Green Hill Solar Farm
EN010170

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

Prepared by: Arthian

Date: ~~November 2025~~February 2026

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APFP Regulation 5(2)(e)

Schedule of Changes

Revision	Section Reference	Description of Changes	Reason for Revision
A	[cover]	Updated to Revision A	As required for submission at Deadline 5.
	[throughout]	Updates to document references	As required for submission at Deadline 5.
	Paragraph 3.2.10	Confirmation that no connection to AW foul or surface-water infrastructure is proposed.	In response to Relevant Representations received by the Environment Agency
	Section 3.5	Updated drainage strategy with respect to BESS surface water and firewater	In response to Relevant Representations received by the Environment Agency
	Paragraph 3.10.2	Confirmation of site maintenance with respect to BESS firewater containment	In response to Relevant Representations received by the Environment Agency
	Section 4.1	Updated summary and conclusions	In response to Relevant Representations received by the Environment Agency
B	[cover]	Updated to Revision A	As required for submission at Deadline 5.
	[throughout]	Updates to document references	As required for submission at Deadline 5.
	Section 2.9	Updated to clarify assessment of impact on off-site flood risk.	In response to ongoing discussions with the Environment Agency.
	Section 3.4	Updated to clarify the proposed firewater management approach.	In response to ongoing discussions with the Environment Agency.
	Section 3.5	Updated to clarify the proposed firewater management approach.	In response to ongoing discussions with the Environment Agency.
	Section 3.7	Updated to clarify the role and limitations of vegetated groundcover and vegetation based controls in the context of firewater runoff	In response to ongoing discussions with the Environment Agency.
	Section 3.8	Updated to clarify the proposed firewater management approach.	In response to ongoing discussions with the Environment Agency.

	Section 3.9	Updated to clarify the proposed firewater maintenance approach.	In response to ongoing discussions with the Environment Agency.
	Section 4.1	Updated to clarify the proposed firewater management approach.	In response to ongoing discussions with the Environment Agency.

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

Prepared by: [redacted]

For: Green Hill Solar Farm Ltd

Site: Green Hill BESS

Date: ~~07/11/2025~~23/02/2026

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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.

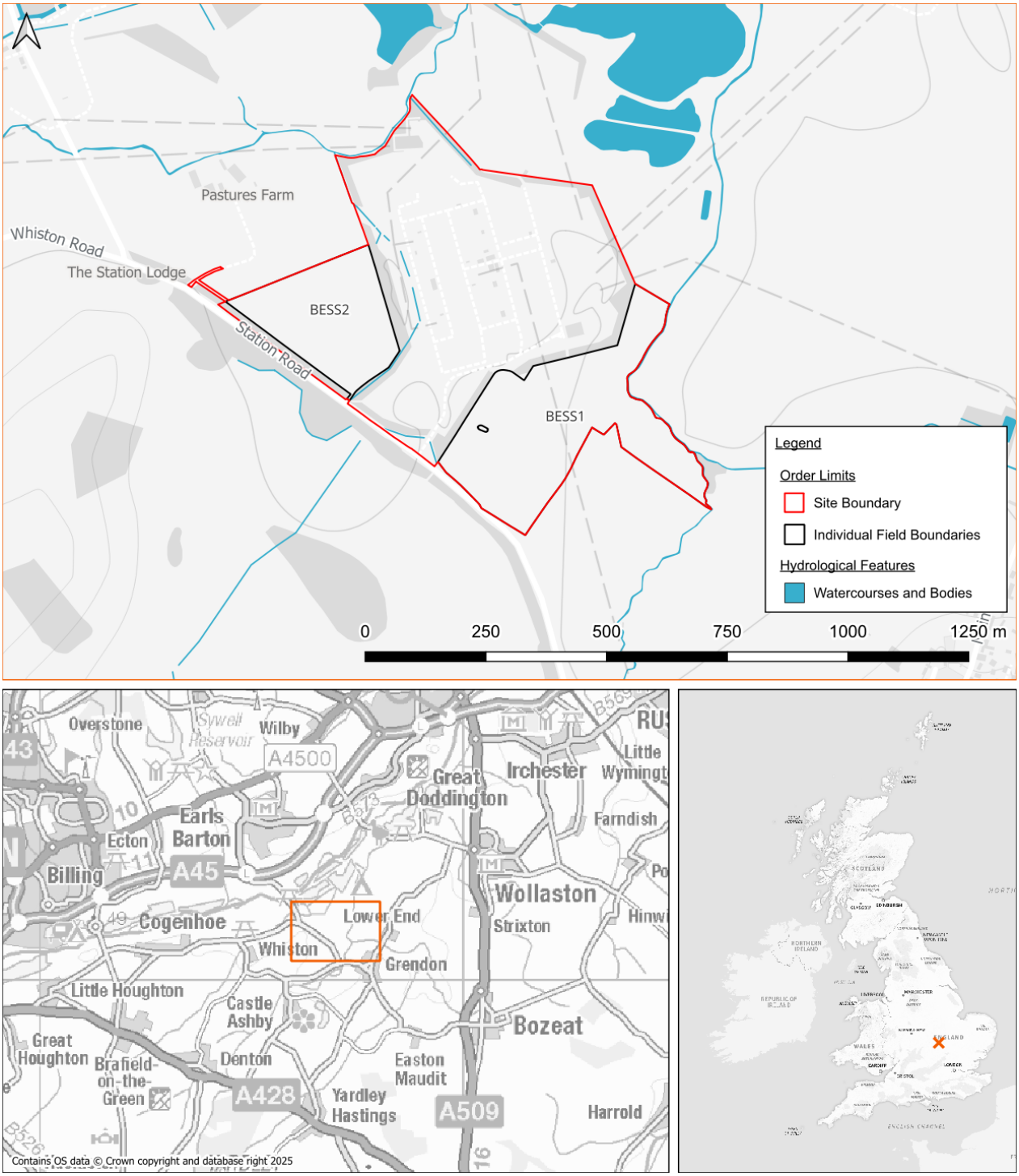

Figure 1: Site Location Plan

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

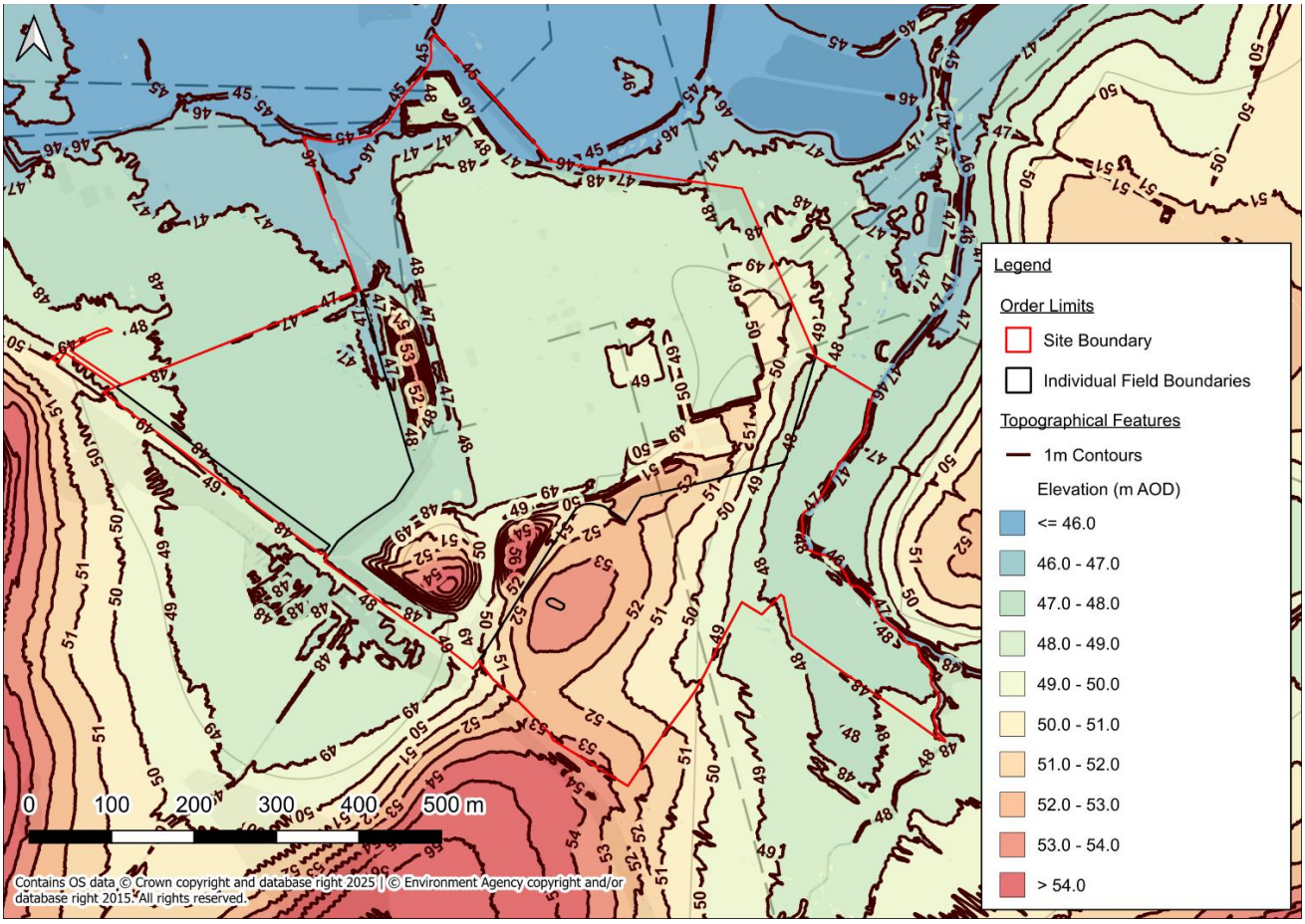

Figure 2: LiDAR Plan

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

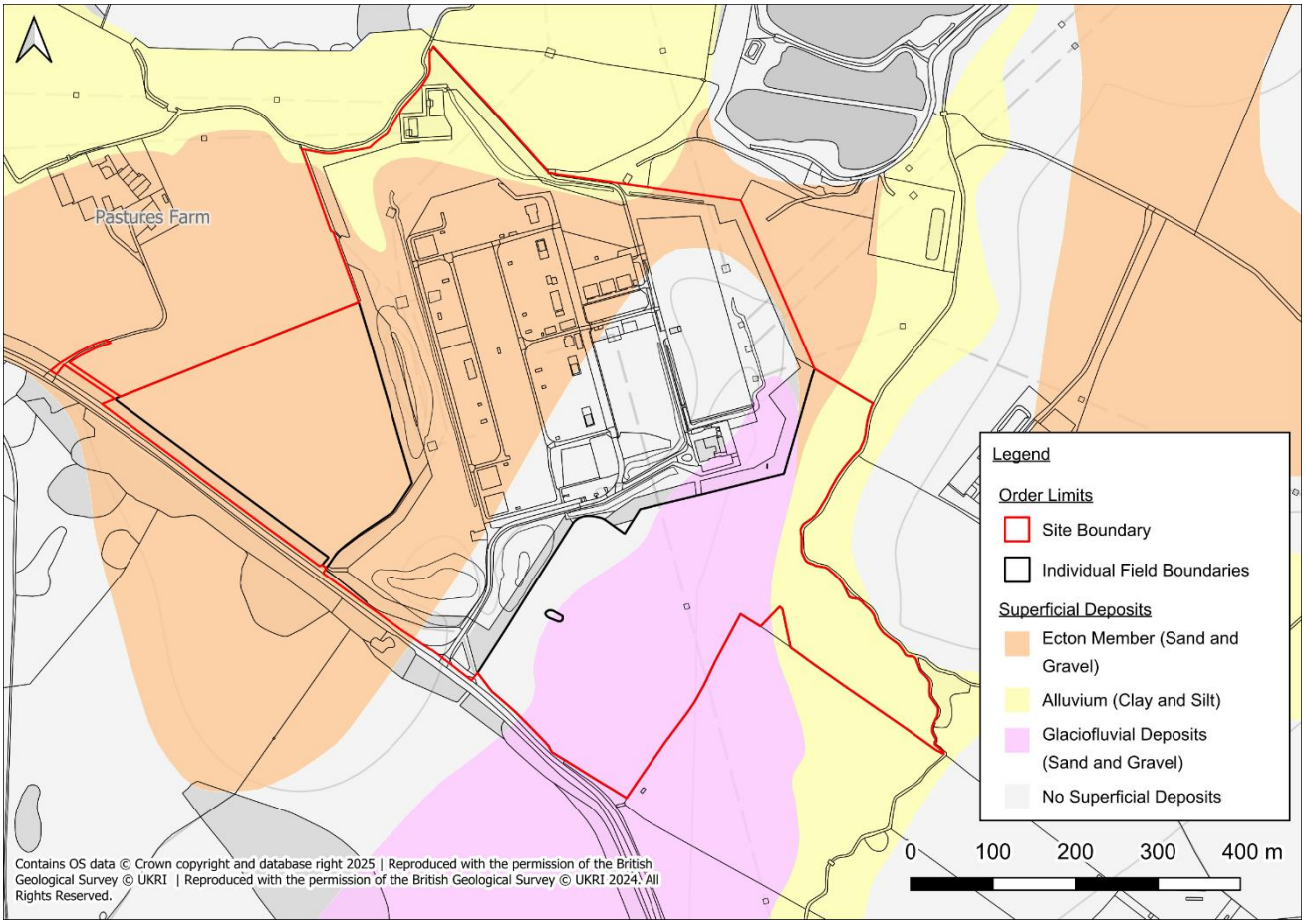

Figure 3: Superficial Deposits

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.

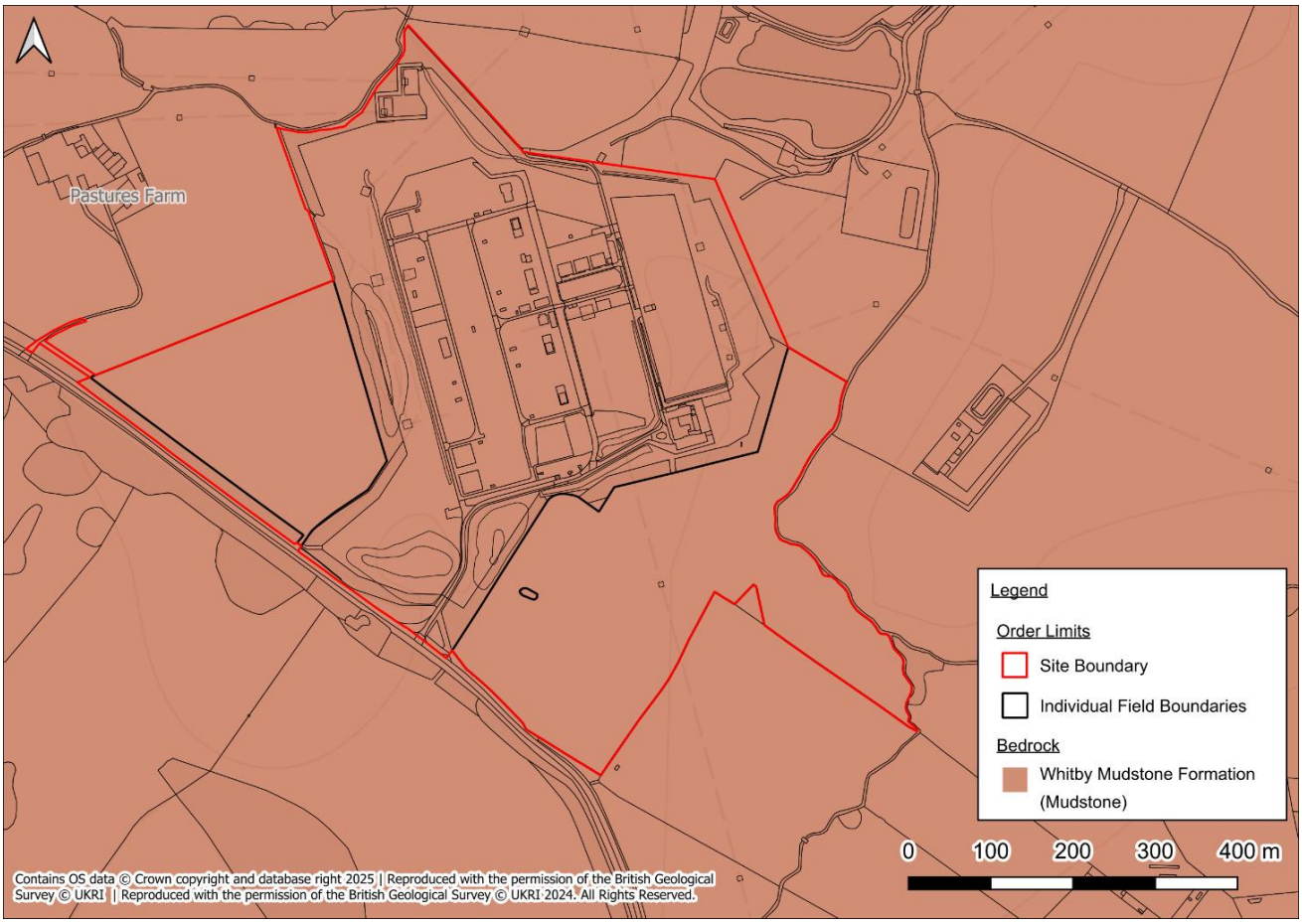

Figure 4: Bedrock Deposits

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) [~~EX1~~EX5/GH7.4_~~A~~D]** 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~~.~~ [EX5/GH6.3.10.6_B].** The BESS arrangement at Green Hill BESS is detailed further in the Drainage Strategy in Section 3.0 of this report.

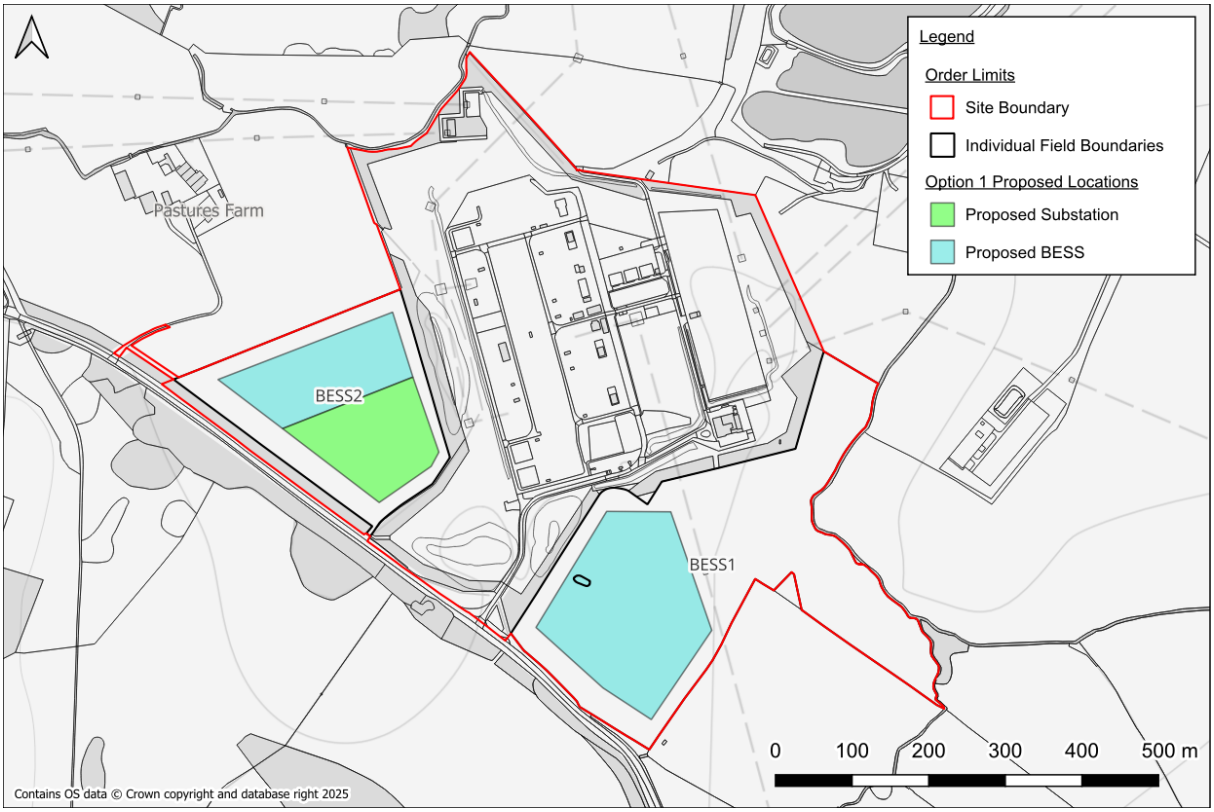

Figure 5: Option 1 Proposed Locations

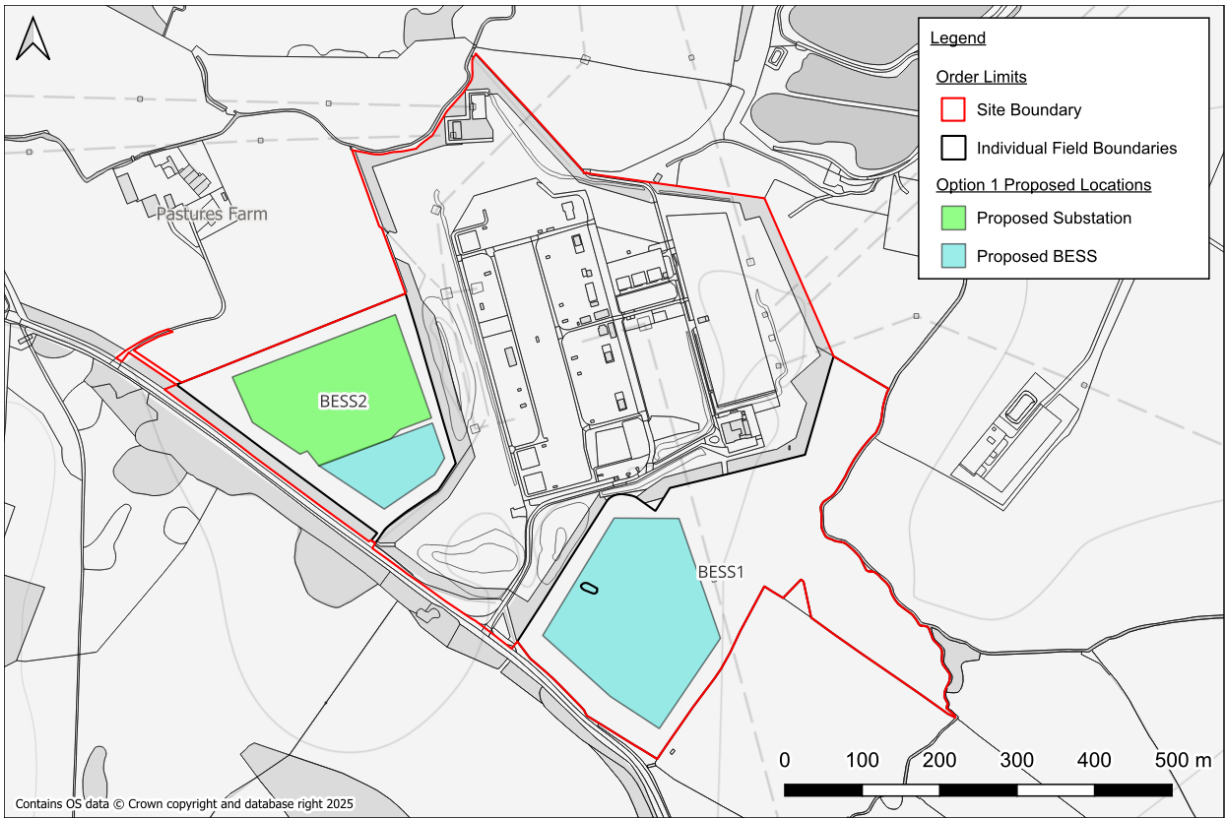

Figure 6: Option 2 Proposed Locations

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.

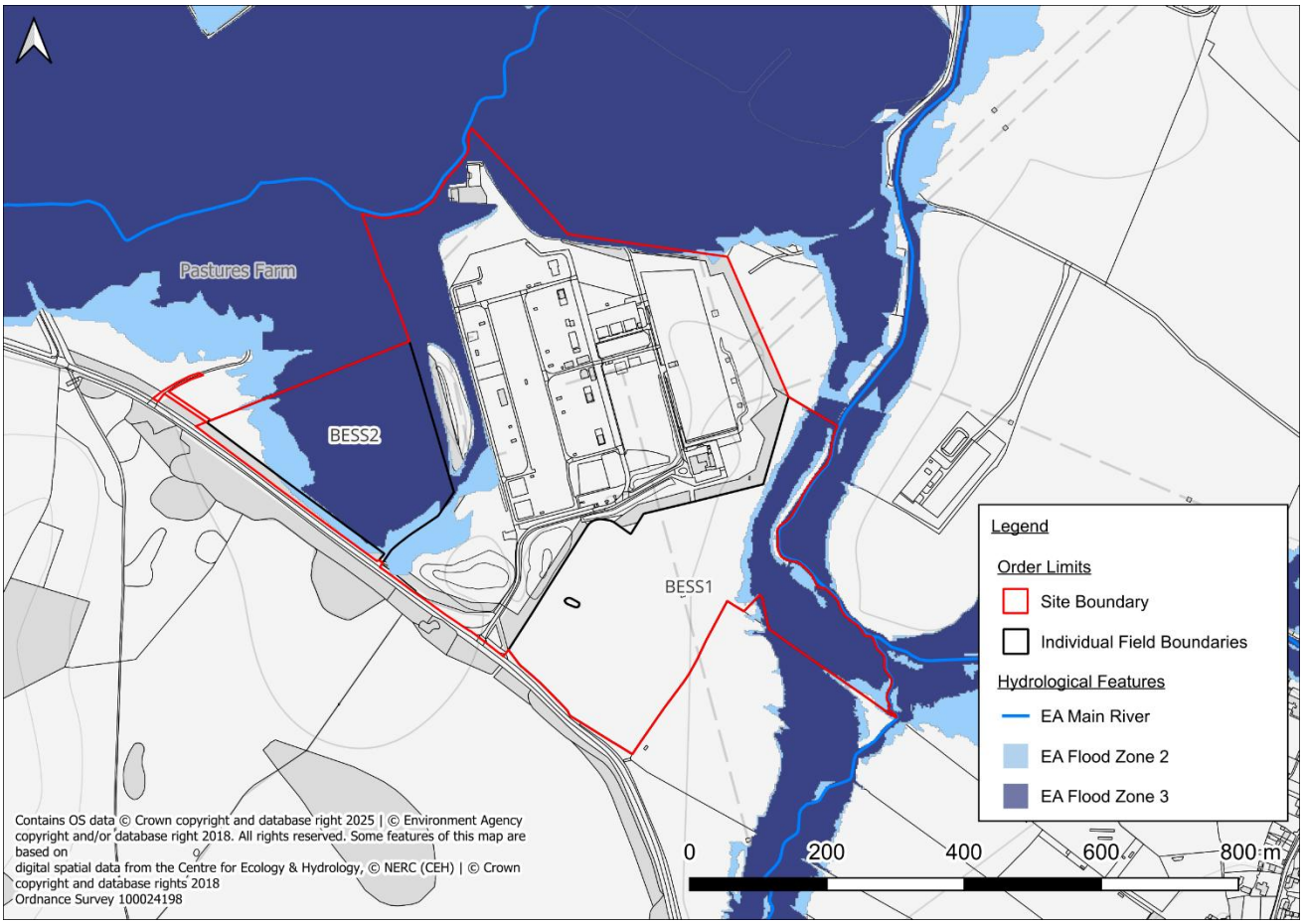

Figure 7: EA's Flood Map for Planning

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.

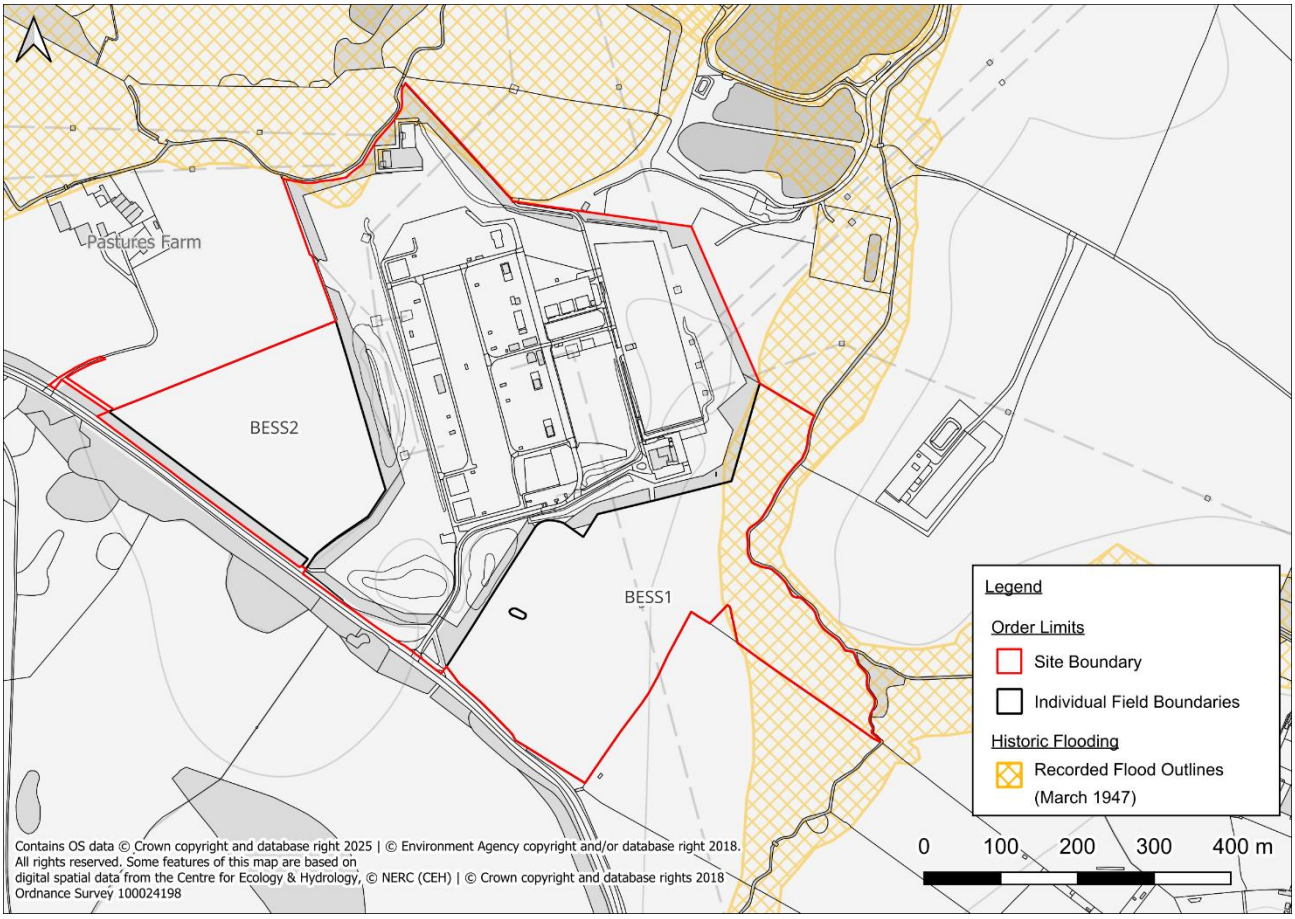

Figure 8: EA Historic Flood Map

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.

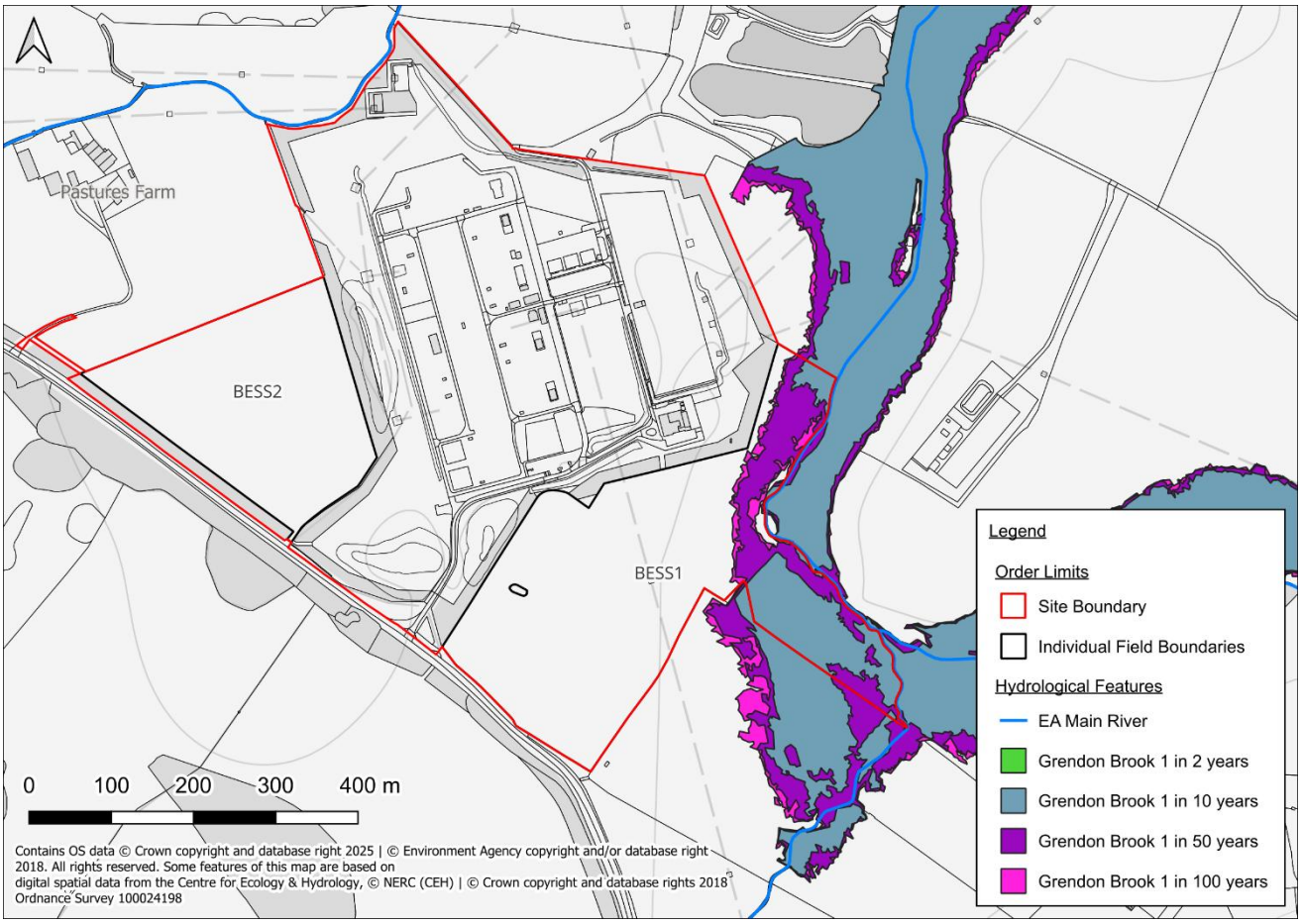

Figure 9: EA Grendon Brook Modelling Defended Flood Extents

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.

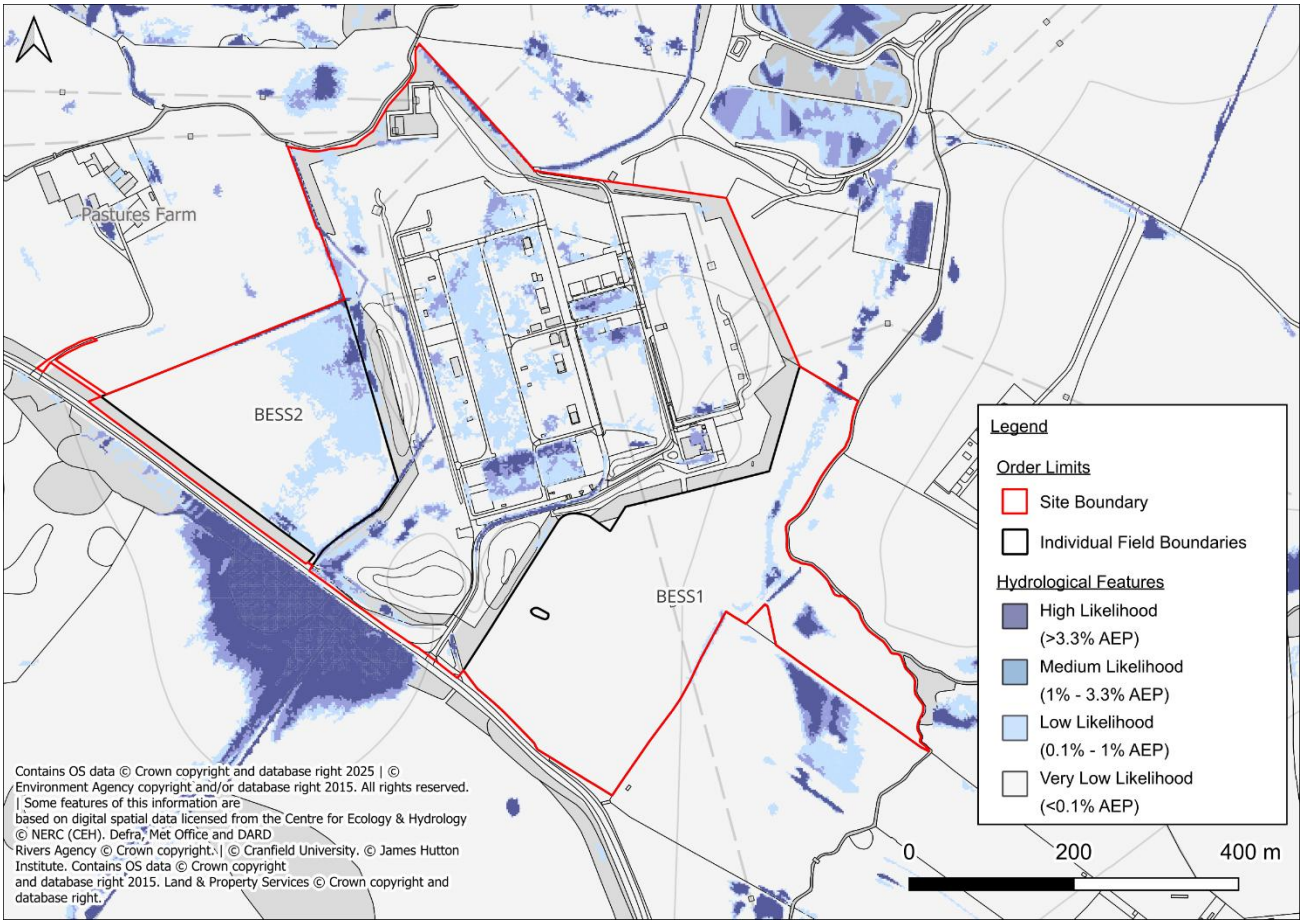

Figure 10: EA's Long-Term Flood Risk Map (Flood Risk from Surface Water)

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.

For Proposed BESS / Substations

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.

Flood Warnings and Evacuation

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~~. Development areas have been located and designed so that there is no loss of functional floodplain storage and no increase in flood levels elsewhere.

2.9.2 Surface water runoff from the Site will be managed through a controlled and attenuated drainage strategy, restricting discharge to greenfield runoff rates and providing on-site attenuation up to and including the 1 in 200 year plus 40% climate change event. This ensures that there will be no increase in runoff rates or volumes to receiving watercourses.

2.9.3 The final detailed drainage design will be confirmed at detailed design stage in accordance with the performance based approach set out in Section 3.0.

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 [EX5/GH6.3.10.1_B]** 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. No connection to Anglian Water foul or surface-water infrastructure is currently proposed or considered necessary. Should it be determined at detailed-design stage that discharge to the public drainage system is required, consultation with Anglian Water will be undertaken to agree connection points, discharge parameters and any necessary consents pursuant to the protective provisions for Anglian Water in Part 5 of Schedule 15 to the DCO.

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~~may be ~~considered~~used, where appropriate, within the BESS development and ~~Substation area. Surface water~~substation areas. Where incorporated into the drainage strategy, the granular sub-base may provide temporary storage as part of the overall attenuation ~~will be achieved using lined sub-base storage beneath the gravel layer, with attenuation volumes for each BESS location detailed in Table 5.~~system. Runoff from battery units and adjacent hardstanding will be directed ~~into this gravel~~to these areas where they form part of the managed drainage network. Indicative attenuation volumes for each BESS location are detailed in Table 5.

~~3.4.11~~ Where required to manage pollutant risk and support firewater containment, permeable surfacing~~, which will act as a temporary storage layer.~~

3.4.12 ~~To prevent infiltration and provide containment~~ systems will incorporate impermeable components and be connected to an isolatable drainage arrangement. The detailed configuration, including whether lining is required in ~~the event of a fire, the sub-base~~specific areas, will be ~~underlain with an impermeable liner. This approach supports~~ confirmed at detailed design stage in accordance with the Site-wide drainage and firewater containment ~~strategy, preventing the mobilisation of contaminants into underlying soils.~~ principles.

~~3.4.12~~3.4.13 Gravel surfacing, where used, will be limited to the battery compound and ~~Substation~~substation areas only, excluding access roads, and will cover a total area of approximately 30,952.6 m^2 for ~~BESS 1~~BESS1 and 35,981.~~8m2~~8 m^2 for BESS2. Attenuation potential has been calculated ~~based~~ on a conservative basis assuming a sub-base depth of 0.35 m and a ~~conservative~~ void ratio of 30%. Final storage volumes and gradients will be verified at detailed design stage.

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~~3.4.14 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, where there is a credible pollution risk associated with BESS infrastructure, the proposed gravel subgrade ~~should be lined~~may require an impermeable barrier (liner or equivalent engineered solution) to prevent ~~potential pollution incidents from mobilising~~mobilisation of contaminants to ~~the~~ ground. The detailed arrangement will be confirmed at detailed design.

~~3.4.14~~3.4.15 The use of lined gravel surfacing should be considered at the detailed design stage.

Underground Attenuation Tanks

~~3.4.15~~3.4.16 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 ~~from BESS 1~~at BESS1 will be discharged to ~~the~~ Grendon Brook located along the eastern boundary of the ~~field~~Field at a restricted discharge rate of 9.99 l/s~~, and~~. Surface water runoff ~~from BESS 2~~at BESS2 will be discharged to the ~~unnamed land drain~~Unnamed Land Drain located along the eastern boundary of the ~~field~~Field at a restricted discharge rate of 9.74 l/s. These discharge rates reflect the existing 1 in 2 year greenfield runoff ~~rate, ensuring~~rates and ensure compliance with greenfield~~-~~ runoff principles.

3.5.2 ~~Runoff generated during storm events~~ Surface water runoff up to and including the 1 in 200 year ~~+~~plus 40 % climate~~-~~ change allowance event will be ~~fully~~ attenuated within the ~~BESS 1~~BESS1 and ~~BESS 2 boundaries~~BESS2 Fields. The ~~total~~required attenuation ~~requirement~~volume at BESS1 is 3,516.5 m^3 ~~at BESS 1~~ and at BESS2 is 3,379.7 m^3 ~~at BESS 2, which can be met in full~~. This attenuation will be delivered through ~~a sealed,~~an impermeable ~~containment~~ and isolatable drainage system ~~beneath the proposed battery-unit and substation areas, excluding access roads.~~ serving each BESS catchment. This may include storage within granular sub-base systems, lined attenuation features, below-ground storage structures, or a combination thereof.

3.5.3 Based on ~~the~~a proposed permeable surfacing area of 30,952.6 m^2 ~~area~~ at ~~BESS 1, the~~BESS1, lined gravel surfacing ~~can~~ has the potential to provide up to 3,714.2 m^3 of ~~storage, whereas at BESS 2~~attenuation. At BESS2, based on a proposed area of 35,981.8 m^2 ~~area, the~~, lined gravel surfacing ~~can~~ has the potential to provide up to 3,778.1 m^3 of ~~storage, providing a small buffer in capacity. The lined sub-base also prevents infiltration and contains potentially contaminated fire-water runoff in accordance with the fire-water management strategy. This represents a feasible outline solution shown on the drainage drawings. At~~ attenuation. A conceptual drainage sketch illustrating the indicative arrangement is included as Annex E.

~~3.5.2~~3.5.4 The attenuation calculations demonstrate that the required storage volume can be achieved within the Site boundary. Should additional storage be required at detailed design~~, alternative impermeable systems~~ stage, further attenuation measures such as ~~lined slabs or individual foundation~~

~~pads may be adopted, provided they achieve equivalent standards of impermeability, containment and controlled discharge~~detention basins or geocellular storage may be incorporated as necessary.

~~3.5.3 The drainage within each BESS compound will be impermeable and fully sealed to prevent infiltration to ground, forming a secondary-containment system for the compound area. Containment may be achieved using a robust geotextile composite, impermeable pond liner, or another construction that provides the same level of impermeability and structural performance. The system will incorporate isolation valves that automatically close in the event of a fire or spill, allowing the contained runoff or fire-water to be held, tested and either treated and released or tankered off-site under controlled conditions.~~

~~3.5.4~~3.5.5 The proposed surface~~-~~ water drainage scheme ensures no increase in runoff rates or volumes over the lifetime of the development. Attenuation calculations have been ~~based~~undertaken on a conservative ~~assumption that~~basis assuming the BESS and substation areas ~~will~~ comprise 100~~-~~% impermeable surfacing~~, which is unlikely in practice.~~. This provides additional robustness ~~and flexibility~~ within the design~~ and is consistent with the **Outline Battery Storage Safety Management Plan [EX1/GH7.7_A]**.~~.

3.5.6 ~~The detailed surface-~~At this stage the Applicant is committing to drainage and pollution prevention principles rather than a fixed construction specification. The detailed surface water drainage scheme will be developed and agreed at detailed design stage and secured through Requirement 11 in the DCO.

3.5.7 For the BESS, runoff will be managed as a discrete drainage catchment via an impermeable and isolatable drainage system, using positive drainage with isolation located at the outfall or an equivalent point of connection. Isolation will be capable of automatic activation during an incident, with manual override provided as a secondary control. The approach is performance based, focused on impermeability where required, isolation capability and controlled management of runoff, including incident response and firewater, with the detailed configuration to be confirmed at detailed design stage.

3.5.8 Impermeability may be achieved through specific components and defined flow paths rather than across the whole compound. Where this approach is adopted, the exceedance strategy will ensure flows are preferentially routed within the BESS envelope to impermeable drainage features during extreme events, preventing uncontrolled off-site discharge. Infiltration will not be relied upon for the treatment of hydrocarbons or dissolved metals. Pollutant risk will be managed through an appropriate combination of impermeable surfacing where required, positive drainage, isolation and treatment measures where necessary.

3.5.9 Under normal operation, the system will manage the design storm event using the agreed climate change allowances. Where the system is isolated, storage and exceedance routing will be configured to retain runoff and, where relevant, firewater within the BESS catchment for a reasonable worst-case event. Discharge will only recommence following confirmation that it is appropriate to do so, with the detailed arrangements agreed at detailed design stage with the LLFA, the EA and other relevant consultees.

3.5.10 For substations, a risk led drainage approach will be applied rather than blanket impermeability. Areas presenting contamination risk, such as transformers containing oil, will be bunded and managed in accordance with standard substation practice and EA requirements. The remainder of the substation yard will typically remain permeable, with local drainage provided only where necessary to manage

surface water and avoid nuisance ponding.

~~3.5.5~~3.5.11 The detailed surface water drainage design will be prepared in accordance with this strategy and submitted to the relevant Local Planning Authority for approval under the applicable DCO Requirement. Before any formal submission to discharge the Requirement, the Authority will consult the respective LLFA to confirm that the detailed design is consistent with the agreed principles of this Flood Risk Assessment and Drainage Strategy, including discharge rates, outfall locations and attenuation or containment measures. This process ensures that the LLFA is engaged at the detailed-design stage and that any comments are addressed prior to approval being granted.

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~~access roads will be directed to the ~~existing~~Site drainage network or ~~the gravel~~to permeable surfacing areas where ~~it can infiltrate into the ground.~~these form part of the managed drainage system. Infiltration will not be relied upon where there is potential contamination risk. Table 7 ~~below~~ demonstrates that the ~~porous~~proposed drainage and surfacing strategy provides ~~sufficient~~appropriate water quality treatment in accordance with SuDS guidance.

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 Vegetated groundcover across the Site is proposed to manage runoff characteristics and reduce sediment and silt mobilisation only. It is not relied upon as a mitigation measure for the treatment of hydrocarbons or dissolved heavy metals. Pollutant control for these substances will instead be achieved through the use of impermeable surfacing, contained drainage systems and, where required, proprietary treatment such as oil separators.

~~3.7.3~~3.7.4 It can be concluded that the inclusion of ~~lined gravel surfacing~~a sealed isolatable drainage system will provide ~~sufficient~~appropriate treatment ~~during~~for suspended solids under normal ~~operation.~~operational conditions. Where attenuation is provided in a below ground system ~~(~~such as tank storage~~), such as in BESS2~~, or where there is potential for hydrocarbon contamination from plant or transformer infrastructure, treatment will ~~need to~~ be provided ~~by a~~through suitably sized ~~separator.~~oil separators and fully contained drainage systems prior to discharge. No reliance is placed on infiltration for the treatment of hydrocarbons or heavy metals

3.8 Firewater Consideration

3.8.1 Given the nature of the ~~development~~BESS, there is a ~~risk of~~potential for fire~~,~~ and ~~contamination may~~ for contaminants to be mobilised by ~~fire suppression~~ external firefighting water. The ~~principal route~~only credible pathway for ~~any firewater loss from the Site~~off-site release is via the ~~proposed~~ surface water drainage system ~~into the~~ , either through infiltration to ground~~. In order to isolate the Site's~~ or discharge at the BESS outfalls. The BESS drainage~~, the proposed gravel subbase~~ will ~~be lined and the proposed outfalls from the drainage system should be controlled by automatically actuated valves.~~therefore be constructed as a discrete, sealed and impermeable catchment, hydraulically separated from the wider Site. Isolation valves will be provided at the outfalls from each BESS compound. Under normal operating conditions the valves will remain open, and the drainage system will function as a conventional surface water system. In the event of a fire, the ~~valve~~valves will ~~be designed to activate to~~automatically close ~~off the battery storage area's drainage system triggered by the fire~~ on receipt of a fire alarm ~~systems. Flows will then back up in~~ signal, placing the system~~.~~ into containment mode and preventing discharge from the BESS drainage catchment.

~~3.8.1~~**3.8.2** When operating in containment mode, firewater and any concurrent rainfall will be retained in line within the drainage network, including pipework and engineered subbase storage, up to the defined containment volume. 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~~ for the reasonable worst case ~~1 in 10~~ fire scenario, comprising the full firefighting water volume together with concurrent rainfall up to the 1 in 1 year ~~storm event.~~ event. In accordance with National Fire Chiefs Council guidance, external firefighting water provision is assumed at 1,900 litres per minute for a minimum duration of two hours, equating to 228 m^3 per BESS compound. The containment system will therefore provide storage for this volume in combination with the defined rainfall allowance. This reflects the operational philosophy that the isolation valve will be closed during a fire event and open during normal conditions. Final containment volumes and detailed hydraulic design will be confirmed at detailed design stage and agreed with the Fire and Rescue Service.

~~3.8.2 According to National Fire Chiefs Council Grid Scale Battery Energy Storage System planning Guidance for FR Guidance, a tank measuring 228m³ 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 [EX1/GH7.7_A].**~~

3.8.3 ~~Following a fire event, wastewater will be tested~~The surface water drainage system serving the BESS areas will, under normal operation, be designed to attenuate runoff up to and including the 1 in 200 year rainfall event plus 40 percent climate change allowance (1 in 200 year + 40% CC), with controlled discharge in accordance with the wider Drainage Strategy. The firewater containment function is additional to, and does not reduce, the standard flood risk design criteria applied to the Site.

3.8.4 Where an internal BESS water based fixed suppression system (automatic or dry pipe) is incorporated within the BESS enclosures, a dedicated water supply and separate containment arrangement will be provided. Runoff from internal suppression systems has the potential to contain elevated pollutant concentrations and will therefore be managed independently of the external surface water system. Backflow prevention measures, including check valves or equivalent devices, will be incorporated to prevent contamination of potable water supplies in accordance with relevant regulations.

3.8.5 Following any fire event, retained water within the isolated drainage and containment system will be sampled and analysed to determine the ~~level of~~ presence and concentration of contaminants. No discharge will occur until appropriate testing has been completed. Where contamination~~. The appropriate disposal method will then be selected, which may include on-site treatment and controlled release, or removal~~ is identified, the retained water will be removed from site ~~via~~by tanker ~~where necessary.~~and transported to an appropriately permitted facility for treatment and disposal. Where testing confirms that water quality is suitable for release, discharge will take place in a controlled manner and only following consultation and agreement with the relevant statutory authority.

~~3.8.3~~**3.8.6** Any discharge of retained water to a watercourse, groundwater or surface water sewer will be subject to the relevant regulatory regime in force at the time. Where required, an Environmental Permit

or other applicable consent will be obtained prior to discharge. No release will occur without prior approval from the relevant regulator, and all actions will be undertaken in accordance with applicable environmental permitting and pollution control legislation. These procedures, including containment design, valve operation and post incident management, are secured through the measures set out in the **Outline Battery Storage Safety Management Plan [EX1EX5/GH7.7_AB]**.

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 Inspection and maintenance of the containment system, isolation valves and associated impermeable drainage features will be incorporated within the operational management plan to ensure long-term integrity and continued performance of the system. Following any fire or spill event, the containment area will be inspected for damage and, where necessary, repaired or reinstated before the drainage system is returned to service, ensuring that full containment capacity is maintained.

3.9.3 Isolation controls shall be subject to a documented inspection, testing and maintenance regime. This shall include defined test frequency in the approved Battery Storage Safety Management Plan, an inspection checklist, record keeping of tests and inspections, defined remedial actions where defects are identified, and an escalation procedure where a test failure is recorded.

3.9.33.9.4 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~~Scheme comprises a BESS which will introduce impermeable ~~surfaces~~areas in the form of equipment and access ~~areas.~~infrastructure. This will result in an increase in surface~~-~~ water runoff ~~from the compound. To~~ . In order to ensure that this increase does not ~~increase~~ result in increased flood risk elsewhere, ~~flow control will be provided and attenuation accommodated within a sealed, impermeable containment system located beneath the BESS and substation areas. The system will include lined gravel surfacing or an equivalent construction capable of providing both attenuation and secondary containment, designed to accommodate storm events~~ runoff will be controlled to greenfield rates and on-site attenuation will be provided up to and including the 1 in 200~~-~~ year plus 40% climate change ~~allowance~~ event. Attenuation will be delivered through an impermeable and isolatable drainage arrangement serving the BESS and substation areas, with the detailed configuration to be confirmed at detailed design stage.

4.1.4 ~~Any surface~~Surface water exceeding the ~~infiltration~~design capacity of the ~~surrounding strata will naturally drain to the surrounding land drains in line with the~~ drainage system will be managed through a defined exceedance strategy that ensures flows are directed within the Site boundary and do not result in uncontrolled off-site discharge.

~~4.1.4~~ 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~~ increase surface roughness ~~of the ground, helping to increase infiltration by reducing~~ , reduce compaction~~,~~ over time and improve water quality ~~by reducing~~ through reduced erosion and mobilisation of ~~pollutants~~sediments. As a result, ~~runoff rates~~overall runoff characteristics across undeveloped areas of the Site may ~~be reduced following development when compared to the existing greenfield scenario~~improve relative to the current baseline.

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

~~4.1.7 This drainage approach is consistent with the **Outline Battery Storage Safety Management Plan**~~

~~[EX1/GH7.7_A]~~

~~4.2~~ Recommendations

~~4.2.1~~4.1.7 Embedded Mitigation is detailed in Section 3.2 of the covering report.

For the proposed BESS ~~/ Substations:~~

~~4.2.2~~4.1.8 ~~All~~ and substation areas, all equipment will be raised by a minimum of ~~150mm, or as high as practically possible,~~150 mm above surrounding ground levels~~.~~, or as high as practicable, to provide resilience against localised surface water ponding.

~~4.2.3~~4.1.9 Firewater~~ (~~, including ~~water run-off~~runoff from fire-fighting ~~equipment)~~activities, and other surface water pollution risks will be managed through ~~the use of~~an impermeable ~~liners,~~and isolatable drainage system incorporating containment ~~systems~~measures and automatic isolation valves ~~that close automatically in the~~with manual override capability. The system will be designed to retain runoff and firewater within the Site for a reasonable worst case event~~ of a fire.~~, preventing uncontrolled discharge. With these measures in place, ~~all~~ potential effects on flood risk and water quality are not considered to be ~~not~~ significant.

~~4.2.4~~4.1.10 The BESS and substation infrastructure ~~can~~will be ~~adequately waterproofed~~designed to withstand the ~~effect~~effects of flooding~~.~~ where necessary. Batteries will be sequentially located within areas of the Site ~~which are located~~ in Flood Zone 1~~.~~ wherever practicable. The supporting hydraulic modelling ~~undertaken at the BESS Site~~ indicates that the majority of BESS1 is ~~in~~located within Flood Zone 1~~ and~~, with only shallow levels of flooding ~~are expected~~predicted in limited areas of 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: [redacted]
Sent: Monday, June 17, 2024 3:29 PM
To: [redacted]
Cc: [redacted] Surface water [redacted]
Subject: RE: Green Hill Solar Farm - contact/response

> [redacted]

Hi [redacted]

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 https://www.floodtoolkit.com/
- 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
[redacted]

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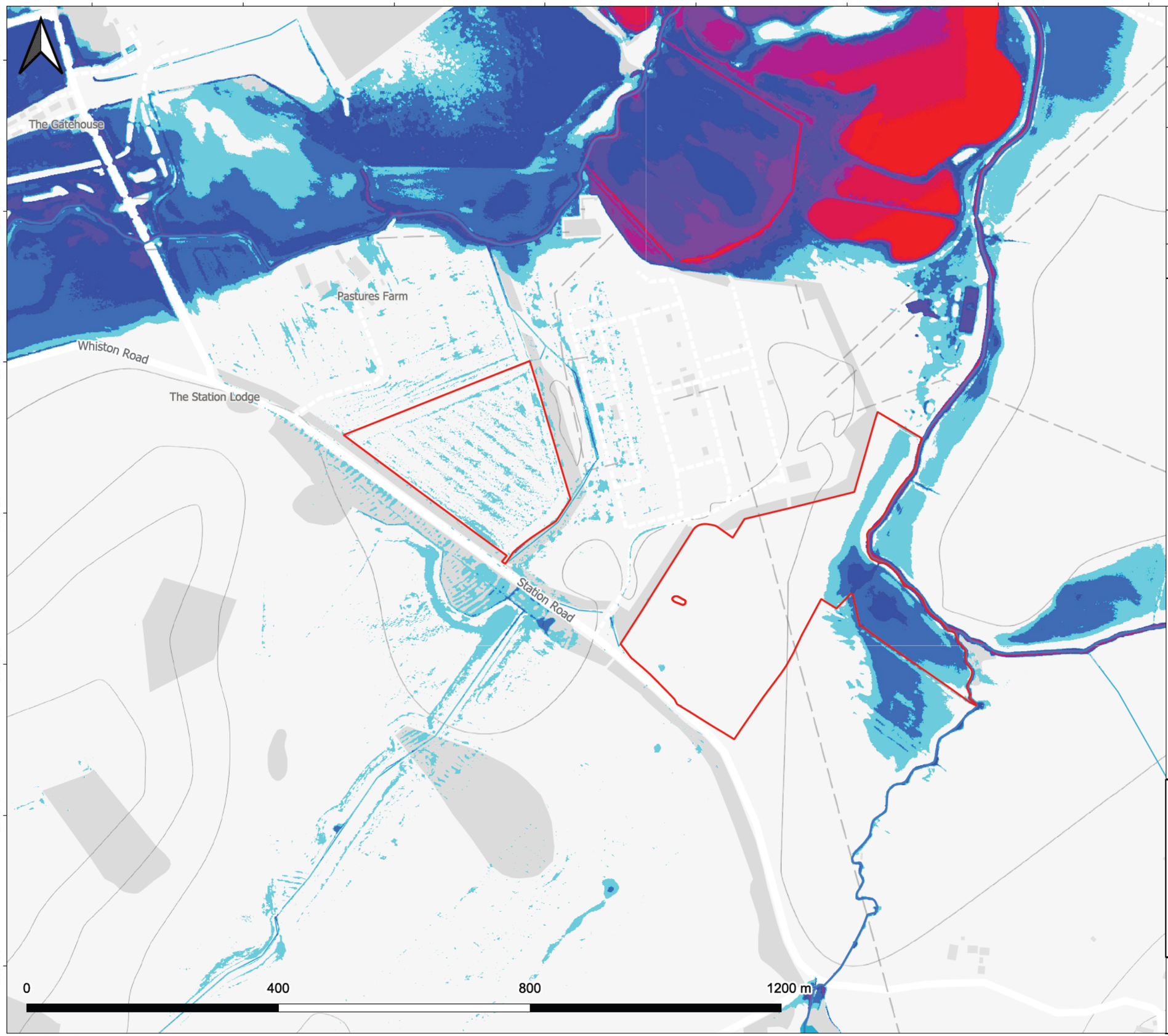
Annex C – Hydraulic Modelling Results



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

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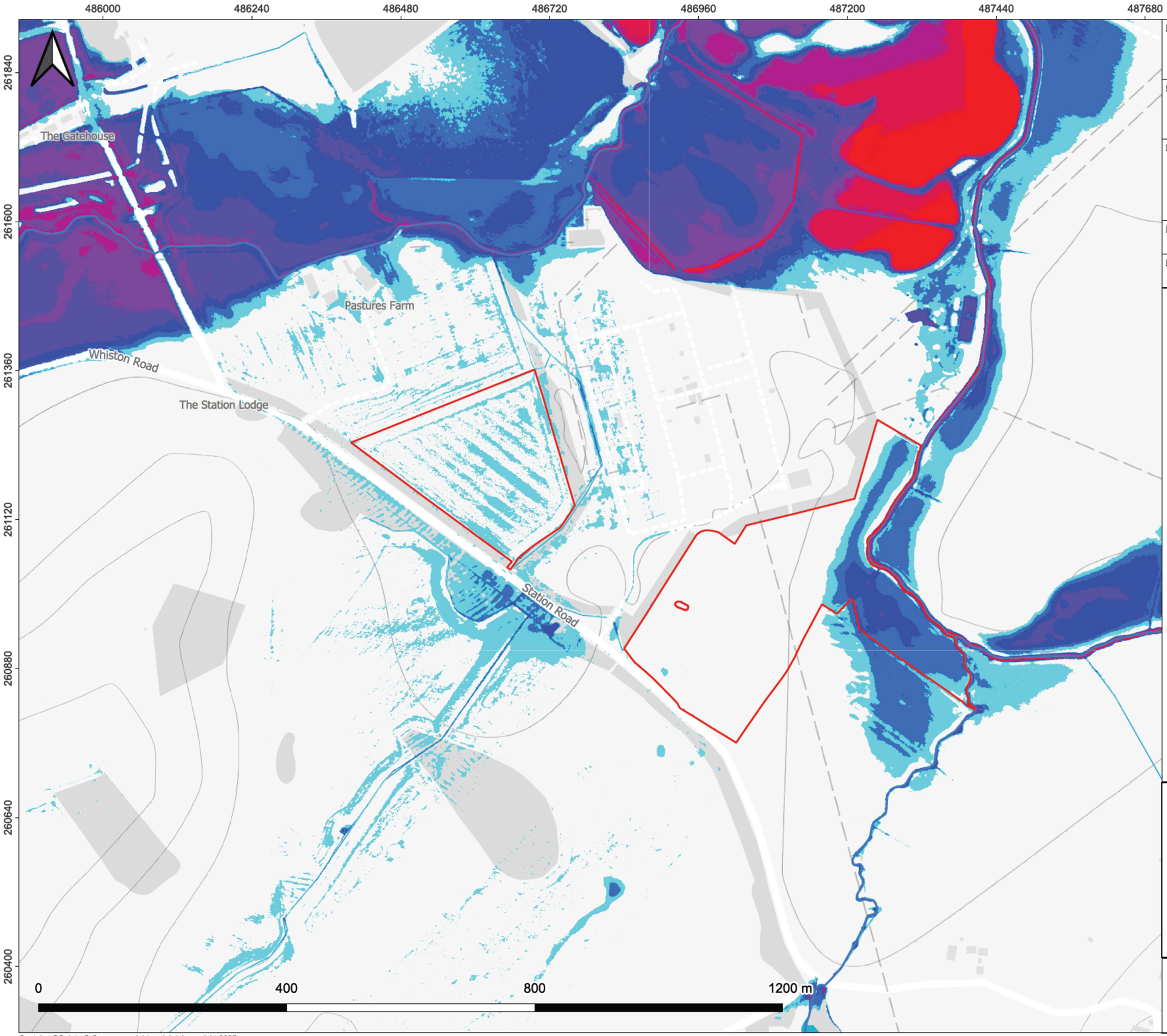

Project Reference:

Green Hill Solar

Client:

Green Hill Solar Farm Ltd.

Drawing Title:

5% AEP flood depths (m)

Drawing Name:	Revision:	Date:
313532_5%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

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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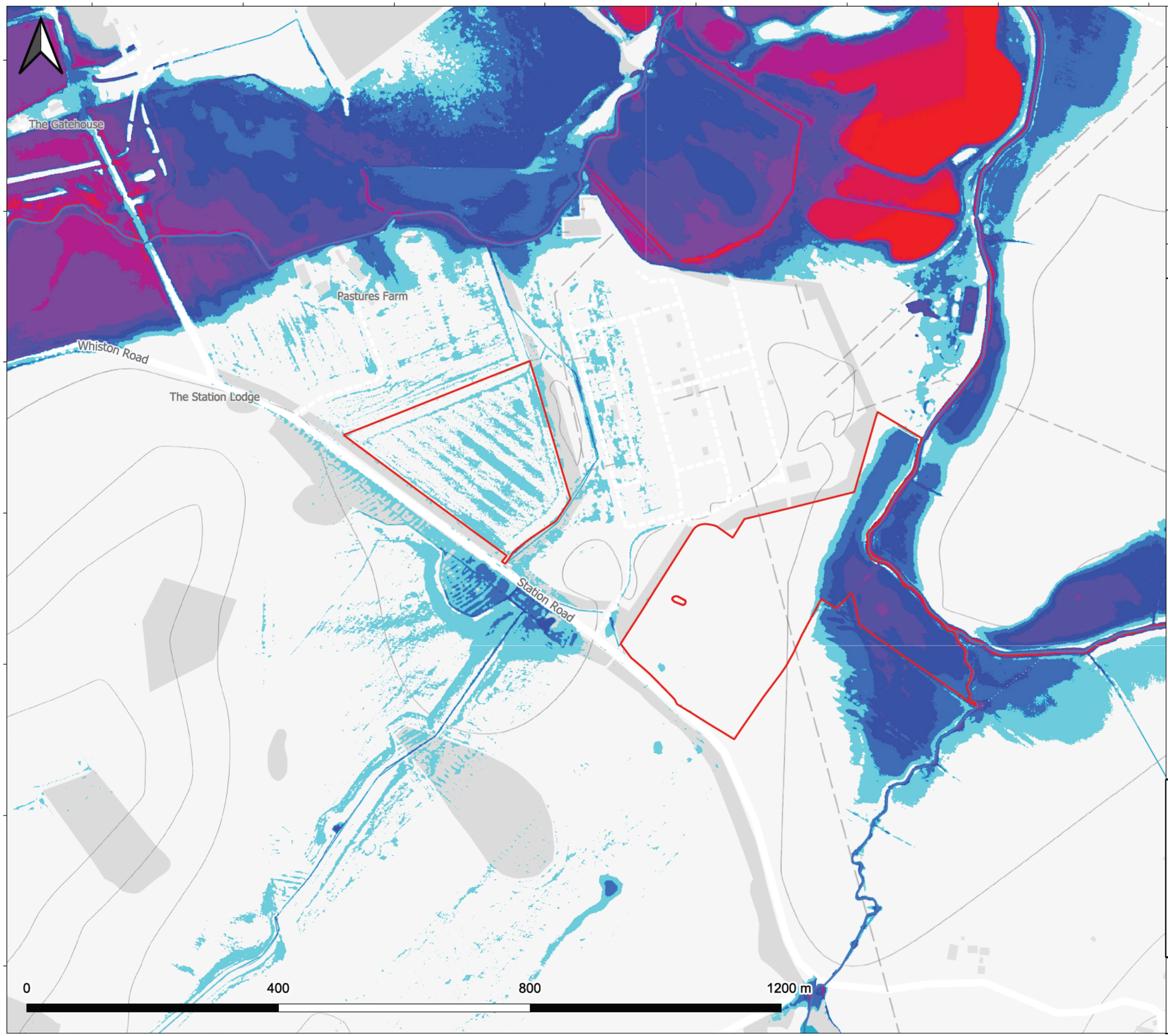

Project Reference:

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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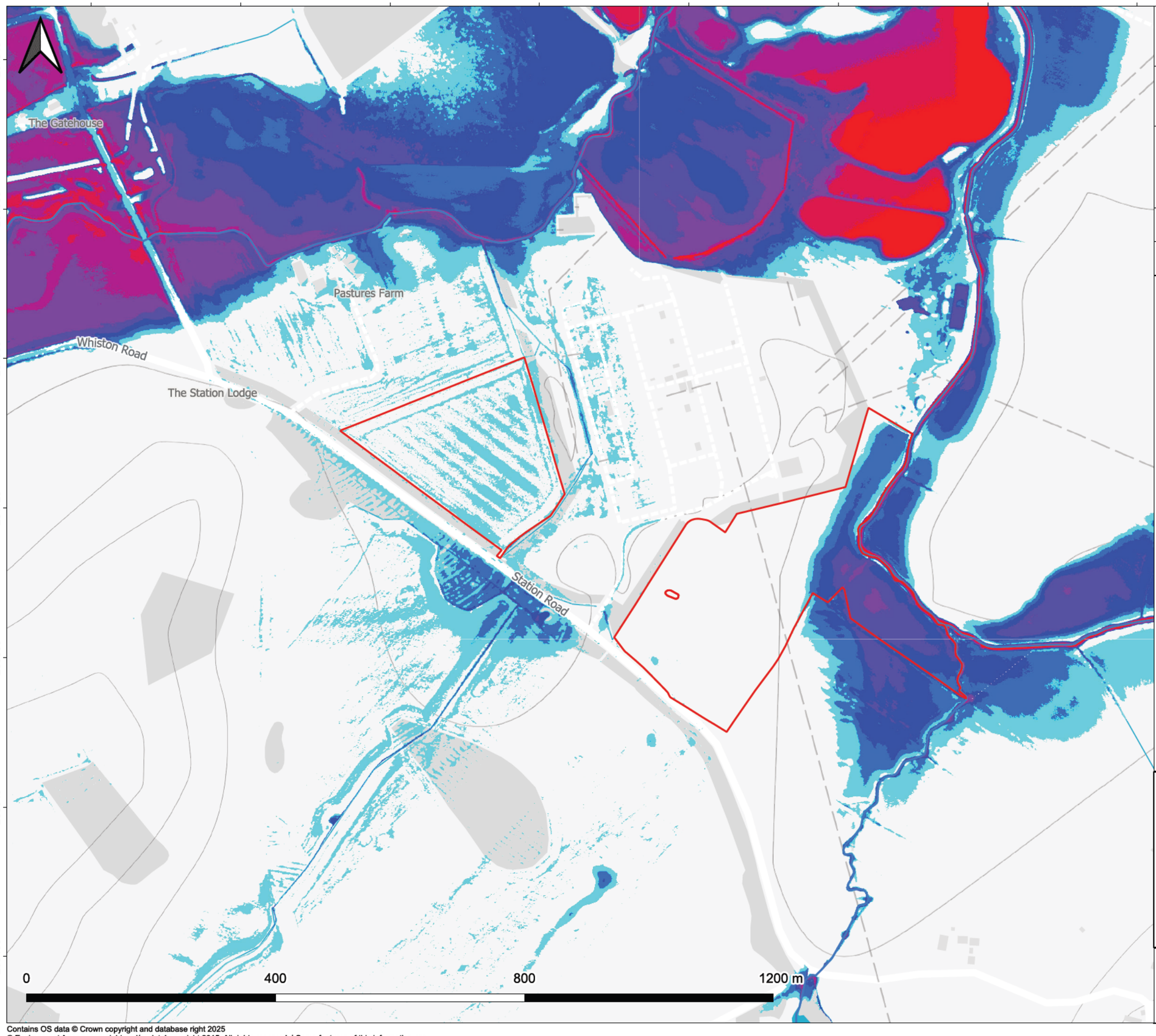

Project Reference:

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

- <= 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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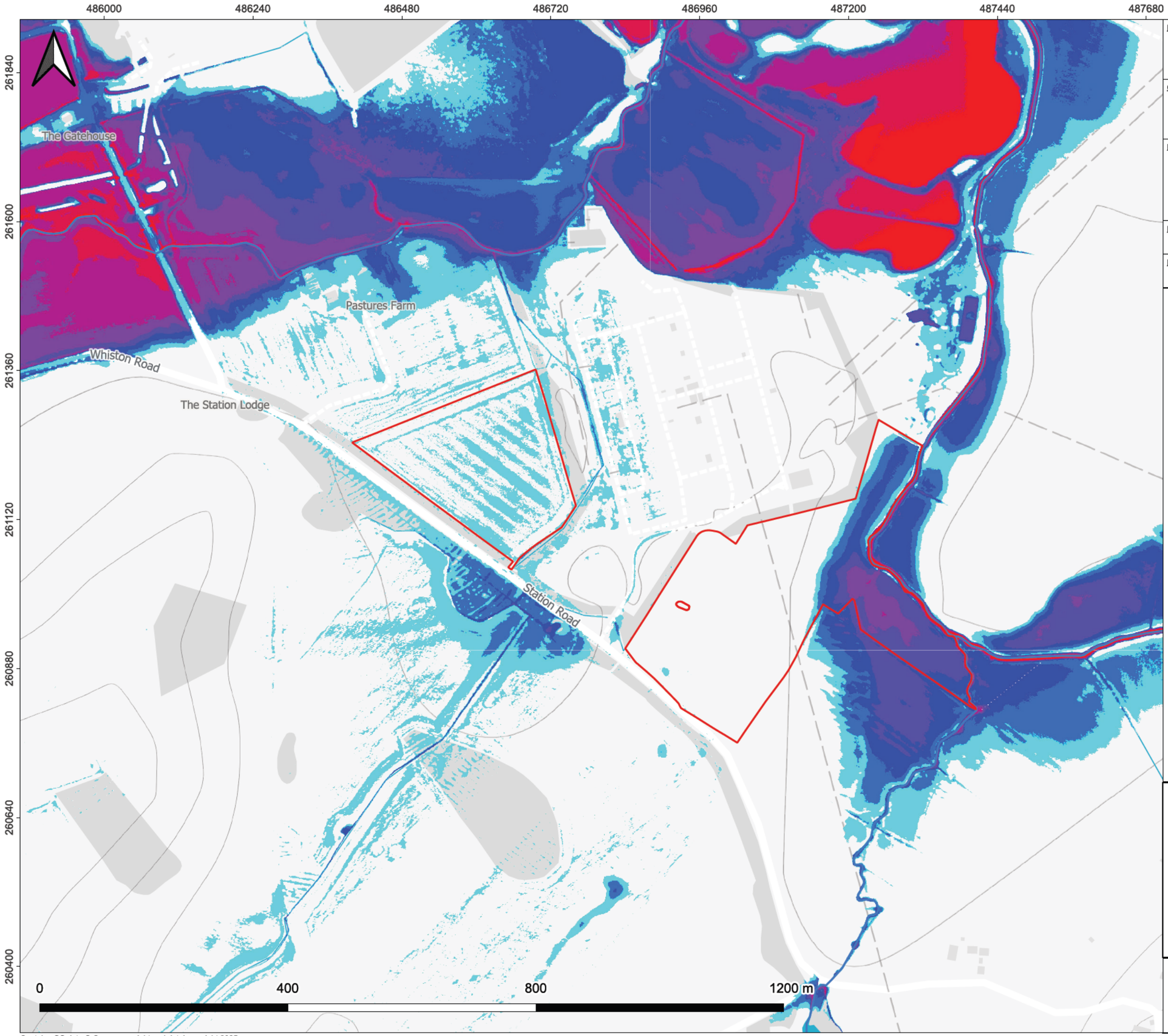

Project Reference:

Green Hill Solar

Client:

Green Hill Solar Farm Ltd.

Drawing Title:

1% AEP + 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

- <= 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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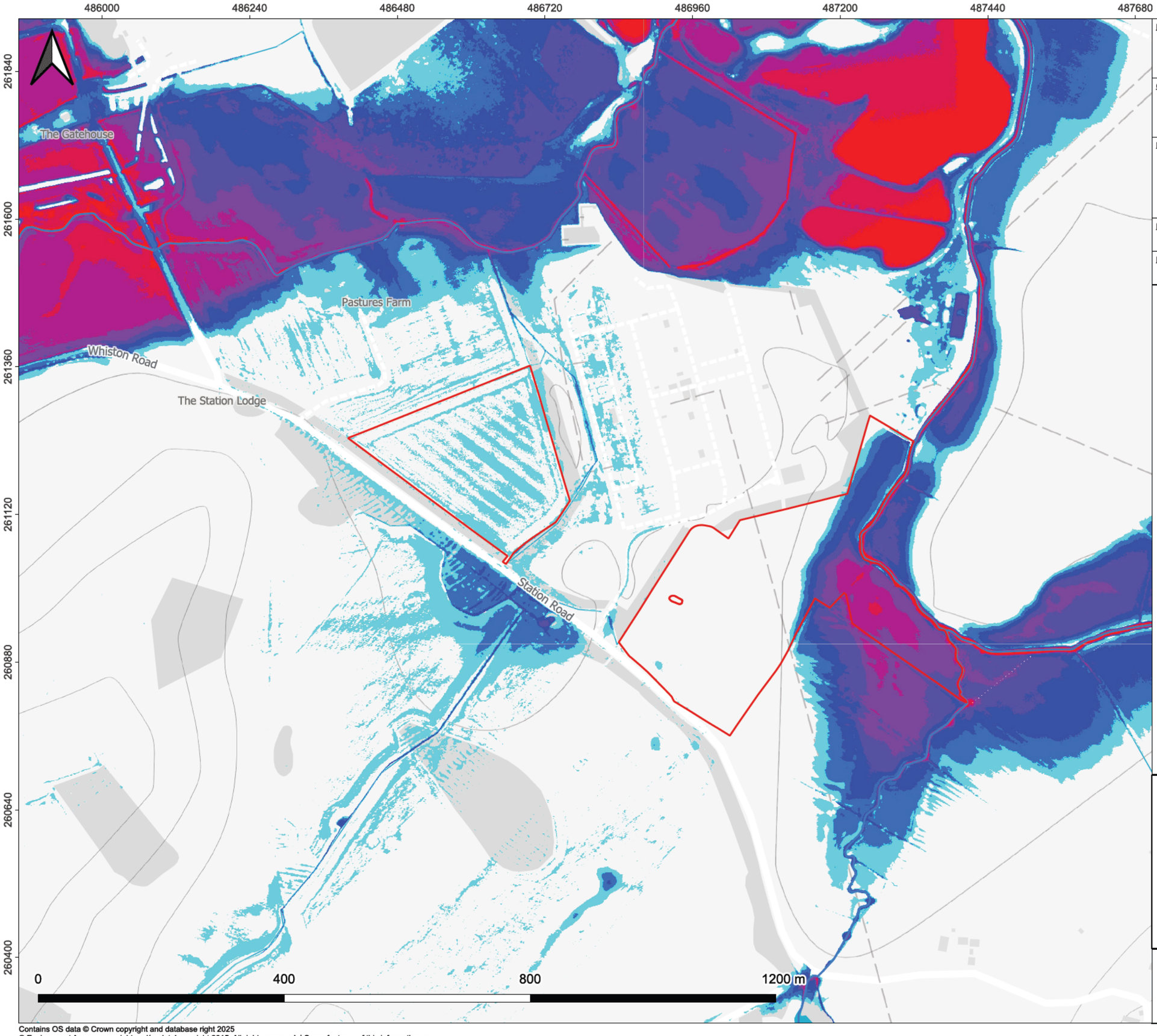

Project Reference:

Green Hill Solar

Client:

Green Hill Solar Farm Ltd.

Drawing Title:

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

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Annex D – Causeway Flow Attenuation Storage Calculations

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)	

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Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	5260.5	0.0	1.000	5260.5	0.0	1.001	0.0	0.0

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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

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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

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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

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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

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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 (m³)	Flood (m³)	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 (m³)
960 minute winter	Storage	Hydro-Brake®	9.0	616.0

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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

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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

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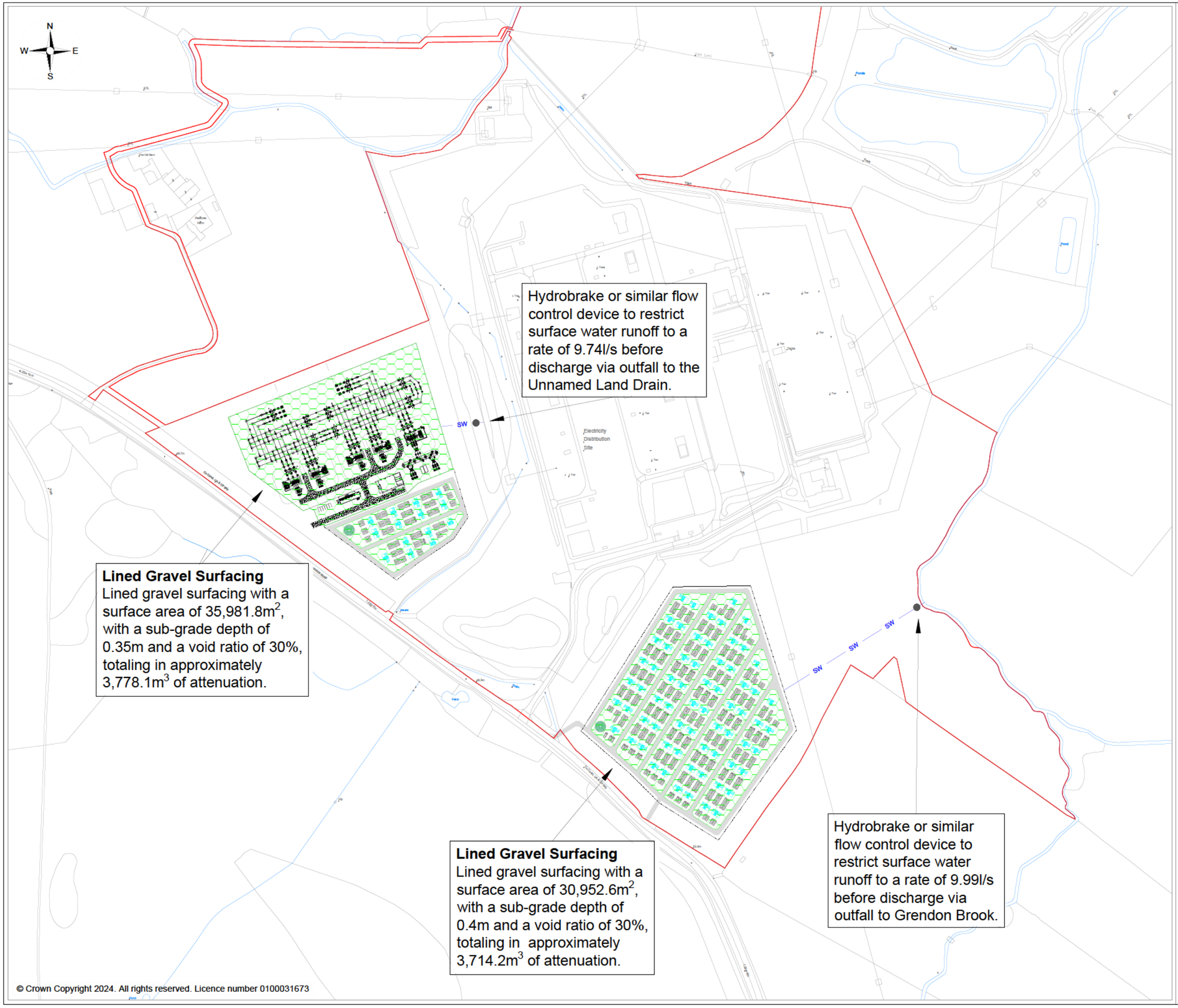
Annex E – Conceptual Drainage Sketch



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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

Arthian

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13 Henderson Road,
Inverness,
IV1 1SN
info@arthian.com
+44 (0) 141 227 2300
https://www.arthian.com

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

[redacted]

[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]