FLOOD RISK ASSESSMENT & SURFACE WATER DRAINAGE STRATEGY

Nuneham Solar Farm

Nuneham Courtenay, South Oxfordshire

On behalf of RES Limited
Date: 09/04/2024 | Pegasus Ref: P21-2947 – Author: Lucy Ginn

Document Management

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1. Introduction

Background

1.1. Pegasus Group has been appointed by RES Limited to undertake a Flood Risk Assessment (FRA) and surface water drainage strategy for a proposed solar farm development in Nuneham Courtenay, South Oxfordshire.

1.2. This assessment considers the risk of flooding from all sources, including tidal, fluvial, surface water, historic, groundwater, sewer, and artificial sources.

National and Local Policies

1.3. The National Planning Policy Framework (NPPF) states that a site-specific Flood Risk Assessment (FRA) will be required for proposals:

a) that are greater than 1 hectare (ha) in area within Flood Zone 1;

b) that are located in Flood Zone 2 or 3 (including minor development and change of use);

c) in an area within Flood Zone 1 which has critical drainage problems;

d) in an area within Flood Zone 1 identified in a Strategic Flood Risk Assessment as being at increased flood risk in the future;

e) in an area in Flood Zone 1 that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

1.4. The site (planning Red Line Boundary) is approximately 56.8ha in area located entirely within Flood Zone 1. A full FRA is therefore required for the proposals.

1.5. As of April 2015, the legislation for dealing with FRAs changed, with additional emphasis placed on the use of Sustainable Drainage Systems (SuDS) within drainage schemes for new developments.

1.6. In February 2016, the Environment Agency (EA) introduced new guidance relating to the climate change allowances that must be considered within an FRA. Since 2016, the allowances for sea level rise, peak river flow and peak rainfall have each been updated.

1.7. Given the above, any new planning application that requires an FRA will also require a surface water drainage strategy to be submitted. The drainage strategy must demonstrate the use of SuDS within the design and should be in line with the requirements as set out within the National Planning Policy Framework Technical Guidance (NPPFTG). The drainage strategy must also account for climate change over the lifetime of the development, in accordance with the climate change allowances published by the EA.

1.8. In addition to the requirements from the NPPF and EA, as discussed above, this assessment has also reviewed the information and requirements included in the South Oxfordshire District Council Strategic Flood Risk Assessment (SFRA) (2019).

2. Existing Site & Hydrology

Site Location & Existing Conditions

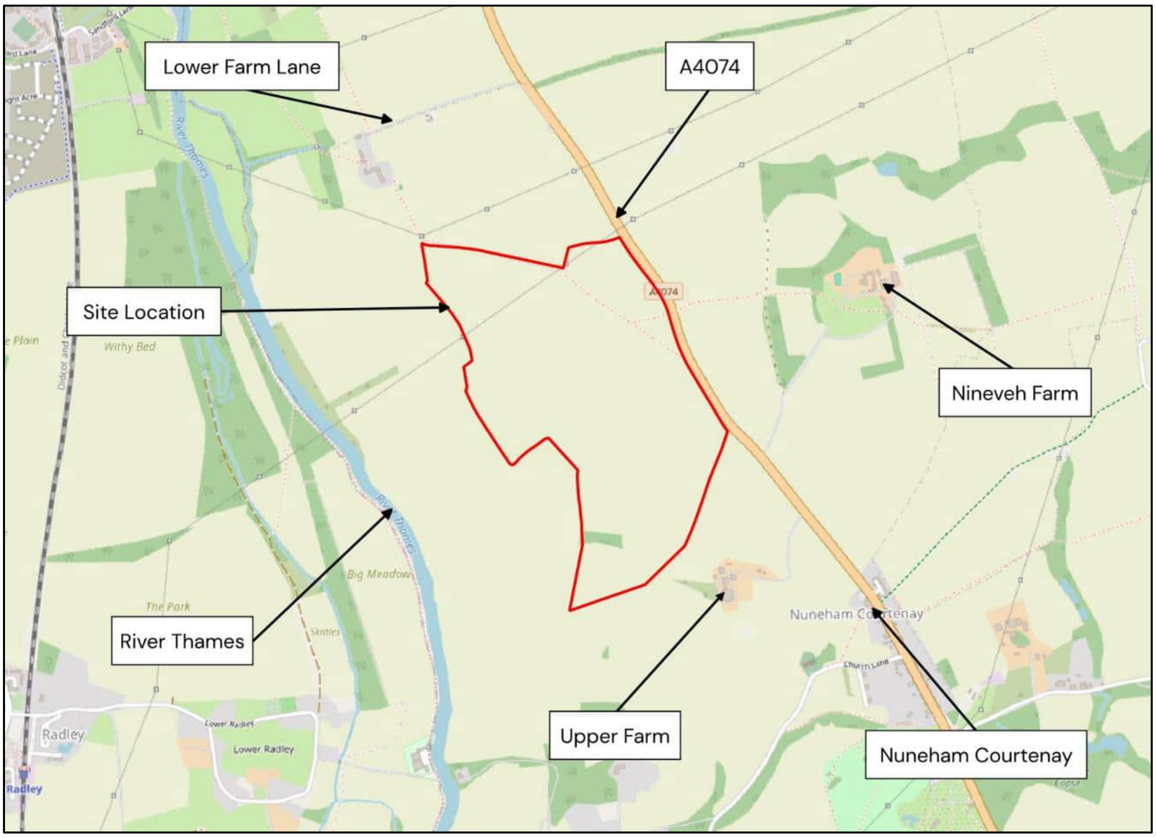
2.1. The site is located alongside the A4074 in Nuneham Courtenay, South Oxfordshire.

2.2. The site is bordered to the north by open green space and Lower Farm Lane beyond, to the east by the A4074 with Nineveh Farm beyond, to the south by open green space and Upper Farm and to the west by open green space and the River Thames beyond.

2.3. Approximate co-ordinates at the centre of the site are E: 454330, N:199983.3. The nearest postcode is OX44 9EF.

2.4. The site location is shown in Figure 2.1.

Figure 2.1 – Site Location



2.5. A topographic survey of the site was conducted by Landmark Surveys Wales in September 2022. The topographic survey is included as part of the wider planning application.

2.6. The topographic survey shows that generally the site falls westerly towards the River Thames. Ground levels on site are shown to range from a high point of approximately 86mAOD in the east to a low point of approximately 56mAOD in the west. The topographic survey also records several Ordinary Watercourses located within the site boundary. These watercourses are located along field boundaries.

Existing Drainage and Hydrology

2.7. There are no Main Rivers located on site. The nearest Main River is the River Thames approximately 450m to the west of the site, as shown in Figure 2.2.

2.8. There are several Ordinary Watercourses flowing through the site. These are generally field boundary ditches assumed to assist with the drainage of the existing agricultural fields.

2.9. Ordinary Watercourses on site, as defined by the topographic survey, are shown in Figure 2.2.

2.10. Geological data from the British Geological Survey (BGS) shows that the majority of the site is underlain by "Ampthill Clay Formation And Kimmeridge Clay Formation (Undifferentiated) – Mudstone". There are also smaller areas of "Ampthill Clay Formation – Mudstone", "Kimmeridge Clay Formation - Siltstone And Sandstone" and "Portland Group - Limestone And Calcareous Sandstone" recorded on site. BGS also record superficial deposits comprising "Head - Clay, Silt, Sand And Gravel" in areas of the site.

2.11. Soilscapes data shows the vast majority of the site is made up of "slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils" with "impeded drainage". There is a thin band of "freely draining slightly acid sandy soils" recorded along the southeastern site boundary.

2.12. The hydrogeology 625k digital hydrogeological map of the UK shows that generally, the site is underlain with "rocks with essentially no groundwater". There is a small area of "moderately productive aquifer" at the northwestern end of the site.

Figure 2.2 –Watercourses

3. Proposed Development

3.1. The site is proposed for a solar farm development across approximately 56.8ha of agricultural land.

3.2. The proposals include:

- Solar panels
- Access tracks
- Inverters and associated hardstanding
- Substation compound
- Temporary construction compound
- Fencing and gates
- Watercourse crossings
- CCTV

3.3. The proposed site layout is included in **Appendix A**.

4. Development Vulnerability & Flood Zone Classification

National Planning Policy Framework (NPPF)

4.1. Local Planning Authorities, (LPA) have a statutory obligation to consult the Environment Agency (EA) on all applications in the flood zones. The EA will consider the effects of flood risk in accordance with the NPPF.

4.2. The NPPF requires that, as part of the planning process:

• A 'site specific' Flood Risk Assessment will be undertaken for any site that has a flood risk potential.

• Flood risk potential is minimised by applying a 'sequential approach' to locating 'vulnerable' land uses.

• Sustainable drainage systems are used for surface water management where practical.

• Flood risk is managed through the use of flood resilient and resistant techniques.

• Residual risk is identified and safely managed.

4.3. Table 1 of NPPF defines each flood zone based on the probability of river and sea flooding in that area, as summarised below:

• Zone 1- Low probability (< 1 in 1000 year for fluvial and tidal events)

• Zone 2- Medium probability (between 1 in 1000 and 1 in 100 year for fluvial events and between 1 in 1000 and 1 in 200 year for tidal events)

• Zone 3a- High probability (> 1 in 100 year for fluvial events and > 1 in 200 year for tidal events)

• Zone 3b- The functional floodplain (>1 in 30 years)

4.4. The NPPF sets out a matrix indicating the types of development that are acceptable in different Flood Zones (see Table 4.1). The proposals are for a solar development which is classified as 'Essential Infrastructure'. The site is entirely located within Flood Zone 1. Essential Infrastructure is appropriate in Flood Zone 1 (see Table 4.1).

Sequential Test

4.5. The site is located entirely in Flood Zone 1. A Sequential Test is therefore not required.

Exception Test

4.6. The proposed development is located in Flood Zone 1. The Exception Test is not required for Essential Infrastructure located in Flood Zone 1 (see Table 4.1).

Table 4.1 – NPPF Guidance

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test Required	✓	✓	✓
Zone 3a	Exception Test Required	✗	Exception Test Required	Exception Test Required	✓
Zone 3b	Exception Test Required	✗	✗	✗	✓

5. Site Specific Flooding Issues and Existing Flood Records

National Planning Policy Framework (NPPF)

5.1. In accordance with the National Planning Policy Framework, this Flood Risk Assessment considers all sources of flooding including:

a) Tidal Flooding – from the sea;

b) Fluvial Flooding – from rivers and streams;

c) Surface Water Flooding – from overland surface water flow and exceedance;

d) Historic Flooding – known historic flooding issues;

e) Groundwater Flooding – from elevated groundwater levels or springs;

f) Flooding from Sewers – exceedance flows from existing sewer systems; and

g) Artificial Sources – reservoirs, canals etc.

Tidal Flooding

5.2. The Flood Map for Planning (see Figure 5.1) defines the entire site as Flood Zone 1, at Low risk of tidal flooding.

5.3. The site's inland location will also ensure that the overall tidal flood risk is considered to be **Very Low.**

Fluvial Flooding

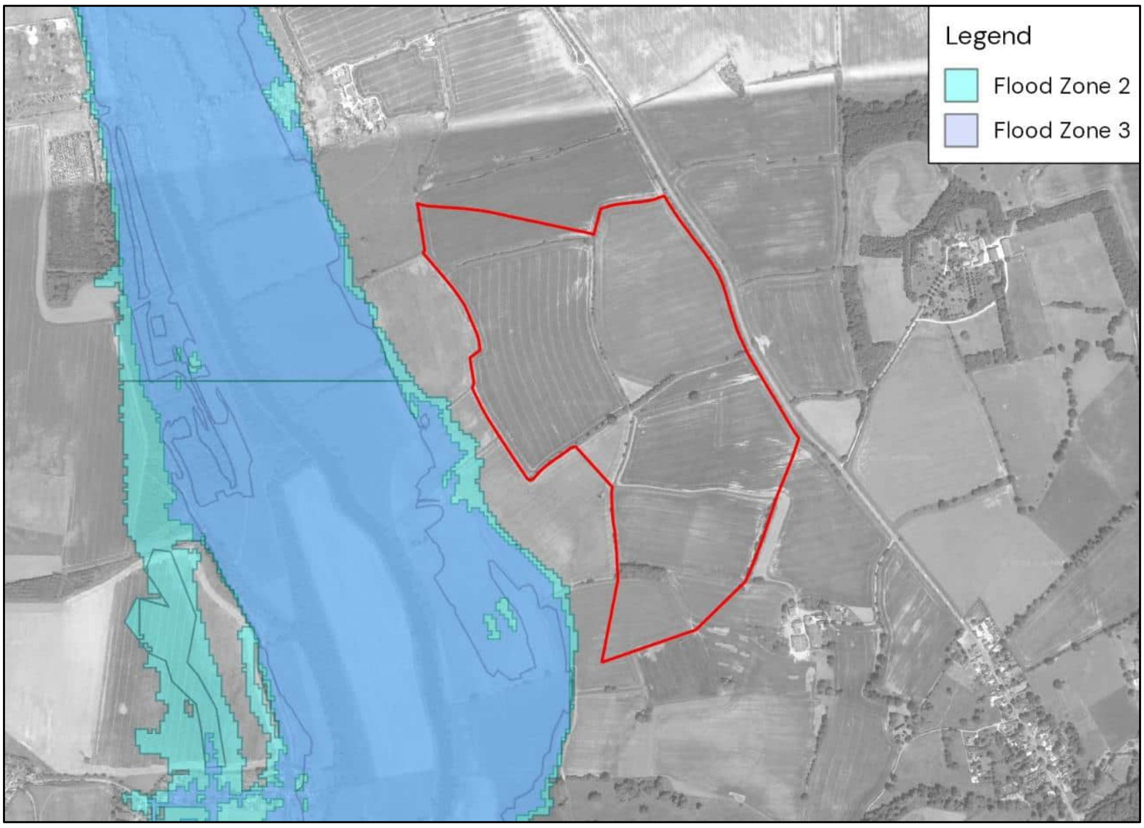
5.4. The Flood Map for Planning (Figure 5.1) defines the site to fall within Flood Zone 1, at Low risk of fluvial flooding, not predicted to be affected by a 1 in 1,000 year flood event.

5.5. There are areas to the west of the site defined as Flood Zone 2/3, associated with the River Thame's fluvial flood risk. LiDAR data however shows that ground levels rise significantly from the edge of Flood Zone 2/3 eastwards across the site. It is therefore considered unlikely that a fluvial flood event associated with the River Thames would impact the site.

5.6. Historic flooding is discussed further below but it is worth noting that the EA's Recorded Flood Outlines data does not generally record any historic fluvial flood events impacting the site.

5.7. Overall, the site is considered to be at **Low** risk of fluvial flooding.

Figure 5.1 – Flood Map for Planning



Surface Water Flooding

5.8. The Risk of Flooding from Surface Water (RoFSW) dataset shows that large areas of the site is not predicted to be impacted by a 1 in 1,000 year rainfall event and is at Very Low risk of surface water flooding (see Figure 5.2). The dataset also highlights areas of High to Low risk, impacted by a 1 in 30 and 1 in 1,000 year rainfall event, respectively, throughout the site. These risk areas are generally associated with surface water flow paths running westerly through the site.

5.9. Generally, the RoFSW dataset does not predict surface water flood depths to exceed 150-300mm during a 1 in 1,000 year rainfall event (see Figure 5.3). There is one area at the northern end of the site where flood depths of 300-600mm are predicted.

5.10. Intentionally through design, there are no proposed inverters located in areas predicted to be at risk of surface water flooding. The substation proposed at the northern end of the site has been intentionally kept out of the 1 in 100 year surface water flood extent (Medium risk). Where the substation is located within the 1 in 1,000 year surface water flood extent (Low risk), the substation infrastructure will be raised above the surface water flood depths predicted here during a 1 in 1,000 year rainfall event. 1 in 1,000 year surface water flood depths at the proposed substation location are predicted to reach up to 150mm.

5.11. Solar panels proposed on site will have their lowest edge raised at least 0.75m above the ground. This will allow surface water, which is not expected to exceed 300mm where solar panels are proposed on site during a 1 in 1,000 year rainfall event, to flow freely below the solar panel.

5.12. With the proposed design considerations and mitigation measures in place, the site is considered to be at **Low** risk of surface water flooding. In addition, the proposed development has been designed as not to impact existing surface water flow paths on site.

Figure 5.2 – RoFSW Extents

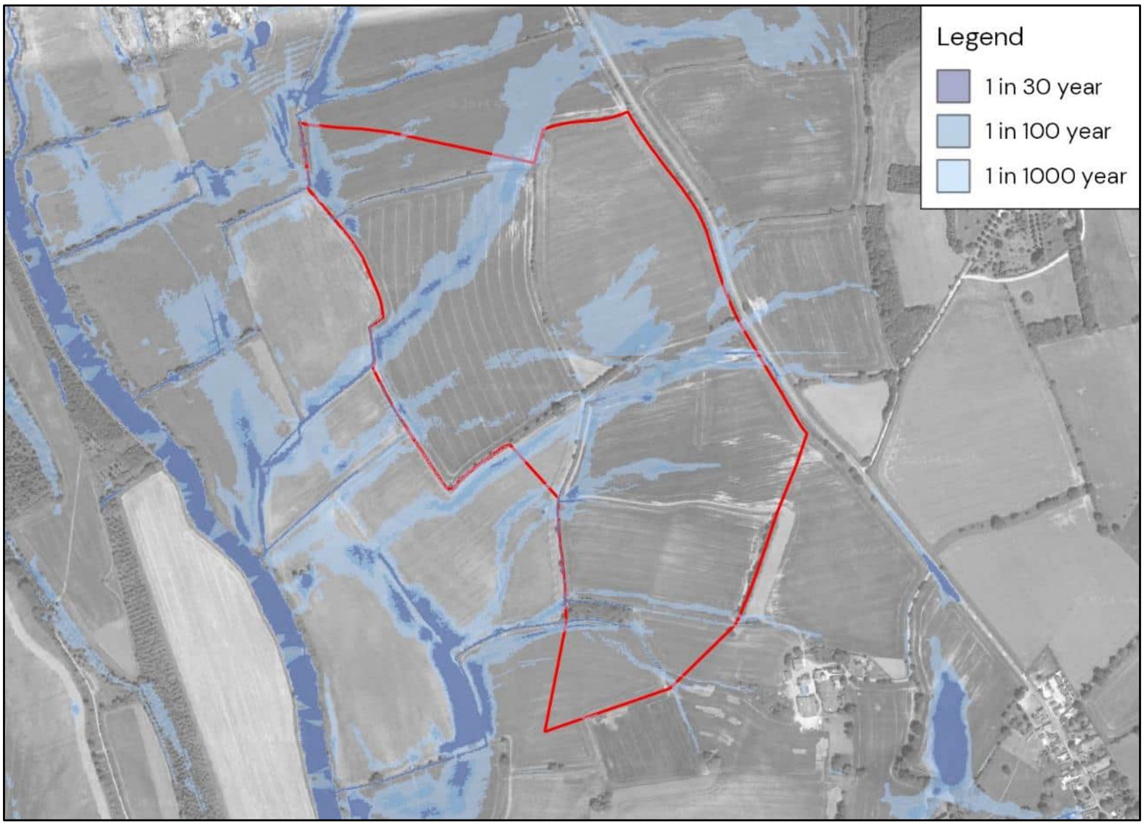
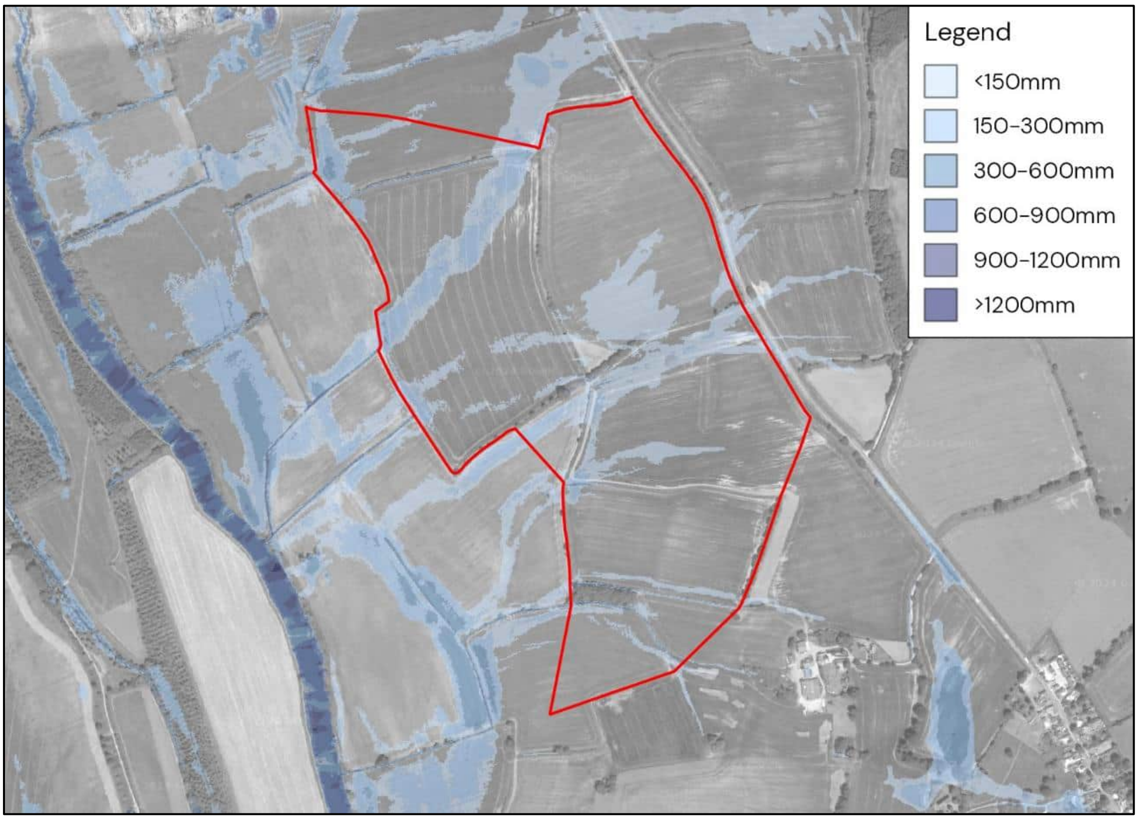


Figure 5.3 – RoFSW 1 in 1000 year Depths



<u>Historic Flooding</u>

5.13. The EA's Recorded Flood Outlines dataset defines several historic flood events to the west of the site alongside the River Thames. Just one historic flood outline is shown to encroach into the site boundary (see Figure 5.4), with this event occurring in March 1947. Less than 1ha of the approximately 56.8 ha is shown to have been impacted. The South Oxfordshire District Council SFRA (2019) details that in March 1947 there was extensive flooding along the length of the River Thames.

5.14. There are no other historic flood events reported to impact the site detailed by EA historic flood data or included in the South Oxfordshire District Council SFRA (2019).

5.15. Overall, the historic flood risk to the site is considered to be **Low.**

Figure 5.4 – EA Recorded Flood Outlines

<u>Groundwater Flooding</u>

5.16. Geological data from BGS shows that majority of the site is underlain by impermeable mudstone bedrock, with smaller areas of siltstone and sandstone also recorded on site. Soilscapes records slowly permeable soils with impeded drainage across much of the site. Generally, the site is defined as 'rocks with essentially no groundwater' by the hydrogeology 625k digital hydrogeological map of the UK. Overall, ground conditions on site are not expected to be associated with groundwater emergence, with conditional generally comprising rocks with essentially no groundwater overlain by impermeable mudstone and impermeable soils.

5.17. Topography on site is also not conducive to groundwater flooding – any groundwater to emerge would follow the existing site topography and flow westerly towards the River Thames.

5.18. The South Oxfordshire District Council SFRA (2019) does not highlight Nuneham Courtney as an area to be at increased groundwater risk, with the risk highlighted along the River Thames between Abingdon and Wallkingford. The River Thames flowing alongside Abingdon is approximately 4km southwest of the site.

5.19. Overall, the risk of groundwater flooding at the site is considered to be **Low**.

Flooding from Sewers

5.20. The South Oxfordshire District Council SFRA (2019) includes records of historic sewer flooding held by Thames Water. At the site's postcode area (OX44 9), there are 8 total recorded incidents. The SFRA does not highlight the site area as one of the "more frequently flooded postcodes".

5.21. As the site is entirely agricultural land, it is unlikely that there is an existing underground drainage network located within the site boundary. Additionally, any flood water from sewers in the close vicinity of the site would follow local topography and would not be expected to accumulate to significant depths within the site boundary.

5.22. Overall, the risk of flooding from sewers to the site is therefore considered to be **Low.**

Flooding from Artificial Sources

5.23. The EA's Reservoir Flood Extents data (Figure 5.5) shows that the site is not predicted to be at risk of reservoir flooding should a catastrophic breach occur during either a wet day when local rivers have already exceeded their banks, or during a dry day when local rivers are flowing under normal conditions.

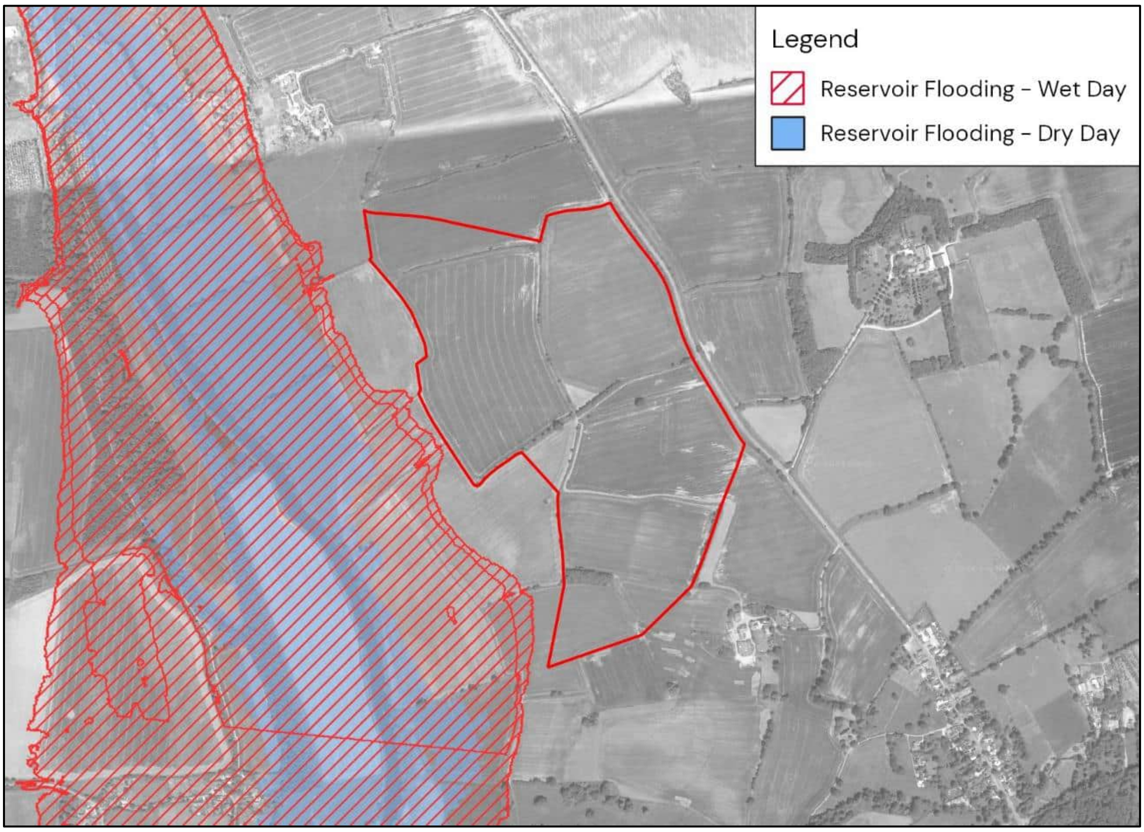
5.24. The Reservoirs Act 1975 requires that all reservoirs are inspected regularly by competent persons to assess the likelihood of failure. The likelihood of reservoir failure is therefore considered minimal and as such, the risk of reservoir flooding impacting the site is considered to be Low. In reference to reservoir flooding, the South Oxfordshire District Council SFRA (2019) states that "the risk of such failure is low and the occurrence of complete reservoir failure is exceptionally rare".

5.25. The South Oxfordshire District Council SFRA (2019) details that "no canals have been identified in South Oxfordshire".

5.26. There are no other artificial sources of flooding identified in the vicinity of the site that would present a flood risk.

5.27. The site is therefore considered to be at **Low** risk of flooding from artificial sources.

Figure 5.5 – EA Reservoir Flood Extents



<u>Post Development Flood Risk Summary</u>

5.28. The risk of flooding to the site from all sources has been assessed above, with the conclusions summarised in Table 5.1:

Table 5.1 – Flood Risk Summary

Flood Source	Flood Risk	Mitigation/Comments
Tidal	Very Low	• The site is located within Flood Zone 1. • The site's inland location ensures that it is well beyond the extent of any tidal influences.
Fluvial	Low	• The site is located in Flood Zone 1. • Areas of Flood Zone 2/3 to the west of the site are at notable lower ground levels than the site, as defined by LiDAR data.

Surface Water	Low	• Large areas of the site are at Very Low risk, not predicted to be impacted by a 1 in 1000 year rainfall event. • No inverters are proposed in areas predicted to be at risk of surface water flooding. • The proposed substation has been kept out of the 1 in 100 year surface water flood extent and where located in the 1 in 1,000 year flood extent, will be raised above the predicted 1 in 1,000 year flood depths. • The lowest edge of all solar panels will be raised 0.75m and will therefore be sited above the predicted 1 in 1000 year surface water flood depths which are predicted to reach a maximum of 300mm where solar panels are proposed on site.
Historic	Low	• The EA's Recorded Flood Outlines dataset records one small encroachment of a historic flood outline into the site. The event occurred in March 1947 and impacted significant lengths of the River Thames.
Groundwater	Low	• The site is underlain with 'rock with essentially no groundwater'. • The bedrock on site is expected to be impermeable, and the soils have 'impeded drainage'. These factors will significantly restrict groundwater emergence. • Topography on site is not considered conducive to groundwater flooding.
Sewers	Low	• As the site is entirely greenfield, it is unlikely that there is an existing underground drainage network located within the site boundary. • Any flood water from sewers in the close vicinity of the site would follow local topography and would not be expected to accumulate within the site boundary.
Artificial	Low	• The EA's Reservoir Flood Extents data shows that the site is not predicted to be at risk of reservoir flooding should a catastrophic breach occur.

		• There are no artificial sources of flooding or canals located in the vicinity of the site that would present a flood risk.

<u>Access & Egress</u>

5.29. Access to the proposed development will be via the A4074 bordering the site to the east. This access road is not considered to be at significant risk of flooding from any source. There are some sections of the road predicted to be at surface water flood risk, but the RoFSW dataset does not generally predict flood depths to exceed 150mm, so vehicular access would not be impeded.

5.30. In addition to the above, the site will be managed remotely and only visited occasionally for maintenance. Site access and egress should therefore not be needed during an extreme flood event.

6. Mitigation Measures and Surface Water Drainage

6.1. This section summarises the proposed mitigation measures proposed on site to ensure that:

a) The development is not at significant risk of surface water flooding.

b) Maintenance access to Ordinary Watercourses is not impacted by the development.

c) The potential impacts of the development on surface water runoff are minimised.

6.2. This section also considers if, with proposed mitigation measures in place, any further measures (such as a surface water drainage strategy) are required to ensure that the proposed development is safe form surface water flooding and that it does not increase surface water flood risk elsewhere.

Surface Water Flood Risk

6.3. As discussed in Section 5, the RoFSW dataset predicts areas of the site to be at risk of surface water flooding. The following mitigation measures have been implemented into the site design to ensure the development remains safe from surface water flooding over its lifetime:

- No isolated inverters are located in areas predicted to be at risk of surface water flooding during an extreme, 1 in 1,000 year rainfall event.
- The proposed substation has been kept out of the 1 in 100 year surface water flood extent (Medium risk). Where the substation is located within the 1 in 1,000 year surface water flood extent (Low risk), the substation infrastructure will be raised above the surface water flood depths predicted here during a 1 in 1,000 year rainfall event. 1 in 1,000 year surface water flood depths at the proposed substation location are predicted to reach up to 150mm.
- All proposed solar panels will have their lowest edge raised at least 0.75m above the ground. Solar panels will therefore be raised above the predicted 1 in 1,000 year surface water flood depths on site which are not predicted to exceed 300mm. Surface water will therefore be able to flow freely beneath the panels and surface water flow paths will not be impacted, nor will the proposed solar panels be at risk of flooding from surface water.

6.4. Overall, with the above mitigation measures in place, the proposed development will not be at significant risk of flooding from surface water.

Ordinary Watercourse and Main River Easements

6.5. To ensure maintenance access to Ordinary Watercourses on site is not impacted by the proposed development, an easement of at least 3 from the top of bank from all Ordinary Watercourses has been left clear of development (excluding proposed access tracks). These easements have been based on topographic survey defined top of bank locations.

Impact of Surface Water Runoff

Solar Panels

6.6. The proposed solar panels will generally comprise a 'fixed system' with vertical supports driven directly into the ground and no need for concrete foundations. There will be a gap of approximately 3m between rows of solar panels.

6.7. There is an area of approximately 1.3ha at the northern end of the site where solar panels will be located on ballasted foundations for heritage/archaeology reasons. The foundations are situated below the solar panel feet only so cover a small area of the total 1.3ha. The impact of these foundations on surface water runoff patterns is therefore not expected to be significant.

6.8. All proposed solar panels will have their lowest edge raised at least 0.75m above the ground. This will ensure that surface water can continue to flow freely below the panels and existing surface water drainage patterns will not be affected.

6.9. Overall, the impact of the proposed solar panels on surface water runoff rates and flow patterns on site is considered to be negligible and no further mitigation measures are proposed.

Inverters

6.10. There are 7 locations for inverters proposed on site. As shown in the proposed site layout included in **Appendix A**, there are also areas of "inverter hardstand" surrounding the isolated inverters on site.

6.11. Of the 7 inverter areas, 4 areas comprise of 339m^2 of impermeable hardstanding whilst the remaining 3 areas comprise of a smaller hardstanding area of 254m^2. A total inverter area hardstanding of 2,118m^2 is therefore proposed on site.

6.12. Although the inverters and their associated hardstanding are small in area, the additional hardstanding has the potential to impact surface water runoff rates.

6.13. Given the above, it is proposed to provided SuDS features of the proposed inverters on site. The proposed surface water drainage strategy is included in Section 7.

Substation

6.14. There is a substation compound proposed at the northern end of the site (see **Appendix A**).

6.15. The proposed substation will include areas of hardstanding and various impermeable containers and as a result, has the potential to increase surface water runoff rates from the site.

6.16. Given the above, it is proposed to provided SuDS features of the proposed substation on site. The proposed surface water drainage strategy is included in Section 7.

Access Tracks

6.17. Proposed access tracks on site will be constructed with a running surface, base/capping layer and subgrade. A typical access track section is included in **Appendix A.**

6.18. The proposed running surface and associated compacted layers may cause localised increases to surface water runoff rates. The proposed access track design however, also includes the provision of a drainage swale should this be required.

6.19. We would recommend that the proposed drainage swales are installed on site to mitigate any potential increase in surface water runoff associated with the access tracks.

6.20. The drainage swales associated with the access tracks will also help capture any overland flows form coming across the site, capturing these flows and keeping surface water on site, away from neighbouring land.

6.21. There are several points where proposed access tracks will need to cross over an Ordinary Watercourse. These watercourse crossings are highlighted on the proposed site layout (Appendix A) and should be designed to ensure the existing flow regime of the watercourses are not impacted.

Proposed Land Use Change

6.22. The proposals will result in the cessation of agricultural activities at the site which will in turn, result in a variety of beneficial effects which will serve to reduce soil compaction and runoff rates from the site, as listed below:

- The site will not be left without vegetation cover during the winter as experienced with arable farming;
- The site will not be intensively trodden or over grazed; and
- The site will not be regularly traversed by heavy machinery.

6.23. Following installation of the panels, the site will be chisel-ploughed or similarly cultivated and seeded with grazing/wild flower grassland. Chisel-ploughing will reduce soil compaction on the site and promote seed growth; it has been proven to significantly increase infiltration rates thereby reducing runoff rates from the site. The proposed Landscape Masterplan is included as part of the wider planning application.

6.24. If grazing is undertaken on site following development, a grazing density will be used to limit compaction and maintain sufficient grass cover.

6.25. Additionally, longer meadow type grasses and wildflower vegetation provide high levels of natural attenuation which will serve to reduce the risks of erosion and limit surface water flows across the site. With the implementation of chisel-ploughing, changing the site's primary function to solar power generation will have several potential longer-term benefits regarding surface water runoff rates.

6.26. Permanent grass cover on the site will also be maintained to ensure the risk of erosion below solar panels is minimised.

7. Proposed Surface Water Drainage Strategy

7.1. As discussed above, the proposed inverters and substation have the potential to increase the surface water runoff from the site. A surface water drainage strategy is therefore required for these areas to ensure flood risk elsewhere does not increase.

Surface Water Management

7.2. The SuDS hierarchy demands that surface water run off should be disposed of as high up the following list as practically possible:

• Into the ground (infiltration) and re-use, or then;

• To a surface water body, or then;

• To a surface water sewer, highway drain or another drainage system, or then;

• To a combined sewer.

7.3. In order to determine the most suitable method of surface water disposal from the site the options listed above have been considered as follows:

Infiltration

7.4. BGS data shows that bedrock at the site generally comprises of mudstone which is expected to have limited permeability. Soilscapes show that the majority of the site consists of clayey soils with impeded drainage. Overall, although infiltration testing has not been complete on site, it is estimated that infiltration rates on site would be relatively poor.

7.5. As mentioned above in Section 6, there are 7 inverters areas proposed on site. Given the small area associated with these inverters and the costs and infrastructure that would be required to discharge surface water runoff from these small features to an attenuation feature to ultimately discharge to a local watercourse, infiltration features are considered more appropriate to manage the limited volume of surface water runoff from the isolated inverters on site. It is also noted that there are some isolated inverters that are located a notable distance from a watercourse on site.

7.6. Based on the above, infiltration-based SuDS have been proposed to manage surface water runoff from the proposed isolated inverters.

Surface Water

7.7. The next option in the SuDS hierarchy is to discharge surface water runoff into an existing surface water body.

7.8. Unlike many of the propose isolated inverters on site, the proposed substation is located close to a local Ordinary Watercourse. In addition, the proposed substation compound is notably larger in size than the isolated inverters. Based on this, it is considered that discharging surface water runoff from the proposed substation into a local watercourse would be the most appropriate solution.

SuDS selection process

7.9. Various methods of SuDS (Sustainable Drainage Systems) should be considered for use as different methods have constraints attached to them and may not be suitable for this development.

7.10. An assessment of the suitability of different SuDS techniques is summarised in Table 7.1 below. Guidance from 'The SuDS manual' C753 has been used to form the basis of this assessment.

Table 7.1 – Assessment of SuDS Suitability

SuDS Technique	Potentially suitable for this development	Justification
Rainwater Harvesting	No	Not considered suitable for solar developments.
Green Roofs	No	Not considered suitable for solar developments.
Infiltration Systems (Soakaways, etc.)	Yes	Proposed to manage surface water runoff from the proposed isolated inverters on site.
Filter Drains	Yes	Could be used to help convey surface water runoff on site.
Swales	Yes	Could be used to convey surface water runoff on site.
Bioretention Systems	No	Not considered suitable due to land take.
Trees	Yes	Could be considered but would not significantly reduce the storage requirements.
Underground storage	Yes	Proposed to manage surface water runoff from the proposed substation.
Detention basins & ponds	No	Could be used but not considered here due to limited space available around the proposed substation.

Wetlands	No	Not considered suitable due to land take.
Permeable Paving	Yes	Could be used for the proposed access tracks.

Inverter Surface Water Drainage Strategy

7.11. As discussed above, it is proposed to manage surface water runoff from the 7 proposed areas for isolated inverters with infiltration-based SuDS.

7.12. Of the 7 inverter areas, 4 areas comprise of 339m^2 of impermeable hardstanding whilst the remaining 3 areas comprise of a smaller impermeable area of 254m^2.

7.13. In order to design the proposed infiltration SuDS features, a conservative infiltration rate of 0.00004m/hour has been estimated. This rate has been informed by Table 25.1 in the CIRIA SuDS Manual which details that "silty clay loam" soils have an infiltration rate of between "$1 \times 10^{-8} – 1 \times 10^{-6}$". A rate of 0.00004m/hour is from the worst case estimated rate of 1×10^{-8}.

7.14. Microdrainage Source Control calculations show that a gravel trench (filter drain) with an infiltration rate of 0.00004m/hour would need to be 2.0m deep, 1.5m wide and 62.5m long to manage surface water runoff from the 4 proposed inverter impermeable areas totalling 339m^2 for all storm events up to and including the 1 in 100 year plus 25%.

7.15. For the 3 inverter areas with an impermeable area of 254m^2, with an infiltration rate of 0.00004m/hour, calculations show that a gravel trench (filter drain) will need to be 1.5m deep, 1.5m wide and 49m long to manage surface water runoff during storm events up to and including the 1 in 100 year plus 25%.

7.16. A rainfall climate change allowance of 25% has been used in accordance with the "Gloucester and the Vale Management Catchment peak rainfall allowances" central allowance to the 2070s.

7.17. Microdrainage Source Control calculations are included in **Appendix B**. The proposed surface water drainage strategy is included in **Appendix C.**

Substation Surface Water Drainage Strategy

7.18. As discussed above, it is proposed to manage surface water runoff from the proposed substation compound with an attenuation feature discharging to a local watercourse. Surface water will drain through a series of perforated pipes at the base on the gravel substation compound (a filter drain) before reaching the proposed attenuation feature.

7.19. It has been conservatively estimated that the full substation compound totalling approximately 0.53ha is impermeable.

7.20. It is proposed to store surface water runoff from the substation area in below ground geo-cellular attenuation crates. The geo-cellular crates are proposed to discharge into the

Ordinary Watercourse to the west of the substation at a restricted rate. The QBAR greenfield runoff rate has been calculated using the IH124 method via Micro Drainage (see **Appendix B**). Rates have been calculated for 50 hectares and then factored down to the substation area of approximately 0.53ha hectares, resulting in a rate of 1.96l/s, which would be rounded up to 2l/s within the MicroDrainage calculations.

7.21. A flow control will be used to restrict the discharge rate into the watercourse, as shown in the surface water drainage strategy included in **Appendix C**.

7.22. The proposed geo-cellular attenuation crates have been designed to manage surface water runoff from a proposed substation compound for all storm events up to and including the 1 in 100 year plus 25%.

7.23. A rainfall climate change allowance of 25% has been used in accordance with the "Gloucester and the Vale Management Catchment peak rainfall allowances" central allowance to the 2070s.

7.24. <u>Water Quality</u>

7.25. The SuDS Manual (CIRIA C753) states that the design of surface water drainage should consider minimising contaminants in surface water runoff discharged from the site. The level of treatment required depends on the proposed land use, according to the pollution hazard indices.

7.26. Table 7.2 shows the pollution indices for the proposed development and applies to both the proposed inverters and the proposed substation.

Table 7.2 – Pollution Hazard Indices – Inverters and Substation

Pollutant	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2	0.05

7.27. Table 7.3 shows the pollution mitigation indices for to a filter drain which is used to manage surface water runoff from both the isolated inverters and substation. It is shown that the pollution mitigation indices exceed the proposed development pollution indices. Therefore, the mitigation measures are deemed adequate for the site.

Table 7.3 – Indicative SuDS Mitigation Indices

Type of SuDS component	Total suspended solids (TSS)	Metals	Hydrocarbons
Filter Drain	0.4	0.4	0.4

8. Summary

8.1. The site is approximately 56.8ha in area and currently entirely greenfield. The site is proposed for a solar farm development.

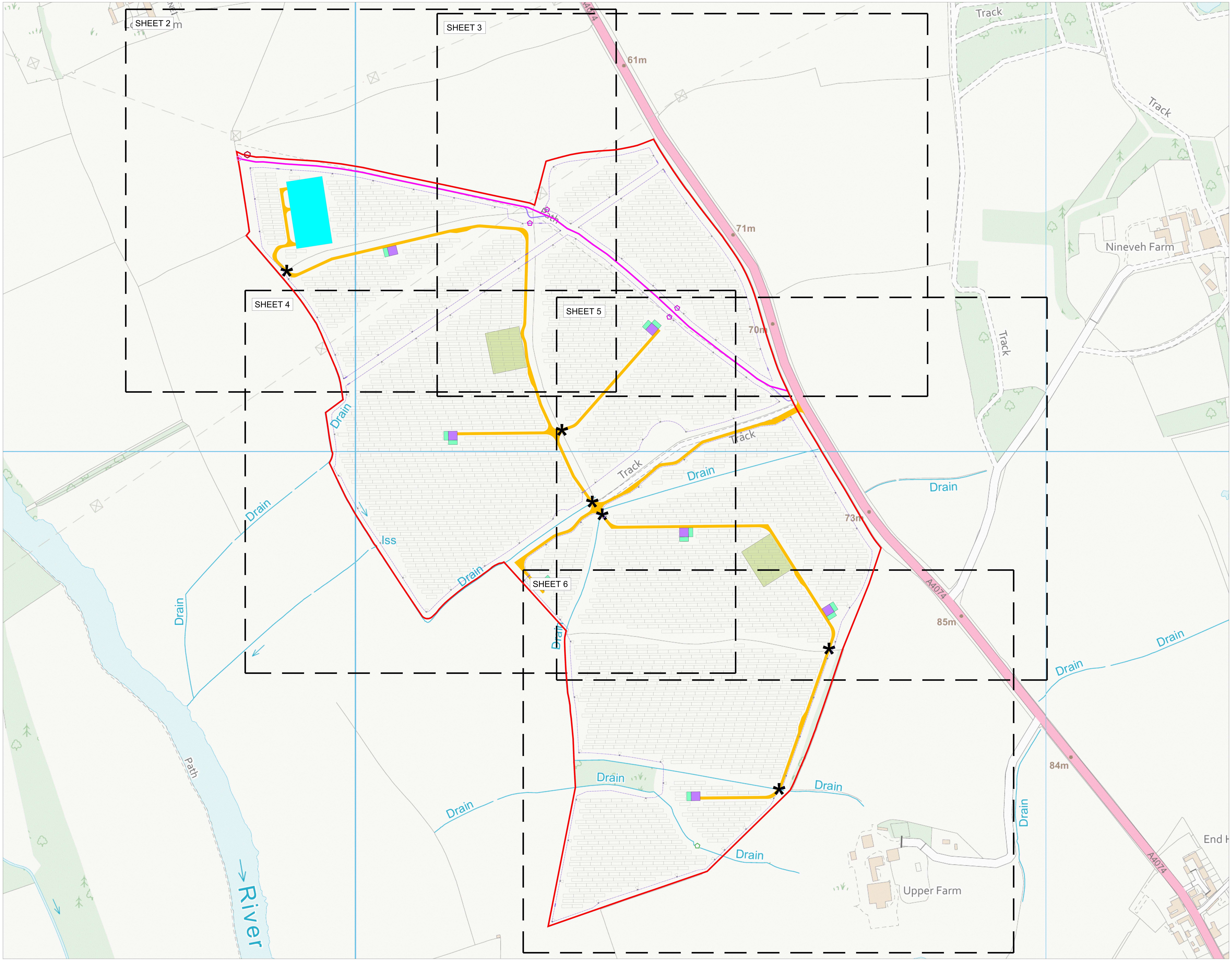
8.2. The site is located entirely in Flood Zone 1, at low risk of flooding from rivers and the sea. Mitigation measures are proposed to ensure the site remains safe from surface water flooding over the development's lifetime. The site is not considered to be at significant risk of flooding from any other source.

8.3. Access and egress are not predicted to be impeded during an extreme flood event, with 1 in 1,000 year surface water flood depths not predicted to exceed 150mm and not other sources of flood risk predicted to impact the access and egress routes.

8.4. A surface water drainage strategy has been developed to ensure the proposed development does not increase surface water runoff rates and associated flood risk on site and elsewhere.

8.5. The proposal is considered to accord with the requirements of the National Planning Policy Framework (NPPF) with residual risk to the site fully mitigated, and as such considered low risk.

Appendix A – Proposed Site Layout



KEY:

- PLANNING BOUNDARY (*OUTSIDE EDGE OF LINE DENOTES BOUNDARY*)
- PROPOSED ACCESS TRACK
- PUBLIC RIGHT OF WAY DEFINITIVE MAP (PRoW)
- PERMISSIVE PATH
- INDICATIVE SOLAR PV ARRAY
- INVERTER
- INVERTER HARDSTAND
- SUBSTATION COMPOUND
- TEMPORARY CONSTRUCTION COMPOUND
- FENCE LINE
- GATE (FENCE)
- WATERCOURSE CROSSING
- EXISTING HEDGEROW GAP TO BE ENLARGED
- PRoW CROSSING POINT
- UPDATED PRoW ACCESS
- INDICATIVE HERITAGE INTERPRETATION BOARD
- CCTV

SITE LOCATION - NOT TO SCALE

OVERVIEW
SHEET 1 OF 6

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
6	FG	BD	EB	2024-03-11	Minor amendments (indicative heritage added, key update)
5	FG	JM	BD	2024-03-04	Minor amendments (OHL constraint buffer update)
4	FG	JM	BD	2024-01-24	Minor amend (background mapping)
3	FG	JM	BD	2024-01-18	Drawing title, planning boundary & PoC update

PURPOSE: PERMITTING	COORDINATES: OSGB 1936
SCALE: 1:2,500 @ A1	DATUM: N/A
LAYOUT DWG: N/A	T-LAYOUT NO.: N/A

PROJECT TITLE

NUNEHAM SOLAR FARM

DRAWING TITLE

FIGURE 5
PLANNING INFRASTRUCTURE LAYOUT ENLARGEMENTS

RES DRAWING NUMBER: 04531-RES-LAY-DR-PT-004 | REV: 6

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Appendix B – MicroDrainage and Greenfield Runoff Calculations

IH 124 Mean Annual Flood

Input

Return Period (years)	100	SAAR (mm)	606	Urban	0.000
Area (ha)	50.000	Soil	0.450	Region Number	Region 6

Results l/s

QBAR Rural	185.6
QBAR Urban	185.6
Q100 years	591.9
Q1 year	157.7
Q2 years	163.5
Q5 years	237.5
Q10 years	300.6
Q20 years	371.7
Q25 years	398.6
Q30 years	420.5
Q50 years	486.2
Q100 years	591.9
Q200 years	695.8
Q250 years	729.2
Q1000 years	957.5

Summary of Results for 100 year Return Period (+25%)

Half Drain Time exceeds 7 days.

Outflow is too low. Design is unsatisfactory.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	98.796	0.296	0.0	6.5	O K
30 min Summer	98.888	0.388	0.0	8.6	O K
60 min Summer	98.983	0.483	0.0	10.6	O K
120 min Summer	99.086	0.586	0.0	12.9	O K
180 min Summer	99.149	0.649	0.0	14.3	O K
240 min Summer	99.194	0.694	0.0	15.3	O K
360 min Summer	99.252	0.752	0.0	16.6	O K
480 min Summer	99.291	0.791	0.0	17.4	O K
600 min Summer	99.318	0.818	0.0	18.0	O K
720 min Summer	99.339	0.839	0.0	18.5	O K
960 min Summer	99.370	0.870	0.0	19.2	O K
1440 min Summer	99.408	0.908	0.0	20.0	O K
2160 min Summer	99.446	0.946	0.0	20.9	O K
2880 min Summer	99.476	0.976	0.0	21.5	O K
4320 min Summer	99.528	1.028	0.0	22.7	O K
5760 min Summer	99.575	1.075	0.0	23.7	O K
7200 min Summer	99.622	1.122	0.0	24.7	O K
8640 min Summer	99.669	1.169	0.0	25.8	O K
10080 min Summer	99.715	1.215	0.0	26.8	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	139.477	0.0	19
30 min Summer	91.239	0.0	34
60 min Summer	56.780	0.0	64
120 min Summer	34.456	0.0	124
180 min Summer	25.458	0.0	184
240 min Summer	20.402	0.0	244
360 min Summer	14.757	0.0	364
480 min Summer	11.634	0.0	484
600 min Summer	9.634	0.0	604
720 min Summer	8.237	0.0	724
960 min Summer	6.405	0.0	964
1440 min Summer	4.464	0.0	1444
2160 min Summer	3.103	0.0	2164
2880 min Summer	2.403	0.0	2884
4320 min Summer	1.692	0.0	4324
5760 min Summer	1.330	0.0	5768
7200 min Summer	1.113	0.0	7208
8640 min Summer	0.968	0.0	8648
10080 min Summer	0.865	0.0	10088

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	98.832	0.332	0.0	7.3	O K
30 min Winter	98.934	0.434	0.0	9.6	O K
60 min Winter	99.041	0.541	0.0	11.9	O K
120 min Winter	99.156	0.656	0.0	14.5	O K
180 min Winter	99.227	0.727	0.0	16.0	O K
240 min Winter	99.277	0.777	0.0	17.1	O K
360 min Winter	99.343	0.843	0.0	18.6	O K
480 min Winter	99.386	0.886	0.0	19.5	O K
600 min Winter	99.416	0.916	0.0	20.2	O K
720 min Winter	99.440	0.940	0.0	20.7	O K
960 min Winter	99.474	0.974	0.0	21.5	O K
1440 min Winter	99.518	1.018	0.0	22.4	O K
2160 min Winter	99.560	1.060	0.0	23.4	O K
2880 min Winter	99.593	1.093	0.0	24.1	O K
4320 min Winter	99.652	1.152	0.0	25.4	O K
5760 min Winter	99.704	1.204	0.0	26.6	Flood Risk
7200 min Winter	99.758	1.258	0.0	27.7	Flood Risk
8640 min Winter	99.810	1.310	0.0	28.9	Flood Risk
10080 min Winter	99.862	1.362	0.0	30.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Winter	139.477	0.0	19
30 min Winter	91.239	0.0	34
60 min Winter	56.780	0.0	64
120 min Winter	34.456	0.0	124
180 min Winter	25.458	0.0	184
240 min Winter	20.402	0.0	244
360 min Winter	14.757	0.0	364
480 min Winter	11.634	0.0	484
600 min Winter	9.634	0.0	604
720 min Winter	8.237	0.0	724
960 min Winter	6.405	0.0	964
1440 min Winter	4.464	0.0	1444
2160 min Winter	3.103	0.0	2164
2880 min Winter	2.403	0.0	2884
4320 min Winter	1.692	0.0	4324
5760 min Winter	1.330	0.0	5768
7200 min Winter	1.113	0.0	7200
8640 min Winter	0.968	0.0	8640
10080 min Winter	0.865	0.0	10080

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 454180 200184 SP 54180 00184
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+25

Time Area Diagram

Total Area (ha) 0.025

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.025

Model Details

Storage is Online Cover Level (m) 100.000

Trench Soakaway Structure

Infiltration Coefficient Base (m/hr)	0.00004	Trench Width (m)	1.5
Infiltration Coefficient Side (m/hr)	0.00004	Trench Length (m)	49.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	1.500
Invert Level (m)	98.500	Cap Infiltration Depth (m)	1.500

Summary of Results for 100 year Return Period (+25%)

Half Drain Time exceeds 7 days.

Outflow is too low. Design is unsatisfactory.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	98.307	0.307	0.0	8.6	O K
30 min Summer	98.401	0.401	0.0	11.3	O K
60 min Summer	98.500	0.500	0.0	14.1	O K
120 min Summer	98.606	0.606	0.0	17.1	O K
180 min Summer	98.672	0.672	0.0	18.9	O K
240 min Summer	98.718	0.718	0.0	20.2	O K
360 min Summer	98.779	0.779	0.0	21.9	O K
480 min Summer	98.818	0.818	0.0	23.0	O K
600 min Summer	98.847	0.847	0.0	23.8	O K
720 min Summer	98.869	0.869	0.0	24.4	O K
960 min Summer	98.900	0.900	0.0	25.3	O K
1440 min Summer	98.940	0.940	0.0	26.4	O K
2160 min Summer	98.979	0.979	0.0	27.5	O K
2880 min Summer	99.010	1.010	0.0	28.4	O K
4320 min Summer	99.064	1.064	0.0	29.9	O K
5760 min Summer	99.112	1.112	0.0	31.3	O K
7200 min Summer	99.161	1.161	0.0	32.7	O K
8640 min Summer	99.210	1.210	0.0	34.0	O K
10080 min Summer	99.258	1.258	0.0	35.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	139.477	0.0	19
30 min Summer	91.239	0.0	34
60 min Summer	56.780	0.0	64
120 min Summer	34.456	0.0	124
180 min Summer	25.458	0.0	184
240 min Summer	20.402	0.0	244
360 min Summer	14.757	0.0	364
480 min Summer	11.634	0.0	484
600 min Summer	9.634	0.0	604
720 min Summer	8.237	0.0	724
960 min Summer	6.405	0.0	964
1440 min Summer	4.464	0.0	1444
2160 min Summer	3.103	0.0	2164
2880 min Summer	2.403	0.0	2884
4320 min Summer	1.692	0.0	4324
5760 min Summer	1.330	0.0	5768
7200 min Summer	1.113	0.0	7208
8640 min Summer	0.968	0.0	8648
10080 min Summer	0.865	0.0	10088

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	98.344	0.344	0.0	9.7	O K
30 min Winter	98.450	0.450	0.0	12.6	O K
60 min Winter	98.560	0.560	0.0	15.7	O K
120 min Winter	98.679	0.679	0.0	19.1	O K
180 min Winter	98.752	0.752	0.0	21.2	O K
240 min Winter	98.804	0.804	0.0	22.6	O K
360 min Winter	98.872	0.872	0.0	24.5	O K
480 min Winter	98.916	0.916	0.0	25.8	O K
600 min Winter	98.948	0.948	0.0	26.7	O K
720 min Winter	98.973	0.973	0.0	27.4	O K
960 min Winter	99.008	1.008	0.0	28.4	O K
1440 min Winter	99.053	1.053	0.0	29.6	O K
2160 min Winter	99.097	1.097	0.0	30.9	O K
2880 min Winter	99.132	1.132	0.0	31.8	O K
4320 min Winter	99.192	1.192	0.0	33.5	O K
5760 min Winter	99.247	1.247	0.0	35.1	O K
7200 min Winter	99.302	1.302	0.0	36.6	O K
8640 min Winter	99.356	1.356	0.0	38.1	O K
10080 min Winter	99.410	1.410	0.0	39.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Winter	139.477	0.0	19
30 min Winter	91.239	0.0	34
60 min Winter	56.780	0.0	64
120 min Winter	34.456	0.0	124
180 min Winter	25.458	0.0	184
240 min Winter	20.402	0.0	244
360 min Winter	14.757	0.0	364
480 min Winter	11.634	0.0	484
600 min Winter	9.634	0.0	604
720 min Winter	8.237	0.0	724
960 min Winter	6.405	0.0	964
1440 min Winter	4.464	0.0	1444
2160 min Winter	3.103	0.0	2164
2880 min Winter	2.403	0.0	2884
4320 min Winter	1.692	0.0	4324
5760 min Winter	1.330	0.0	5768
7200 min Winter	1.113	0.0	7200
8640 min Winter	0.968	0.0	8640
10080 min Winter	0.865	0.0	10080

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 454180 200184 SP 54180 00184
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+25

Time Area Diagram

Total Area (ha) 0.033

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.033

Model Details

Storage is Online Cover Level (m) 100.000

Trench Soakaway Structure

Infiltration Coefficient Base (m/hr)	0.00004	Trench Width (m)	1.5
Infiltration Coefficient Side (m/hr)	0.00004	Trench Length (m)	62.5
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	2.000
Invert Level (m)	98.000	Cap Infiltration Depth (m)	2.000

Summary of Results for 100 year Return Period (+25%)

Half Drain Time : 2102 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.208	0.708	0.0	1.2	1.2	139.3	O K
30 min Summer	98.423	0.923	0.0	1.3	1.3	181.5	O K
60 min Summer	98.640	1.140	0.0	1.4	1.4	224.2	O K
120 min Summer	98.865	1.365	0.0	1.5	1.5	268.4	O K
180 min Summer	98.993	1.493	0.0	1.6	1.6	293.6	O K
240 min Summer	99.075	1.575	0.0	1.6	1.6	309.8	O K
360 min Summer	99.167	1.667	0.0	1.7	1.7	327.9	O K
480 min Summer	99.210	1.710	0.0	1.7	1.7	336.4	O K
600 min Summer	99.228	1.728	0.0	1.7	1.7	339.7	O K
720 min Summer	99.230	1.730	0.0	1.7	1.7	340.2	O K
960 min Summer	99.207	1.707	0.0	1.7	1.7	335.7	O K
1440 min Summer	99.115	1.615	0.0	1.6	1.6	317.5	O K
2160 min Summer	98.980	1.480	0.0	1.6	1.6	291.1	O K
2880 min Summer	98.877	1.377	0.0	1.5	1.5	270.9	O K
4320 min Summer	98.735	1.235	0.0	1.5	1.5	242.9	O K
5760 min Summer	98.636	1.136	0.0	1.4	1.4	223.4	O K
7200 min Summer	98.562	1.062	0.0	1.4	1.4	208.9	O K
8640 min Summer	98.502	1.002	0.0	1.3	1.3	197.1	O K
10080 min Summer	98.452	0.952	0.0	1.3	1.3	187.2	O K
15 min Winter	98.294	0.794	0.0	1.2	1.2	156.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	139.477	0.0	91.6	19
30 min Summer	91.239	0.0	96.9	34
60 min Summer	56.780	0.0	200.2	64
120 min Summer	34.456	0.0	210.6	124
180 min Summer	25.458	0.0	220.4	184
240 min Summer	20.402	0.0	228.0	244
360 min Summer	14.757	0.0	236.9	362
480 min Summer	11.634	0.0	241.6	482
600 min Summer	9.634	0.0	244.2	602
720 min Summer	8.237	0.0	245.5	722
960 min Summer	6.405	0.0	245.7	962
1440 min Summer	4.464	0.0	241.7	1426
2160 min Summer	3.103	0.0	429.0	1728
2880 min Summer	2.403	0.0	418.4	2104
4320 min Summer	1.692	0.0	394.7	2936
5760 min Summer	1.330	0.0	514.2	3752
7200 min Summer	1.113	0.0	537.7	4608
8640 min Summer	0.968	0.0	561.3	5368
10080 min Summer	0.865	0.0	584.8	6248
15 min Winter	139.477	0.0	92.4	19

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	98.535	1.035	0.0	1.4	1.4	203.5	O K
60 min Winter	98.779	1.279	0.0	1.5	1.5	251.6	O K
120 min Winter	99.033	1.533	0.0	1.6	1.6	301.6	O K
180 min Winter	99.180	1.680	0.0	1.7	1.7	330.3	O K
240 min Winter	99.275	1.775	0.0	1.7	1.7	349.0	O K
360 min Winter	99.383	1.883	0.0	1.8	1.8	370.4	O K
480 min Winter	99.437	1.937	0.0	1.8	1.8	380.9	O K
600 min Winter	99.462	1.962	0.0	1.8	1.8	385.8	O K
720 min Winter	99.470	1.970	0.0	1.8	1.8	387.3	O K
960 min Winter	99.456	1.956	0.0	1.8	1.8	384.6	O K
1440 min Winter	99.376	1.876	0.0	1.8	1.8	369.0	O K
2160 min Winter	99.225	1.725	0.0	1.7	1.7	339.2	O K
2880 min Winter	99.107	1.607	0.0	1.6	1.6	316.0	O K
4320 min Winter	98.923	1.423	0.0	1.6	1.6	279.8	O K
5760 min Winter	98.783	1.283	0.0	1.5	1.5	252.3	O K
7200 min Winter	98.674	1.174	0.0	1.4	1.4	230.9	O K
8640 min Winter	98.583	1.083	0.0	1.4	1.4	213.0	O K
10080 min Winter	98.506	1.006	0.0	1.3	1.3	197.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	91.239	0.0	102.6	34
60 min Winter	56.780	0.0	205.8	64
120 min Winter	34.456	0.0	222.3	122
180 min Winter	25.458	0.0	234.8	182
240 min Winter	20.402	0.0	242.7	240
360 min Winter	14.757	0.0	251.8	358
480 min Winter	11.634	0.0	256.5	476
600 min Winter	9.634	0.0	258.9	590
720 min Winter	8.237	0.0	260.0	708
960 min Winter	6.405	0.0	259.8	934
1440 min Winter	4.464	0.0	254.3	1382
2160 min Winter	3.103	0.0	448.8	1968
2880 min Winter	2.403	0.0	440.9	2220
4320 min Winter	1.692	0.0	422.6	3156
5760 min Winter	1.330	0.0	575.7	4040
7200 min Winter	1.113	0.0	602.5	4968
8640 min Winter	0.968	0.0	628.9	5800
10080 min Winter	0.865	0.0	655.0	6656

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 454180 200184 SP 54180 00184
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+25

Time Area Diagram

Total Area (ha) 0.537

Time From:	(mins) To:	Area (ha)
0	4	0.537

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 97.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	207.0	207.0	2.100	0.0	576.2
2.000	207.0	576.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0054-2000-2550-2000
Design Head (m)	2.550
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	54
Invert Level (m)	97.450
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.550	2.0
Flush-Flo™	0.233	1.2
Kick-Flo®	0.482	0.9
Mean Flow over Head Range	-	1.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.0	1.200	1.4	3.000	2.2	7.000	3.2
0.200	1.2	1.400	1.5	3.500	2.3	7.500	3.3
0.300	1.1	1.600	1.6	4.000	2.5	8.000	3.4
0.400	1.1	1.800	1.7	4.500	2.6	8.500	3.5
0.500	1.0	2.000	1.8	5.000	2.7	9.000	3.6
0.600	1.0	2.200	1.9	5.500	2.8	9.500	3.7
0.800	1.2	2.400	1.9	6.000	3.0		
1.000	1.3	2.600	2.0	6.500	3.1		

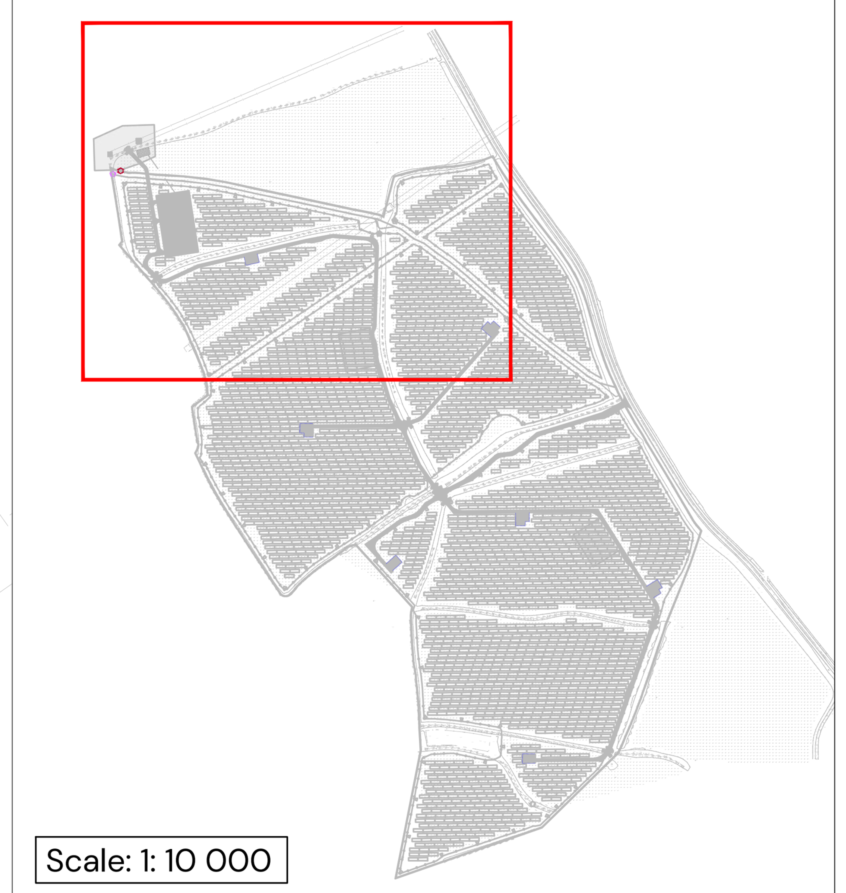
Appendix C – Surface Water Drainage Strategy

N

Notes:

A Site specific Topographical Survey was undertaken by Landmark Surveys Wales (date: September 2022; drawing reference: 6387)

Site Layout was produced by RES (date: N/A; drawing reference: 04531-RES-LAY-DR-PT-004)



REV	DATE	DESCRIPTION	REVISED	CHECKED	APPROVED
P3	21/03/2024	Updated Site Layout	LG	LAJ	LAJ
P2	12/02/2024	Updated Site Layout	LG	LAJ	LAJ
P1	21/12/2023	First Issue	MR	LG	LAJ

Drainage Strategy Drawing Sheet 1

Land West of A4074, South Oxfordshire

CLIENT:
RES Ltd

DATE: 21/12/23
SCALE: As Noted
DRAWN BY: MR
CHECKED BY: LG
APPROVED BY: LAJ

DRAWING NUMBER: P21-2947 - PEG - XX - XX - DR - C - 0100 - P3
PG OFFICE / TEAM: BRS/IN

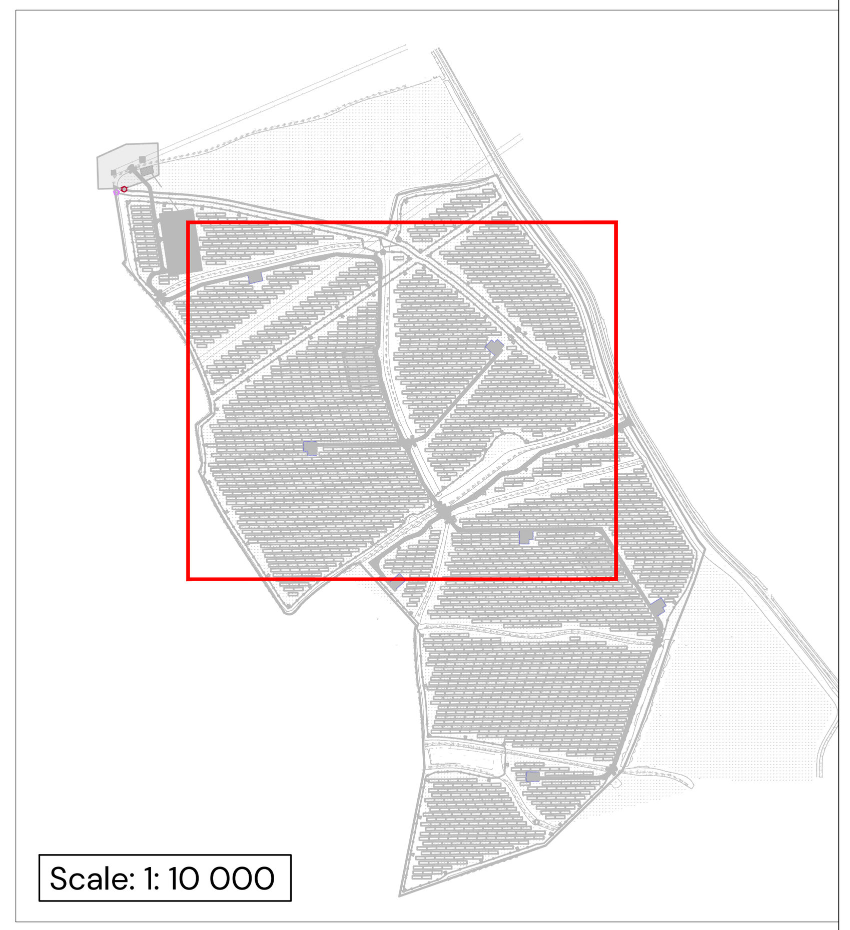
PEGASUS REF No: P21-2947
DRAWING STATUS: SO

PEGASUS GROUP

Notes:

A Site specific Topographical Survey was undertaken by Landmark Surveys Wales (date: September 2022; drawing reference: 6387)

Site Layout was produced by RES (date: N/A; drawing reference: 04531-RES-LAY-DR-PT-004)



REV	DATE	DESCRIPTION	REVISED	CHECKED	APPROVED
P3	21/03/2024	Updated Site Layout	LG	LAJ	LAJ
P2	12/02/2024	Updated Site Layout	LG	LAJ	LAJ
P1	21/12/2023	First Issue	MR	LG	LAJ

Drainage Strategy Drawing Sheet 2

Land West of A4074,
South Oxfordshire

CLIENT:
RES Ltd

DATE: 21/12/2023
SCALE: As Noted
DRAWN BY: MR
CHECKED BY: LG
APPROVED BY: LAJ

DRAWING NUMBER: P21-2947 - PEG - XX - XX - DR - C- 0101 - P3
PG OFFICE / TEAM: BRS/IN

PEGASUS REF No: P21-2947
DRAWING STATUS: SO

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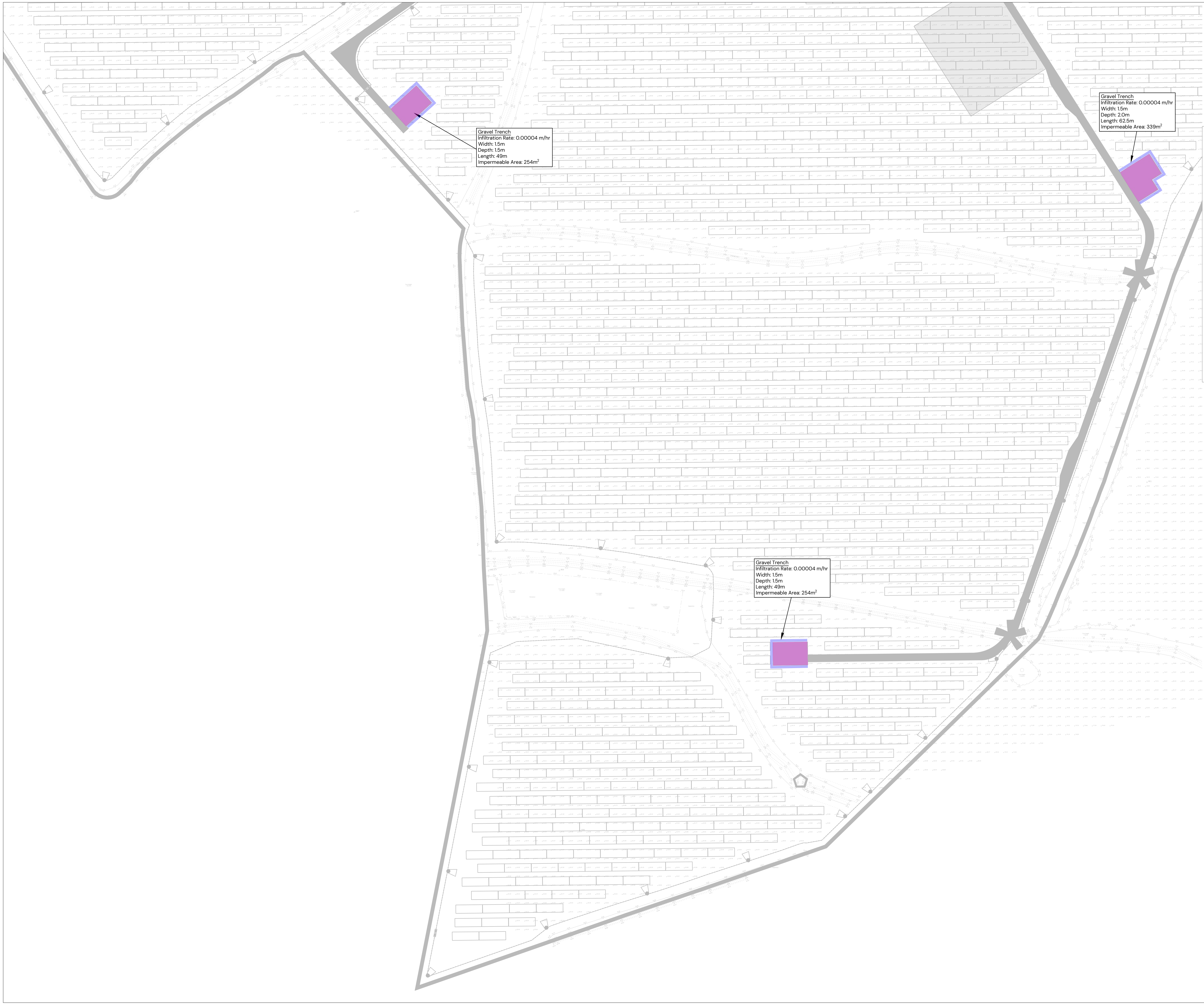
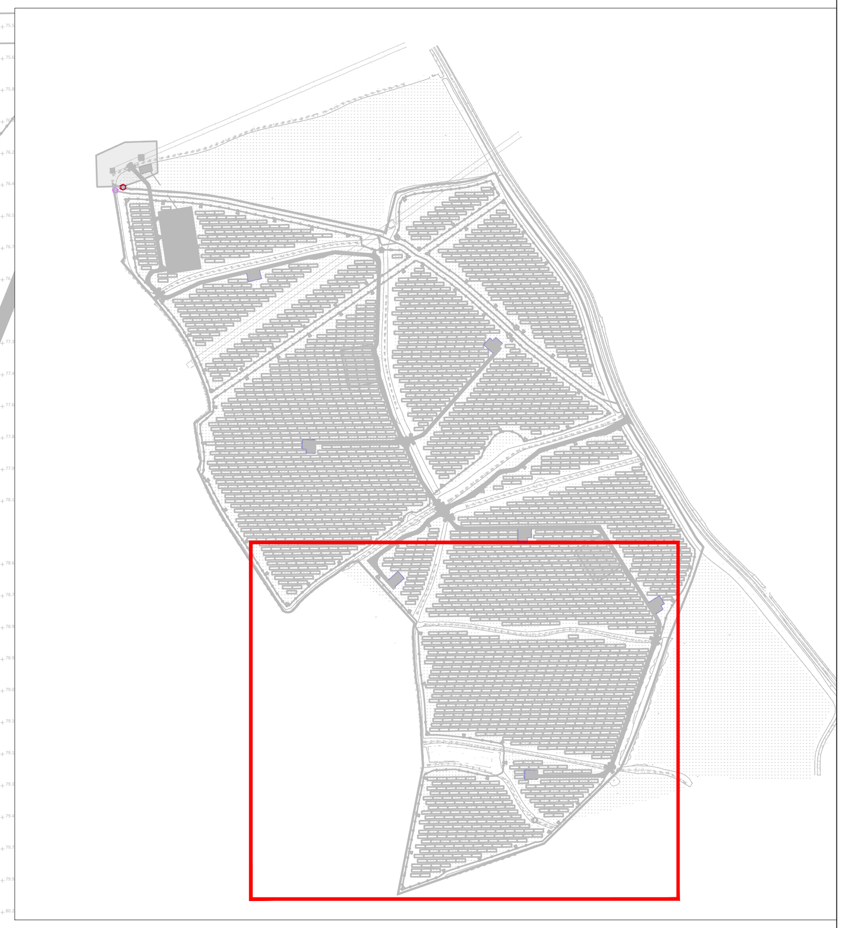


Notes:

A Site specific Topographical Survey was undertaken by Landmark Surveys Wales (date: September 2022; drawing reference: 6387)

Site Layout was produced by RES (date: N/A; drawing reference: 04531-RES-LAY-DR-PT-004)



REV	DATE	DESCRIPTION	REVISED	CHECKED	APPROVED
P3	21/03/2024	Updated Site Layout	LG	LAJ	LAJ
P2	12/02/2024	Updated Site Layout	LG	LAJ	LAJ
P1	21/12/2023	First Issue	MR	LG	LAJ

Drainage Strategy Drawing
Sheet 3

Land West of A4074,
South Oxfordshire

CLIENT:
RES Ltd

DATE:
21/12/2023

SCALE:
As Noted

DRAWN BY: MR
CHECKED BY: LG
APPROVED BY: LAJ

DRAWING NUMBER:
P21-2947 - PEG - XX - XX - DR - C - 0102 - P3

PG OFFICE / TEAM:
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PEGASUS REF No:
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