Flood Risk Assessment

Cotmoor Solar Farm
Southwell
Nottinghamshire

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1. Executive Summary

1.1.1 JBM Solar Projects 6 Ltd are applying for permission for a Solar Farm at Cotmoor Farm, Southwell. The site is gently undulating pastoral and arable agricultural land.

1.1.2 This document considers the flood risk to the site and presents a drainage strategy to mitigate against the potential downstream impacts of development.

1.1.3 The site falls within Flood Zone 1 and is at low risk of flooding from rivers and the sea. The proposals constitute 'Less Vulnerable' development and are appropriate in Flood Zone 1. The site is not considered to be at risk of flooding from groundwater, sewers, reservoirs or other artificial sources.

1.1.4 There are three ordinary watercourses within the site these are highlighted on the Risk of Flooding from Surface Water map. This risk from these watercourses will be mitigated by all panels being located at least 8m from the top of bank. During a 1 in 1,000 year event some overland flow is predicted but only to depths of 0.15m. Infrastructure in these areas will be elevated 0.6m above ground and will therefore be safe. Equally they will not impact upon flood risk elsewhere.

1.1.5 The vast majority of the proposals will not have a significant impact on site runoff being very small in context of the site area and spatially distributed across the site. Furthermore, the change of use of the land from intensively cultivated arable land will allow establishment of natural vegetation and a commensurate improvement in soil structure which will reduce downstream flooding and pollution.

1.1.6 Runoff from the building associated with the large substation will be stored in an attenuation basin and conveyed by shallow swales, which will mitigate the potential impact of the change in land use.

1.1.7 It is proposed that two small surface water attenuation areas are created in the catchment of the Westthorpe Dumble and Potwell Dyke, this will reduce downstream flood risk in the town of Southwell which has experienced numerous flood events in the recent past.

1.1.8 This document demonstrates that the proposals meet the aims of the National Planning Policy, being safe from all sources of flooding and reducing downstream flood risk and pollution.

2. Introduction

2.1 Background

2.1.1 Calibro has been appointed by *JBM Solar Projects 6 Ltd* to undertake a Flood Risk Assessment (FRA) for a proposed development comprising a solar farm and associated infrastructure.

2.1.1 The National Planning Policy Framework (NPPF) requires that the planning system takes full account of flood risk. This requires that:

- 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 disposal where practicable;
- Flood risk is managed through the use of flood resilient and resistant techniques;
- Residual risk is identified and safely managed;
- Safe access and egress to and from the development can be achieved.

2.1.2 NPPF states that a site-specific Flood Risk Assessment will be required for proposals:

a) that are greater than 1 hectare in area within Flood Zone 1;
b) for all proposed developments in Flood Zones 2 and 3;
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.

2.1.3 The site is approximately 107ha and therefore requires an FRA in accordance with NPPF.

2.1.4 This assessment considers the risks of all types of flooding to the site and provides mitigation measures to minimise flood risk to the site and reduce flood risk elsewhere. This includes a drainage statement to manage surface water and accounts for climate change for the lifetime of the development.

3. Existing Site and Hydrology Characteristics

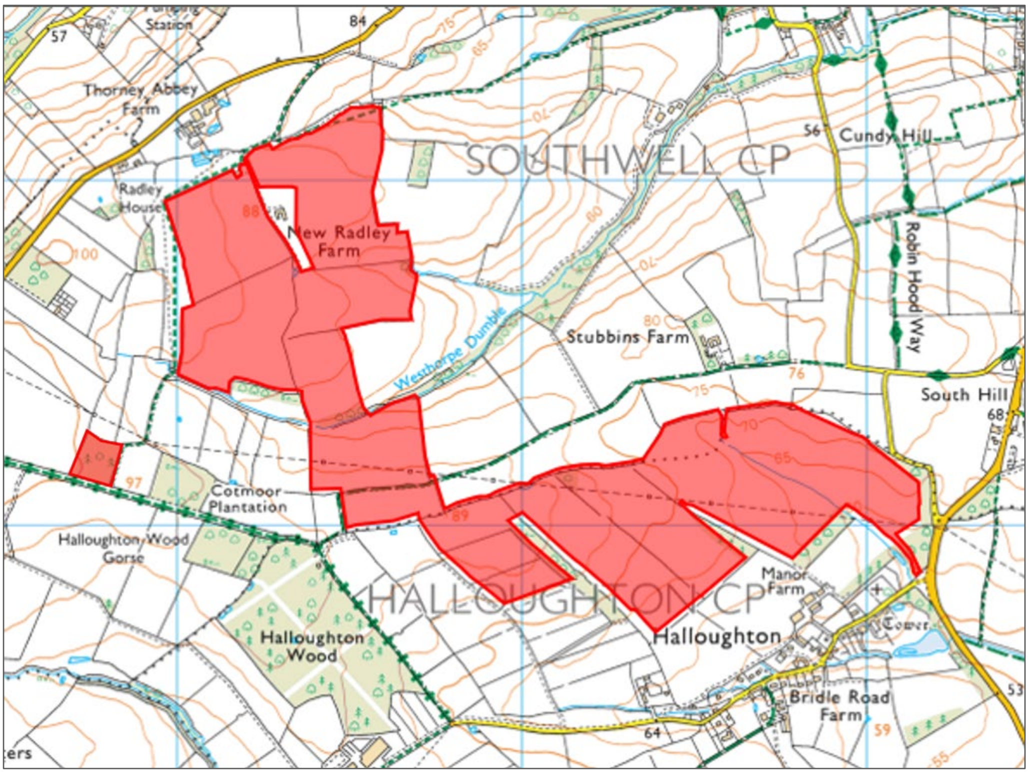
3.1 Site Description

3.1.1 The site is located at Halloughton, Southwell, Nottinghamshire. The approximate co-ordinates at the centre of the site are E: 468050; N: 352050, and the post code is NG25 0QS.

3.1.2 The entire site is 107.81ha in area. The site is greenfield, comprising arable and pastoral agricultural fields divided by hedges. Pylons cross the site on a broadly east-west axis.

3.1.3 The site is predominantly surrounded by agricultural fields with some small stands of woodlands on the southern edges. Access roads are located to the north of the site and the southeast of the site. Figures 3.1 shows the site boundary and local context.

Figure 3.1 – Site Context



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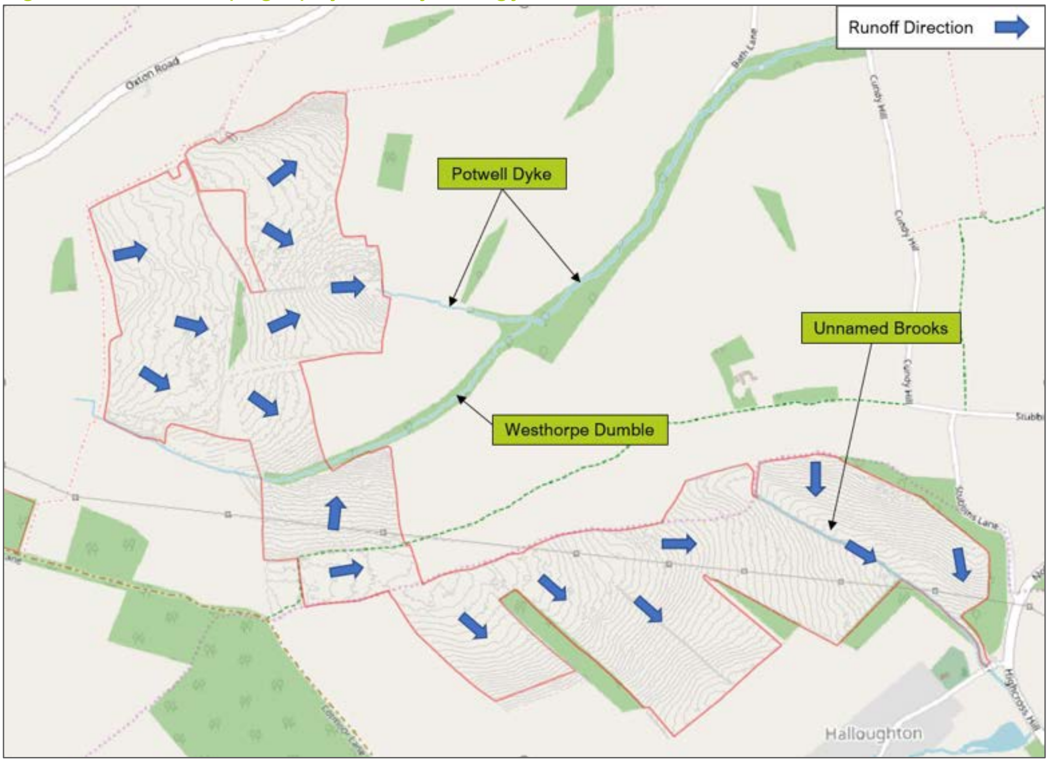
3.2 Topography

3.2.1 The site levels range from 95.5mAOD on the northwestern site boundary to 52.6mAOD in the far southeast of the site. A ridge line divides the site broadly into two, with a northern and southern section. The land across the site gently undulates, generally falling towards the local watercourses within gradients in the range 1 in 25 to 1 in 50.

3.2.2 0.5m contours derived from the topographic survey are shown along with local watercourses and the direction of surface water runoff in Figure 3.2.

Figure 3.2 – Site Topography and Hydrology



3.3 Existing Drainage and Hydrology

3.3.1 There are no Main Rivers located close to the site. There are three Ordinary Watercourses recorded on open mapping data as shown in Figure 3.2. There are also land drainage ditches located across the site. The entire site falls within the Trent Catchment and the Humber River Basin District

3.3.2 The northern part of the site ultimately drains to the Westhorpe Dumble and the Potwell Dyke. The Potwell Dyke flows through Southwell before discharging into the River Greet.

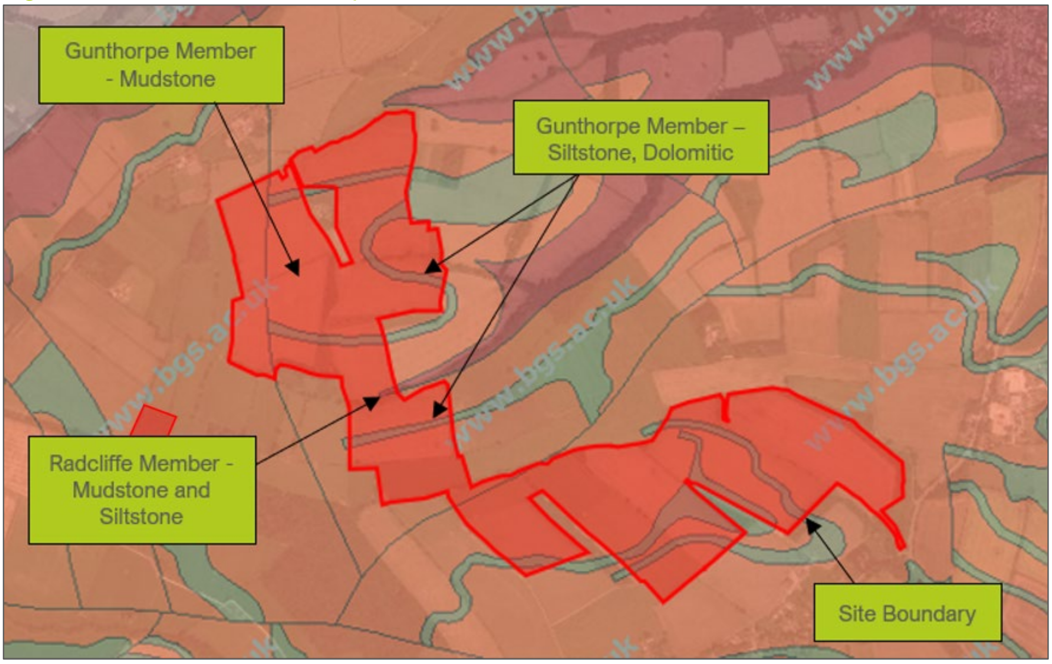
3.3.3 The southern part of the site generally drains in southeasterly direction to join an unnamed watercourse which is a tributary of the Halloughton Dumble.

3.3.4 Public sewer records have been acquired from Severn Trent Water. This shows that there are no public sewers located within the vicinity of the site. A copy of the sewer plans can be found in Appendix B.

3.4 Geology and Soils

3.4.1 Geological data held by the British Geological Survey (BGS) shows that the site is underlain by three bedrock types. The majority of the site is underlain by "*Gunthorpe Member – Mudstone*" which is interspersed with seams of "*Gunthorpe Member – Siltstone, Dolomitic*". There is also a small area of "*Radcliffe Member – Mudstone And Siltstone*" in the east of the site. No superficial deposits are recorded within the site. The bedrock strata is shown in Figure 3.3.

Figure 3.3 – BGS Bedrock Map



3.4.2 The BGS Hydrogeology aquifer classification (625k) records the geology as being a 'Low Productivity Aquifer' stating that *"Flow is virtually all through fractures and other discontinuities"*.

3.4.3 The site is located in a High Groundwater Vulnerability Zone, but it is not located in a Groundwater Source Protection Zone.

3.4.4 SoilScapes Mapping records two soil types on the site. The main part of the site is classified as "*Slightly acid loamy and clayey soils with impeded drainage*". The central area of the site and a small area in the north east is classified as "*Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils*".

3.4.5 Google Earth aerial imagery shows extensive areas of bare soil, often ploughed in line with the fall of the land. The land is currently used as pasture and for arable cultivation.

3.4.6 During a site visit on May 22nd 2020, the soil was noted as being heavy clay with large cracks evident in arable fields. Josh Wells of the Trent Rivers Trust advised that in such conditions runoff from the fields was fast and absorption and infiltration limited.

Figure 3.4 – Google Earth Imagery (July 2017)

Figure 3.5 – Google Earth Imagery (March 2019)

4. Flood Risk

4.1 National Planning Policy Framework (NPPF)

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

a) Tidal Flooding – from sea;
b) Fluvial Flooding – from rivers and streams;
c) Surface Water Flooding – from intense rainfall events;
d) Groundwater flooding – from elevated groundwater levels or springs;
e) Flooding from sewers – from existing sewer systems; and
f) Artificial sources – from reservoirs, canals etc.

4.2 Historical Flooding and Local Flood Alleviation Works

4.2.1 The Environment Agency (EA) does not hold any record of historical flooding on the site.

4.2.2 The Lead Local Flood Authority (Nottinghamshire County Council) and advise that there is:

"Some history of flooding from watercourses and highways in the area."

4.2.3 There have been numerous flood events in Southwell which receives flows from the Westhorpe Dumbell and Potwell Dyke. A site visit was carried out with representatives from the Trent Rivers Trust and the Southwell Flood Forum they advised that the catchment had a rapid response to rainfall events especially when saturated by rainfall or when the ground is particularly dry and cracked.

4.2.4 Some measures have been put in place to reduce flooding in the catchment such as wood debris dams and a bunded storage area. Some of the woody debris dams are adjacent to the site in incised channels but do not fall within the application. These works, particularly the bunded storage (which can withhold approximately 200m^3 of water) have apparently caused a demonstrable reduction in flood risk.

Figure 4.1 – Bunded Storage upstream of Southwell (May 2020)

Figure 4.2 – Timber dam adjacent to site (May 2020)

4.3 Flood Zones

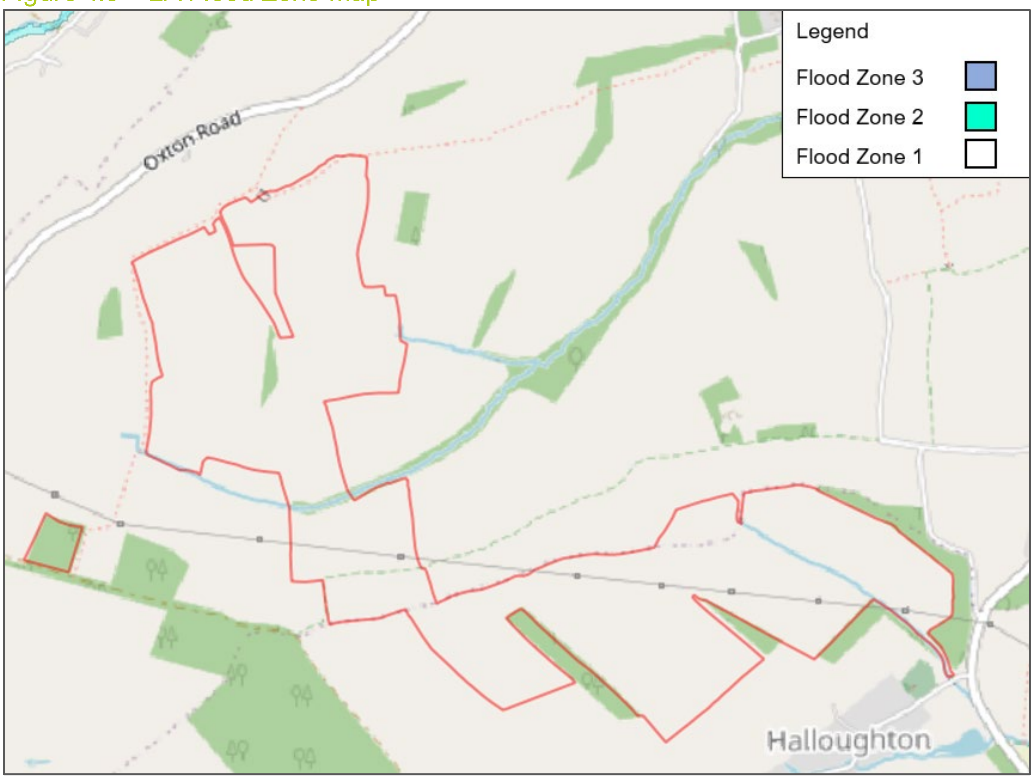
4.3.1 The Flood Zones indicate the probability of the site flooding from rivers and the sea, excluding the presence of flood defences. The flood risk that the Flood Zones represent is classified in Table 4.1 below.

Table 4.1 – EA Flood Zone Classification

Flood Zone	Risk	Tidal Flooding Annual Exceedance Probability	Fluvial Flooding Annual Exceedance Probability
1	Low	< 0.1%	
2	Medium	0.1% - 1%	0.1% - 0.5%
3	High	> 1%	> 0.5%
3b	Functional Floodplain	Land where water has to flow or be stored in times of flood. This is defined in the relevant SFRA.	

4.3.2 The EA Flood Zone Map defines the entire site as Flood Zone 1 (Figure 4.1). This area is not predicted to be affected by a 1 in 1,000 year (0.1%) event and the risk is categorized as being **Low**.

Figure 4.3 – EA Flood Zone Map



4.4 Surface Water Flooding

4.4.1 The Risk of Flooding from Surface Water (RoFSW) mapping indicates areas prone to surface water flooding. The methodology uses a digital terrain model with a 2m horizontal grid and consistently underestimates the storage and conveyance of small-scale watercourses.

4.4.2 Figure 4.4 shows that the vast majority of the site will not be affected by a 1 in 1,000 year rainfall event and is at very low risk of pluvial flooding. There are three areas that are classified as high risk located across the site. These are associated with existing watercourses that flow through the site.

4.4.3 The RoFSW flood predicts that high risk (1 in 30 year) rainfall events will be contained within the well-defined watercourse channels. During the medium (1 in 100 year event), some small areas beyond the watercourses are predicted to be flooded to depths of up to 0.15m in the northern part of the site.

Figure 4.4 – RoFSW Extents

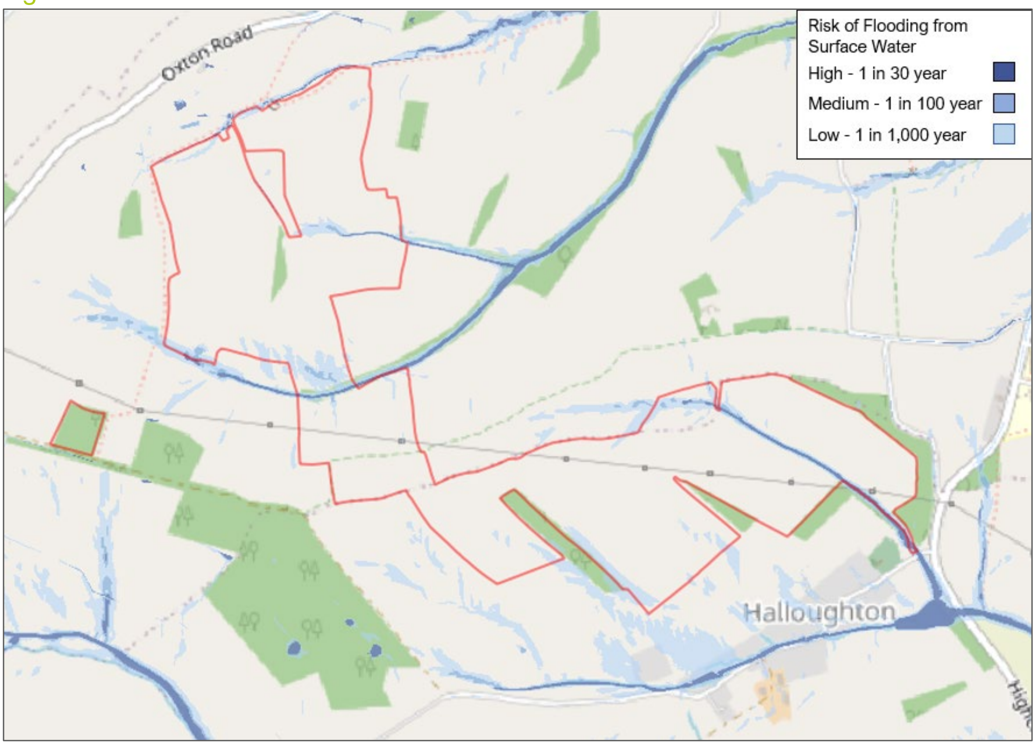
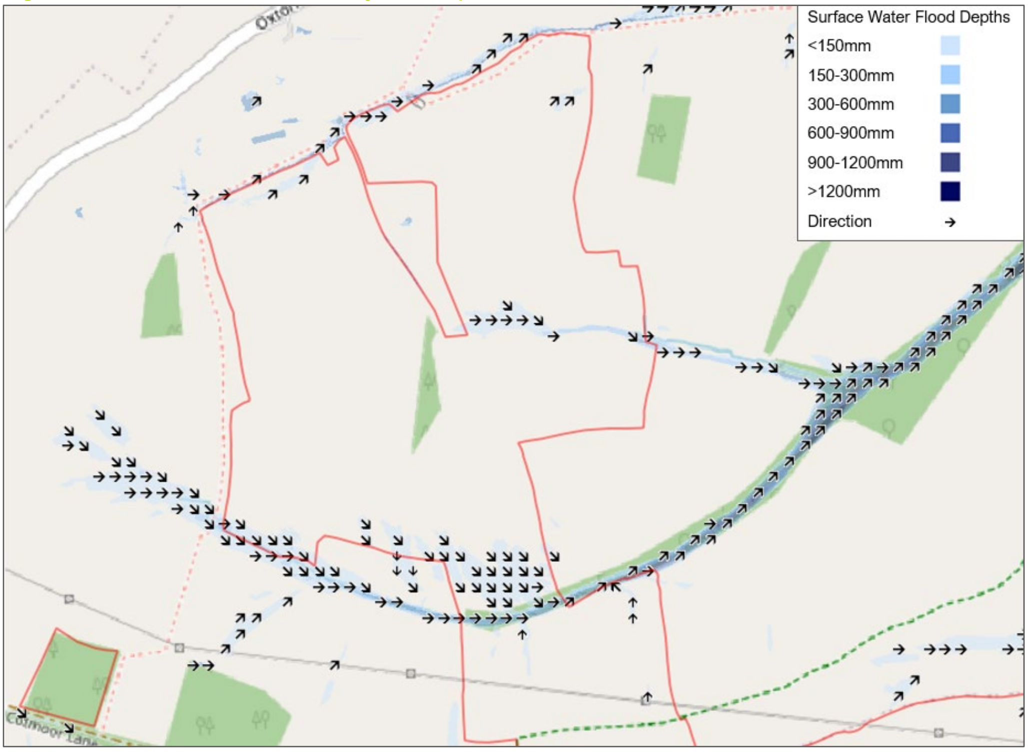


Figure 4.5 – RoFSW 1 in 1,000 year Depths - Northern Part of the Site

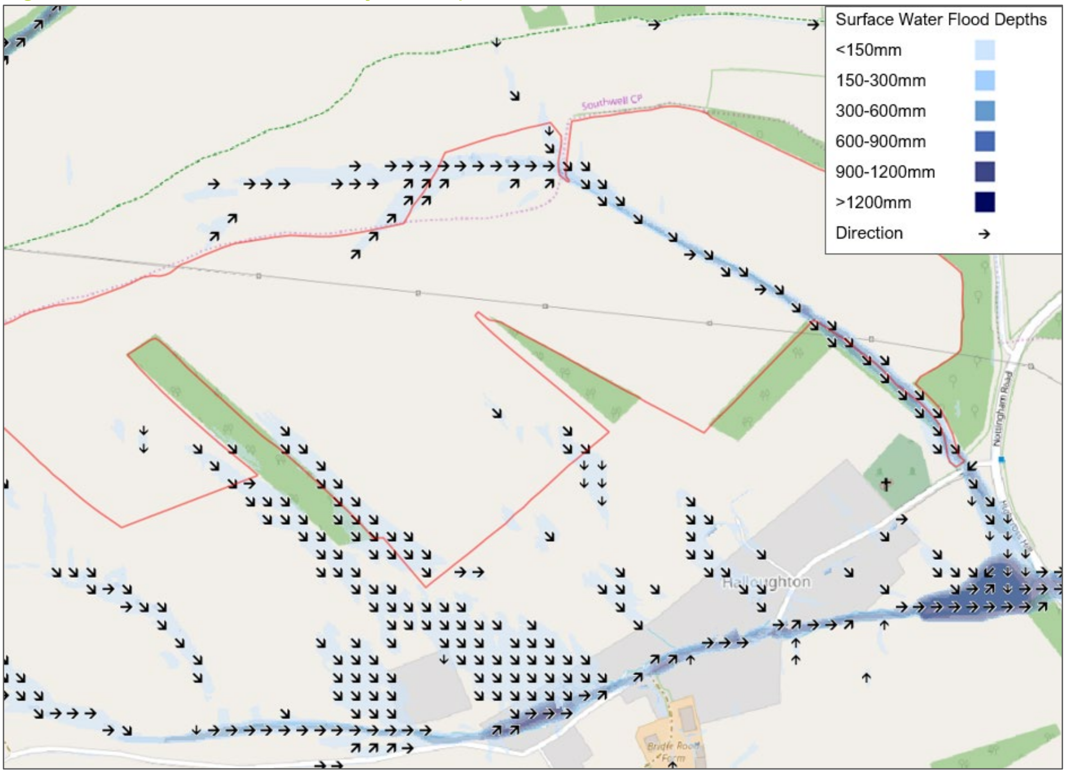


4.4.4 During the 1 in 1,000 year event, some minor flooding to depths of up to 0.15m are predicted. In the north (see Figure 4.5), these areas generally associated with existing watercourses.

4.4.5 All of the watercourses have an 8m easement in which there will be no infrastructure which is sufficient to mitigate against the risk of surface water flooding.

4.4.6 In the southern part of the site (see Figure 4.6) depths beyond the channel during the 1 1 in 1,000 year event are below 0.15m.

Figure 4.6 – RoFSW 1 in 1,000 year Depths - Southern Part of the Site



4.4.7 All infrastructure in these areas a will be raised 0.6m above ground levels allowing water to flow underneath it. Therefore, surface water flooding will not pose a risk to the development and the development will not change the existing runoff patterns.

4.4.8 The development is considered to be at very low risk of flooding from surface water. A surface water drainage strategy is proposed in Section 6.

4.5 Groundwater Flooding

4.5.1 The hydrogeology aquifer classification shows that the site is located on a low productivity "*aquifer in which flow is virtually all through fractures and discontinuities*".

4.5.2 The BGS maps indicate that the site is underlain by mudstone and siltstone bedrock with no superficial deposits. The mudstone and siltstone bedrock has low permeability, so groundwater emergence is unlikely. If groundwaters locally rise above the ground's surface it would flow overland in accordance with the site topography to the channels on site. No depressions are highlighted by the RoFSW map where water would be expected to accumulate to a significant depth.

4.5.3 The risk of flooding from groundwater at this stage is assessed as being **Very Low**.

4.6 Flooding from Sewers

4.6.1 There are no known private sewers located on-site, or public sewers located within the vicinity of the site. Therefore, the risk of sewer flooding to the site is considered to be **Negligible**.

4.7 Flooding from Artificial Sources

4.7.1 Mapping data from the Environment Agency show that the site is located outside the flood extents presented by potential breach of large reservoirs. There are no canals or large artificial water bodies that pose a risk to the site.

4.7.2 The development is considered to be at **Negligible** risk of flooding from reservoirs, canals and artificial sources.

4.8 Safe Access and Egress

4.8.1 Site access and egress will not be impeded during extreme flood events. The solar farm will be controlled remotely and will only be visited occasionally for maintenance operations.

5. Proposed Development

5.1 Site Proposals

5.1.1 The proposals are for a solar farm and associated infrastructure including maintenance tracks and perimeter fences. The proposed solar panel arrangement is shown in Figures 5.1 and 5.2 showing the panel edges to be between 0.8 and 1.05m above ground. Inverter containers will be located at least 0.8m above ground.

Figure 5.1 – Typical panel arrangement front elevation

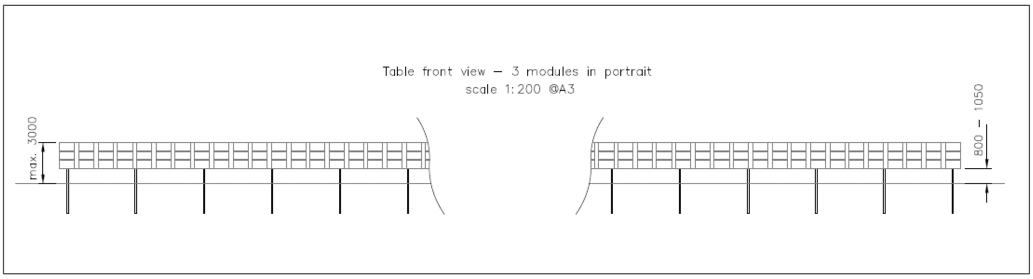
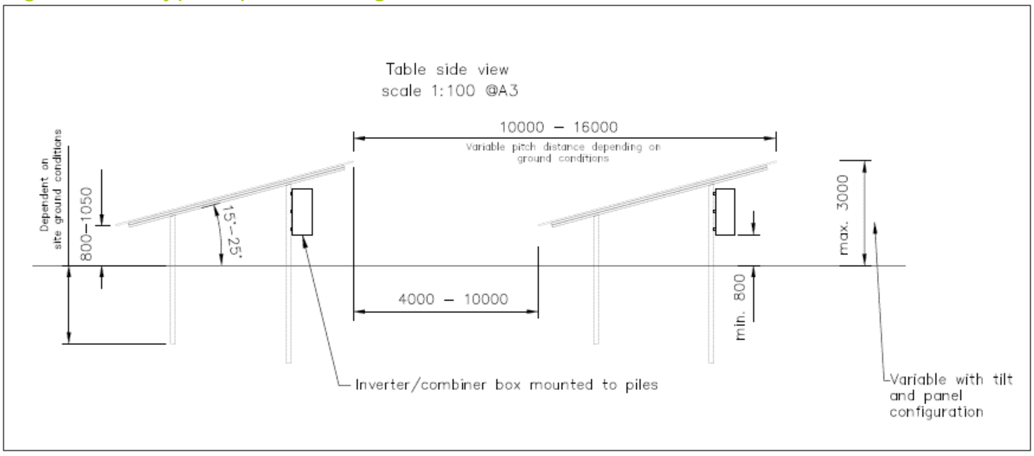
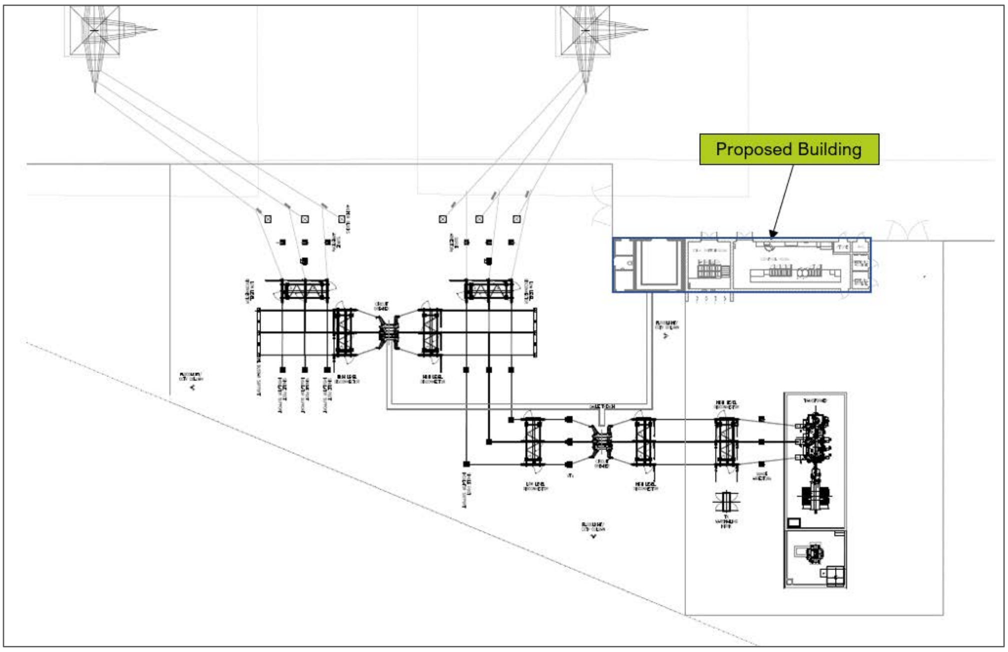


Figure 5.2 – Typical panel arrangement side elevation



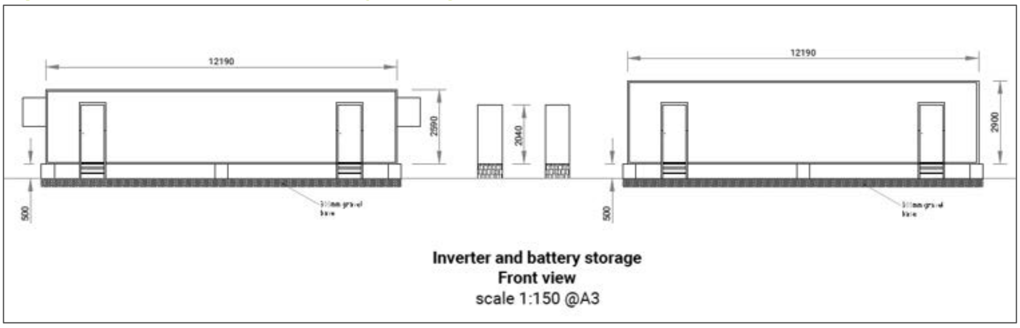
5.1.2 A substation is proposed in the south of the site where connection will be made to the grid. The exporting substation arrangement with associated building containing the control room and switch gear is shown in Figure 5.3

Figure 5.3 – Substation and connection to grid proposals



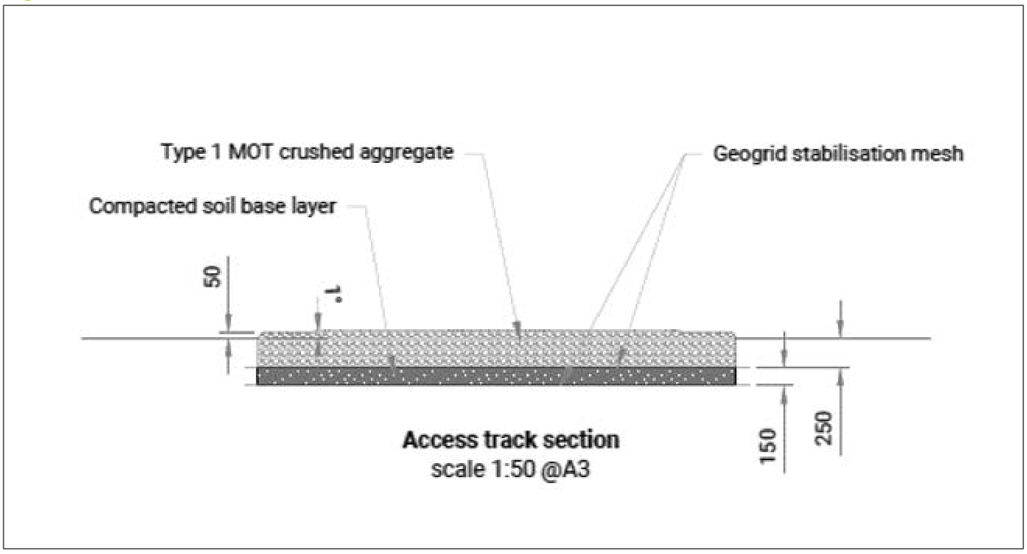
5.1.3 The site proposals include supporting equipment including 16 inverter/transformer containers, 11 battery stations (each comprising 2-3 containers containing batteries and an inverter) and two spares containers. All of the containers will be elevated above the ground surface on footings. The inverters and battery station will be sited within areas surfaced with 300mm of gravel. A typical elevation is shown in Figure 5.4.

Figure 5.4 – Inverter and battery storage containers



5.1.4 Roads within the site will be formed of 250mm of Type 1 crushed aggregate as shown in Figure 5.5. The site will be accessed from the south.

Figure 5.5 – Road construction section



5.1.5 The site layout plan is contained within Appendix A.

5.2 Development Vulnerability

5.2.1 Table 2 of the Planning Practice Guidance (PPG) defines which types of development are acceptable in each Flood Zone and is reproduced overleaf (Table 5.1). The proposed development is for a solar farm which is generally considered to fall within the 'Less Vulnerable' Category. The development is located in Flood Zone 1 and therefore, is appropriate.

Table 5.1 – PPG Development Vulnerability Classification

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

5.3 Sequential Test

5.3.1 The sequential test is required for development in Flood Zones 2 and 3 in. All development is located within Flood Zone 1 and therefore the sequential test is not required.

5.4 Exception Test

5.4.1 The development proposals are classed as 'Less Vulnerable' and located within Flood Zone 1 and therefore an exception test is not required.

6. Flood Risk Mitigation Measures

6.1 Ordinary Watercourses

6.1.1 There are several watercourses within the application site. No development is proposed within 8 metres of these watercourses. This will mitigate against the risk of surface water flooding as well as avoiding the requirement for land drainage consent.

6.2 Surface Water Flood Risk

6.2.1 There are several watercourses within the application site. No development is proposed within 8m of these watercourses. Some areas are shown to be a risk of surface water flooding to depths of up to 0.15m during a 1 in 1,000 year storm event. All infrastructure in these areas will be raised by at least 0.6m above ground levels and no further mitigation is required.

6.3 Downstream Flood Risk Alleviation

6.3.1 It is proposed that two storage features are created in the Potwell Dyke in the northern part of the site. The location of these features is shown in Figure 6.1. These features would serve to slow the flow in the upper parts of the catchment in order to reduce the peaks experienced in Southwell were property flooding is relatively frequent.

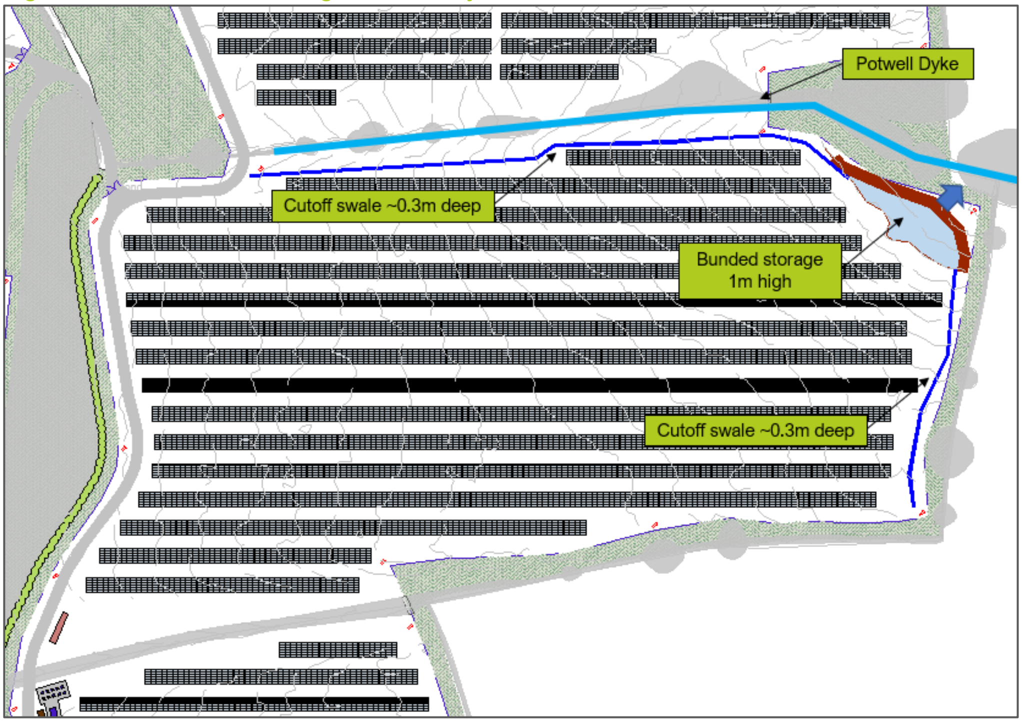
6.3.2 The storage features would be similar in scale and design approach to the existing bunded feature adjacent to the Potwell Dyke upstream of Southwell. The concept presented in Figures 6.2 and 6.3 will provide a total of approximately 800m^3 of storage which exceeds the capacity of the existing feature.

6.3.3 The bunds would be formed of clay borrowed from the site keyed into the existing ground to an appropriate depth to prevent seepage underneath it. They would have side slopes of approximately 1 in 3 and a crest at least 1m wide. The bunds would be dressed in topsoil and seeded with a native vegetation.

6.3.4 An illustrative cross-section concept design (reproduced with permission of the Trent Rivers Trust) is presented in Figure 6.4.

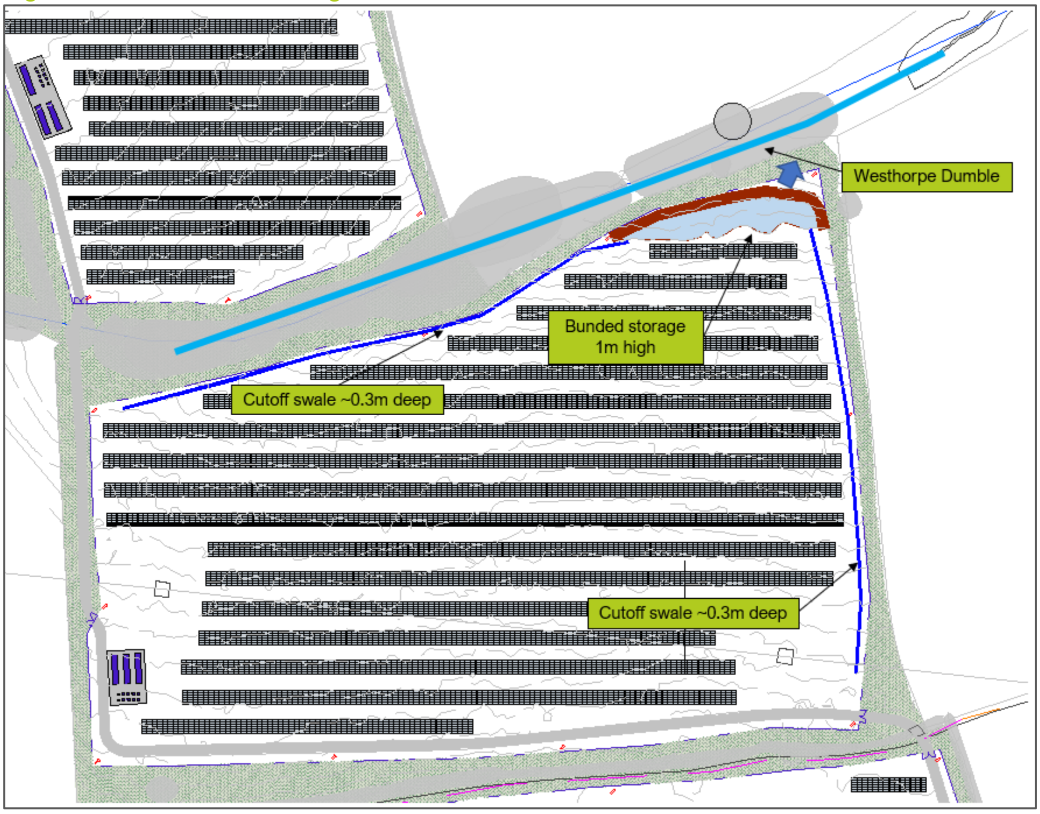
Figure 6.1 – Storage feature locations

Figure 6.2 – Northern storage feature layout



6.3.5 Outlet from the bund would be via a pipe through the embankment and an overspill arrangement would be provided to manage flows should the capacity become exceeded.

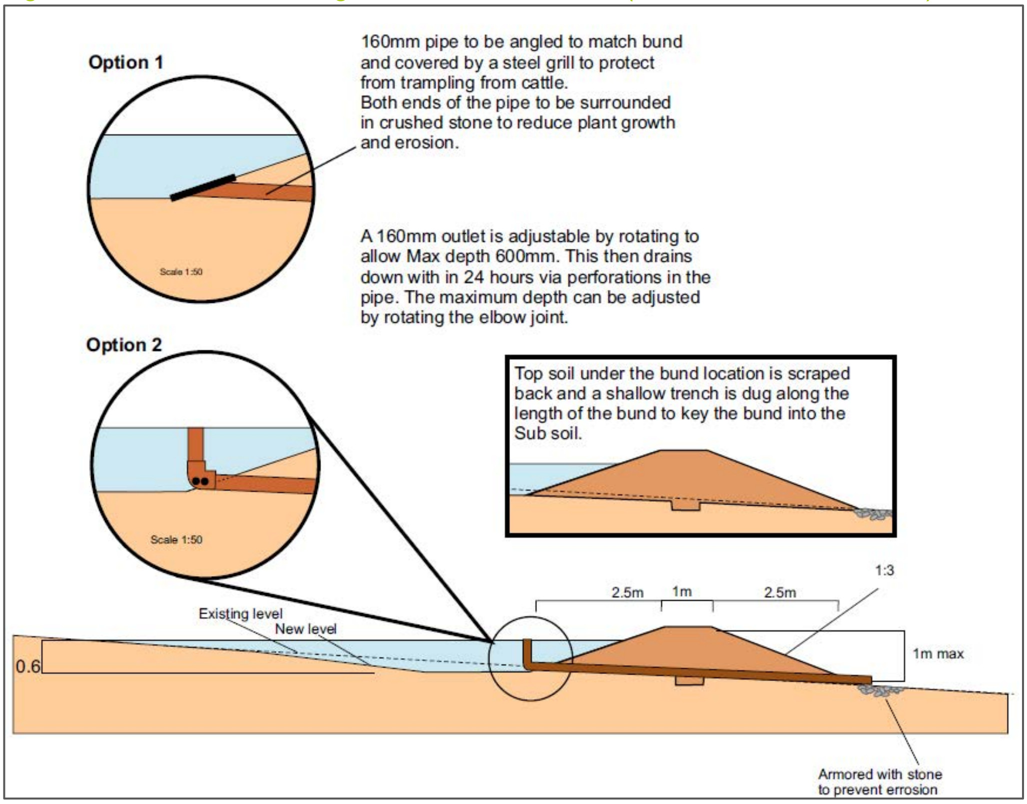
Figure 6.3 – Southern Storage Feature



6.3.6 Cut-off swales approximately 0.3m deep would gather water from the field boundaries to maximise the area which drains to the storage features.

6.3.7 In order to maximise the effectiveness of these features, the pipe diameter should be determined in consultation with the Trent Rivers Trust. Trent Rivers Trust have implemented similar works in the catchment, recorded their performance during heavy rainfall events and have a wealth of knowledge on how the catchment responds to rainfall.

Figure 6.4 – Illustrative storage feature cross-section (credit: Trent Rivers Trust)



7. Proposed Drainage Strategy

7.1 Consultation

7.1.1 Nottinghamshire County Council Lead Local Flood Authority were contacted to discuss the approach for managing surface water and agreed in principle with the approach set out below. Representatives from Southwell Flood Forum and Trent Rivers Trust were met on site to discuss the proposals on May 22nd 2020.

7.2 Surface Water Management

7.2.1 The proposed development is for a solar farm and consequently, the main part of the site will be taken up by solar panels. Rows of solar panels will be separated by gaps in the 4-6.5m range (see Figure 5.2). The solar arrays themselves have thermal expansion gaps.

Figure 7.1 – Typical Solar Panel Arrangement (showing expansion gaps)

7.2.2 The concentration of runoff from the panels will be spatially localised at the micro-level. Once rainfall hits the soil it will initially take up any available depression storage and soil moisture deficit before moving laterally through the soil. If the incident rainfall exceeds the rate of soakage into the ground it will move laterally above the soil and soak into areas which are within the 'rain shadow' of the panels.

7.2.3 The battery stations will be located in areas surfaced with 300mm gravel, which will provide an increase in surface water storage and not impair the infiltration capacity of the soil below.

7.2.4 The spares containers (2 no.) and individual inverters (12 no.) are relatively small in area ~30m^2 and dispersed throughout the site. Across the 100ha site, they total an area of approximately 0.042ha (0.04% of the site area). They will be located on small concrete footings which will allow runoff spread laterally through the soil in a similar manner to the solar panels.

7.2.5 The proposed access tracks occupy a limited area within the site and will be formed of granular material. Therefore, no significant change is expected to greenfield runoff rates or volumes.

7.2.6 The exporting substation with connection to the National Grid will predominantly comprise electrical infrastructure sited on concrete footings within a large gravel compound. Water will be able to freely disperse and distribute throughout the gravel

7.2.7 Associated with the substation will be a building with a plan area of 165m^2. As there is potential for this area to increase runoff rates locally, it is proposed that this water is stored and released at a controlled rate.

7.2.8 Across the site the cessation of intensive agricultural activities will gradually allow vegetation to recover, soil structure to improve and organic matter and humus content to increase, especially in areas which were formally ploughed and left to bare earth and those areas where overgrazing and trafficking has caused compaction and erosion.

7.2.9 The work of Dr Richard Smith (Technical Advisor to the EA) concludes that farming processes, particularly the use of machinery and overgrazing of livestock cause compaction in most situations.

7.2.10 *“Farming during these extended wet periods is very tricky without causing damage to soil structure by compression which causes soil compaction. Skilful cultivation of naturally well drained soils is possible at field capacity without causing compaction. However, on the more slowly permeable land with high clay content, it is much more difficult to travel on and work soils at field capacity without causing damage…. Healthy soils can bounce back with biological activity, but this can take time.”*

Source: Sustainable Soils Alliance

7.2.11 This compaction causes a corresponding decrease in depression storage, absorption, infiltration and an increase in runoff rates, soil erosion, pollution and flooding downstream:

"When soils become compacted, they are more likely to become waterlogged and experience surface ponding that leads to run-off and flooding. This increases nutrient losses to watercourses causing pollution and reducing nutrient levels in soil"

Source: The state of the environment: soil (Environment Agency, 2019)

7.2.12 The change of use to a solar farm will therefore result in a reduction in and runoff rates and volumes, erosion and pollution. The reduction in the application of herbicides and fertilisers will also result in a reduction in water pollution.

7.2.13 Figures 7.2-7.4 shows the contrast between arable land and solar farm taken on May 22nd 2020 after relatively dry weather for the preceding two months. The arable land was noticeably harder under foot and exhibited significant cracks from shrinkage. Where the panels are located the ground was not as severely cracked and vegetation was lush, indicating better retention moisture within the soil.

Figure 7.2 – Arable land adjacent to solar farm

Figure 7.3 – Close up of arable ground

Figure 7.4 – Close up of solar farm ground

7.3 Managing Surface Water

7.3.1 The SuDS hierarchy demands that surface water runoff should be managed as high up the following list as practically possible:

- Into the ground (infiltration), 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.

7.3.2 In order to determine the most suitable method of surface water management, the options have been assessed below, with the highest option in the SuDS hierarchy used:

Infiltration

7.3.3 A desk study has assessed the likely potential of the area around the substation for infiltration and the use of soakaways. The BGS geology maps indicate that the site is underlain by mudstone and siltstone which are not suitable for soakaway. The overlying soil is clayey which drains slowly. Consequently, infiltration is not considered to be a viable method for the drainage system for the substation area.

Surface Water Body

7.3.4 The next option in the SuDS hierarchy is to discharge surface water runoff into a nearby surface water body at greenfield runoff rates. The nearest watercourse is located to the northeast of the substation within the application boundary. It is therefore proposed that surface water will discharge into this watercourse.

7.4 SuDS selection process

7.4.1 There are various methods of SuDS (Sustainable Drainage Systems) and their relative merits have been considered in the context of the site proposals. In this case it was concluded that an attenuation basin with swales for conveyance is the most appropriate approach to managing surface water.

7.5 Climate Change

7.5.1 The proposed drainage strategy has been designed to accommodate surface water flows without flooding up to, and including, the 1 in 100-year storm event plus climate change. For a solar farm development, the design life is expected to be 40 years and therefore the climate change allowance should be 20%, as shown in Table 7.1.

Table 7.1 – EA Peak Rainfall Intensity Allowance

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

7.6 Surface Water Strategy

Proposed Discharge Rates

7.6.1 Existing greenfield runoff rates have been calculated using ReFH2. This method uses the FEH point descriptors and specially derived plot-scale equations to determine greenfield runoff rates. It is considered to be the most up-to-date and accurate method available for calculating greenfield runoff rates.

7.6.2 The soils and geology of the FEH catchment have been reviewed, which suggests the catchment descriptors are reasonable. The FEH catchment boundary used is shown in Figure 6.1. The greenfield runoff rates are summarised in Table 7.3, with the calculations included in Appendix C.

Table 7.2 – Greenfield runoff rates for the site

Events	Greenfield runoff rates (l/s/ha)	Site greenfield runoff rates (l/s)
1 in 1 Year	5.34	531.7
1 in 2 year	6.68	665.1
1 in 30 Year	16.61	1,653.9
1 in 100 Year	22.64	2,254.3

Proposed Drainage Strategy

7.6.3 It is proposed to form an attenuation basin to manage runoff from the building associated with the exporting substation. The basin is designed to manage an impermeable area of $600m^2$ which is almost four times the area of the proposed building. This will allow it to manage runoff from the intervening area and provide a net betterment.

7.6.4 The basin will cover an area of approximately $150m^2$ have a maximum depth of 0.5m and 1 in 4 side slopes providing a total storage volume of $47.8m^3$ of storage.

7.6.5 During the design (1 in 100 year plus 20%) event the maximum depth of storage will be 0.325m utilising $27.6m^3$ of storage and leaving 0.175m of freeboard. At a depth of 0.4m an overflow arrangement should be included to prevent uncontrolled overtopping

7.6.6 Discharge from the basin will be controlled by a 50mm orifice contained within an inspection chamber to a maximum rate of 2.9l/s equivalent to approximately 0.1% of the calculated total site runoff. A smaller orifice would significantly increase the risk of blockage and this is therefore considered to by the minimum practicable discharge rate.

7.6.7 Water will be conveyed to and from the basin with swales. The swales will have a base width of 0.5m a depth of 0.5m and 1 in 1 side slopes. The swales will provide water treatment by means of filtration and settlement.

7.6.8 Discharge will be a via a 150m long swale to an Ordinary Watercourse. It is proposed that this swale is constructed at a gradient of 1 in 250.

7.6.9 All of the features should be sown with a native grass mix or similar and unlined to maximise infiltration. Over time the features will be colonised by local vegetation.

7.6.10 In rainfall events that exceed the 1 in 100 year return period, plus 20% climate change, the natural topography will direct flows away from the substation towards the attenuation basin. Should the capacity of the basin be exceeded, it is proposed that water will flow over a broad earth spill reinforced with geotextile and flow into the swale.

7.6.11 The drainage proposals are shown in Appendix D. The details of these features will be confirmed at detailed design stage.

7.7 Maintenance Regime

7.7.1 Maintenance of drainage features are essential so that the surface water drainage system operates effectively. The responsibility of maintaining the proposed drainage components will be either by the landowner or site operator.

7.7.2 The only formal drainage feature will be the swale and the basin. The maintenance activities associated with these features will be:

- Inspection of the outlet control and overflow spillway – biannually and after extreme rainfall events
- Vegetation cutting - biannually or in accordance with guidance from an ecologist.

7.8 Construction Management

7.8.1 During the construction of the solar farm there is potential for soil compaction and erosion through vehicular movements. It is recommended that these effects are duly considered as part of a Construction Environmental Management Plan.

7.8.2 It is recommended that following measures are considered:

- Use of low tyre pressure machinery to reduce compaction
- A delivery and construction schedule that minimises repeat journeys
- Temporary measures such as sediment traps using geotextiles, straw and temporary bunding

7.8.3 Following completion of the project it is recommended that the soil is adequately prepared and seeded with a native grass mix to facilitate rapid establishment of ground cover where it has been disturbed as part of the construction process.

8. Conclusions

8.1.1 The site falls within Flood Zone 1 and is at low risk of flooding from rivers and the sea. The proposals constitute 'Less Vulnerable' development and are appropriate in Flood Zone 1.

8.1.2 The site is not considered to be at risk of flooding from groundwater, sewers, reservoirs or other artificial sources.

8.1.3 The risk of flooding from Ordinary Watercourses and on-site ditches will be mitigated by no infrastructure being located adjacent to them. This of shallow surface water flooding risk will be mitigated by the solar panels and associated inverters being raised 0.8m above the ground.

8.1.4 The solar panels and containers housing batteries, inverters and storage dispersed across the site will have an insignificant impact on the response of the land to rainfall. These elements will be raised above the ground on footings or stanchions. This will preserve the existing ground below and allow for normal functioning of depression storage, absorption into the soil moisture store and infiltration.

8.1.5 Drainage for the building associated with the exporting substation will be managed in an attenuation basin. Drainage from the basin will be limited by a 50mm orifice to the minimum practicable discharge rate, which in this case is 2.3l/s. Water will be conveyed by swales which will slow the flow, encourage deposition and filtration and improve runoff quality.

8.1.6 Additionally, it is proposed that two storage features are created to store surface water runoff from fields in the Potwell Dyke catchment. The design should be developed in close consultation with Trent River Trust to maximise the reduction in flood risk downstream particularly in the village of Southwell.

8.1.7 The cessation of intensive agriculture across the 107ha site will allow establishment of natural grassland and a commensurate improvement in soil structure. This will reduce runoff rates and volumes, soil erosion and pollution.

8.1.8 In conclusion, the proposals will be safe from all forms of flooding and provide a betterment in terms of downstream flood risk and pollution and therefore meet the aims of NPPF with regards to flood risk and drainage.

Appendix A
Site Layout Plan

KEY

- Site Boundary
- Public Right of Way
- Public Right of Way (Through Site)
- Solar Panels
- Central Inverter
- Spares Container
- Customer Substation
- Battery Station
- CCTV Mast
- Vehicular Access
- Proposed Hedgerow
- Proposed Trees
- Grass - Solar Park Long Term Grazing Mix
- Field Margin Planting - EM2 Standard General Purpose Meadow Mix
- Existing Vegetation/Trees/Woodland
- Temporary Construction Compound
- Maintenance Track
- Maintenance Track (RPA)
- Security Fence
- Area for Biodiversity

Native Hedgerow Planting
30% Crataegus monogyna
25% Prunus spinosa
15% Acer campestre
15% Corylus avellana
10% Ilex aquifolium
5% Rosa canina

Native Trees
Acer campestre
Crataegus monogyna
Euonymus europaeus

Revisions:
First Issue- 28/11/2019 JS
A - (16/03/2020 JS) Revised layout and planting proposals added
B - (27/03/2020 JS) Revised boundary and biodiversity enhancement area added
C - (15/04/2020 JS) Revised boundary
D - (07/05/2020 JS) Grass mixes added
E - (13/05/2020 JS) Revised layout
F - (27/05/2020 JS) Revised layout and drainage
G - (03/06/2020 JS) Additional planting and notes added
H - (29/06/2020 JS) Revised layout

Site Layout and Planting Proposals

Cotmoor Solar Farm

Client: JBM Solar Projects 20 Ltd
DRWG No: P18-2917_12 Sheet No: _ REV: H
Drawn by : JS Approved by: SC
Date: 29/06/2020
Scale: 1:3000 @ A1

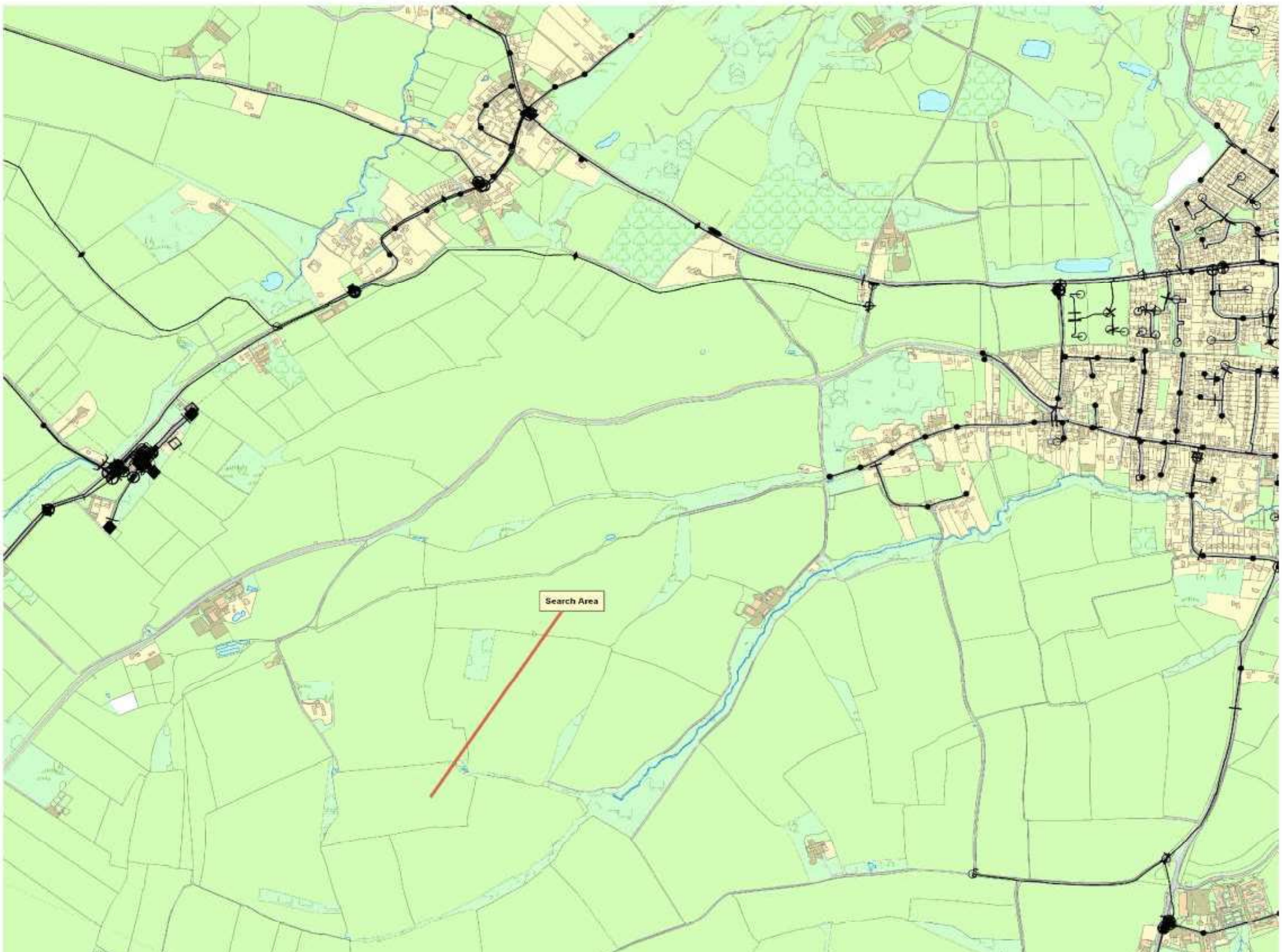
0 250m

Pegasus Environment

DESIGN | ENVIRONMENT | PLANNING | ECONOMICS | HERITAGE

Appendix B
Public Sewer Records

WATER RECORD Land on the South Side of, Oxton Road, Southwell, NG25 0QZ



Appendix C

Greenfield Runoff and Microdrainage Calculations

UK Design Flood Estimation

Generated on Tuesday, March 24, 2020 7:32:54 PM by Alex
Printed from the ReFH2 Flood Modelling software package, version 3.0.7275.28566

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details

Checksum: F5FB-8CB1

Site name: FEH_Point_Descriptors_468004_352731(1)

Easting: 468004

Northing: 352731

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.01

Using plot scale calculations: Yes

Model: ReFH2.3

Site description: None

Model run: 2 year

Summary of results

Rainfall - FEH 2013 model (mm):	15.62	Total runoff (ML):	0.04
Total Rainfall (mm):	9.11	Total flow (ML):	0.09
Peak Rainfall (mm):	1.38	Peak flow (m^3/s):	0.01

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	01:42:00	No
Timestep (hh:mm:ss)	00:06:00	No
SCF (Seasonal correction factor)	0.59	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Winter	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	128.57	No
Cmax (mm)	288.93	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	25.49	No
BR	1.17	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No
Exporting drained area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.1174	0.0000	0.0522	0.0000	0.000403	0.000403
00:06:00	0.1640	0.0000	0.0731	0.0000	0.000401	0.000406
00:12:00	0.2289	0.0000	0.1022	0.0000	0.000399	0.00042
00:18:00	0.3187	0.0000	0.1426	0.0001	0.000398	0.000451
00:24:00	0.4424	0.0000	0.1985	0.0001	0.000397	0.000503
00:30:00	0.6118	0.0000	0.2756	0.0002	0.000396	0.000587
00:36:00	0.8408	0.0000	0.3809	0.0003	0.000396	0.000714
00:42:00	1.1405	0.0000	0.5205	0.0005	0.000396	0.000902
00:48:00	1.3811	0.0000	0.6364	0.0008	0.000397	0.00117
00:54:00	1.1405	0.0000	0.5305	0.0011	0.0004	0.00155
01:00:00	0.8408	0.0000	0.3940	0.0016	0.000405	0.00203
01:06:00	0.6118	0.0000	0.2882	0.0022	0.000412	0.00259
01:12:00	0.4424	0.0000	0.2092	0.0028	0.000422	0.0032
01:18:00	0.3187	0.0000	0.1511	0.0034	0.000434	0.00383
01:24:00	0.2289	0.0000	0.1088	0.0040	0.00045	0.00446
01:30:00	0.1640	0.0000	0.0781	0.0046	0.000468	0.00507
01:36:00	0.1174	0.0000	0.0559	0.0051	0.000488	0.00562
01:42:00	0.0000	0.0000	0.0000	0.0056	0.000511	0.0061
01:48:00	0.0000	0.0000	0.0000	0.0059	0.000535	0.00646
01:54:00	0.0000	0.0000	0.0000	0.0061	0.00056	0.00665
02:00:00	0.0000	0.0000	0.0000	0.0061	0.000586	0.00668
02:06:00	0.0000	0.0000	0.0000	0.0060	0.000612	0.00657
02:12:00	0.0000	0.0000	0.0000	0.0057	0.000636	0.00637
02:18:00	0.0000	0.0000	0.0000	0.0054	0.000659	0.00611
02:24:00	0.0000	0.0000	0.0000	0.0051	0.000681	0.00579
02:30:00	0.0000	0.0000	0.0000	0.0048	0.000701	0.00545
02:36:00	0.0000	0.0000	0.0000	0.0044	0.000719	0.00509
02:42:00	0.0000	0.0000	0.0000	0.0040	0.000735	0.00474
02:48:00	0.0000	0.0000	0.0000	0.0036	0.00075	0.00439
02:54:00	0.0000	0.0000	0.0000	0.0033	0.000763	0.00409
03:00:00	0.0000	0.0000	0.0000	0.0030	0.000774	0.00381
03:06:00	0.0000	0.0000	0.0000	0.0028	0.000785	0.00356
03:12:00	0.0000	0.0000	0.0000	0.0025	0.000794	0.00333
03:18:00	0.0000	0.0000	0.0000	0.0023	0.000802	0.00311
03:24:00	0.0000	0.0000	0.0000	0.0021	0.000809	0.0029

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
03:30:00	0.0000	0.0000	0.0000	0.0019	0.000815	0.0027
03:36:00	0.0000	0.0000	0.0000	0.0017	0.00082	0.0025
03:42:00	0.0000	0.0000	0.0000	0.0015	0.000824	0.00231
03:48:00	0.0000	0.0000	0.0000	0.0013	0.000827	0.00212
03:54:00	0.0000	0.0000	0.0000	0.0011	0.000829	0.00193
04:00:00	0.0000	0.0000	0.0000	0.0009	0.00083	0.00175
04:06:00	0.0000	0.0000	0.0000	0.0007	0.000831	0.00158
04:12:00	0.0000	0.0000	0.0000	0.0006	0.000831	0.00141
04:18:00	0.0000	0.0000	0.0000	0.0004	0.00083	0.00126
04:24:00	0.0000	0.0000	0.0000	0.0003	0.000828	0.00114
04:30:00	0.0000	0.0000	0.0000	0.0002	0.000826	0.00103
04:36:00	0.0000	0.0000	0.0000	0.0001	0.000824	0.000961
04:42:00	0.0000	0.0000	0.0000	0.0001	0.000821	0.000907
04:48:00	0.0000	0.0000	0.0000	0.0001	0.000818	0.00087
04:54:00	0.0000	0.0000	0.0000	0.0000	0.000815	0.000844
05:00:00	0.0000	0.0000	0.0000	0.0000	0.000812	0.000826
05:06:00	0.0000	0.0000	0.0000	0.0000	0.000809	0.000814
05:12:00	0.0000	0.0000	0.0000	0.0000	0.000806	0.000807
05:18:00	0.0000	0.0000	0.0000	0.0000	0.000803	0.000803
05:24:00	0.0000	0.0000	0.0000	0.0000	0.000799	0.000799
05:30:00	0.0000	0.0000	0.0000	0.0000	0.000796	0.000796
05:36:00	0.0000	0.0000	0.0000	0.0000	0.000793	0.000793
05:42:00	0.0000	0.0000	0.0000	0.0000	0.00079	0.00079
05:48:00	0.0000	0.0000	0.0000	0.0000	0.000787	0.000787
05:54:00	0.0000	0.0000	0.0000	0.0000	0.000784	0.000784
06:00:00	0.0000	0.0000	0.0000	0.0000	0.000781	0.000781
06:06:00	0.0000	0.0000	0.0000	0.0000	0.000778	0.000778
06:12:00	0.0000	0.0000	0.0000	0.0000	0.000775	0.000775
06:18:00	0.0000	0.0000	0.0000	0.0000	0.000772	0.000772
06:24:00	0.0000	0.0000	0.0000	0.0000	0.000769	0.000769
06:30:00	0.0000	0.0000	0.0000	0.0000	0.000766	0.000766
06:36:00	0.0000	0.0000	0.0000	0.0000	0.000763	0.000763
06:42:00	0.0000	0.0000	0.0000	0.0000	0.00076	0.00076
06:48:00	0.0000	0.0000	0.0000	0.0000	0.000757	0.000757
06:54:00	0.0000	0.0000	0.0000	0.0000	0.000754	0.000754
07:00:00	0.0000	0.0000	0.0000	0.0000	0.000751	0.000751

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
07:06:00	0.0000	0.0000	0.0000	0.0000	0.000748	0.000748
07:12:00	0.0000	0.0000	0.0000	0.0000	0.000745	0.000745
07:18:00	0.0000	0.0000	0.0000	0.0000	0.000742	0.000742
07:24:00	0.0000	0.0000	0.0000	0.0000	0.000739	0.000739
07:30:00	0.0000	0.0000	0.0000	0.0000	0.000736	0.000736
07:36:00	0.0000	0.0000	0.0000	0.0000	0.000733	0.000733
07:42:00	0.0000	0.0000	0.0000	0.0000	0.000731	0.000731
07:48:00	0.0000	0.0000	0.0000	0.0000	0.000728	0.000728
07:54:00	0.0000	0.0000	0.0000	0.0000	0.000725	0.000725
08:00:00	0.0000	0.0000	0.0000	0.0000	0.000722	0.000722
08:06:00	0.0000	0.0000	0.0000	0.0000	0.000719	0.000719
08:12:00	0.0000	0.0000	0.0000	0.0000	0.000716	0.000716
08:18:00	0.0000	0.0000	0.0000	0.0000	0.000714	0.000714
08:24:00	0.0000	0.0000	0.0000	0.0000	0.000711	0.000711
08:30:00	0.0000	0.0000	0.0000	0.0000	0.000708	0.000708
08:36:00	0.0000	0.0000	0.0000	0.0000	0.000705	0.000705
08:42:00	0.0000	0.0000	0.0000	0.0000	0.000702	0.000702
08:48:00	0.0000	0.0000	0.0000	0.0000	0.0007	0.0007
08:54:00	0.0000	0.0000	0.0000	0.0000	0.000697	0.000697
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000694	0.000694
09:06:00	0.0000	0.0000	0.0000	0.0000	0.000691	0.000691
09:12:00	0.0000	0.0000	0.0000	0.0000	0.000689	0.000689
09:18:00	0.0000	0.0000	0.0000	0.0000	0.000686	0.000686
09:24:00	0.0000	0.0000	0.0000	0.0000	0.000683	0.000683
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000681	0.000681
09:36:00	0.0000	0.0000	0.0000	0.0000	0.000678	0.000678
09:42:00	0.0000	0.0000	0.0000	0.0000	0.000675	0.000675
09:48:00	0.0000	0.0000	0.0000	0.0000	0.000673	0.000673
09:54:00	0.0000	0.0000	0.0000	0.0000	0.00067	0.00067
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000667	0.000667
10:06:00	0.0000	0.0000	0.0000	0.0000	0.000665	0.000665
10:12:00	0.0000	0.0000	0.0000	0.0000	0.000662	0.000662
10:18:00	0.0000	0.0000	0.0000	0.0000	0.00066	0.00066
10:24:00	0.0000	0.0000	0.0000	0.0000	0.000657	0.000657
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000655	0.000655
10:36:00	0.0000	0.0000	0.0000	0.0000	0.000652	0.000652

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
10:42:00	0.0000	0.0000	0.0000	0.0000	0.000649	0.000649
10:48:00	0.0000	0.0000	0.0000	0.0000	0.000647	0.000647
10:54:00	0.0000	0.0000	0.0000	0.0000	0.000644	0.000644
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000642	0.000642
11:06:00	0.0000	0.0000	0.0000	0.0000	0.000639	0.000639
11:12:00	0.0000	0.0000	0.0000	0.0000	0.000637	0.000637
11:18:00	0.0000	0.0000	0.0000	0.0000	0.000634	0.000634
11:24:00	0.0000	0.0000	0.0000	0.0000	0.000632	0.000632
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000629	0.000629
11:36:00	0.0000	0.0000	0.0000	0.0000	0.000627	0.000627
11:42:00	0.0000	0.0000	0.0000	0.0000	0.000624	0.000624
11:48:00	0.0000	0.0000	0.0000	0.0000	0.000622	0.000622
11:54:00	0.0000	0.0000	0.0000	0.0000	0.00062	0.00062
12:00:00	0.0000	0.0000	0.0000	0.0000	0.000617	0.000617
12:06:00	0.0000	0.0000	0.0000	0.0000	0.000615	0.000615
12:12:00	0.0000	0.0000	0.0000	0.0000	0.000612	0.000612
12:18:00	0.0000	0.0000	0.0000	0.0000	0.00061	0.00061
12:24:00	0.0000	0.0000	0.0000	0.0000	0.000608	0.000608
12:30:00	0.0000	0.0000	0.0000	0.0000	0.000605	0.000605
12:36:00	0.0000	0.0000	0.0000	0.0000	0.000603	0.000603
12:42:00	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
12:48:00	0.0000	0.0000	0.0000	0.0000	0.000598	0.000598
12:54:00	0.0000	0.0000	0.0000	0.0000	0.000596	0.000596
13:00:00	0.0000	0.0000	0.0000	0.0000	0.000593	0.000593
13:06:00	0.0000	0.0000	0.0000	0.0000	0.000591	0.000591
13:12:00	0.0000	0.0000	0.0000	0.0000	0.000589	0.000589
13:18:00	0.0000	0.0000	0.0000	0.0000	0.000586	0.000586
13:24:00	0.0000	0.0000	0.0000	0.0000	0.000584	0.000584
13:30:00	0.0000	0.0000	0.0000	0.0000	0.000582	0.000582
13:36:00	0.0000	0.0000	0.0000	0.0000	0.00058	0.00058
13:42:00	0.0000	0.0000	0.0000	0.0000	0.000577	0.000577
13:48:00	0.0000	0.0000	0.0000	0.0000	0.000575	0.000575
13:54:00	0.0000	0.0000	0.0000	0.0000	0.000573	0.000573
14:00:00	0.0000	0.0000	0.0000	0.0000	0.000571	0.000571
14:06:00	0.0000	0.0000	0.0000	0.0000	0.000568	0.000568
14:12:00	0.0000	0.0000	0.0000	0.0000	0.000566	0.000566

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
14:18:00	0.0000	0.0000	0.0000	0.0000	0.000564	0.000564
14:24:00	0.0000	0.0000	0.0000	0.0000	0.000562	0.000562
14:30:00	0.0000	0.0000	0.0000	0.0000	0.000559	0.000559
14:36:00	0.0000	0.0000	0.0000	0.0000	0.000557	0.000557
14:42:00	0.0000	0.0000	0.0000	0.0000	0.000555	0.000555
14:48:00	0.0000	0.0000	0.0000	0.0000	0.000553	0.000553
14:54:00	0.0000	0.0000	0.0000	0.0000	0.000551	0.000551
15:00:00	0.0000	0.0000	0.0000	0.0000	0.000549	0.000549
15:06:00	0.0000	0.0000	0.0000	0.0000	0.000546	0.000546
15:12:00	0.0000	0.0000	0.0000	0.0000	0.000544	0.000544
15:18:00	0.0000	0.0000	0.0000	0.0000	0.000542	0.000542
15:24:00	0.0000	0.0000	0.0000	0.0000	0.00054	0.00054
15:30:00	0.0000	0.0000	0.0000	0.0000	0.000538	0.000538
15:36:00	0.0000	0.0000	0.0000	0.0000	0.000536	0.000536
15:42:00	0.0000	0.0000	0.0000	0.0000	0.000534	0.000534
15:48:00	0.0000	0.0000	0.0000	0.0000	0.000532	0.000532
15:54:00	0.0000	0.0000	0.0000	0.0000	0.00053	0.00053
16:00:00	0.0000	0.0000	0.0000	0.0000	0.000528	0.000528
16:06:00	0.0000	0.0000	0.0000	0.0000	0.000525	0.000525
16:12:00	0.0000	0.0000	0.0000	0.0000	0.000523	0.000523
16:18:00	0.0000	0.0000	0.0000	0.0000	0.000521	0.000521
16:24:00	0.0000	0.0000	0.0000	0.0000	0.000519	0.000519
16:30:00	0.0000	0.0000	0.0000	0.0000	0.000517	0.000517
16:36:00	0.0000	0.0000	0.0000	0.0000	0.000515	0.000515
16:42:00	0.0000	0.0000	0.0000	0.0000	0.000513	0.000513
16:48:00	0.0000	0.0000	0.0000	0.0000	0.000511	0.000511
16:54:00	0.0000	0.0000	0.0000	0.0000	0.000509	0.000509
17:00:00	0.0000	0.0000	0.0000	0.0000	0.000507	0.000507
17:06:00	0.0000	0.0000	0.0000	0.0000	0.000505	0.000505
17:12:00	0.0000	0.0000	0.0000	0.0000	0.000503	0.000503
17:18:00	0.0000	0.0000	0.0000	0.0000	0.000501	0.000501
17:24:00	0.0000	0.0000	0.0000	0.0000	0.000499	0.000499
17:30:00	0.0000	0.0000	0.0000	0.0000	0.000497	0.000497
17:36:00	0.0000	0.0000	0.0000	0.0000	0.000495	0.000495
17:42:00	0.0000	0.0000	0.0000	0.0000	0.000493	0.000493
17:48:00	0.0000	0.0000	0.0000	0.0000	0.000492	0.000492

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:54:00	0.0000	0.0000	0.0000	0.0000	0.00049	0.00049
18:00:00	0.0000	0.0000	0.0000	0.0000	0.000488	0.000488
18:06:00	0.0000	0.0000	0.0000	0.0000	0.000486	0.000486
18:12:00	0.0000	0.0000	0.0000	0.0000	0.000484	0.000484
18:18:00	0.0000	0.0000	0.0000	0.0000	0.000482	0.000482
18:24:00	0.0000	0.0000	0.0000	0.0000	0.00048	0.00048
18:30:00	0.0000	0.0000	0.0000	0.0000	0.000478	0.000478
18:36:00	0.0000	0.0000	0.0000	0.0000	0.000476	0.000476
18:42:00	0.0000	0.0000	0.0000	0.0000	0.000474	0.000474
18:48:00	0.0000	0.0000	0.0000	0.0000	0.000473	0.000473
18:54:00	0.0000	0.0000	0.0000	0.0000	0.000471	0.000471
19:00:00	0.0000	0.0000	0.0000	0.0000	0.000469	0.000469
19:06:00	0.0000	0.0000	0.0000	0.0000	0.000467	0.000467
19:12:00	0.0000	0.0000	0.0000	0.0000	0.000465	0.000465
19:18:00	0.0000	0.0000	0.0000	0.0000	0.000463	0.000463
19:24:00	0.0000	0.0000	0.0000	0.0000	0.000462	0.000462
19:30:00	0.0000	0.0000	0.0000	0.0000	0.00046	0.00046
19:36:00	0.0000	0.0000	0.0000	0.0000	0.000458	0.000458
19:42:00	0.0000	0.0000	0.0000	0.0000	0.000456	0.000456
19:48:00	0.0000	0.0000	0.0000	0.0000	0.000454	0.000454
19:54:00	0.0000	0.0000	0.0000	0.0000	0.000453	0.000453
20:00:00	0.0000	0.0000	0.0000	0.0000	0.000451	0.000451
20:06:00	0.0000	0.0000	0.0000	0.0000	0.000449	0.000449
20:12:00	0.0000	0.0000	0.0000	0.0000	0.000447	0.000447
20:18:00	0.0000	0.0000	0.0000	0.0000	0.000446	0.000446
20:24:00	0.0000	0.0000	0.0000	0.0000	0.000444	0.000444
20:30:00	0.0000	0.0000	0.0000	0.0000	0.000442	0.000442
20:36:00	0.0000	0.0000	0.0000	0.0000	0.00044	0.00044
20:42:00	0.0000	0.0000	0.0000	0.0000	0.000439	0.000439
20:48:00	0.0000	0.0000	0.0000	0.0000	0.000437	0.000437
20:54:00	0.0000	0.0000	0.0000	0.0000	0.000435	0.000435
21:00:00	0.0000	0.0000	0.0000	0.0000	0.000434	0.000434
21:06:00	0.0000	0.0000	0.0000	0.0000	0.000432	0.000432
21:12:00	0.0000	0.0000	0.0000	0.0000	0.00043	0.00043
21:18:00	0.0000	0.0000	0.0000	0.0000	0.000428	0.000428
21:24:00	0.0000	0.0000	0.0000	0.0000	0.000427	0.000427

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
21:30:00	0.0000	0.0000	0.0000	0.0000	0.000425	0.000425
21:36:00	0.0000	0.0000	0.0000	0.0000	0.000423	0.000423
21:42:00	0.0000	0.0000	0.0000	0.0000	0.000422	0.000422
21:48:00	0.0000	0.0000	0.0000	0.0000	0.00042	0.00042
21:54:00	0.0000	0.0000	0.0000	0.0000	0.000419	0.000419
22:00:00	0.0000	0.0000	0.0000	0.0000	0.000417	0.000417
22:06:00	0.0000	0.0000	0.0000	0.0000	0.000415	0.000415
22:12:00	0.0000	0.0000	0.0000	0.0000	0.000414	0.000414
22:18:00	0.0000	0.0000	0.0000	0.0000	0.000412	0.000412
22:24:00	0.0000	0.0000	0.0000	0.0000	0.00041	0.00041
22:30:00	0.0000	0.0000	0.0000	0.0000	0.000409	0.000409
22:36:00	0.0000	0.0000	0.0000	0.0000	0.000407	0.000407
22:42:00	0.0000	0.0000	0.0000	0.0000	0.000406	0.000406

Appendix

Catchment descriptors

Name	Value	User-defined value used?
BFIHOST	0.36	No
BFIHOST19	0.35	No
PROPWET (mm)	0.27	No
SAAR (mm)	637	No

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.211	0.211	2.2	16.7	Flood Risk
30 min Summer	0.258	0.258	2.5	21.0	Flood Risk
60 min Summer	0.288	0.288	2.7	23.9	Flood Risk
120 min Summer	0.294	0.294	2.7	24.4	Flood Risk
180 min Summer	0.292	0.292	2.7	24.3	Flood Risk
240 min Summer	0.287	0.287	2.7	23.8	Flood Risk
360 min Summer	0.272	0.272	2.6	22.3	Flood Risk
480 min Summer	0.255	0.255	2.5	20.7	Flood Risk
600 min Summer	0.238	0.238	2.4	19.1	Flood Risk
720 min Summer	0.222	0.222	2.3	17.7	Flood Risk
960 min Summer	0.194	0.194	2.1	15.2	O K
1440 min Summer	0.153	0.153	1.9	11.6	O K
2160 min Summer	0.113	0.113	1.6	8.4	O K
2880 min Summer	0.090	0.090	1.3	6.6	O K
4320 min Summer	0.068	0.068	1.0	4.9	O K
5760 min Summer	0.058	0.058	0.8	4.2	O K
7200 min Summer	0.052	0.052	0.7	3.7	O K
8640 min Summer	0.048	0.048	0.6	3.4	O K
10080 min Summer	0.045	0.045	0.6	3.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.340	0.0	17.9	19
30 min Summer	86.474	0.0	23.6	33
60 min Summer	54.023	0.0	29.6	60
120 min Summer	31.986	0.0	35.1	92
180 min Summer	23.540	0.0	38.8	126
240 min Summer	18.916	0.0	41.5	160
360 min Summer	13.848	0.0	45.6	228
480 min Summer	11.074	0.0	48.6	294
600 min Summer	9.288	0.0	51.0	360
720 min Summer	8.030	0.0	52.9	424
960 min Summer	6.352	0.0	55.8	550
1440 min Summer	4.540	0.0	59.8	794
2160 min Summer	3.230	0.0	63.9	1148
2880 min Summer	2.538	0.0	66.9	1500
4320 min Summer	1.811	0.0	71.6	2204
5760 min Summer	1.434	0.0	75.7	2936
7200 min Summer	1.205	0.0	79.5	3672
8640 min Summer	1.051	0.0	83.2	4400
10080 min Summer	0.941	0.0	86.8	5136

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	0.234	0.234	2.4	18.8	Flood Risk
30 min Winter	0.286	0.286	2.7	23.7	Flood Risk
60 min Winter	0.321	0.321	2.8	27.1	Flood Risk
120 min Winter	0.325	0.325	2.9	27.6	Flood Risk
180 min Winter	0.320	0.320	2.8	27.1	Flood Risk
240 min Winter	0.311	0.311	2.8	26.2	Flood Risk
360 min Winter	0.287	0.287	2.7	23.8	Flood Risk
480 min Winter	0.262	0.262	2.5	21.4	Flood Risk
600 min Winter	0.239	0.239	2.4	19.2	Flood Risk
720 min Winter	0.217	0.217	2.3	17.2	Flood Risk
960 min Winter	0.180	0.180	2.1	14.0	O K
1440 min Winter	0.130	0.130	1.7	9.7	O K
2160 min Winter	0.088	0.088	1.3	6.5	O K
2880 min Winter	0.069	0.069	1.1	5.0	O K
4320 min Winter	0.055	0.055	0.8	4.0	O K
5760 min Winter	0.048	0.048	0.6	3.4	O K
7200 min Winter	0.043	0.043	0.5	3.1	O K
8640 min Winter	0.040	0.040	0.5	2.8	O K
10080 min Winter	0.037	0.037	0.4	2.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	131.340	0.0	20.1	18
30 min Winter	86.474	0.0	26.5	32
60 min Winter	54.023	0.0	33.2	60
120 min Winter	31.986	0.0	39.3	96
180 min Winter	23.540	0.0	43.4	136
240 min Winter	18.916	0.0	46.5	172
360 min Winter	13.848	0.0	51.1	246
480 min Winter	11.074	0.0	54.5	314
600 min Winter	9.288	0.0	57.1	382
720 min Winter	8.030	0.0	59.3	448
960 min Winter	6.352	0.0	62.5	572
1440 min Winter	4.540	0.0	67.0	810
2160 min Winter	3.230	0.0	71.6	1168
2880 min Winter	2.538	0.0	75.0	1500
4320 min Winter	1.811	0.0	80.2	2208
5760 min Winter	1.434	0.0	84.8	2944
7200 min Winter	1.205	0.0	89.0	3592
8640 min Winter	1.051	0.0	93.2	4416
10080 min Winter	0.941	0.0	97.2	5144

Model Details

Storage is Online Cover Level (m) 0.500

Tank or Pond Structure

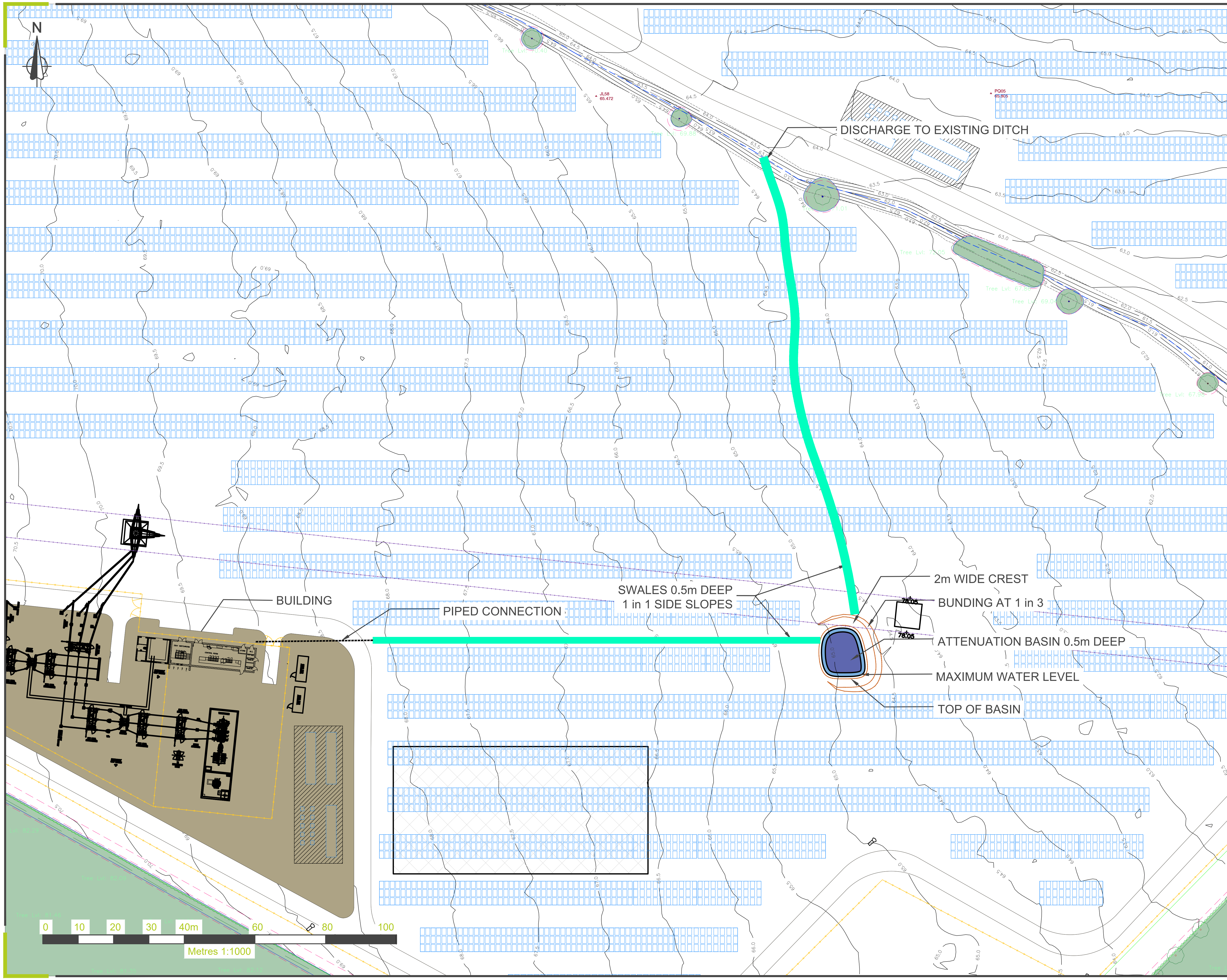
Invert Level (m) 0.000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	69.0	0.300	99.0	0.500	122.0

Orifice Outflow Control

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 0.000

Appendix D
Surface Water Drainage Proposals



NOTES

1. THIS DRAWING IS A SURFACE WATER DRAINAGE STRATEGY AND IS NOT SUITABLE FOR CONSTRUCTION PURPOSES

2. THE DISCHARGE SWALE ALIGNMENT IS INDICATIVE AND SHOULD BE DESIGNED TO AVOID SOLAR PANEL STANCHIONS WHERE POSSIBLE.

3. DISCHARGE FROM THE ATTENUATION BASIN SHOULD BE RESTRICTED USING A 50mm ORIFICE SET AT THE INVERT LEVEL OF THE BASIN

4. A FOREBAY SHOULD BE CREATED NEAR THE INLET OF THE ATTENUATION BASIN TO ENCOURAGE SEDIMENTATION AND REDUCE THE RISK OF BLOCKAGE.

5, A SPILLWAY SHOULD BE CREATED AT A STORAGE DEPTH OF 0.4, TO ALLOW CONTROLLED OVERFLOW INTO THE DISCHARGE SWALE IN CASE OF EXCEEDANCE.

REV:	DESCRIPTION:	BY:	DATE:
02	for information	AB	29/06/20
01	for information	AB	28/05/20
-	for information	AB	31/03/20

STATUS: for information

CLIENT: JBM Solar Ltd

SITE: Cotmoor Solar Farm Nottinghamshire

TITLE: Surface Water Drainage Proposals

calibro
transport, highway & infrastructure consultants
t: 0117 2441 970 www.calibro-consultants.com

SCALE AT A3:	DATE:	DRAWN:	CHECKED:
1:1000 @ A3	28/05/20	AB	WW
PROJECT NO:		DRAWING NO:	REVISION:
BR-629-0007		100	02

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