FLOOD RISK ASSESSMENT AND DRAINAGE SCHEME

BURSTEAD SOLAR FARM AND BATTERY STORAGE 'FREE GO'

LAND SOUTH AND EAST OF GREAT BURSTEAD, BILLERICAY, ESSEX

NOVEMBER 2023

www.ensoenergy.co.uk

Flood Risk Assessment and Drainage Scheme

Burstead Solar Farm 'Free Go'

22/11/2023

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1. EXECUTIVE SUMMARY

1.1. This Flood Risk Assessment (FRA) and Drainage Scheme (DS) has been carried out for the Proposed Development consisting of the installation and operation of a solar farm and battery storage facility with associated infrastructure on land south and east of Great Burstead, Billericay, Essex. The FRA and DS is prepared to accompany a 'Free Go' application following the previous refusals (March 2023 and April 2023).

1.2. The Proposed Development will solely be located within the eastern parcel (Fields 1 and 2) of the Application Site. All information within this FRA-DS will relate solely to the eastern parcel as that is where the entire development is located. There is no development proposed within the western parcel which remains within the red line but shall continue in its current agricultural use.

1.3. The Environment Agency (EA) Flood Map for Planning shows that most of the Application Site is located within Flood Zone 1. There is a very small area of Flood Zone 3, associated with the River Crouch, however only panels, fences and CCTV will be located within those areas at risk. Upon inspection of the topography of the Application Site. The maximum depth of flooding during the 1 in 100 year flood event will be 0.4m above ground level (AGL). The panels are located 0.8m AGL, therefore they will be located above the flood level, with a freeboard of 0.4m and be able to operate safely during a flood event. Additionally, fences and CCTV are classed as 'Water Compatible Development'. Electrical Infrastructure, such as battery storage containers, inverter/transformer stations and the substation, are located wholly within Flood Zone.

1.4. The proposed type of development is classed as 'Essential Infrastructure' and therefore development in Flood Zone 2 and 3 is deemed appropriate as long as there is safe operation during times of flooding, which has been proven to be the case.

1.5. Where the EA map demonstrates areas of surface water risk, which is more extensive within the Site being associated with the River Crouch and drainage ditches, the topographical survey, as well as aerial maps and site visit photos, were studied to determine if there will be surface water flooding. This indicated that there were some areas at risk of pluvial flooding, with a depth of up to 0.3m. However, only solar panels will be located in these areas at risk of pluvial flooding. As outlined above, the solar panels will be raised by approximately 0.8m, therefore being above the surface water flooding depth, with suitable freeboard.

1.6. It has been demonstrated that the Proposed Development's impact on surface water runoff is minimal due to the small amount of impermeable infrastructure proposed for the Application Site (1,106.8m^2). However, attenuation storage has still been factored into the design.

1.7. The small-scale nature of the five inverter / transformer stations is unlikely to warrant a formalised drainage system. Runoff from this infrastructure and any associated hard standing should be directed to a percolation area for discharge to ground. Should surface water accumulate around any of these locations, a simple soakaway can be constructed to allow water soak into the underlying subsoils.

1.8. This soil class has a Standard Percentage Runoff of 0.47 which suggests that they provide limited opportunity for infiltration. Prior to the detailed drainage design stage, which should be conditioned as part of any planning consent, infiltration testing will be undertaken in accordance with BRE 365[25]. Should infiltration drainage not be appropriate, the drainage design will need be altered and discharge locations agreed with a revised limiting discharge rate appropriate to the drainage design. A limiting discharge rate of 2l/s would seem appropriate; however, this will be agreed with the council post consent when the detailed drainage design is being undertaken.

Proposed Drainage Strategy (Solar Farm)

1.9. It is proposed to construct two soakaway channels within the Application Site. The location of the channels have been chosen on the downward slope, near to the River Crouch which runs past the southern boundary of the Application Site and to a tributary which runs through the centre of the Application Site. The intent is to capture any overland flow in the SuDS device, prior to releasing into the natural surface water system at greenfield run off rates.

1.10. The proposed soakaways will have an overall length of approximately 325m, with a base width of 0.5m, a 0.5m design depth and a 0.15m freeboard. It will be filled with crushed rock with a void ratio of 20% and will provide a total storage volume of approximately 16.3m^3. This is greater than the volume of additional runoff generated as a result of the impermeable buildings (11.0m^3). It is therefore considered that this not only adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area but provides improvement.

Proposed Drainage Strategy (Battery Compound)

1.11. The drainage strategy will consist of an underground piped system connecting to an attenuation storage structure to the north of the main grid compound. The attenuation structure will be designed to hold a volume of 63m^3 with the detailed design of the structure prepared as a Condition of planning permission prior to the construction period. As the auxiliary transformer on site will hold a volume of oil, the system will include a Class 1 full retention separator. The battery compound will form a permeable base to the same specification of the access tracks.

1.12. The discharge point will be into the drain which dissects the Proposed Development (Fields 1 and 2). It is important to note that this is the outline drainage design stage and is subject to change on receipt of the infiltration testing which will be undertaken post consent.

1.13. The SuDS features will be implemented during the construction phase of the Proposed Development. They will be maintained throughout the lifespan of the Proposed Development, generally in accordance with the recommendations in the appropriate guidance.

1.14. Additional drainage measures to be implemented on-site include the following:

- **Solar Panels:** current grass cover is to be retained or reinstated adjacent to and under panels in order to maximise bio-retention;
- **Access Tracks:** access tracks are to be permeable and constructed from stone. Swales or similar shall be utilised to collect runoff from access tracks. Where swales are utilised, check dams formed from gravels and other excavated material shall be placed in the swale at frequent intervals; and,
- **Inverters / Transformers etc:** the scale of these types of structures is unlikely to warrant a formalised drainage system. Runoff from this infrastructure and any associated hard standing should be directed to a percolation area for discharge to ground. Should surface water accumulate around any of these locations then a simple soakaway can be constructed to allow water soak into the underlying subsoils.

1.15. The Flood Risk Assessment (FRA) and Drainage Strategy (DS) has therefore demonstrated that the Proposed Development will **not increase flood risk** away from the Application Site during the construction, operation and decommissioning phases. The Proposed Development is therefore considered to be acceptable in planning policy terms.

2. INTRODUCTION

BACKGROUND

2.1. Neo Environmental Ltd has been appointed by Enso Green Holdings J Ltd (the "Applicant") to undertake a Flood Risk Assessment ("FRA") and Drainage Scheme ("DS") for a proposed solar farm and battery storage development with associated infrastructure (the "Proposed Development") on land south and east of Great Burstead, Billericay, Essex (the "Application Site"). The FRA and DS is prepared to accompany a 'Free Go' application following the previous refusals (March 2023 and April 2023).

DEVELOPMENT DESCRIPTION

2.2. The Proposed Development will consist of the construction of PV panels mounted on metal frames, new access tracks, underground cabling, transformers, perimeter fencing with access gates, a control room, spare parts containers, battery storage and all ancillary grid infrastructure and associated works.

2.3. This assessment will only consider the above ground elements of the Proposed Development. The underground cables which connect the site to the grid substation have not been considered further as they will mostly be along the public road verge or under the surface and will have no impact on flood risk or drainage.

SITE DESCRIPTION

2.4. The area of the Proposed Development comprises of approximately 59 ha of land, which is solely located within the eastern parcel (Fields 1 and 2) of the Application Site. All information within this FRA-DS will relate solely to the eastern parcel as that is where the Proposed Development is located. The field boundaries consist of a mixture of trees and hedgerows. Ground levels within the Proposed Development vary from approximately 54m AOD to 16m AOD.

2.5. The Proposed Development is accessed from Granites Chase.

2.6. The Proposed Development is centred at approximate grid reference E570075, N192850. The wider landscape contains the town of Great Burstead and Billericay.

SCOPE OF REPORT

2.7. The aim of this assessment is to identify the baseline geological and hydrological conditions of the site and surrounding area; to assess the potential impacts of the Proposed Development during the construction, operation and decommissioning phases; to identify the risk of flooding at the proposed Application Site; and to recommend mitigation measures where appropriate.

2.8. This FRA and DS has been prepared in accordance with National Planning Policy Guidelines.

2.9. This report is supported by the following figures and appendices:

- Appendix A Figures:
  - Figure 1: Watercourses with Photo Locations;
  - Figure 2: Field Numbers
  - Figure 3: Topographical Survey
  - Figure 4: Risk of Flooding from Rivers and Sea
  - Figure 5: Risk of Pluvial Flooding
  - Figure 6: Outline SuDS Design
- Appendix B: Photo Appendix
- Appendix C: Flow Output (Solar Farm)
- Appendix D: Flow Output (Substation and Battery Compound)

STATEMENT OF AUTHORITY:

2.10. This FRA and DS has been produced by Michael McGhee and Tom Saddington of Neo Environmental. Having completed a civil engineering degree in 2012, Michael has worked on over 1GW of renewable development flood risk and drainage impact assessments across the UK and Ireland whilst working towards becoming a Chartered Engineer. Michael has over 10 years of environmental consultancy experience, mainly producing technical assessments for energy projects. Tom has an undergraduate degree in Bioengineering and graduated with an

MSc in Environmental and Energy Engineering in January 2020. He has been working on various technical assessments including flood risk assessment reports for numerous renewable developments in Ireland and the UK

3. POLICY AND LEGISLATION

3.1. A review of relevant legislation has been conducted to ensure the Proposed Development complies with the following:

- EU Directive on the Assessment and Management of Flood Risks [2007/60/EC][1] implemented in England via the Flood and Water Management Act 2010[2] and the Flood Risk Regulations 2009[3];
- The Water Framework Directive [2000/60/EC][4] as implemented in England via the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[5];
- The Groundwater Directive (GWD) (2006/118/EC)[6] as implemented by the Groundwater (Water Framework Directive) (England) Direction 2016 and Environmental Permitting (England and Wales) Regulations 2016.
- National Planning Policy Framework, 2021[7]

[1] European Parliament (2007). Directive 2007/60/EC of the European Parliament and of the Council establishing a framework for the assessment and management of flood risks. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32007L0060

[2] UK Government (2010). Flood Water a Management Act 2010. Available at https://www.legislation.gov.uk/ukpga/2010/29/contents

[3] UK Government (2009). The Flood Risk Regulations 2009. Available at http://www.legislation.gov.uk/uksi/2009/3042/contents

[4] European Parliament (2000). Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy ("The Water Framework Directive"). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060.

[5] UK Government (2017). The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Available at http://www.legislation.gov.uk/uksi/2017/407/contents/made

[6] European Parliament (2006). Directive 2006/118/EC of the European Parliament and of the Council establishing a framework for the protection of groundwater against pollution and deterioration ("The Water Framework Directive"). Available athttps://www.eea.europa.eu/policy-documents/groundwater-directive-gwd-2006-118-ec

[7] UK Government, National Planning Policy Framework, 2021, Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

REVIEW OF LOCAL PLANNING POLICY

Basildon Development Plan

3.2. The Basildon Local Plan was adopted in 1998 and the weight given to the remaining saved policies are to be considered in the context of the NPPF. None of the remaining saved policies relate to flooding or sustainable drainage.

Rochford Development Plan

3.3. The Rochford Core Strategy[8] (the "CS") was published in December 2011 and is the main document of the Local Development Framework ("LDF"). The CS presents an extensive list of policies regarding development management within the District. Of these policies, the following are considered relevant to this assessment.

Table 3-1: Plan Flood Management Policies/Objectives (key points summarised)

Planning Policy/Objective	Comment
"Policy ENV3 – Flood Risk *The Council will direct development away from areas at risk of flooding by applying the sequential test and, where necessary, the exceptions test, as per PPS25. The vast majority of development will be accommodated within Flood Zone 1. However, considering the very limited supply of previously developed land in the District, proposed development on previously developed land within Flood Zone 3 will be permitted if it enables a contribution towards the District's housing requirement that would otherwise require the reallocation of Green Belt land, providing that it passes the exceptions tests and is able to accommodate the necessary flood defence infrastructure.* *The Council will continue to work with the Environment Agency to manage flood risk in a sustainable manner through capitalising on opportunities to make space for water wherever possible and through the continued provision of flood defences where necessary. "*	The Flood Risk Assessment will consider the impacts of overall Flood-Risk due to the Proposed Development.

8 Rochford Council. Rochford Core Strategy. Available at https://www.rochford.gov.uk/core-strategy-0

"Policy ENV4 – Sustainable Drainage Systems (SUDS) *All residential development over 10 units will be required to incorporate runoff control via SUDS to ensure runoff and infiltration rates do not increase the likelihood of flooding.* *The requirement for SUDs will only be relaxed where there is conclusive evidence demonstrating that the system is not viable on a particular site."*	The DS will ensure SuDS are applied.

Strategic Flood Risk Assessment

3.4. AECOM was commissioned to prepare Strategic Flood Risk Assessment (SFRA) for South Essex, which includes Basildon Council. The assessment is based upon historic flood records, hydraulic modelling data and the EA's Flood Map for Planning. The assessment outlines the fluvial and pluvial flood zones; however, these refer to the Environment Agency mapping and therefore that will be used in this report to delineate the flood zones.

3.5. The SFRA has identified areas within the Application Site of being at risk of pluvial, fluvial and groundwater flooding. These will be investigated further within the FRA.

4. METHODOLOGY

4.1. Flood planning policy and guidance for England is contained within the National Planning Policy Framework and in relation to flood risk it states:

"A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving:

- *sites of 1 hectare or more;*
- *land which has been identified by the Environment Agency as having critical drainage problems;*
- *land identified in a strategic flood risk assessment as being at increased flood risk in future;*
- *land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use"*

4.2. As this Proposed Development is over 1 hectare in size then a site-specific FRA is necessary. The objectives of a site-specific FRA are to establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- the evidence for the local planning authority to apply (if necessary) the Sequential Test, and;
- whether the development will be safe and pass the Exception Test, if applicable.

4.3. The Guidelines provide five vulnerability categories, based on the type of proposed development, which are detailed as follows:

- Essential Infrastructure
  - Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including <u>electricity generating power stations</u> and grid and primary substations; and water treatment works that need to remain operational in times of flood. The proposed development falls into this category.

Table 4-1: Flood Risk Vulnerability Classification

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	Appropriate	Appropriate	Appropriate	Appropriate	Appropriate
Zone 2	Appropriate	Exception Test Required	Appropriate	Appropriate	Appropriate
Zone 3a	Exception Test Required [x]	Not Appropriate	Exception Test Required	Appropriate	Appropriate
Zone 3b	Exception Test Required *	Not Appropriate	Not Appropriate	Not Appropriate	Appropriate*
[x] *In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.*					
[*] *In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:* • *remain operational and safe for users in times of flood;* • *result in no net loss of floodplain storage;* • *not impede water flows and not increase flood risk elsewhere.*					

4.4. Development should only be allowed in areas at risk of flooding where, in the light of the site-specific FRA (and the sequential and exception tests, as applicable) it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- the development is appropriately flood resistant and resilient;
- it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

4.5. Site specific FRA's should also provide surface water management arrangements at the site using sustainable drainage systems wherever appropriate, to ensure there is no increase in flood risk to others off-site.

4.6. This FRA addresses these matters.

5. BASELINE CONDITIONS

5.1. This section presents the information gathered on the existing topographical, geological, hydrological and hydrogeological conditions of the Application Site and its immediate surroundings.

5.2. A site walkover survey was also undertaken in order to identify hydrological, geological, flood risk and drainage features within the Application Site. A photographic record of drainage features is contained within **Appendix B** and the photo locations can be seen in **Figure 1 of Appendix A**.

5.3. When referring to field numbers please see **Figure 2: Appendix A**.

TOPOGRAPHY

5.4. A topographical survey was undertaken at the Application Site (**see Figure 3: Appendix A**). Ground levels within the Proposed Development vary from approximately 54m AOD on the northern boundary of Field 1 to 16m AOD in the southeast corner of Field 2. All fields generally slope to the south and east.

GEOLOGY & SOIL

5.5. The geological conditions of the Application Site were identified utilising the British Geological Society ("BGS") Spatial Resources online geological mapping[9] system. It is underlain by London Clay Formation. London Clay Formation formed approximately 48 to 56 million years ago in the Palaeogene Period. This is overlain by Head in Fields –1 and 2 and Alluvium in Fields 1 and 2. Head formed up to 3 million years ago in the Quaternary Period. Alluvium formed up to 2 million years ago in the Quaternary Period.

5.6. Borehole records were examined on the BGS Spatial Resources online geological mapping system. There are numerous borehole records in the area which confirm that clay is found 0.15m below ground level.

[9] BGS Geology of Britain Map., Available at http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Soil

5.7. Different soil types have different capabilities of soaking up water, the efficiency of which is dependent upon the structure and infiltration capacity. The Soilscapes[10] map has been utilised to obtain soil data. It classes the soil across the majority of the Application Site as 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils'. In part of the Proposed Development it classes the soils as 'Slightly acid loamy and clayey soils with impeded drainage'.

5.8. According to the Wallingford Procedure 'Winter Rain Acceptance Potential' (WRAP) map[11], the soil classification for the site is Class 4. This soil class has a Standard Percentage Runoff (SPR) of 0.47 and will provide limited infiltration opportunities. Infiltration testing will be conducted post consent to confirm whether infiltration drainage is suitable. This will inform the detailed drainage design which will also be undertaken post consent and should dealt with by means of a suitably worded condition.

HYDROLOGY

5.9. According to the Environment Agency Catchment Data Explorer[12], the Application Site lies within the Essex Combined Management Catchment. Within this, the site lies within the Crouch and Roach Operational Catchment.

Local River Network

5.10. The Application Site is within the catchment of the River Crouch, which is located along the southern boundary of the Application Site and has an overall classification of "moderate" under the Water Framework Directive. All drains within the Application Site which lead to the River Crouch, will eventually discharge into the North Sea.

Internal Watercourses

5.11. As discussed previously, there are no internal watercourses within the site, however there are a number of field drains which divert all surface water to the River Crouch to the south (See **Figure 1: Appendix A**).

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[10] Cranfield Soil and Agrifood Institute, Soilscapes website. Available at http://www.landis.org.uk/soilscapes/

[11] UK Sustainable Drainage and Guidance Tools. Greenfield Runoff Estimation for the Sites. Available at: http://www.uksuds.com/greenfieldrunoff_js.htm

[12] Environment Agency, Catchment Data Explorer, Available at https://environment.data.gov.uk/catchment-planning/ManagementCatchment/3104

FLOOD ZONE CLASSIFICATION

5.12. The Environment Agency (EA) Flood Map for Planning[13] shows that most of the Application Site is located within Flood Zone 1. There is however one small area of Flood Zone 2 and 3 in the south of the Field 2, an area described as "*high probability*" of flooding in **Table 1: Flood Zones** of the "*Planning Practice Guidance to the National Planning Policy Framework*", which is located along the southeast boundary of the Application Site and is from the River Crouch.

5.13. Flood Zone 3 is categorised as being the highest flood risk and comprises land assessed as having a 1 in 100 or greater annual probability of river flooding or land having a 1 in 200 or greater annual probability of sea flooding, see **Figure 4: Appendix A.**

HISTORIC FLOODING

5.14. The Environment Agency historic flood map[14] is a GIS layer showing the maximum extent of individual Recorded Flood Outlines from the river, the sea and groundwater springs that meet a set criterion. It shows areas of land that have previously been subject to flooding in England. The map shows that no part of the Application Site has been included within this historic flood extent with the closest area of historic flooding occurring approximately 3.9km to the southeast of the Application Site.

5.15. A review of the Strategic Flood Risk Assessments covering the area has identified that there are no specific records of flooding for the site.

HYDROGEOLOGY

5.16. The Application Site is not located within a source protection zone (SPZ).

Groundwater Vulnerability

5.17. Groundwater Vulnerability refers to the intrinsic geological and hydrogeological characteristics that determine the ease at which groundwater may be contaminated by human activities. The more vulnerable the groundwater is, the more easily it can be contaminated by surface water.

[13] Environment Agency Flood Map For Planning. Available at: https://flood-map-for-planning.service.gov.uk/
[14] Environment Agency, Historic Flood Outlines, Available at https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/HistoricFloodMap&Mode=spatial

5.18. According to the Environment Agency Groundwater Vulnerability Maps, the groundwater vulnerability across the Application Site is considered to be ‘Low’ and ‘Unproductive'.

6. FLOOD RISK ASSESSMENT

SEQUENTIAL TEST

6.1. The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones as refined in the Strategic Flood Risk Assessment for the area provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

Fluvial and Coastal Flood Risk

6.2. The EA Mapping shows that the very southern section of Field 2 is located within Flood Zone 2 and 3 (See **Figure 4: Appendix A**), however only panels, fences and CCTV will be located within those areas at risk. Upon inspection of the topography of the Application Site, the maximum depth will be 0.4m above ground level (AGL), therefore, as the panels have a freeboard of 0.8m AGL, they will be located above the potential flooding in Flood Zone 2 and 3 and still be able to operate safely during a flood event. Additionally, fences and CCTV are classed as 'Water Compatible Development'. Electrical Infrastructure, such as battery storage containers, inverters and the substation, is located within Flood Zone 1 only. Access tracks are also within Flood Zone 1.

6.3. Therefore, according to **Table 4 – 1**, 'Water Compatible Development' is acceptable within Flood Zones 2 and 3. All electrical infrastructure, except as small number of panels which are raised above the flood zone, is located within Flood Zone 1, which according to **Table 4 – 1** is deemed appropriate.

6.4. The proposed type of development is classed as 'Essential Infrastructure' and therefore the limited development in Flood Zone 2 and 3 is deemed appropriate as long as there is safe operation during times of flooding, which has been proven to be the case.

Pluvial Flood Risk

6.5. In addition to fluvial and coastal flood risk, the EA also provide surface water flood maps[15]. A detailed surface water flood map was requested from the EA and can be seen as **Figure 5: Appendix A**. This shows the areas at risk of surface water flooding within the Application Site.

6.6. **Figure 3: Appendix A** shows the topographical survey of the Application Site. Where the EA map demonstrates areas of surface water risk, the topographical survey, as well as aerial maps and site visit photos, were studied to determine if there will be surface water flooding. This indicated that there were some areas at risk of pluvial flooding, with a depth of up to 0.3m, within the most western site area as well as the most southern. However, only solar panels, fences, access tracks and CCTV will be located in these areas at risk of pluvial flooding. The panels will be pile driven and lifted above ground level by a minimum height of 0.8m and therefore any ponding will occur well beneath the lowest part of the panels. The maximum ponding depth is likely to be approximately 0.3m due to the topography of the area where the panels are located within the surface water flood zone. **Appendix B** shows some images where surface water may accumulate with the location of where the photos were taken visible on **Figure 1: Appendix A.**

Groundwater Flood Risk

6.7. Groundwater flooding is a "hidden" risk that is often difficult to distinguish from other types of flooding. For example, rising groundwater often forms in low-lying areas which are also susceptible to the accumulation of surface water.

6.8. Upon inspection of the areas susceptible to groundwater flooding map[16] for the South Essex SFRA, it shows that there is up to a 75% chance of groundwater flooding within the Application Site. However, as outlined above, groundwater flooding is only likely to occur in low-lying areas that are susceptible to pluvial flooding. Where potential for pluvial flooding is shown in **Figure 5: Appendix**, the susceptibility of groundwater flooding increases according to the groundwater flooding map. Therefore, as the map assesses in squares of 1km^2, it is reasonable to assume that the risk of groundwater flooding will be confined to those areas at risk of pluvial flooding.

6.9. Based on the above, the risk of flooding from groundwater for the part of the Application Site outside the predicted floodplain is likely to be **low**.

[15] EA Surface water flood maps: https://check-long-term-flood-risk.service.gov.uk/map

[16] AECOM. Areas susceptible to Groundwater Flooding. Available at: https://www.basildon.gov.uk/media/8951/South-Essex-Level-1-SFRA-2018-Appendices-pages-93-124/pdf/South_Essex_Level_1_SFRA_-_2018_-_Appendices_pages_93-124.pdf?m=636858327876370000

SITE ACCESS POINTS

6.10. The access point into the site will be from an existing access point off Granites Chase. All surface waters should be directed into the site, with no overland flow from the Proposed Development areas reaching the public highway.

7. DRAINAGE SCHEME

INTRODUCTION

7.1. There is a requirement in the PPG for proposals to incorporate surface water drainage measures that have a neutral or beneficial effect on the risk of flooding both on and off the Site.

7.2. Surface water arising from a developed site should, as far as is practicable, be managed to mimic the surface water flows arising from the site prior to the Proposed Development, while reducing the flood risk at the site itself and elsewhere.

METHODOLOGY

Catchment Characteristics

7.3. Catchment characteristics were obtained from the Flood Studies Report[17]. Catchment sizes were measured using ArcGIS and catchment boundaries were produced based on the site-specific topographical survey.

Greenfield Runoff and Stormwater Storage

7.4. Greenfield runoff rates and stormwater storage requirements have been obtained using the following tools:

- HR Wallingford UK Sustainable Drainage Greenfield Runoff Estimation Tool (using IH124[18] methodology due to the small-scale nature of the catchment).
- Flow – Causeway Drainage design software (using IH124 methodology due to the small-scale nature of the catchment).
- The areas of permeable and impermeable surfaces have been estimated and are based upon the Proposed Development layout.

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[17] Institute of Hydrology, Flood Studies Report (1975)

[18] Institute of Hydrology (1994). *Flood estimation for small catchments. Report No IH124*, Wallingford.

Greenfield Runoff rates

7.5. The IH24 methodology is used for calculating the Greenfield runoff rates. This is recommended by the Institute of Hydrology for catchments below 200 ha.

7.6. The IH124 equation estimates Qbar with the following equation:

$$Qbar - rural \ = \ 0.00108\,x\,(0.01\,x\,AREA)0.89\,x\,SAAR1.17\,x\,SPR2.17, m3/s$$

where:

- Qbar-rural is the mean annual flood flow from a rural catchment (approximately 2-3-year return period).
- AREA is the area of the catchment in ha.
- SAAR is the standard average annual rainfall for the period 1961 to 1990, available from the Flood Studies Report
- SPR is Standard Percentage Runoff coefficient for the soil category.

Calculating storage estimates

7.7. The storage estimates are calculated using the inputs below:

- Return Period
- Climate Change
- Impermeable Area
- Peak Discharge

7.8. The return period and climate change are combined with the Flood Studies Report (FSR) parameters and storm durations to generate the rainfall used. The result from these calculations is the attenuation storage required for the Application Site as a result of the additional runoff generated by the Proposed Development.

Site and Project Descriptions

7.9. The Proposed Development will have a very limited extent of impermeable ground cover. The area beneath the solar panels will remain as grassland and the post-development site infiltration rate will not change.

7.10. Rainwater falling onto each panel will drain freely onto the ground beneath the panels and infiltrate the ground at the same rate as it does in the site's existing greenfield state. Thus, the total surface area of the photovoltaic array is not considered an impermeable area.

7.11. Similarly, any rainwater falling onto the permeable access tracks will soak into the ground beneath at the same rate that it presently does. The ground at the substation and battery compound is also constructed with permeable gravel.

7.12. The extent of impermeable area created as a result of the Proposed Development is summarised in **Table 7-1**.

Table 7-1: Extent of less permeable areas created by the Proposed Development

Building	Total Solar Farm (m2)	Battery Storage and Substation Area (m2)	Total
23 x Battery containers. (12.1m x 2.4m each)		673.4	673.4
12 x Battery Storage Inverters (6.0m x 2.4m)		172.8	**172.8**
1 x Control Room (6.0m x 3.0m)		18.0	**18.0**
2 x Storage Containers (12.2m x 2.4m)		58.6	**58.6**
1 x Auxiliary Transformer (4.1m x 4.1m)		16.8	**16.8**
1 x Substation (11.7m x 4.0m)		46.8	**46.8**
5 x Inverter/Transformer Stations. (12.2m x 2.4m)	146.4		**146.4**
Total Impermeable Area	146.4	940.4	**1,106.8**
Site Area (m^2)	1,195,000.0		

7.13. In its current greenfield state, the Application Site is considered to be 100% undeveloped. As a result of the Proposed Development, the extent of impermeable hardstanding introduced will be approximately 1,106.8m^2 or 0.1% of the total site area.

7.14. Due to the small size of the Inverter/Transformer Stations and their widespread nature of their locations across the Application Site, it is impractical to connect them into a drainage scheme. Water runoff from these buildings will slowly drain into the underlying geology through infiltration and the impact of this will be **negligible**. Should surface water accumulate around any of these locations, a simple soakaway can be constructed to allow water soak into the underlying subsoils.

Existing Drainage Arrangements

Existing Runoff Rates

7.15. The existing runoff rates and hydrological characteristics of the Proposed Development are detailed in **Table 7-2** below (assumes the site as 100% greenfield at present).

Table 7-2: Pre-Development Greenfield runoff rates.

Site Make Up	Green Field	
	Solar Farm	Substation and Battery Compound
Greenfield Method	IH124	IH124
Positively Drained Area (ha)	0.014	0.094
SAAR (mm)	573	573
Soil Index	4	4
Standard Percentage Runoff	0.47	0.47
Region	6	6
	Runoff rate (l/s)	Runoff rate (l/s)
QBar	0.1	0.4
1 year	0.0	0.3
1 in 30 year	0.1	0.7
1 in 100 year	0.1	0.9

7.16. The limiting discharge will be taken as the QBar rate seen in **Table 7-2**. Should infiltration drainage not be appropriate, the drainage design will need be altered and discharge locations agreed with a revised limiting discharge rate appropriate to the drainage design. A limiting discharge rate of 2l/s would seem appropriate; however, this will be agreed with the council post consent when the detailed drainage design is being undertaken.

Post Development Runoff Rate

7.17. The surface water runoff rate resulting from the Proposed Development has been based on the areas of hardstanding introduced, which will have a lower permeability than the existing greenfield composition.

7.18. Surface water runoff was derived using the Modified Rational Method as outlined within the methodology.

7.19. Using this approach, the runoff rate for the 1-in-100-year, 360-minute storm event, inclusive of the 40% climate change allowance would be a combined 28m^3 for the solar and battery areas.

Proposed Drainage Arrangements

7.20. The SuDS Manual[19] is the current best practice guidance on the use of SuDS. It promotes the use of a hierarchical approach to managing runoff. This approach is outlined below:

- Prevention - Preventing runoff by reducing impermeable areas.
- Source Control - Effective control of runoff at or very near its source.
- Site Control - Planned management of water in a local area or site.
- Regional Control - Designing a system that can efficiently manage the runoff from a site, or several sites.

7.21. The use of SuDS is generally accepted to have greater benefits than conventional drainage systems and these include[20]:

- Managing runoff volumes and flow rates from hard surfaces, reducing the impact of urbanisation on flooding;

19 CIRIA (2015). Report C753, The SuDS Manual

20 Susdrain. Sustainable drainage. Accessed http://www.susdrain.org/delivering-suds/using-suds/background/sustainable-drainage.html

- Providing opportunities for using runoff where it falls;
- Protecting or enhancing water quality (reducing pollution from runoff);
- Protecting natural flow regimes in watercourses;
- SuDs are sympathetic to the environment and the needs of the local community;
- Providing an attractive habitat for wildlife in urban watercourses;
- Providing opportunities for evapotranspiration from vegetation and surface water; and
- Encouraging natural groundwater/aquifer recharge (where appropriate).

7.22. The surface water drainage strategy for the Proposed Development seeks to provide a sustainable and integrated surface water management scheme for the whole Application Site and aims to ensure no increase in downstream flood risk by managing discharges from the Proposed Development to the local water environment in a controlled manner.

7.23. To comply with current policies, guidance and best practice, the volume and quality of surface water runoff discharged off-site from the Proposed Development at this Application Site will need to be controlled using SuDS.

7.24. In compliance with the above, the drainage strategy has been developed to meet the following key principles;

- Mimic existing (greenfield) drainage arrangements as far as possible;
- Avoid increases in the greenfield rate, volume and frequency of offsite discharge;
- Avoid significant deterioration in water quality of discharges and no detrimental impact in downstream water quality;
- Achieve the above criteria for all storms up to and including the 100-year event; and,
- Incorporate an allowance for climate change (40%).

Indicative Surface Water Storage Requirements

7.25. Indicative storm water storage volumes have been estimated using Causeway's Drainage Design Flow software. The storage calculations include up to the critical storm 100-year return period event (including a 40% allowance for climate change) and the design limits discharge rates back to greenfield runoff rates. The results are enclosed in **Appendix C and D.** These are estimated from the new surfaces added to the Proposed Development.

- Attenuation storage limits the rate of surface runoff discharge from the Proposed Development to match the pre-development greenfield runoff rates; and
- All storage calculations have been given a climate change allowance factor of 40% that has been added to the rain depths.

Table 7-3: Storage Estimates

Storage Estimates		
	Solar Farm	Substation and Battery Compound
Return Period (years)	100 years	100 years
Climate Change (%)	40	40
Impermeable Area (ha)	0.014	0.094
Peak Discharge (l/s)	0.1	0.4
Total storage Requirement (m^3)	$11m^3$	$63m^3$

Proposed Drainage Strategy (Solar Farm)

7.26. It is proposed to construct two soakaway channels within the Application Site (See **Figure 6: Appendix A**). The location of the channels have been chosen on the downward slope, near to the River Crouch which runs past the southern boundary of the Application Site. The intent is to capture any overland flow in the SuDS device, prior to releasing into the natural surface water system at greenfield run off rates.

7.27. The proposed soakaways will have an overall length of approximately 325m, with a base width of 0.5m, a 0.5m design depth and a 0.15m freeboard. It will be filled with crushed rock with a void ratio of 20% and will provide a total storage volume of approximately $16.3m^3$. This is greater than the volume of additional runoff generated as a result of the impermeable buildings ($11.0m^3$). It is therefore considered that this not only adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area but provides improvement.

Proposed Drainage Strategy (Substation and Battery Compound)

7.28. The drainage strategy will consist of an underground piped system connecting to an attenuation storage structure to the north of the compound, see **Figure 6: Appendix A**. The attenuation structure will be designed to hold a volume of $63m^3$ with the detailed design of the structure being prepared as a Condition of planning permission prior to the construction.

As the auxiliary transformer on site will hold a volume of oil, the system will include a Class 1 full retention separator.

7.29. The discharge point will be into the drain which dissects the Proposed Development (Fields 1 and 2). It is important to note that this is the outline drainage design stage and is subject to change on receipt of the infiltration testing which will be undertaken post consent.

7.30. The SuDS features will be implemented during the construction phase of the Proposed Development and the swales will be planted with vegetation to protect against soil erosion. They will be maintained throughout the lifespan of the Proposed Development, generally in accordance with the recommendations in the appropriate guidance.

7.31. Additional drainage measures to be implemented on-site include the following:

- Solar Panels: current grass cover is to be retained or reinstated adjacent to and under panels in order to maximise bio-retention;
- Access Tracks: access tracks are to be permeable and constructed from stone. Swales or similar shall be utilised to collect runoff from access tracks. Where swales are utilised, check dams formed from gravels and other excavated material shall be placed in the swale at frequent intervals; and,
- Inverters / Transformers etc: the scale of these types of structures is unlikely to warrant a formalised drainage system. Runoff from this infrastructure and any associated hard standing should be directed to a percolation area for discharge to ground. Should surface water accumulate around any of these locations then a simple soakaway can be constructed to allow water soak into the underlying subsoils.

CONSTRUCTION PHASE DRAINAGE ARRANGEMENTS

7.32. Due to the addition of a temporary construction compound during the construction phase, additional drainage measures will be implemented to help attenuate the increase in surface water flows, if surface water is observed discharging from the construction compound.

7.33. Runoff from these areas is anticipated to have higher silt loading due to mobilised soils from excavated surfaces, fines from track aggregate and sludge due to traffic.

7.34. Hardstanding runoff will be directed to a swale on the compound's lowest boundary. This drainage scheme will be removed at the end of the construction stage and the area reinstated.

Designing for Exceedance Events

7.35. Overland flow routes will not be altered by the construction of the Proposed Development as it is not proposed to significantly change ground levels. The drainage has been designed so that flooding will not occur for up to and including the 1-in-100-year storm event (including 40% climate change consideration).

7.36. Should an exceedance of this 1 in 100-year critical storm event occur, surface water will flow the same way as at present, into the surrounding field drains. There are no sensitive receptors between the Application Site and the field drains.

Long Term Maintenance of SuDS

7.37. The long-term management and maintenance of the proposed SuDS will be the responsibility of the site owner and/or operators and a detailed maintenance plan could be controlled by a suitably worded Condition. These responsibilities include:

- Periodic cutting or grazing of vegetation;
- Observation of infiltration performance;
- If poor infiltration is observed then any accumulated silt/litter will be removed and aeration of the soil will be undertaken to improve permeability; and
- Maintain the structural integrity of the SuDS proposals.

Potential for Soil Erosion

7.38. The key to avoiding increased runoff and the transport of soil into watercourses is to maintain soil permeability and vegetative cover. Permeable land surfaces underneath and between panels should be able to absorb rainfall as long as they are not compacted and there is some vegetation to bind the soil surface.

7.39. Soil compaction will be limited during construction and operation of the solar farm. During construction, only light machinery will be required to install the solar arrays. Any HGVs delivering components will be restricted to site access tracks and the temporary construction compounds.

7.40. The risks of runoff and soil erosion are lowest on land with a gradual gradient with cohesive soils and are highest on dry, sandy and steeply sloping soil surfaces. Furthermore, the slope aspect of the land can also have an effect on runoff rates and soil erosion. The aspect of solar panels will be south-facing and, therefore, north or south facing slopes will result in runoff flowing in a parallel direction to that of the runoff from the panels; thereby remaining relatively diffuse and unlikely to result in concentrated flows that could cause soil erosion, apart from where very steep slopes occur.

7.41. East or west facing slopes will result in runoff flowing in a perpendicular direction to that of runoff from the panels; this will result in runoff becoming concentrated along the drip-line of each row, which could lead to increased soil erosion.

7.42. With regard to the Proposed Development, the site has a moderate gradient for the most part. The orientation of the solar panels could concentrate surface water flow in some areas of the Application Site and increase the risk of soil erosion. However, there is only a small increase in non-permeable land due to the development so the surface waters will mostly continue as present except at the battery and substation locations. However, this has its own formal drainage scheme which will discharge at greenfield rates into the existing drainage network and therefore won't have an impact on soil erosion.

7.43. Other mitigation techniques which are in place to avoid soil erosion include:

- Maintaining vegetative areas in between the solar arrays to help interrupt and slow the channelised flows, reducing erosion and also enhance and promote the infiltration and interception capacity. Where possible bare ground or gravel should be avoided.
- A robust soil, grass, and/or land management plan will be in place to keep land in good condition. If the ground becomes bare due to lack of maintenance the peak discharge has the potential to increase significantly.
- After construction the soil should be chisel ploughed, harrowed, or similar, to mitigate soil compaction during construction. This will ensure that the site can infiltrate to its potential.

8. SUMMARY & CONCLUSIONS

8.1. This FRA and DS has been carried out for the Proposed Development consisting of the installation and operation of a solar farm and battery storage facility with associated infrastructure on land south and east of Great Burstead, Billericay, Essex.

8.2. The EA Flood Map for Planning shows that most of the Application Site is located within Flood Zone 1. There is a very small area of Flood Zone 3, associated with the River Crouch, however only panels, fences and CCTV will be located within those areas at risk. Upon inspection of the topography of the Application Site. The maximum depth of flooding during the 1 in 100 year flood event will be 0.4m AGL. The panels are located 0.8m AGL, therefore they will be located above the flood level, with a freeboard of 0.4m and be able to operate safely during a flood event. Additionally, fences and CCTV are classed as 'Water Compatible Development'. Electrical Infrastructure, such as battery storage containers, inverter/transformer stations and the substation, are located wholly within Flood Zone.

8.3. The proposed type of development is classed as 'Essential Infrastructure' and therefore development in Flood Zone 2 and 3 is deemed appropriate as long as there is safe operation during times of flooding, which has been proven to be the case.

8.4. Where the EA map demonstrates areas of surface water risk, which is more extensive within the Site being associated with the River Crouch and drainage ditches in both parcels, the topographical survey, as well as aerial maps and site visit photos, were studied to determine if there will be surface water flooding. This indicated that there were some areas at risk of pluvial flooding, with a depth of up to 0.3m. However, only solar panels will be located in these areas at risk of pluvial flooding. As outlined above, the solar panels will be raised by approximately 0.8m, therefore being above the surface water flooding depth, with suitable freeboard.

8.5. It has been demonstrated that the Proposed Development's impact on surface water runoff is minimal due to the small amount of impermeable infrastructure proposed for the Application Site (1,106.8m^2). However, attenuation storage has still been factored into the design.

8.6. The small-scale nature of the inverter / transformer stations is unlikely to warrant a formalised drainage system. Runoff from this infrastructure and any associated hard standing should be directed to a percolation area for discharge to ground. Should surface water accumulate around any of these locations, a simple soakaway can be constructed to allow water soak into the underlying subsoils.

8.7. This soil class has a Standard Percentage Runoff of 0.47 which suggests that they provide limited opportunity for infiltration. Prior to the detailed drainage design stage, which should be conditioned as part of any planning consent, infiltration testing will be undertaken in accordance with BRE 365[25]. Should infiltration drainage not be appropriate, the drainage design will need be altered and discharge locations agreed with a revised limiting discharge rate appropriate to the drainage design. A limiting discharge rate of 2l/s would seem appropriate; however, this will be agreed with the council post consent when the detailed drainage design is being undertaken.

Proposed Drainage Strategy (Solar Farm)

8.8. It is proposed to construct three soakaway channels within the Application Site. The location of the channels have been chosen on the downward slope, near to the River Crouch which runs past the southern boundary of the Application Site. The intent is to capture any overland flow in the SuDS device, prior to releasing into the natural surface water system at greenfield run off rates.

8.9. The proposed soakaways will have an overall length of approximately 325m, with a base width of 0.5m, a 0.5m design depth and a 0.15m freeboard. It will be filled with crushed rock with a void ratio of 20% and will provide a total storage volume of approximately 16.3m^3. This is greater than the volume of additional runoff generated as a result of the impermeable buildings (11.0m^3). It is therefore considered that this not only adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area but provides improvement.

Proposed Drainage Strategy (Battery Compound)

8.10. The drainage strategy will consist of an underground piped system connecting to an attenuation storage structure to the north of the main grid compound. The attenuation structure will be designed to hold a volume of 63m^3 with the detailed design of the structure prepared as a Condition of planning permission prior to the construction period. As the auxiliary transformer on site will hold a volume of oil, the system will include a Class 1 full retention separator. The battery compound will form a permeable base to the same specification of the access tracks.

8.11. The discharge point will be into the drain which dissects the Proposed Development (Fields 1 and 2). It is important to note that this is the outline drainage design stage and is subject to change on receipt of the infiltration testing which will be undertaken post consent.

8.12. The SuDS features will be implemented during the construction phase of the Proposed Development. They will be maintained throughout the lifespan of the Proposed Development, generally in accordance with the recommendations in the appropriate guidance.

8.13. Additional drainage measures to be implemented on-site include the following:

- Solar Panels: current grass cover is to be retained or reinstated adjacent to and under panels in order to maximise bio-retention;

- **Access Tracks:** access tracks are to be permeable and constructed from stone. Swales or similar shall be utilised to collect runoff from access tracks. Where swales are utilised, check dams formed from gravels and other excavated material shall be placed in the swale at frequent intervals; and,

- **Inverters / Transformers etc:** the scale of these types of structures is unlikely to warrant a formalised drainage system. Runoff from this infrastructure and any associated hard standing should be directed to a percolation area for discharge to ground. Should surface water accumulate around any of these locations then a simple soakaway can be constructed to allow water soak into the underlying subsoils.

8.14. The Flood Risk Assessment (FRA) and Drainage Strategy (DS) has therefore demonstrated that the Proposed Development will **not increase flood risk** away from the Application Site during the construction, operation and decommissioning phases. The Proposed Development is therefore considered to be acceptable in planning policy terms.

9. APPENDICES

APPENDIX A: FIGURES

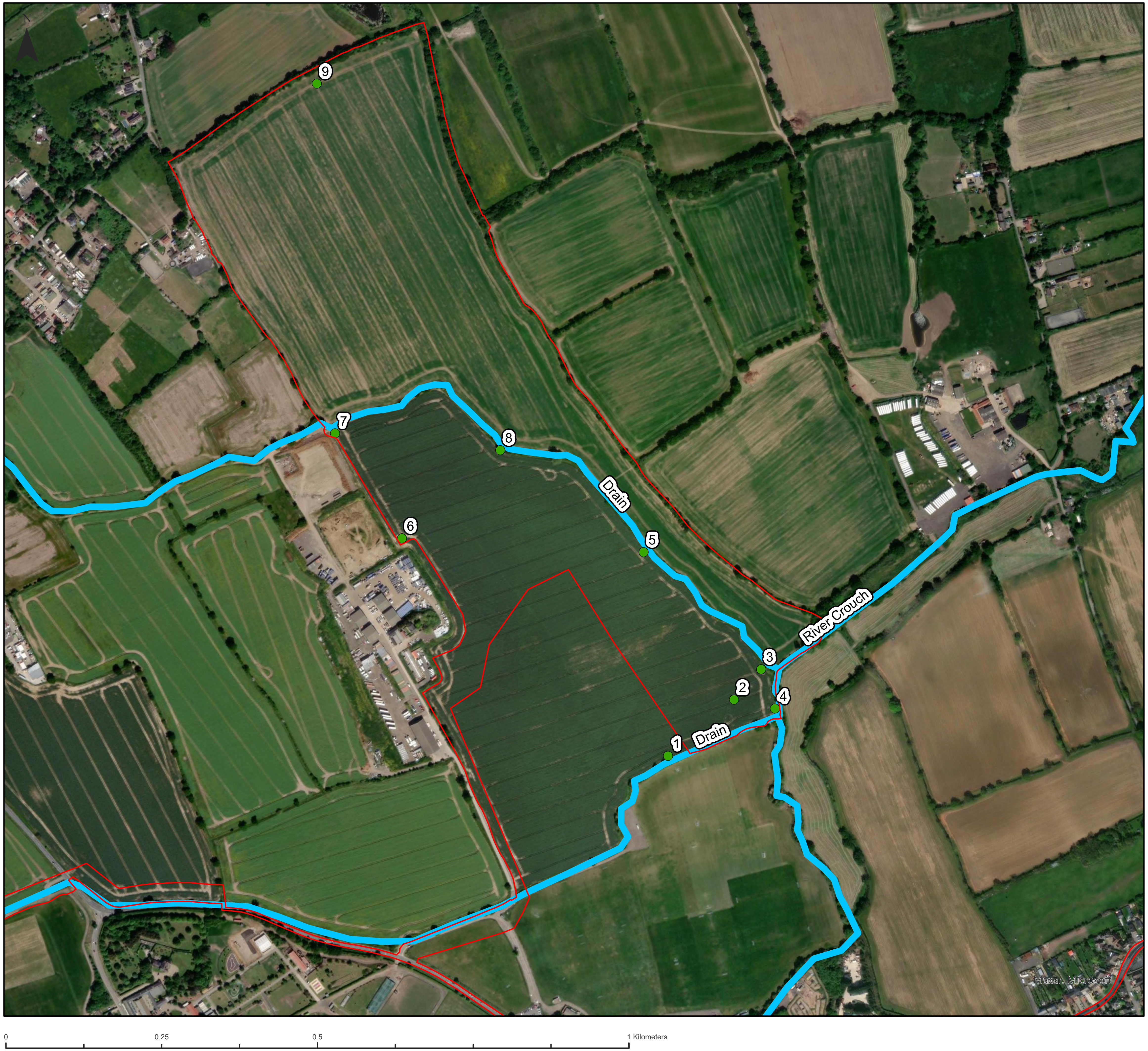
- Figure 1: Watercourses with Photo Locations;
- Figure 2: Field Numbers
- Figure 3: Topographical Survey
- Figure 4: Risk of Flooding from Rivers and Sea
- Figure 5: Risk of Pluvial Flooding
- Figure 6: Outline SuDS Design

APPENDIX B: PHOTO APPENDIX

APPENDIX C: FLOW OUTPUT (SOLAR FARM)

APPENDIX D: FLOW OUTPUT (SUBSTATION AND BATTERY COMPOUND)

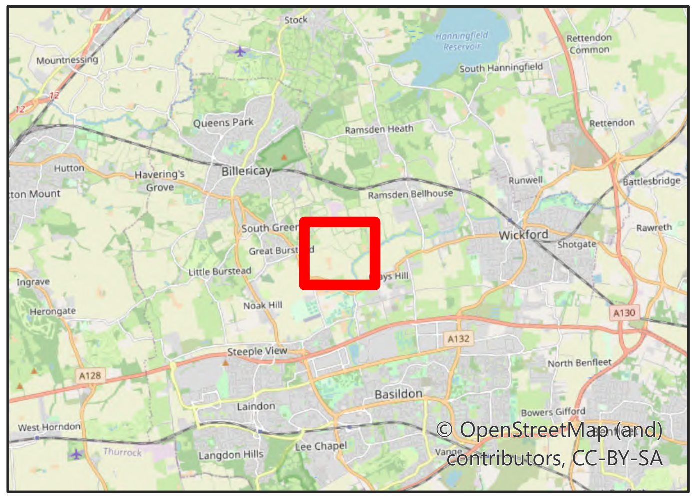
Burstead Solar Farm Watercourses and Photo Locations Figure 1



Key

- Development Boundary
- Photo Locations
- Watercourses

Neo Office Address:
Wright Business Centre, 1 Lonmay Road, Glasgow, G33 4EL



Date: 08/03/2022
Drawn By: Tom Saddington
Scale (A3): 1:6,000
Drawing No: NEO00947/003I/A

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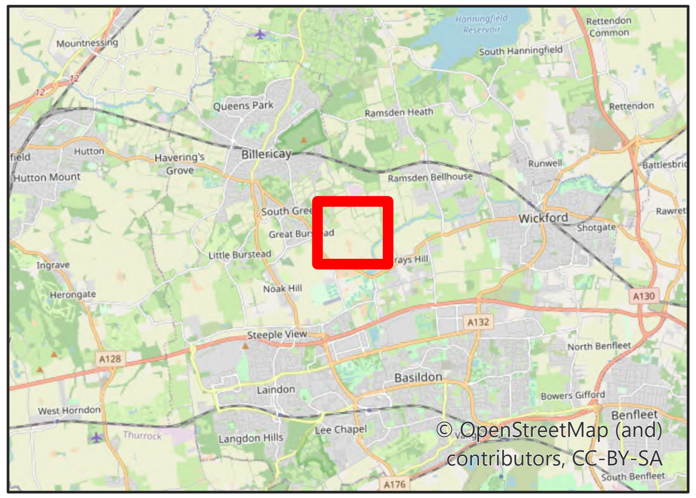
0 0.13 0.25 0.5 Kilometers

Burstead Solar Farm
Field Numbers
Figure 2

Key

Development Boundary

Neo Office Address:
Wright Business Centre, 1 Lonmay Road, Glasgow, G33 4EL



Date: 08/03/2022
Drawn By: Tom Saddington
Scale (A3): 1:6,000
Drawing No: NEO00947/004I/A

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Drawn By: Jamie McGhee
Address: Wright Business Centre
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Ver.	Date	Comments
A	08/03/2022	

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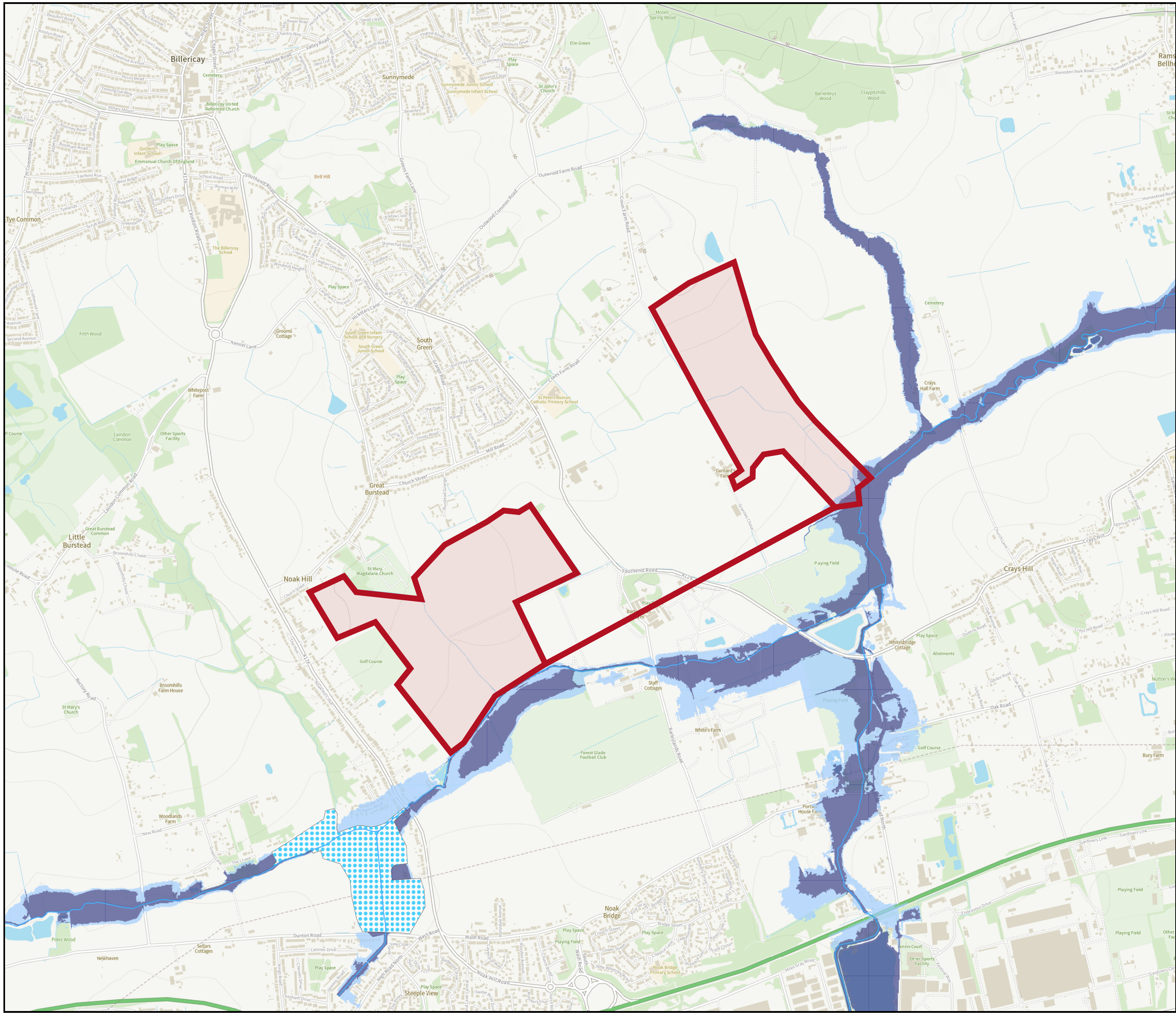
Project: Burstead Solar Farm
Client: Enso Energy
Drawing: Topographical Survey
Project No.: NEO00947
Drawing No. : NEO00947_003I_A Figure 3
Drawn: JM **Checked:** MM **Approved:** PN
Scale: 1:5,000 @ A1 **Revision:** A
Date: 08 March 2022



Environment Agency

Flood map for planning

Your reference
Burstead

Location (easting/northing)
569222/192459

Scale
1:25000

Created
9 Mar 2022 13:17

Selected area

Flood zone 3

Flood zone 3: areas benefitting from flood defences

Flood zone 2

Flood zone 1

Flood defence

Main river

Flood storage area

0 200 400 600m

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Risk of Surface Water Flooding Map

Legend

- Flood Extent 1 in 30
- Flood Extent 1 in 100
- Flood Extent 1 in 1000

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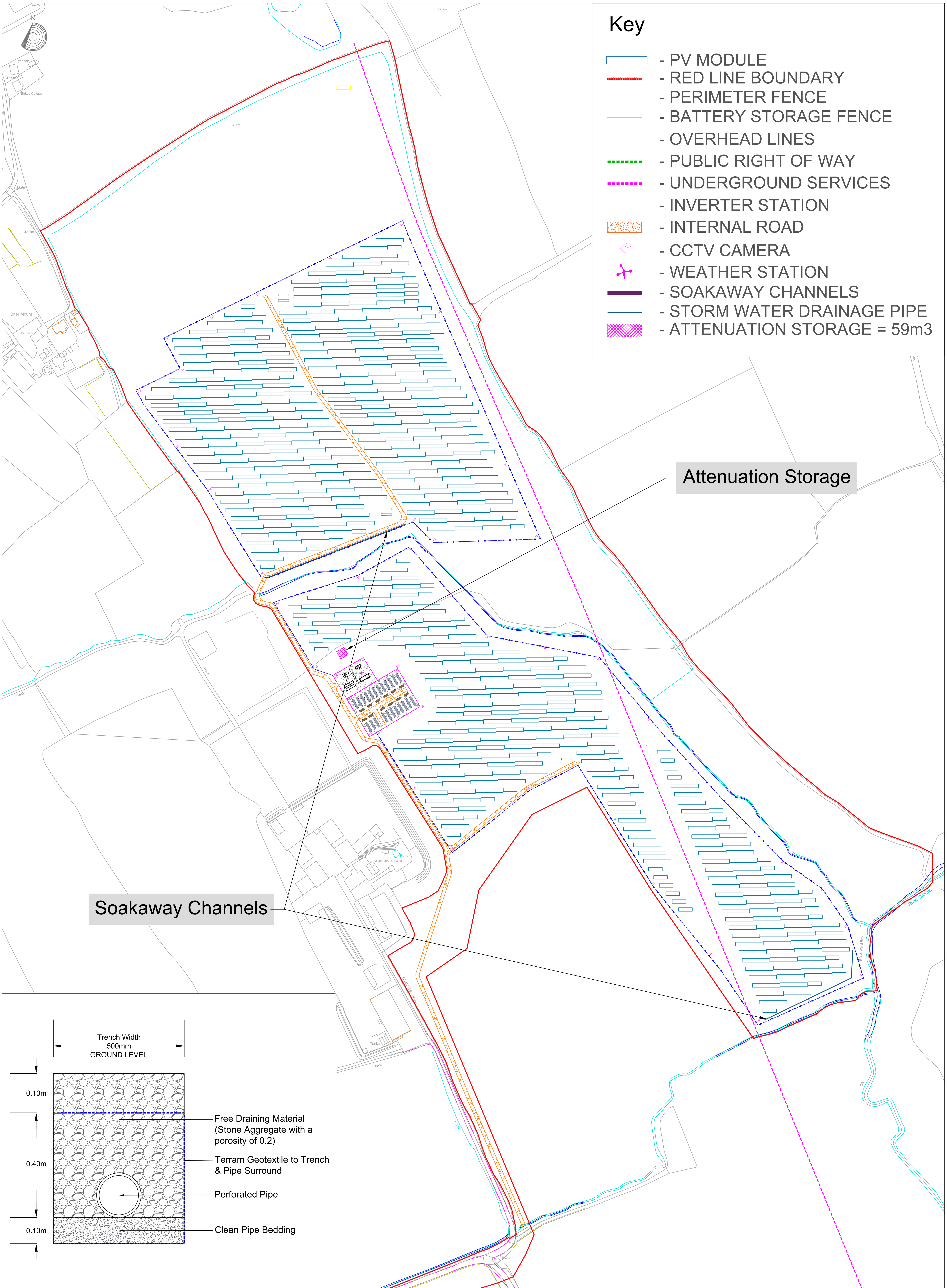

Rev	Date	Comments

Project:	Burstead Solar Farm	**Project No.:**	NEO00947
Client:	Enso Energy	**Drawing No. :**	NEO00947_004I_B Figure 7
Drawing:	Outline SuDs Design	**Drawn:** JM	**Checked:** MM **Approved:** PN
		Scale:	1:1500 @ A1
		Date:	22 November 2023
		Revision:	A

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Appendix B: Site Hydrology Photos

Photo 1: Field drain approx 8m wide by 3m deep

Photo 2: Surface Water Evidence in southeast of Field 2

Photo 3: Drain converging with River Crouch

Photo 4: Surface water flooding in southeast of Field 2

Photo 5: Topography sloping southeast towards drains and River Crouch

Photo 6: Topography sloping north towards drain

Photo 7: Culvert approx. 1.5m diameter

Photo 8: Drain approx. 6m wide by 3m deep

Photo 9: High point showing all surface water will flow south towards the drain

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	30	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m³/ha)	0.0
M5-60 (mm)	20.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	0.0
Summer CV	0.750	30 year (l/s)	0.1
Winter CV	0.840	100 year (l/s)	0.1
Analysis Speed	Normal	Check Discharge Volume	✓
Skip Steady State	x	100 year 360 minute (m³)	4

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 %)
1	0	0	0
30	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)	0.014	Betterment (%)	0
SAAR (mm)	573	QBar	0.1
Soil Index	4	Q 1 year (l/s)	0.0
SPR	0.47	Q 30 year (l/s)	0.1
Region	6	Q 100 year (l/s)	0.1
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)	0.014	Storm Duration (mins)	360
Soil Index	4	Betterment (%)	0
SPR	0.47	PR	0.413
CWI	86.370	Runoff Volume (m³)	4

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	30	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m³/ha)	0.0
M5-60 (mm)	20.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	0.3
Summer CV	0.750	30 year (l/s)	0.7
Winter CV	0.840	100 year (l/s)	0.9
Analysis Speed	Normal	Check Discharge Volume	✓
Skip Steady State	x	100 year 360 minute (m³)	24

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 %)
1	0	0	0
30	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)	0.094	Betterment (%)	0
SAAR (mm)	573	QBar	0.4
Soil Index	4	Q 1 year (l/s)	0.3
SPR	0.47	Q 30 year (l/s)	0.7
Region	6	Q 100 year (l/s)	0.9
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)	0.094	Storm Duration (mins)	360
Soil Index	4	Betterment (%)	0
SPR	0.47	PR	0.413
CWI	86.370	Runoff Volume (m³)	24

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