Witham and River Brant where it is represented by “*(1D) Flood Storage*” *Areas*” only. “*Flood Compartments*” (flood mapping objects) were subsequently created to cover the proposed solar farm (where it is located within the hydraulic model’s boundary) to produce flood depth contour outputs for flood mapping. Flood compartments allow for flood depths from the 1D storage areas to be superimposed to the ground model in that location.

[4] DEFRA (2023) Climate Change Allowances for Peak River Flow. Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk) Accessed 16/07/2024

3.6 Assumptions

AECOM have assumed the following (which may result in model and output limitations):

- the 2015 InfoWorks RS hydraulic model is suitable for the purpose of this study.
- the 2015 Upper Witham Lincoln's 1% AEP 40-hour duration hydrology was suitable for this study.
- climate change has been applied by increasing the hydrological boundaries peak scaling factor by the respective climate change allowance percentage (i.e. inflows will be increased by a factor of 1.32 for the 32% climate change event). This follows the same approach used in the 2015 Upper Witham study.
- the Upper Witham Grantham hydraulic model was not run with the updated climate change allowances to obtain boundary conditions for the Claypole boundary. AECOM has used the same approach as the 2015 study by multiplying the 1% AEP Claypole inflow by the Climate Change scaling factor event being modelled (i.e. a 1.32 scaling factor will be used for the 32% climate change event, etc). This is likely to represent a conservative approach.
- the downstream boundary conditions have been retained as per the "UW_Lincoln_Defended_>1pAEP" network. This was not previously changed in the 2015 climate change model runs.
- the operational structure rules will remain unchanged and are still appropriate for the purpose of this assessment.
- only the fluvial flood risk where the solar farm is located within the hydraulic models 1D storage polygons are reported on. Flood compartments have been used for flood mapping purposes (correspond to the 1D storage polygons) to create flood depth contours only.
- AECOM have not assessed, mapped or reported the flood risk to the solar panels outside of the '2015 River Witham Lincoln 1D Storage Areas'. Solar panels and infrastructure outside of these 1D storage areas may be at risk from other sources of flood risk and should be assessed separately.
- there have not been any significant developments on the River Witham's or River Brant's floodplain which may impact 1D storage area's definition.
- the 1 m 2020 DTM composite is a necessary replacement for flood mapping purposes to the 2 m 2014 LiDAR dataset.

4. Results

4.1 Design Runs

The model was run for the 1% AEP plus 32% climate change and plus 57% climate change for the 40-hour duration events. Flood depths less than 0.05m have not been mapped.

Analysis of the 1% AEP plus 32% and plus 57% climate change model results found that fluvial flooding within the proposed site boundary primarily occurs on the western floodplain of the River Brant, with maximum modelled depths in the site boundary of up to 2.0 m (excluding depths in the river channel), as shown in Figure 4-1 and Figure 4-2.

In both the 1% AEP event plus 32% ('higher central') climate change scenario **and** the 1% AEP event plus 57% ('upper') climate change scenario, most of the proposed solar panels are not flooded. However, a relatively small proportion of the proposed solar panels situated in the River Brant floodplain are subject to flooding of up to 0.50 m above existing ground elevation; this upper limit of flood depth is applicable to both the 'higher central' and 'upper' climate change scenarios. Since the solar panels will be set 0.80 m above ground elevation across the site, the total freeboard will be at least 0.30 m.

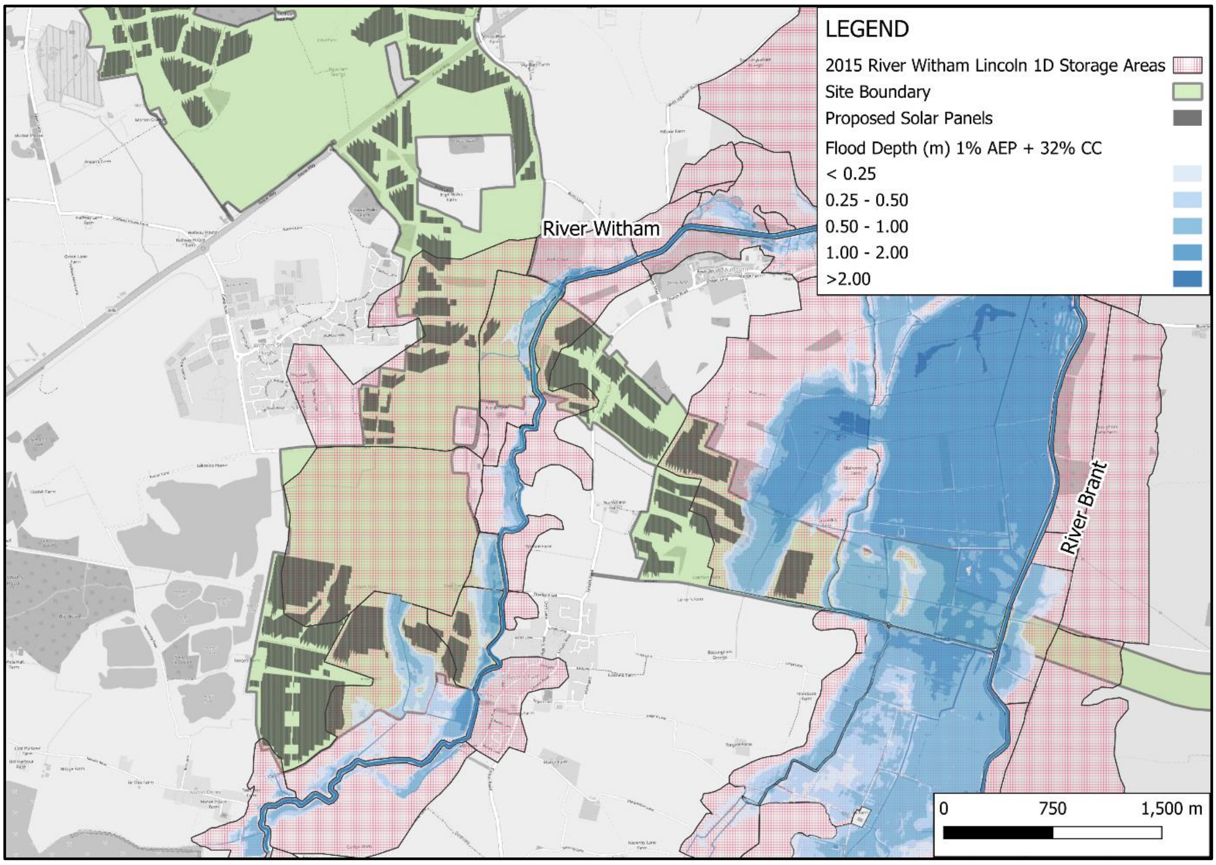


Figure 4-1 Flood depth mapping of the proposed solar farm site for the 1% AEP plus 32% climate change design event

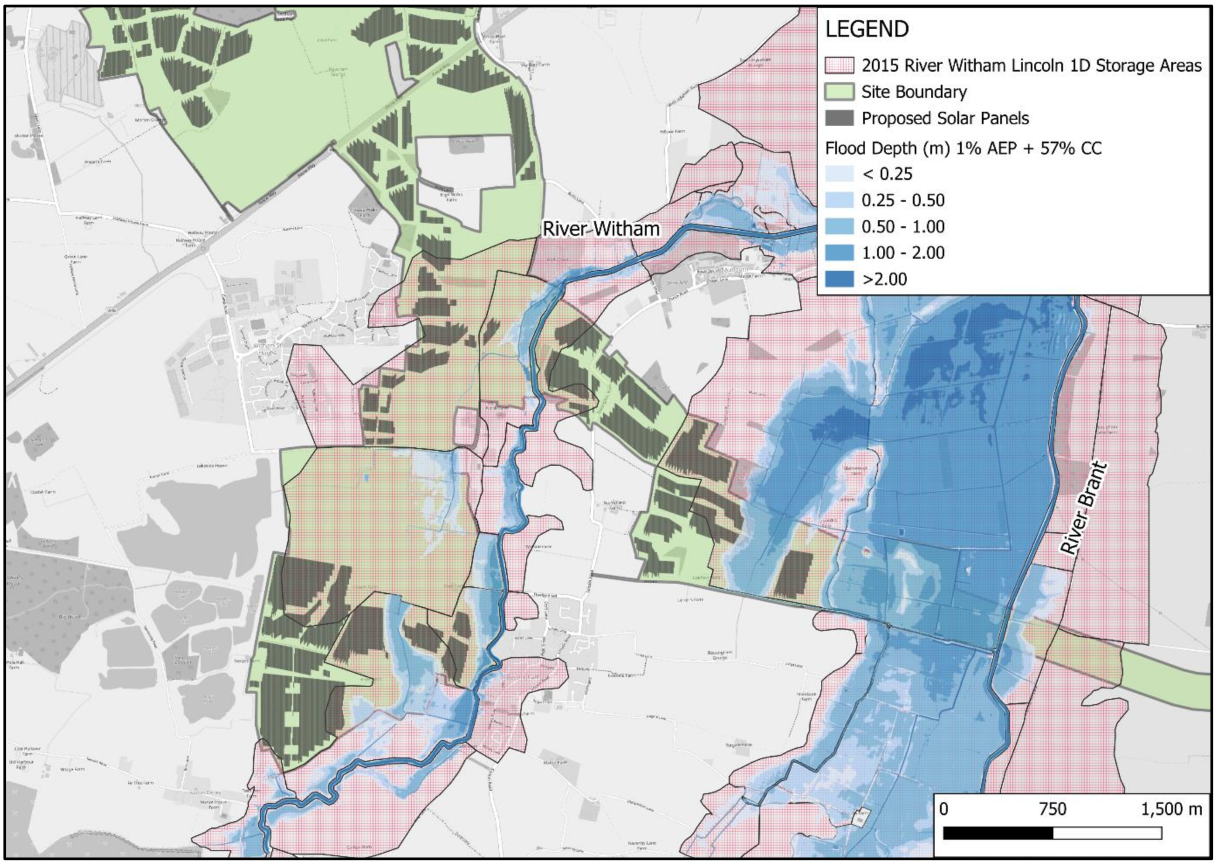


Figure 4-2 Flood depth mapping of the proposed solar farm site for the 1% AEP plus 57% climate change design event

5. Conclusion

AECOM were provided with the 2015 InfoWorks Upper Witham Lincoln model to assess the baseline flood risk to a proposed solar farm. The hydraulic model was updated to contain flood compartments (flood mapping objects) where the proposed solar farm intersected the existing hydraulic model extent. The updated hydraulic model was run with the existing 1% AEP event plus the new climate change uplift allowances of 32% and 57%. Flood depth contours were exported from the hydraulic model to show the baseline flood risk compared to the location of the proposed solar farm (within the existing hydraulic model's boundary).

Analysis of the hydraulic model outputs suggest:

- Flood depths within the proposed solar farm site boundary were up to 2.0 m in areas, with more widespread flooding occurring in the western floodplain of the River Brant.
- A majority of the solar panels are not located within the modelled flood depths; however, there are a limited number of solar panels on the River Brant floodplain which do flood to a depth of at most 0.5 m above existing ground elevation. This upper limit of flood depth is applicable in both the 1% AEP event plus 32% ('higher central') climate change and 1% AEP event plus 57% ('upper') climate change scenarios.

As the solar panels will be set 0.80 m above existing ground elevation, there will be a freeboard of at least 0.3 m to the solar panels across the site.

Annex G Panel Leg Calculations

DCO Stage: Panel Support Design			Piled HEA 160 I-Beams (cm2)	Rounded (cm2)	Non Piled Sigma Beam S140 (cm2)	Rounded (cm2)
Approx. 1562 panels per ha		Cross Section Area	38.8	39	8.82	9

DCO Actual Design - 1 in 100yr Plus 32% CC Depth

Field	Area (ha)	PV panels per ha	No. of Panels	HEA 160 Legs per Panel	HEA 160 Cross Section Area leg (m2)	Sigma 140 Legs per Panel	Sigma Cross Section (m2)	Leg Cross Section Area per panel	Total Area (m2)	Average Depth flood risk (m)	TOTAL Leg Volume (m3)
53	3.00	1562	4686	1	0.0039	2	0.0009	0.0057	26.71	0.55	14.69
57	0.08	1562	125	1	0.0039	2	0.0009	0.0057	0.71	0.1	0.07
59	0.36	1562	562	1	0.0039	2	0.0009	0.0057	3.21	0.4	1.28
60	0.46	1562	719	1	0.0039	2	0.0009	0.0057	4.10	0.25	1.02
62	1.95	1562	3046	1	0.0039	2	0.0009	0.0057	17.36	0.025	0.43
TOTAL	5.85	TOTAL	9138							TOTAL VOLUME LOST (m3)	17.50

Approx depth increase (mm)
0.49
0.09
0.36
0.22
0.02
0.24

DCO Stage: Panel Support Design

Table 1: Panel Design (Legs per panel)

	A	B	C	D	E	F	G
1	Size (Qt. of modules per tracker) [-]	Length [m]	Non-drive piles [-]	Drive-piles [-]	Qt. of trackers in project [-]	Qt. of non-drive piles in project [-]	Qt. of drive piles in project [-]
2	15.00	21.37	2	1	5,535	11,070.00	5,535.00

Figure 1 - Illustrative Panel Design

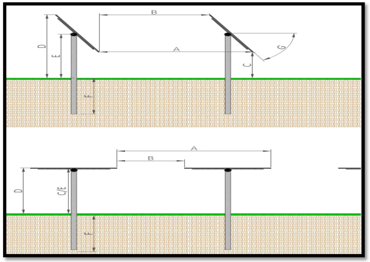


Table 2: Minimum and Maximum Parameters PV Panels

ID	Item	Minimum Value (m)	Maximum Value (m)	Unit
B	Interrow distance	1.6	3.8	m
E	Axis height	1.5	2.5	m
F	Ground penetration	-	4	m

SECTION										GROSS CROSS SECTION PROPERTIES				
Section Type	Section name	h (mm)	b (mm)	c (mm)	h_c (mm)	h_s (mm)	t (mm)	G (kg/m)	A_{paint} (m^2/m)	A (cm^2)	I_y (cm^4)	W_y (cm^3)	I_z (cm^4)	W_z (cm^3)
S 200	S 200x4	200	65	20	100	36	4,00	11,57	0,78	14,64	814,7	83,13	49,22	13,51
	S 200x3						3,00	8,85		11,19	633,3	64,29	40,02	10,76
	S 200x2,5						2,50	7,45		9,38	535,3	54,21	34,55	9,20
	S 200x2						2,00	6,01		7,53	433,2	43,76	28,53	7,52
	S 200x1,75						1,75	5,28		6,59	380,4	38,37	25,28	6,63
	S 200x1,5						1,50	4,54		5,64	326,8	32,93	21,92	5,72
S 170	S 170x4	170	60	15	70	36	4,00	10,00	0,68	12,66	502,4	60,53	35,91	10,53
	S 170x3						3,00	7,67		9,71	392,9	47,06	29,43	8,44
	S 170x2,5						2,50	6,46		8,15	333,1	39,77	25,50	7,24
	S 170x2						2,00	5,22		6,55	270,3	32,18	21,12	5,93
	S 170x1,75						1,75	4,59		5,74	237,6	28,24	18,74	5,24
	S 170x1,5						1,50	3,96		4,94	204,3	24,25	16,27	4,52
S 140	S 140x4	140	60	15	40	34	4,00	9,05	0,62	11,47	313,5	46,11	34,92	10,21
	S 140x3						3,00	6,97		8,82	246,3	35,91	28,69	8,21
	S 140x2,5						2,50	5,88		7,41	209,2	30,43	24,89	7,05
	S 140x2						2,00	4,75		5,96	170,1	24,66	20,64	5,79
	S 140x1,75						1,75	4,18		5,22	149,7	21,65	18,32	5,11
	S 140x1,5						1,50	3,60		4,48	128,7	18,61	15,92	4,42

HEA 160

Geometry

- Depth
- Width
- Web thickness
- Flange thickness
- Inner depth between flanges
- Root fillet radius
- Depth of straight portion of web

Sectional Area

- Sectional area

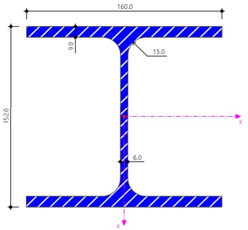
Bending

- Area moment of inertia about y-axis
- Area moment of inertia about z-axis
- Polar area moment of inertia
- Radius of gyration about y-axis
- Radius of gyration about z-axis
- Polar radius of gyration
- Statical moment of area about y-axis
- Statical moment of area about z-axis
- Elastic section modulus about y-axis

h	152.0	mm
b	160.0	mm
t_w	6.0	mm
t_f	9.0	mm
h_i	134.0	mm
r_1	15.0	mm
d	104.0	mm
A	38.80	cm^2
I_y	1670.00	cm^4
I_z	616.00	cm^4
I_p	2286.00	cm^4
i_y	65.7	mm
i_z	39.8	mm
i_p	76.8	mm
max S_y	123.00	cm^3
max S_z	28.95	cm^3
W_y	220.00	cm^3

HEA 160

- DIN 1025-3:1994-03
- Özkan



[mm]

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Annex H Impact of Vegetation and Solar Panel Infrastructure on Rainfall Runoff and Time to Peak

Research on the hydrological impacts of solar farms, including studies by Cook and McCuen and Pennsylvania State University, suggests that the presence of solar panels and vegetation has a minimal effect on runoff characteristics, including time to peak, compared to the existing site conditions, primarily in relation to a vegetated surface.

Cook and McCuen Study (2013) (Ref. 30)
The research, published in the *Journal of Hydrologic Engineering*, aimed to understand the hydrological impacts of solar panels to determine whether stormwater controls are required to manage peak runoff volume and rates.
Cook and McCuen developed a hydrological model which simulated runoff for pre-panel and post-panel conditions. The study conducted a sensitivity analysis to examine the effect of different ground cover types, including grass, gravel, and bare soil, on the surface water runoff characteristics.

The key elements of the study are discussed below:

Impact on Runoff Characteristics: The study found that the introduction of solar panels caused only minor changes in peak runoff volumes, peak discharge rates, and times to peak. When grass was maintained under the panels, there was a non-significant increase in runoff, with peak volume increasing by approximately 0.35% and peak runoff rate by approximately 0.31%.

Time to Peak Delay: The study observed a slight delay in the time to peak—by one time increment, or 12 seconds. This was attributed to the impact of the panels on runoff velocity, although the effect was such that it did not have a significant hydrological impact.

Vegetation and Runoff: The roughness coefficient for grass (0.15) was considered typical for short-grassed areas, such as meadow grass typically used for grazing. The study concluded that with proper vegetation under and between the solar panels, runoff characteristics, including time to peak, remained largely unaffected by the presence of solar infrastructure.

Effect of Panel Angle: The study also examined the impact of solar panel angle on runoff. Runoff velocities increase with slope, so the angle of the solar panel was considered a potential factor influencing hydrologic responses. An analysis was completed for panel angles of 30°, 45°, and 70°, with the assessment representing a range of conditions from winter to summer. The study found that the panel angle had only a slight effect on runoff volumes and discharge rates. Specifically, comparisons between a 45° base condition and angles of 30° and 70° showed only minor variations (less than 0.5%) in results for peak runoff and volume, indicating that panel angle, while it may affect runoff velocities to some degree, does not significantly alter the overall hydrologic response of the DCO Site.

The research by Cook and McCuen noted boundary swales, as well as good, vegetated ground cover, is a suitable mitigation measure to counter any non-significant increase in runoff from a solar panel field.

Pennsylvania State University Study (2024) (Ref. 31)

The more recent study by Pennsylvania State University, titled "*Quantifying Soil Moisture and Evapotranspiration Heterogeneity within a Solar Farm*," examined how solar farms affect soil moisture distribution, evapotranspiration rates, and stormwater management.

The study conducted field investigations of two existing solar farms in Pennsylvania USA where they tested the soil moisture content for various ground covers, including bare soil, gravel, and grassed areas distributed throughout the farms. It was concluded that the introduction of solar panels and vegetation led to no significant change in runoff characteristics and that healthy vegetation can successfully manage surface water runoff from solar farms.

Key findings included:

Vegetation Establishment: The research showed that vegetation established well beneath the solar panels, which would typically be equivalent to a short meadow grass or a grazed field .

Soil Moisture and Evapotranspiration: The study noted that while solar panels can reduce evapotranspiration and alter soil moisture beneath them, these effects were offset by maintaining healthy vegetation and implementing engineered stormwater controls.

Additionally, the Building Research Establishment (BRE) National Solar Centre guidance document "*Agricultural Good Practice Guidance for Solar Farms*" (2014) (Ref. 29) supports the idea that solar farms, particularly those with vegetation maintained underneath the panels, have minimal impacts on runoff.

According to the BRE guidance, solar panel infrastructure typically disturbs less than 5% of the ground. This leaves approximately 95% of the ground area accessible for vegetation growth, which can help maintain or enhance stormwater management, similar to the pre-existing regime.

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According to the BRE guidance, solar panel infrastructure typically disturbs less than 5% of the ground. This leaves approximately 95% of the ground area accessible for vegetation growth, which can help maintain or enhance stormwater management, similar to the pre-existing regime.