Phoenix Solar Park, Pembroke

Flood Consequence Assessment

On behalf of: **Wessex Solar Energy**

Project Ref: 332610851/100 | Rev: - | Date: December 2023

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For and on behalf of Stantec UK Limited				

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DRAFT	05/12/23	Draft for comment	EE	JNP	JNP
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Executive Summary

This Flood Consequence Assessment (FCA) has been prepared by Stantec UK Ltd to support a planning application for a solar farm development on land west of Blackberry Lane near the village of Cosheston, Pembrokeshire.

In accordance with the fundamental objectives of Planning Policy Wales (PPW), the FCA demonstrates that:

(i) The development is safe;

(ii) The development does not increase flood risk; and,

(iii) The development does not detrimentally affect third parties.

The National Resources Wales (NRW) data confirms that the site is located wholly within Flood Zone A, defined in the Technical Advice Note: Development and Flood Risk as follows:

> **Flood Zone A 'Low Probability' – land to be considered at little or no risk of fluvial or tidal/coastal flooding.**

The NRW online flood mapping indicates that the majority of the site is at 'Very Low' risk of surface water flooding, with localised areas of 'Low', 'Medium' and 'High' risk associated with the ditches running through the site.

The proposals for this development constitute a '*Less Vulnerable*' land use, which is considered appropriate within Flood Zone A in accordance with TAN15. The proposed masterplan shows that all proposed development will be located within Flood Zone 1 and within areas of 'very low' or 'low' surface water flood risk, post-development.

The flood risk mitigation strategy for the development consists of the following elements:

- Surface water drainage will be provided in the form of swales down slope of the PV panels, which will intercept surface water flows following the existing natural flow paths present on the site. The swales will act to capture and store the water before it is discharged via a piped outfall to the watercourses located within the red line boundary.

- The proposed inverter cabins and control building will have a suitable freeboard (minimum of 150mm above external ground level).

- Hence, there will be no increased flood risk to external receptors as part of the development proposals.

In conclusion, this FCA demonstrates that through the incorporation of the above flood risk mitigation, the proposed development is safe for its lifetime and complies with the requirements of PPW and TAN15.

Summary of Key FRA Data

Aspect of flood risk	Applicable Guidance/ Source of Data, proposed by Stantec	Summary	Section of FRA
Site Location	n/a	Three development parcels near Cosheston, Pembrokeshire. Approximate OS grid references: West Parcel: 201,345m E; 203,380m N South Parcel: 201,455m E; 203,180m N East Parcel: 201,790m E; 203,450m N	**3.1**
Existing Ground Levels	Azimuth Land Surveys Ltd.	West Parcel: 37.35m AOD to 19.60m AOD South Parcel: 27.60m AOD to 25.46m AOD East Parcel: 35.95m AOD to 23.15m AOD	**3.2**
Primary source of flood risk	NRW maps	Surface Water	**5.1**
Presence of flood defences	NRW maps	None	**n/a**
Proposed Development	Proposals by Wessex Solar Energy	Development of a solar farm consisting of Photovoltaic panels, inverter cabins, control cabin and access road.	**6.0**
Planning Aspects			
Flood Risk Vulnerability	TAN15: Development and Flood Risk	'Less Vulnerable' – appropriate in Flood Zone A.	**6.0**
Flood Zone	NRW Development Advice Map (DAM)	Flood Zone A 'Low Probability'	**5.1**
Applicable Climate Change Allowances	WG climate change allowances guidance	+20% and +40% for peak rainfall intensity	**4.0**
Proposed Mitigation Measures			
Ground Floor Levels	BS8533:2017 PCC SFCA	It is recommended that ground floor levels are set a suitable freeboard above surrounding ground (minimum 150mm) to mitigate the residual flood risk associated with excess surface water runoff in an extreme rainfall event.	**7.2**
Floodplain Storage	n/a	Site is located outside of floodplain, therefore no impact on floodplain storage or flood flow routes.	**7.3**
Safe Access	n/a	Continuous safe access available onto track located to south-west of Parcel South.	**7.3**
Surface Water Drainage	WG Statutory Standards for Sustainable Drainage Systems	Proposed SuDS strategy based on swales with piped outfalls to watercourses within or adjacent to site boundary.	**8.0**

Abbreviations

ABI	-	Association of British Insurers
AP	-	Annual Probability
BGS	-	British Geological Survey
CDM	-	Construction (Design and Management)
CIRIA	-	Construction Industry Research and Information Association
DDA	-	Disability Discrimination Act
DEFRA	-	Department for Environment, Food and Rural Affairs
EA	-	Environment Agency
FRA	-	Flood Risk Assessment
GIS	-	Geographic Information System
LLFA	-	Lead Local Flood Authority
m. AOD	-	Metres Above Ordnance Datum (Newlyn)
PCC	-	Pembrokeshire County Council
PPW	-	Planning Policy Wales
RoSWF	-	Risk of Surface Water Flooding
SuDS	-	Sustainable Drainage Systems
SFCA	-	Strategic Flood Consequence Assessment
TAN15	-	Technical Advisory Note 15: Development and Flood Risk

1 Introduction

1.1 Scope of Report

1.1.1 This Flood Consequences Assessment (FCA) has been prepared by Stantec, on behalf of our client, Wessex Solar Energy, to support a planning application for the construction of a solar farm, on land west of Blackberry Lane, near the village of Cosheston in Pembrokeshire, Wales.

1.1.2 The report is based on the available flood risk information for the site as detailed in **Section 1.2** and prepared in accordance with the planning policy requirements set out in **Section 1.3**. The scope of the FCA is consistent with the guidance contained in Planning Policy Wales (PPW) and Technical Advisory Note 15 (TAN15): Development and Flood Risk.

1.1.3 Stantec has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The authors and reviewers of the document are all experienced engineers and members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

1.2 Sources of Information

1.2.1 The FCA has been prepared based on the following sources of flood risk information:

- **National Resources Wales (NRW) published 'Open Data' datasets** available online, reproduced with OS mapping under license to Stantec (contains Ordnance Survey data © Crown copyright and database right [2023], contains National Resources Wales information © 2023 National Resources Wales and database right) (see **Appendix A**);
- **Topographic Survey** by Azimuth Land Surveys Ltd., dated November 2013 (see **Appendix B**);
- **Trial pit logs** by CC Ground Investigations Ltd, dated 5th June 2020 (see **Appendix C**);
- **Development proposals** by Wessex Solar Energy, dated December 2023 (see **Appendix D**);
- The **NRW online flood maps** at:
  https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en
- **Pembrokeshire County Council (PCC) Stage 1 Strategic Flood Consequence Assessment (SFCA)**, dated September 2019;
- **PCC Local Flood Risk Management Strategy**, dated February 2015;
- The **South West Wales SFCA Final Report**, dated November 2022;
- **CIRIA Sustainable Drainage Systems (SuDS) Manual C753**, dated November 2015.

1.2.2 PCC is the Lead Local Flood Authority (LLFA) and Sustainable Drainage Approving Body (SAB) for the site. The relevant sections of their SFCA and local planning policy have been reviewed as part of compiling this report.

1.3 Caveats and Exclusions

1.3.1 This FCA has been prepared in accordance with TAN15 and Local Planning Policy. The proposed flood management and surface water management strategies are based on the relevant British Standards (BS8533), the standing advice provided by NRW, PCC or based on common practice.

1.3.2 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves “construction” work, as defined by the CDM Regulations. As such it is the responsibility of the proposed developer (ultimate client) to fulfil its duties under the CDM Regulations.

1.3.3 The findings of this FCA are based on data available at the time of the study and on the subsequent assessment that has been undertaken to date. They relate to current development proposals as outlined in **Section 6**.

1.3.4 An updated national study on the projected impacts of climate change was released in November 2018 by the Met Office (UKCP18). In the short-term there is no published guidance on how these updated projections should be considered in development planning and, until such guidance is released, NRW confirms that the consideration of climate change should continue to be based on the current NRW advice ‘Flood Consequence Assessments: Climate Change Allowances’ (August 2016); NRW’s guidance updated in 2021 has therefore been referred to as a basis for this study.

1.3.5 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development. Stantec do not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

2 Planning Policy Context

2.1.1 This FRA has been prepared in accordance with the relevant national and local planning policy and statutory authority guidance as detailed below.

2.2 National Policy and Guidance

2.2.1 National policy in relation to flood risk is contained within **Planning Policy Wales (PPW) Edition 11,** updated November 2021 and issued by the Welsh Government (WG), with particular reference to the 'Water and Flood Risk' section and the WG **'Technical Advisory Note 15 (TAN15): Development and Flood Risk'**, dated July 2004.

2.2.2 These documents demonstrate a flood risk management approach for the lifespan of the proposed development considering the effects of climate change. The documents set the framework to minimise vulnerability, provide resilience to the impacts of climate change, and to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures.

2.2.3 In September 2021, the WG updated the climate change allowances for peak river flow, rainfall intensity and sea level rise, and are outlined in the **'Flood Consequences Assessments: Climate Change Allowances'** guidance document and supersedes the guidance issued in August 2016 (ref. CL-03-16). Climate change allowances are discussed further in **Section 4**.

2.2.4 The WG **'Statutory standards for sustainable drainage systems (SuDS) – designing, constructing, operating and maintaining surface water drainage systems'** was released in 2018 and provides the standards in relation to the design of surface water drainage systems in Wales. Further guidance was released for SuDS Approving Bodies (SABs) in 2019 under the WG **'Sustainable Drainage (SuDS) Statutory Guidance'** for the implementation of Schedule 3 to the Flood and Water Management Act 2010, the mandatory use of SuDS on new developments and approval/adoption by the SAB.

2.3 Local Policy and Guidance

PCC Local Development Plan (LDP)

2.3.1 Local planning policy is contained within the **PCC Local Development Plan (LDP) – up to 2021** (adopted February 2013). PCC is currently working on a replacement LDP for Pembrokeshire; however, this is still under consultation.

2.3.2 The current LDP does not contain any specific policies in relation to flooding, however the guidance accompanying **Policy GN.1 General Development Policy**, states:

"Where there are concerns that a proposal would cause harm to health and safety through contamination, adverse impact on air quality, land instability, flooding or erosion, professional advice will be sought from the relevant authority. Where such concerns relate to fluvial or coastal flooding and/or erosion, the provisions of the relevant Shoreline Management Plan and/or Catchment Flood Management Plan will inform consideration of the health and safety issues.

In some instances, anticipated on-site or off-site problems may render development inappropriate; in other cases, development may be possible if mitigation is available, to make the proposal resilient to the identified problems. No housing allocations have been identified within C1 or C2 flood zones in the Plan. A small number of other allocations are located within C1 or C2 flood zones. Where allocations are at risk of fluvial or surface water flooding, this is identified within the SPG Development Sites, with requirements establishing the level of information to be provided at application stage."

3 Site Setting

3.1 Site Description

3.1.1 The site comprises 14.1 hectares (ha) of land located immediately west of Blackberry Lane and north of the A477, near to the village of Cosheston, Pembrokeshire, Wales (see **Figure 3.1** and **Appendix A**).

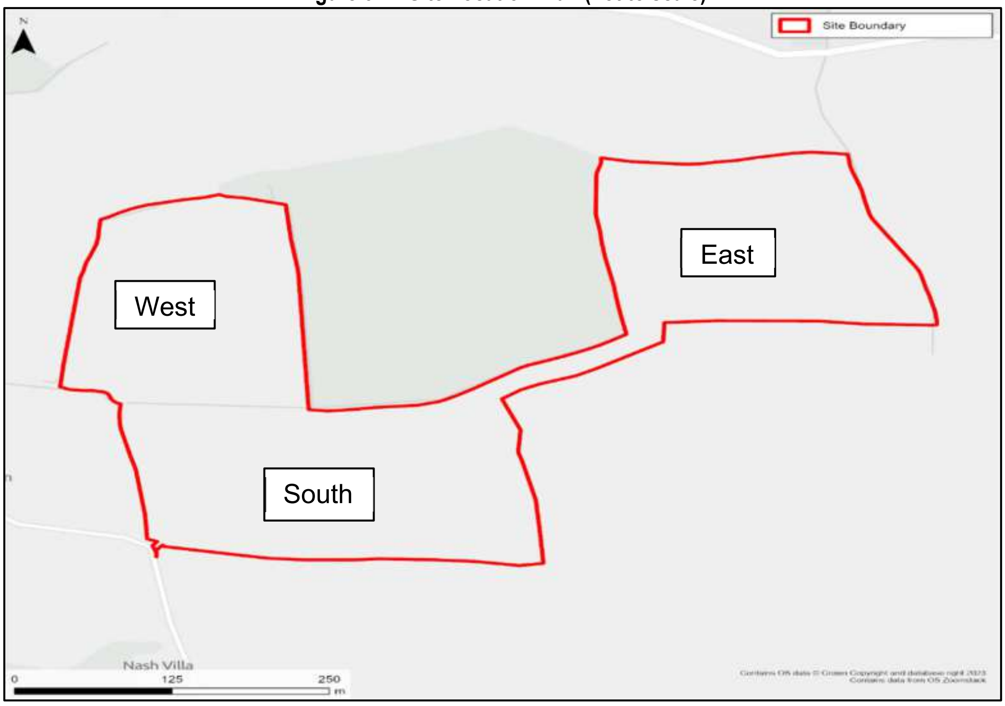
3.1.2 The site lies within the administrative boundary of PCC who are also the LLFA for the area.

3.1.3 There are 3 no. parcels of land proposed for the solar farm development, all of which are agricultural fields and are shown on **Figure 2.1**, and are as follows:

- West Parcel: OS grid reference 201,345m E; 203,380m N;
- South Parcel: OS grid reference 201,455m E; 203,180m N;
- East Parcel: OS grid reference 201,790m E; 203,450m N.

3.1.4 The site is located approximately 100 metres (m) south of the 'Pembrokeshire Coast National Park' boundary.

Figure 3.1: Site Location Plan (not to scale)



3.2 Topography

3.2.1 A topographic survey was undertaken for the site by Azimuth Land Surveys Ltd. in November 2013 and is provided in **Appendix B**.

3.2.2 The topography can be summarised for each parcel as follows:

- West Parcel: The ground slopes from 37.35m AOD along the northern boundary to 19.60m AOD in the south-western corner of the parcel;

- South Parcel: The ground slopes from 27.60m AOD in the east to 25.46m AOD in the south-western corner and 20.10m AOD in the north-western corner of the parcel;

- East Parcel: The ground slopes from 35.95m AOD in the north-western corner to 23.15m AOD in the south-eastern corner of the parcel.

3.3 Hydrological Setting

3.3.1 There are no designated 'main rivers' located on site. The site lies within the catchment of the Cleddau and Pembrokeshire Coastal Rivers. Ford Pill discharges into the River Carew and is located approximately 850m northeast of the site. Cosheston Pill discharges into the River Cleddau (a designated 'main river') and is located approximately 900m to the west of the site.

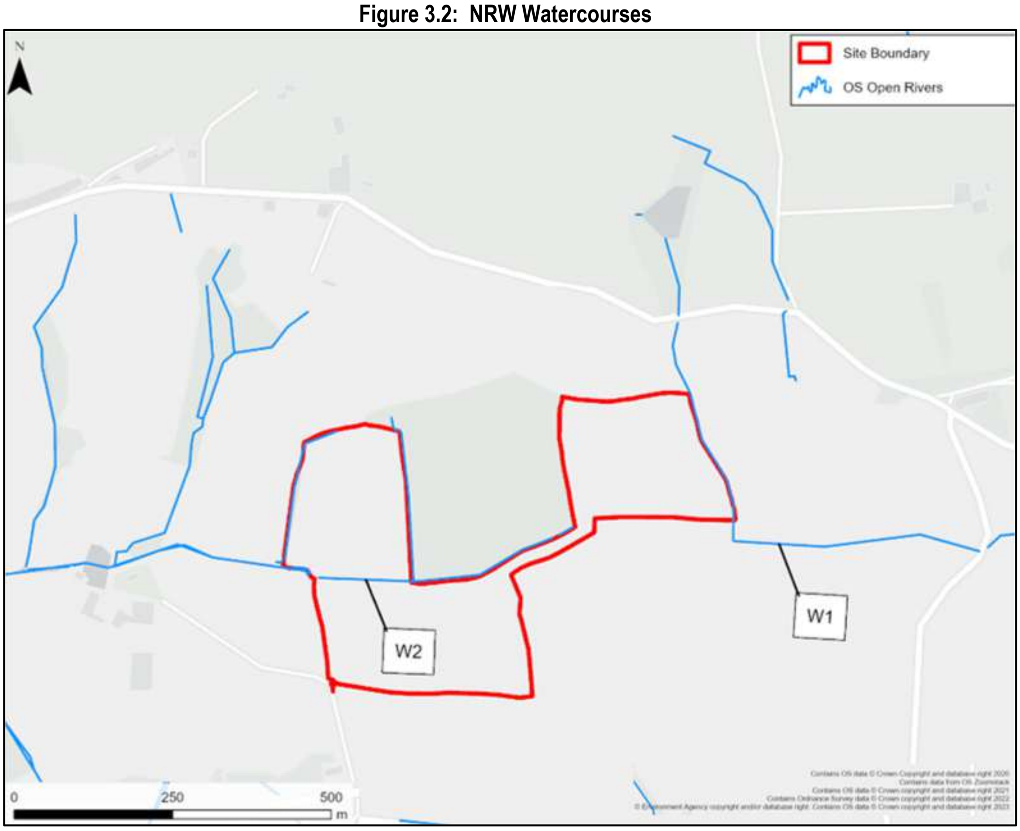
3.3.2 A drain is located 150m south of the site, along the northern boundary of the A477. This is assumed to flow downslope to the west.

3.3.3 There are two minor ditches or drainage features which are located on site, shown on online mapping and in **Figure 2.2**:

- **W1** – flowing south along the northeast boundary and then east towards Blackberry Lane;

- **W2** – flowing west along the southern boundary of a small, wooded area and then west towards Lower Nash Farm. A Spring also flows southwards along the western boundary of the wooden area before flowing into W2 and continuing west.

Figure 3.2: NRW Watercourses



3.4 Existing Drainage Arrangements

3.4.1 The whole site is currently used for grazing and silage.

3.4.2 Surface water run-off currently drains either by infiltration or to the existing field boundaries and natural ditches which surround the site.

3.5 Geology and Hydrogeology

3.5.1 From a review of the 1:50,000 scale bedrock geology map from the British Geological Survey (BGS) online digital viewer, the bedrock beneath the site, from north to south, comprises the **Cosheston Group (Sandstone)**, the **Avon Group (Limestone and Mudstone)** and the **Black Rock Subgroup And Gully Oolite Formation (Limestone)**.

3.5.2 The Cosheston Group and Avon Group are both classified as 'Secondary A' aquifers. The Black Rock Subgroup And Gully Oolite Formation are classified as a 'Principal' aquifer by NRW.

3.5.3 The online BGS 1:50,000 scale superficial geology map indicates that there are no deposits across the site.

3.5.4 The UK Soil Observatory (UKSO) online 'Soilscapes for England and Wales' viewer indicates that the northern part of the site comprises 'slowly permeable seasonally wet acid loamy and clayey soils.' Central and southern parts of the site are located on 'freely drainage slightly acid but base-rich soils.'

3.5.5 Trial pits were excavated on site by CC Ground Investigations Ltd in June 2020, of which three were also used to carry out soakaway testing in accordance with BRE 365 (2016). The soakaway testing results confirmed that the site is not suitable for infiltration. A copy of the trial pit logs is provided in **Appendix C**.

4 Impact of Climate Change

4.1.1 PPW and the associated TAN15 place emphasis on the need to fully consider – and design for – the impacts of climate change as set out in the planning guidance. The guidance provides contingency allowances for potential increases due to climate change in:

- Peak river flow;
- Rainfall intensity; and
- Sea level rise.

4.1.2 Peak river flow and sea level rise are not applicable as the site is located at a significant distance from the fluvial floodplain and there is no tidal influence.

4.1.1 The potential increase in peak rainfall intensity needs to be considered in the surface water drainage strategy for new developments.

4.1.2 The anticipated changes in peak rainfall intensity in small catchments (less than 5km^2), or urbanised drainage catchments are summarised in **Table 4.1**. For large rural drainage catchments, the peak river flow allowances are applied.

4.1.3 The guidance states that:

> "*Both the central and upper estimates should be assessed to understand the range of impact. As a minimum, development proposals should be assessed against the central estimate to inform design levels. Where the assessment indicates a significant flood risk for the upper estimate (e.g. depths, velocity), the flood consequences assessment will need to indicate the mitigation measures required to protect people and property.*"

Table 4.1: Climate Change – Peak Rainfall Intensity Allowances

Applies across all of Wales	2020s (2015-2039)	2050s (2040-2069)	2080s (2070-2115
Upper Estimate	10%	20%	**40%**
Central Estimate	5%	10%	**20%**

4.1.4 As the proposed development is considered as having a design life of around 60 years, a +20% and +40% climate change allowance will be assessed within the surface water drainage strategy discussed in **Section 7**.

5 Overview of Flood Risk

5.1.1 The following has been determined from the Stantec GIS flood maps provided in **Appendix A**, which are based on the NRW Open-Source datasets available online and reproduced with OS mapping under license to Stantec.

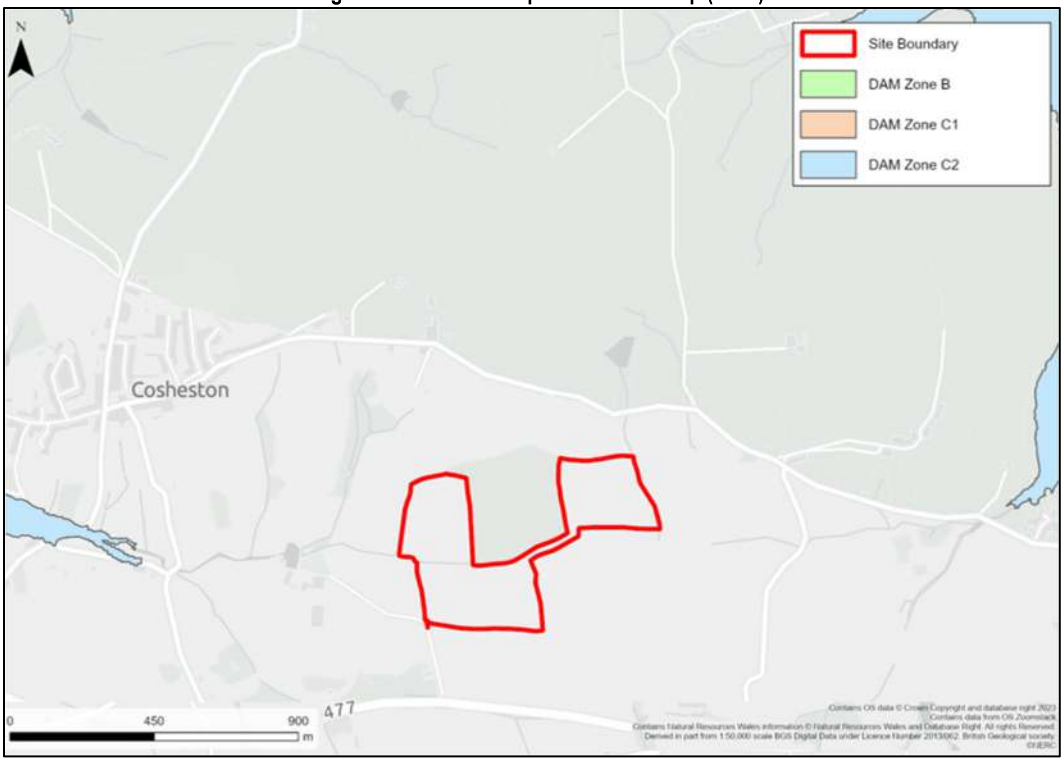
5.2 Development Advice Map (DAM)

5.2.1 The first phase in identifying whether a site is potentially at risk of flooding is to consult the WG Development Advice Map (DAM), available on the NRW website. This provides an initial indication of the extent of the Flood Zones. The Flood Zones are defined in Figure 1 of the TAN15 and PPW as follows:

- **Flood Zone A 'Low Probability'** – Considered to be at little or no risk of fluvial or tidal/coastal flooding;
- **Flood Zone B 'Medium Probability'** – Areas known to have been flooded in the past evidenced by sedimentary deposits;
- **Flood Zone C 'High Probability'** – Based on the Environment Agency (EA) extreme flood outline, equal to or greater than 0.1% (1 in 1000 Annual Probability (AP)) for river, tidal or coastal flooding.
    - **Flood Zone C1** – Areas of the floodplain which are developed and served by significant infrastructure, including flood defences;
    - **Flood Zone C2** – Areas of the floodplain without significant defence infrastructure.

5.2.2 A copy of the current DAM Flood Map for the site is included in **Figure 5.1** and **Stantec Figure 005** in **Appendix A**.

Figure 5.1: WG Development Advice Map (DAM)



5.2.3 The DAM indicates that the whole site is located within **Flood Zone A** and is therefore considered to be at little or no risk of fluvial flooding or tidal/coastal flooding.

5.3 Surface Water

5.3.1 The NRW 'Flood Map for Surface Water' shows where areas could be potentially susceptible to surface water flooding in an extreme rainfall event. The latest mapping assesses flooding resulting from severe rainfall events based on the following three scenarios:

- 'High' Risk: 1 in 30 (3.3%) or greater AP rainfall event;
- 'Medium' Risk: Between a 1 in 100 (1%) and 1 in 30 (3.3%) AP rainfall event;
- 'Low' Risk: Between 1 in 1000 (0.1%) and 1 in 100 (1%) AP rainfall event;
- 'Very Low' Risk: Lower than 1 in 1000 (0.1%) AP rainfall event.

5.3.2 The NRW Flood Map in **Figure 5.2** indicates that the majority of the site is at 'Very Low' risk of surface water flooding. There are areas of 'Low' to 'High' risk associated with minor drainage features W1 and W2, described in **Section 2.3**, and their associated topographic lows.

Figure 5.2: EA Risk of Flooding from Surface Water Map

5.3.3 It should be noted that the surface water maps are generated using a generic methodology on a national scale, whereby rainfall is routed over a ground surface model. The analysis does not take account of any specific local information on below-ground drainage infrastructure and infiltration, although an adjustment is included in urban areas to account for the impact of sewerage and a standard infiltration allowance based on soil type. Consequently, the mapping provides a guide to potentially vulnerable areas based on the general topography of an area.

5.4 Reservoir

5.4.1 NRW provides maps showing the risk of flooding in the event of a breach from reservoirs, based only on large reservoirs (over 10,000 cubic metres of water).

5.4.2 This mapping shows that the proposed site is not considered to be at risk in the event of a reservoir breach.

5.4.3 It should be emphasised that the likelihood of flooding from reservoir breach is very small in any case; NRW is the enforcement authority for the Reservoirs Act (1975) and all large, raised reservoirs are inspected and supervised by reservoir panel engineers.

5.4.4 NRW website states:

> '*Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, we ensure that reservoirs are inspected regularly, and essential safety work is carried out'*.

5.4.5 The risk of such an occurrence is therefore considered negligible.

5.5 Groundwater

5.5.1 PCC SFCA 2019 states under Section 3.1.1 – Flood datasets omitted in this study:

"*Groundwater Flooding – no such dataset from either council.*"

5.5.2 Trial pits were excavated on site by CC Ground Investigations Ltd in June 2020, of which three were also used to carry out soakaway testing in accordance with BRE 365 (2016). Trial pits were excavated down to a depth of 2m below ground level and no groundwater was encountered (**Appendix C**).

5.5.3 If groundwater flooding was to occur on site, it would flow overland and be captured by existing field boundary ditches. As such, the risk of groundwater flooding on site is anticipated to be negligible.

5.6 Sewer Flooding

5.6.1 As the existing site is open fields, it is unlikely that sewerage infrastructure is present at the site. The risk of sewer flooding is therefore considered to be low.

5.7 Pembrokeshire SFCA

5.7.1 The PCC Stage 1 SFCA was released in September 2019. The information of specific relevance to the site is as follows:

- The site is located within Flood Zone A;
- There are no records of past flooding on or within the immediate vicinity of the site.

5.8 South West Wales Stage 1 SFCA

5.8.1 The South West Wales – Stage 1 SFCA Final Report was released in November 2022 to provide information on flood risk across the South West Wales Councils (Carmarthenshire County, Neath Port Talbot, Pembrokeshire County and Swansea County), and the Brecon Beacons and Pembrokeshire Coast National Park Authorities.

5.8.2 The information provided within the Stage 1 SFCA is consistent with that in **Section 5.7** and there are no records of flooding on or within the immediate vicinity of the site.

5.9 Summary of Flood Risk

5.9.1 **Table 5.1** provides an overview of flood risk to and from the site, based on the information obtained and detailed in this section.

Table 5.1: Summary of Flood Risk

Source of Flooding	Flood Risk Impact to the Site	Flood Risk Impact from the Site	Comment
Fluvial			The site is located in Flood Zone A 'Low Probability' – considered to be at little or no risk of fluvial or tidal/coastal flooding, according to the WG DAMs.
Tidal			The site is not located within an area at risk of tidal flooding.
Surface Water/ Pluvial			The NRW mapping indicates that majority of the site is located within an area which is considered as being at a 'Very Low' risk of surface water flooding, with localised areas of 'Low', 'Medium' and 'High' risk shown in along routes of ordinary watercourses running adjacent to boundaries. Nature of development is low in impermeable area which is to be managed through swales.
Groundwater			Trial pitting completed in June 2020 encountered no groundwater. PCC hold no groundwater flooding dataset. Any groundwater would be captured by the existing ordinary watercourses along field boundaries. Therefore, the overall risk is 'negligible'.
Reservoirs, Canals, Ponds and Other Artificial Sources			The NRW map for flood risk from reservoirs confirms the development site is not at risk in the event of a reservoir failure. No canals or other artificial sources are in immediate vicinity.
Sewers/Water Mains			The SFCA does not have any information relating to sewers or water mains on site. We are not currently aware of any sewers located on site or within the immediate vicinity. Any flooding from sewers would be captured by the existing ordinary watercourses along field boundaries. Therefore, the overall risk is considered 'negligible'.
Key:		**Low/Negligible Risk** – No noticeable impact to or from the Site and not considered to be a constraint to development	
		Medium Risk – Issue requires consideration but not a significant constraint to development	
		High Risk – Major constraint to development requiring active consideration in mitigation proposals	

5.9.2 The proceeding sections, specifically **Section 7**, outline the required mitigation to manage the flood risk impacts identified to have a medium or high risk (see **Table 5.1**). There is a predominantly low flood risk related to all other sources, as detailed in **Table 5.1**.

5.9.3 The management of residual flood risk is covered in **Section 8**.

6 Proposed Development and Sequential Test

6.1 Proposed Development

6.1.1 A detailed description of the proposed development is included elsewhere in the planning application. Plans illustrating the development proposals are included in **Appendix B**, however a brief description is outlined below.

6.1.2 The proposed development would comprise:

- Access track approximately 864m in length;
- 6,160 PhotoVoltaic (PV) Cells or Panels across 770 racks;
- Control Building x 1 – 7m length x 3m width x 4m height;
- Inverter Cabins x 5 – 10.4m length x 2.6m width x 3.18 height;
    - Foundations of the inverter cabins – 12.25m length x 4.6m width
- Surface water drainage swales to capture runoff from the site;
- Temporary construction compound within the southern parcel.

6.2 TAN15 Vulnerability Classification

6.2.1 TAN15 classifies development according to its vulnerability to flooding. There are three categories, as defined in Figure 2 of TAN15:

- Emergency services;
- High vulnerable development;
- Less vulnerable development.

6.2.2 TAN15 does not explicitly define the flood risk vulnerability of Solar Parks. However, there will be no permanent staff based on site and the PV panels and any other sensitive equipment can be raised off the ground. Hence, the proposed development is considered to be classified as ‘less vulnerable’.

6.2.3 The proposed development is therefore considered to be appropriate for the DAM’s classification of Flood Zone A.

7 Proposed Surface Water Drainage Strategy

7.1 Introduction

7.1.1 The key design criteria for the surface water management system detailed in the following documents:

- PPW and TAN15
- The WG 'Statutory standards for sustainable drainage systems'
- The updated 'Flood Consequences Assessments: Climate change allowances' guidance.

7.1.2 The aim of the surface water management strategy is to focus on the management of surface water within the site boundary, to prevent any likelihood of flooding to adjacent sites, in line with the current Sustainable Drainage Systems (SuDs) guidance and standards.

7.1.3 TAN15 recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites and recommends that priority is given to the use of SuDS in new development. The LLFA also promotes the utilisation of SuDS in new development.

7.2 Discharge Destination

7.2.1 As the intention of SuDS is to mimic the natural drainage regime of the undeveloped site, the WG 'Statutory standards for SuDS' states the following (consistent with the Building Regulations H3 hierarchy):

S1 Surface water runoff destination

Priority Level 1: Surface water runoff is collected for use;
Priority Level 2: Surface water runoff is infiltrated to ground;
Priority Level 3: Surface water runoff is discharged to a surface water body;
Priority Level 4: Surface water runoff is discharged to a surface water sewer, highway drain, or another drainage system;
Priority Level 5: Surface water runoff is discharged to a combined sewer.

7.2.2 The hierarchy is discussed below in relation to the site.

(i) Collection for Reuse

7.2.3 The proposals are for a solar farm development which will mostly be unmanned. Under Paragraph G1.4 of the WG 'Statutory standards for SuDS', the exception of "*there is no foreseeable demand for non-potable water on the site throughout its design life*" is applicable.

7.2.4 The collection of surface water runoff for re-use is therefore not considered further in this assessment.

(ii) Infiltrated to Ground

7.2.5 The soakage testing undertaken by CC Ground Investigations in June 2020 found that the site had poor infiltration potential, therefore ruling out infiltration as a means of discharge of surface water runoff from the site. A copy of the soakaway results is provided in **Appendix C**.

(ii) Discharge to a Surface Water Body or Watercourse

7.2.6 There are two no. ordinary watercourses running between or on the boundaries of the parcels and it is therefore proposed to discharge surface water runoff from the site to these receptors.

7.3 Design Criteria and Outline Surface Water Drainage Strategy

7.3.1 The nature of the proposed Solar park is such that the majority of the site will remain as greenfield land, retaining the existing drainage regime. The exceedance in surface water runoff will come from the minor increase in impermeable area from the 5no. Inverter Cabins (0.015ha) and the Control Building (0.002ha) and rack supports (0.049ha – 0.16sqm per support and 4 supports per rack). The total impermeable area in this assessment is **0.066ha**.

7.3.2 The new onsite access track construction is proposed to comprise Type 1 and Type 2 Aggregate with a Geotextile membrane. It has been assumed that due to the nature of the track, it will have low vehicular usage and thus low compaction. It has therefore been taken as permeable and has not been considered further in the drainage calculations.

7.3.3 The change in run-off characteristics of each parcel of land arising from the introduction of small areas of impermeable surface is in effect zero as the percentage of the parcels changed from greenfield to impermeable is less than 1% of the total parcel areas.

7.3.4 It is proposed to manage surface water runoff from each parcel via shallow boundary swales with a 100mm diameter piped outfall to the nearest ditch as shown on the sketch in **Appendix D**.

7.3.5 The WG Statutory Standard S2 states the following in relation to surface water runoff hydraulic control:

> “*1) Surface water should be managed to prevent, so far as possible, any discharge from the site for the majority of rainfall events of less than 5mm.*
>
> *2) The surface water runoff rate for the 1 in 1 year return period event (or agreed equivalent) should be controlled to help mitigate the negative impacts of the development runoff on the morphology and associated ecology of the receiving surface water bodies.*
>
> *3) The surface water runoff (rate and volume) for the 1% (1 in 100 year) return period event (or agreed equivalent) should be controlled to help mitigate negative impacts of the development on flood risk in the receiving water body.*
>
> *4) The surface water runoff for events up to the 1% (1 in 100 year) return period (or agreed equivalent) should be managed to protect people and property on and adjacent to the site from flooding from the drainage system.*
>
> *5) The risks (both on site and off site) associated with the surface water runoff for events greater than the 1% (1 in 100 year) return period should be considered. Where the consequences are excessive in terms of social disruption, damage or risk to life, mitigating proposals should be developed to reduce these impacts.*
>
> *6) Drainage design proposals should be examined for the likelihood and consequences of any potential failure scenarios (e.g. structural failure or blockage, and the associated flood risks managed where possible.*”

7.3.6 The existing pre-development greenfield runoff rates for 1ha has been calculated using the FEH 2008 Method (FEH2022 rainfall data and point descriptors). A copy of the calculations is provided in **Appendix D**.

7.3.7 The equivalent greenfield runoff rate for the impermeable area would be very small (0.5 l/s or less) and therefore it is not feasible or appropriate to restrict the runoff from the swales as the risk of blockage to the pipe or flow control would be unacceptable.

7.3.8 It should also be noted that the swales will also receive the runoff from the fields/parcels themselves however their purpose is to be designed to accommodate the runoff from the impermeable areas (i.e. additional runoff that is anticipated to be produced over the existing greenfield scenario).

7.3.9 The outfalls from the swales to the receiving ditches/watercourse are proposed to be 100mm diameter pipes as a practical solution to restricting the flow and in line with the 'agricultural' nature of the land drainage. The greenfield runoff rate for each parcel area (defined by existing topography) is provided in **Table 8.2**.

Return Period	Greenfield Runoff Rate (l/s)		
	Parcel West (3.2ha)	Parcel South (5.4ha)	Parcel East (3.4ha)
1 in 1 year	24.0	40.6	25.5
Q_{BAR}	30.8	52.0	32.7
1 in 30 year	61.0	103.0	64.8
1 in 100 year	74.6	125.8	79.2

Table 7.1: Existing Greenfield Runoff Rates

7.3.10 The MicroDrainage results in **Appendix D** shows that the outflow from each parcel (impermeable areas only) for the 1 in 100 annual probability +40% allowance for climate change rainfall event is as follows:

- Parcel West (0.017ha): 8.6 l/s
- Parcel South (0.031ha): 8.7 l/s
- Parcel East: (0.018ha): 7.3 l/s

7.3.11 As outlined in **Section 4**, the appropriate climate change allowances for peak rainfall intensity are +20% and +40% for the site.

7.3.12 The proposed surface water drainage system has been designed with no flooding up to and including the 1 in 100 annual probability +40% allowance for climate change rainfall event as shown in the MicroDrainage results in **Appendix D**. Additional capacity is provided for the inclusion of the wider extreme event overland flows from the fields.

7.3.13 The swales will be 0.15-0.23m deep with a 0.15-0.40m base width and a 1:4 side slope.

7.3.14 The excavation and laying of connecting and outfall pipes will take consideration of the presence of tree stems/roots.

7.4 Effect of Solar Panels on Surface Water Runoff

7.4.1 There is some debate over whether the installation of solar farms affects the surface water runoff regime across a site. In theory, the underlying greenfield site and its ability for runoff to percolate/flow overland at a similar rate is retained for a solar park in comparison to, for example the construction of a residential or commercial development where roof and other impermeable surfacing change the runoff dynamics at the site and require surface water management to mitigate any adverse impacts.

7.4.2 A paper entitled '*Hydrologic Response of Solar Farms*' by Cok and McCuen (2013, American Society of Civil Engineers) analyses the hydrologic effects of solar farm installation and simulating runoff both for pre- and post-panelled conditions, and found that:

> "*Using sensitivity analyses, the solar panels themselves did not have a significant effect on the runoff volumes, peaks, or times to peak. However, if the ground cover under the panels is gravel or bare ground, owing to design decisions or lack of maintenance, the peak discharge may increase significantly with storm-water management needed.*
>
> *In addition, the kinetic energy of the flow that drains from the panels was found to be greater than that of the rainfall, which could cause erosion at the base of the panels. Thus, it is recommended that the grass beneath the panels be well maintained or that a buffer strip be placed after the most downgradient row of panels.*"

7.4.3 It is proposed as part of a maintenance regime for the site that the areas between the panels are regularly inspected and seeded to maintain grassland cover so that the natural surface and runoff regime is retained.

7.4.4 It is therefore concluded that the introduction of the solar panels does not significantly change the run-off characteristics of the overall site. Any local concentration of run-off from the panels is managed by a combination of retaining the existing ground cover and the swales for extreme events.

7.5 Designing for Exceedance

7.5.1 Paragraph G2.37 of the SuDS Guidance states that:

> "*Extreme events exceeding the design event (usually the 1% - 1 in 100 year return period) could occur and may result in overland flows within the site, onto the site and from the site to adjacent areas. The duration of flooding, maximum depth, maximum velocity and the route of flood flows should be established and managed so as to mitigate the flood impact to people and property.*"

7.5.2 The inverter cabins will have a suitable freeboard above external ground level to mitigate the residual risk of surface water ingress during extreme rainfall events.

7.5.3 The swales will provide attenuation for the solar panel array supports and the inverter/control cabin roofs. They will also receive surface water runoff from the fields themselves. When the swales are at capacity, the runoff from the fields will flow overland towards the field boundary ditches as per the existing drainage regime.

7.6 Other Considerations

Pollution Control

7.6.1 Appropriate pollution control measures will be included in the surface water drainage system to minimise the risk of contamination or pollution entering the receiving systems from surface water runoff from the development.

7.6.2 The management of drainage within the temporary construction compound will be managed through a Construction Environmental Management Plan (CEMP), details of which will be provided at the detailed design stage prior to any construction commencing.

7.6.3 The surface water runoff from the site will be from roofs and solar panel arrays and will therefore be a very low pollution risk. Swales will treat runoff before it is discharged to the receptor.

Adoption and Management

7.6.4 The ongoing management and maintenance of the proposed surface water management systems will fall under the responsibility of WSE as the owners and operators of the site.

7.6.5 Long term management of surface water drainage assets, including any SuDS components, is essential to ensure they continue to function to their design standard. As such, a management and maintenance plan will be developed to ensure the systems continue to work effectively.

7.6.6 The final strategy for adoption of SuDS and the SuDS maintenance plan, including a maintenance schedule and details of easements and outfalls for the drainage system, will be produced at the detailed design phase.

8 Residual Risk

8.1.1 It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible; however, it is practicable to minimise the risk by allowing a substantial freeboard (safety margin) and by using suitable construction and management techniques.

8.1.2 There remains a residual risk of surface water/pluvial flooding due to the surcharging of surface water management systems in exceedance events. Regular inspection and maintenance of any drainage systems should also be undertaken to further mitigate this residual risk.

8.1.3 The proposed inverter cabins and control building will have a suitable freeboard (minimum of 150mm above external ground level).

8.1.4 Construction methodology will be agreed at the detailed design stage with a CEMP to be provided prior to any construction commencing.

8.1.5 As such, the residual risk is considered to be acceptable for the lifetime of the development.

9 Conclusions

9.1.1 This Flood Consequences Assessment (FCA) has been prepared by Stantec, on behalf of our client, Wessex Solar Energy, to support a planning application for the construction of a solar farm, on land west of Blackberry Lane, near the village of Cosheston in Pembrokeshire, South Wales.

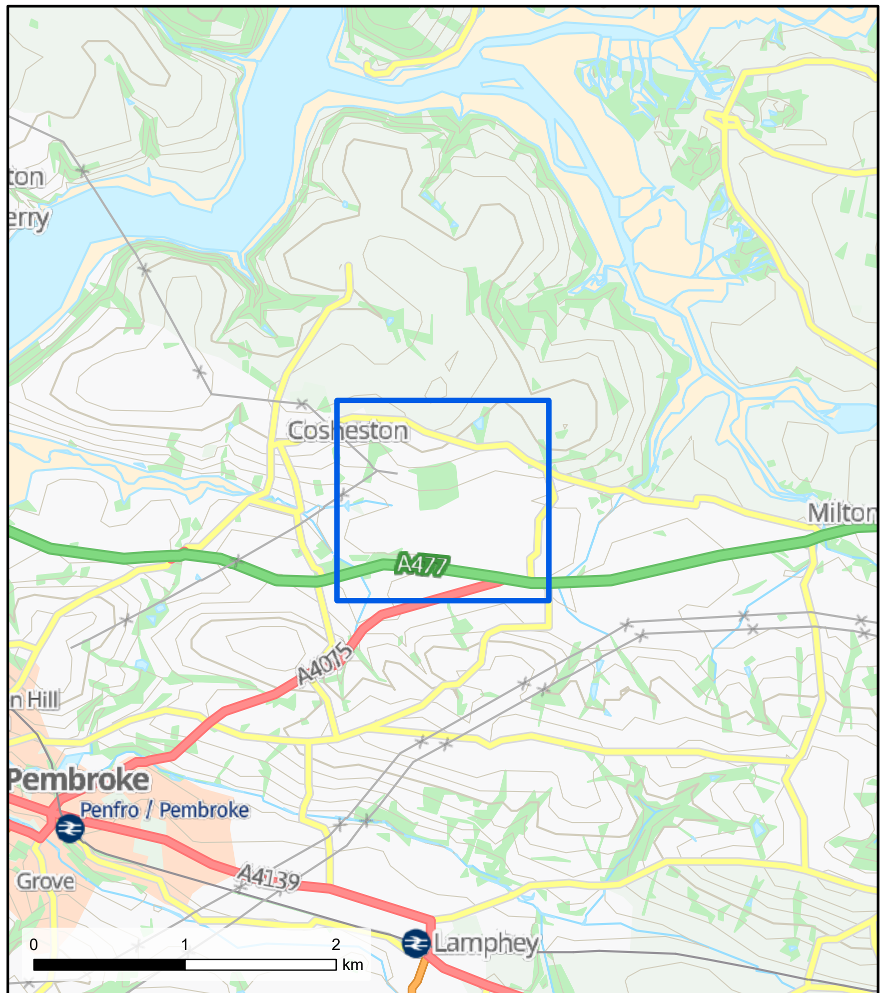
9.1.2 This FCA concludes that:

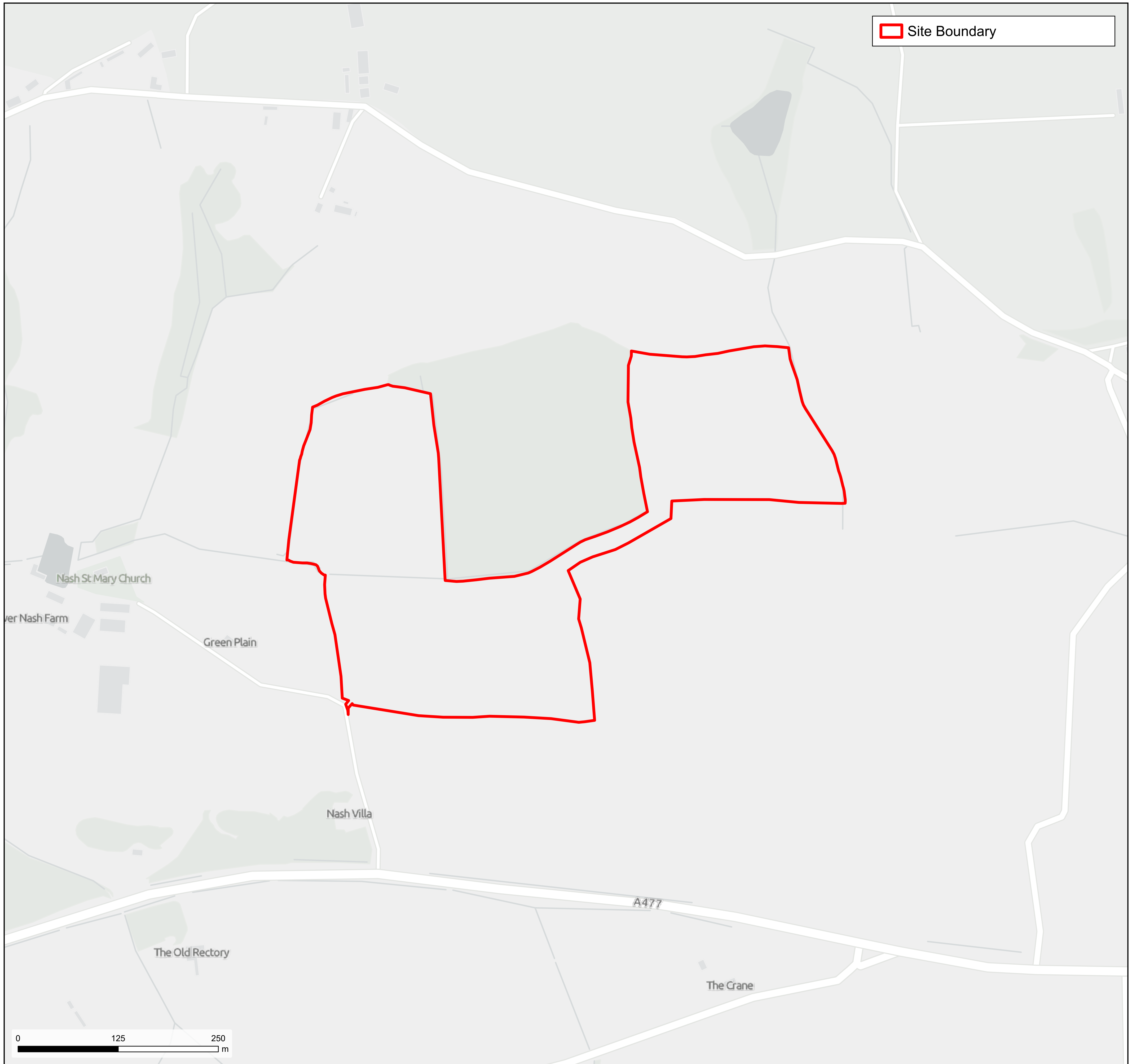
- The Welsh Government and Natural Resources Wales DAM's confirms the proposed development is located within Flood Zone A.
- Flood risk from reservoirs, sewers or groundwater sources is considered to be 'negligible'.
- The proposed development is categorised as 'less vulnerable' and in accordance with TAN15, the development is considered appropriate for Flood Zone A.
- Surface water drainage will be provided in the form of swales down slope of the PV panels, which will intercept surface water flows following the existing natural flow paths present on the site. The swales will act to capture and store the water before it is discharged via a piped outfall to the watercourses located within the red line boundary.
- The proposed inverter cabins and control building will have a suitable freeboard (minimum of 150mm above external ground level).
- Hence, there will be no increased flood risk to external receptors as part of the development proposals.

9.1.3 In conclusion, the proposed development will be safe from flooding and there will be no detrimental impact on third parties. The proposal complies with the TAN15 and local planning policy with respect to flood risk and is an appropriate development at this location.

Appendix A NRW Open Source Flood Maps

- Site Location Plan
- Area Topography (LiDAR)
- Watercourse Location
- NRW River Flood Risk Depth
- NRW Flood Zones for Surface Water
- NRW Development Advice Map Zones
- Source Protection Zones
- NRW Recorded Historic Flood Extents





Stantec

Client

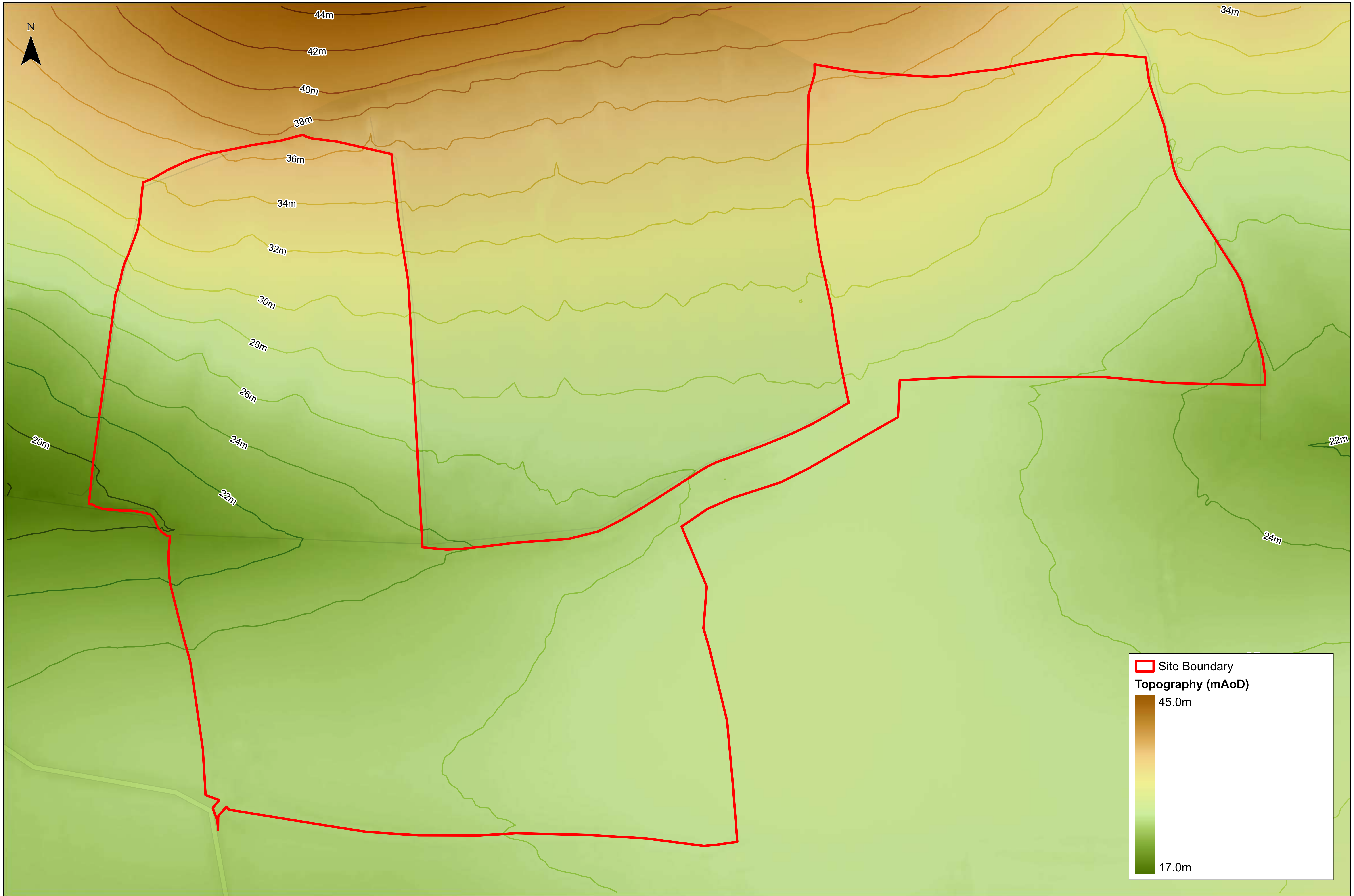
WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

Site Location

Date: 21/11/2023	
Drawn: JP	Checked: EE
Figure: 01	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx



Stantec

Client

WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

Topography - Detailed

0 100 200 m

Contains OS data © Crown Copyright and database right 2023
Contains data from OS Zoomstack

1:2,000 @ A3	Date: 21/11/2023
Drawn: JP	Checked: EE
Figure: 03.1	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx

Client

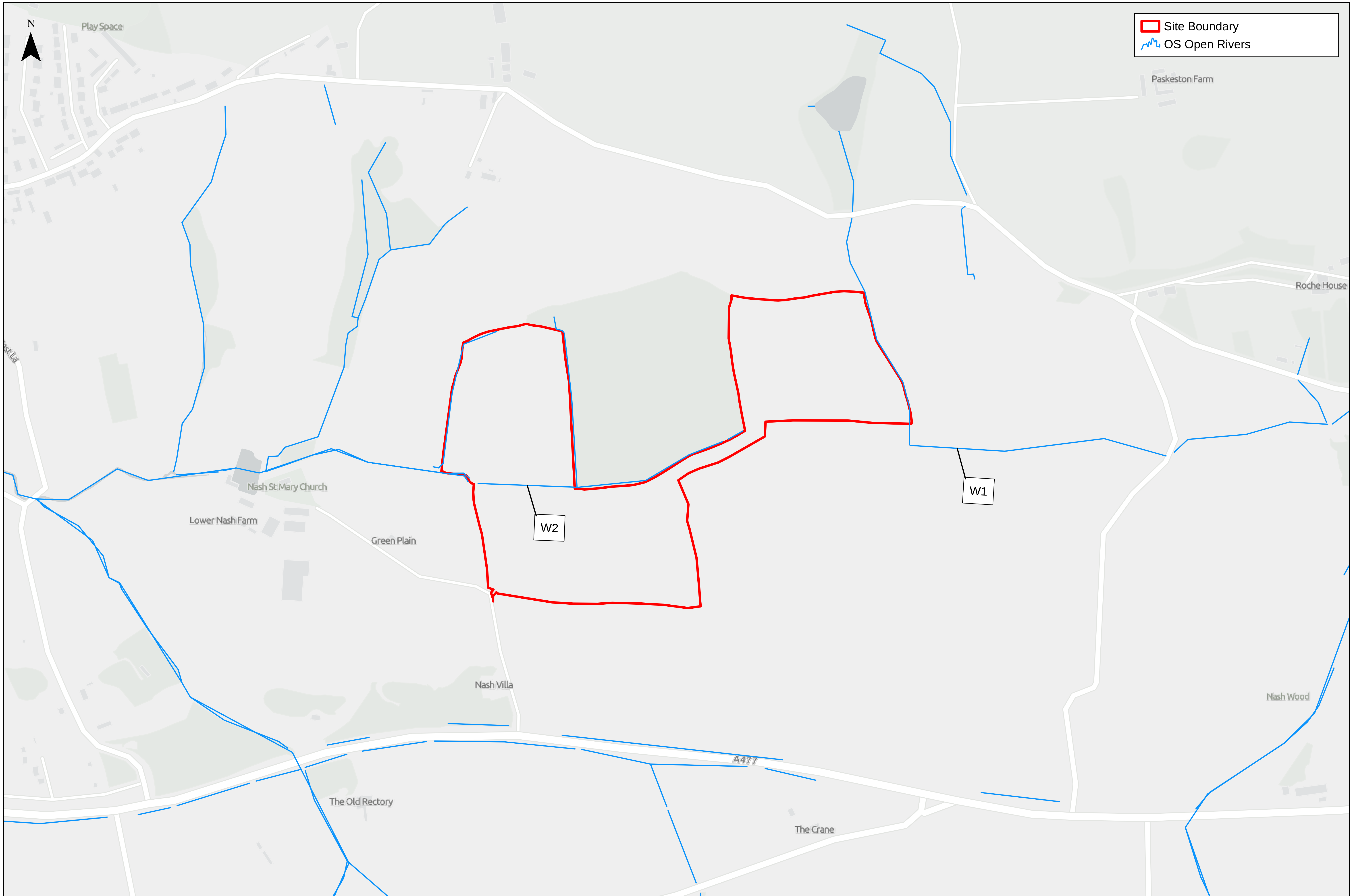
WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

NRW Flood Zones for Rivers

1:5,000 @ A3	Date: 21/11/2023
Drawn: JP	Checked: EE
Figure: 04	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx



Client

WESSEX SOLAR ENERGY

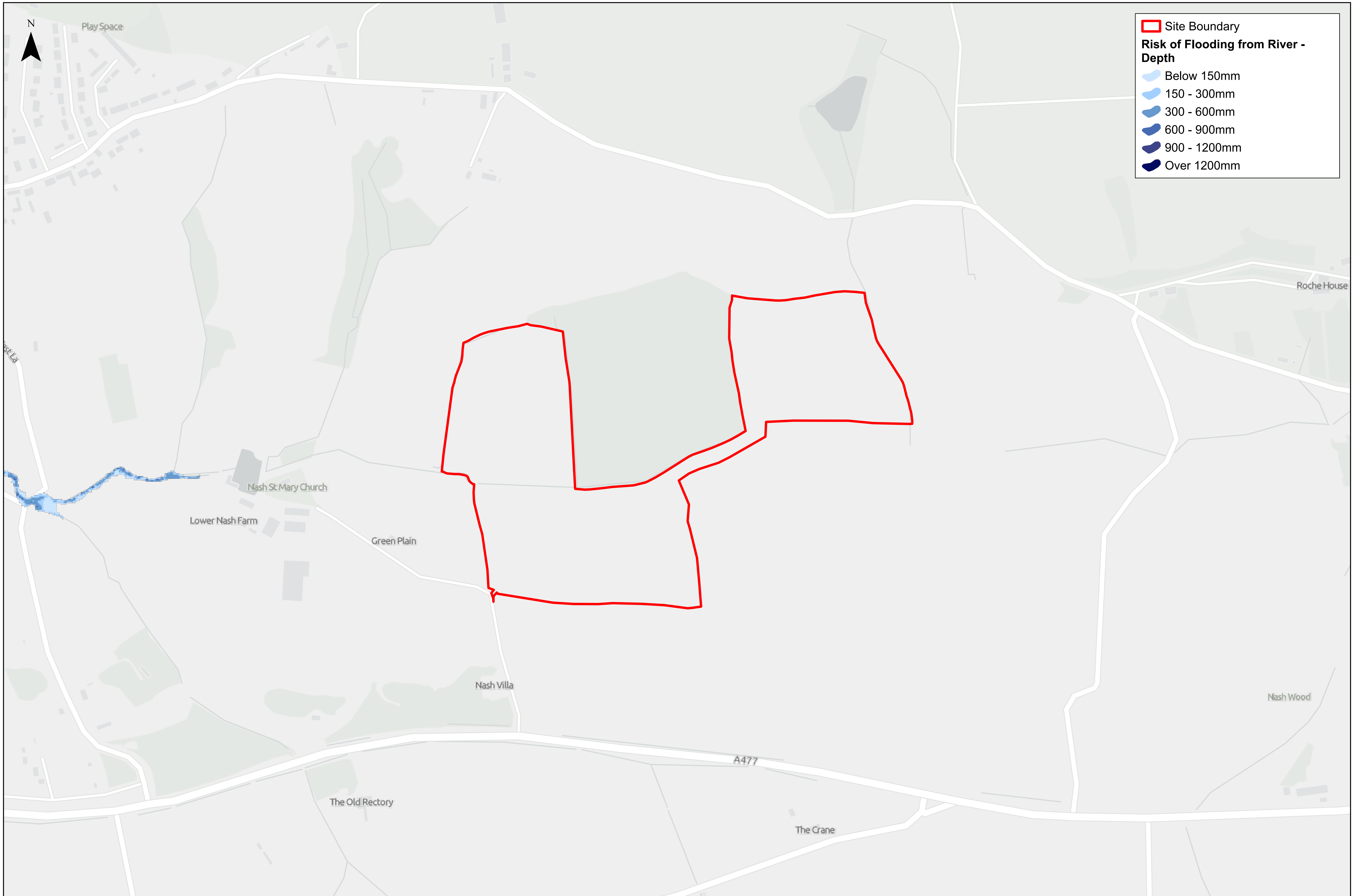
BLACKBERRY LANE SOLAR PARK

Watercourse Location

0 250 500 m

1:5,000 @ A3	Date: 20/11/2023
Drawn: JP	Checked: EE
Figure: 04.1	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx



Client

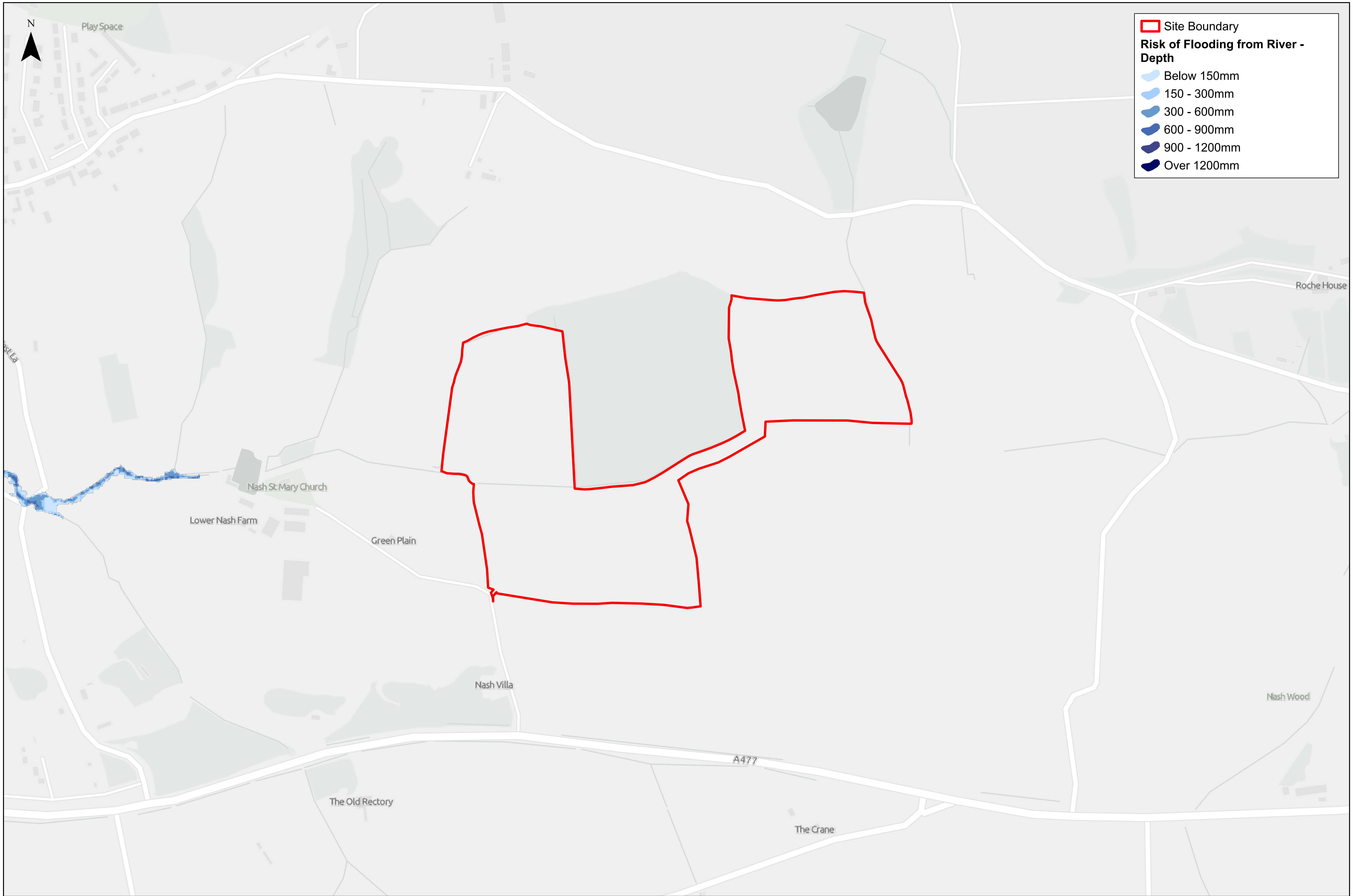
WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

NRW River Water Flood Risk - Depth
3.3 Percent Chance

1:5,000 @ A3	Date: 21/11/2023
Drawn: JP	Checked: EE
Figure: 04.2	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx



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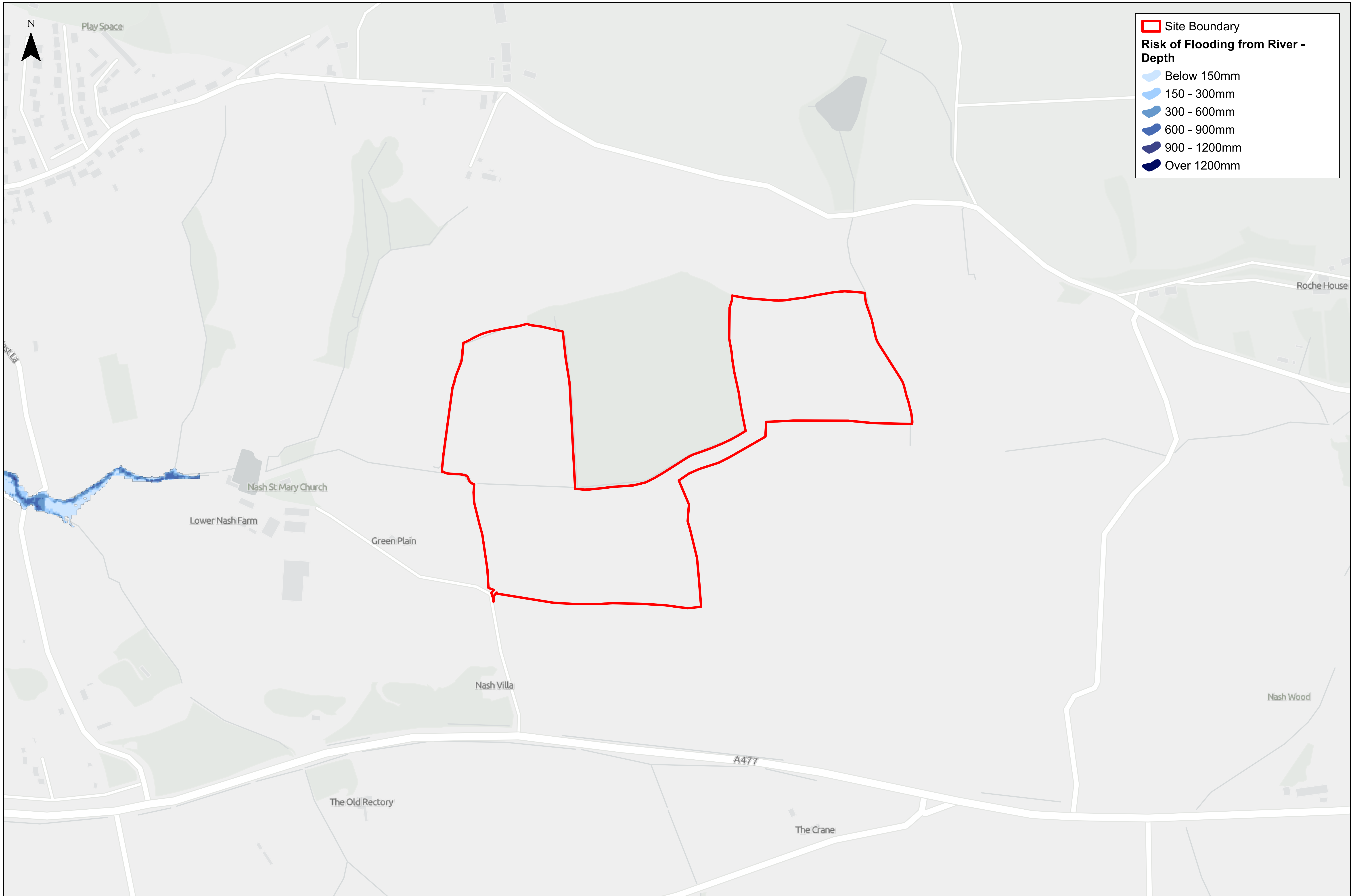
WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

NRW River Water Flood Risk - Depth

1.0 Percent Chance

1:5,000 @ A3	Date: 21/11/2023
Drawn: JP	Checked: EE
Figure: 04.3	Rev: A



Stantec

Client: WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

NRW River Water Flood Risk - Depth

0.1 Percent Chance

0 250 500 m

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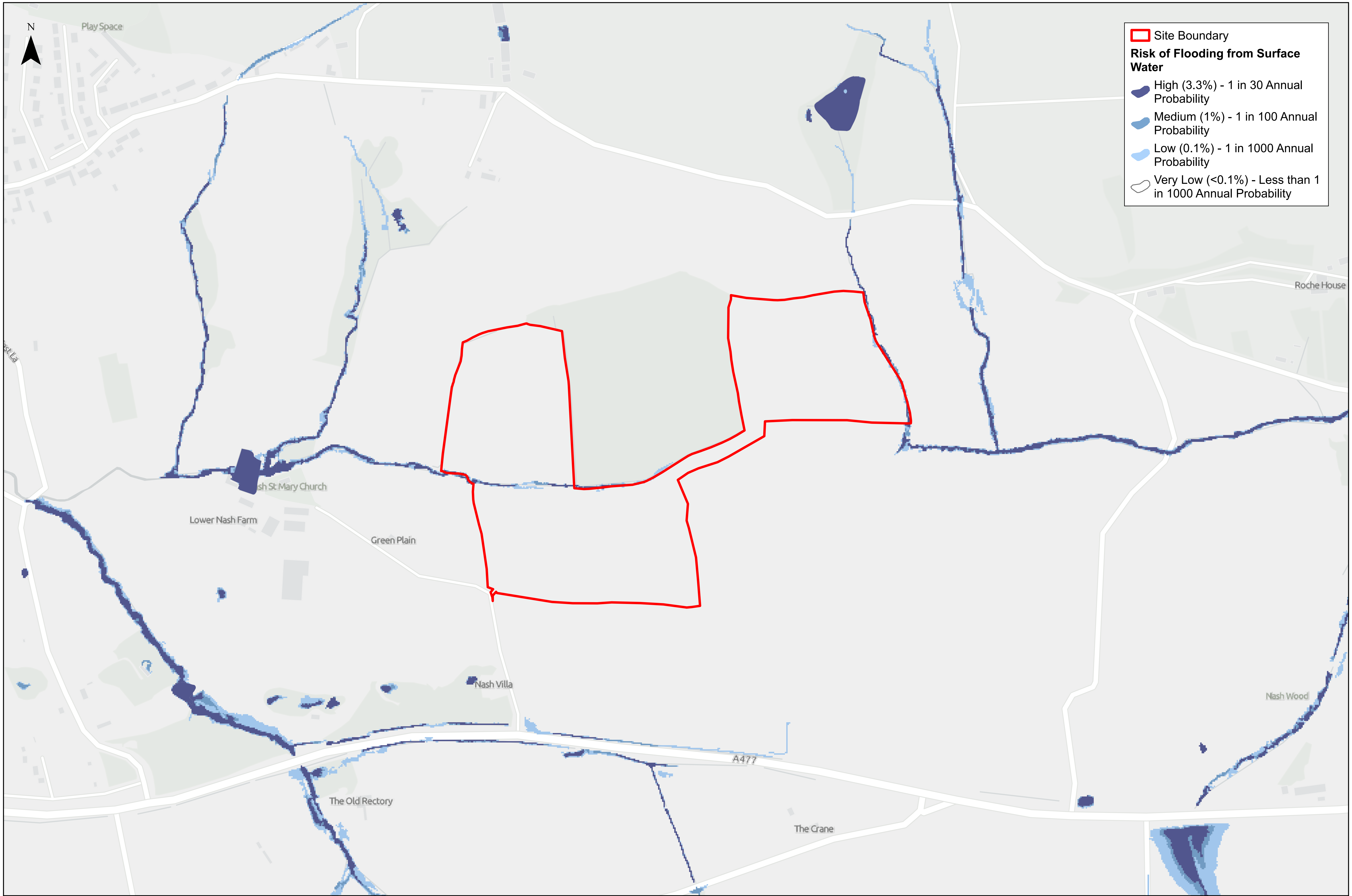
Drawn: JP	Checked: EE
Figure: 04.4	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx



Stantec

Client

WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

NRW Flood Zones for Surface Water and Small Watercourses

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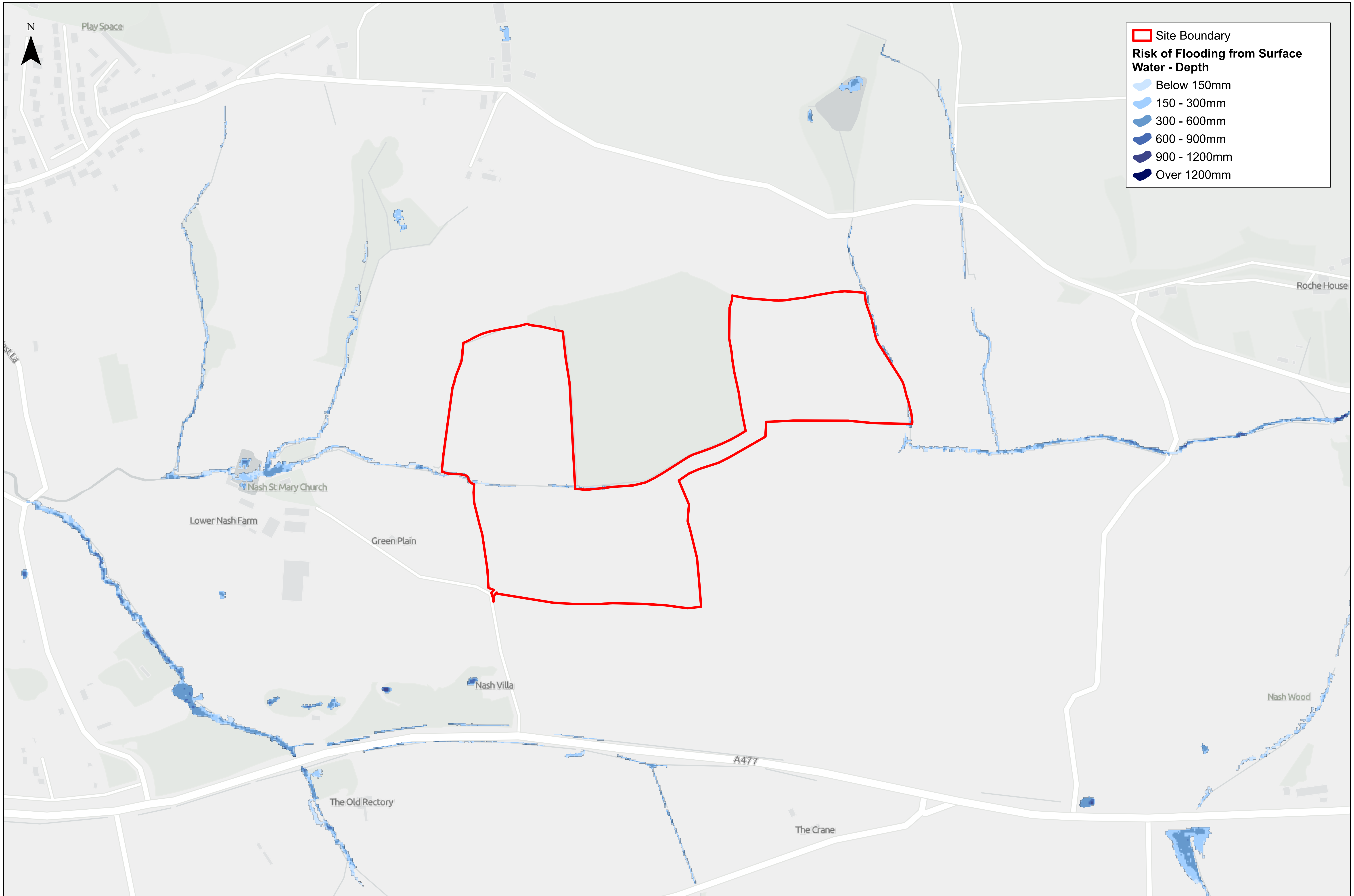
Drawn: JP	Checked: EE
Figure: 05	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx



Stantec

Client

WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

NRW Surface Water Flood Risk - Depth
3.3 Percent Chance

0 250 500 m

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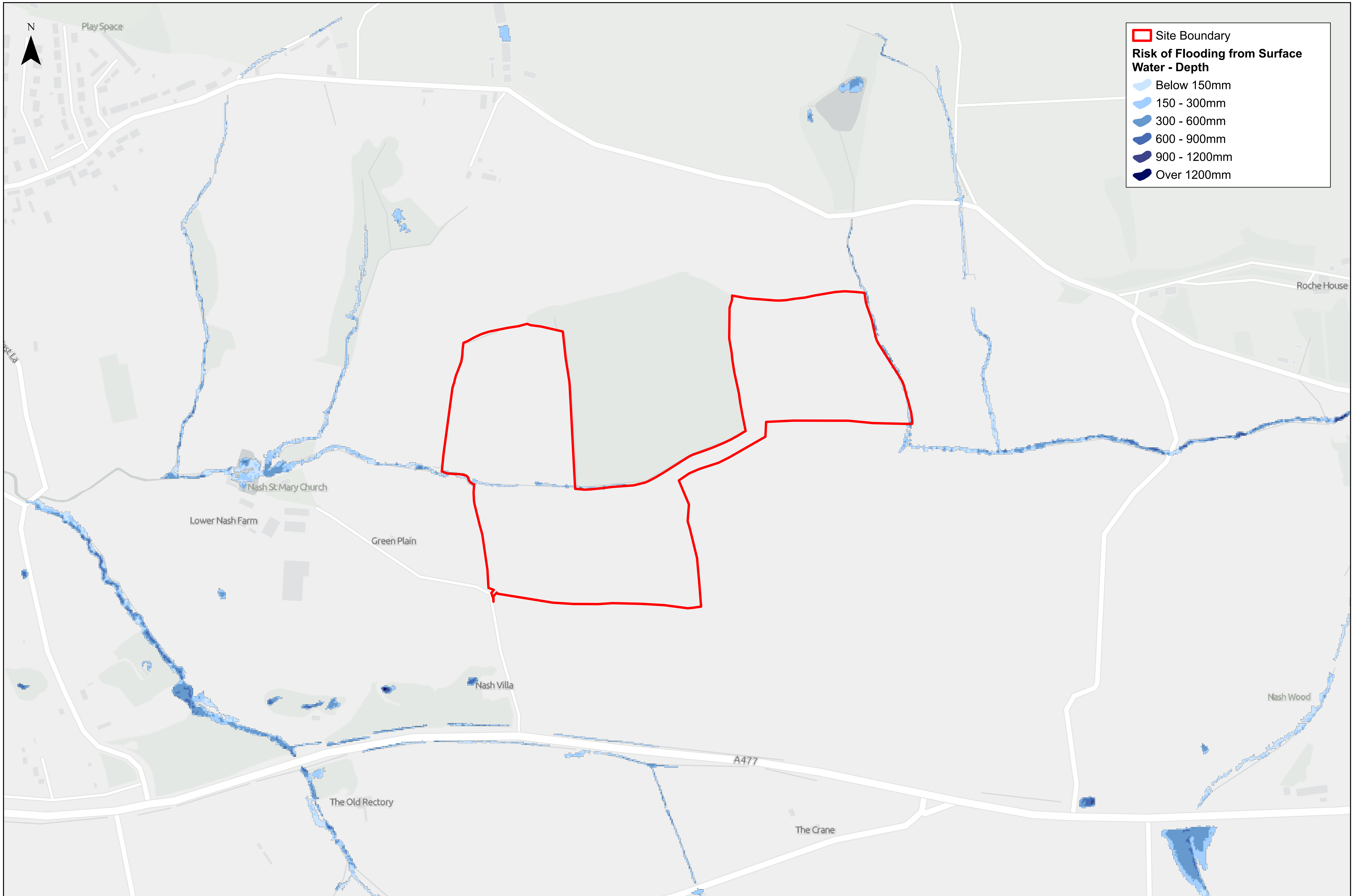
Drawn: JP	Checked: EE
Figure: 05.1	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx



Stantec

Client

WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

NRW Surface Water Flood Risk - Depth
1.0 Percent Chance

0 250 500 m

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Drawn: JP	Checked: EE
Figure: 05.2	Rev: A

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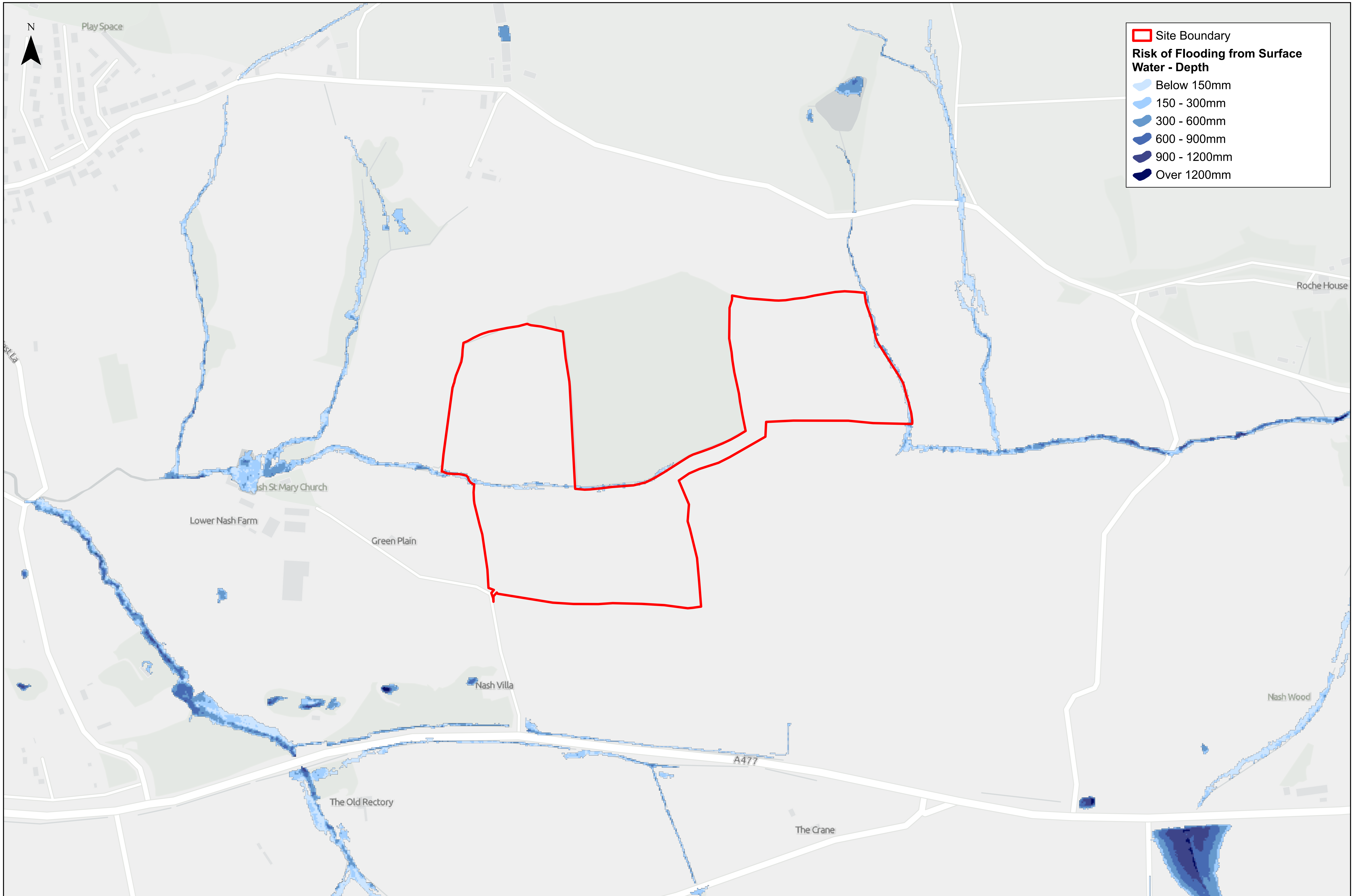

Client

WESSEX SOLAR ENERGY

Stantec

BLACKBERRY LANE SOLAR PARK

NRW Surface Water Flood Risk - Depth
0.1 Percent Chance

0 250 500 m

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Figure: 05.3	Rev: A

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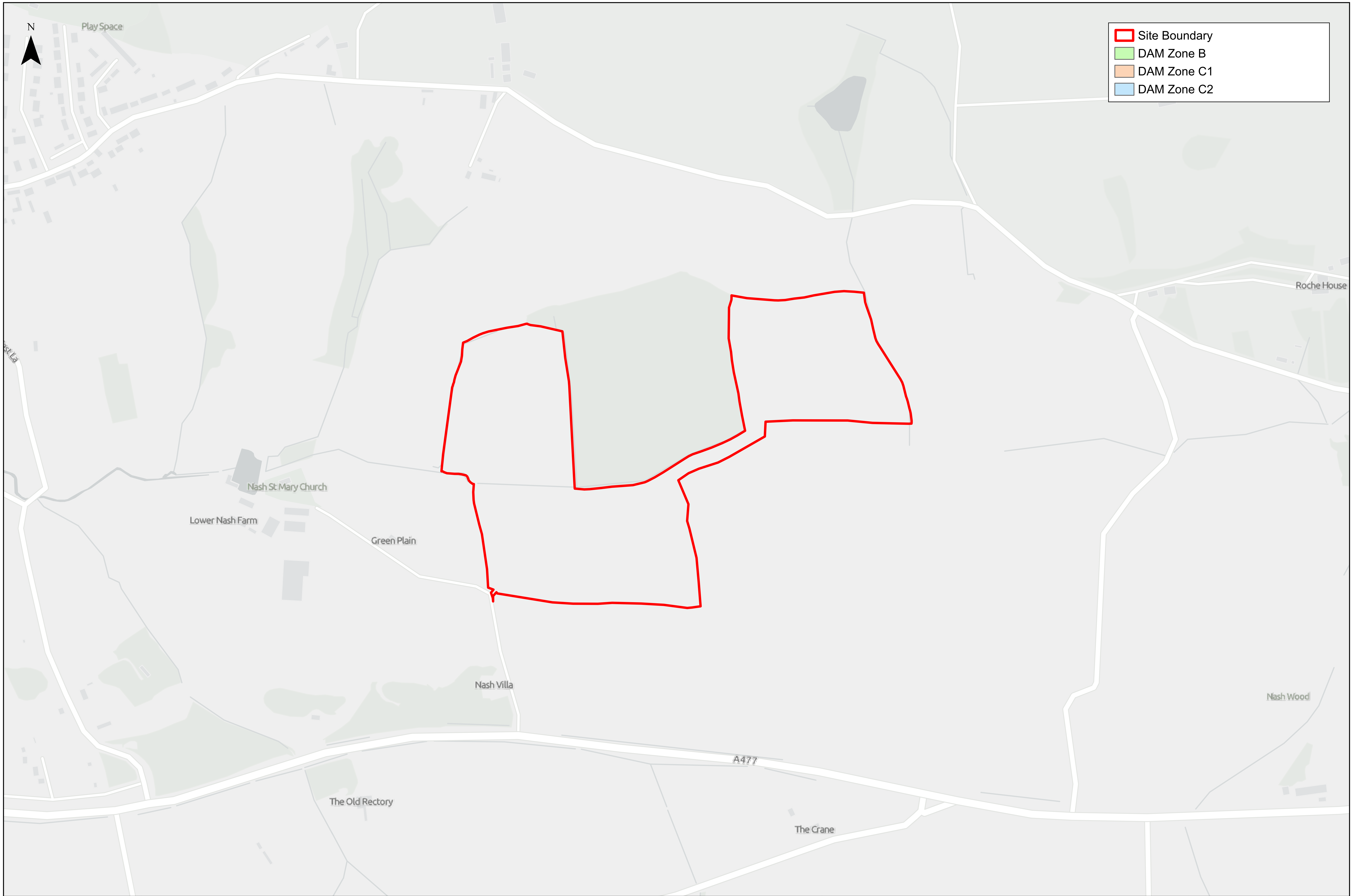

Stantec

Client

WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

Development Advice Map (DAM) Zones

0 250 500 m

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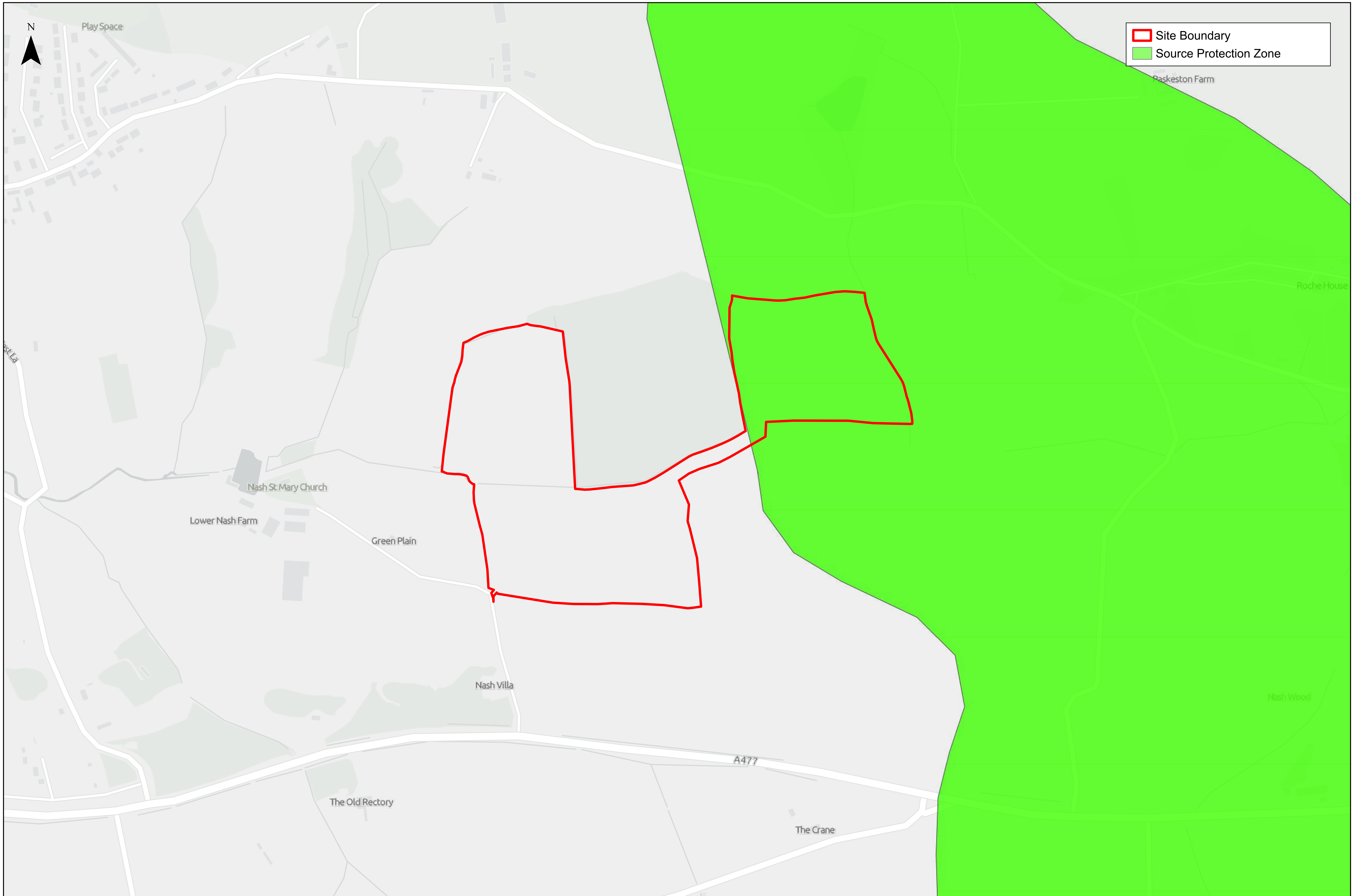
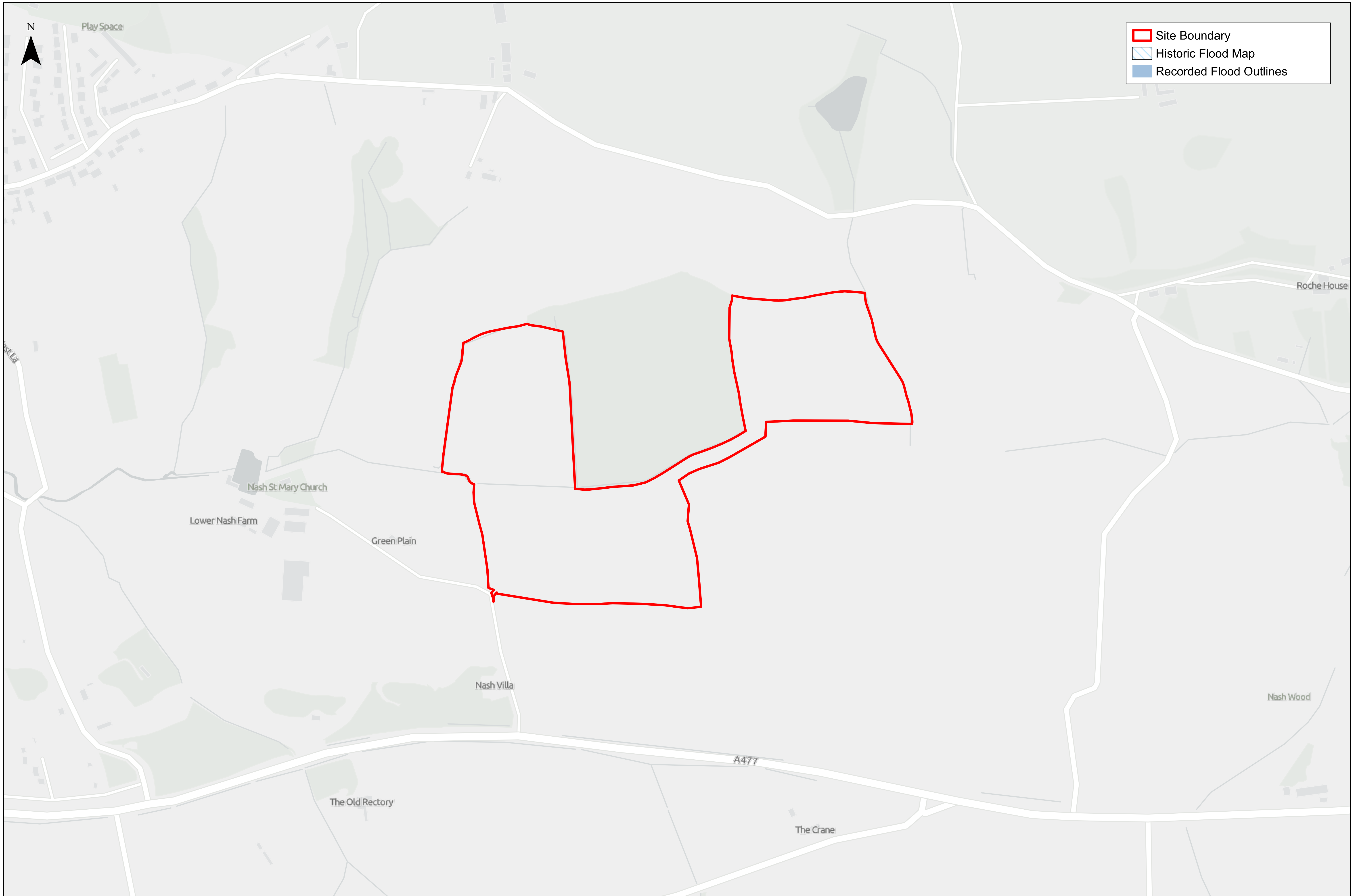
Drawn: JP	Checked: EE
Figure: 06	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx



Stantec	Client WESSEX SOLAR ENERGY	**BLACKBERRY LANE SOLAR PARK** NRW Ground Water Source Protection Zones	0 250 500 m	1:5,000 @ A3	Date: 21/11/2023
				Drawn: JP	Checked: EE
				Figure: 07	Rev: A



Stantec

Client

WESSEX SOLAR ENERGY

BLACKBERRY LANE SOLAR PARK

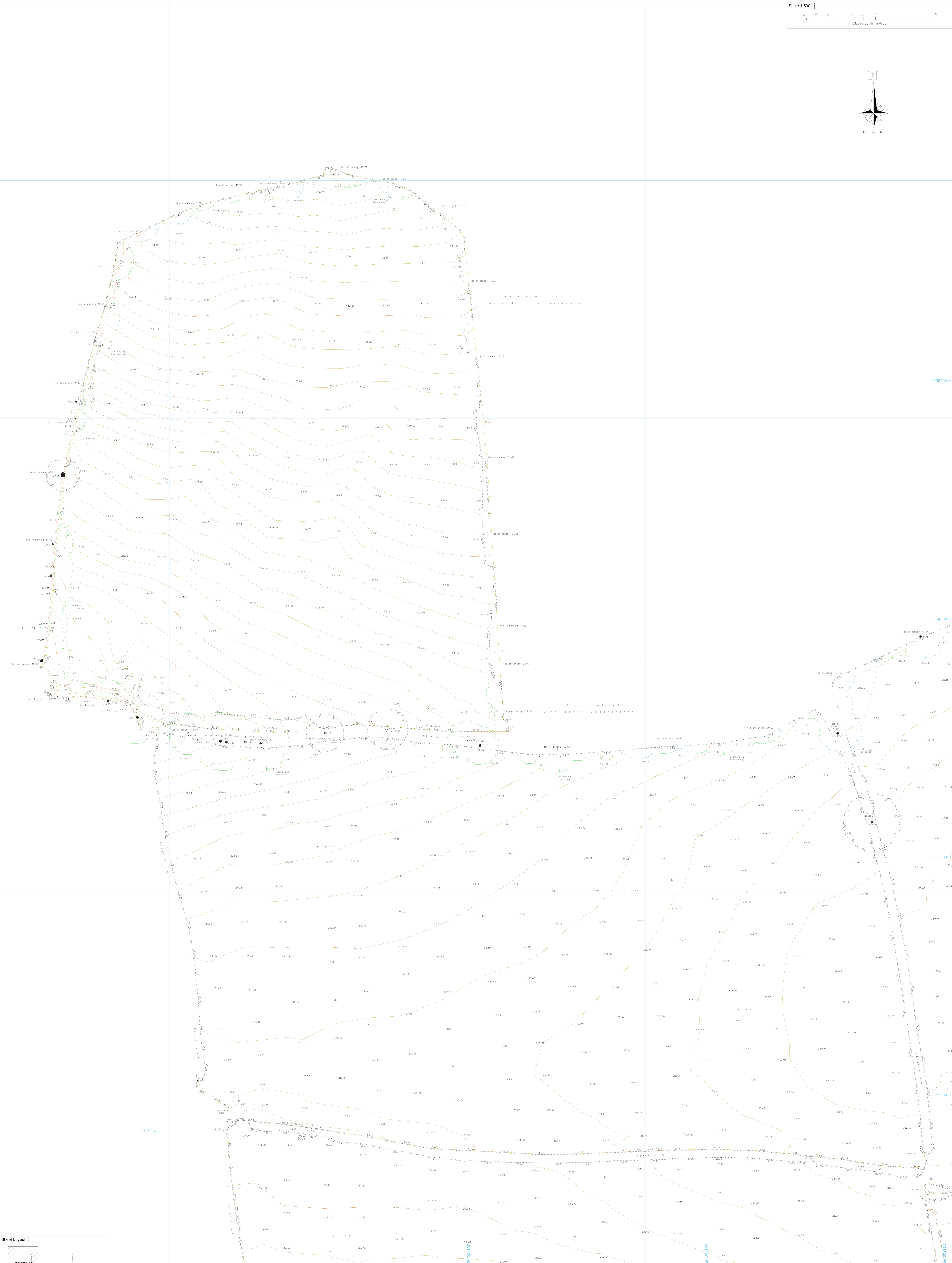
NRW Recorded Historic Flood Extents

1:5,000 @ A3	Date: 21/11/2023
Drawn: JP	Checked: EE
Figure: 08	Rev: A

Document Path: C:\Projects\332610851\332610851.aprx

Appendix B Topographic Survey

- Azimuth Land Surveys Ltd. Drawing WE2665-01 & 03 dated November 2013



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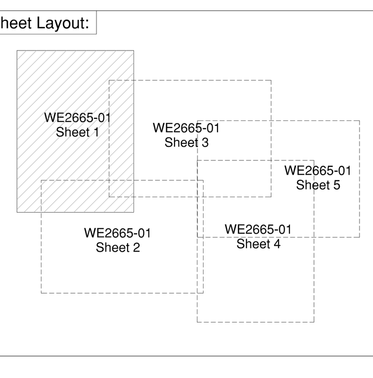

THE SURVEY ASSOCIATION

AZIMUTH GEO DATA-AZIMUTH LAND SURVEYS

Ordnance Survey ® Ordnance Survey Licensed Partner

Planning Maps - Vector Mapping - Raster Mapping - Aerial Imagery - Historical Mapping - Environmental Data - Land Registry Title Plans

www.azimuthgeodata.co.uk

Abbreviations:

B/RW	brick retaining wall
BB	Belisha beacon
BI	bollard (illuminated)
BL	bollard
BT	telecom inspection cover
BW	brick wall
C/RW	concrete retaining wall
CATV	cable television cover
CB	close boarded
CM	corrugated metal
conc.	concrete
CP/BW	concrete post & barbed wire
CP/CL	concrete post & chain link
CP/CP	concrete post & panel
CP/W	concrete post & wire mesh
CPS	concrete paving slabs
DC	drainage channel
DK	drop kerb
DR	drain
EP	electricity pole
ER	earthing rod
FB	flower bed
FFL	finished floor level
FS	flagstaff
G/W	gabion wall
GP	gate post
GV	gas valve
HR	handrail
HY	fire hydrant
IC	inspection cover (general)
IR	metal railings
Iwn	interwoven wood slat
JB	junction box
KO	kerb outlet
LP	lamp post
MH	manhole
MK	marker
MM	metal mesh
MP	mile post
NB	name board
O/H	overhead
OB	open boarded
OHC	overhead cable/wire
P/C	post & chain fence
PA	paling
PO	post
RE	rodding eye
RG	road gully
RP	reflector post
RS	road sign
RSJ	rolled steel joint
RWP	rain water pipe
S/RW	stone retaining wall
Sap.	sapling
SP	sign post
SPS	stone paving slabs
stay	stay wire
STN	survey control station
SV	water stop valve
SVP	soil vent pipe
tact.	tactile paving
THL	threshold level
TL	traffic light
TP	telephone pole
VP	vent pipe
Wlap	wood lap
WM	water meter
WP/BW	wood post & barbed wire
WP/R	wood post & rail
WP/W	wood post & wire
ht	height (of feature)
↑	arrow indicates up (unless otherwise stated)
△9002	survey control point

Drainage features:

CL	cover level
ID	invert depth
IL	invert level
FWS	foul water sewer
SWS	storm water sewer
CWS	combined water sewer
UTD	unable to determine
UTL	unable to lift
ø	pipe diameter (mm)
SL	soffit level
←	arrow indicates direction of flow

Notes:

Revisions:

ALS

- Topographical Surveys
- Engineering Surveys
- Measured Building Surveys
- Boundary Surveys
- OS Mapping and Data Centre
- Europe - Africa - Middle East

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Tel: 01633 263575 Fax: 01633 213767

Land adjacent to Blackberry Lane Pembrokeshire, SA72 4SU

Topographical Survey - Sheet 1

Client	Wessex Solar Energy						
Coord Grid	Plane Grid Related to National Grid			Level Datum	OSBM via Active GPS Network		
Scale	1:500@A0	Date	Nov. 2013	Status	Final	Job No.	WE2665
Surveyed	A. Jolliffe	Drawn	R. Williams	Checked	R. Williams	Dwg. No.	WE2665-01

Topographical Surveys
Engineering Surveys
Measured Building Surveys
Boundary Surveys
OS Mapping and Data Centre
Europe - Africa - Middle East

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Tel: 01633 263575 Fax: 01633 213767

Land adjacent to Blackberry Lane
Pembrokeshire, SA72 4SU

Topographical Survey - Sheet 3

Client	Wessex Solar Energy						
Coord Grid	Plane Grid Related to National Grid			Level Datum	OSBM via Active GPS Network		
Scale	1:500@A0	Date	Nov. 2013	Status	Final	Job No.	WE2665
Surveyed	A. Jolliffe	Drawn	R. Williams	Checked	R. Williams	Dwg. No.	WE2665-01

Appendix C Trial Pit Logs

- Soakaway Test Results by CC Ground Investigations Ltd. dated June 2020

CC GROUND INVESTIGATIONS LTD

SOAKAWAY TEST

Telephone: 01452 739165, Fax: 01452 739220, Email: info@ccground.co.uk

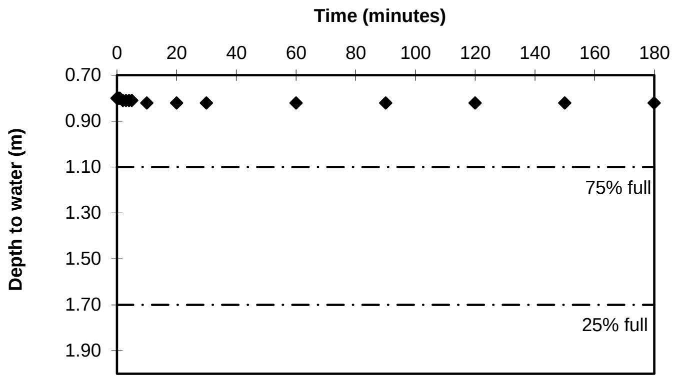
		Pit No **TP4** Sheet 1 of 1
Project Name: Blackberry Lane	Project No: C6755	Date 05/06/2020
Location: Pembroke, Pembrokeshire		Logged By MM
Client: Wessex Solar Power Ltd		Checked By MA

TEST 1:

LENGTH	2.00	m
BREADTH	0.70	m
DEPTH	2.00	m
WATER LEVEL	Dry	
FILL LEVEL	0.80	m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **m/s^{-1}**

Insufficient soakaway to calculate infiltration rate



REMARKS:

Test carried out in general accordance with BRE 365 (2016).

CC GROUND INVESTIGATIONS LTD

SOAKAWAY TEST

Telephone: 01452 739165, Fax: 01452 739220, Email: info@ccground.co.uk

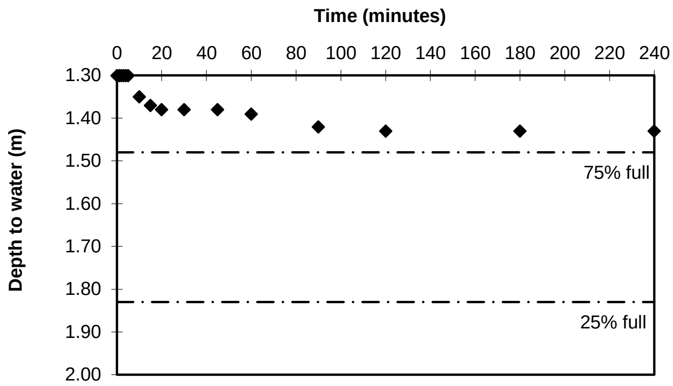
		Pit No **TP57** Sheet 1 of 1
Project Name: Blackberry Lane	Project No: C6755	Date 05/06/2020
Location: Pembroke, Pembrokeshire		Logged By MM
Client: Wessex Solar Power Ltd		Checked By MA

TEST 1:

LENGTH	2.10	m
BREADTH	0.80	m
DEPTH	2.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.30	m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **m/s^{-1}**

Insufficient soakaway to calculate infiltration rate



REMARKS:

Test carried out in general accordance with BRE 365 (2016).

CC GROUND INVESTIGATIONS LTD

SOAKAWAY TEST

Telephone: 01452 739165, Fax: 01452 739220, Email: info@ccground.co.uk

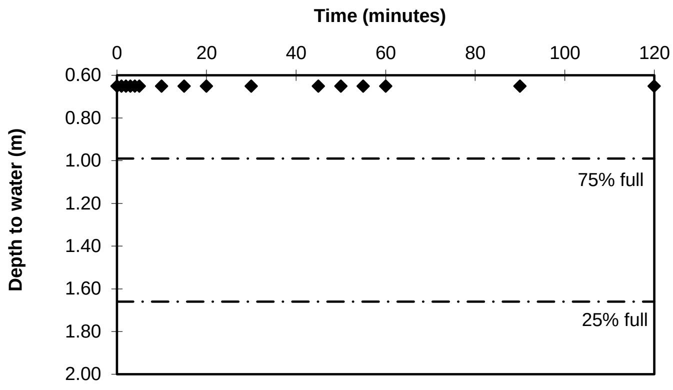
Project Name: Blackberry Lane	Project No: C6755	Pit No **TP38A** Sheet 1 of 1
Location: Pembroke, Pembrokeshire		Date 05/06/2020
		Logged By MM
Client: Wessex Solar Power Ltd		Checked By MA

TEST 1:

LENGTH	2.00 m
BREADTH	0.70 m
DEPTH	2.00 m
WATER LEVEL	Dry
FILL LEVEL	0.65 m
v_{p75-25}	m^3
a_{p50}	m^2
t_{p75-25}	min

soil infiltration rate, *f* **m/s^{-1}**

Insufficient soakaway to calculate infiltration rate



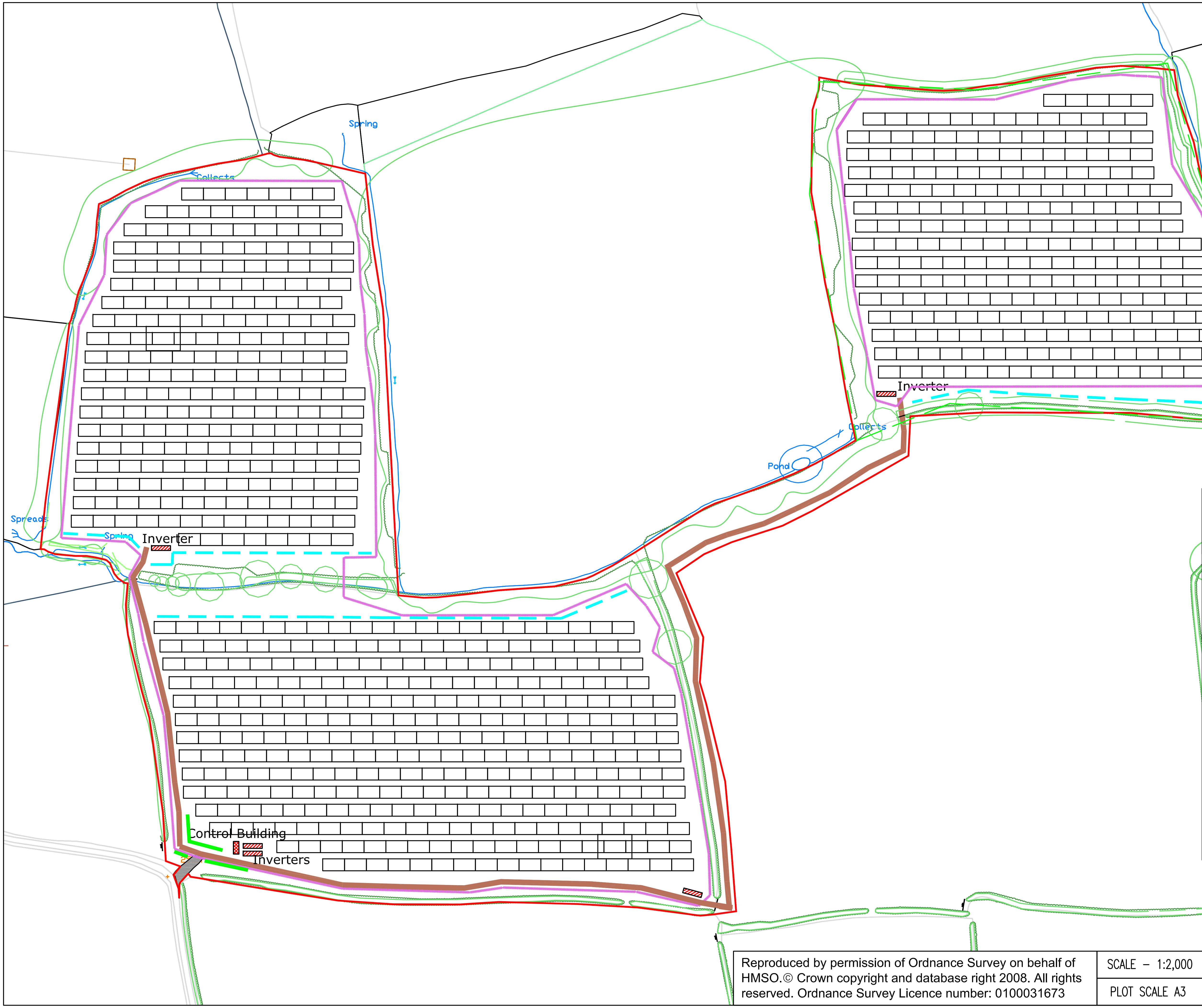
REMARKS:

Test carried out in general accordance with BRE 365 (2016).

Appendix D Wessex Solar Energy Drawings

Phoenix Solar Park Figures:

- 1.2 Site Boundary and Indicative Layout
- 6.1 Mounted Panel Dimensions
- 6.2A Inverter Cabin
- 6.2B Control Building
- 6.3 Indicative Access Track Cross-Section
- 6.6 Temporary Site Compound Layout



Note: Swales will be 0.-0.23m deep, 0.15-0.4m wide within their base, with 1 in 4 side slopes and >5% gradient.

KEY

- PLANNING BOUNDARY
- NEW ACCESS TRACK
- NEW SECURITY FENCE
- NEW SECURITY GATE
- EXISTING DITCHES AND RIVER
- PROPOSED NEW SWALES
- EXISTING VEGETATION
- NEW HEDGEROW PLANTING
- NEW HARDSTANDING

PHOENIX SOLAR PARK

FIGURE 1.2

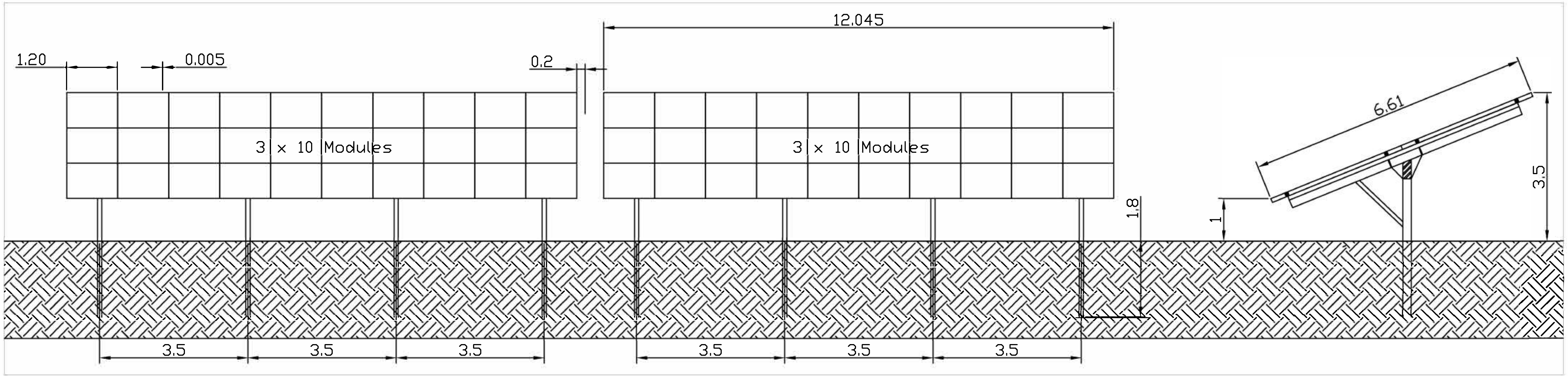
SITE BOUNDARY AND INDICATIVE LAYOUT

Drawn:	CPA
Checked:	WSE
Approved:	APPROVED
REV A:	02/10/23
REV B:	19/12/23

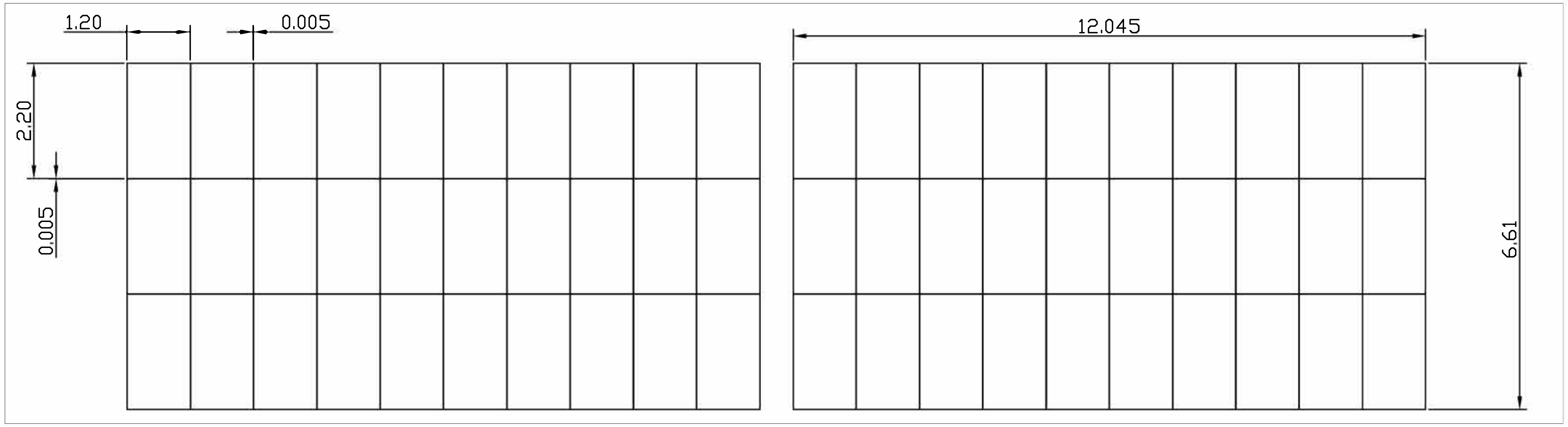
WESSEX SOLAR ENERGY

SCALE – 1:2,000

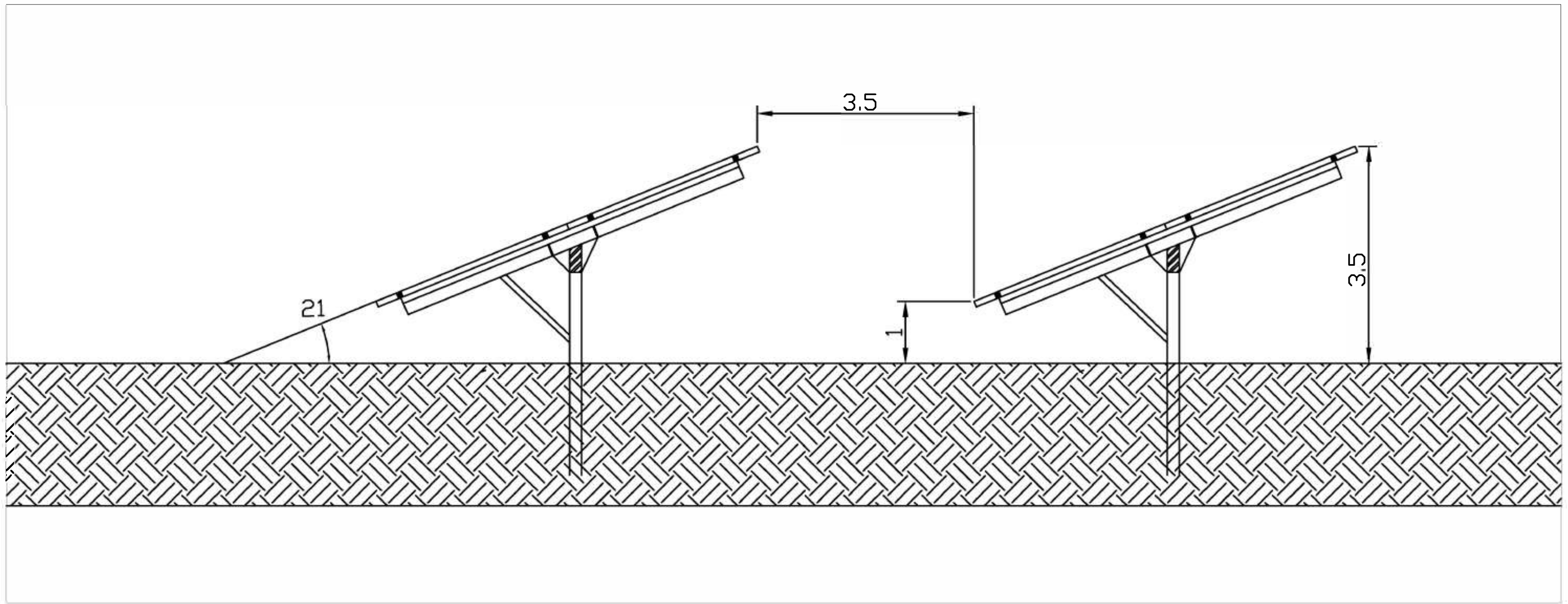
PLOT SCALE A3



South Elevation



Top Elevation



Notes

1. The number and spacing depths of mounting columns are given for information only. These details may change depending on the particular soil conditions and wind and snow loadings on individual sites.

2. Dimensions are indicative and may vary.

3. All sizes are in metres unless otherwise stated.

East Elevation

5m

PHOENIX SOLAR PARK

FIGURE 6.1

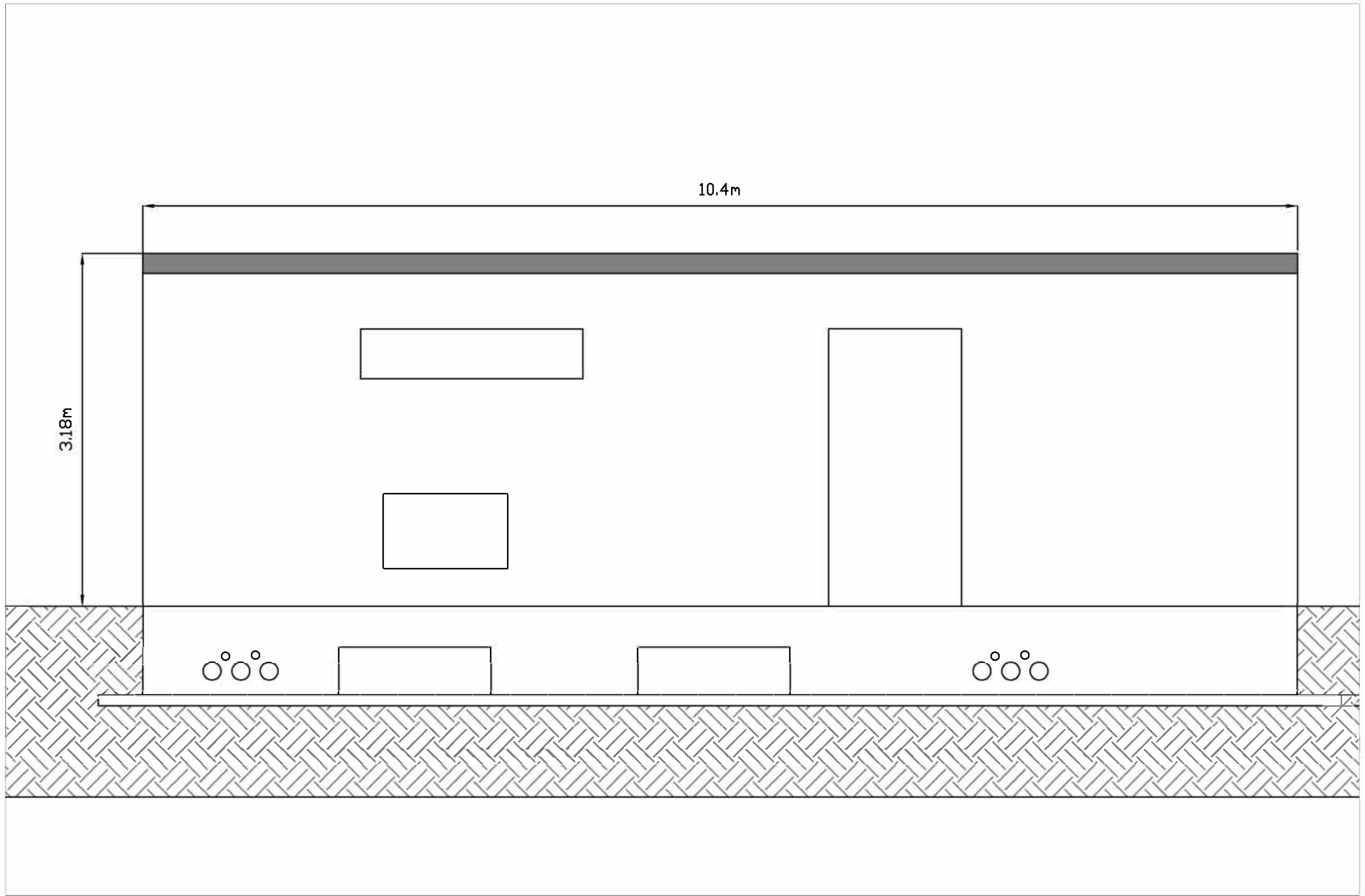
MOUNTED PANEL DIMENSIONS

SCALE – 1:100

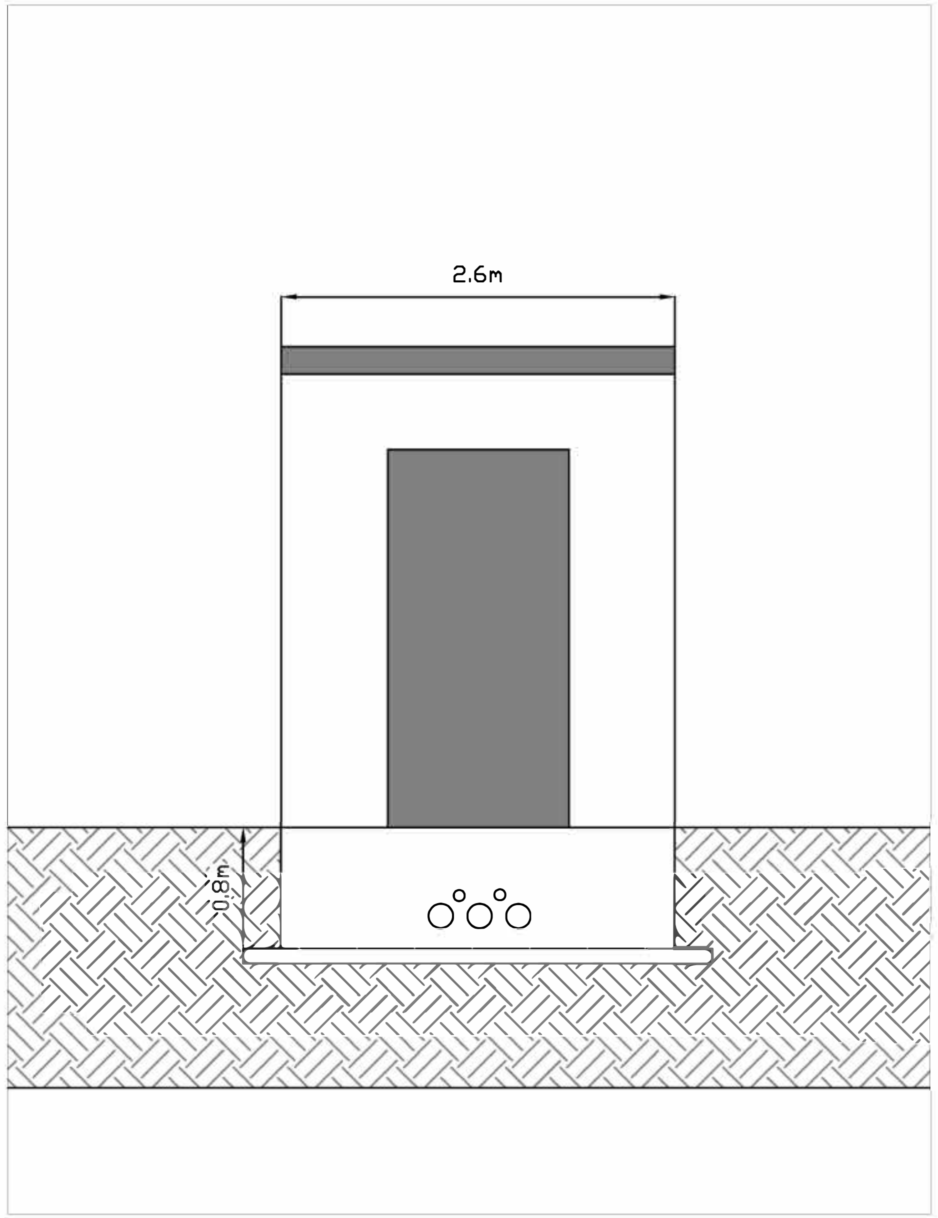
PLOT SCALE A3

Drawn: CPA
Checked: WE
Approved: APPROVED
Date: 06/10/23

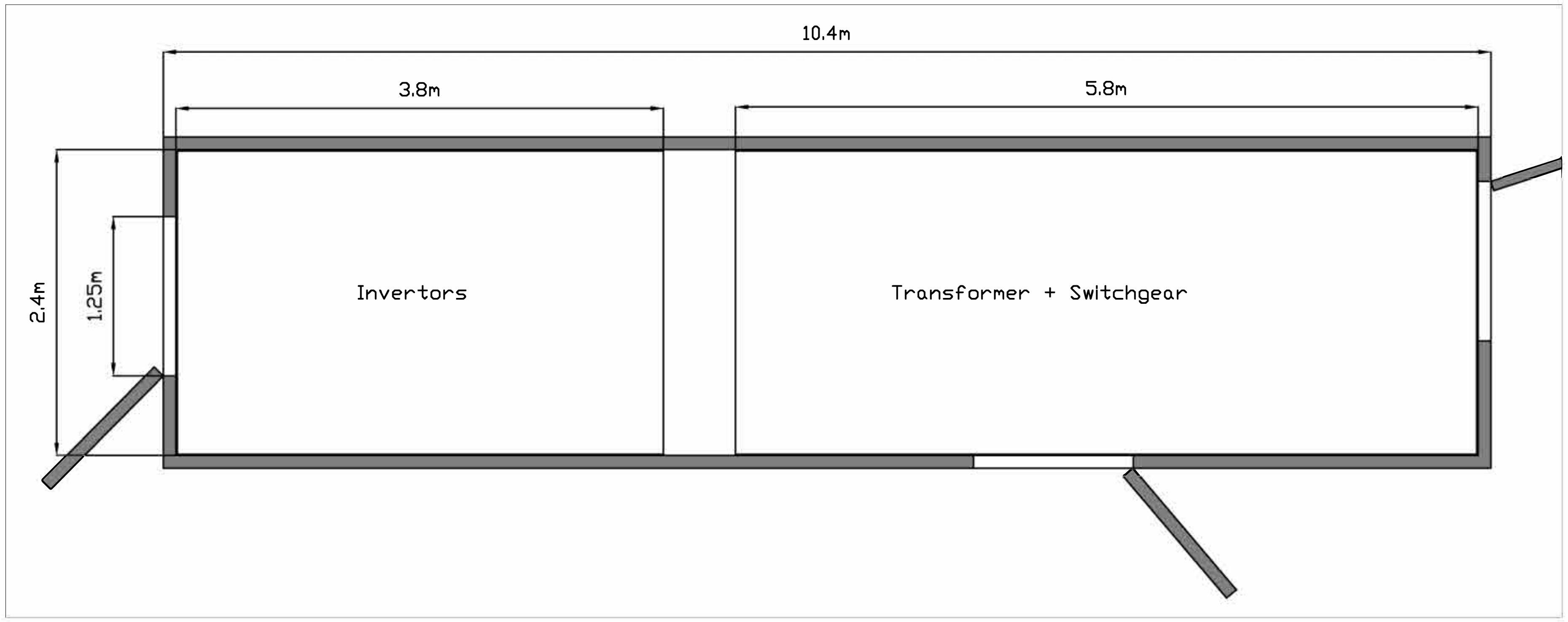
Wessex Solar Energy



FRONT ELEVATION



SIDE ELEVATION



PHOENIX SOLAR PARK

FIGURE 6.2A

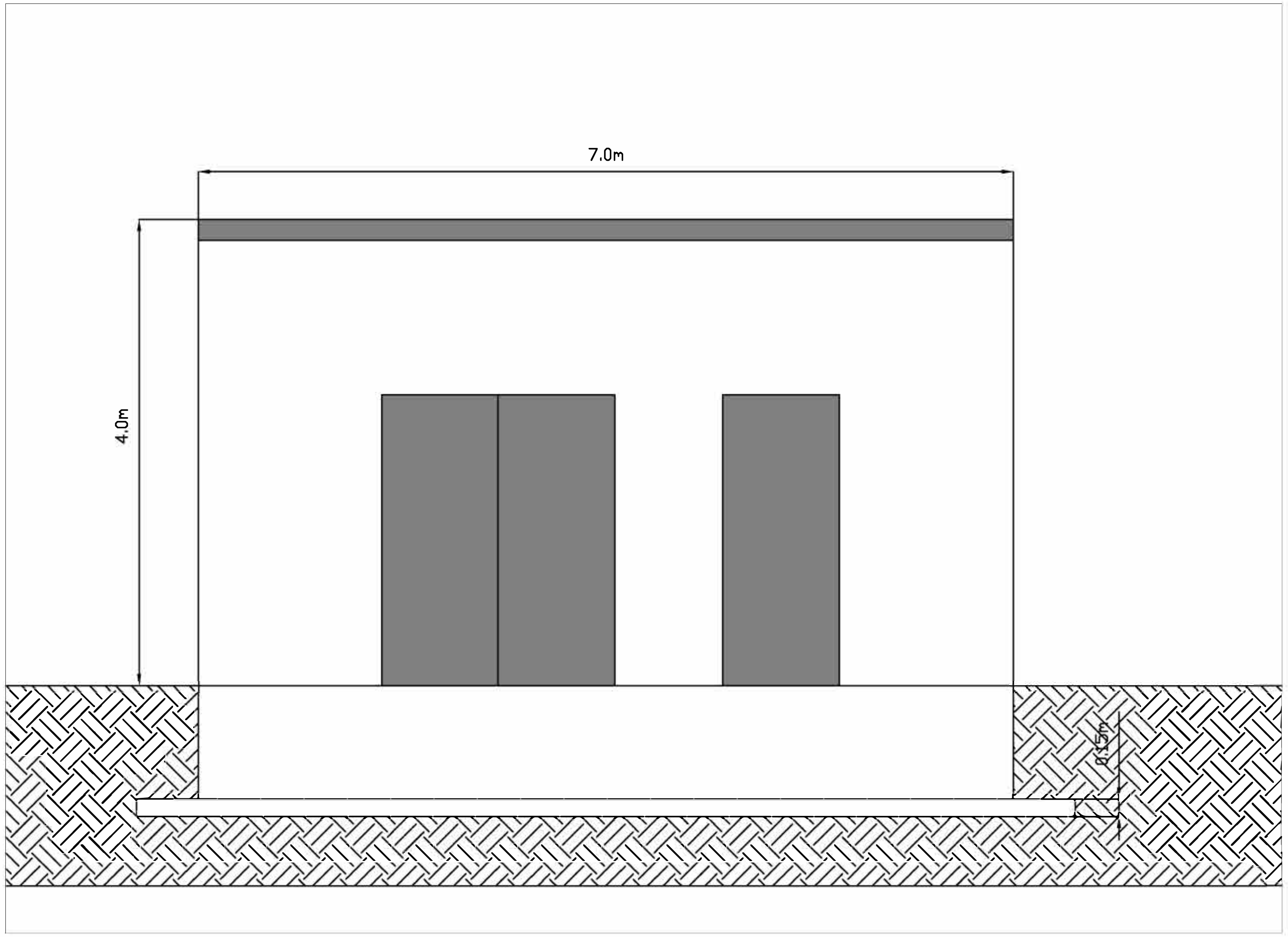
INVERTER CABIN

SCALE 1:50

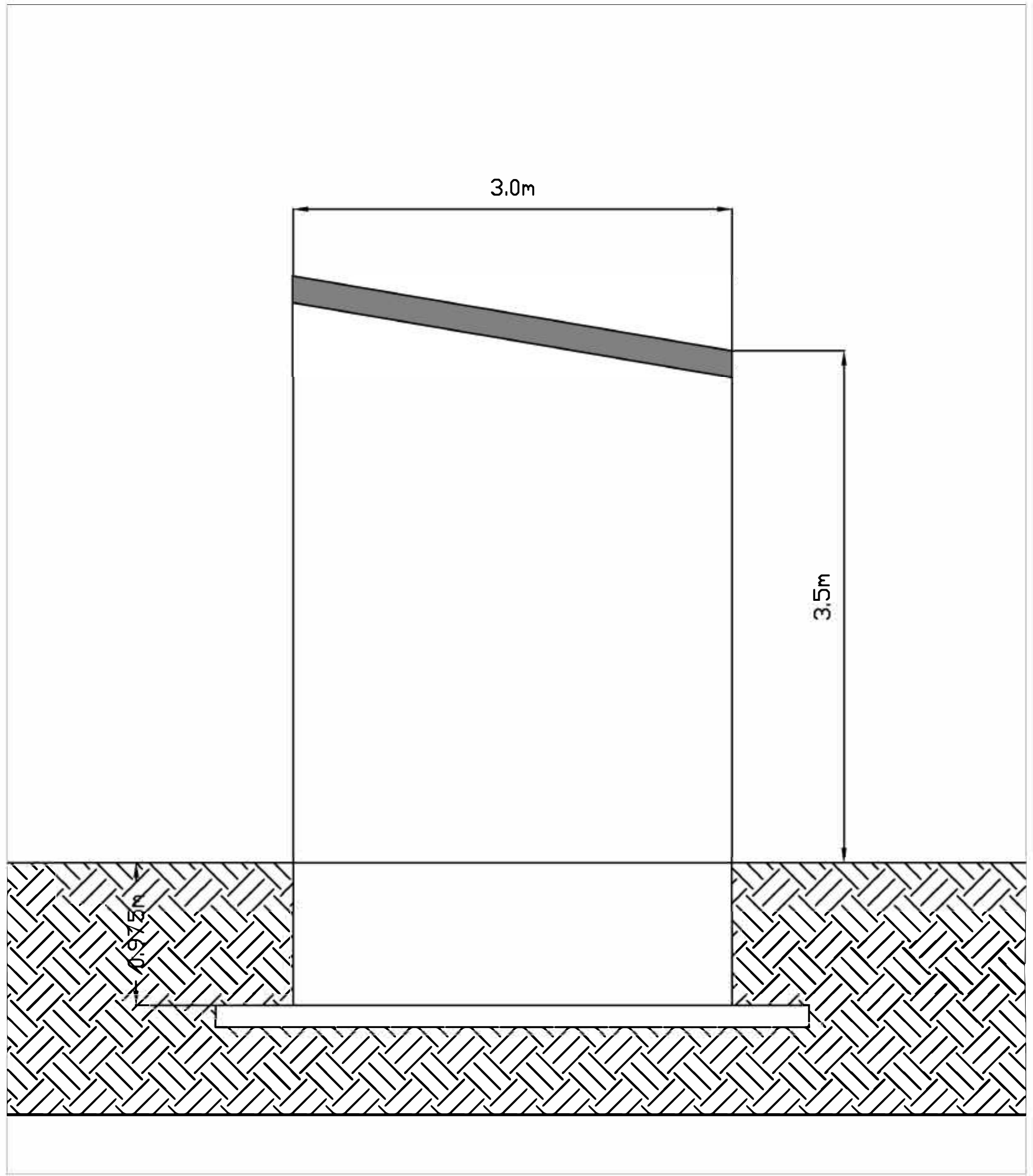
PLOT SCALE A3

Drawn: CPA
Checked: WE
Approved: APPROVED
Date: 19/12/23

Wessex Solar Energy



FRONT ELEVATION

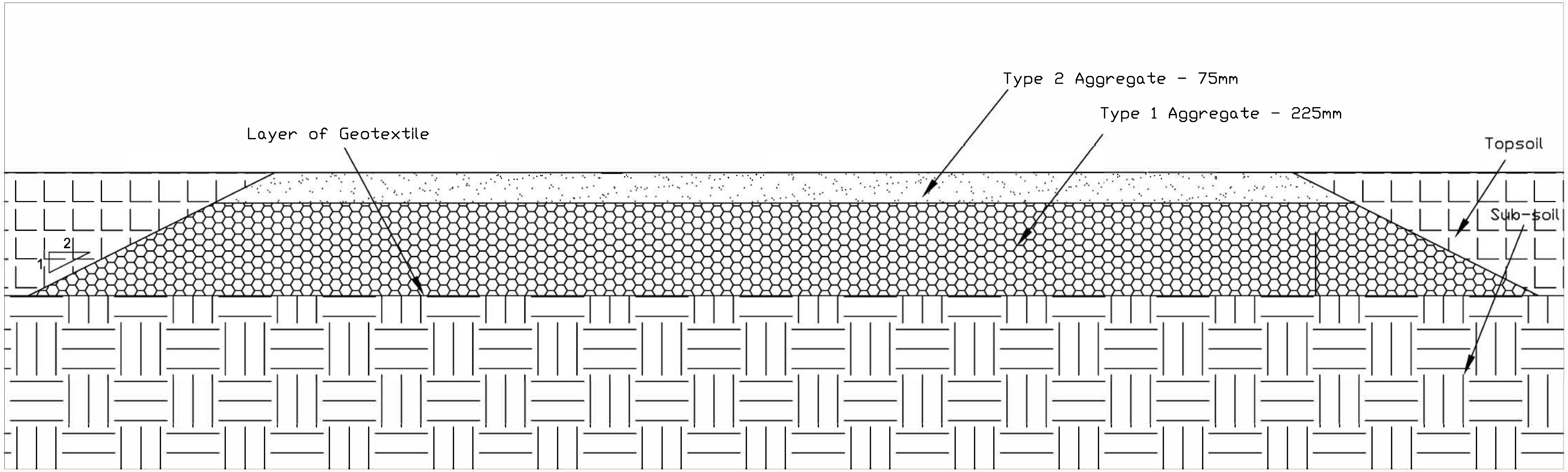


SIDE ELEVATION

PHOENIX SOLAR PARK
FIGURE 6.2B
CONTROL BUILDING

SCALE 1:50	Drawn: CPA Checked: WE Approved: APPROVED Date: 19/12/23
PLOT SCALE A3	

Wessex Solar Energy



Notes

1. 300mm of Topsoil will be stripped to found the road on suitable subsoil.

2. All dimensions are approximate and may vary following detailed design.

PHOENIX SOLAR PARK

FIGURE 6.3

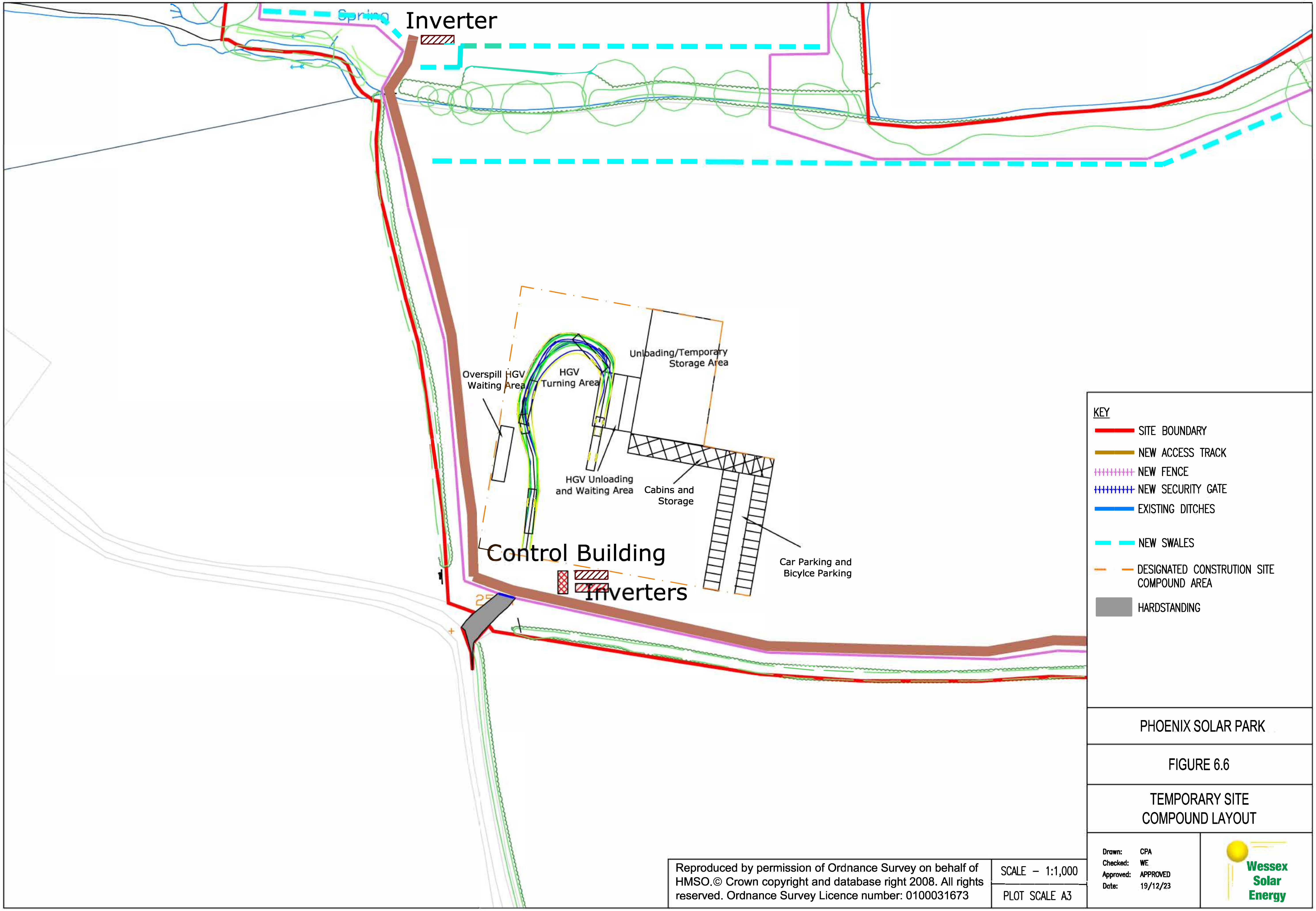
INDICATIVE ACCESS TRACK CROSS -SECTION

SCALE 1:10

PLOT SCALE A3

Drawn: CPA
Checked: WE
Approved: APPROVED
Date: 19/12/23

Wessex Solar Energy



PHOENIX SOLAR PARK

FIGURE 6.6

TEMPORARY SITE COMPOUND LAYOUT

SCALE – 1:1,000

PLOT SCALE A3

Drawn: CPA
Checked: WE
Approved: APPROVED
Date: 19/12/23

Wessex Solar Energy

Appendix E Proposed Drainage Information

- Greenfield Runoff Rates
- WSE Phoenix Solar Park Figure 1.2 with added drainage
- MicroDrainage Source Control Cascade outputs

FEH Greenfield Runoff

Using the 2008 Statistical Method QMED Equation

Stantec

Project Title	Blackberry Solar Farm	
Project No	332610851	100

Methodology as set out in SuDS Manual 24.3.2 — SUDS Manual Chapter 24

1 Retrieve FEH Catchment Information

Define BFIHOST definition source		FEH		*see note 1*
Catchment Descriptors	**BFIHOST**	0.473		
	SAAR	1104.0		*see note 1*
	FARL	1.0		*see note 2*

2 Derive QBAR (mean annual flood)

Define area	**Site Area**	1.0	ha	
	Applied Area	50.0	ha	*see note 3*
FEH Index Flood (SuDS Manual Equation 24.2)	**QMED (Q_2)**	8.5	l/s	*see note 4*
Calculate QBAR by dividing QMED by 2yr growth factor	**QBAR**	9.6	l/s	*see note 5*

3 Select appropriate growth factors

FSR Hydrological Region		9	*(refer to FSR Hydrological Region tab)*
100yr Growth Curve Factor	GQ_{100}	2.42	
30yr Growth Curve Factor	GQ_{30}	1.98	
10yr Growth Curve Factor	GQ_{10}	1.49	
2yr Growth Curve Factor	GQ_2	0.88	
1yr Growth Curve Factor	GQ_1	0.78	

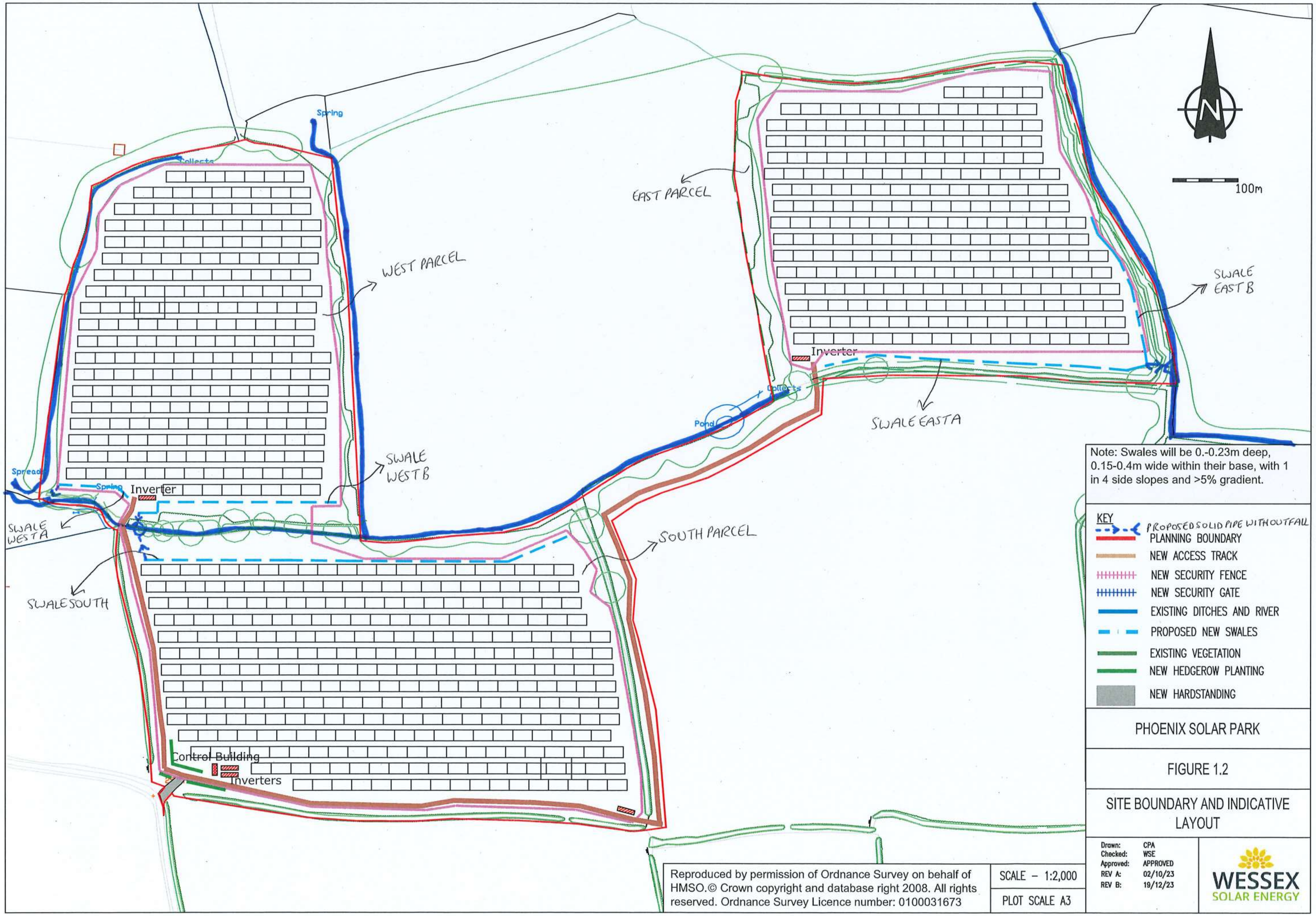
4 Derive Flood Frequency

Greenfield Runoff per 1ha

100yr Peak Runoff Rate	Q_{100}	23.3	l/s	Q_{100}	23.3	l/s/ha
30yr Peak Runoff Rate	Q_{30}	19.1	l/s	Q_{30}	19.1	l/s/ha
10yr Growth Curve Rate	Q_{10}	14.3	l/s	Q_{10}	14.3	l/s/ha
QBAR Peak Runoff Rate	QBAR	9.6	l/s	Q_{BAR}	9.6	l/s/ha
2yr Peak Runoff Rate	Q_2	8.5	l/s	Q_2	8.5	l/s/ha
1yr Peak Runoff Rate	Q_1	7.5	l/s	Q_1	7.5	l/s/ha

DOCUMENT ISSUE RECORD

Rev	Comments	Prepared	Date	Checked	Date
-	Original calculation	E Edney	07/11/2023	J Pulsford	19/12/2023



Note: Swales will be 0.-0.23m deep, 0.15-0.4m wide within their base, with 1 in 4 side slopes and >5% gradient.

KEY

- PROPOSED SOLID PIPE WITHOUTFALL
- PLANNING BOUNDARY
- NEW ACCESS TRACK
- NEW SECURITY FENCE
- NEW SECURITY GATE
- EXISTING DITCHES AND RIVER
- PROPOSED NEW SWALES
- EXISTING VEGETATION
- NEW HEDGEROW PLANTING
- NEW HARDSTANDING

PHOENIX SOLAR PARK

FIGURE 1.2

SITE BOUNDARY AND INDICATIVE LAYOUT

Drawn:	CPA
Checked:	WSE
Approved:	APPROVED
REV A:	02/10/23
REV B:	19/12/23

WESSEX SOLAR ENERGY

SCALE – 1:2,000

PLOT SCALE A3

Cascade Summary of Results for 231218 Blackberry Lane Swale East A.SRCX

Upstream Structures	Outflow To	Overflow To
231218_Blackberry Lane Swale East B.SRCX	(None)	(None)

Half Drain Time : 2 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	24.191	0.171	0.0	7.3	7.3	1.2	O K
30 min Summer	24.190	0.170	0.0	7.2	7.2	1.2	O K
60 min Summer	24.169	0.149	0.0	6.6	6.6	0.9	O K
120 min Summer	24.137	0.117	0.0	4.8	4.8	0.5	O K
180 min Summer	24.120	0.100	0.0	3.8	3.8	0.3	O K
240 min Summer	24.109	0.089	0.0	3.1	3.1	0.3	O K
360 min Summer	24.095	0.075	0.0	2.3	2.3	0.2	O K
480 min Summer	24.084	0.064	0.0	1.9	1.9	0.1	O K
600 min Summer	24.078	0.058	0.0	1.6	1.6	0.1	O K
720 min Summer	24.074	0.054	0.0	1.4	1.4	0.1	O K
960 min Summer	24.070	0.050	0.0	1.2	1.2	0.1	O K
1440 min Summer	24.063	0.043	0.0	0.8	0.8	0.0	O K
2160 min Summer	24.056	0.036	0.0	0.6	0.6	0.0	O K
2880 min Summer	24.053	0.033	0.0	0.5	0.5	0.0	O K
4320 min Summer	24.048	0.028	0.0	0.4	0.4	0.0	O K
5760 min Summer	24.046	0.026	0.0	0.3	0.3	0.0	O K
7200 min Summer	24.044	0.024	0.0	0.3	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	126.207	0.0	4.5	12
30 min Summer	87.218	0.0	6.3	20
60 min Summer	57.895	0.0	8.3	34
120 min Summer	34.230	0.0	9.9	64
180 min Summer	25.256	0.0	10.9	94
240 min Summer	20.381	0.0	11.7	124
360 min Summer	15.080	0.0	13.0	184
480 min Summer	12.158	0.0	14.0	244
600 min Summer	10.281	0.0	14.8	302
720 min Summer	8.961	0.0	15.5	364
960 min Summer	7.212	0.0	16.6	478
1440 min Summer	5.301	0.0	18.3	722
2160 min Summer	3.899	0.0	20.2	1080
2880 min Summer	3.146	0.0	21.7	1444
4320 min Summer	2.340	0.0	24.3	2132
5760 min Summer	1.917	0.0	26.5	2920
7200 min Summer	1.664	0.0	28.8	3624

Cascade Summary of Results for 231218 Blackberry Lane Swale East A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	24.043	0.023	0.0	0.2	0.2	0.0	O K
10080 min Summer	24.042	0.022	0.0	0.2	0.2	0.0	O K
15 min Winter	24.191	0.171	0.0	7.3	7.3	1.3	O K
30 min Winter	24.180	0.160	0.0	6.9	6.9	1.1	O K
60 min Winter	24.152	0.132	0.0	5.7	5.7	0.6	O K
120 min Winter	24.118	0.098	0.0	3.6	3.6	0.3	O K
180 min Winter	24.102	0.082	0.0	2.7	2.7	0.2	O K
240 min Winter	24.091	0.071	0.0	2.2	2.2	0.1	O K
360 min Winter	24.078	0.058	0.0	1.6	1.6	0.1	O K
480 min Winter	24.073	0.053	0.0	1.3	1.3	0.1	O K
600 min Winter	24.069	0.049	0.0	1.1	1.1	0.1	O K
720 min Winter	24.067	0.047	0.0	1.0	1.0	0.1	O K
960 min Winter	24.061	0.041	0.0	0.8	0.8	0.0	O K
1440 min Winter	24.055	0.035	0.0	0.6	0.6	0.0	O K
2160 min Winter	24.050	0.030	0.0	0.4	0.4	0.0	O K
2880 min Winter	24.047	0.027	0.0	0.3	0.3	0.0	O K
4320 min Winter	24.043	0.023	0.0	0.3	0.3	0.0	O K
5760 min Winter	24.041	0.021	0.0	0.2	0.2	0.0	O K
7200 min Winter	24.040	0.020	0.0	0.2	0.2	0.0	O K
8640 min Winter	24.039	0.019	0.0	0.2	0.2	0.0	O K
10080 min Winter	24.038	0.018	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.495	0.0	31.0	4264
10080 min Summer	1.376	0.0	33.3	5112
15 min Winter	126.207	0.0	4.8	12
30 min Winter	87.218	0.0	6.7	20
60 min Winter	57.895	0.0	8.9	34
120 min Winter	34.230	0.0	10.5	64
180 min Winter	25.256	0.0	11.6	96
240 min Winter	20.381	0.0	12.5	124
360 min Winter	15.080	0.0	13.8	182
480 min Winter	12.158	0.0	14.9	242
600 min Winter	10.281	0.0	15.7	296
720 min Winter	8.961	0.0	16.5	358
960 min Winter	7.212	0.0	17.7	490
1440 min Winter	5.301	0.0	19.5	718
2160 min Winter	3.899	0.0	21.5	1072
2880 min Winter	3.146	0.0	23.1	1452
4320 min Winter	2.340	0.0	25.8	2132
5760 min Winter	1.917	0.0	28.1	2960
7200 min Winter	1.664	0.0	30.5	3792
8640 min Winter	1.495	0.0	32.9	4304
10080 min Winter	1.376	0.0	35.4	4968

Cascade Rainfall Details for 231218 Blackberry Lane Swale East A.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 201796 203176 SN 01796 03176
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.800
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.011

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.011

Cascade Model Details for 231218 Blackberry Lane Swale East A.SRCX

Storage is Online Cover Level (m) 24.200

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	187.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	100.0
Porosity	1.00	Cap Volume Depth (m)	0.180
Invert Level (m)	24.020	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.4		

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	35.0	Coefficient of Contraction	0.600
Length (m)	16.000	Upstream Invert Level (m)	24.020
Roughness k (mm)	0.600		

Cascade Summary of Results for 231218 Blackberry Lane Swale East B.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	231218_Blackberry Lane Swale East A.SRCX	(None)

Half Drain Time : 1 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	24.154	0.104	0.0	4.0	4.0	0.3	O K
30 min Summer	24.151	0.101	0.0	3.8	3.8	0.2	O K
60 min Summer	24.137	0.087	0.0	3.0	3.0	0.2	O K
120 min Summer	24.115	0.065	0.0	1.9	1.9	0.1	O K
180 min Summer	24.106	0.056	0.0	1.5	1.5	0.1	O K
240 min Summer	24.101	0.051	0.0	1.2	1.2	0.0	O K
360 min Summer	24.095	0.045	0.0	0.9	0.9	0.0	O K
480 min Summer	24.090	0.040	0.0	0.7	0.7	0.0	O K
600 min Summer	24.087	0.037	0.0	0.6	0.6	0.0	O K
720 min Summer	24.084	0.034	0.0	0.6	0.6	0.0	O K
960 min Summer	24.081	0.031	0.0	0.4	0.4	0.0	O K
1440 min Summer	24.076	0.026	0.0	0.3	0.3	0.0	O K
2160 min Summer	24.072	0.022	0.0	0.2	0.2	0.0	O K
2880 min Summer	24.070	0.020	0.0	0.2	0.2	0.0	O K
4320 min Summer	24.067	0.017	0.0	0.1	0.1	0.0	O K
5760 min Summer	24.066	0.016	0.0	0.1	0.1	0.0	O K
7200 min Summer	24.065	0.015	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	126.207	0.0	1.8	11
30 min Summer	87.218	0.0	2.4	18
60 min Summer	57.895	0.0	3.2	34
120 min Summer	34.230	0.0	3.8	64
180 min Summer	25.256	0.0	4.2	94
240 min Summer	20.381	0.0	4.6	122
360 min Summer	15.080	0.0	5.1	182
480 min Summer	12.158	0.0	5.4	244
600 min Summer	10.281	0.0	5.8	302
720 min Summer	8.961	0.0	6.0	368
960 min Summer	7.212	0.0	6.5	476
1440 min Summer	5.301	0.0	7.1	728
2160 min Summer	3.899	0.0	7.9	1064
2880 min Summer	3.146	0.0	8.5	1460
4320 min Summer	2.340	0.0	9.4	2144
5760 min Summer	1.917	0.0	10.3	2840
7200 min Summer	1.664	0.0	11.2	3584

Cascade Summary of Results for 231218 Blackberry Lane Swale East B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	24.063	0.013	0.0	0.1	0.1	0.0	O K
10080 min Summer	24.063	0.013	0.0	0.1	0.1	0.0	O K
15 min Winter	24.152	0.102	0.0	3.9	3.9	0.2	O K
30 min Winter	24.142	0.092	0.0	3.3	3.3	0.2	O K
60 min Winter	24.124	0.074	0.0	2.3	2.3	0.1	O K
120 min Winter	24.105	0.055	0.0	1.4	1.4	0.1	O K
180 min Winter	24.098	0.048	0.0	1.1	1.1	0.0	O K
240 min Winter	24.093	0.043	0.0	0.9	0.9	0.0	O K
360 min Winter	24.087	0.037	0.0	0.6	0.6	0.0	O K
480 min Winter	24.083	0.033	0.0	0.5	0.5	0.0	O K
600 min Winter	24.081	0.031	0.0	0.4	0.4	0.0	O K
720 min Winter	24.078	0.028	0.0	0.4	0.4	0.0	O K
960 min Winter	24.075	0.025	0.0	0.3	0.3	0.0	O K
1440 min Winter	24.072	0.022	0.0	0.2	0.2	0.0	O K
2160 min Winter	24.069	0.019	0.0	0.2	0.2	0.0	O K
2880 min Winter	24.067	0.017	0.0	0.1	0.1	0.0	O K
4320 min Winter	24.064	0.014	0.0	0.1	0.1	0.0	O K
5760 min Winter	24.063	0.013	0.0	0.1	0.1	0.0	O K
7200 min Winter	24.062	0.012	0.0	0.1	0.1	0.0	O K
8640 min Winter	24.061	0.011	0.0	0.1	0.1	0.0	O K
10080 min Winter	24.061	0.011	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.495	0.0	12.0	4248
10080 min Summer	1.376	0.0	12.9	4960
15 min Winter	126.207	0.0	1.9	11
30 min Winter	87.218	0.0	2.6	18
60 min Winter	57.895	0.0	3.4	34
120 min Winter	34.230	0.0	4.1	62
180 min Winter	25.256	0.0	4.5	92
240 min Winter	20.381	0.0	4.9	122
360 min Winter	15.080	0.0	5.4	184
480 min Winter	12.158	0.0	5.8	240
600 min Winter	10.281	0.0	6.1	300
720 min Winter	8.961	0.0	6.4	364
960 min Winter	7.212	0.0	6.9	470
1440 min Winter	5.301	0.0	7.6	730
2160 min Winter	3.899	0.0	8.4	1060
2880 min Winter	3.146	0.0	9.0	1444
4320 min Winter	2.340	0.0	10.0	2188
5760 min Winter	1.917	0.0	10.9	2824
7200 min Winter	1.664	0.0	11.9	3640
8640 min Winter	1.495	0.0	12.8	4432
10080 min Winter	1.376	0.0	13.8	5216

Cascade Rainfall Details for 231218 Blackberry Lane Swale East B.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 201796 203176 SN 01796 03176
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.800
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.007

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.007

Cascade Model Details for 231218 Blackberry Lane Swale East B.SRCX

Storage is Online Cover Level (m) 24.200

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	103.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	100.0
Porosity	1.00	Cap Volume Depth (m)	0.150
Invert Level (m)	24.050	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.2		

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	35.0	Coefficient of Contraction	0.600
Length (m)	16.000	Upstream Invert Level (m)	24.050
Roughness k (mm)	0.600		

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 4 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	21.538	0.218	0.0	8.5	8.5	3.5	O K
30 min Summer	21.543	0.223	0.0	8.7	8.7	3.7	O K
60 min Summer	21.529	0.209	0.0	8.3	8.3	3.2	O K
120 min Summer	21.485	0.165	0.0	7.1	7.1	1.7	O K
180 min Summer	21.458	0.138	0.0	6.1	6.1	1.1	O K
240 min Summer	21.443	0.123	0.0	5.1	5.1	0.8	O K
360 min Summer	21.424	0.104	0.0	4.0	4.0	0.5	O K
480 min Summer	21.412	0.092	0.0	3.3	3.3	0.4	O K
600 min Summer	21.403	0.083	0.0	2.8	2.8	0.3	O K
720 min Summer	21.397	0.077	0.0	2.4	2.4	0.3	O K
960 min Summer	21.386	0.066	0.0	2.0	2.0	0.2	O K
1440 min Summer	21.375	0.055	0.0	1.4	1.4	0.1	O K
2160 min Summer	21.368	0.048	0.0	1.1	1.1	0.1	O K
2880 min Summer	21.363	0.043	0.0	0.9	0.9	0.1	O K
4320 min Summer	21.357	0.037	0.0	0.6	0.6	0.1	O K
5760 min Summer	21.353	0.033	0.0	0.5	0.5	0.0	O K
7200 min Summer	21.351	0.031	0.0	0.5	0.5	0.0	O K
8640 min Summer	21.350	0.030	0.0	0.4	0.4	0.0	O K
10080 min Summer	21.348	0.028	0.0	0.4	0.4	0.0	O K
15 min Winter	21.542	0.222	0.0	8.7	8.7	3.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	126.207	0.0	7.8	12
30 min Summer	87.218	0.0	10.8	21
60 min Summer	57.895	0.0	14.4	36
120 min Summer	34.230	0.0	17.0	66
180 min Summer	25.256	0.0	18.8	96
240 min Summer	20.381	0.0	20.2	126
360 min Summer	15.080	0.0	22.4	184
480 min Summer	12.158	0.0	24.1	244
600 min Summer	10.281	0.0	25.5	306
720 min Summer	8.961	0.0	26.7	366
960 min Summer	7.212	0.0	28.6	486
1440 min Summer	5.301	0.0	31.6	714
2160 min Summer	3.899	0.0	34.8	1100
2880 min Summer	3.146	0.0	37.5	1420
4320 min Summer	2.340	0.0	41.8	2160
5760 min Summer	1.917	0.0	45.6	2880
7200 min Summer	1.664	0.0	49.5	3592
8640 min Summer	1.495	0.0	53.4	4304
10080 min Summer	1.376	0.0	57.3	5128
15 min Winter	126.207	0.0	8.3	13

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	21.539	0.219	0.0	8.6	8.6	3.6	O K
60 min Winter	21.513	0.193	0.0	7.9	7.9	2.6	O K
120 min Winter	21.457	0.137	0.0	6.0	6.0	1.1	O K
180 min Winter	21.434	0.114	0.0	4.6	4.6	0.7	O K
240 min Winter	21.420	0.100	0.0	3.7	3.7	0.5	O K
360 min Winter	21.404	0.084	0.0	2.8	2.8	0.3	O K
480 min Winter	21.393	0.073	0.0	2.3	2.3	0.2	O K
600 min Winter	21.385	0.065	0.0	1.9	1.9	0.2	O K
720 min Winter	21.379	0.059	0.0	1.7	1.7	0.1	O K
960 min Winter	21.373	0.053	0.0	1.3	1.3	0.1	O K
1440 min Winter	21.367	0.047	0.0	1.0	1.0	0.1	O K
2160 min Winter	21.359	0.039	0.0	0.7	0.7	0.1	O K
2880 min Winter	21.355	0.035	0.0	0.6	0.6	0.0	O K
4320 min Winter	21.351	0.031	0.0	0.4	0.4	0.0	O K
5760 min Winter	21.348	0.028	0.0	0.4	0.4	0.0	O K
7200 min Winter	21.346	0.026	0.0	0.3	0.3	0.0	O K
8640 min Winter	21.344	0.024	0.0	0.3	0.3	0.0	O K
10080 min Winter	21.343	0.023	0.0	0.3	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	87.218	0.0	11.5	22
60 min Winter	57.895	0.0	15.3	38
120 min Winter	34.230	0.0	18.0	66
180 min Winter	25.256	0.0	20.0	96
240 min Winter	20.381	0.0	21.5	124
360 min Winter	15.080	0.0	23.8	184
480 min Winter	12.158	0.0	25.6	246
600 min Winter	10.281	0.0	27.1	308
720 min Winter	8.961	0.0	28.3	366
960 min Winter	7.212	0.0	30.4	488
1440 min Winter	5.301	0.0	33.5	738
2160 min Winter	3.899	0.0	37.0	1100
2880 min Winter	3.146	0.0	39.8	1428
4320 min Winter	2.340	0.0	44.4	2204
5760 min Winter	1.917	0.0	48.5	2856
7200 min Winter	1.664	0.0	52.6	3648
8640 min Winter	1.495	0.0	56.7	4288
10080 min Winter	1.376	0.0	60.9	4824

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 201796 203176 SN 01796 03176
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.800
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.031

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.031

Model Details

Storage is Online Cover Level (m) 21.550

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	262.5
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	150.0
Porosity	1.00	Cap Volume Depth (m)	0.230
Invert Level (m)	21.320	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.4		

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	35.0	Coefficient of Contraction	0.600
Length (m)	10.000	Upstream Invert Level (m)	21.320
Roughness k (mm)	0.600		

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 1 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	20.113	0.063	0.0	1.9	1.9	0.1	O K
30 min Summer	20.110	0.060	0.0	1.7	1.7	0.1	O K
60 min Summer	20.103	0.053	0.0	1.3	1.3	0.0	O K
120 min Summer	20.093	0.043	0.0	0.9	0.9	0.0	O K
180 min Summer	20.087	0.037	0.0	0.7	0.7	0.0	O K
240 min Summer	20.084	0.034	0.0	0.5	0.5	0.0	O K
360 min Summer	20.079	0.029	0.0	0.4	0.4	0.0	O K
480 min Summer	20.076	0.026	0.0	0.3	0.3	0.0	O K
600 min Summer	20.074	0.024	0.0	0.3	0.3	0.0	O K
720 min Summer	20.073	0.023	0.0	0.2	0.2	0.0	O K
960 min Summer	20.070	0.020	0.0	0.2	0.2	0.0	O K
1440 min Summer	20.067	0.017	0.0	0.1	0.1	0.0	O K
2160 min Summer	20.065	0.015	0.0	0.1	0.1	0.0	O K
2880 min Summer	20.063	0.013	0.0	0.1	0.1	0.0	O K
4320 min Summer	20.061	0.011	0.0	0.1	0.1	0.0	O K
5760 min Summer	20.060	0.010	0.0	0.1	0.1	0.0	O K
7200 min Summer	20.059	0.009	0.0	0.1	0.1	0.0	O K
8640 min Summer	20.060	0.010	0.0	0.1	0.1	0.0	O K
10080 min Summer	20.058	0.008	0.0	0.0	0.0	0.0	O K
15 min Winter	20.112	0.062	0.0	1.8	1.8	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	126.207	0.0	0.8	10
30 min Summer	87.218	0.0	1.0	18
60 min Summer	57.895	0.0	1.4	32
120 min Summer	34.230	0.0	1.6	62
180 min Summer	25.256	0.0	1.8	94
240 min Summer	20.381	0.0	2.0	122
360 min Summer	15.080	0.0	2.2	184
480 min Summer	12.158	0.0	2.3	244
600 min Summer	10.281	0.0	2.5	304
720 min Summer	8.961	0.0	2.6	366
960 min Summer	7.212	0.0	2.8	480
1440 min Summer	5.301	0.0	3.1	734
2160 min Summer	3.899	0.0	3.4	1088
2880 min Summer	3.146	0.0	3.6	1420
4320 min Summer	2.340	0.0	4.0	2156
5760 min Summer	1.917	0.0	4.4	2880
7200 min Summer	1.664	0.0	4.8	3424
8640 min Summer	1.495	0.0	5.2	4320
10080 min Summer	1.376	0.0	5.5	5192
15 min Winter	126.207	0.0	0.8	10

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	20.105	0.055	0.0	1.5	1.5	0.1	O K
60 min Winter	20.097	0.047	0.0	1.0	1.0	0.0	O K
120 min Winter	20.086	0.036	0.0	0.6	0.6	0.0	O K
180 min Winter	20.081	0.031	0.0	0.5	0.5	0.0	O K
240 min Winter	20.078	0.028	0.0	0.4	0.4	0.0	O K
360 min Winter	20.074	0.024	0.0	0.3	0.3	0.0	O K
480 min Winter	20.072	0.022	0.0	0.2	0.2	0.0	O K
600 min Winter	20.070	0.020	0.0	0.2	0.2	0.0	O K
720 min Winter	20.068	0.018	0.0	0.2	0.2	0.0	O K
960 min Winter	20.067	0.017	0.0	0.1	0.1	0.0	O K
1440 min Winter	20.064	0.014	0.0	0.1	0.1	0.0	O K
2160 min Winter	20.062	0.012	0.0	0.1	0.1	0.0	O K
2880 min Winter	20.061	0.011	0.0	0.1	0.1	0.0	O K
4320 min Winter	20.059	0.009	0.0	0.1	0.1	0.0	O K
5760 min Winter	20.059	0.009	0.0	0.1	0.1	0.0	O K
7200 min Winter	20.058	0.008	0.0	0.0	0.0	0.0	O K
8640 min Winter	20.058	0.008	0.0	0.0	0.0	0.0	O K
10080 min Winter	20.057	0.007	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	87.218	0.0	1.1	18
60 min Winter	57.895	0.0	1.5	34
120 min Winter	34.230	0.0	1.7	64
180 min Winter	25.256	0.0	1.9	96
240 min Winter	20.381	0.0	2.1	122
360 min Winter	15.080	0.0	2.3	182
480 min Winter	12.158	0.0	2.5	254
600 min Winter	10.281	0.0	2.6	306
720 min Winter	8.961	0.0	2.7	350
960 min Winter	7.212	0.0	2.9	464
1440 min Winter	5.301	0.0	3.2	714
2160 min Winter	3.899	0.0	3.6	1068
2880 min Winter	3.146	0.0	3.9	1580
4320 min Winter	2.340	0.0	4.3	2080
5760 min Winter	1.917	0.0	4.7	2816
7200 min Winter	1.664	0.0	5.1	3736
8640 min Winter	1.495	0.0	5.5	4520
10080 min Winter	1.376	0.0	5.9	4672

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 201796 203176 SN 01796 03176
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.800
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.003

Time From:	(mins) To:	Area (ha)
0	4	0.003

Model Details

Storage is Online Cover Level (m) 20.200

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	44.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	100.0
Porosity	1.00	Cap Volume Depth (m)	0.150
Invert Level (m)	20.050	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.2		

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	60.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	20.050
Roughness k (mm)	0.600		

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 2 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Σ Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	20.993	0.153	0.0	6.7	6.7	0.8	O K
30 min Summer	20.989	0.149	0.0	6.6	6.6	0.8	O K
60 min Summer	20.971	0.131	0.0	5.6	5.6	0.6	O K
120 min Summer	20.942	0.102	0.0	3.9	3.9	0.3	O K
180 min Summer	20.927	0.087	0.0	3.0	3.0	0.2	O K
240 min Summer	20.917	0.077	0.0	2.4	2.4	0.1	O K
360 min Summer	20.903	0.063	0.0	1.8	1.8	0.1	O K
480 min Summer	20.896	0.056	0.0	1.5	1.5	0.1	O K
600 min Summer	20.892	0.052	0.0	1.3	1.3	0.1	O K
720 min Summer	20.889	0.049	0.0	1.1	1.1	0.1	O K
960 min Summer	20.884	0.044	0.0	0.9	0.9	0.0	O K
1440 min Summer	20.877	0.037	0.0	0.7	0.7	0.0	O K
2160 min Summer	20.872	0.032	0.0	0.5	0.5	0.0	O K
2880 min Summer	20.869	0.029	0.0	0.4	0.4	0.0	O K
4320 min Summer	20.864	0.024	0.0	0.3	0.3	0.0	O K
5760 min Summer	20.862	0.022	0.0	0.2	0.2	0.0	O K
7200 min Summer	20.861	0.021	0.0	0.2	0.2	0.0	O K
8640 min Summer	20.860	0.020	0.0	0.2	0.2	0.0	O K
10080 min Summer	20.859	0.019	0.0	0.2	0.2	0.0	O K
15 min Winter	20.991	0.151	0.0	6.6	6.6	0.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	126.207	0.0	3.5	11
30 min Summer	87.218	0.0	4.9	19
60 min Summer	57.895	0.0	6.5	34
120 min Summer	34.230	0.0	7.7	64
180 min Summer	25.256	0.0	8.5	94
240 min Summer	20.381	0.0	9.1	124
360 min Summer	15.080	0.0	10.1	184
480 min Summer	12.158	0.0	10.9	246
600 min Summer	10.281	0.0	11.5	300
720 min Summer	8.961	0.0	12.0	358
960 min Summer	7.212	0.0	12.9	488
1440 min Summer	5.301	0.0	14.3	710
2160 min Summer	3.899	0.0	15.7	1100
2880 min Summer	3.146	0.0	16.9	1428
4320 min Summer	2.340	0.0	18.9	2120
5760 min Summer	1.917	0.0	20.6	2848
7200 min Summer	1.664	0.0	22.4	3560
8640 min Summer	1.495	0.0	24.1	4336
10080 min Summer	1.376	0.0	25.9	5192
15 min Winter	126.207	0.0	3.8	11

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	20.978	0.138	0.0	6.1	6.1	0.6	O K
60 min Winter	20.954	0.114	0.0	4.6	4.6	0.4	O K
120 min Winter	20.924	0.084	0.0	2.8	2.8	0.2	O K
180 min Winter	20.909	0.069	0.0	2.1	2.1	0.1	O K
240 min Winter	20.900	0.060	0.0	1.7	1.7	0.1	O K
360 min Winter	20.892	0.052	0.0	1.3	1.3	0.1	O K
480 min Winter	20.888	0.048	0.0	1.0	1.0	0.0	O K
600 min Winter	20.884	0.044	0.0	0.9	0.9	0.0	O K
720 min Winter	20.880	0.040	0.0	0.8	0.8	0.0	O K
960 min Winter	20.876	0.036	0.0	0.6	0.6	0.0	O K
1440 min Winter	20.871	0.031	0.0	0.5	0.5	0.0	O K
2160 min Winter	20.866	0.026	0.0	0.3	0.3	0.0	O K
2880 min Winter	20.864	0.024	0.0	0.3	0.3	0.0	O K
4320 min Winter	20.861	0.021	0.0	0.2	0.2	0.0	O K
5760 min Winter	20.859	0.019	0.0	0.2	0.2	0.0	O K
7200 min Winter	20.857	0.017	0.0	0.1	0.1	0.0	O K
8640 min Winter	20.857	0.017	0.0	0.1	0.1	0.0	O K
10080 min Winter	20.856	0.016	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	87.218	0.0	5.2	19
60 min Winter	57.895	0.0	6.9	34
120 min Winter	34.230	0.0	8.1	64
180 min Winter	25.256	0.0	9.0	94
240 min Winter	20.381	0.0	9.7	124
360 min Winter	15.080	0.0	10.8	182
480 min Winter	12.158	0.0	11.6	246
600 min Winter	10.281	0.0	12.2	304
720 min Winter	8.961	0.0	12.8	368
960 min Winter	7.212	0.0	13.7	486
1440 min Winter	5.301	0.0	15.1	716
2160 min Winter	3.899	0.0	16.7	1128
2880 min Winter	3.146	0.0	18.0	1448
4320 min Winter	2.340	0.0	20.0	2188
5760 min Winter	1.917	0.0	21.9	2904
7200 min Winter	1.664	0.0	23.8	3336
8640 min Winter	1.495	0.0	25.6	4184
10080 min Winter	1.376	0.0	27.5	5232

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 201796 203176 SN 01796 03176
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.800
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.014

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.014

Model Details

Storage is Online Cover Level (m) 21.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	128.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	100.0
Porosity	1.00	Cap Volume Depth (m)	0.160
Invert Level (m)	20.840	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.3		

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	60.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	20.840
Roughness k (mm)	0.600		