PROPOSED DEVELOPMENT OF SOLAR PHOTOVOLTAIC PANELS AND ASSOCIATED WORKS AT WESTHIDE SOLAR FARM, HEREFORDSHIRE

FLOOD RISK ASSESSMENT

J-14440

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Report No.	Issue Detail	Originator	Date	Checked By	Date
01	ERSUN (Westhide SPV Ltd)	LB	02/08/2022	-	02/08/2022
02	ERSUN (Westhide SPV Ltd)	HG	29/11/2022	-	29/11/2022
03	ERSUN (Westhide SPV Ltd)	HG	29/11/2022	-	29/11/2022

For: ERSUN (Westhide SPV Ltd)

Job No: J-14440
Date: November 2022
Edition: 03

CONTENTS

APPENDICES

1 INTRODUCTION

ERSUN (Westhide SPV Ltd) are currently investigating the possibility of the development of a solar PV farm site on land north of Westhide, Herefordshire, HQ1 3QG.

As the site is over 1ha in size it is necessary to produce a Flood Risk Assessment for the site, in accordance with the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) to accompany the planning application.

In addition to this, a pre app was submitted in March 2021 under application reference 211010/CE. Some comments have been made in regard to the flood risk and Sustainable Drainage for the development:

"Drainage considerations

Fluvial Flood Risk Review of the Environment Agency's Flood Map for Planning indicates that the majority of the site is located within the low probability Flood Zone 1. However, areas of the site along the northern boundary adjacent to the watercourse are within Flood 2 and 3, medium to high probability of flooding respectively.

Policy SD3 in the CS deals specifically with sustainable water management and water resources. The policy requires sustainable water management to form part of all new development in order to reduce flood risk; to avoid an adverse impact on water quality; to protect and enhance groundwater resources and to provide opportunities to enhance biodiversity, health and recreation.

As the proposed development is located within Flood Zone 2 and 3 and is more than 1ha, in accordance with Environment Agency standing advice, the planning application will need to be

supported by a Flood Risk Assessment (FRA) undertaken in accordance with National Planning Policy Framework (NPPF) and its supporting Planning Practice Guidance."

In order to address these requirements, Nijhuis Industries have been commissioned to prepare a Flood Risk Assessment for the development, generally in accordance with PPG. The FRA will address the risks of flooding and provide proposals for minimising risks to acceptable levels if practicable.

2 SITE LOCATION AND DESCRIPTION

2.1 Site Location

The proposed solar park development is to take place on land at Westhide, Herefordshire, West Midlands, HR1 3RQ. The Ordnance Survey Grid Reference for the centre of the site is SO 57686 44457. The site location plan is included in **Appendix A** and in Figure 2.1 below.

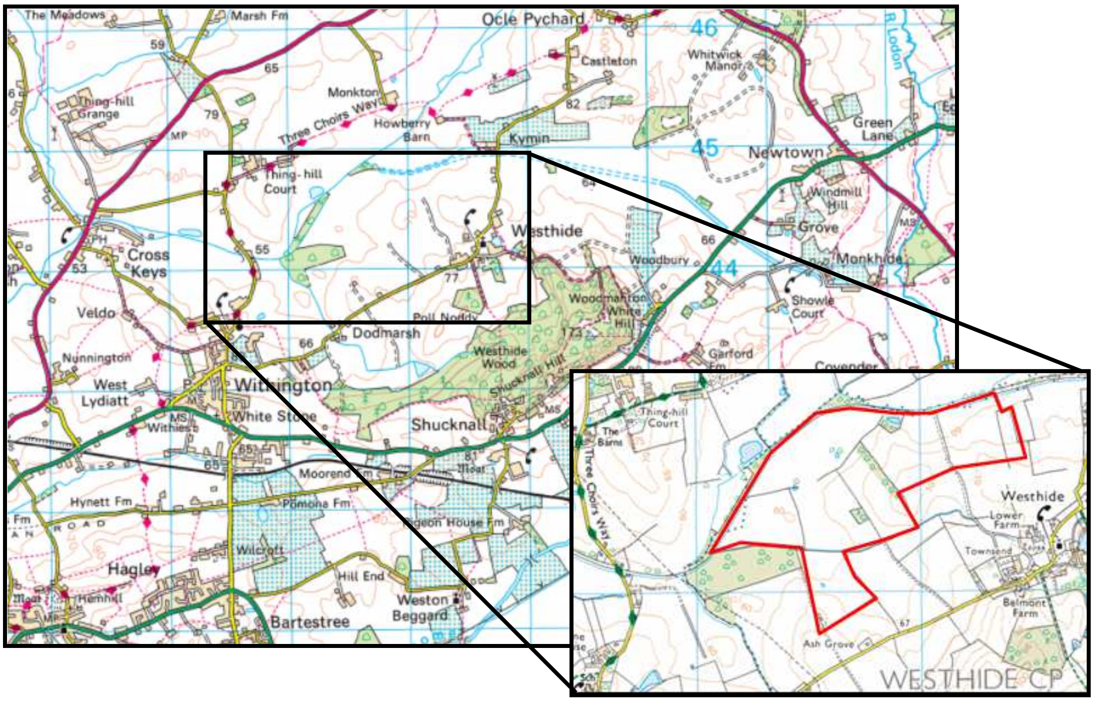


Figure 2.1 Site Location Plan

With respect to topography the site has elevations between 56m AOD and 72m AOD. All elevations are based on site specific topographic survey data.

2.2 Existing Usage

The existing site consists of a grassed area, currently used as agricultural land to the north-western extent of the hamlet of Westhide.

2.3 Proposed Usage

It is proposed to install a solar PV farm and associated infrastructure over an area of approximately 22.5ha. The site is to consist of solar modules supported by a table/racking system, each with support posts. Further landscaping works will be put forward within the design proposal, such as hedging, fencing and planting arrangements.

2.4 Existing Hydrology

The development site is located in an area of relatively flat countryside. The surrounding area comprises mainly of agricultural land and small hamlets. There is a watercourse at the northern boundary which comprises of a network of tributaries to the River Cale.

3.0 FLOODING MECHANISMS

A number of possible flooding mechanisms have been considered at the site and are discussed below.

3.1 Groundwater Flooding

There are limited sources of information available to assess groundwater flood risk as groundwater risk mapping is still in its infancy. Groundwater levels can be affected by periods of sustained heavy rainfall which can cause levels to rise, potentially resulting in periods of sustained flooding. This mechanism of flooding can be related to the presence of aquifers.

The Herefordshire Council Strategic Flood Risk Assessment (SFRA) states;

“Records of groundwater flooding in Herefordshire are limited. However this is likely to be because groundwater flooding is often perceived as surface water flooding as is therefore not accurately recorded, rather than groundwater flooding not being a potentially significant source of flood risk.”

“Groundwater flooding will typically occur in permeable geology such as sand and gravels that allow for the relatively free movement of groundwater, often responding to rising river levels if located in close proximity to a watercourse or following extended periods of rainfall that will cause groundwater levels to rise. A review of superficial and bedrock geology available through the British Geological Survey (BGS) can therefore provide an indication of where groundwater flooding is most likely to occur.”

MAGIC mapping data online have produced maps that show the groundwater vulnerability of areas across the UK. This mapping system shows that the site straddles two risk categories and therefore there is a Medium to High vulnerability of groundwater flooding at the site as seen in **Figure 3.1** below.

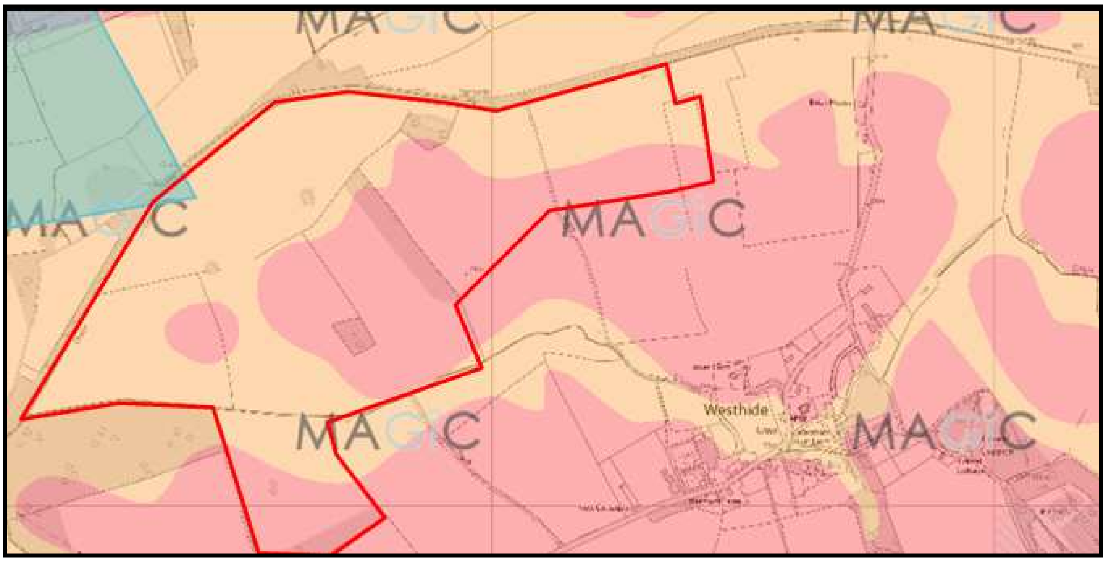


Figure 3.1 MAGIC Map ground water vulnerability Map

The Cranfield Soil and Agrifood Institute (CSAI) Soilscapes map displays the type of soils within the site location.

As shown below in **Figure 3.2** the subject site is composed of several soil types, including “*Slightly acid loamy and clayey soils with impeded drainage*”, this was further confirmed by percolation testing on site which failed to drain. Furthermore, no groundwater was encountered within the trial pits.

Given the nature of the development, with vulnerable infrastructure raised above the ground level, it is considered that groundwater flooding does not pose a significant risk to most of the development site. Therefore, groundwater flooding will not be considered further within this report.

3.2 Overland Sheet Flow

The catchment area upstream of the development site consists mainly of greenfield. As such the potential for overland flow that can directly affect the site is considered to be small. The site is covered with permeable ground which provides varying degrees of infiltration depending on the subsoil; these factors will serve to reduce the potential for overland flows to develop.

The Environment Agency Risk of Flooding from Surface Water map, as shown below in **Figure 3.3**, indicates that the site largely is not at risk of Surface Water Flooding, but there are areas to the north-west at 'low' risk of surface water flooding. The flooding is below a depth of 300mm, and the site is not at risk during a high-risk scenario.

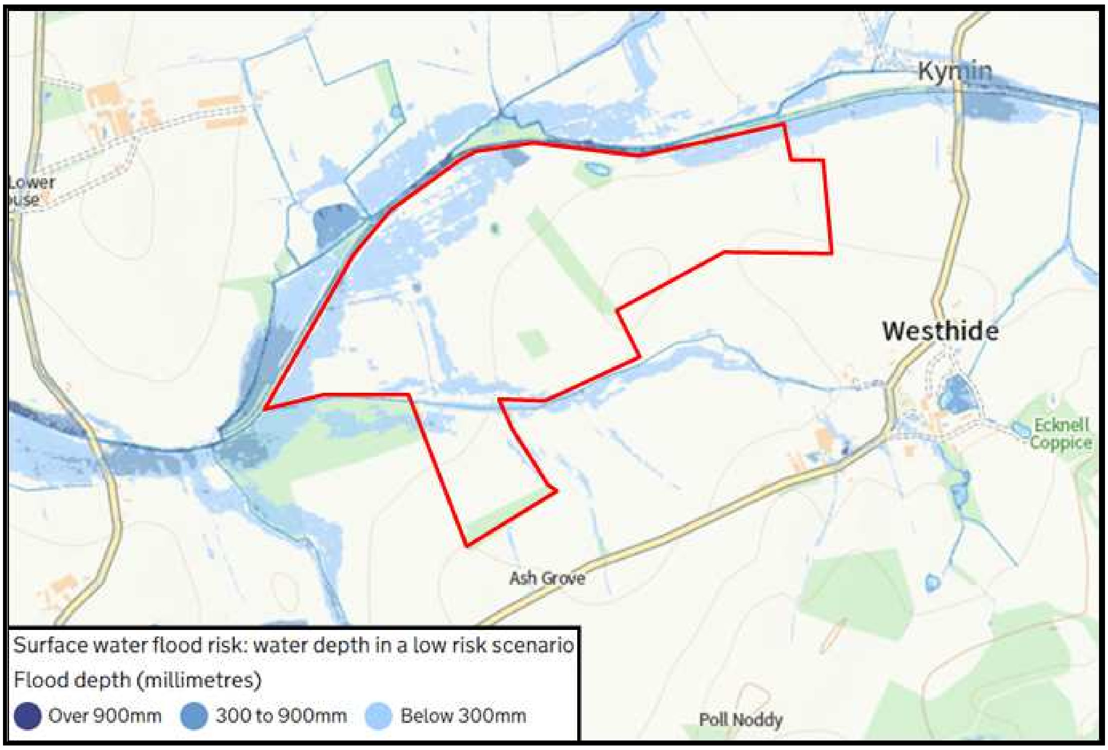


Figure 3.3 Extract from EA risk of surface water flooding map

Given the assessed overall low risk of flooding on the site, and the nature of the development infrastructure being at least 0.8m above the ground, it is considered that surface water flooding will not cause issues relating to the operation of the site and will not be considered further within this report.

3.3 Fluvial (River) Flooding

The site is shown to be partially located within Flood Zone 3 (high risk). Therefore, fluvial flooding will be considered further within this report.

Figure 3.4 Extract from EA Flood Map for Planning

3.4 Tidal Flooding

The site is shown to be located approximately 37 miles from the sea. Therefore, tidal flooding will not be considered further within this report.

3.5 Flooding as a Result of Development

The proposed development has the potential to introduce impermeable area around the site where the land was previously permeable. This could have the potential to increase the runoff rates across the site which could increase the flood risk to adjacent sites.

The drainage system need only contend with the volume of runoff from this area to ensure flood risk is not increased, however, additional storage should be provided to allow for inconsistencies and provide betterment. The potential for a sustainable drainage system to be installed within the development is outlined further below in this report.

3.6 Land Usage Effects On Flood Risk

Changing the site’s primary function to solar power generation will have benefits regarding runoff rates if there is an inclusion of drainage features.

The drainage features would provide betterment to the existing situation in terms of runoff rates and flood risk.

4.0 HYDRAULIC MODELLING

A hydraulic model was built using Infoworks ICM modelling software. ICM uses a 2D mesh to represent the modelled surface and is generated using a ground model and relevant polygons. These features define the ground levels, roughness and infiltration values in each element within the mesh.

4.1 Data and Information

A combination of data sets was used to create a digital terrain model covered by the ICM model.

Light Detection and Ranging (LiDAR) data at 1m resolution was obtained to create a base for the DTM of the site

River cross sections were surveyed by SLR Consulting Ltd giving accurate representation of the river geometry.

The extent of the modelled watercourses was specified to enable the model to account for a suitable length of floodplain upstream and downstream of the subject site. This was necessary to ensure out-of-bank flows were stable and representative.

4.2 Technical Approach

The model has been developed in InfoWorks ICM, incorporating a 1D river reach, 1D river structures (culverts & bridges), and a 2D topographic surface to replicate the flood plain.

4.3 Model Extent

The model extents were determined to encompass sufficient upstream and downstream boundaries as to accurately represent the dynamics of the watercourses. These included 4 upstream boundary inflows and 1 downstream boundary.

The inflow point was defined at the upstream end of the river reach.

The downstream boundary is set approximately 1139m downstream till A465. No specific river level has been applied (i.e., a free discharge has been assumed) since the model has been extended sufficiently far past the development site (in order to incorporate a number of tributaries to the River Cale. The total model extent is shown below in **Figure 4.3.**

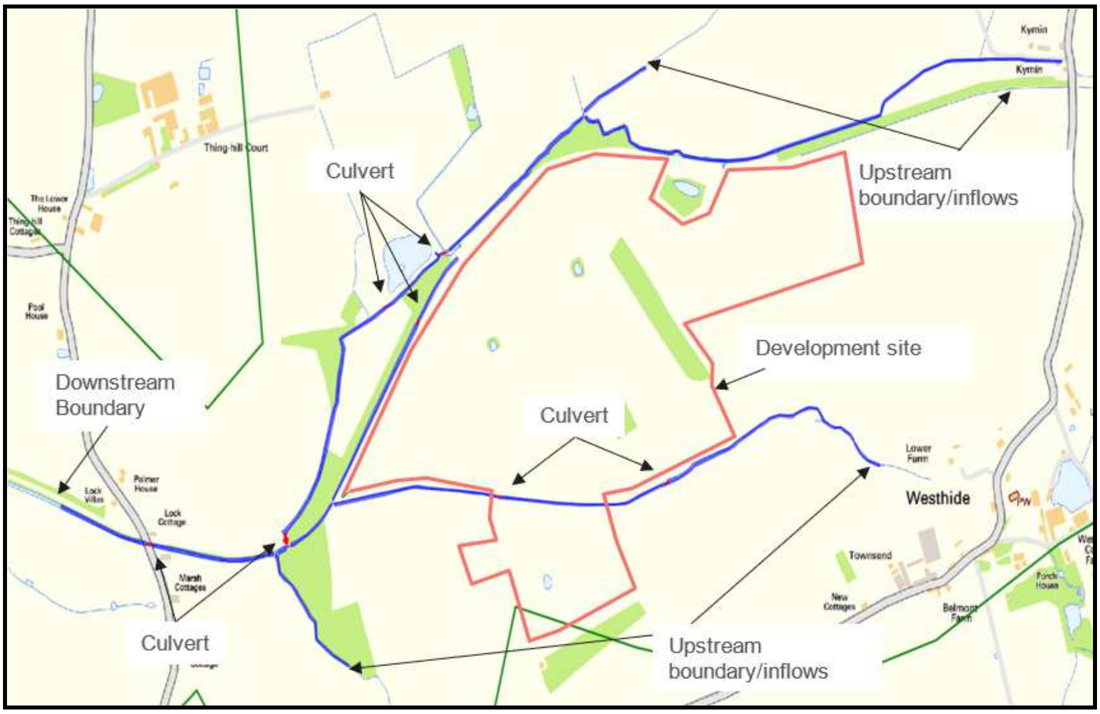


Figure 4.1: ICM Model Extents

4.4 Channel Geometry and Profile

The surveyed cross sections were used to define the channel geometry. Bank lines were manually delineated connecting the cross-section lines, with reference to the 'banks' observable within LiDAR data, reference aerial imagery, and site walkover photos.

4.5 2D Model

4.6 Culverts and Structures

A total of 8 structures were included within the modelling, comprising of 2 bridges and 6 culverts. The structures are tabled below;

Culvert / Structure	X	Y	Model Representation
Bridge next to Lock Cottage	356655.09	244107.19	4700 wide x 2284 mm high. Mesh zone added to represent the deck.
D/s of Lock cottage at section 7	356973.08	244100.74	2000 wide x 2084 mm high
Bridge next to the pond at section 12	357193.32	244539.45	1410 wide x 1450 mm high
Piped overflow to the pond	357335.09	244643.07	2*300mm diameter pipe
Culvert DS of section 29	357271.01	244518.13	2*300mm diameter pipe
Culvert DS of section 33	357454.09	244192.99	1*300mm diameter pipe 1*700mm diameter pipe
Culvert DS of section 36	357838.79	244220.44	1000 wide x 501 mm high
Culvert DS of section 38	358260.86	244292.32	250mm diameter pipe

Table 4.1: Culverts and Structures

4.7 Catchment Topography

A 2D mesh was generated using the LiDAR elevation data. The key parameters applied are shown below in **Table 3**.

Parameter	Value	Justification
Maximum triangle area	50 m	Considered to provide sufficiently coarse spatial resolution
Minimum triangle area	10 m	Provides flexibility to account for fairly flat terrain
Terrain sensitive meshing	Yes	-

Table 4.2: 2D Mesh Parameters

4.8 Structures and Buildings

The cottage and workshop buildings have been added as a polygon void.

Boundary Conditions

The upstream boundary of the model has been defined using a total of 4 inflows (See Section 5). The inflow point was defined at the upstream end of the river reach.
The downstream boundary is set approximately 1139m downstream till A465. No specific river level has been applied (i.e., a free discharge has been assumed) since the model has been extended sufficiently far past the development site (in order to incorporate a number of tributaries to the River Cale.

4.9 Hydrogeological Parameters

The impact of surface roughness on flood depths and conveyance in this location was considered to be negligible. As a result, the 2D model roughness has been set to 0.035mm, representing the fields, and no spatial variation has been considered.

No infiltration parameters have been applied to ensure a conservative approach to predicting flood depths.

5.0 HYDROLOGY

An inflow file representing the 1 in 100-year plus climate change event (+40%) was derived using FEH13. In order to account for the various inflow points and the increase in flow across the model, a total of 4 inflow hydrographs were used.

5.1 Validation/Benchmarking

The ICM Model outputs have been compared to the EA Flood Map for Planning shown below in **Figures 5.1 and 5.2**.

While there are some differences in the flood extent at the north and south of the model, the extent and depth of flooding in the area of the development site is well correlated, demonstrating that upstream flow rates and the representation of the local topography is relatively comparable.

The overall level correlation is considered suitable for the assessment of flood risk at the development site.

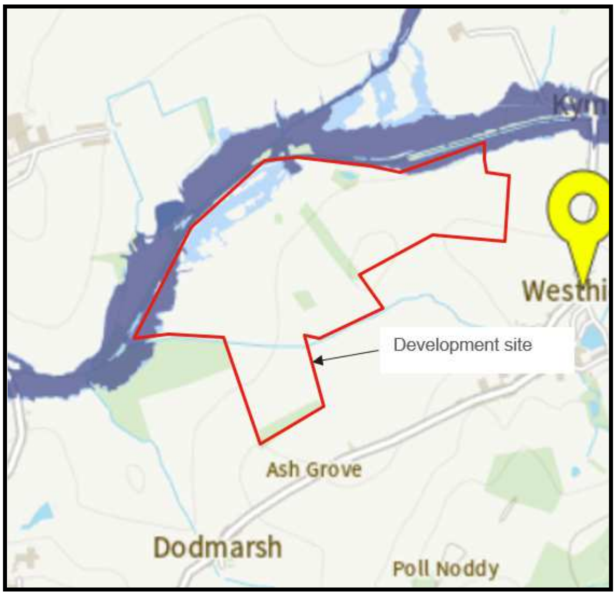


Figure 5.1: EA Flood Map for Planning

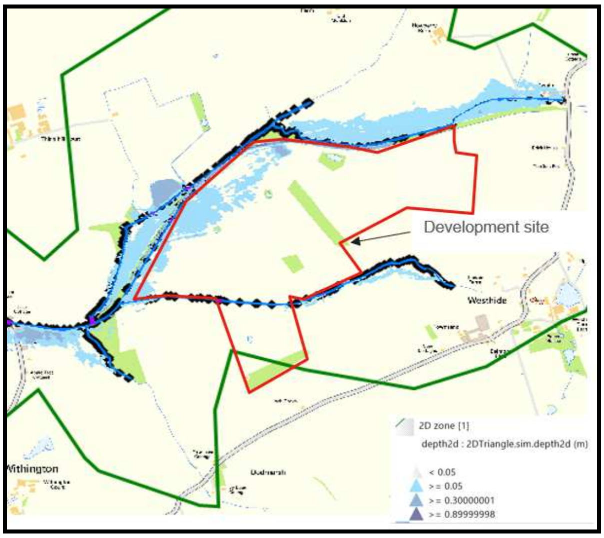


Figure 5.2: ICM Model Flood Extents

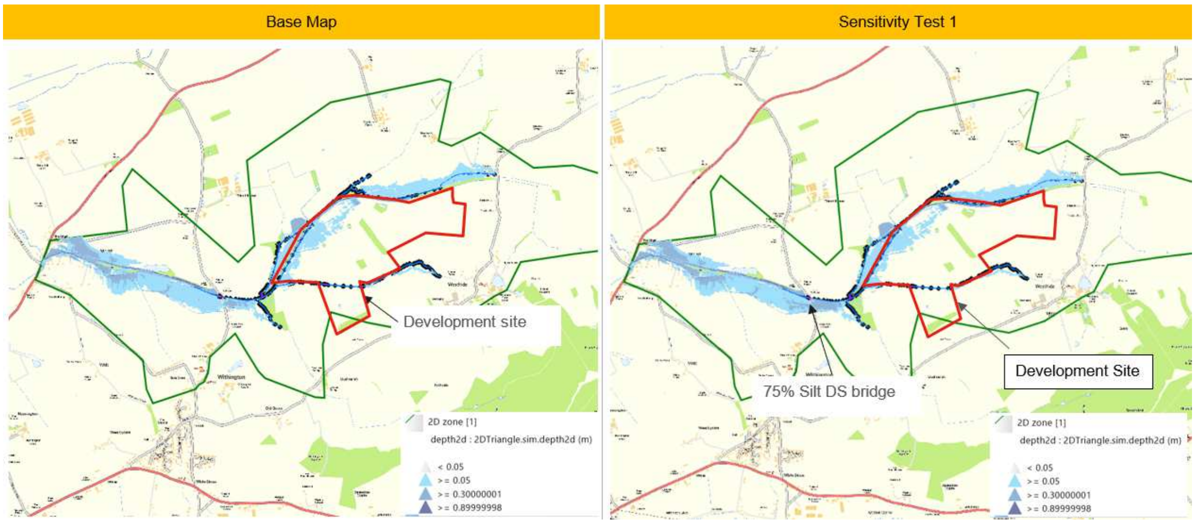
5.2 Sensitivity Testing

Sensitivity tests have been carried out to ensure model parameters applied are robust and realistic. There are two sensitivity tests which have been carried out, as follows:

1. Sensitivity Test 1- Blockages
2. Sensitivity Test 2: River reach roughness

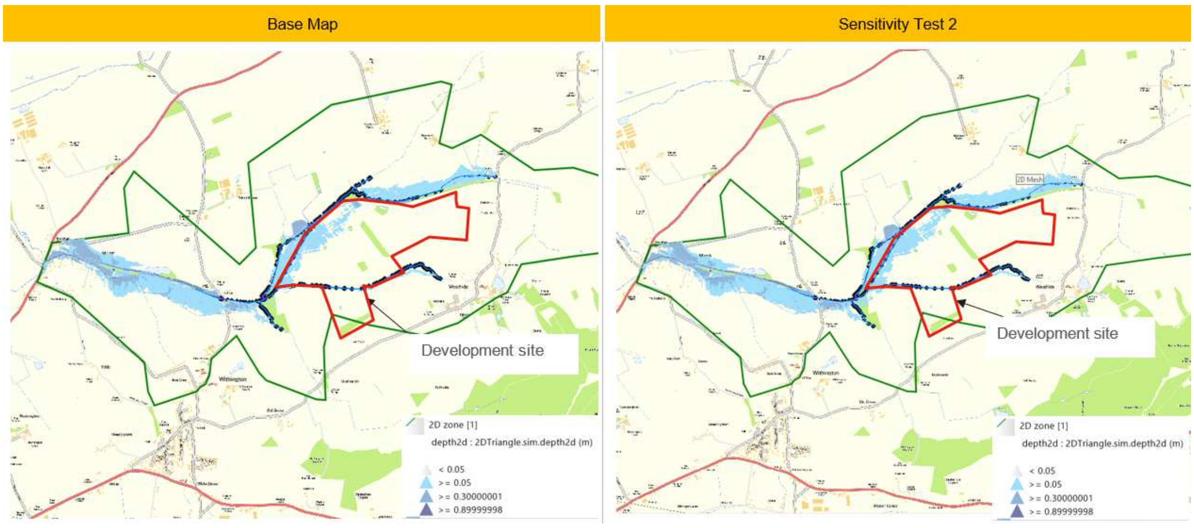
5.2.1 Sensitivity Testing 1

The DS bridge was blocked by applying sediment equating to 75% of the opening height. The predictions show that the blockage resulted in an increased depth in the downstream but had limited effect on the development site .



5.2.2 Sensitivity Testing 2

The roughness of the river reach was increased to 0.045mm. The predictions show only a slight increase in floodwater extent around the location of the new development.



5.3 Limitations and Uncertainties

The primary limitations of the model and the uncertainty that they cause have been outlined in the following table:

Limitation / Assumption	Details	Impact on Model Predictions / Confidence
Lack of detailed structural information on the bridges/culverts in the model area	No dimensional information available to accurately represent the structures, conveyance capacity, and impact of flooding	Potential to change flood predictions, however, peak flood levels at many of the culverts/bridges are relatively close to overtopping, limiting the potential impact of any restriction to flow.
No spatially varying 2D roughness applied	-	Not considered to significantly impact flood predictions
No 2D infiltration applied	-	Conservative prediction of flooding since the model experiences no losses (representing a fully saturated catchment)
Resolution and accuracy of LiDAR along watercourse	The accuracy along vegetated sections of the channel can produce spurious elevation levels and smooth out depressions	Reduced accuracy of channel bank levels and adjacent 2D levels
Assumed cross section	The cross section in between the surveyed cross sections have been assumed to provide proper gradient.	The assumed sections are interpolated based on the upstream and downstream section and may not represent the actual site condition.

Table 5.1: Model limitations and uncertainties

6.0 FLOOD RISK ASSESSMENT

An analysis of the risk posed to the proposed solar farm development on land north of Westhide has been undertaken to define the flood plain extent and to determine the critical depth of flooding during the 1 in 100yr + CC storm event.

The Environment Agency data did not provide sufficient detail to facilitate an accurate assessment of the site, consequently an ICM Infoworks Hydraulic Model was produced to define an accurate flood plain and to determine potential depths of flooding at various strategic locations across the site.

The outputs of this model show the depth of water across the local floodplain when the overtopping scenario was run. We have added the solar site outlined in green to be representative. This can be found in **Appendix B** and is shown below in **Figure 6.1**.

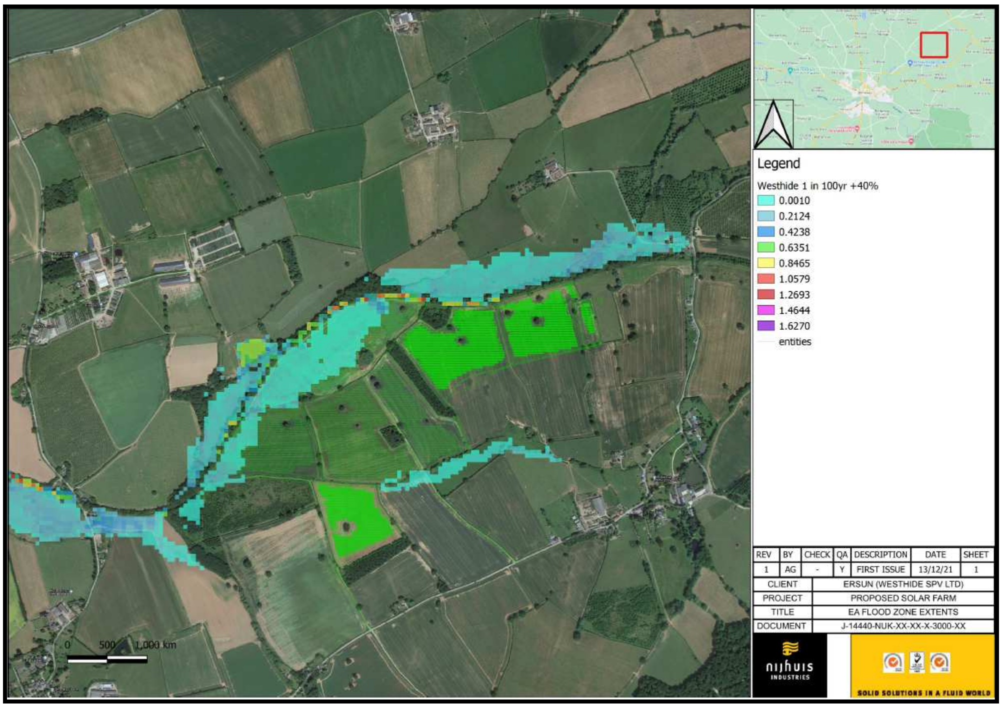


Figure 6.1: Overview Flood Extent Map

In general the majority of the site is within Flood Zone 1 and not at risk of flooding. As indicated by the EA flood maps, the northern extent is at risk of flooding during the 1 in 100 year flood event plus 40% climate change, as well as a very small area of the southern portion which only effects approximately 5 tables.

The flooding experienced within the site itself is minimal and generally indicates a maximum potential flood depth during the 1 in 100year + CC flood event of **0.21m**. As the panels in this location are expected to have a minimum height above ground level of 0.8m there is not anticipated to be any impact by this intensity storm event. Furthermore, all inverters, substations and containers are located in Flood Zone 1.

7.0 FLOOD MITIGATION MEASURES

The following mitigation measures are proposed to minimise the impacts of potential flooding to the solar park infrastructure in the case of an extreme flood event. As panels and the inverters, substation and containers are all above the flood zone or in flood zone 1, the mitigation measures are in regards to the rest of the site.

- All Services (cabling etc) should be designed and installed to be flood resilient / water compatible. This should be achieved in accordance with appropriate design standards and best practise guidance.

- The panels will be supported by piles which are adequately spaced to allow for the free flow of water between them. Structural assessment should be undertaken to ensure the panel supports can resist additional dynamic loadings induced by a flood event.

- The security fencing mesh sizing should be made as large as reasonably practical to ensure free flow of flood water through the fence and reduce the possibility of debris build up affecting flow routes.

- A SuDS scheme to manage surface water runoff is outlined in **Section 8** of this report.

- If flood water is present on the site, construction and maintenance operations should be avoided. A suitable risk assessment should be undertaken to assess whether it is safe to access the site, during a flood event. Given the infrequent nature of the maintenance requirements for a PV site, it is highly unlikely that maintenance would occur at the same instance as a flood event. Maintenance can be re-scheduled if a flood warning is in place.

- During the construction phase of the project materials, equipment and site services should be located in Flood Zone 1 (Low Risk Areas) when practicable.

The site has the potential to be a contamination risk as spoil present during construction could enter the watercourse during a flood event. There are a number of measures that should be undertaken to prevent this occurring including (but not limited to);

- Preventing soil from being washed off-site through surface water run-off or fluvial influences;

- Loose spoil stored off-site in Flood Zone 1 if possible;

- Excavated material for swales to be permanently removed to provide compensatory storage.

7.1 Effect on Adjacent Sites

The extent of the impermeable areas introduced across the site by the proposed development is relatively small. Therefore, any additional runoff from the impermeable areas will be small and more than adequately could be managed by an appropriate SuDS. As such there will be no impact on the nearby watercourses and neighbouring sites as a result of the proposed development.

In addition, the pragmatic approach to the design of the SuDS will provide an improved storage and interception capacity. This capacity will reduce any potential flood risks to adjacent sites that are created by surface water runoff, when compared to the pre-development situation.

8.0 SUSTAINABLE DRAINAGE SCHEME (SUDS)

8.1 Overview

SuDS is a concept that incorporates long term environmental and social factors in order to design surface water drainage systems, in accordance with the ideals of sustainable development. SuDS takes into account the quantity and quality of surface water runoff, and the value of surface water to the urban and rural environments. Many existing urban drainage systems can cause problems of flooding, pollution or damage to the environment, so it is the aim of the SuDS to avoid this in the future.

Most proposed urbanisation creates impermeable surfaces which will need drainage solutions to remove surface water runoff. Traditionally, it is only quantity of flow that has been accounted for in drainage solutions, preventing floods locally by conveying the water away from the site swiftly in underground pipes. These traditional methods frequently alter natural flow patterns which can lead to problems elsewhere in the catchment area. More recently, water quality issues must be accounted for, in order to avoid pollutants from urban areas being transported into rivers or groundwater.

Other aspects, such as water resources, community facilities, landscaping and provision of wildlife habitats have been largely ignored; a well-designed and well managed SuDS can offer the following benefits:

- management of runoff flow rates, reducing the environmental impact of urbanisation
- maintenance or enhancement of water quality
- consideration to the requirements of the local community
- enhancement of biodiversity in urban watercourses
- maintain the natural groundwater level

8.2 Design Standards

Design of the site drainage infrastructure and Sustainable Urban Drainage System (SuDS) is to be carried out in line with best practice and to industry standard design procedures. A number of publications, including design guidance and best practice guidance will be applied to different components of the final infrastructure. The sections below provide an overview of the design standards to be used on this project for various aspects of the infrastructure design.

8.3 The CIRIA SuDS Manual

This document is a comprehensive publication covering design, construction, operation and maintenance of SuDS. The advice and best practice outlined in this document has been utilised in the design of the site SuDS features, which have been detailed in this report.

8.4 Building Regulations Part H

Building Regulations Part H ‘Drainage and Waste Disposal’ covers the design and installation of surface water and foul water systems. All private drainage including pipes, manholes, down pipes, and other drainage infrastructure on the site should be designed and installed in accordance with this document.

8.5 The Wallingford Procedure

Developed by HR Wallingford, this publication covers the design of urban drainage systems. In addition, the document includes regional rainfall data for use in design for varying return period events.

Basic sizing calculations for the swales and the estimation of the runoff volumes have been made using this method.

8.6 National Planning Policy Framework

The National Planning Policy Framework (NPPF) contains the policy relating to the appropriate assessment of flood risk within the UK. The associated technical guidance provides further details on the definitions, classifications and constraints used to apply national policy to new developments.

It contains details on flood zone definition, site specific FRA's, vulnerability classifications, appropriate development, climate change allowances, residual risk management, flood resilience, the sequential test and the exception test.

8.7 Percolation Testing

In order to determine a suitable drainage strategy, percolation testing was undertaken in late May 2021 in two locations.

Both trial pits failed to drain sufficiently and drained approximately 0.003m in 5 hours. Therefore, it was determined that an infiltration based drainage scheme would not be suitable for the development and as such, an attenuation based scheme will be outlined utilising the nearby watercourses.

During the design of the conceptual SuDS layout, it is considered that the primary function of the SuDS will be the interception and storage of water until such time as it evaporates or conveys to the nearby watercourses/ditches.

8.8 Environmental Considerations

The nature of the development means that runoff could originate from the solar panel arrays, solar panel pile system and inverters. The runoff from the panels poses a low environmental risk. It has been assumed that any additional foul/industrial waste from the maintenance and operation of the park will be disposed of elsewhere.

The use of heavy plant on wet scrubland may cause the topsoil to be disrupted which in-turn can pose a pollution risk to the local River. Although the swales may provide some benefits, it is advised that silt fences are installed during the construction phase of the project to intercept silt laden runoff, if construction traffic or adverse weather is likely to cause damage to the topsoil.

9.0 SUDS DESIGN

Since the solar panels are located on a sloped frame between approximately 0.8 on the lowest edge and generally more than 2m at the higher edge above ground level, it is anticipated that rain falling on each solar panel table will run off the panels and flow/infiltrate in the sheltered rain shadow area underneath the down-slope modules. A minimum of 10mm gap surrounding the panels will allow water to drain off each module. 9m buffer strips from watercourses and ditches were included as part of the design.

The SuDS design will not consider the runoff from the access and maintenance roads as these will be constructed of grass tracks/unbound crushed stones/gravel or similar permeable materials, which will allow infiltration of water on these areas. The access roads will, therefore, not increase surface water runoff rates from the site.

Following consultation with the LLFA the SuDS scheme has been revised. The LLFA have requested that the calculations should be based on the overall solar panel area being impermeable. As such the SuDS is outlined below.

The proposed SuDs have been designed as per the guidance in Herefordshire Council SuDS Handbook with particular reference to Section 8.2 for polytunnels and solar panel development.

Based on the proposed layout and following the LLFA request the impermeable area of the site is considered to be 118,679m^2.

The greenfield runoff rate for the site based on the impermeable area has been calculated using ICP-SuDS to be 88.0 l/s as such the flow for the site will be restricted to this.

Using the impermeable area and proposed flow control rate of 88.0 l/s the proposed attenuation basin is to have a surface area of 6,000m^2 with a depth of 1.5m, this is sized for the 1 in 100 year event with a 50% allowance for climate change. This basin is to be located in Field C and will discharge into the nearby ditch/watercourse.

The basin should have a 500mm bund around the top to act as freeboard.

It is proposed that the surface water from the site will be collected within ditches, swales and French drain/conveyance trenches across the site that will provide further storage and will act as conveyance to the basin.

The use of pipes has been restricted where possible but is noted to be unavoidable in some areas. These are detailed on the drawing.

It is proposed that all outfalls and inlets are fitted with trash screens to prevent any debris entering any of the proposed pipework.

The details showing surface water management features are outlined in **Drawing 3001** in **Appendix C**.

It is considered that the proposed SuDS are conservative approach to the impact that a solar site has on the greenfield rates and the runoff post development.

It is recommended that as part of the planning permission a condition relating to the maintenance and management of the surface water drainage scheme is applied. This will ensure that a robust and stringent plan for the site can be implemented to ensure optimal performance of all elements of the SuDS for the site.

9.1 Mitigation of Channelisation

The surface water usually flows from the surface of the solar array to the areas in between the rows with an increased kinetic energy. This leads to an increased concentration of surface water and erosion in these areas and has the potential to create channelised flows, eroding the soil further and increasing the volumes and rates of surface water discharge. Therefore, necessary mitigation is required to combat this effect and it should be demonstrated that whatever land management techniques are being used to ensure that the land maintains or improves its current infiltration potential include small amounts of storage too.

Maintaining vegetative areas in between the solar arrays at a long length to help interrupt and slow the channelised flows, reducing erosion and also enhance and promote the infiltration and interception capacity.

Mitigation of channelisation:

- An enforceable and robust soil, grass, and/or land management plan to keep land in good condition is key. Where possible bare ground or gravel should be avoided.
- The incorporation of bunds to help interrupt and slow the channelised flows, enhance and promote the infiltration and interception capacity, and to help spread the water over a greater surface area.
- After construction the soil should be chisel ploughed, or similar, to mitigate soil compaction during construction. This will ensure that the site can infiltrate to its potential.
- During the first few years it is important to hold frequent inspections of the planting and soil to ensure it is growing properly, isn’t bare and isn’t compacted.
- Any remedial work should occur as soon as possible.

9.2 Summary

Percolation testing was conducted onsite and proved to be poor. Therefore, a series of conveyance swales/drains have been outlined connecting to a proposed attenuation basin. With 9m watercourse/ditch buffer zones included in the design.

The impermeable area of the site has been dictated by the LLFA and therefore the SuDS design has been chosen to reflect this.

A set of recommendations to mitigate channelisation of surface water flow outlined.

To ensure that the introduced structures do not impact nearby watercourses and neighbouring sites, a full SuDS has been proposed for the site, including an attenuation basin to make sure the outflow rate is controlled.

10 POLICY SUMMARY

The development has been shown to be partly located within Flood Zone 3. In accordance with Planning Practice Guidance (PPG) Table 3, a development of this type *"Essential utility infrastructure"* is deemed to be subject to the Sequential and Exception Test (see Figure 8.1 below).

It is also noted that; *''In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.''*

This has been addressed within the surface water drainage and mitigation measures illustrated above within this report.

Flood Zones	Flood Risk Vulnerability Classification				
	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 *	Exception Test required *	✗	✗	✗	✓*

Key:

✓ Development is appropriate

✗ Development should not be permitted.

Figure 10.1 PPG Table 3

With respect to the NPPF & PPG it would appear that the site could be developed, although it would be necessary to demonstrate that no reasonably developable sites are available in lower risk flood zones in order to pass the sequential test. However, it should be noted that the strict requirements for the placement of a solar PV site (i.e. distance from the sub-station, visual impact etc.), finding an alternative site would likely prove difficult. Paragraph 3 of PPG states:

"The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones as refined in the Strategic Flood Risk Assessment for the area provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding).

Although now superseded by the NPPF, the previous PPS 25 provided planning guidance in relation to flood risk and it is considered that certain sections are still relevant. Paragraph 4.39 of PPS 25 states the following specifically regarding renewable energy projects which is not covered in the NPPF:

"Specific national planning policy in Planning Policy Statement 22 Renewable Energy advises how, given the particular factors that relate to renewable energy projects, LPAs should not use a sequential approach in the consideration of such proposals."

As such this suggests that a renewable energy proposal such as this one should not be subject to the Sequential Test.

When assessing a potential site and selecting suitable fields, developers must consider a large number of environmental and technical assessment criteria. These must converge in order to make a site suitable for solar PV development.

Two of the three fields included in the amended Westhide scheme contain flood plain sections. The reason for selecting these fields in favour of other neighbouring fields (that have no flood plain sections) is due to the weight being given to other aspects of suitability; and in this case, namely agricultural land grade and landscape and visual impact.

Fields C and F consist of ALC grade 3b soil and as such (and as per planning policy and guidance) are deemed preferable for solar development than other neighbouring fields, which consist of higher-grade land (grades 1 and 2).

Fields C and F are also very well screened by existing planting and very well contained within the local landscape, meaning that a proposal in these fields would have less impact than on other neighbouring fields.

This report also demonstrates that flood risk can be successfully managed in these fields, thereby making these fields suitable for a solar scheme.

It is for these reasons that it is considered necessary that the solar scheme is located in a flood risk area for operational reasons.

As the site is classified as ‘essential infrastructure’, the development is therefore also subject to the Exception Test.

NPPF Paragraph 102 states *“If following the application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate. For the exception test to be passed:*

- *It must be demonstrated that the development provides wider sustainability benefits to the community that outweighs flood risk.*
- *The FRA must demonstrate that the development will be safe over its lifetime given the vulnerability of it users.*

It would appear that this development would meet the requirements of the Exception Test (including wider sustainability benefits demonstrated within other supporting documents in the planning application), provided the mitigation measures recommended in this report are adopted.

11 CONCLUSIONS AND RECOMMENDATIONS

The proposed development is shown to be partially located within Flood Zone 3 according to EA flood mapping.

The site level has a maximum elevation of 56m AOD dropping to 72m AOD.

An ICM Infoworks model has been constructed with a view to quantifying the risk of fluvial flooding during a 1 in 100 year plus + 40% Climate Change event.

The production of the model has shown that during the 1 in 100year + CC fluvial flood event, the maximum predicted flood depth is **0.22m.**

The panels are situated a minimum of 0.8m above the ground level and as such are not at risk of flooding. Furthermore, all inverters, substation and the containers are within Flood Zone 1 and free from flooding. It is therefore anticipated that all vulnerable infrastructure is outside of the flood zone extents.

The study has identified a number of mitigation proposals to reduce the risk of flooding to the areas in the flood zone to an acceptable level. These include:

- Sufficient spacing between the piles supporting the panels to minimise flow disruption during a flood event.
- The security fencing mesh sizing should be made as large as reasonably practical to reduce the chance of blockage and obstruction of flow routes.
- No structures would be placed in 9m buffer zone around the watercourses and ditches, in accordance to waterboard recommendations.

This study has investigated the impact that the development will have on runoff rates from the site. The SuDS for the site has been designed following comments from the LLFA. This has resulted in the entire development be considered as impermeable and therefore an attenuation basin has been design for the runoff from the site with an outfall into the nearby ditch/watercourse.

A proposed development either entirely or partially within Flood Zones 2 or 3 would be required to pass the Sequential Test; demonstrating that there are no other reasonably developable sites at a lower risk of flooding. However, where NPPF does not cover areas within the superseded PPS25, then PPS25 is still considered relevant. Paragraph 3.49 of PPS25 states that renewable energy projects such as this do not require the application of the Sequential Test.

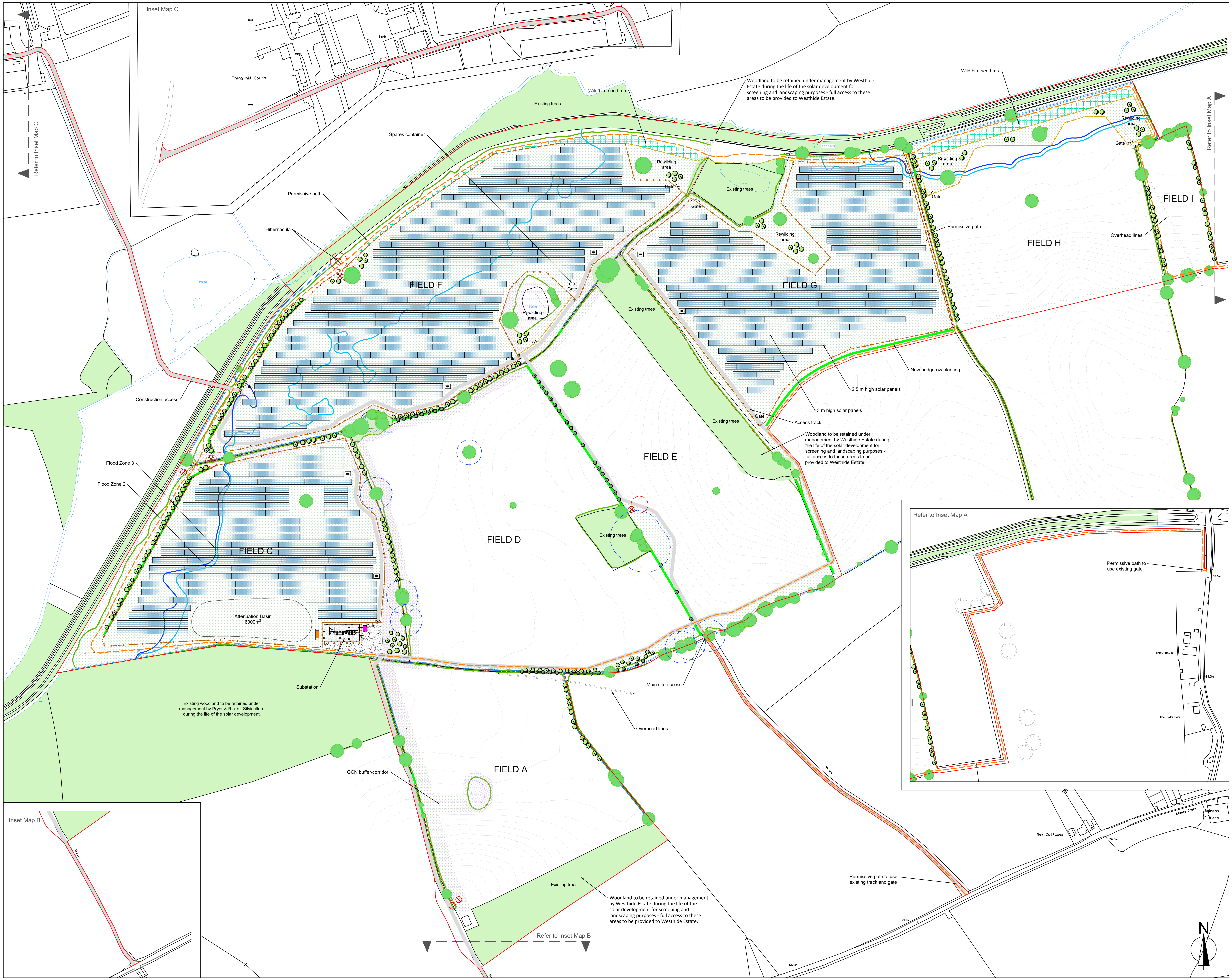
The proposed development is classified as ‘essential infrastructure’, in which the development would be required to pass the Exception Test before being deemed appropriate. It is anticipated that the site would pass the Exception Test as it provides wider sustainability benefits and can be developed safely with regards to flood risk (as set out in **Sections 5-7**).

It is clear there are a number of potential flood risks at the site. However, if appropriate mitigation measures are considered/implemented during the detailed design stage of the project based on the flood depths and development proposals, it is anticipated that the flood risks can be suitably mitigated.

It is considered that the flood risk to the site can be managed, and the site can be developed safely.

The ICM Infoworks ICMT files have not been included within this submission but will be supplied to the Environment Agency directly upon request.

APPENDIX A SITE LOCATION



GENERAL NOTES:

1. ALL DIMENSIONS AND LEVELS SHALL BE CHECKED ON SITE PRIOR TO CONSTRUCTION WORK COMMENCING.
2. ALL LANDSCAPE DRAWINGS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEER'S AND ARCHITECT'S DRAWINGS AND SPECIFICATIONS.
3. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH THE LANDSCAPE SPECIFICATION.
4. ANY DISCREPANCY CONCERNING THE DRAWINGS SHOULD BE REFERRED TO THE CA IMMEDIATELY.
5. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
6. ALL LEVELS IN METRES.
7. DO NOT SCALE OFF THIS DRAWING.
8. EXISTING SERVICE ALIGNMENTS SHALL BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO CONSTRUCTION WORK COMMENCING.

Site boundary

Existing

- Existing woodland
- Existing tree (surveyed)
- Existing hedgerow (surveyed) all to be retained and enhanced to 3m high winter cut height
- Existing overhead utility/electricity lines (surveyed)
- Existing water course / pond
- Existing tree planting retained and enhanced
- Buffer zone for ancient and veteran trees
- Flood zone 2
- Flood zone 3

Proposed

- Proposed tree planting (*Indicative - refer to Landscape Mitigation and Enhancement Plans*)
- Poor quality trees to be removed (please refer to arb survey, drwg # 210409-WSS-SP-AM)
- New species-rich hedgerow planting
- Proposed species-rich grassland
- Proposed wild bird seed mix grassland (0.5 ha total)
- Great Crested Newt (GCN) ecological buffer
- Hibernacula
- 2.5 m high post and wire fencing to have mammal gates for mammal access
- 2.4 m high palisade fencing *(around DNO customer substation)*
- 1.2 m high timber post and rail fencing *(to rewilding areas)*
- Access track
- CCTV camera
- Inverter transformer unit
- DNO switch housing
- Customer substation
- Substation hardstanding
- Proposed solar panels 2.5 m high
- Proposed solar panels 3 m high
- Permissive path

DRAWING NOTES:

Field G to have 2.5 m high solar panels along the southern edge. 3m high solar panels to be used elsewhere.

During the design development process Field B was removed from the proposals and, therefore, it is not shown or referred to on the Masterplan.

Rev:	Date:	Description:	Drawn	Ch'd
A	21/09/2021	Ecology and landscape additions as per comments	GS	JH
B	04/10/2021	Site access and permitted path amended as per comments	GS	JH
C	01/11/2021	Contours added	GS	JH
D	16/11/2021	Substation relocated and redline boundary updated. Minor amendments as per comments	JH	AS
E	18/11/2021	Redline boundary update	JH	AS
F	23/11/2021	Redline boundary update	JH	AS
G	14/06/2022	Updates as per local authority comments	JH	AS
H	20/06/2022	Minor amendments as per comments	JH	AS
I	23/06/2022	Amendments to GCN corridor	JH	AS
J	26/09/2022	Removal of panels in Fields H and I	JH	AS
K	26/09/2022	Updated mitigation and permissive path	JH	AS
L	27/09/2022	Updated mitigation and permissive path	JH	AS
M	11/10/2022	Removal of panels in Fields A, D and E	JH	AS
N	18/10/2022	Updated panel layout	JH	AS
O	20/10/2022	Updated panel layout - Attenuation basin added	JH	AS

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Tel: +44 (0)117 923 0455

enquiries@thelandmarkpractice.com
www.thelandmarkpractice.com

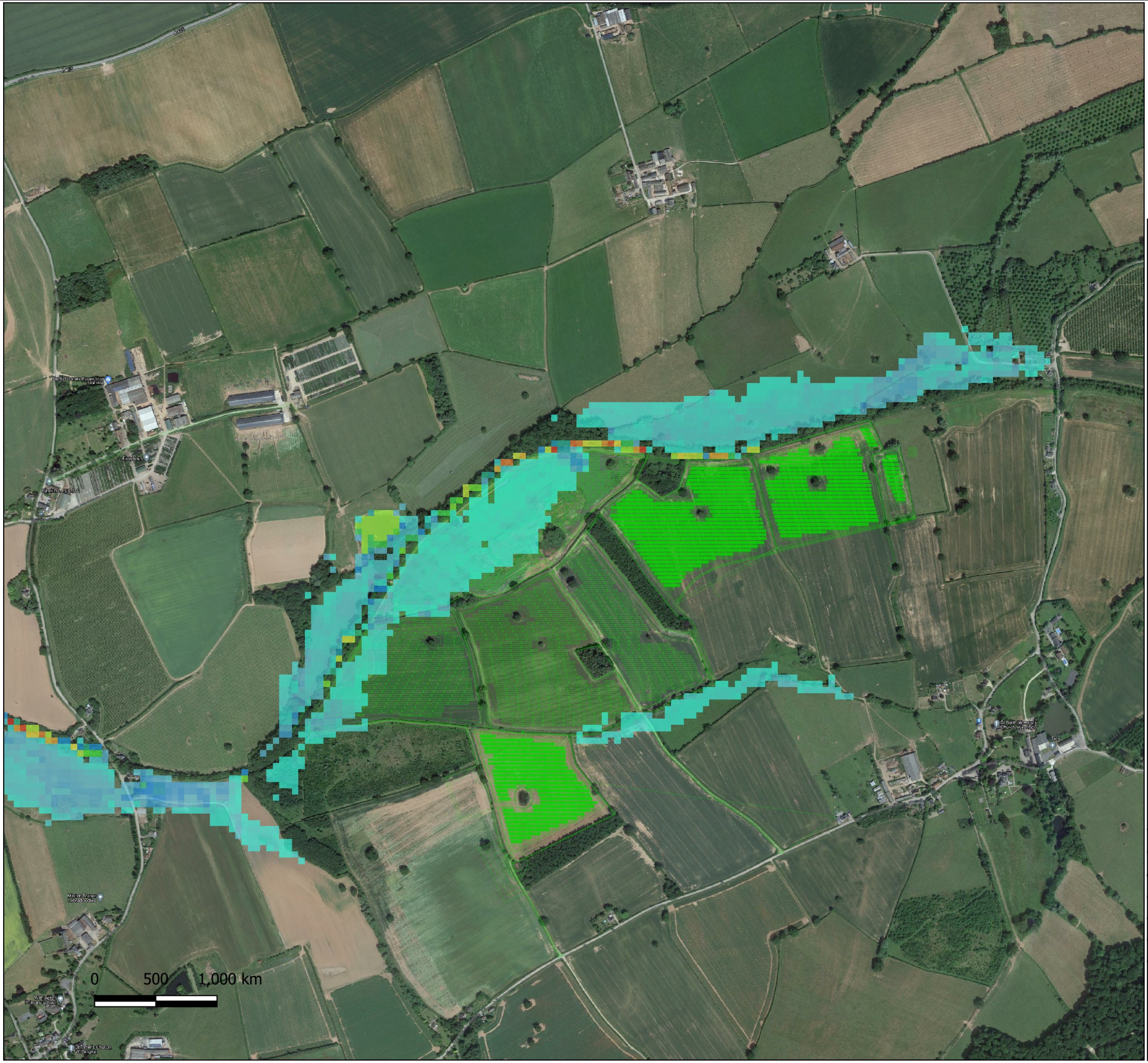
CLIENT
ERSUN (WESTHIDE SPV) LTD

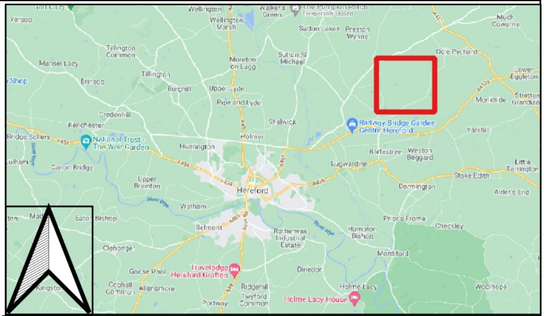
PROJECT
WESTHIDE SOLAR

TITLE
MASTERPLAN

Status: PLANNING	Drawn: GS	Checked: JH
Scale: 1:2,000@A1	Date: 20.07.21	Approved: GM
Drawing Number: 3352_L_GA_0_01		Rev: O

APPENDIX B FLOOD EXTENTS





Legend

Westhide 1 in 100yr +40%

- 0.0010
- 0.2124
- 0.4238
- 0.6351
- 0.8465
- 1.0579
- 1.2693
- 1.4644
- 1.6270
- entities

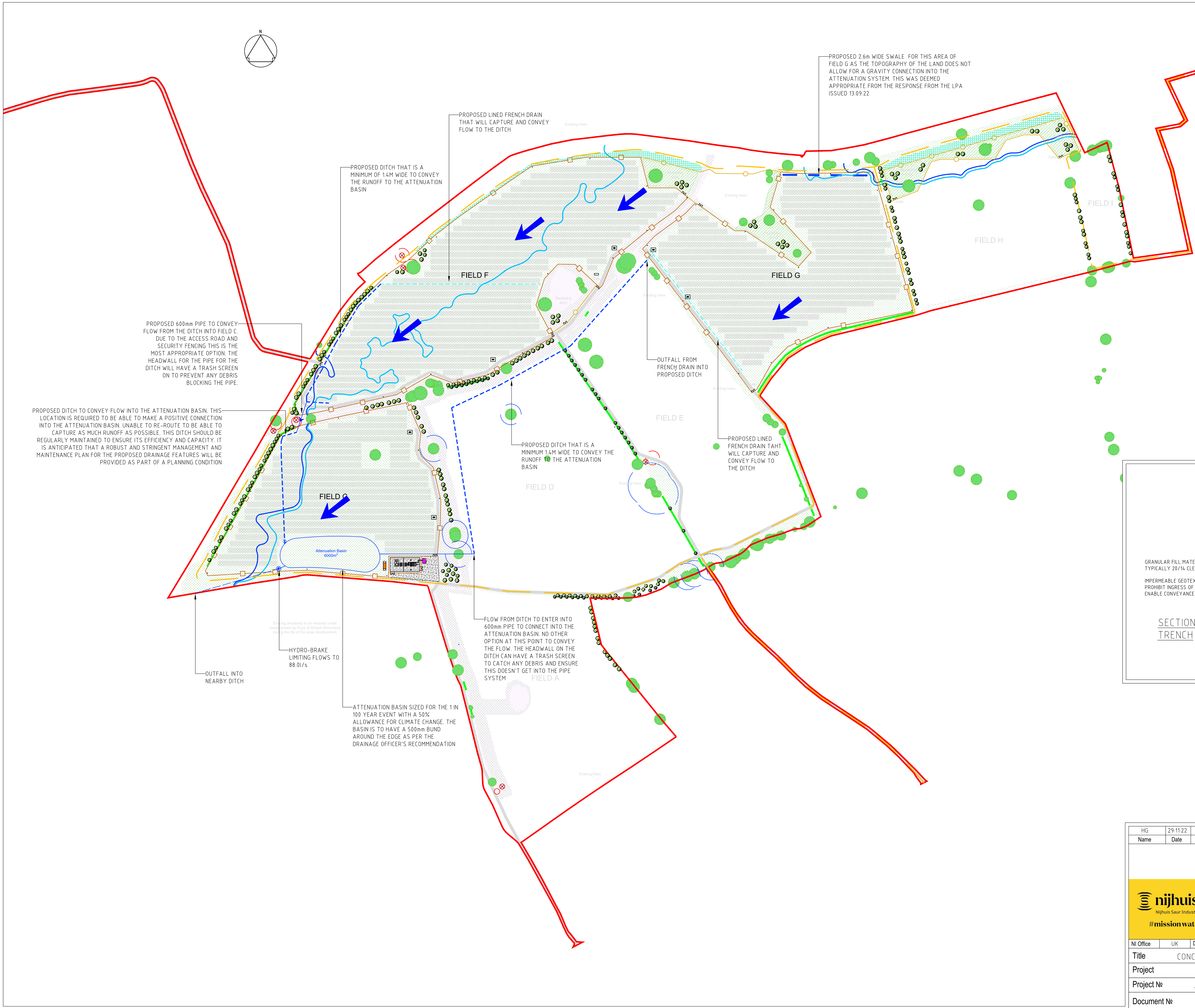
REV	BY	CHECK	QA	DESCRIPTION	DATE	SHEET
1	AG	-	Y	FIRST ISSUE	13/12/21	1

CLIENT	ERSUN (WESTHIDE SPV LTD)
PROJECT	PROPOSED SOLAR FARM
TITLE	EA FLOOD ZONE EXTENTS
DOCUMENT	J-14440-NUK-XX-XX-X-3000-XX

nijhuis INDUSTRIES

SOLID SOLUTIONS IN A FLUID WORLD

APPENDIX C SUDS DESIGN



NOTES

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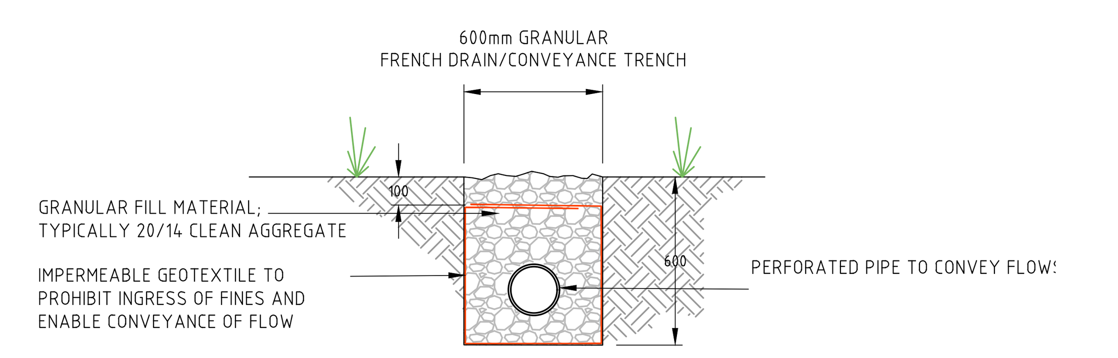
2. THIS DRAWING IS ONLY TO BE USED FOR THE PURPOSES DESCRIBED IN THE STATUS BOX BELOW WORK TO FIGURED DIMENSIONS ONLY, DO NOT SCA
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WIT ALL OTHER DRAWINGS, DETAILS AND SPECIFICATI PERTAINING TO THE WORK DESCRIBED.
4. MATERIALS AND WORKMANSHIP SHALL COMPLY T THE APPROPRIATE BRITISH STANDARDS AND COD OF PRACTICE UNLESS OTHERWISE STATED.
5. THE ACTIVITIES REQUIRED TO CONSTRUCT THE WO SHOWN ON DRAWINGS CLEARLY MARKED FOR CONSTRUCTION, MAY BE SUBJECT TO THE PROVISIONS OF THE CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS 2015 THE CONTRACT AND CLIENT MUST ENSURE THAT THEY ARE ADEQUATELY CONVERSANT WITH THESE REGULATIONS AND THAT THE APPROPRIATE PROCEDURES REQUIRED UNDER THE REGULATIONS ARE OBSERVED AT ALL TIMES.

KEY

- SITE DEVELOPMENT BOUNDARY
- PROPOSED DRAINAGE DITCH
- PROPOSED FRENCH DRAIN/CONVEYANCE TRENCH
- PROPOSED SWALE
- OVERLAND FLOW ROUTE
- PROPOSED HYDRO-BRAKE



SECTION THROUGH TYPICAL FRENCH DRAIN/CONVEYNANCE TRENCH

HG	29:11:22	AMENDMENTS OF SUDS DESIGN AS PER LLFA COMMENTS	P(
Name	Date	Remarks	Revi

INFORMATION

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#missionwater

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NI Office	UK	Drawn by	HG	Date	20:10:22	Status	PRELIMINARY	
Title	CONCEPTUAL SURFACE WATER DRAINAGE							Revision
								Checked by
Project	WESTHIDE SOLAR FARM							Release Date 2(
Project №	J14440			Quotation №				Size
								Sheet
Document №	J14440-NUK-SWD-XX-DR-D-3001-P03							Scale 1
								Unit

APPENDIX D CALCULATIONS

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	11.868	Urban	0.000
SAAR (mm)	700	Region Number	Region 9

Results	**l/s**
QBAR Rural	40.4
QBAR Urban	40.4
Q100 years	88.0
Q1 year	35.5
Q30 years	71.2
Q100 years	88.0

Summary of Results for 100 year Return Period (+50%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.094	0.594	87.9	0.0	87.9	2823.6	O K
30 min Summer	99.275	0.775	87.9	0.0	87.9	3754.7	O K
60 min Summer	99.458	0.958	87.9	0.0	87.9	4724.7	O K
120 min Summer	99.631	1.131	87.9	0.0	87.9	5679.7	O K
180 min Summer	99.717	1.217	87.9	0.0	87.9	6167.3	Flood Risk
240 min Summer	99.766	1.266	87.9	0.0	87.9	6447.6	Flood Risk
360 min Summer	99.814	1.314	87.9	0.0	87.9	6725.6	Flood Risk
480 min Summer	99.834	1.334	87.9	0.0	87.9	6837.5	Flood Risk
600 min Summer	99.835	1.335	87.9	0.0	87.9	6846.5	Flood Risk
720 min Summer	99.827	1.327	87.9	0.0	87.9	6796.1	Flood Risk
960 min Summer	99.804	1.304	87.9	0.0	87.9	6663.1	Flood Risk
1440 min Summer	99.747	1.247	87.9	0.0	87.9	6339.1	Flood Risk
2160 min Summer	99.649	1.149	87.9	0.0	87.9	5781.8	O K
2880 min Summer	99.538	1.038	87.9	0.0	87.9	5162.5	O K
4320 min Summer	99.337	0.837	87.9	0.0	87.9	4078.6	O K
5760 min Summer	99.171	0.671	87.9	0.0	87.9	3214.5	O K
7200 min Summer	99.043	0.543	87.8	0.0	87.8	2566.7	O K
8640 min Summer	98.950	0.450	86.7	0.0	86.7	2104.7	O K
10080 min Summer	98.885	0.385	85.0	0.0	85.0	1789.2	O K
15 min Winter	99.165	0.665	87.9	0.0	87.9	3186.2	O K
30 min Winter	99.368	0.868	87.9	0.0	87.9	4243.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	143.160	0.0	2925.6	0.0	105
30 min Summer	94.048	0.0	3876.1	0.0	117
60 min Summer	58.882	0.0	5103.3	0.0	142
120 min Summer	35.637	0.0	6188.1	0.0	192
180 min Summer	26.221	0.0	6831.7	0.0	244
240 min Summer	20.970	0.0	7284.4	0.0	294
360 min Summer	15.222	0.0	7927.7	0.0	398
480 min Summer	12.134	0.0	8418.4	0.0	502
600 min Summer	10.169	0.0	8809.6	0.0	608
720 min Summer	8.798	0.0	9134.9	0.0	686
960 min Summer	6.996	0.0	9653.5	0.0	806
1440 min Summer	5.057	0.0	10355.6	0.0	1066
2160 min Summer	3.650	0.0	11598.9	0.0	1480
2880 min Summer	2.893	0.0	12251.6	0.0	1872
4320 min Summer	2.082	0.0	13174.5	0.0	2628
5760 min Summer	1.647	0.0	14023.9	0.0	3344
7200 min Summer	1.372	0.0	14596.1	0.0	4024
8640 min Summer	1.182	0.0	15062.8	0.0	4680
10080 min Summer	1.041	0.0	15429.9	0.0	5328
15 min Winter	143.160	0.0	3291.8	0.0	106
30 min Winter	94.048	0.0	4346.3	0.0	118

Summary of Results for 100 year Return Period (+50%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	99.571	1.071	87.9	0.0	87.9	5348.0	O K
120 min Winter	99.763	1.263	87.9	0.0	87.9	6426.0	Flood Risk
180 min Winter	99.858	1.358	87.9	0.0	87.9	6976.9	Flood Risk
240 min Winter	99.913	1.413	87.9	0.0	87.9	7299.4	Flood Risk
360 min Winter	99.969	1.469	87.9	0.0	87.9	7631.6	Flood Risk
480 min Winter	99.994	1.494	87.9	0.0	87.9	7781.4	Flood Risk
600 min Winter	100.000	1.500	87.9	0.0	87.9	7817.0	Flood Risk
720 min Winter	99.993	1.493	87.9	0.0	87.9	7780.2	Flood Risk
960 min Winter	99.961	1.461	87.9	0.0	87.9	7588.0	Flood Risk
1440 min Winter	99.889	1.389	87.9	0.0	87.9	7158.9	Flood Risk
2160 min Winter	99.756	1.256	87.9	0.0	87.9	6386.4	Flood Risk
2880 min Winter	99.600	1.100	87.9	0.0	87.9	5505.5	O K
4320 min Winter	99.289	0.789	87.9	0.0	87.9	3824.1	O K
5760 min Winter	99.054	0.554	87.8	0.0	87.8	2620.0	O K
7200 min Winter	98.903	0.403	85.6	0.0	85.6	1877.5	O K
8640 min Winter	98.837	0.337	79.6	0.0	79.6	1561.0	O K
10080 min Winter	98.806	0.306	71.1	0.0	71.1	1412.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	58.882	0.0	5723.7	0.0	142
120 min Winter	35.637	0.0	6935.6	0.0	194
180 min Winter	26.221	0.0	7654.6	0.0	244
240 min Winter	20.970	0.0	8159.9	0.0	296
360 min Winter	15.222	0.0	8876.7	0.0	400
480 min Winter	12.134	0.0	9422.0	0.0	504
600 min Winter	10.169	0.0	9855.2	0.0	608
720 min Winter	8.798	0.0	10213.6	0.0	714
960 min Winter	6.996	0.0	10778.2	0.0	870
1440 min Winter	5.057	0.0	11497.6	0.0	1138
2160 min Winter	3.650	0.0	12995.3	0.0	1600
2880 min Winter	2.893	0.0	13726.2	0.0	2040
4320 min Winter	2.082	0.0	14775.9	0.0	2784
5760 min Winter	1.647	0.0	15712.9	0.0	3448
7200 min Winter	1.372	0.0	16355.9	0.0	4040
8640 min Winter	1.182	0.0	16882.9	0.0	4600
10080 min Winter	1.041	0.0	17306.2	0.0	5304

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.400	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+50

Time Area Diagram

Total Area (ha) 11.868

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.500	24	28	0.500	48	52	0.500	72	76	0.500
4	8	0.500	28	32	0.500	52	56	0.500	76	80	0.500
8	12	0.500	32	36	0.500	56	60	0.500	80	84	0.500
12	16	0.500	36	40	0.500	60	64	0.500	84	88	0.500
16	20	0.500	40	44	0.500	64	68	0.500	88	92	0.500
20	24	0.500	44	48	0.500	68	72	0.500	92	96	0.368

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 98.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	4465.0	1.500	5999.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0368-8800-1500-8800
Design Head (m)	1.500
Design Flow (l/s)	88.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	368
Invert Level (m)	98.500
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	87.9	Kick-Flo®	1.128	76.6
Flush-Flo™	0.590	87.9	Mean Flow over Head Range	-	72.5

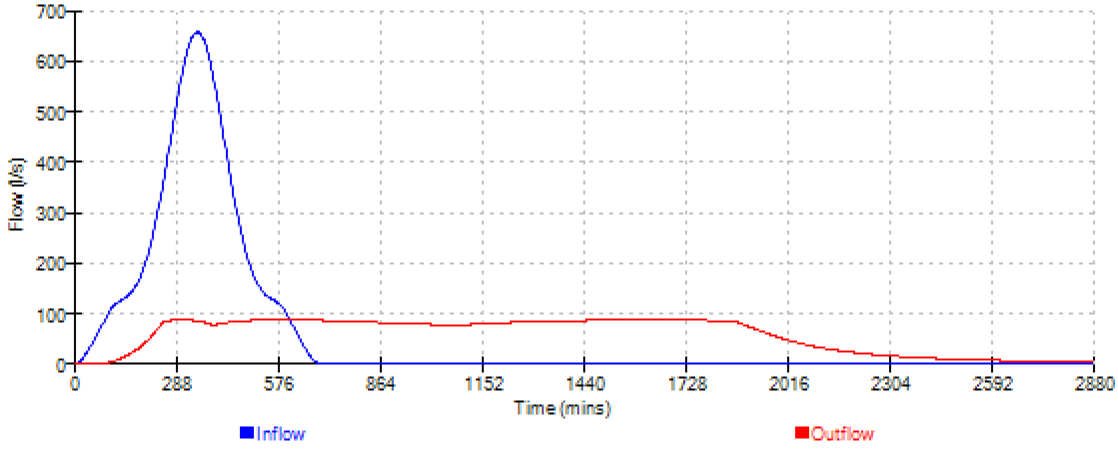
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

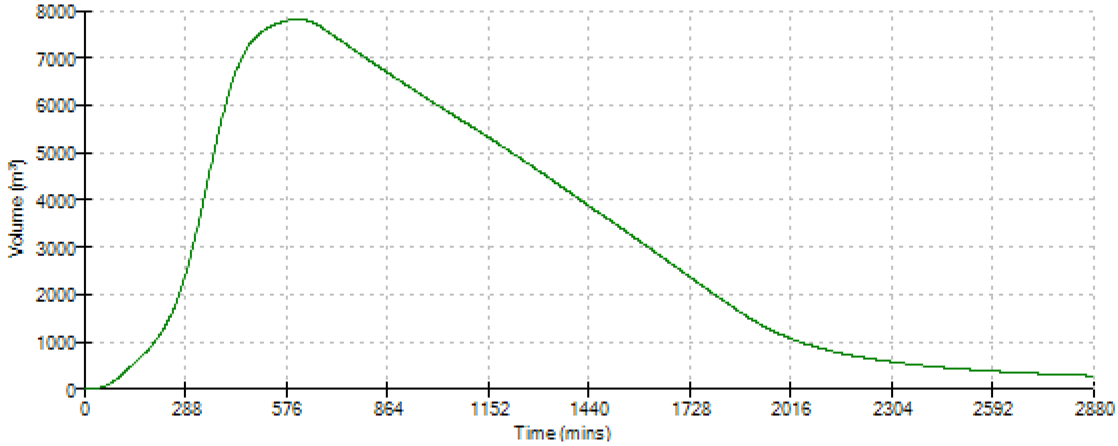
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.5	1.200	78.9	3.000	123.1	7.000	186.2
0.200	36.8	1.400	85.0	3.500	132.7	7.500	192.6
0.300	69.2	1.600	90.7	4.000	141.6	8.000	198.8
0.400	85.5	1.800	96.0	4.500	150.0	8.500	204.8
0.500	87.4	2.000	101.0	5.000	157.9	9.000	210.6
0.600	87.9	2.200	105.8	5.500	165.5	9.500	216.3
0.800	86.3	2.400	110.4	6.000	172.7		
1.000	82.3	2.600	114.8	6.500	179.6		

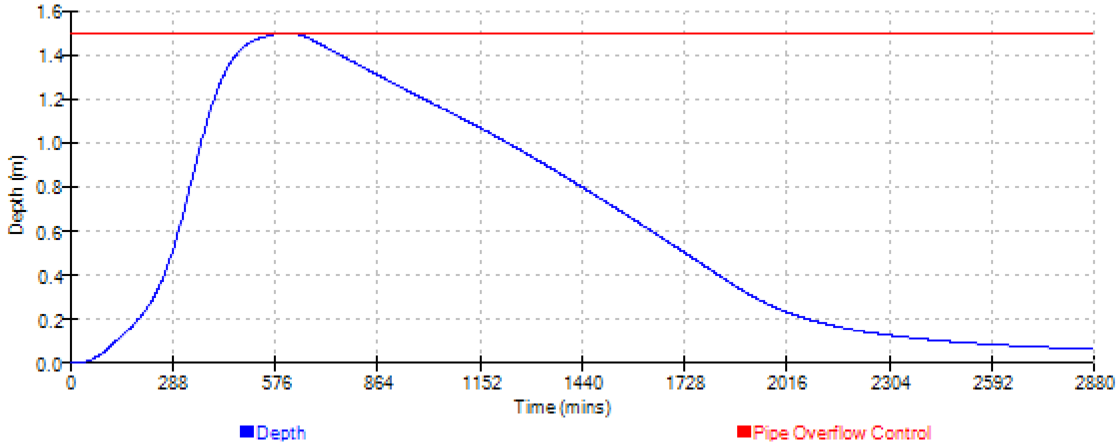
Pipe Overflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	10.0	Coefficient of Contraction	0.600
Length (m)	10.000	Upstream Invert Level (m)	100.000
Roughness k (mm)	0.600		

Event: 600 min Winter







Flood Risk | Water | Wastewater | Civil | Structural | M&E | Highways | CDM | H&S

Truro Office | Nanjerrick Court, Allet | Truro, Cornwall | TR4 9DJ |
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Wokingham Office | 15 Metro Centre | Toutley Road | Wokingham, Berkshire | RG41 1QW UK |
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