FENWICK SOLAR FARM

Preliminary Environmental Information Report

Volume III Appendix 9-4: Preliminary Drainage Strategy

March 2024

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Prepared for:
Fenwick Solar Project Limited

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1. Introduction

1.1 Scheme Description and Background

1.1.1 AECOM has been commissioned to prepare a concept Drainage Strategy (DS) as an appendix to the Preliminary Environmental Information Report (PEIR) prepared to inform Fenwick Solar Farm's ('the Scheme') statutory consultation process. The Scheme is located approximately 6 km north of the city of Doncaster, South Yorkshire, UK.

1.1.2 The Scheme would comprise the construction, operation and maintenance, and decommissioning of a solar photovoltaic (PV) electricity generating facility with a total capacity exceeding 50 megawatts (MW) together with energy storage (referred to as the Battery Energy Storage System (BESS)) and an export connection to the National Grid via the Existing National Grid Thorpe Marsh Substation. The Scheme will be located within the 'Site' and will be the subject of the DCO Application. Further information on the Scheme is included within **PEIR Volume I Chapter 2: The Scheme.**

1.1.3 The land on which the Scheme is located comprises three main areas, referred to collectively as 'the Site':

a. The 'Solar PV Site', which is the location where ground mounted Solar photovoltaic (PV) Panels, electrical sub-stations and energy storage facilities would be installed;

b. The 'Grid Connection Corridor', which includes some local roads which may be impacted by the Scheme; and

c. The 'Existing National Grid Thorpe Marsh Substation', the area located within the existing compound for the National Grid's Thorpe Marsh Substation.

1.1.4 The Site is located within South Yorkshire and falls within the City of Doncaster Council's administrative area.

1.1.5 This Preliminary Drainage Strategy solely relates to the preliminary drainage design of the Solar PV Site, and relates to the handling surface water generated by new impermeable areas within this part of the Site. The strategy only considers the drainage of the Solar PV Site during Scheme operation.

1.1.6 No drainage design is proposed for the Grid Connection Corridor during operation, as the Grid Connection Cables would be buried below ground with the above ground routes restored to greenfield conditions. Therefore, the Grid Connection Corridor is deemed to not contribute any additional surface water runoff. Similarly, no drainage design is proposed for the Existing National Grid Thorpe Marsh Substation, which is deemed to not contribute any additional surface water runoff.

1.1.7 The Solar PV Site comprises an area of approximately 421 ha comprised predominantly of agricultural fields. The topography of the area is relatively flat, with existing ground levels under 10 m Above Ordnance Datum (AOD) according to online Ordnance Survey (OS) mapping. There are flood plains associated with the River Went at the northern extent of the Solar PV site. In addition, there are numerous other Ordinary Watercourses within the Site Boundary that fall under the jurisdiction of the Lead Local Flood Authority, the City of Doncaster Council, or Danvm Internal Drainage Board. These watercourses drain surface water from the surrounding agricultural areas.

1.1.8 A Framework Construction Environment Management Plan (CEMP) (**PEIR Volume III Appendix 2-1: Framework Construction Environmental Management Plan (CEMP)**) has been prepared which incorporates measures aimed at preventing flood risk during the construction works.

1.1.9 This Preliminary Drainage Strategy will be reviewed prior to the DCO Application submission, having regard to comments by applicable stakeholders.

1.1.10 The following stakeholders will be consulted during the PEIR consultation where applicable:

a. Lead Local Flood Authority – City of Doncaster Council;

b. The Environment Agency; and

c. Danvm Drainage Commissioners, part of the Yorkshire and Humber Drainage Boards.

1.2 Design Assumptions

1.2.1 The following design assumptions have been used to produce this preliminary strategy:

a. The Solar PV Panels would be raised from the ground, allowing rainfall/runoff to infiltrate into the ground beneath the Solar PV Panels. Where there are natural slopes, the ground would be restored under the Solar PV Panels with contour scraping. This would encourage surface flow to sit on the slopes and infiltrate rather than forming preferential flow paths down slopes. Therefore, the Solar PV Panels would not lead to a substantive increase in impermeable area within the Solar PV Site. The drainage regime of the Solar PV Panels areas is therefore assumed to remain consistent with its pre-developed state.

b. The BESS Area requires some areas of hardstanding, namely; the service roads, BESS Battery Containers, fire substation and control areas, and water tank within the BESS Area –these areas are considered to be 100% impermeable. The On-Site Substation within the Solar PV Site is considered to be 100% impermeable as a worst-case scenario. It has also been assumed that 100% of the runoff from these areas would contribute to the drainage system, and therefore a Volumetric Runoff Coefficient (Cv) of 1 has been used.

c. New access roads would be permeable outside of the BESS Area. Therefore, the wider Solar PV Site's access roads would not lead to an increase in impermeable area. The drainage regime of the access roads is therefore assumed to remain consistent with its pre-developed state.

d. The drainage system for new impermeable areas has been designed to accommodate the 1 in 100-year storm, plus a 40% allowance for an increase in peak rainfall intensity due to climate change.

e. The discharge of surface water for new impermeable areas via infiltration is unlikely to be viable due to ground conditions. This could be confirmed with on-site Ground Investigation works during the detailed design stage following DCO consent.

f. Flood Estimation Handbook (FEH) 2022 rainfall data has been used for this assessment.

2. Supporting Information

2.1 Flood Risk

2.1.1 The potential flood risk to the Scheme is summarised in Table 1. For further detail on the Scheme's potential flood risk, refer to the Preliminary Flood Risk Assessment provided at **PEIR Volume III Appendix 9-3: Preliminary Flood Risk Assessment**.

Table 2-1: Flood Risk Summary for Solar PV Site

Flood Risk Source	Pre-Scheme Flood Risk Level	Post-Scheme Flood Risk Level	Comments
Fluvial	Low (south, west), high (north, east)	Low (majority of Solar PV Site)	Discharge from impermeable areas detailed in the Preliminary Drainage Strategy are to be restricted to Greenfield rates, mitigating increases to peak river flow rates. The Environment Agency's Flood Map for Planning (Ref. 1) shows the majority of the south and west areas are within Flood Zone 1, including the BESS Area and On-Site Substation. The north and east areas are located within Flood Zone 2/3 associated with the River Went and Fleet Drain. Areas of Flood Zone 3 within the Solar PV Site are shown to be in areas where there is a reduction in risk of flooding from rivers and the sea due to the presence of flood defences.

Flood Risk Source	Pre-Scheme Flood Risk Level	Post-Scheme Flood Risk Level	Comments
Tidal	Low	Low	The closest tidal source to the Solar PV Site is the River Don, which is tidally influenced, near to the Site. The River Don is located approximately 3.6 km to the south of the Solar PV Site. The Humber Estuary is another tidal source in the surrounding area, the tidal limit of the Humber Estuary is located approximately 14 km to the north east of the Site. Due to the distance from the tidal sources, the flood risk to the Solar PV Site from tidal flooding is considered to be low.
Pluvial (surface water)	Very Low (majority), Low-High (localised areas)	Low	Increased surface water runoff is proposed to be managed to mimic the pre-Scheme conditions for up to and including the 1 in 100 + 40% climate change event.
Groundwater	Low	Low	The Doncaster Strategic Flood Risk Assessment (Ref. 2) indicates that the Solar PV Site is located in an area where there is a <25% chance of groundwater emergence.
Sewers	Very Low	Very Low	No change to flood risk level.

Flood Risk Source	Pre-Scheme Flood Risk Level	Post-Scheme Flood Risk Level	Comments
Artificial Sources	Low	Low	The Environment Agency's Long Term Flood Risk Map (Ref. 3) the majority of the Grid Connection Corridor is located within an area at risk of flooding from reservoirs when there is also flooding from rivers. The consequences from reservoir failure can be severe, however, the Environment Agency note that this is a worst-case prediction; reservoirs are maintained to a very high standard and are extremely unlikely to fail.

2.2 Existing Surface Water Drainage

2.2.1 The area within the Solar PV Site is largely greenfield. It consists of mainly agricultural fields (arable) with smaller areas of individual trees, hedgerows, tree belts (linear), watercourses and ditches.

2.2.2 Within the Solar PV Site there is Fenwick Common Drain which flows in an east to north east direction towards Fleet Drain. Fleet Drain is located within the Solar PV Site and flows north east until flowing directly north towards its confluence with the River Went. Ell Wood and Fenwick Grange Drain (Ordinary Watercourse) flows in an easterly direction, along the southern edge of the Solar PV Site beginning north of Moss at the south west corner of the Solar PV Site. There are multiple other smaller unnamed agricultural ditches and drains located within the Solar PV Site, which are likely to drain to these surface water features.

2.2.3 For existing land/field drains it is recommended to contact the relevant water company and Danvm Drainage Commissioners, part of the Yorkshire and Humber Drainage Board to agree discharge rates and locations. This should be undertaken during the next phase of the Scheme.

2.3 Geology and Hydrogeology

2.3.1 The Soilscape map viewer (Ref. 4) describes the soils beneath the Solar PV Site as *"slowly permeable seasonally wet, slightly acid but base-rich loamy and clayey soils".* As such the ground is considered unsuitable for infiltration at this stage - further ground investigation may be undertaken to confirm this at a later stage of the project.

2.3.2 Groundwater vulnerability for the Solar PV Site is generally low, however, there are small areas of medium/medium to high vulnerability where the Breighton Sand Formation and the alluvial deposits are mapped in the Solar

PV Site and the surrounding 1 km Study Area. It should be noted that there is a Principal and Secondary B Aquifer underlaying the Solar PV Site.

2.3.3 No site-specific ground investigation information is currently available, however, a review of selected British Geological Survey (BGS) borehole records has been undertaken. The borehole logs indicate that shallow groundwater between 0.6 m and 3 m is likely to be encountered within the underlying Sherwood Sandstone. The groundwater within the Solar PV Site generally flows in a north easterly direction.

3. Proposed Surface Water Drainage Strategy

3.1 Overview

3.1.1 At this stage of the development of the Scheme design, the drainage strategy is limited to the assessment of required attenuation storage. As the Scheme is further developed, the strategy will be refined. Presented here is a high-level description of the intended drainage system as it is currently envisioned.

3.1.2 As the Solar PV Site is largely a greenfield site, it is considered that rainfall will currently permeate into the ground where it falls, and that any runoff generated within arable fields collects in local low spots where it naturally infiltrates to ground or enters a watercourse. The topography of the Solar PV Site is relatively flat, with existing ground levels under 10 m AOD according to online OS mapping. The proposed Surface Water Drainage Strategy aims to mimic the natural drainage conditions of the Solar PV Site as far as possible.

3.1.3 The Solar PV Panels would be held above ground typically on narrow (<100 mm) diameter piled legs. This prevents sealing the ground with an impermeable surface and would allow any rainwater to infiltrate into the ground. In order to limit the potential for channelisation from rainfall dripping off the end of the Solar PV Panels, the areas between, under and surrounding the Solar PV Panels would be planted with native grassland and the ground shaped with light rolling following natural contours. This planting and shaping would intercept and absorb rainfall running off the Solar PV Panels, preventing it from concentrating and potentially forming channels in the ground.

3.1.4 The BESS infrastructure and On-Site Substation are assumed to be 100% impermeable. In order to drain surface water from these proposed impermeable areas, it is proposed to construct a swale around the BESS Area and On-Site Substation. The swale would collect and treat surface water before discharge. Due to the expected low permeability of the area, it is proposed the primary discharge from the Solar PV Site would be to local watercourses. The discharge to these watercourses would be maintained at existing greenfield runoff rates through the use of flow control structures. The flow control would use a restriction on the outlet of the swale which would hold water back within the swale and release it at a controlled rate.

3.1.5 A key consideration of BESS sites is the management of fire water. Swales around the BESS Area and On-Site Substation would be lined with an impermeable membrane or similar to prevent any pollution associated with fire water runoff from entering the ground. Penstocks would also be used in the event of a fire to prevent any pollution associated with fire water runoff from entering the local watercourses without prior testing. The swale would be sized to store surface water and fire water. This is described further in Section 3.9 herein.

3.1.6 In the event of an extreme event, which is an event greater than the design event, the drainage system would likely become inundated and overtop. In this scenario exceedance flows would escape the swale. The swale would be designed to guide this flow to a watercourse without impacting any infrastructure.

3.2 Contributing Areas

3.2.1 The new impermeable areas within the Solar PV Site are related to the BESS Area and On-Site Substation. The BESS Area would be located on the south west side of the Solar PV Site and would have an area of 51,880 m^2. The On-Site Substation would have an area of 20,000 m^2 providing a total area of 71,880 m^2 (approximately 7.2 ha). Of this area, the service roads, BESS Battery Containers, fire substation and control areas, and four fire water tanks within the BESS Area are all considered as 100% impermeable, accounting for an area of 44305 m^2. All of the On-Site Substation is considered 100% impermeable. The total impermeable area is thus 64305 m^2 (approximately 6.4 ha).

3.2.2 A Volumetric Runoff Coefficient (Cv) of 1 has been used in this design as 100% of the runoff is contributing to the drainage system.

3.3 Greenfield Run-off Rates

3.3.1 The equivalent greenfield runoff rates for the BESS Area and On-Site Substation have been calculated for the Solar PV Site using HR Wallingford’s UKSuDS Greenfield Runoff Rate Estimation tool, based on the proposed contributing impermeable area. Refer to Annex B for the calculated rates. For this calculation, the total impermeable areas for the BESS Battey Containers and On-Site Substation were considered together for greenfield discharge rates, as shown in Table 3-1.

Table 3-1: Greenfield Discharge Rates (Combined BESS Area and On-Site Substation)

Return Period (Years)	Discharge Rate (l/s) (6.4 ha)
2	31
10	53
30	68
30 + 35% CC	94
100	88
100 + 40% CC	127

3.4 Proposed Attenuation

3.4.1 Attenuation would be required within the Solar PV Site to temporarily store surface water runoff generated from the BESS Area and On-Site Substation. The storage would be spread across the Solar PV Site and the stored water discharged to the surrounding watercourses at the restricted greenfield rate. Attenuation would be provided in the form of swales surrounding the BESS Area and On-Site Substation.

3.4.2 In order to calculate the size of the attenuation for the Solar PV Site, standard rainfall data from the Flood Estimation Handbook (FEH) 2022 has been used.

3.4.3 Based on the DEFRA online climate change allowance tool, both the Don and Rother Management Catchment peak require a 40% uplift for rainfall intensity associated with the 1 in 100-year event based on using the upper end allowance.

3.4.4 The attenuation features for the BESS Area and On-Site Substation have been sized to accommodate the 1 in 100-year event plus a 40% allowance for climate change. The required storage volume was determined using the InfoDrainage 'Quick Storage Estimate' tool. The 'Quick Storage Estimate' tool provides an upper and lower estimate for the storage volume required, as shown in Annex A. The median value of the upper and lower estimates will be used to size the attenuation. The volume requirements are detailed in Table 3-2 .

3.4.5 As a conservative approach it has been considered that the discharge rate from the Site is 31 l/s equivalent to the 1 in 2-year return period. This approach assumes that complex controls are not provided on the system.

Table 3-2: Attenuation Volume Requirements

Feature	Attenuation Volume Required (m^3)
BESS Area and On-Site Substation	67.5

3.4.6 In addition to the attenuation requirements for regular surface water runoff during normal operation, the swale would also be required to store fire water runoff in the event of a fire. The impact on attenuation requirements as a result of fire water runoff storage are discussed further in the Section 3.9 herein.

3.5 Water Quality

3.5.1 Firefighting water, and its potential contaminants, have not been included in this section. This is because any fire water applied to the BESS Area in the event of an incident would be contained within the swale and removed from the Solar PV Site via controlled methods (e.g. tanker) if found to be polluted (please see Section 3.9 for further details).

3.5.2 To assess the risk to receiving watercourses, an assessment has been undertaken of the proposed surface water drainage system in accordance with the Simple Index Approach (SIA), as detailed within CIRIA C753 The SuDS Manual. This method determines the pollution hazard level of the land use proposed and then assesses the level of treatment the proposed drainage system would provide to ensure it provides sufficient water quality mitigation. In order to pass the Simple Index Approach, the following condition must be met for each of the three pollutants (Total Suspended Solids, Metals and Hydrocarbons) considered in this approach:

$$\text{Total SuDS Mitigation Index} \geq \text{Pollution Hazard Index}$$

3.5.3 The impermeable areas within the Solar PV Site relates to the BESS Area and the On-Site Substation. In accordance with the SuDS Manual this land use is best defined as ‘commercial/industrial’ roofs. Table 3-3 details the pollution hazard indices associated with this land use. Table 3-4 lists the mitigation indices associated with the swale. These values demonstrate the Simple Index Approach (SIA) condition is met for each of the pollutants as the mitigation indices are higher than the hazard indices. Therefore, the proposed swales surrounding the BESS Area and On-Site Substation would be sufficient to treat the runoff from these areas.

Table 3-3: Pollution Hazard Indices for BESS Area and On-Site Substation

Land Use	Pollution Hazard Indices			
	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Other roof (typically commercial/industrial roofs)	Low	0.3	0.2	0.05

Table 3-4: Mitigation Indices for BESS Area and On-Site Substation Swales

Type of Sustainable Drainage Systems (SuDS) Component	Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
BESS Area/On-Site Substation Swales	0.5	0.6	0.6

3.5.4 The service roads within the BESS Area were taken as impermeable, whilst the access roads within the wider Solar PV Site would be permeable. Regardless of construction type the roads would be trafficked so could pollute local watercourses. Perimeter swales would be used to capture any pollutants before discharging to watercourses. Tables 6 and 7 list the pollutant hazard indices and mitigation indices used as part of the SIA and demonstrates the proposed perimeter swales would be sufficient to treat the runoff from the access roads.

Table 3-5: Pollution Hazard Indices for Access Road

Land Use	Pollution Hazard Indices			
	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Low traffic roads non-residential	Low	0.5	0.4	0.4

Land Use	Pollution Hazard Indices			
	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
car parking with infrequent change (i.e. <300 traffic movements/day)				

Table 3-6: Mitigation Indices for Access Road

Type of SuDS Component	Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Perimeter Swales	0.5	0.6	0.6

3.6 Exceedance Flows

3.6.1 The proposed surface water drainage network has been designed to accommodate runoff from all storms up to and including the 100 year +40% return period. For an extreme storm event in excess of this, any runoff that cannot be retained by the proposed attenuation would flow overland, following the existing topography. This runoff would follow the current surface water flow paths towards the surrounding watercourses. Finished ground levels will be shaped to prevent this exceedance flow from impacting property or infrastructure as it travels to such watercourses.

3.7 Amenity and Ecological Value for SuDS Features

3.7.1 Incorporating swales within the Solar PV Site provides an opportunity to add ecological value to the Solar PV Site. The swales would support plant and wildlife that might otherwise be displaced by the Scheme.

3.8 Impact of Designated Nature Conservation Sites

3.8.1 Runoff from fire water from the BESS Areas would be captured so that it cannot discharge off site or to ground. Runoff would be tested and removed off site by tanker if contamination were found to be present.

3.8.2 There are no SSSIs, Special Areas of Conservation (SACs), Special Protected Areas (SPAs) located within the Solar PV Site (taken from DEFRA's MAGIC Map system). The nearest SSSIs to the Site are Forlom Hope Meadow, Shirley Pool and Went Ings Meadows which are within approximately 6.0 km, 4.4 km and 5.5 km respectively from the Solar PV Site.

3.9 Fire Water Run-off

3.9.1 The BESS Areas require fire water tanks to supress a fire, should one break out.

3.9.2 Fire water runoff may thus contain particles from the fire. In the unlikely event of fire water being discharged, the runoff would be contained and tested/treated before being allowed to discharge to the local watercourses.

3.9.3 It is proposed to contain firefighting water runoff within the swale surrounding the BESS Battery Containers, where it could be held and tested before either being released into the surrounding watercourses or taken off site by a tanker for treatment elsewhere. The swale would then be cleaned of all contaminants.

3.9.4 The swale would be underlain with an impermeable liner to prevent any contaminants entering the groundwater system. The flow control for the swale would be controlled by a penstock valve that can be closed before a fire is put out.

3.9.5 National Fire Chiefs Council (NFCC) guidance has been used to determine the volume storage of fire water runoff. The NFCC guidance states firefighting supplies *'should be capable of delivering no less than 1,900 litres per minute for at least 2 hours'.* On top of this supply requirement, a 30% additional capacity has been applied for storage in the swale. This equates to approximately 300 m^3 assuming new water supply throughout the two-hour period.

3.9.6 The design includes four water tanks within the BESS Area. The water supply for the fire water tanks is assumed to be supplied by potable water mains.

3.9.7 By using the swale for fire water storage as well as surface water storage, there is the potential that, in the event of a fire, the swale may already contain surface water and reduce the capacity for fire water storage. Therefore, the swale should be sized to serve both purposes. It is considered overly conservative to provide the required fire water storage on top of the 1 in 100 year + 40% storage already provided, as it is extremely unlikely a fire will occur at the same time as the 1 in 100-year event. Therefore, taking a pragmatic approach, an allowance has been made that a 1 in 2-year event could occur at the same time as a fire. Therefore, the swale would need to contain the 1 in 2-year event plus the fire water storage runoff or the 1 in 100 year + 40% event on its own, whichever is greater (thereby providing for the worst-case scenario).

3.9.8 In order to determine the attenuation volume required, a quick storage estimate calculation has been made for the BESS Area and On-Site Substation based on the 1 in 2-year event (see Annex A) – this gives a value of 49 m^3. A comparison has then been made between the 1 in 2-year event plus fire water storage and the 1 in 100 year +40% CC event. Table 8 identifies the worst-case scenario storage volume (343.5 m^2) and will be used during the design development.

3.9.9 The volume requirements for containment of fire water runoff within the swale and its configuration are subject to agreement with the Fire and Rescue Service.

Table 3-7: Attenuation Storage

Attenuation Storage (m^3)			
1 in 2-year	**1 in 100 + 40%**	**Fire water storage**	**Total**
43.5		300	343.5
	67.5		67.5

3.10 Adoption and Maintenance

3.10.1 The proposed Drainage Strategy would be maintained by the Applicant, and secured through the DCO.

4. References

Ref. 1 Environment Agency (2023). Flood Map for Planning. Available at: https://flood-map-for-planning.service.gov.uk/. [Accessed 7 August 2023].

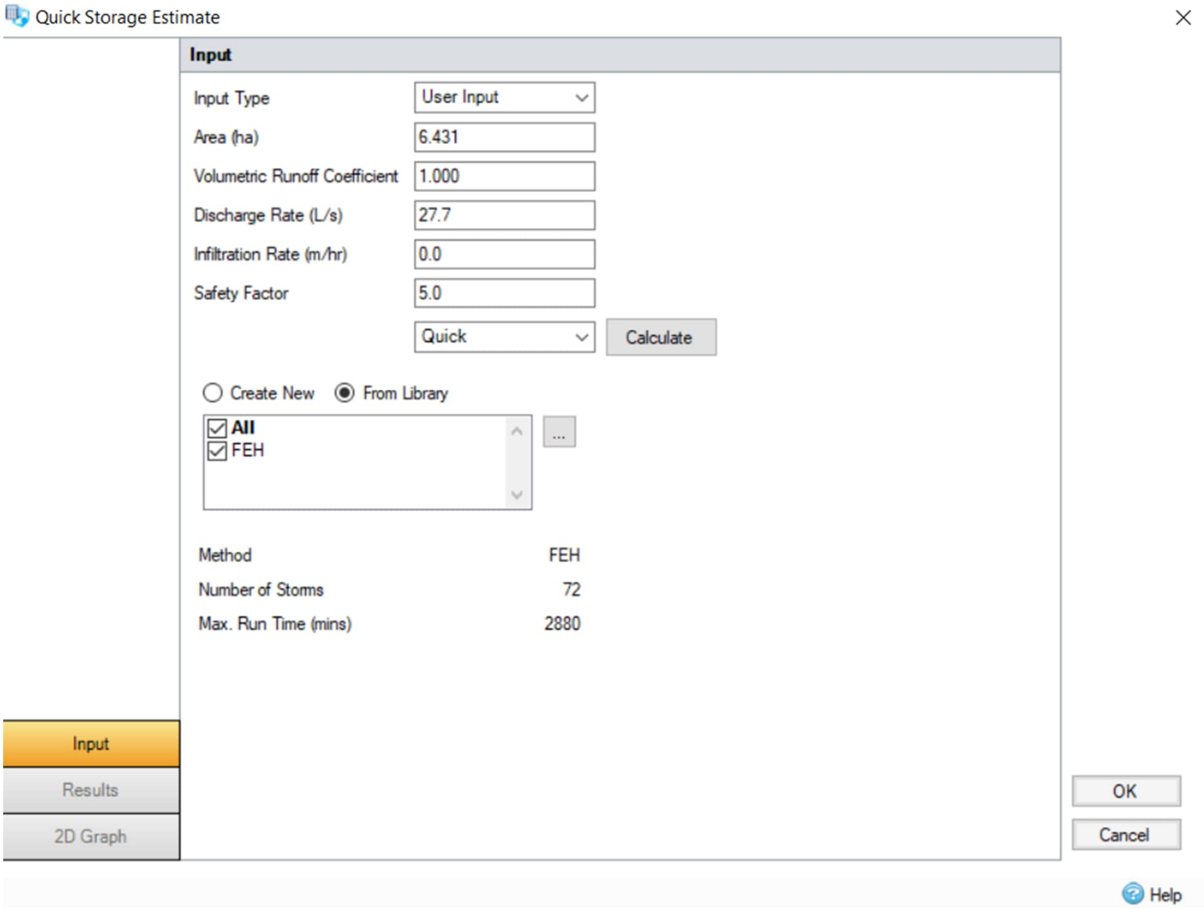
Ref. 2 City of Doncaster Council (2023). Local Flood Risk Management Strategy 2023-2029. Available at: https://www.doncaster.gov.uk/services/transport-streets-parking/flood-risk-management. [Accessed 7 August 2023].

Ref. 3 Environment Agency (2023). Long Term Flood Risk Map. Available at: https://check-long-term-flood-risk.service.gov.uk/map. [Accessed 7 August 2023].

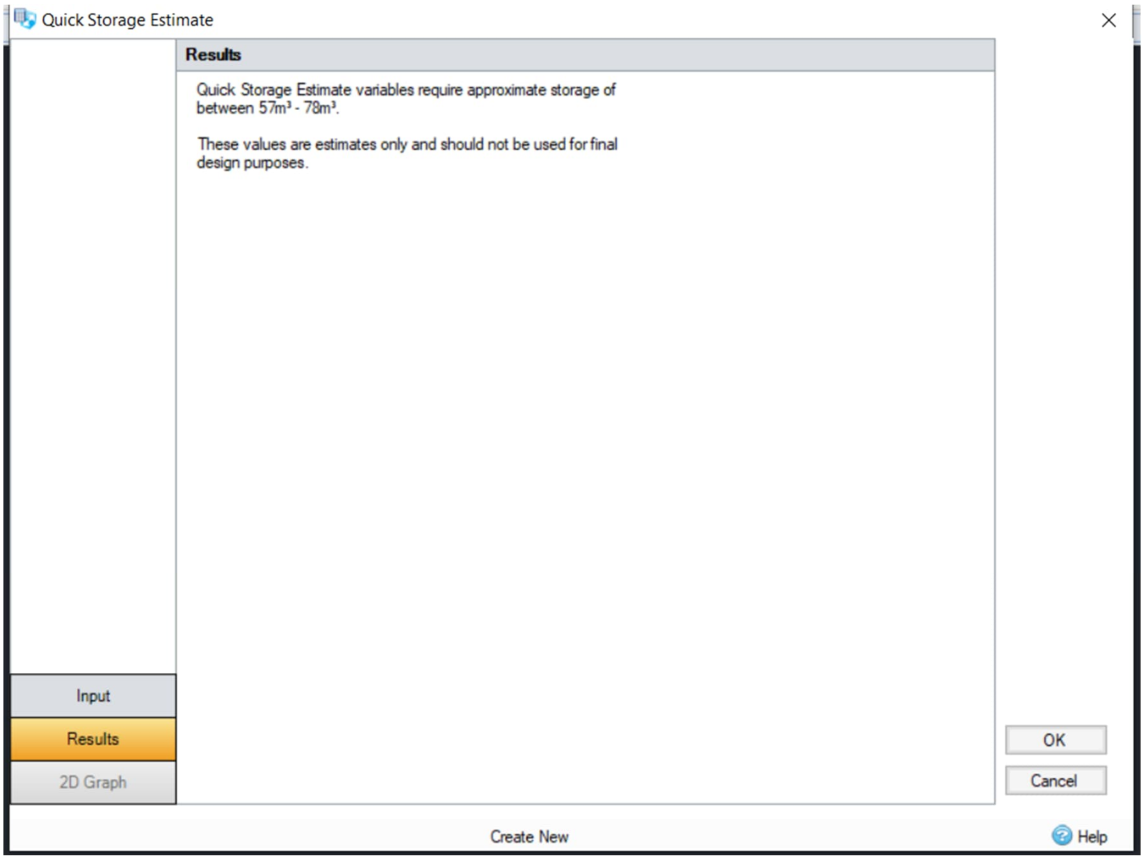
Ref. 4 Cranfield Soils and Agrifood Institute (2023) Soilscapes Viewer. Available at: https://www.landis.org.uk/soilscapes/ [Accessed 18 December 2023]

Annex A – InfoDrainage Quick Storage Estimates for Attenuation

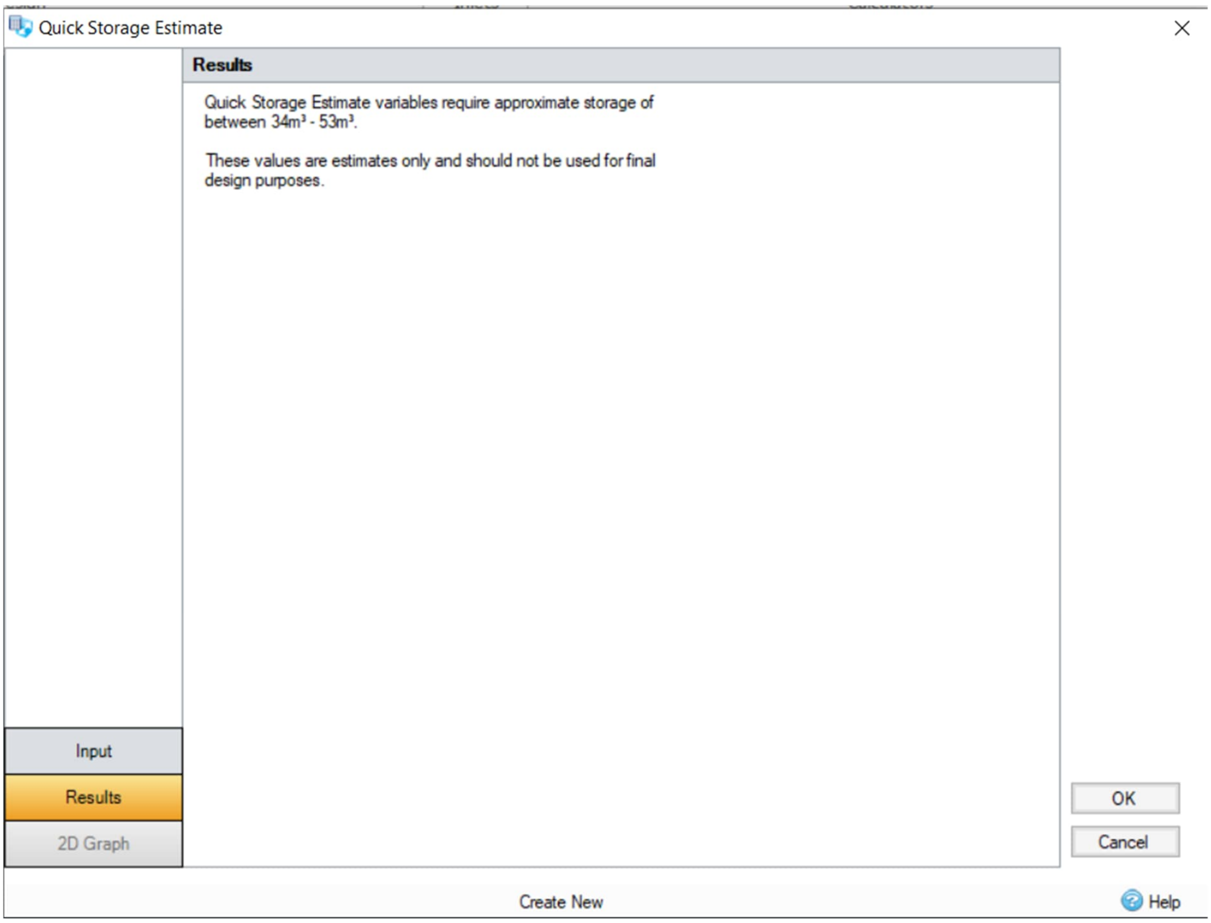
InfoDrainage Quick Storage Estimator Analysis for 1 in 100 year + 40% CC event



The discharge rate was calculated by using the 2 year rural peak flow (4.31 l/s/ha) multiplied by the impermeable area (6.431 ha). *



100+40% CC



1 in 2 year

Annex B – Greenfield Runoff Rates

Calculating REFH2 Runoff Rates

FEH Point Descriptor File

FEH_Point_Descriptors_459993_415339_v5_0_1.xml

ArcHydro Shapefiles (if multiple catchments required)

Catchments	NA
Drainage Lines	NA

REFH Rainfall Used

2022

METHOD

(To be carried out for each catchment if there is more than one)

Page 1: Catchment/Point Data

1 Import point descriptors to ReFH2 (software automatically defaults to plot scale equations)

2 Set catchment area to 0.5km² (50ha)

Page 2: Rainfall Events

3 Set ARF to 1.0

4 By default FEH22 DDF rainfall should be toggled, but switch to FEH13 if required.

Page 3: Event Modelling

5 Software estimates Tp and BL (in the Model Parameters tab) based on 0.5km2 area. Make a note of these below

Note: Will be the same for all catchments if you are calculating flow for multiple catchments and the same point descriptors are used for all

Tp	2.469
BL	32.399

6 In the Catchment Descriptors tab set catchment area to that of plot site. (Input to REFH2 is required in km² but also displays in ha. below)

Catchment areas from ArcHydro Analysis			
Catchment	Catchment area (m²)	Catchment area (km²)	Catchment area (ha)
1	71880	0.07188	7.188
2		0.00000	0.000
3		0.00000	0.000
4		0.00000	0.000

7 Re-set Tp and BL to the default values above

8 Re-set ARF to 1.0 again (in the rainfall page) as it changes back to default when you change the area

FOR GREENFIELD RUNOFF RATES

9 Export peak flows for all return periods

Note: only as-rural peak flows (Column E in exported csv file) are applicable

10 Open exported csv and copy columns A, B and E into the table in 'Greenfield - Peak Flows' sheet to convert the flows to l/s/ha and l/s

11 Export **'as rural'** hydrographs for all return periods (if required)

FOR GREENFIELD RUNOFF VOLUME (if required)

12 Set duration to 6hrs5mins with 5 min data interval (assuming a 6 storm is the design standard for the volume calculation)

13 Make sure that the correct ARF, Tp and BL values are set

14 Export **'as rural'** hydrographs for all return periods (this can be used to calculate stoarge volumes if required)

FOR POST-DEVELOPMENT RUNOFF RATES (if required)

15 Revert back to default duration

16 Make sure that the correct ARF, Tp and BL values are set

17 In Urbanisation tab set urban area to that of the impermable area of the site

Catchment	Impermeable area (m²)	Impermeable area (km²)	Impermeable area (ha)
1	64305	0.06431	6.431
2		0.00000	0.000
3		0.00000	0.000
4		0.00000	0.000

18 In Urbanisation tab set impervious runoff factor (IRF) and imperviousness factor (IF) to 1.0

19 Export peak flows for all return periods
Note: only **'urbanised'** peak flows (Column C in exported csv file) are applicable

20 Open exported csv and copy columns A, B and C into the table in 'Post-Development - Peak Flows' sheet to convert the flows from m³/s to l/s/ha and l/s

FOR POST-DEVELOPMENT RUNOFF VOLUME (if required)

21 Set duration to 6hrs5mins with 5 min data interval

22 Make sure that the correct ARF, Tp and BL values are set

23 Export **'urbanised'** hydrographs for all return periods

Catchment 1 Peak Flows

Description	Return period (yrs)	As-rural peak flow (m^3/s)	As rural peak flow (l/s/ha)	As rural peak flow (l/s)
2 year	2	0.03	4.31	30.97
10 year	10	0.05	7.29	52.41
30 year	30	0.07	9.41	67.63
30 year 1.35 CC	30	0.09	12.92	92.86
100 year	100	0.09	12.12	87.10
100 year 1.4 CC	100	0.13	17.48	125.64

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