Green Hill Solar Farm
EN010170

Environmental Statement
Appendix 10.11: Flood Risk Assessment and Drainage Strategy
Annex J: Green Hill BESS

Prepared by: Arthian

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Appendix 10.11: Annex J - Flood Risk Assessment & Drainage Strategy - Green Hill BESS

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For: Green Hill Solar Farm Ltd

Site: Green Hill BESS

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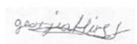
GH	Georgia Hirst	BSc (Hons), MSc, Consultant	
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1. Site Details

The aim of this section of the report is to outline key environmental information associated with the baseline environment.

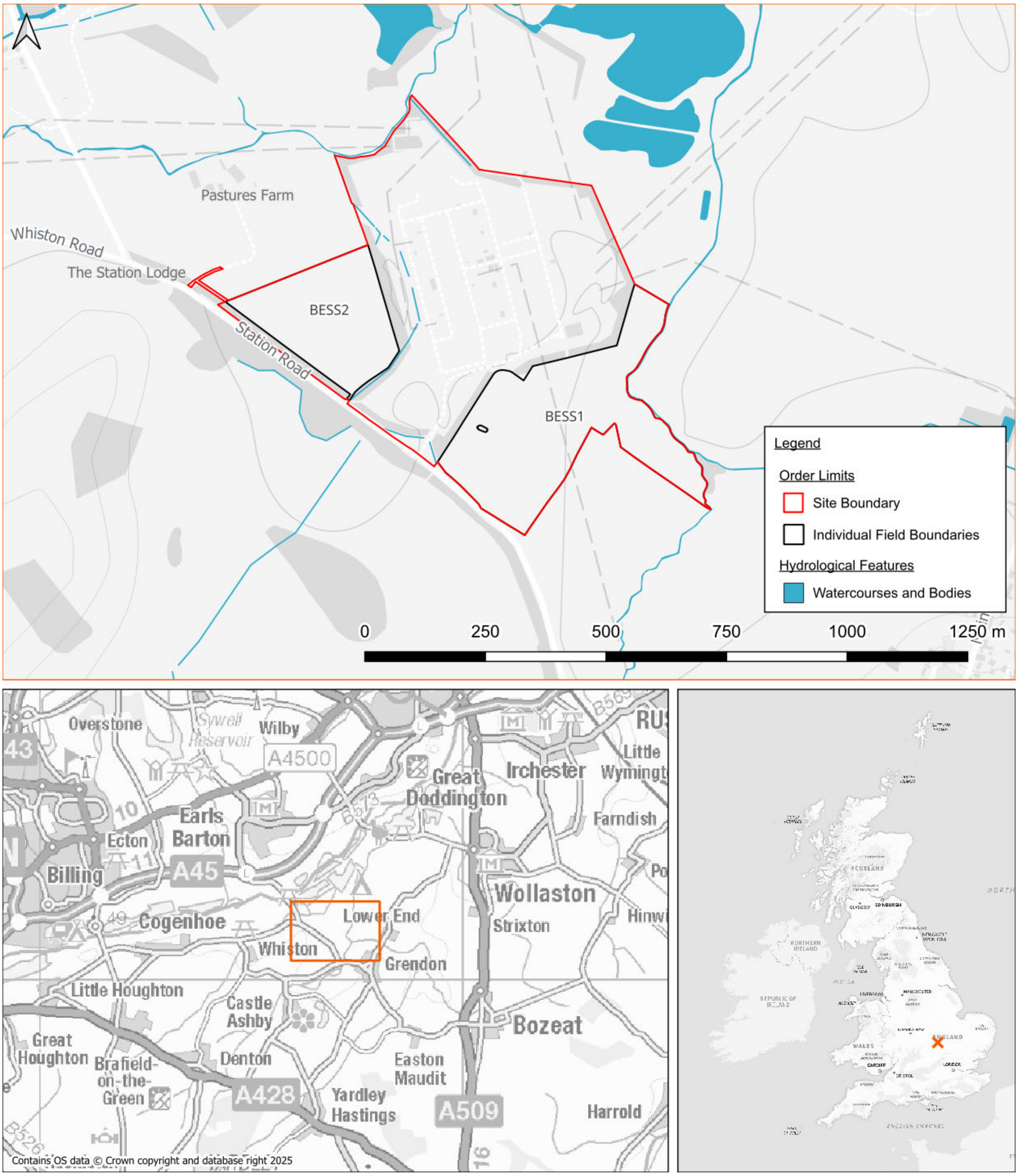


Figure 1: Site Location Plan

1.1 Site Location

1.1.1 Green Hill BESS is in a rural area situated approximately 750m northwest of Grendon and 7.5km east of Northampton. Grendon Lakes are adjacent to the northeast of the Site. The National Grid Reference for BESS 1 is approximately 487070, 261050, and BESS2 is approximately 486560, 261200.

1.2 Existing Site Conditions

1.2.1 Online mapping (including Google Maps / Google Streetview imagery, accessed March 2025)[i] shows that the Site is greenfield. The Site is bordered by more rural land with the exception of Grendon National Grid Substation which is situated between the Fields BESS1 and BESS2 (north of BESS1 and east of BESS2). Access to the Site is provided via the existing field entrances and one new access point off Station Road.

1.3 Topography

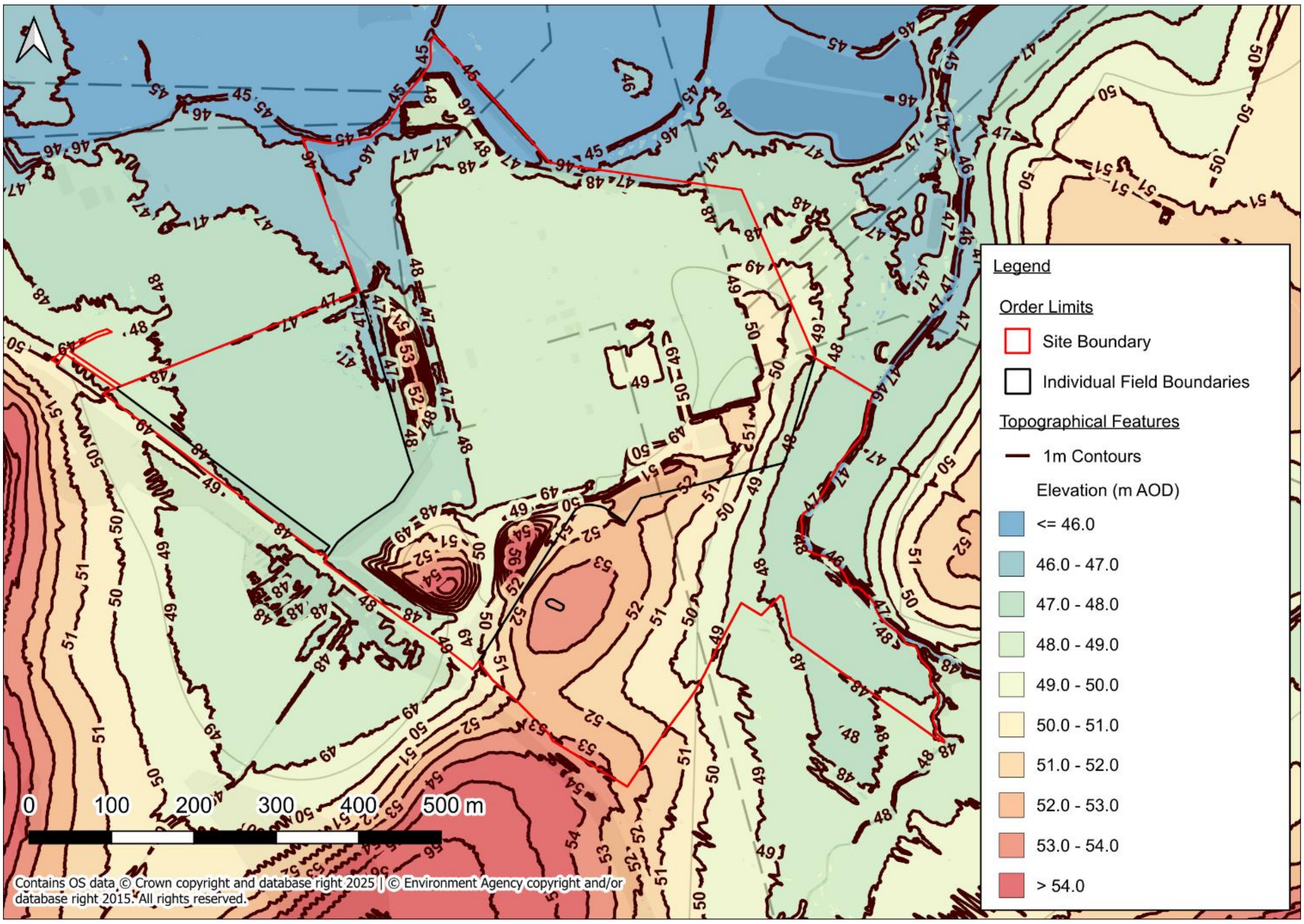


Figure 2: LiDAR Plan

1.3.1 Topographic levels to metres Above Ordnance Datum (m AOD) have been derived from a 1m resolution Environment Agency (EA) composite 'Light Detecting and Ranging' (LiDAR) Digital Terrain Model (DTM). A review of LiDAR ground elevation data shows that the Field BESS 1 slopes from approximately 51m AOD in the west to approximately 47m AOD in the east. Field BESS2 is relatively flat at approximately 47m AOD, with the exception of the western corner at 48m AOD and 46m AOD along the eastern boundary (Figure 2).

1.4 Hydrology

1.4.1 The nearest main river is Grendon Brook which flows in a northerly direction and forms the eastern boundary of BESS1. There is also Whiston Brook, a main river, which is located approximately 190m north of BESS2. A drainage ditch is located along the southern boundary of BESS2, which flows in a northernly direction and joins Whiston Brook.

1.4.2 Whiston Brook and Grendon Brook flow in a general north-eastern direction before they all converge to the River Nene approximately 3.5km northeast of the BESS1 and BESS2.

1.4.3 Main rivers fall within the responsibility of the EA.

1.5 Water Framework Directive Status

1.5.1 The Site is located within the Grendon Brook Water Body Catchment[ii]. A summary of the Water Body Classification for the catchment are included as Annex A.

1.6 Geology

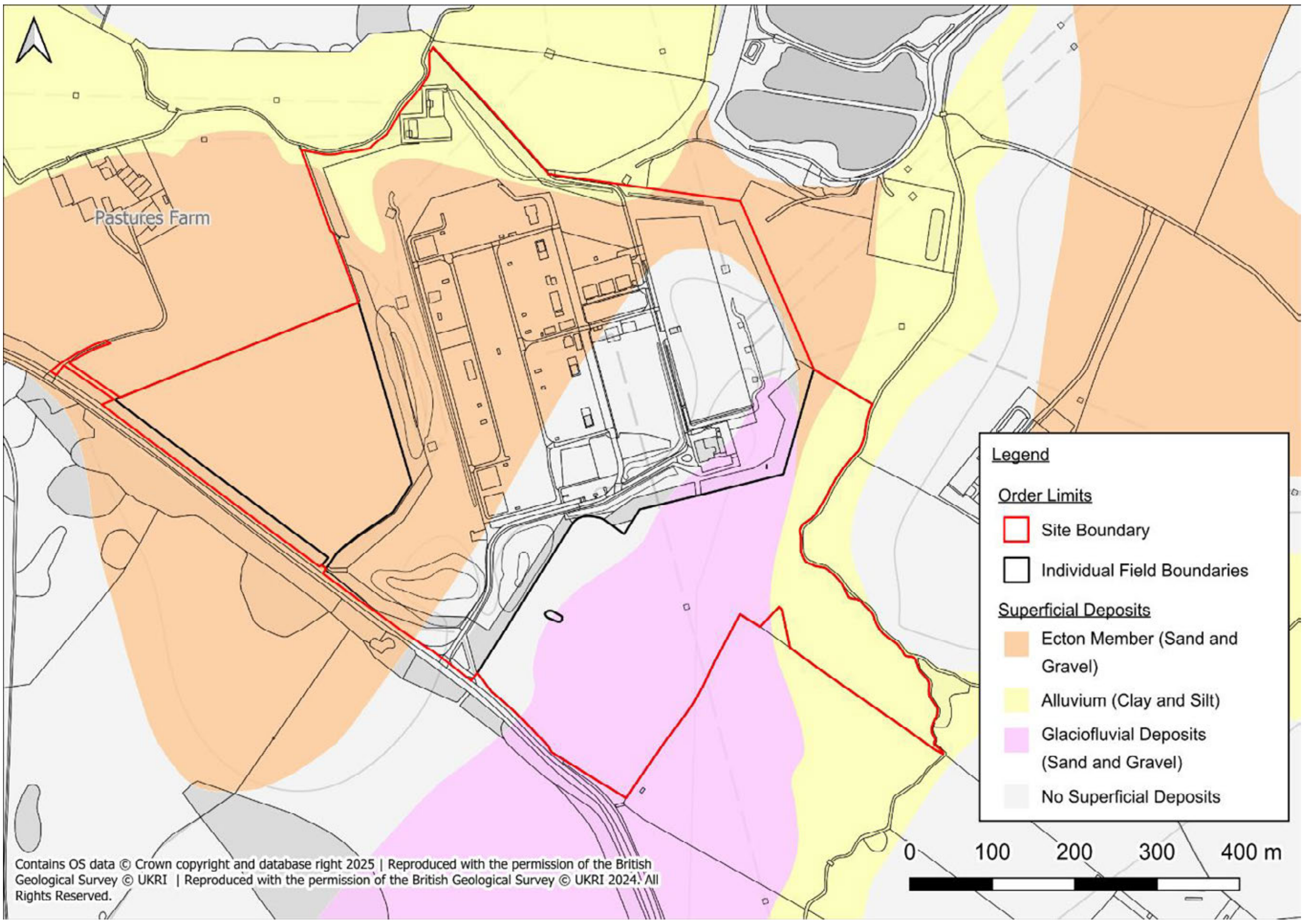


Figure 3: Superficial Deposits

1.6.1 Reference to the British Geological Survey (BGS) online mapping[iii] (1:50,000 scale) indicates that the BESS1 and BESS2 Fields are underlain by differing superficial deposits (Figure 3):

- BESS1 - Alluvium to the east (clay and silt), Glaciofluvial Deposits in the central area (sand and gravel) and no superficial deposits in the west.
- BESS2 – Ecton Member (sand and gravel).

1.6.2 The superficial deposits are identified as being underlain by Whitby Mudstone Formation consisting of mudstone (Figure 4).

1.6.3 The geological mapping is available at a scale of 1:50,000 and as such may not be accurate on a Site-specific basis.

1.6.4 The closest historical BGS borehole record (BGS Ref: SP86SE52) is located in the south of BESS2 (NGR 486580, 261130). The borehole record indicates that the following geology was encountered:

- Topsoil to 1.2m below ground level (bgl); and
- Clay from 1.2m to 3.3m bgl.

1.6.5 No water strikes were encountered.

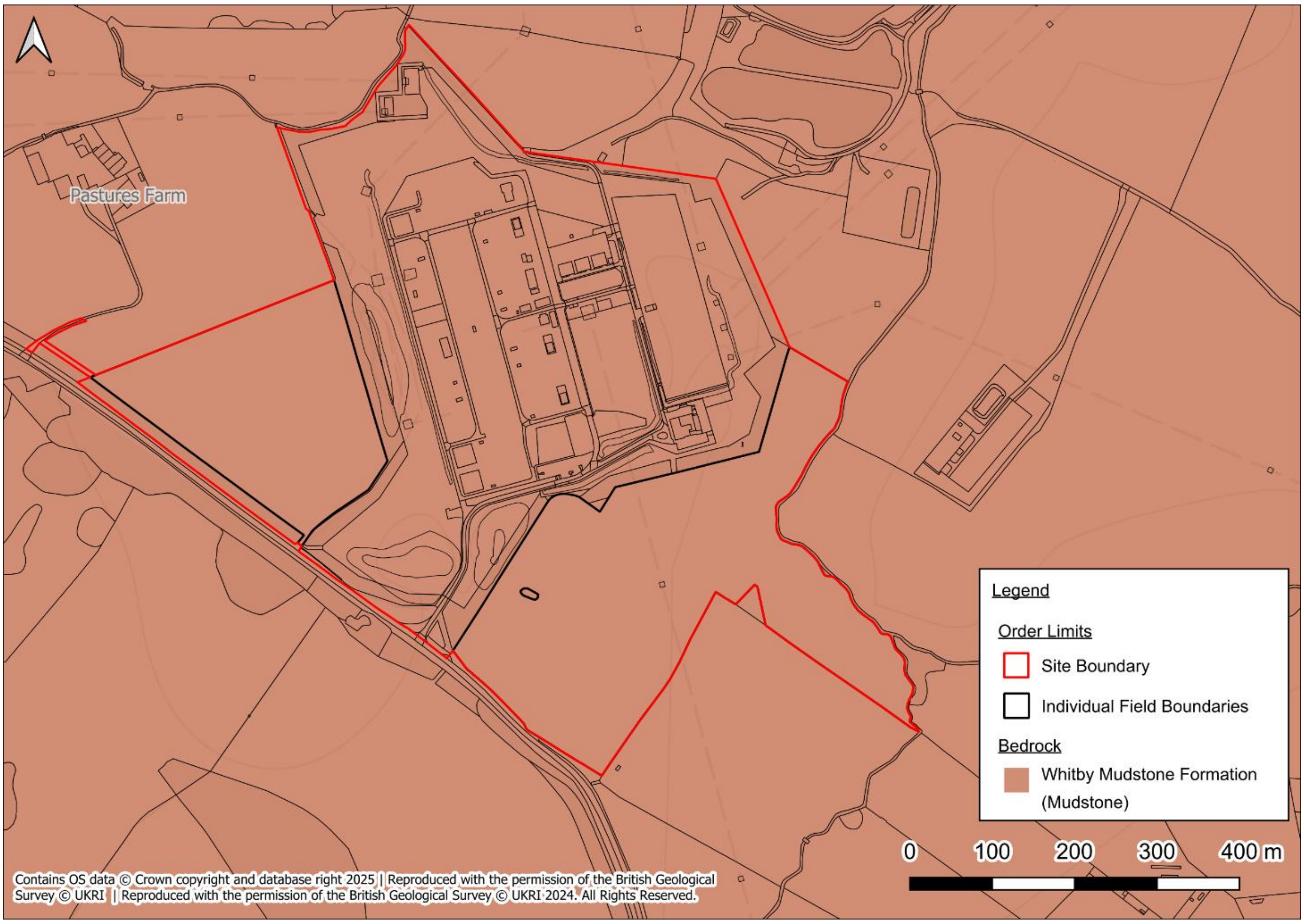


Figure 4: Bedrock Deposits

1.7 Hydrogeology

1.7.1 According to the EA's Aquifer Designation data, obtained from MAGIC Map's online mapping[iv] [accessed

March 2025], the superficial deposits at each BESS Field are as follows:

- BESS1 – Secondary A Aquifer/ Unproductive Aquifer
- BESS2 – Secondary A Aquifer

1.7.2 The underlying Whitby Mudstone Formation is described as an Unproductive Aquifer.

1.7.3 The EA's 'Source Protection Zones' data, obtained from MAGIC Map's online mapping [accessed March 2025], indicates that the Site is not located within a Groundwater Source Protection Zone.

1.8 Proposed Site Conditions

1.8.1 The proposed Scheme at Green Hill C comprises a Battery Energy Storage System (BESS) site, including a substation. At the time of writing, two design options are being considered for the BESS 2 field — one with the substation located to the north of the field, and one with it to the south. An acoustic bund is proposed which bounds the north-western boundary of the BESS 2 Field. An Outline Landscape and Ecological Management Plan (OLEMP) [EN010170/APP/GH7.4] supports the DCO application and confirms that landscaping and embedded mitigation measures will be implemented across the site boundary.

1.8.2 Figures 5 and 6 illustrate the two layout options, and Table 1 details the proposed areas derived from the final design plans in AutoCAD.

Table 1 : Green Hill BESS areas

	Areas (m^2)			
	Whole Site	Substation	BESS	Total Hardstanding
BESS1	114,085	/	40,381	40,381
BESS2 Option 1*	58,598	18,674	20,166	38,840
BESS2 Option 2**	58,598	29,493	9,539	39,032

*Option 1 is with the substation located to the south of BESS2 as shown in Figure 5.

**Option 2 is with the substation located to the north of BESS2 as shown in Figure 6.

1.8.3 The preferred location for the BESS at the time of writing is detailed within this report, however BESS may also be located within the separate Appendix titled **Appendix 10.6 Annex E - Flood Risk Assessment and Drainage Strategy - Green Hill C.** The BESS arrangement at Green Hill BESS is detailed further in the Drainage Strategy in Section 3.0 of this report.

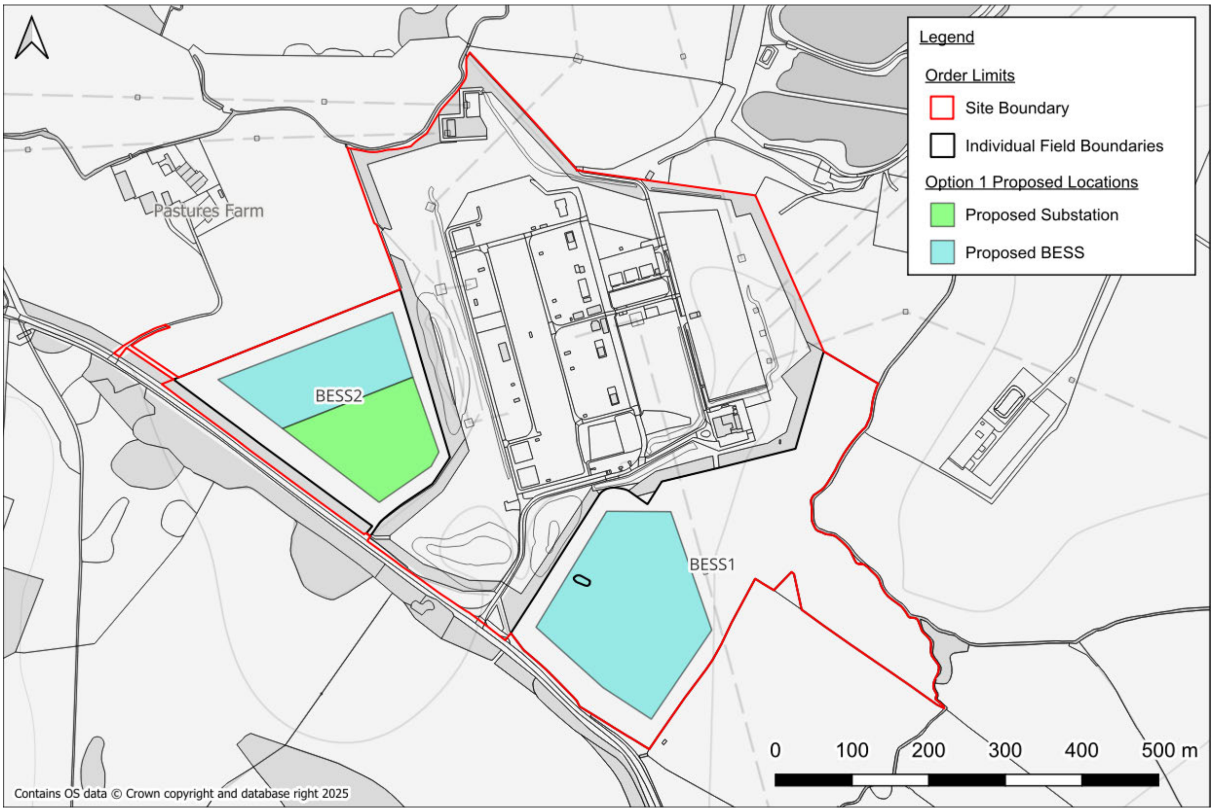


Figure 5: Option 1 Proposed Locations

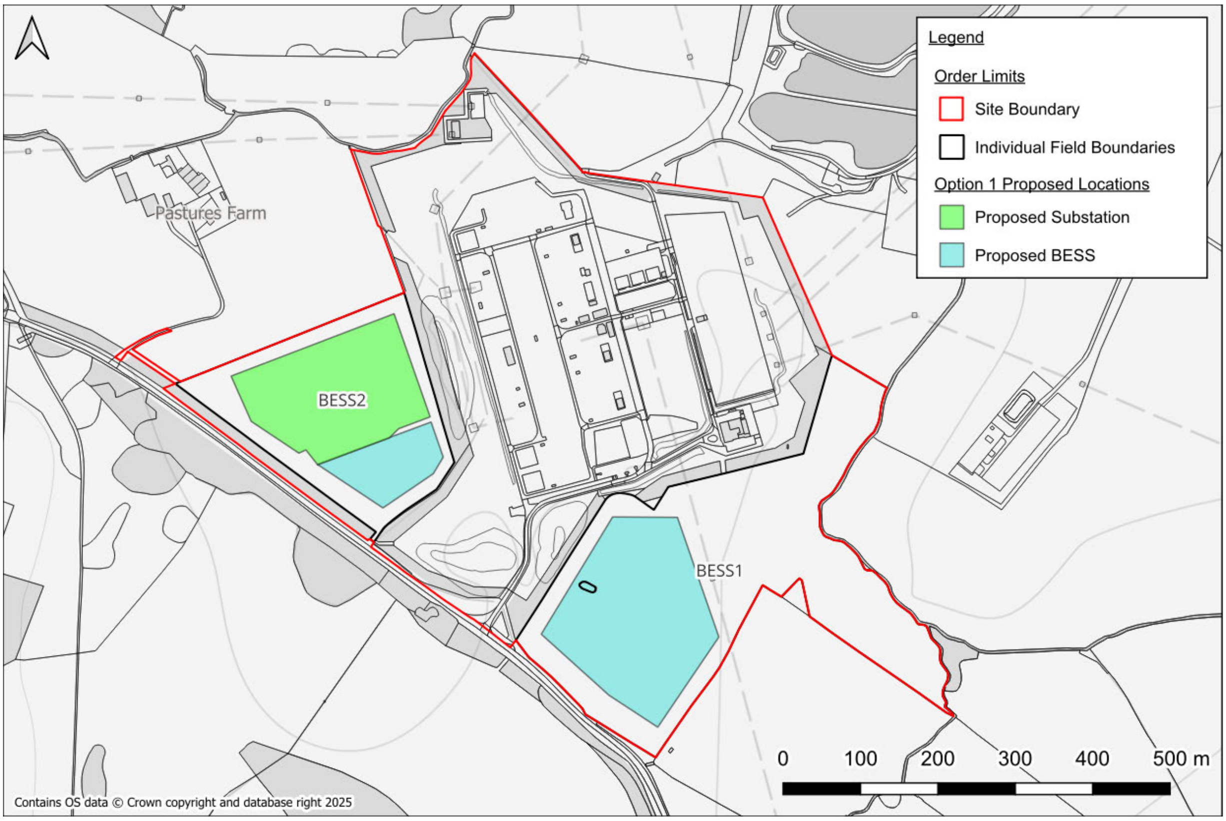


Figure 6: Option 2 Proposed Locations

2. Assessment of Flood Risk

The aim of this section of the report is to assess and summarise the existing flood risk at Green Hill BESS.

2.1 Fluvial Flood Risk

2.1.1 The nearest watercourses are Grendon Brook, a main river located along the eastern boundary of BESS1 and flowing in a northernly direction, and Whiston Brook, a main river located approximately 190m north of BESS2 flowing in a northeasterly direction. There is also a drainage ditch along BESS2's southern boundary which flows in a northernly direction before joining Whiston Brook. All of the land drains are classified as ordinary watercourses. These fall under the regulatory remit of the LLFA, which has permissive powers to manage flood risk but is not responsible for routine maintenance. Maintenance responsibilities lie with the riparian landowners. By contrast, Main Rivers fall under the responsibility of the EA.

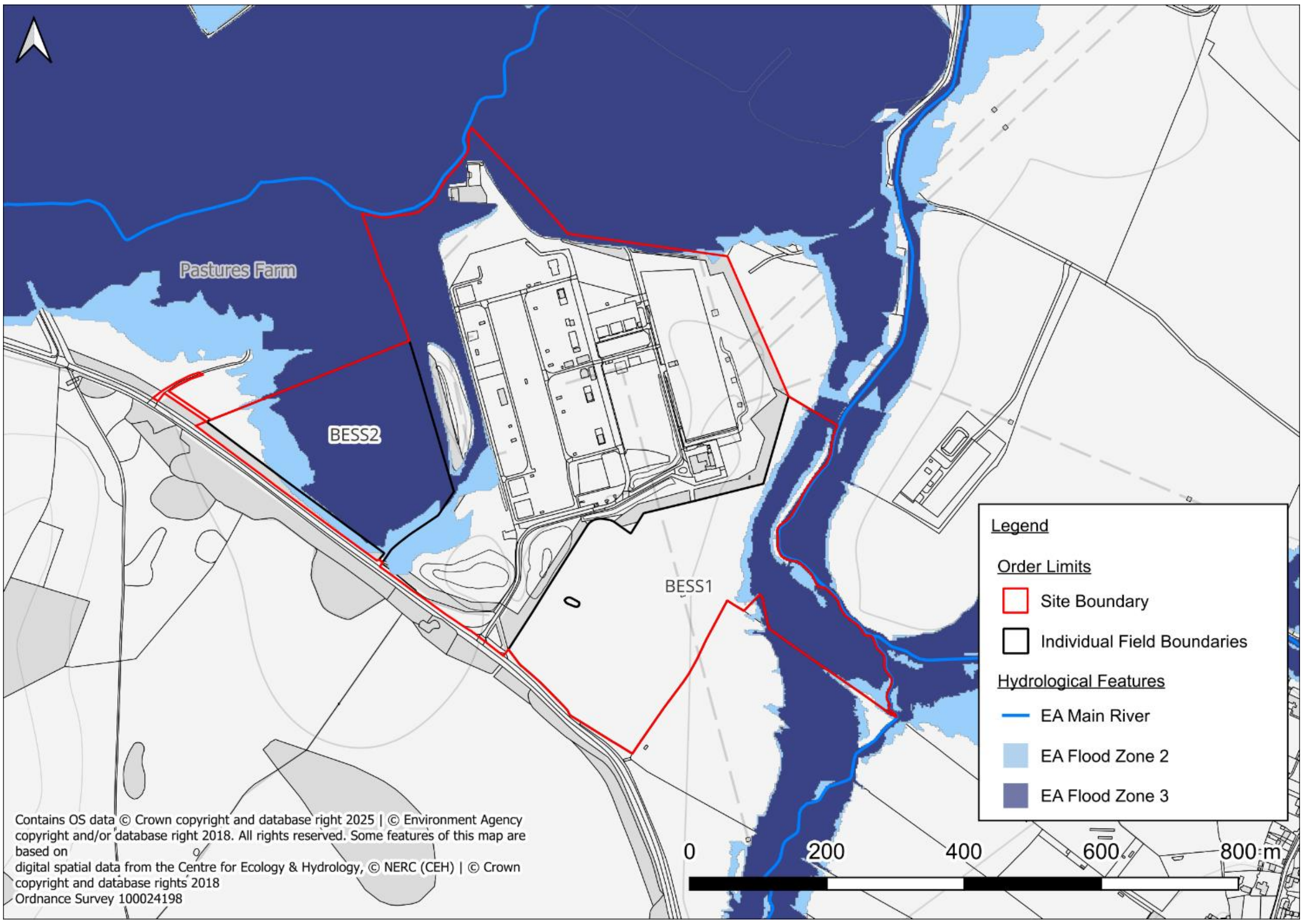


Figure 7: EA's Flood Map for Planning

2.1.2 Fluvial flooding could occur if Whiston Brook, Grendon Brook and or the drainage ditch overtopped or breached their banks/defences during or following an extreme rainfall event.

2.1.3 According to the EA's Flood Map for Planning[v] (updated March 2025), The majority of BESS2 is within

Flood Zones 2 and 3, areas considered to have between 0.1% and 1% chance or greater annual probability of flooding from rivers or the sea. Whereas BESS1 is partially within Flood Zones 2 and 3 to the east and the remaining areas are within Flood Zone 1, an area considered to have <0.1% annual probability of flooding from rivers or the sea. The extents within BESS1 remain outside of any areas of development, whereas BESS2 is to be developed within the extent, however this is discussed in the sections below.

2.1.4 Green Hill BESS is situated at a minimum elevation of approximately 45m AOD, whereas Whiston Brook and Grendon Brook are both situated at approximately 44m AOD and are therefore 1m below the Site. Any out of channel flooding from Whiston Brook may therefore flow onto the eastern area of BESS1. However, BESS2 is approximately 4m above the river at the closest point and therefore the river is unlikely to flow onto this Field.

2.1.5 The EA 'Historical Flood Map' and 'Recorded Flood Outlines Map' (Figure 8) indicates that there has been a historic flood event in March 1947 the eastern area of BESS1. The assumed cause of the flood event is due to operational failure or breach of defence.

2.1.6 According to the EA's 'Spatial Flood Defences with Standardised Attributes' dataset, there is a Natural High Ground defence located along Whiston Brook along with a Standard of Protection (SoP) of up to 1 in 100 years with an unknown condition, however it appears to be regularly inspected. The defence has a crest level of approximately 45m AOD.

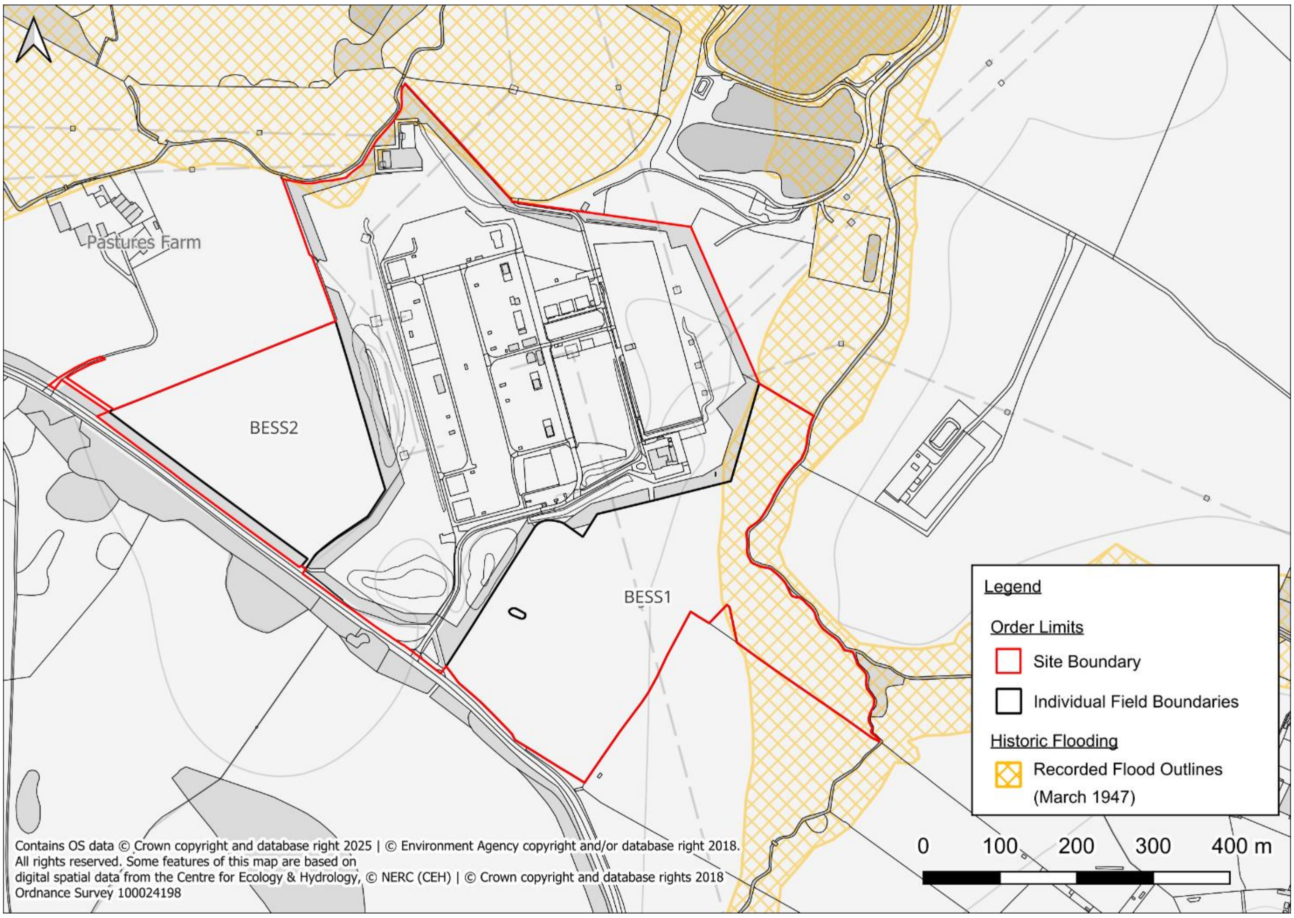


Figure 8: EA Historic Flood Map

2.1.7 There is no Site-specific information within third party reports relating to fluvial flood risk.

Consultation

2.1.8 The EA were consulted in January 2024, a response was received in February 2024 and included hydraulic models for Grendon Brook and the Middle Nene. Flood extents for the Grendon Brook model (including the defended 1 in 10 year, 1 in 50 year and 1 in 100 year scenarios) are included as Figure 9. The mapping finds that only the eastern extents of BESS1 are within the flood extents of the 1 in 10 year scenario and greater. In order to get a more accurate understanding of flood risk at the Site and the complex interactions between the Grendon Brook and other watercourses within the vicinity, further hydraulic modelling was undertaken by Arthian Ltd and is detailed below.

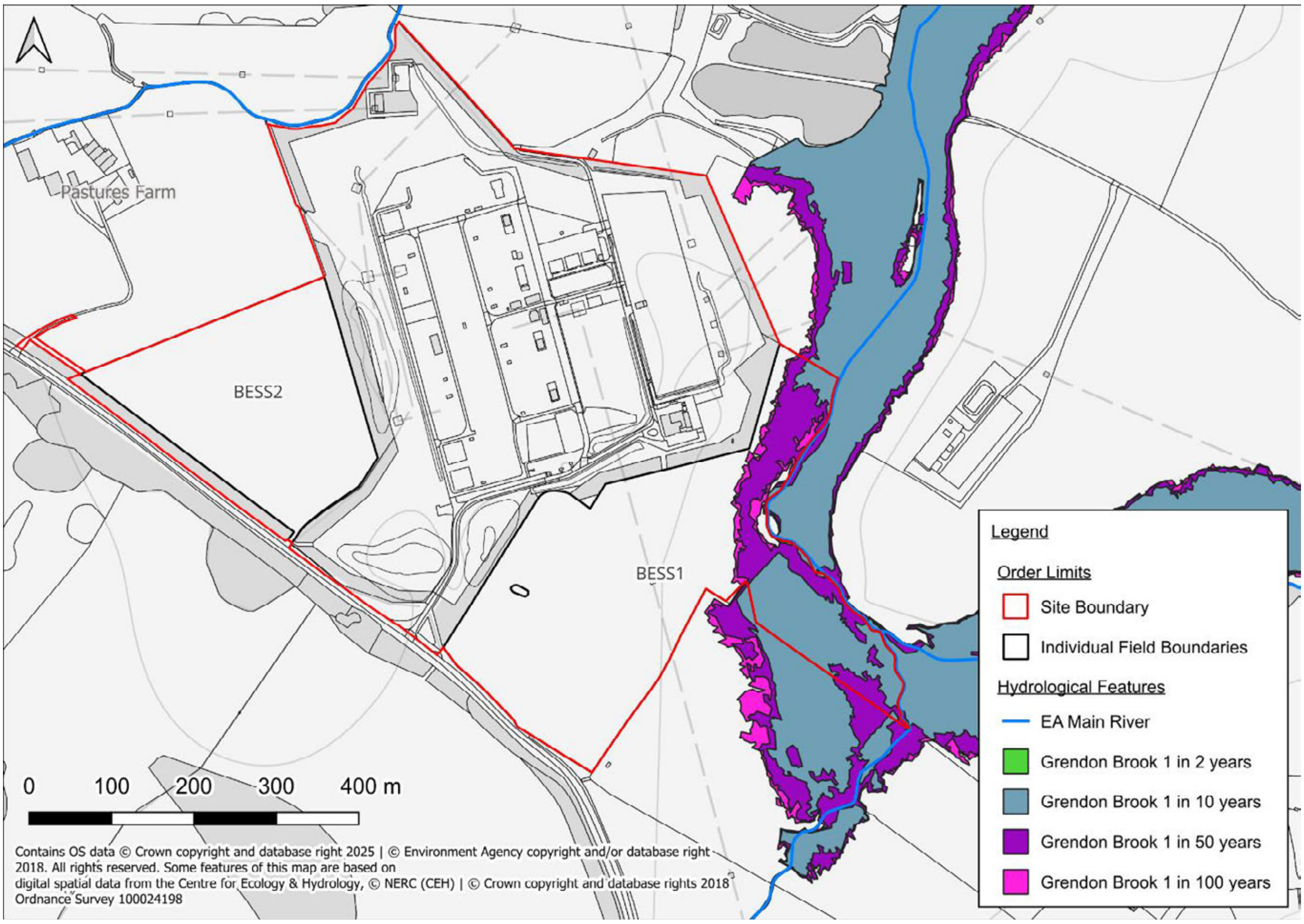


Figure 9: EA Grendon Brook Modelling Defended Flood Extents

Hydraulic Modelling

2.1.9 A 1D modelling approach has been undertaken to model flood risk from the River Nene and Grendon Brook using Flood Modeller. A 2D direct rainfall approach has been undertaken to model the small ordinary watercourse known as "Field Drain" which runs through the proposed BESS2 Field.

2.1.10 Due to the nature of the development, undertaking a detailed channel survey and constructing a new Site-specific 1D-2D model of the watercourse was not considered necessary or proportionate, ongoing consultation with the EA indicates that there is a general agreement on the approach. Outputs of the modelling undertaken are included in Annex C, and include the 50% AEP scenario up to the 0.1% AEP scenario, including the 1% AEP + 13% CC event, also known as the design event. Results also include the 1% AEP + 36% CC event, which is the credible maximum scenario for the Nene Management Catchment *(the 2080s Upper End climate change allowance) and acts as a sensitivity test for the model.

2.1.11 Given the limited extent of the upstream catchment of the Field Drain watercourse, a rainfall-runoff modelling approach has been adopted to assess fluvial flood risk. This model indicates no fluvial flooding of the site, with no fluvial flows identified from the watercourse during the 1% AEP +25% CC rainfall event. Some localised ponding is shown within the site boundary, but this is hydraulically disconnected from the watercourse and is attributed to surface water accumulation in localised depressions within the DTM. This ponding will be managed by the proposed site drainage system therefore the proposed BESS and its surrounding acoustic bund can therefore be considered to lie within Flood Zone 1 and are at very low risk of fluvial flooding. As such, no further attention is required in the context of the assessment of fluvial flood risk.

2.1.12 The maximum flood depths during each scenario are detailed below:

Table 2: Maximum Flood Depths across BESS1/ BESS2 (m)

Return Period (AEP)	BESS1	BESS2
50%	Western extents of Field remain flood free, east ranging from 0.3-0.8.	All depths <0.3
5%	Western extents of Field remain flood free, east ranging between 0.3 – 1.	All depths <0.3
1%	Western extents of Field remain flood free, east largely 0.6-1.2 with isolated area 0.9 – 1.5	All depths <0.3
1% +13% CC	Western extents of Field remain flood free, east largely 0.6-1.2 with isolated area 0.9 – 1.5	All depths <0.3
1% +36% CC	Western extents of Field remain flood free, east largely 0.6-1.2 with isolated area 1.2-1.8.	All depths <0.3
0.1%	Western extents of Field remain flood free, east with depths ranging from 0.3 up to 2.1 in two isolated areas.	All depths <0.3

2.1.13 It is proposed that the main substation infrastructure will be constructed within the south of BESS2, which is located outside of modelled fluvial flood risk. The associated BESS infrastructure is proposed to be within the remaining areas of BESS2, and the western extents of BESS1. The western extents of BESS1 are shown to remain flood free during all modelled events.

2.1.14 The North Northamptonshire LLFA was contacted in February 2024. A response was received in April 2024 and is included in Annex B. Further to this, the EA and LLFA were consulted with throughout the pre-application process, with guidance complied with where required. Green Hill BESS is not located within an IDB.

2.1.15 Given that development at BESS1 is outside of the flood extents and that the flood extents within BESS2 have flood depths below 0.3m, Green Hill BESS is considered to be at **Low** risk of fluvial flooding.

2.2 Surface Water Flood Risk

2.2.1 The EA's National Flood Risk Assessment Mapping (NaFRA), known as the Long Term Flood Risk Map (Surface Water)[vi] was updated in January 2025.

2.2.2 The NaFRA mapping provides an updated view of surface water flooding across the Fields, however it should be noted that at the time of writing, the NaFRA mapping only delivers climate change insight up to the year 2060.

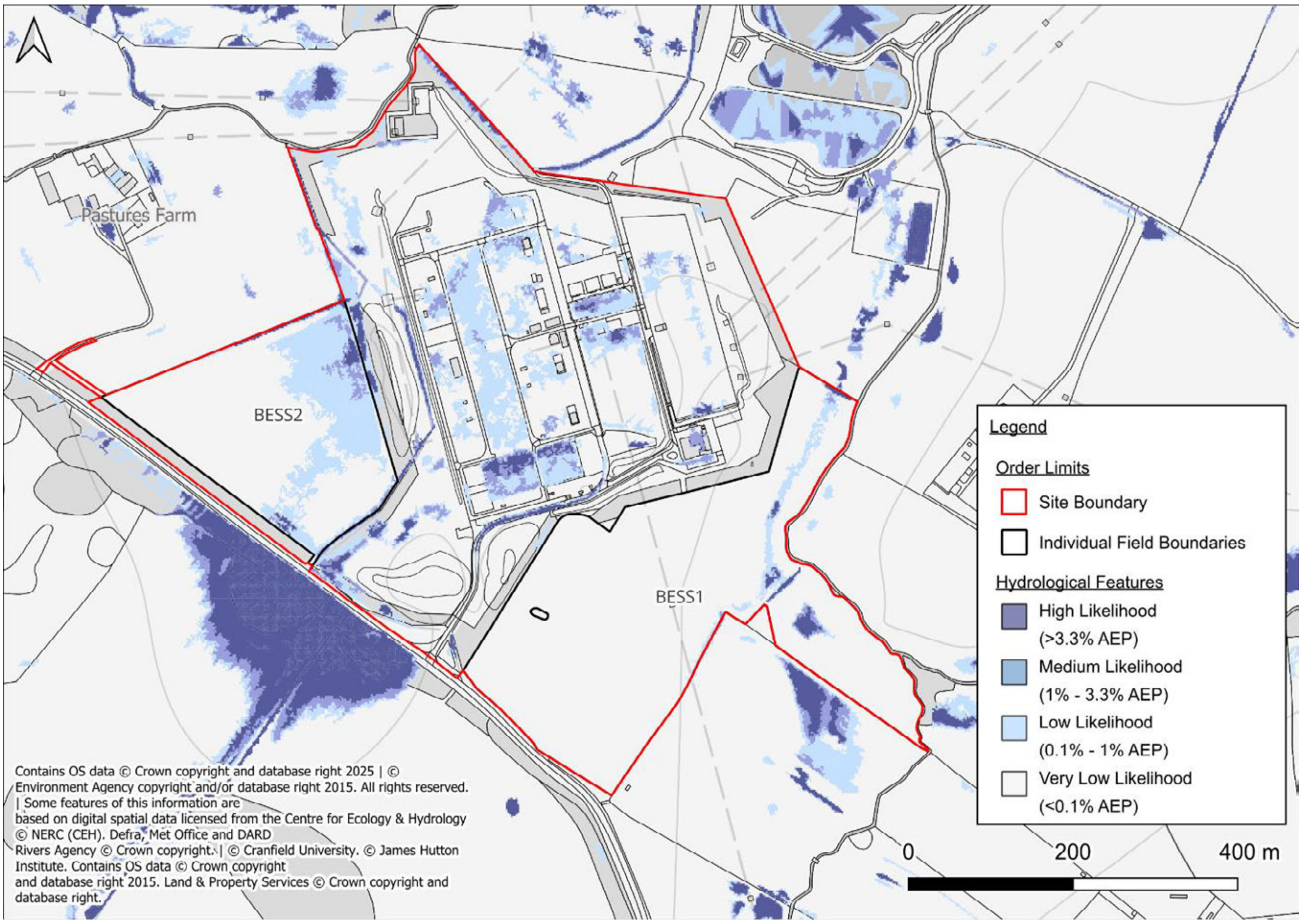


Figure 10: EA's Long-Term Flood Risk Map (Flood Risk from Surface Water)

2.2.3 The previous EA Risk of Flooding from Surface Water (RoFSW) mapping indicates that Green Hill BESS is mainly at Low risk of surface water flooding, meaning it has a 0.1% - 1% annual probability of flooding. Additionally, there is a small area of High risk flooding in the eastern area of BESS1, which is considered to have >3.3% annual probability of flooding.

2.2.4 The updated NaFRA mapping has been assessed and indicates that surface water flooding extents have reduced at Green Hill BESS (Figure 11). As described in the fluvial section above, the surface water flooding extents largely correspond with Grendon Brook and the land drainage ditch which flow adjacent to BESS1 and BESS2, respectively.

2.2.5 The NaFRA surface water mapping indicates that the whole of Green Hill BESS is expected to have depths below 0.3m. Surface water depths of less than 0.3m are typically passable by both vehicles and pedestrians.

2.2.6 2D direct rainfall modelling of the Field Drain has been undertaken by Arthian which indicate only shallow areas of surface water flooding in BESS2, this is detailed further in Section 2.2.12 above.

2.2.7 Any potential surface water flooding arising at or near to Green Hill BESS would be directed north, away from the Site, following the local topography and the watercourses.

2.2.8 Based on the above, it can therefore be concluded that Green Hill BESS is at **Low** risk of surface water flooding.

2.3 Groundwater Flood Risk

2.3.1 Details of geology can be found in Section 1.0 above. There were no water strikes encountered in the closest borehole to the south of Field BESS2.

2.3.2 The 2017 SFRA Groundwater Risk Map indicates that the Site is in an area of Negligible risk.

2.3.3 Groundwater levels correspond with river levels. As such groundwater flooding could occur during periods of prolonged high water levels in the Unnamed Main River.

2.3.4 The Field BESS2 will be predominantly hardstanding, limiting the vertical migration of groundwater. The Scheme does not include any basement structures or buildings requiring permanent occupation. Only unstaffed, above-ground supporting infrastructure is proposed, which would not be sensitive to low-level groundwater seepage. BESS1 will be partially hardstanding, however, the rest of the Site will remain the same and drain as per existing.

2.3.5 It can therefore be concluded that the risk of groundwater flooding is **Low.**

2.4 Sewer Flooding

2.4.1 No Site-specific incidents of sewer flooding have been identified from relevant third-party reports. On the basis of the Site's rural setting the presence of sewerage infrastructure is unlikely. Utility records have been checked and no sewers are identified within the Site. It can therefore be concluded that the risk of sewer flooding is **Low.**

2.5 Reservoir and Canal Flooding

2.5.1 There are no canals within the vicinity of the Site.

2.5.2 The EA 'Flood Risk from Reservoirs' map shows that the Site is at risk of flooding from reservoirs when river levels are normal and/or flooded.

2.5.3 The EA state that reservoir flooding is extremely unlikely to happen. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the EA ensure that reservoirs are inspected regularly, and essential safety work is carried out.

2.5.4 It can therefore be concluded that there is **Low** risk of flooding from artificial sources.

2.6 Residual Flood Risks

2.6.1 A residual risk is an exceedance event, such as the greater than 1 in 1000 year (<0.1% AEP) flood event that would overtop the Unnamed Main River and potentially impact the Site. As the probability of a 1 in 1000 year flood event occurring is <0.1% in any given year, the probability is low and, therefore, no further mitigation beyond what is proposed is required.

2.6.2 In the event of the defences failing or an exceedance event occurring, the residual risk to people working within the Site can be managed through the implementation of an appropriate Site management plan, which recognises the residual risks and details what action is to be taken by staff in the event of a flood to put occupants in a place of safety.

2.7 Summary of Flood Risk and Mitigation

2.7.1 It can be concluded that fluvial flooding is the main potential source of flood risk to the Site, with the north-east of BESS1 having a **Moderate** fluvial risk. The remainder of BESS1, and the entirety of the BESS2 Field are assessed as having a **Low** fluvial risk. All other sources of flooding are considered to have a **Low** to **Negligible** risk, however it would be prudent to include the below mitigation measures.

2.8 Embedded Mitigation

2.8.1 Embedded Mitigation is detailed in Section 3.2 of the covering report.

<u>For Proposed BESS / Substations</u>

2.8.2 All equipment will be raised by a minimum of 150mm, or as high as practically possible, above surrounding ground levels.

2.8.3 Firewater (including water run-off from fire-fighting equipment) and other surface water pollution risks will be managed through the use of impermeable liners, containment systems and isolation valves that close automatically in the event of a fire. With these measures in place, all potential effects on flood risk and water quality are considered to be not significant.

2.8.4 The BESS and substation infrastructure can be adequately waterproofed to withstand the effect of flooding. Batteries will be located within areas outside of the 0.1% AEP flood extent, where this hasn't been possible, equipment will be raised 0.6m above the 0.1% AEP flood level or as high as practicable.

<u>Flood Warnings and Evacuation</u>

2.8.5 Flood Warnings / Flood Alerts[vii] do cover this area therefore Site management should sign up to the free EA Floodline service to receive flood alerts.

2.8.6 Access to the Site will be required relatively infrequently, typically by technicians for maintenance and inspection works or Site management. Such works can be scheduled as to avoid the Site during times of flood.

2.9 Impact on Off-Site Flood Risk

2.9.1 Green Hill BESS will not displace floodwater from the floodplain and will be appropriately designed on gravel beds to ensure that the Site continues to drain accordingly. The surface water management has been considered in Section 3.0 below.

3. Drainage Strategy

3.1 Introduction

3.1.1 The Site currently comprises undeveloped land which is not formally drained and is therefore considered to be 100% permeable. Figures 5 and 6 above show the locations of the BESS and Substation areas and the two options for BESS2.

3.1.2 It is understood that the Upper Nene Valley Gravel Pits SPA is located downstream of the Site, the below strategy will ensure that the proposed development will not have a detrimental impact in terms of discharge rates and surface water quality.

3.1.3 North and West Northampton council state in their local policy documents (refer to **Appendix 10.1 Flood Risk Assessment and Drainage Strategy Covering Report** for further information on local policy) that 'all new development in the Upper Nene catchment must be designed for a flood with a 0.5% probability (1 in 200 chance) occurring in any year, including an appropriate allowance for climate change. This includes design of mitigation for main river flooding and any surface water attenuation.' Therefore, for the purposes of this assessment, attenuation will be designed to accommodate up to a 200 year event including a 40% allowance for climate change.

3.1.4 The proposed development is for a BESS, located in the Fields BESS1 and BESS2. A Substation will also be located within BESS2. This drainage strategy will assess both the potential layouts options of BESS2.

3.1.5 The increase in hardstanding area will result in an increase in surface water runoff rates and volumes. In order to ensure the proposed development will not increase flood risk elsewhere, surface water discharge from the Site will be controlled.

3.2 Drainage Hierarchy

3.2.1 The recommended surface water drainage hierarchy (Paragraph 5.8.15 of the NPS EN-1[viii] and Paragraph 056 (Ref ID: 7-056-20220825) of the PPG: Flood Risk and Coastal Change[ix]) is to utilise soakaway systems or infiltration where feasible, followed by discharging to an appropriate watercourse. If neither option is viable, discharge to a public surface water sewer should be considered, followed by a combined sewer. As a last resort, discharge to a highway drain or other drainage system may be considered.

3.2.2 The following options assume normal operation, during a potential pollution event (such as a fire), the system will be isolated and managed. Firewater management is discussed further below.

Surface Water Discharge to Soakaway

3.2.3 The first consideration for the disposal of surface water is infiltration (soakaways and permeable surfaces). As described above, Field BESS2 is underlain by Ecton Member, and Field BESS1 is underlain by no superficial deposits to the west, Glaciofluvial Deposits in the central area, and Alluvium to the east.

3.2.4 Ecton Member is a known low-permeability formation and is not considered suitable for infiltration drainage. Although glaciofluvial and alluvial deposits may contain granular material, they are typically heterogeneous and include layers of low-permeability silt and clay, which can significantly constrain infiltration. Additionally, the site lies in close proximity to several watercourses, and where superficial deposits are permeable, the groundwater table is likely to be shallow due to hydraulic connectivity with nearby surface waters. This presents a constraint for soakaway design, as BRE 365 requires a minimum of 1 metre clearance between the base of the infiltration system and the highest expected groundwater level. Given these geological and hydrogeological limitations, infiltration techniques are not considered technically suitable in this location.

3.2.5 BRE 365 soakaway testing is therefore not proposed at this stage, as infiltration is not relied upon in the current drainage strategy. This assessment adopts a combination of passive infiltration over undeveloped greenfield areas and lined attenuation systems with controlled discharge where formal drainage is required. As infiltration is not currently proposed, soakaway testing is not considered necessary or proportionate to support the DCO application. Should infiltration be deemed feasible at detailed design stage, soakaway testing would be undertaken at that time in accordance with BRE 365 and relevant LLFA guidance.

Surface Water Discharge to Watercourse

3.2.6 Where soakaways are not suitable, a connection to a watercourse is the next consideration.

3.2.7 The nearest watercourse to BESS1 is to Grendon Brook which is located along the eastern boundary. Given the elevation of the Site above the watercourse, discharge to Grendon Brook at a limited discharge rate of 9.99l/s appears to be feasible via gravity.

3.2.8 The nearest watercourse to BESS2 is the Unnamed Land Drain located along the eastern boundary. Given the elevation of the Site above the watercourse, discharge to the Unnamed Land Drain at a limited discharge rate of 9.69 l/s for option 1 and 9.74l/s for option 2, appears to be feasible via gravity.

3.2.9 Discharge rates are discussed in detail below in Section 3.3.

Surface Water Discharge to Sewer

3.2.10 As described above, connections to the Unnamed Land Drain/Grendon Brook are feasible and therefore a connection to the public surface water sewer is not the preferred option. Should it be determined that direct discharge to the Land Drain / Grendon Brook is not preferable, a discharge to the public drainage system could be considered.

3.3 Surface Water Discharge

3.3.1 The existing greenfield runoff rates generated for BESS1 and BESS2 have been estimated using the Revitalised Flood Hydrograph Model (ReFH2) method, provided in Table 3 below. Greenfield runoff calculations for BESS1 are based off the 40,381m^2 proposed hardstanding area whereas for BESS2, option 1 is based on the 38,840m^2 proposed hardstanding area and option 2 is based off the 39,032m^2 proposed hardstanding area.

Table 3: Runoff Rates

Return Period (Years)	Runoff Rate (l/s)		
	BESS1	BESS2 Option 1	BESS2 Option 2
1 in 2	9.99	9.69	9.74
1 in 10	17.17	16.65	16.74
1 in 30	21.8	21.15	21.26
1 in 100	27.37	26.56	26.69
1 in 1000	44.53	43.2	43.42

3.3.2 A flow rate of 9.99l/s is proposed for BESS1 whereas a flow rate of 9.74l/s is proposed for BESS2. A conservative approach has been adopted by applying the runoff rate calculated for BESS2 option 2, which represents the option with the greatest hardstanding area.

Attenuation Storage

3.3.3 In order to achieve a discharge rate of 9.99l/s and 9.74l/s for BESS1 and BESS2 respectively, attenuation storage will be required. Storage estimates have been provided using Causeway Flow and are included in Annex D. Table 4 below provides the input parameters for the calculations and the estimated storage volumes required for the proposed hardstanding area in each BESS Field. Option 2 at BESS2 has been used for the purpose of the drainage calculations as this option has the larger hardstanding area and can therefore be applied to either option.

Table 4: Attenuation Storage Volume Parameters

	BESS1	BESS2
Proposed Discharge Rate	9.99l/s	9.74l/s
Total Proposed Impermeable Area	40,381m^2	39,032m^2
Design Head	1m	1m
Flow Control Device	HydroBrake/Orifice Plate	HydroBrake/Orifice Plate
Estimated Storage Volume (1 in 200 year + 40% CC)	3,516.5m^3	3,379.7m^3

3.3.4 The attenuation volumes are provided for indicative purposes only and should be verified at the detailed design stage.

3.4 Sustainable Drainage Systems

3.4.1 Attenuation storage should be provided in the form of Sustainable Drainage Systems (SuDS) where practical. The following SuDS options have been considered:

Soakaways

3.4.2 As described above, the use of soakaways is not considered to be feasible.

Swales, Detention Basins and Ponds

3.4.3 Sufficient space is available on-Site to incorporate above-ground attenuation features such as swales, detention basins, or ponds. These features would serve a dual function by managing surface water runoff and providing containment capacity in the event of a fire, helping to isolate potentially contaminated firewater from the wider environment. To support this function, features can be lined where necessary to prevent infiltration into underlying soils and mobilisation of contaminants.

3.4.4 Attenuation features should be located towards the lower-lying parts of the BESS 2/Substation area to facilitate gravity drainage and positioned outside of the 0.1% AEP flood extents. The selection and specification of these features will be confirmed at detailed design stage, with due regard to firewater containment requirements and pollution control measures as outlined in Section 3.9 of this report.

Filter Drains/Strips

3.4.5 Filter drains are stone- or gravel-filled trenches that provide temporary subsurface storage to support the filtration, conveyance, and attenuation of surface water runoff. They are typically designed to receive lateral inflows from adjacent impermeable areas, ideally pre-treated via a filter strip to reduce sediment and pollutant loads. By encouraging flow through the granular medium, filter drains help manage peak runoff rates and provide attenuation by temporarily storing water within the voids of the fill material, particularly when paired with a controlled outlet.

3.4.6 Filter drains are most effectively used alongside access tracks, roads, and hardstanding areas where space for above-ground SuDS features may be limited. They can also be used to intercept runoff at the edge of impermeable areas and form part of a wider treatment train to manage water quality and flow rates prior to discharge or onward conveyance.

Bioretention Systems

3.4.7 Bioretention systems (including rain gardens and raised box planters) are shallow landscaped depressions that can reduce runoff rates and volumes and treat pollution. They also provide attractive landscape features and biodiversity. Bioretention systems can help reduce flow rates from a Site by promoting infiltration / evapotranspiration and providing some attenuation storage. Bioretention systems can also provide very effective treatment functionality. Bioretention systems are a very flexible surface water management component that can be integrated into a wide variety of developments / densities using different shapes, materials, planting, and dimensions. Bioretention systems (including rain gardens) should be considered within the detailed drainage design.

Rainwater Harvesting

3.4.8 Bioretention systems, including rain gardens, are shallow landscaped features designed to capture, slow, and treat surface water runoff. They reduce runoff rates and volumes through a combination of infiltration, evapotranspiration, and attenuation, while also providing excellent water quality treatment. In addition to their functional role, bioretention systems offer visual amenity, biodiversity benefits, and can be integrated into the overall landscape strategy.

3.4.9 These systems are highly flexible and can be configured in various shapes, sizes, and planting arrangements to suit different development layouts. Within the BESS Fields of the Site, bioretention systems may be used to manage runoff from hardstanding and access routes. Where firewater or contamination risks are present, these features can be lined to prevent infiltration into underlying soils. Bioretention systems should be considered at the detailed design stage as part of the surface water management approach for the BESS zone.

Green Roofs

3.4.10 Green roofs are not proposed as part of the current development plans, and are not considered appropriate for the BESS or Substation infrastructure due to structural and operational constraints.

Porous/Permeable Surfacing

3.4.11 Permeable gravel surfacing will be considered, where appropriate, within the BESS development and Substation area. Surface water attenuation will be achieved using lined sub-base storage beneath the gravel layer, with attenuation volumes for each BESS location detailed in Table 5. Runoff from battery units and adjacent hardstanding will be directed into this gravel surfacing, which will act as a temporary storage layer.

3.4.12 To prevent infiltration and provide containment in the event of a fire, the sub-base will be underlain with an impermeable liner. This approach supports the Site-wide firewater containment strategy, preventing the mobilisation of contaminants into underlying soils. Gravel surfacing will be limited to the battery compound and Substation areas only, excluding access roads, and will cover a total area of approximately 30,952.6 m^2 for BESS 1 and 35,981.8m2 for BESS2. Attenuation potential has been calculated based on a sub-base depth of 0.35 m and a conservative void ratio of 30%.

Table 5: Permeable Surfacing (Gravel Beds) Attenuation Potential

	BESS1	BESS2
Total Proposed Impermeable Area	40,381m^2	39,032m^2
Proposed Gravel Surfacing Area	30,952.6m^2	35,981.8m^2
Estimated Required Storage Volume (1 in 200 year + 40% CC)	3,516.5m^3	3,379.7m^3
Lined Gravel Surfacing Attenuation Potential*	3,714.2m^3	3,778.1m^3

* Assumes a sub grade depth of 0.4m and a void ratio of 30% for BESS1 and a sub grade depth of 0.35m and a void ratio of 30% for BESS2.

3.4.13 The provision of storage within the sub-grade material would only be feasible in areas with a proposed gradient of <1 in 20 as detailed within CIRIA RP992/28 (Design Assessment Checklists for Permeable/Porous Pavement)[x]. Site gradients should be confirmed at the detailed design stage. The amount of storage provided within permeable surfacing is subject to sub-grade depth and gradient. Given the nature of the Site the proposed gravel subgrade should be lined to prevent potential pollution incidents from mobilising to the ground.

3.4.14 The use of lined gravel surfacing should be considered at the detailed design stage.

<u>Underground Attenuation Tanks</u>

3.4.15 Storage could be provided within underground attenuation tanks or within oversized pipes. This should be considered further within the detailed design stage.

3.5 Preferred Drainage Scheme

3.5.1 Surface water runoff at BESS1 will be discharged to the Grendon Brook located along the eastern boundary of the Field at a limited discharge rate of 9.99l/s. Whereas, surface water runoff at BESS2 will be discharged to the Unnamed Land Drain located along the eastern boundary of the Field at a limited discharge rate of 9.74l/s. The discharge rates reflect the existing 1 in 2 year greenfield runoff rate, ensuring compliance with greenfield runoff principles.

3.5.2 Surface water runoff up to the 1 in 200 year +40% climate change allowance event will be attenuated within the BESS1 and BESS2 Fields. The required attenuation at BESS1 is 3,516.5m^3, and at BESS2 the required attenuation is 3,379.7m^3. The required attenuation can be provided wholly in the form of lined gravel surfacing located under the proposed battery units and substation area, excluding the roads. Based on a 30,952.6m^2 proposed area at BESS1, lined gravel surfacing can provide up to 3,714.2m^3 of attenuation, whereas on BESS2, based on a proposed area of 35,981.8m^2, lined gravel surfacing can provide up to 3,778.1m^3 of attenuation. A conceptual drainage sketch detailing the above has been included as Annex E.

3.5.3 Based on conceptual drainage calculations, the lined gravel surfacing provides the required attenuation volume for both BESS Fields up to a 1 in 200 year +40% cc event, however if additional attenuation is required during the detailed design phase, attenuation ponds and geocellular storage should be considered further.

3.5.4 The proposed surface water drainage scheme ensures no increase in runoff rates or volumes over the lifetime of the development. Additionally, attenuation calculations have been based on a conservative assumption that the BESS and Substation areas will comprise 100% impermeable surfacing, which is unlikely in practice. This approach provides additional robustness and flexibility within the design.

3.6 Event Exceedance

3.6.1 Storage will be provided for the 1 in 200 year plus 40% CC event. Storm events in excess of the 1 in 200 year plus 40% CC event should be permitted to produce temporary shallow depth flooding within non developed areas including where necessary the access roads.

3.6.2 BESS2, the proposed location for the substation, is not identified to be at risk from fluvial flooding up to the 1 in 200 year +40% CC event. The speckling visible in the model outputs indicates areas of expected surface water ponding in the undeveloped scenario. Surface water on-Site will be managed through a comprehensive drainage system designed to modern standards and guidance (as detailed in Section 3.4). This will ensure there is no surface water ponding or surcharging above ground during events up to the 1 in 200 year + 40% CC event. The units will be raised by a minimum of 150mm, or as high as practically possible, above surrounding ground levels to prevent exceedance flooding from impacting the

Site and to ensure significant resilience to flooding.

3.7 Surface Water Treatment

3.7.1 It is noted that the BESS facility is located in a Special Protection Area / Ramsar / Site of Special Scientific Interest. Sufficient treatment for the BESS and substation will be incorporated into the Site. In accordance with the CIRIA C753 publication 'The SuDS Manual' (2015)[xi], other roofs have a 'low' pollution hazard level, with commercial yards classified as having a 'medium' pollution hazard level. Table 6 below shows the pollution hazard indices for each land use.

Table 6: Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Other Roofs (typically commercial/industrial roofs)	Low	0.5	0.2**	0.4
Commercial Yard and Delivery Areas, Non-residential Car Parking and all roads except Low Traffic Roads	Medium	0.7	0.6	0.7

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.2

* Indices values range from 0-1.

** up to 0.8 where there is potential for metals to leach from the roof

3.7.2 Where practical, runoff from roofs and roads will be directed to the existing drainage or the gravel where it can infiltrate into the ground. Table 7 below demonstrates that the porous surfacing provides sufficient treatment.

Table 7: SuDS Mitigation Indices

	Mitigation Indices		
Type of SuDS	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
Permeable Surfacing	0.7	0.6	0.7

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' -Table 26.3

3.7.3 It can be concluded that the inclusion of lined gravel surfacing will provide sufficient treatment during normal operation. Where attenuation is provided in a below ground system (tank storage), such as in BESS2, treatment will need to be provided by a suitably sized separator.

3.8 Firewater Consideration

3.8.1 Given the nature of the development there is a risk of fire, and contamination may be mobilised by fire suppression water. The principal route for any firewater loss from the Site is via the proposed surface water drainage system into the ground. In order to isolate the Site's drainage, the proposed gravel subbase will be lined and the proposed outfalls from the drainage system should be controlled by automatically actuated valves. In the event of a fire, the valve will be designed to activate to close off the battery storage area's drainage system triggered by the fire alarm systems. Flows will then back up in the system. The system will be designed to accommodate the 1 in 200 plus 40% climate change storm event, therefore a sufficient amount of storage is provided to contain a reasonable worst case 1 in 10 year storm event.

3.8.2 According to National Fire Chiefs Council Grid Scale Battery Energy Storage System planning Guidance for FR Guidance, a tank measuring 228m^3 will be required to supply a fire hydrant located adjacent to the BESS developments. Guidance also states that fire and rescue services may wish to increase this requirement, given the size of the development there is available space on-Site to provide additional storage. The design approach, including containment, valve operation and emergency response procedures, is further detailed in the Outline Battery Storage Safety Management Plan [EN010170/APP/GH7.7].

3.8.3 Following a fire event, wastewater will be tested to determine the level of contamination. The appropriate disposal method will then be selected, which may include on-site treatment and controlled release, or removal from site via tanker where necessary. These procedures are secured through the measures set out in the Outline Battery Storage Safety Management Plan (EN010170/APP/GH7.7).

3.9 Maintenance

3.9.1 Maintenance of communal drainage features such as permeable surfacing or an attenuation tank will be the responsibility of the Site owner. Maintenance of shared surface water drainage systems can be arranged through appointment of a Site management company.

3.9.2 Maintenance schedules for an attenuation tank and permeable surfacing are included in Annex F. Maintenance of the separator will be as per the manufacturer's guidance.

4. Conclusions and Recommendations

4.1 Conclusions

4.1.1 The proposed development is for a BESS Site, with associated infrastructure and access roads.

Flood Risk

4.1.2 It can be concluded that fluvial flooding is the main potential source of flood risk to the Site, with the north-east of BESS1 having a Moderate fluvial risk. The remainder of BESS1, and the entirety of the BESS2 Field are assessed as having a Low fluvial risk. All other sources of flooding are considered to have a Low to Negligible risk, however it would be prudent to include the below mitigation measures.

Drainage Strategy

4.1.3 The proposed development is for a BESS which will introduce impermeable drainage area in the form of equipment and access. This will result in an increase in surface water runoff. In order to ensure the increase in surface water runoff will not increase flood risk elsewhere, flow control will be used, and attenuation provided on-Site in the form of lined gravel surfacing beneath the BESS and substation area to accommodate storm events up to and including the 1 in 200 year plus 40% climate change event.

4.1.4 Any surface water exceeding the infiltration capacity of the surrounding strata will naturally drain to the surrounding land drains in line with the existing scenario.

4.1.5 The heavily managed agricultural land will be replaced with wildflowers and grassland. This will help to reduce run off rates by increasing the roughness of the ground, helping to increase infiltration by reducing compaction, and improve water quality by reducing erosion and mobilisation of pollutants. As a result, runoff rates may be reduced following development when compared to the existing greenfield scenario.

4.1.6 The proposed drainage scheme therefore meets the four pillars of SuDS (water quality, water quantity, amenity and biodiversity).

4.2 Recommendations

4.2.1 Embedded Mitigation is detailed in Section 3.2 of the covering report.

For proposed BESS / Substations:

4.2.2 All equipment will be raised by a minimum of 150mm, or as high as practically possible, above surrounding ground levels.

4.2.3 Firewater (including water run-off from fire-fighting equipment) and other surface water pollution risks will be managed through the use of impermeable liners, containment systems and isolation valves that close automatically in the event of a fire. With these measures in place, all potential effects on flood risk and water quality are considered to be not significant.

4.2.4 The BESS and substation infrastructure can be adequately waterproofed to withstand the effect of flooding. Batteries will be sequentially located within areas of the Site which are located in Flood Zone 1. The supporting hydraulic modelling undertaken at the BESS Site indicates the majority of BESS1 is in Flood Zone 1 and only shallow levels of flooding are expected in BESS2.

Annex A- Grendon Brook Water Body Catchment Classification Summary

Classification Item	2019 Classification		2019 Classification		Cycle 3 Objectives	
	Cycle 2	Cycle 3	Cycle 3	Status	Year	Reasons
Ecological	Moderate	Moderate	Moderate	Moderate	2022	
Biological Quality Elements	N/A	Moderate	Moderate	Moderate	2022	
Invertebrates	N/A	Good	Good	Good	2022	
Macrophytes and Phytobenthos Combined	N/A	Moderate	Moderate	Moderate	2022	Disproportionately expensive: Disproportionate burdens; Technically infeasible: No known technical solution is available
Physio-Chemical Quality Elements	Moderate	Moderate	Moderate	Moderate	2022	
Acid Neutralising Capacity	N/A	N/A	N/A	N/A	2022	
Ammonia (Phys-Chem)	High	N/A	High	Moderate	2022	
Dissolved Oxygen	High	High	High	High	2022	
Phosphate	Poor	Poor	Poor	Poor	2022	
Temperature	High	High	High	High	2022	
pH	High	High	High	High	2022	
Hydromorphological Supporting Elements	Supports Good	Supports Good	N/A	N/A	2022	
Supporting Elements (surface Water)	Moderate	N/A	N/A	N/A	2022	
Mitigation Measures Assessment	Moderate or less	N/A	N/A	N/A	2022	
Specific Pollutants	High	N/A	N/A	N/A	2022	
Iron	N/A	N/A	N/A	N/A	2022	
Maganese	N/A	N/A	N/A	N/A	2022	
Chemical	N/A	Fail	Fail	N/A	2022	Natural conditions: Chemical status recovery time; Technically infeasible: No known technical solution is available
Priority Hazardous Substances	N/A	Fail	Fail	N/A	2022	Natural conditions: Chemical status recovery time; Technically infeasible: No known technical solution is available
Benzo(a)pyrene	N/A	Good	Good	N/A	2022	
Dioxins and dioxin-like compounds	N/A	Good	Good	N/A	2022	
Heptachlor and cis-Heptachlor Epoxide	N/A	Good	Good	N/A	2022	
Hexachlorobenzene	N/A	Good	Good	N/A	2022	
Hexachlorobutadiene	N/A	Good	Good	N/A	2022	
Mercury and Its Compounds	N/A	Fail	Fail	N/A	2022	Natural conditions: Chemical status recovery time
Perfluorooctane sulphonate (PFOS)	N/A	Fail	Fail	N/A	2022	Technically infeasible: No known technical solution is available
Polybrominated diphenyl ethers (PBDE)	N/A	Fail	Fail	N/A	2022	Natural conditions: Chemical status recovery time
Priority substances	N/A	Good	Good	N/A	2022	
Cypermethrin (Priority)	N/A	Good	Good	N/A	2022	
Fluoranthene	N/A	Good	Good	N/A	2022	
Other Pollutants	N/A	N/A	N/A	N/A	2022	

Annex B – North Northamptonshire Council LLFA Response

From: Harkin, Liam <L[redacted]
Sent: Monday, June 17, 2024 3:29 PM
To: [redacted]
Subject: RE: Green Hill Solar Farm - contact/response

> You don't often get email from [redacted]

Hi Joshua,

Please see in red answers to your queries.

- Instances of historic flooding at or near this location; We are pulling this data together and will forward on to you shortly.
- Details of flood defences in the area; Flood defence information is available from the EA here - https://flood-map-for-planning.service.gov.uk/
- Information regarding maintenance of land drains and management of flood risk in the area; Much of this information can be found in our local standards and guidance document (attached) and at [redacted]
- Any restrictions in developing near a IDB owned watercourse; and - You must apply for Land Drainage Consent if you want to: Do work on, over, under or near an ordinary watercourse (within 9 metres of the landward toe of the bank), or make changes to any structure that helps control water.
- Do you have specific requirements for discharge rates to land drains and could you please provide these? – Details of discharge rate requirements can be found in the attached standards and guidance document.

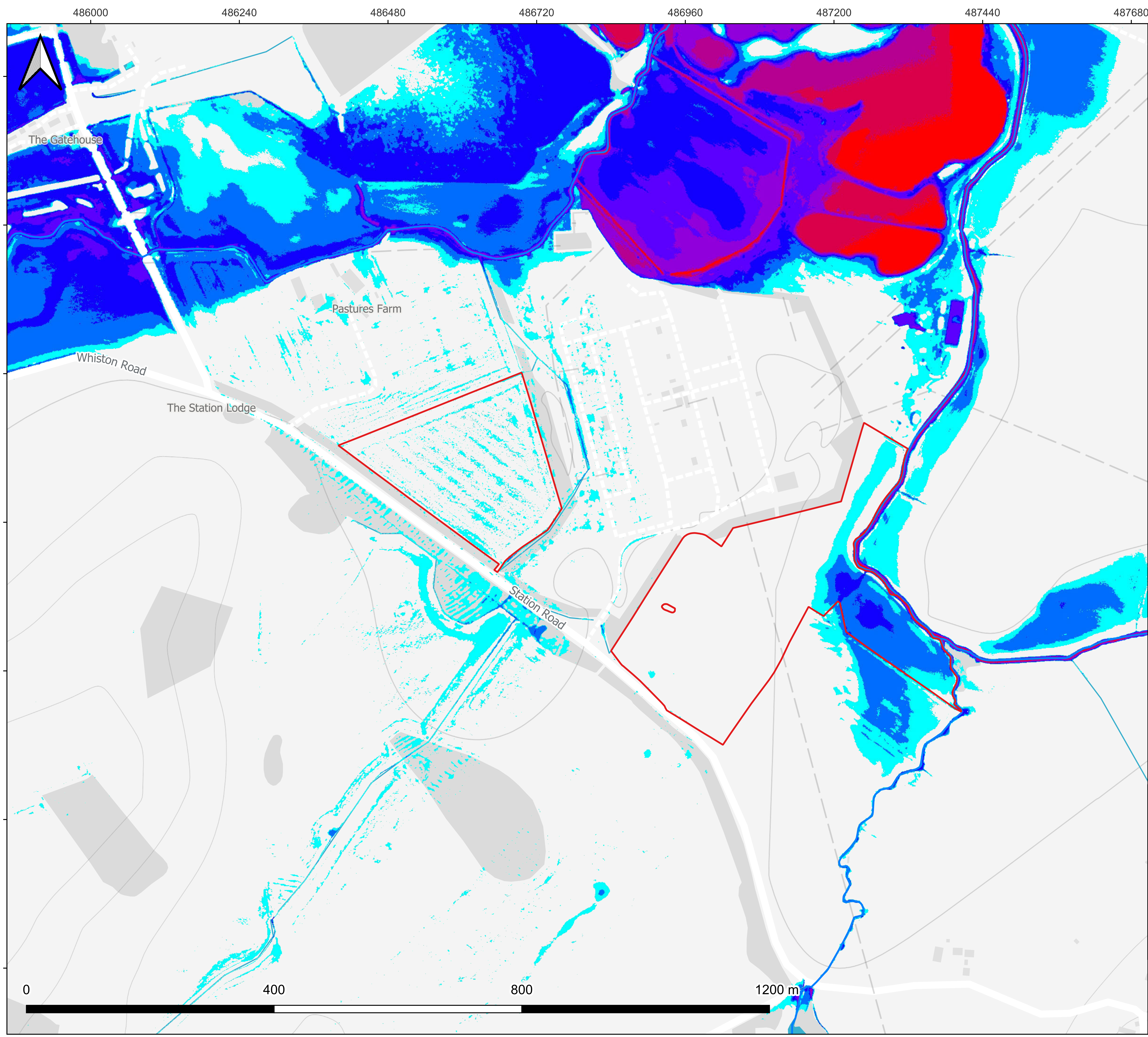
We're happy to arrange a call to discuss your proposals in greater detail. We have availability Wednesday or Thursday this week, I then go on leave and have availability from the 3rd of July onwards.

Kind regards,

[redacted]
Environment Team Leader

E:[redacted]

Annex C – Hydraulic Modelling Results



Project Reference:
Green Hill Solar

Client:
Green Hill Solar Farm Ltd.

Drawing Title:
50% AEP flood depths (m)

Drawing Name:	Revision:	Date:
313532_50%AEP	A	11 Apr 2025

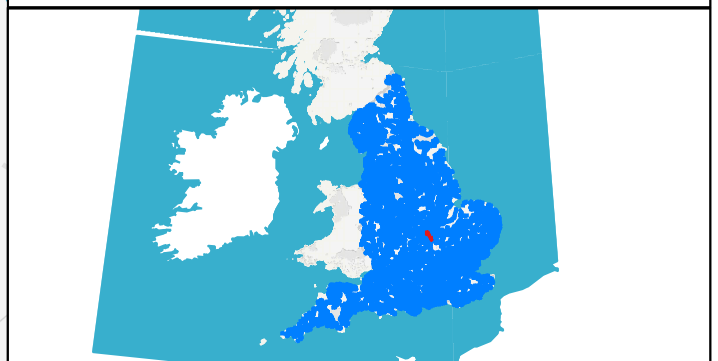
Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	IR	JR	JR

Legend

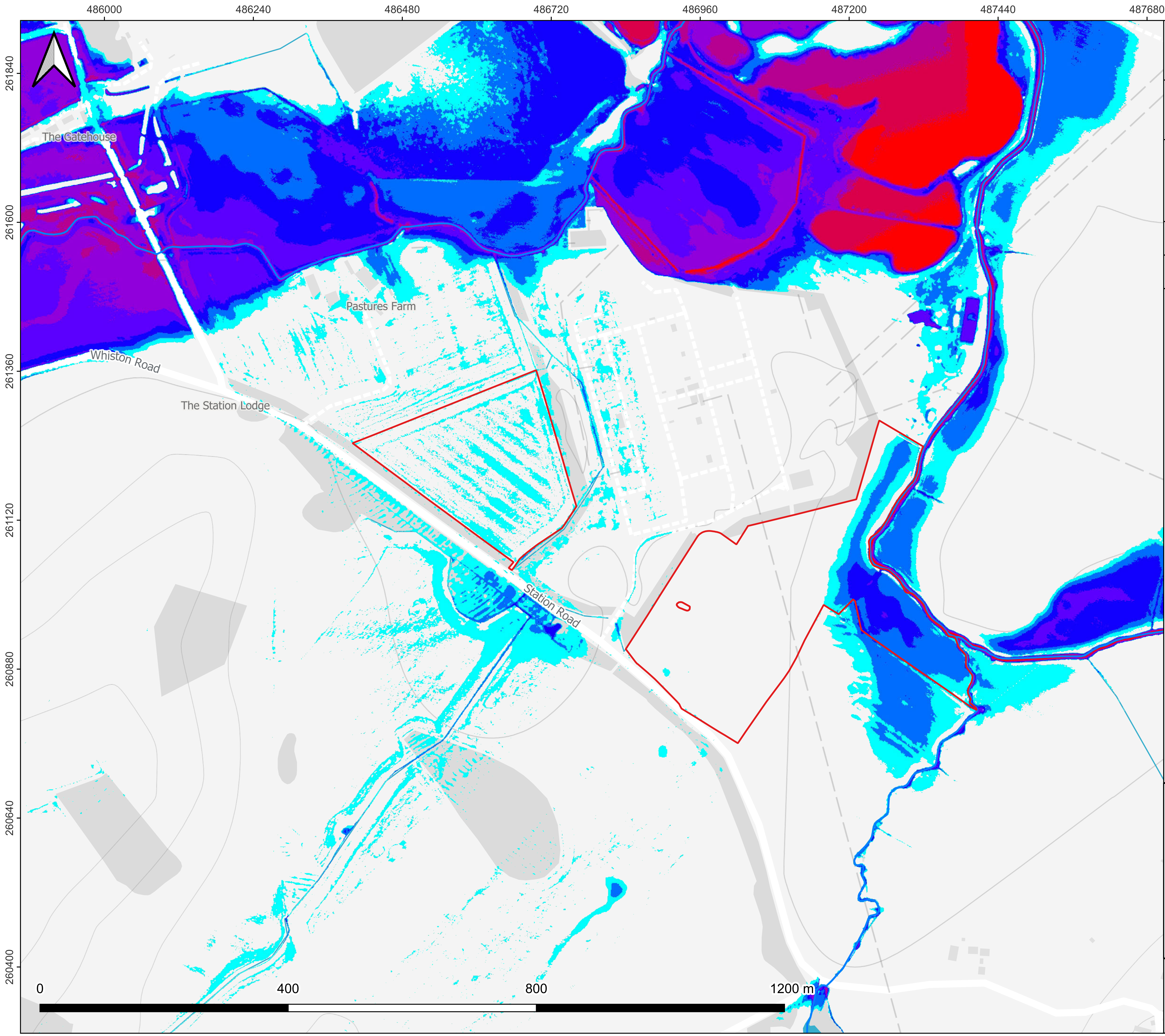
- Green Hill Solar
- Main Rivers

Q2

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.50
- 1.50 - 1.80
- 1.80 - 2.10
- > 2.10



Arthian



Project Reference:

Green Hill Solar

Client:

Green Hill Solar Farm Ltd.

Drawing Title:

5% AEP flood depths (m)

Drawing Name:	Revision:	Date:
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Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	IR	JR	JR

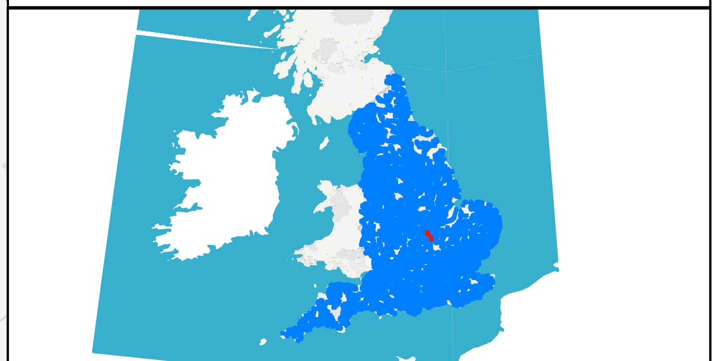
Legend

Green Hill Solar

Main Rivers

Q20

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.50
- 1.50 - 1.80
- 1.80 - 2.10
- > 2.10



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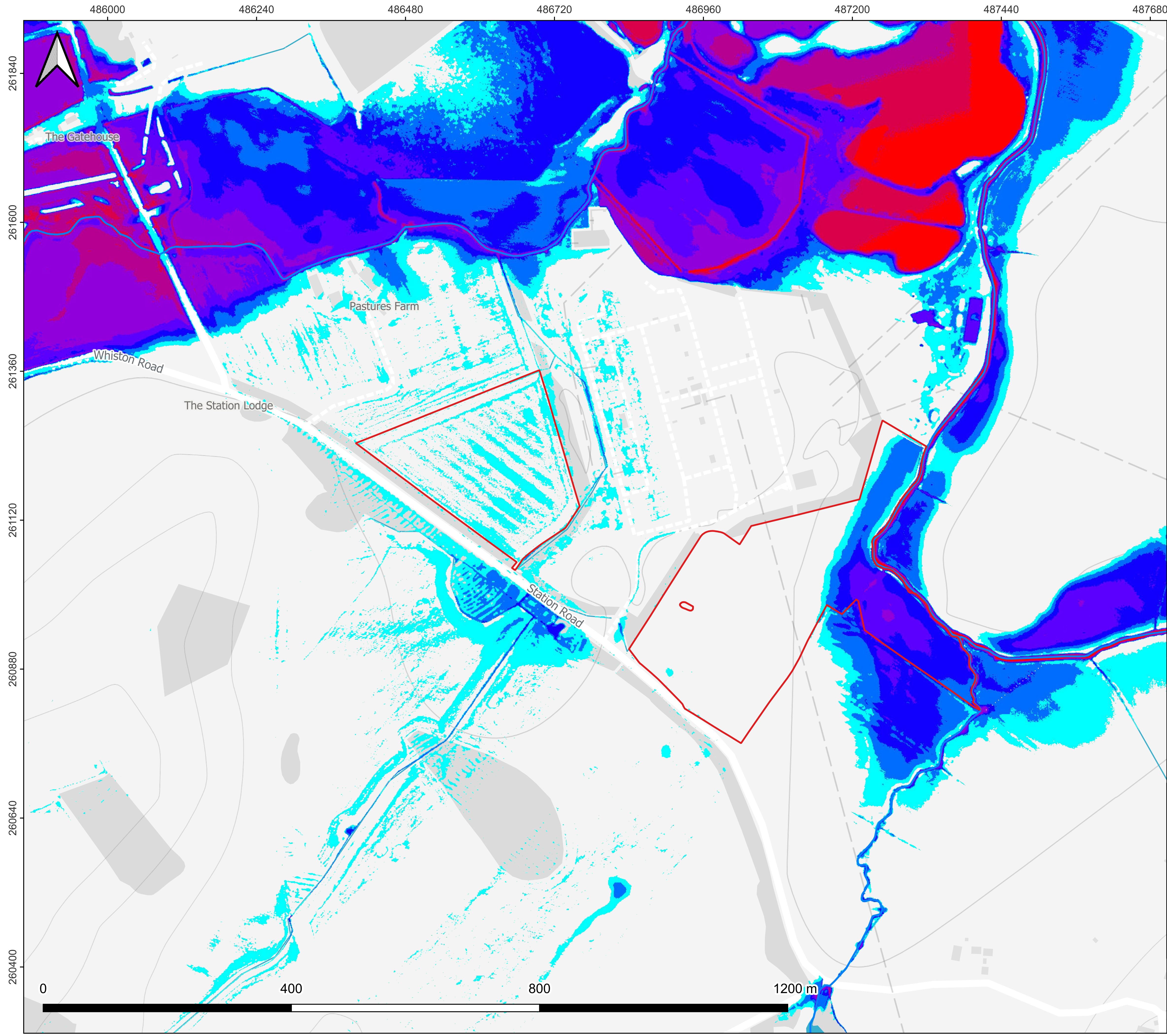


Project Reference:

Green Hill Solar

Client:

Green Hill Solar Farm Ltd.

Drawing Title:

1% AEP flood depths (m)

Drawing Name:	Revision:	Date:
313532_1%AEP	A	11 Apr 2025

Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	IR	JR	JR

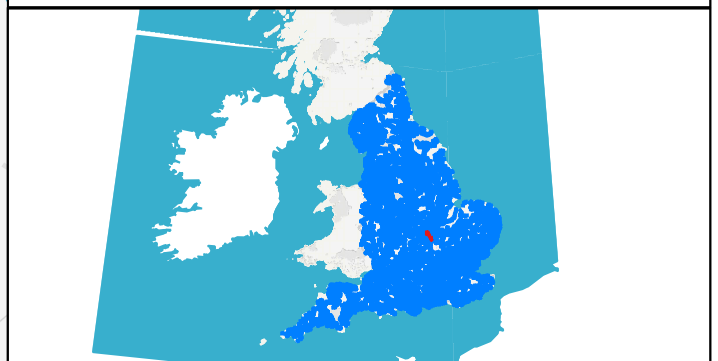
Legend

Green Hill Solar

Main Rivers

Q100

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.50
- 1.50 - 1.80
- 1.80 - 2.10
- > 2.10



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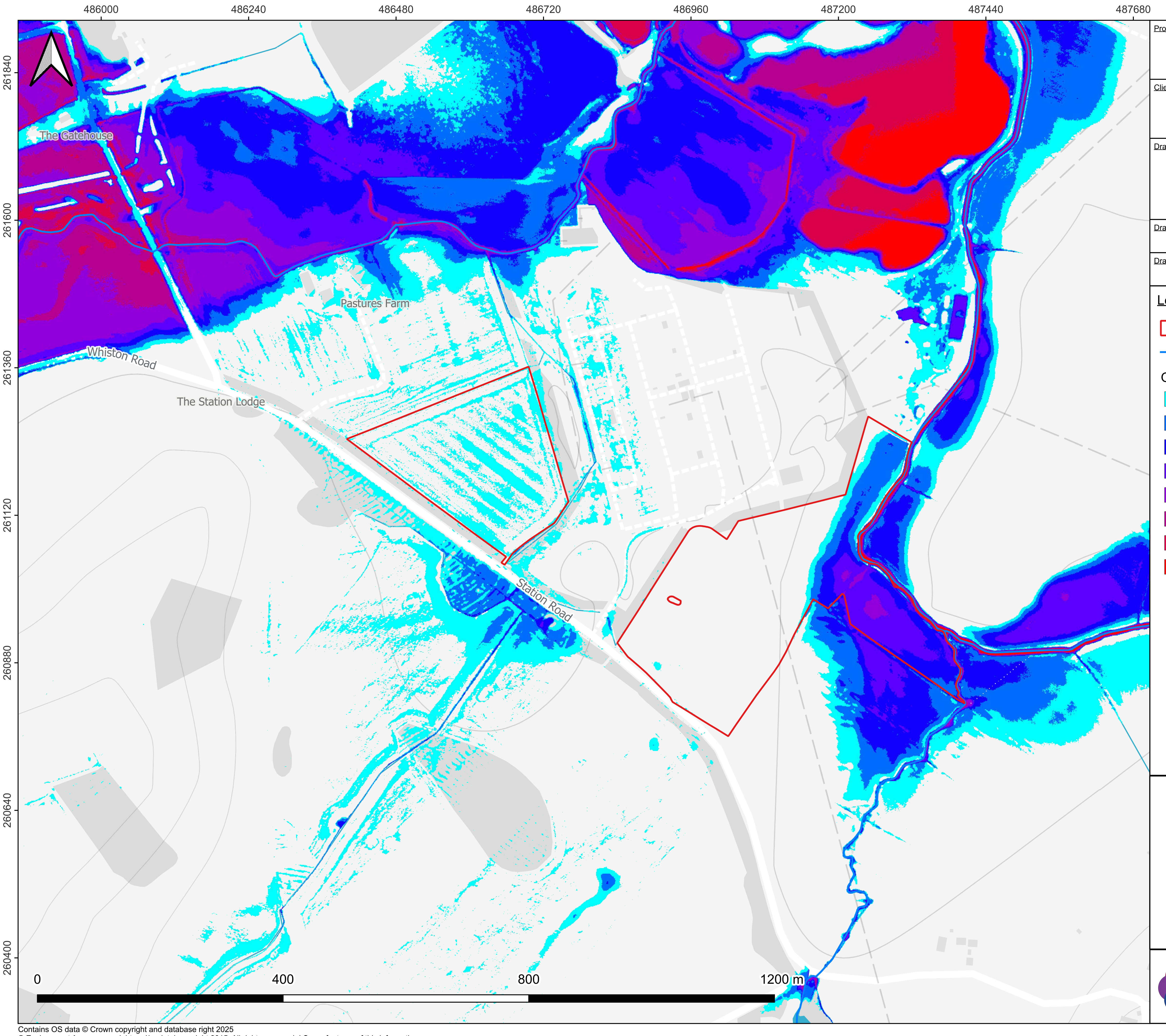

Project Reference:	Green Hill Solar
Client:	Green Hill Solar Farm Ltd.
Drawing Title:	1% AEP + 13% CC flood depths (m)

Drawing Name:	Revision:	Date:
313532_1%AEP+13%CC	A	11 Apr 2025

Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	IR	JR	JR

Legend

- Green Hill Solar
- Main Rivers

Q100CC13

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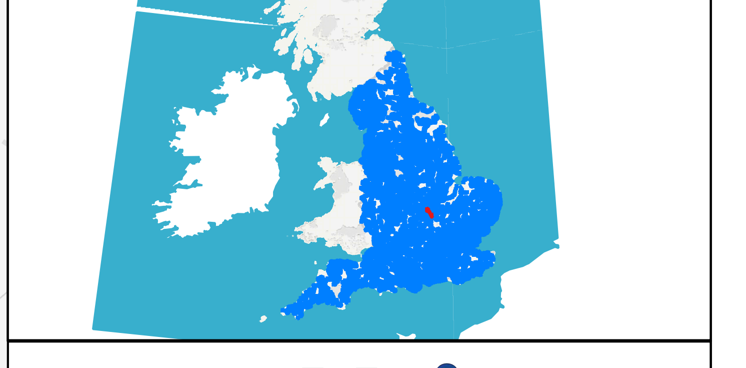
- 1.50 - 1.80
- 1.80 - 2.10
- > 2.10



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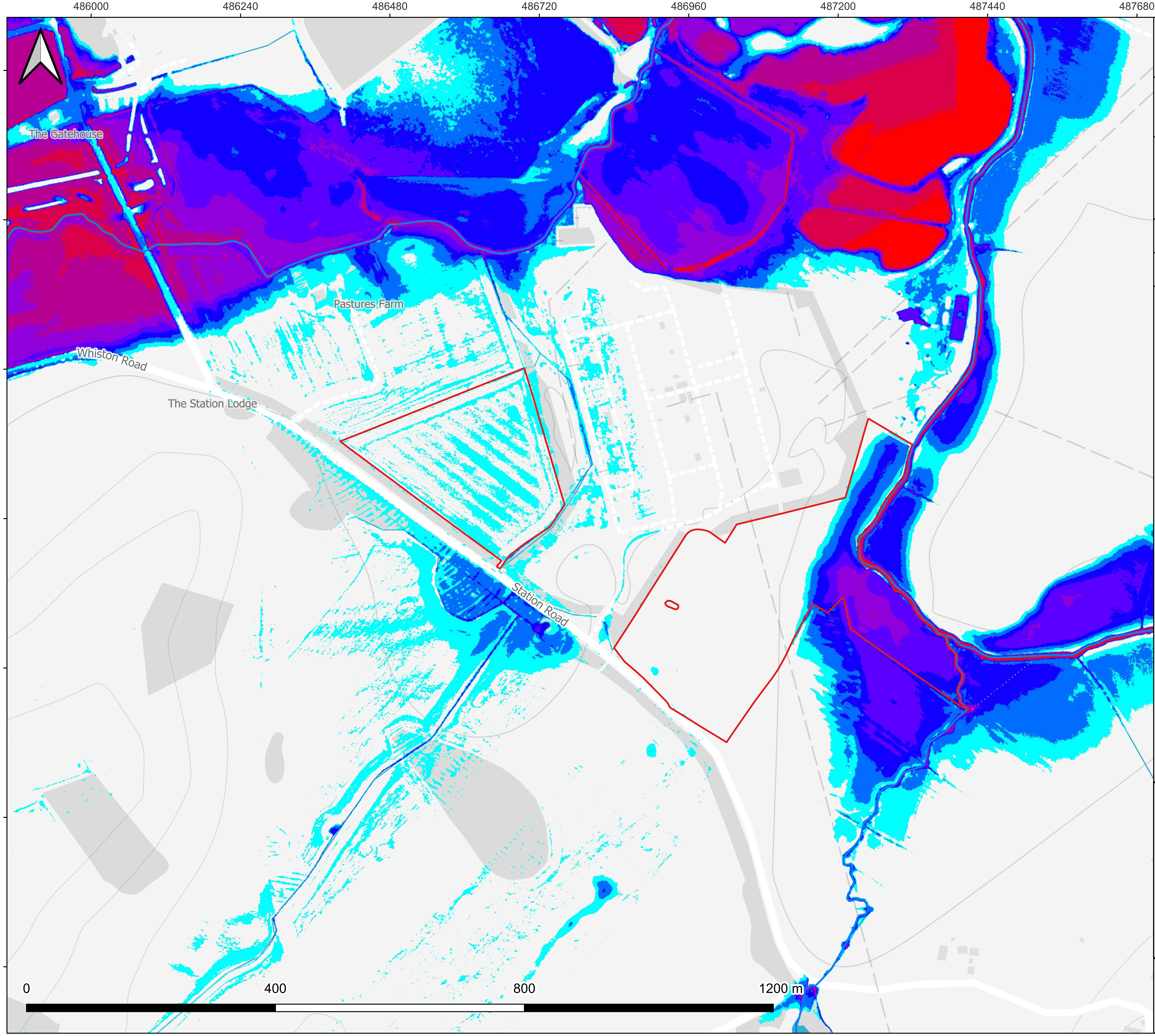

Project Reference:

Green Hill Solar

Client:

Green Hill Solar Farm Ltd.

Drawing Title:

1% AEP + 36% CC flood depths (m)

Drawing Name:	Revision:	Date:
313532_1%AEP+36%CC	A	11 Apr 2025

Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	IR	JR	JR

Legend

Green Hill Solar

Main Rivers

Q100CC36

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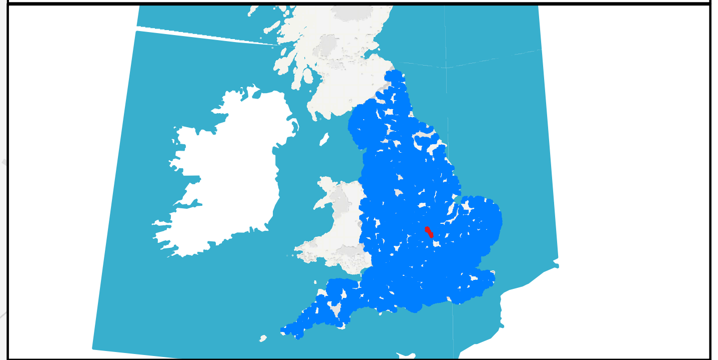
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.50
- 1.50 - 1.80
- 1.80 - 2.10
- > 2.10



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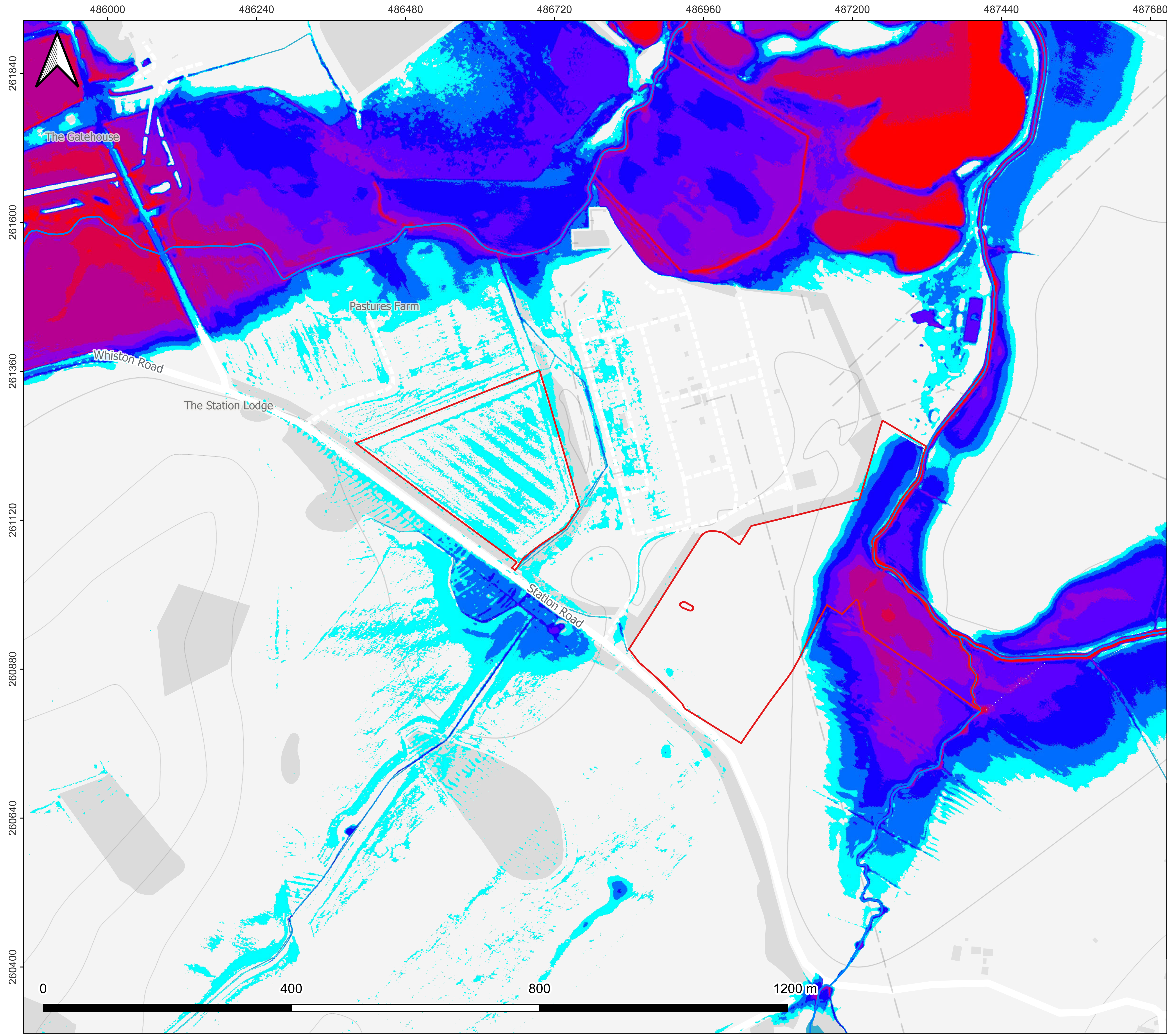


Project Reference:

Green Hill Solar

Client:

Green Hill Solar Farm Ltd.

Drawing Title:

0.1% AEP flood depths (m)

Drawing Name:	Revision:	Date:
313532_0.1%AEP	A	11 Apr 2025

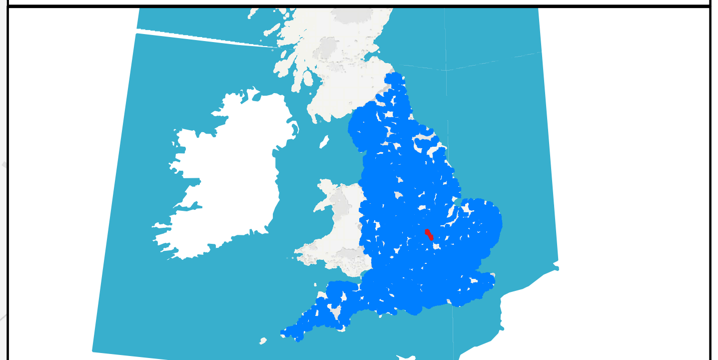
Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	IR	JR	JR

Legend

- Green Hill Solar
- Main Rivers

Q1000

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.50
- 1.50 - 1.80
- 1.80 - 2.10
- > 2.10



Arthian

Annex D – Causeway Flow Attenuation Storage Calculations

CAUSEWAY

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	200	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)		Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	10.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Easting (m)	Northing (m)	Depth (m)
Storage	4.038	5.00	100.000	0.000	0.000	2.000

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	Check Discharge Volume	✓
Summer CV	0.750	Drain Down Time (mins)	240	100 year 360 minute (m³)	
Winter CV	0.840	Additional Storage (m³/ha)	20.0		
Analysis Speed	Detailed	Check Discharge Rate(s)	x		

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
30	40	0	0
100	40	0	0
200	40	0	0

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)		Storm Duration (mins)	360
Soil Index	1	Betterment (%)	0
SPR	0.10	PR	
CWI		Runoff Volume (m³)	

Node Storage Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	97.500	Product Number	CTL-SHE-0140-9200-1000-9200
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	9.2	Min Node Diameter (mm)	1200

Node Storage Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	98.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	5260.5	0.0	1.000	5260.5	0.0	1.001	0.0	0.0

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 85.19%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	Storage	945	98.474	0.474	125.7	2388.4360	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	Storage	Hydro-Brake®	9.1	617.4

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 85.19%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	Storage	945	98.602	0.602	154.5	3034.6350	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	Storage	Hydro-Brake®	9.6	637.4

Results for 200 year +40% CC Critical Storm Duration. Lowest mass balance: 85.19%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	Storage	1410	98.698	0.698	124.3	3516.4830	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
1440 minute winter	Storage	Hydro-Brake®	10.0	902.2

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)		Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	10.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Storage	3.903	5.00	100.000	1200	0.000	0.000	2.000

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
30	40	0	0
100	40	0	0
200	40	0	0

Node Storage Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	97.500	Product Number	CTL-SHE-0142-9400-1000-9400
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	9.4	Min Node Diameter (mm)	1200

Node Storage Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	98.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	6312.6	0.0	1.000	6312.6	0.0	1.001	0.0	0.0

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 85.70%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
960 minute winter	Storage	945	98.379	0.379	121.5	2291.5780	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m^3)
960 minute winter	Storage	Hydro-Brake®	9.0	616.0

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 85.70%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	Storage	945	98.483	0.483	149.3	2915.9790	0.0000	OK

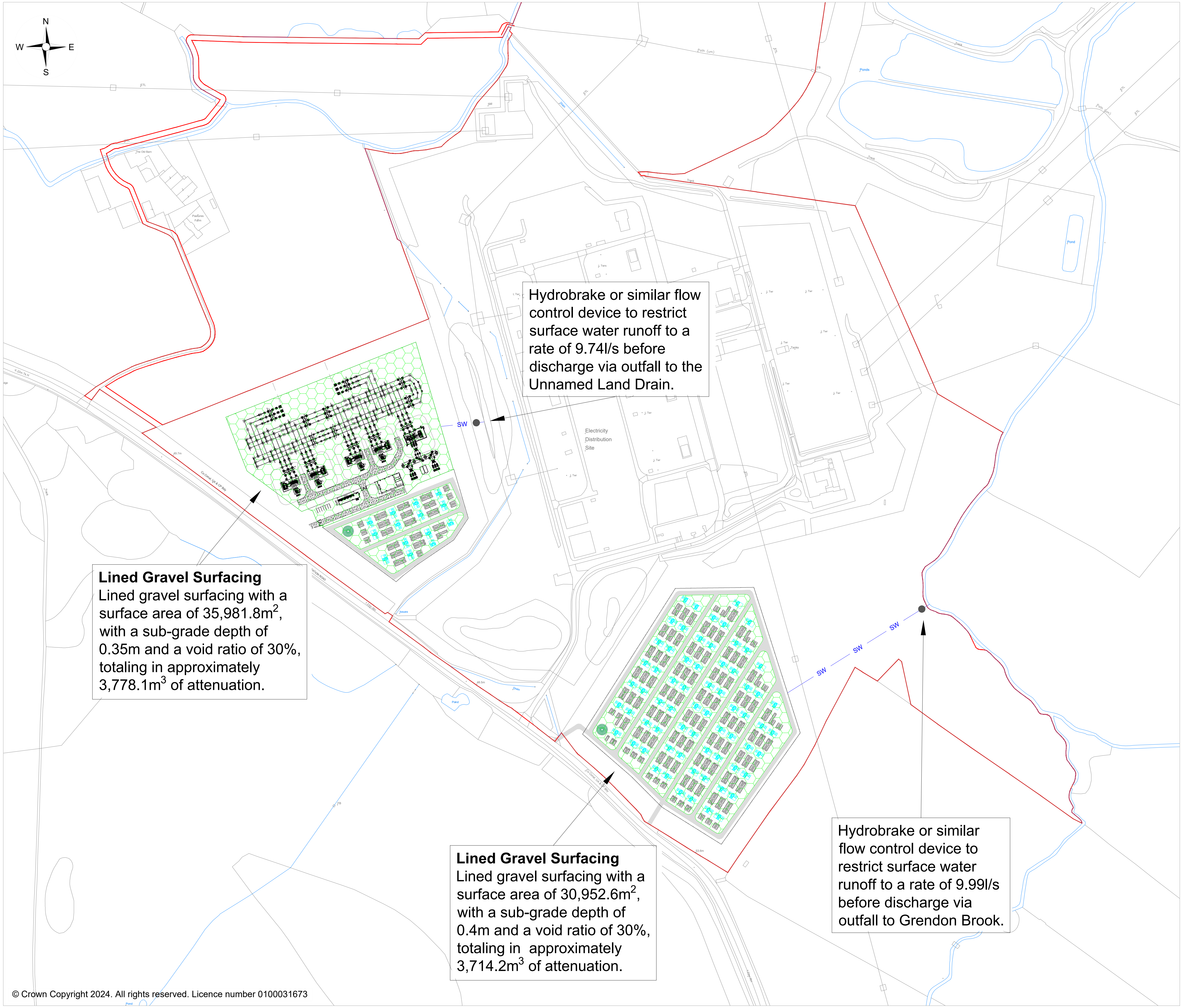
Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	Storage	Hydro-Brake®	9.3	632.8

Results for 200 year +40% CC Critical Storm Duration. Lowest mass balance: 85.70%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	Storage	945	98.559	0.559	170.0	3379.6560	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	Storage	Hydro-Brake®	9.7	645.1

Annex E – Conceptual Drainage Sketch



Legend:

- Site Location
- Proposed Surface Water Sewer
- Proposed Lined Gravel Surfacing
- Proposed Hydrobrake (or similar flow control device)

Final Revision:	Date:	Description:	By:	Chk:
-	-	-	-	-
-	-	-	-	-

All Dimensions to be checked on site and not scaled from this drawing.
This drawing is not for construction
This drawing is for planning only
All services to be checked on site and not scaled from this drawing

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Conceptual

Client: **Green Hill Solar Ltd.**

Site: **Green Hill Solar BESS**

Drawing Title: **Conceptual Drainage Sketch**

Date:	Scale:	Paper Size:
11 April 2025	Not to Scale	A3 (297 x 420mm)

Drawn By:	Checked By:	Status:	Final Revision:
LA	JR	Final	1

CAD Ref:	Drawing No:
A3 Landscape	313532

Annex F – Maintenance Schedules

Pervious Pavements Maintenance Schedule

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on Site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required - once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth - if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Attenuation Storage Tanks Maintenance Schedule

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae, or other matter; remove and replace surface infiltration medium, as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial Actions	Repair/rehabilitate inlets, outlet, overflows, and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents, and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

[i] Google Maps
[ii] England | Catchment Data Explorer
[iii] GeoIndex (onshore) - British Geological Survey

iv MAGIC
v Get flood risk information for planning in England - Flood map for planning - GOV.UK
vi Where do you want to check? - Check your long term flood risk - GOV.UK
vii Flood alerts and warnings - GOV.UK
viii EN-1 Overarching National Policy Statement for Energy

ix Flood risk and coastal change - GOV.UK
x [redacted]
xi [redacted]