West Springfield Solar

Flood Risk Assessment & Drainage Impact Assessment

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Making Sustainability Happen

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Basis of Report

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Acronyms and Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
CC	Climate Change
DTM	Digital Terrain Model
EA	Environment Agency
FFL	Finished Floor Level
FOI	Freedom of information
FRA	Flood Risk Assessment
ICM	Integrated Catchment Model
LiDAR	Light Detection and Ranging
NFRA	National Flood Risk Assessment
NPF4, NPF3	National Planning Framework 4, 3
NGR	National Grid Reference
PVA	Potentially Vulnerable Area
OS	Ordnance Survey
QA	Quality Assurance
RCP	Representative Concentration Pathway
SEPA	Scottish Environment Protection Agency
SGS	Sub-grid sampling
SPP	Scottish Planning Policy
THC	The Highland Council
UKCP18	United Kingdom Climate Projections – 2018 dataset

1.0 Introduction

SLR Consulting Ltd (SLR) has been appointed by TRIO West Springfield Solar LLP to provide consultancy services to support a proposed solar farm development on the Rankeilour Estate ('the Site') in Fife, located at National Grid Reference (NGR) NO 33101 11548 and postcode area KY15 5RE.

This report addresses the flood risk, outline surface water drainage, and firewater drainage aspects associated with the Proposed Development, which comprises the construction of a solar farm and associated infrastructure on the Rankeilour Estate. Further details of the development are provided in Section 1.3.

1.1 Policy and Guidance

This assessment has been completed in accordance with relevant guidance issued by Fife Council, The Scottish Government, and the Scottish Environment Protection Agency (SEPA). It takes cognisance of *National Planning Framework 4*[1] and the *Flood Risk Management (Scotland) Act 2009.* This assessment also references and takes due consideration (where appropriate) of following principal guidance and policy documents:

- British Standards Institution (2017), Assessing and Managing Flood Risk in Development – Code of Practice, Report BS-8533:2017, October 2017;
- CIRIA (2004) Development and Flood Risk – Guidance for the construction Industry, Report C624;
- SEPA (2022) Technical Flood Risk Guidance for Stakeholders[2] (Reference SS-NFR-P-002), June 2022;
- SEPA (2024) Flood Risk and Land Use Vulnerability Guidance, July 2024 ; and,
- SEPA (2018) Planning Background Paper Flood Risk (LUPS-BP-GU2a v3), July 2018.

1.2 Site Location

The Site is located immediately to the west of Springfield, some 3km southwest of Cupar. The Site comprises undeveloped agricultural land and covers an area of approximately 1km^2.

The Site is bounded to the north by the existing properties and woodland of the Rankeilour Estate. In the western area of the Site, the Site is bounded to the north by the Rankeilour Burn, which runs in a southerly direction through the Site. The Site is bounded to the east by Springfield, to the south by agricultural land and the Edinburgh to Aberdeen railway line, and to the west by a road that runs from Bow of Fife in the north to North Lodge to the south of the Site.

Access and egress to/from the Site are presently afforded by the existing unnamed road to the Rankeilour Mansion House from Springfield to the east, or from West Lodge to the west.

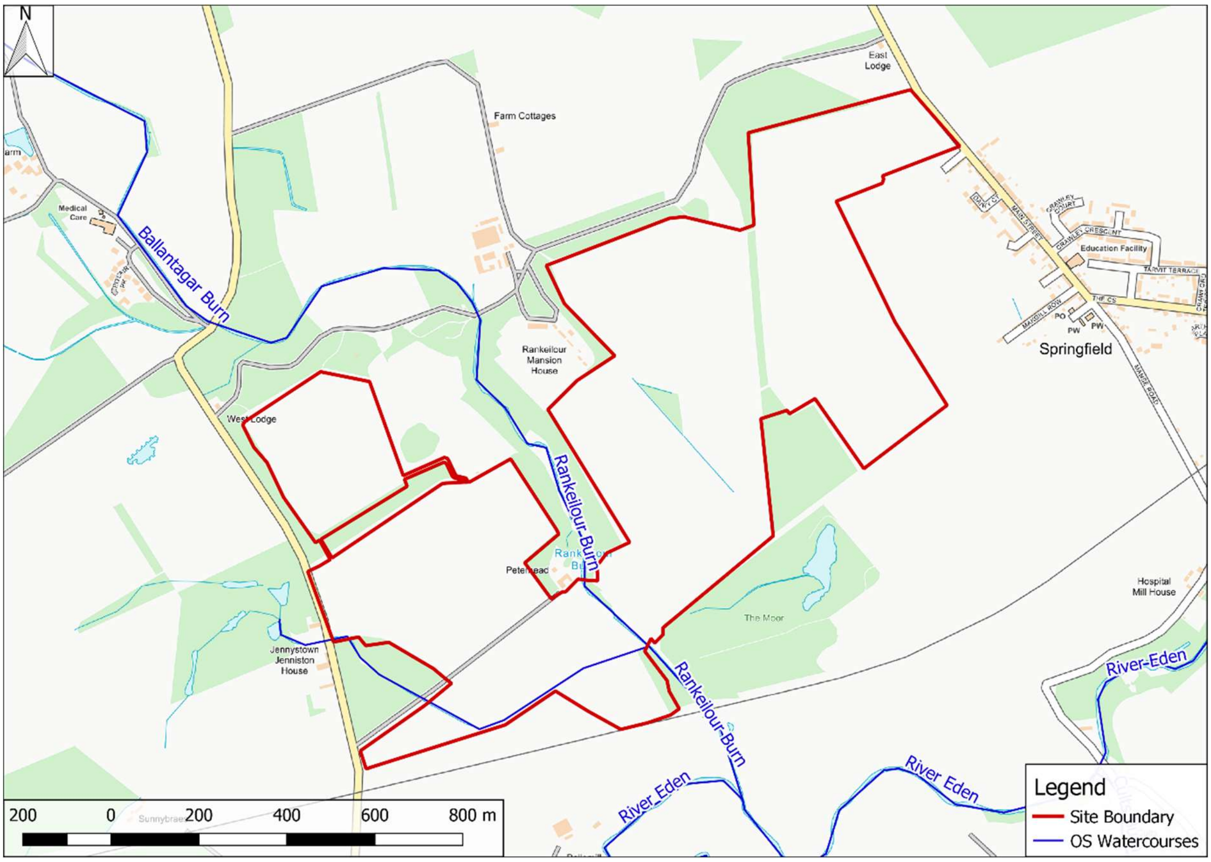
[1] Scottish Government (2023), National Planning Framework 4, available at: https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2023/02/national-planning-framework-4/documents/national-planning-framework-4-revised-draft/national-planning-framework-4-revised-draft/govscot%3Adocument/national-planning-framework-4.pdf, last accessed March 2025

[2] Scottish Environment Protection Agency (2022), Technical Flood Risk Guidance for Stakeholders, available at: https://www.sepa.org.uk/environment/land/planning/guidance-and-advice-notes/, last accessed February 2025

The proposed primary access is via a new connection to an unnamed road to the northwest of Springfield.

A Site location plan is provided in Figure 1-1.

Figure 1-1 : Site Location

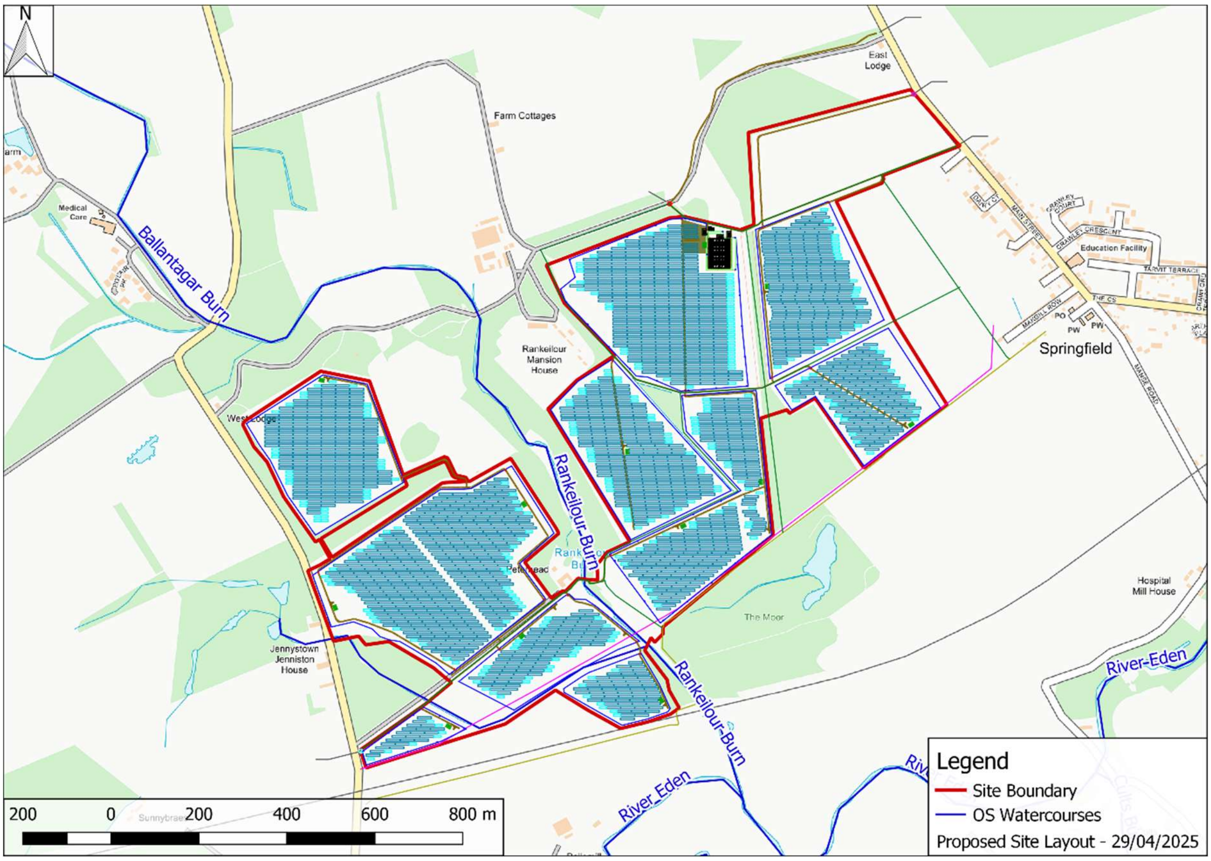


1.3 Proposed Development

The Proposed Development consists of solar panels, battery storage units, and associated infrastructure, as well as the replacement of an existing access/egress crossing over the Rankeilour Burn. The Proposed Development layout is shown in Figure 1-2, with a more detailed overview included in Appendix A.

No changes to existing ground levels are proposed.

Figure 1-2 : Proposed Site Layout



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1.4 Existing Site and Topography

1.4.1 Local Topography

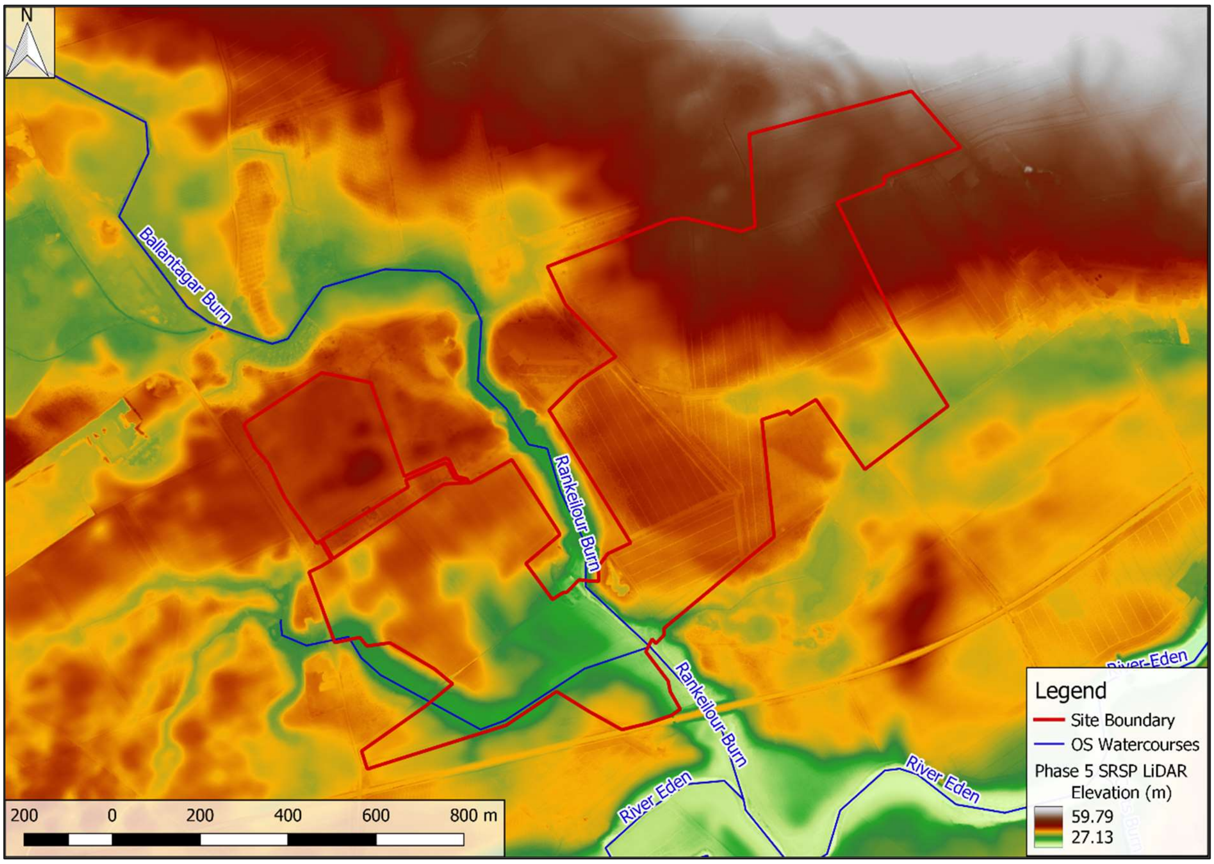
Phase 5 50cm spatial resolution Light Detection and Ranging (LiDAR) aerial photogrammetric data for the Site was sourced from the Scottish Remote Sensing Portal[3]. This was used to inform the catchment delineation for flow estimation and was used as a base for the hydraulic modelling.

A limited topographic survey of the Rankeilour Burn channel and associated structures was carried out on 19/02/2025 by SLR staff using a Trimble DA2 GNSS (GPS) receiver and Trimble TDC600 handheld unit at a 1cm precision level.

The local topography generally slopes down towards the Rankeilour Burn. Levels slope from approximately 53m Above Ordnance Datum (AOD) in the northeastern corner of the Site to approximately 32m AOD at the most downstream end of the Rankeilour Burn within the Site boundary.

[3] https://remotesensingdata.gov.scot/data#/map

Figure 1-3 : Local Topography



1.4.2 Geological Setting

The Site is indicated on British Geological Survey (BGS) mapping[4] to be underlain by sandstone of the Glenvale Sandstone Formation. The sandstone bedrock is overlain by superficial glaciofluvial sheet deposits of gravel, sand, and silt to the west, Devensian till to the northeast, and alluvium deposits of clay, sand, silt, and gravel following the Rankeilour Burn channel.

The Soil Map of Scotland[5] indicates that the Site is underlain by freely draining humus-iron podzols in the western portion of the Site and imperfectly draining brown earth soils in the eastern portion of the Site.

BGS classify the bedrock as a regionally important multi-layered highly productive aquifer of the Stratheden Group.

[4] BGS, GeoIndex Onshore, available at: https://mapapps2.bgs.ac.uk/geoindex/home.html?layers=BGSBedEngGeol,BGSSupEngGeol,BGSEGFSReports,BGSUSAReports, last accessed March 2025

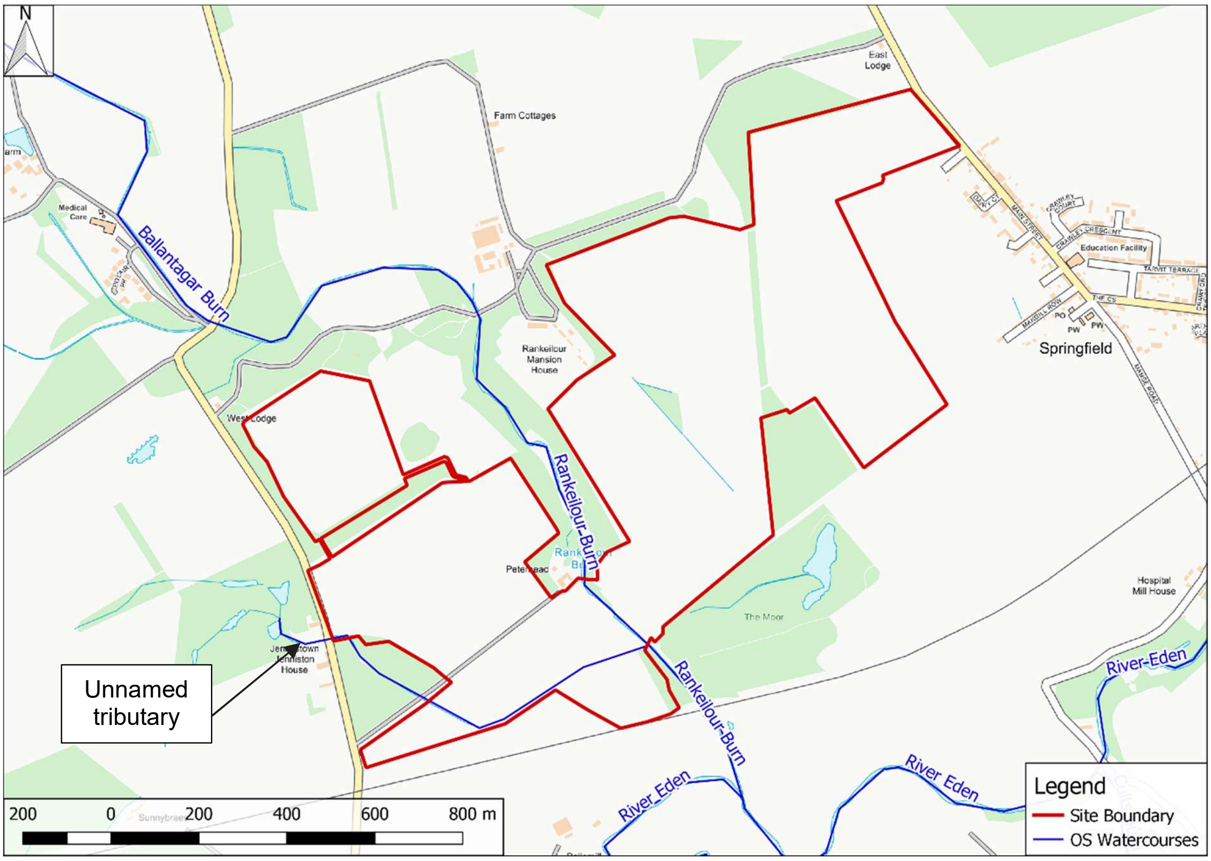
[5] Scotland's Soils, available at: https://map.environment.gov.scot/Soil_maps/?layer=2, last accessed March 2025

1.4.3 Local Hydrology

The Rankeilour Burn flows in a southerly direction through the Site. A minor tributary of the Rankeilour Burn flows through the Site from some minor ponds at Jennystown to the west. These watercourses are indicated on Figure 1-4 below.

Downstream of the Site, the Rankeilour Burn discharges to the River Eden, which flows in an easterly direction to discharge to the North Sea some 17km northeast of the Site near St Andrews.

Figure 1-4 : Local Hydrology



The Rankeilour Burn drains a catchment area of 52.14km^2 upstream of the railway line at the southern end of the Site. The catchment area is shown and discussed in the detailed hydrological assessment in Section 5.1.

1.5 Site Survey

A Site walkover was conducted on 19/02/2025 by two experienced SLR hydrologists. The following photographs were taken during the Site walkover and focus on the Rankeilour Burn, the unnamed tributary, and hydraulic structures associated with the Rankeilour Burn. Figure 1-5 outlines the photograph locations relative to the Site boundary.

Photograph 1-1 and Photograph 1-2 show the Rankeilour Burn upstream of the Site and immediately upstream of the confluence with the unnamed tributary respectively. Photograph 1-3 shows the unnamed tributary upstream of the confluence with the Rankeilour Burn.

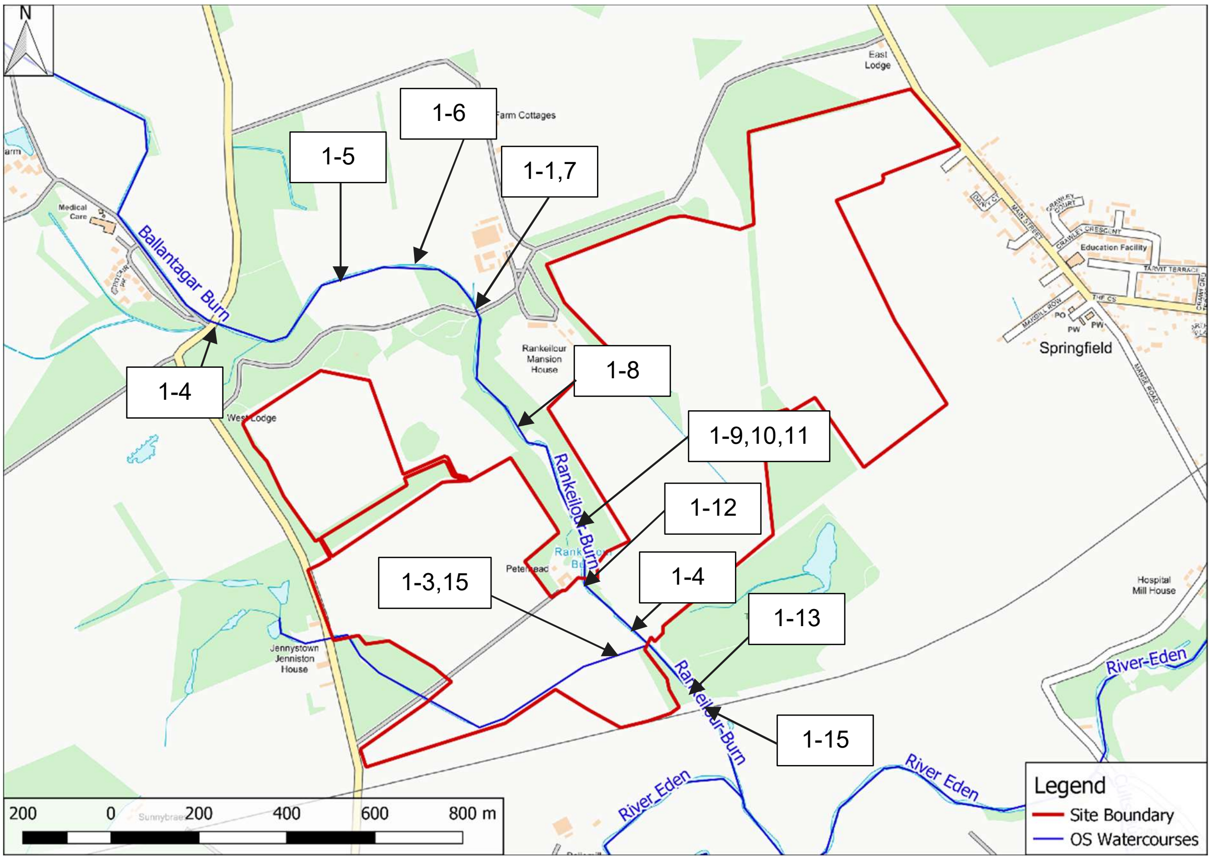
Photograph 1-4 through Photograph 1-8 show road bridges and foot bridges along the reach of the Rankeilour Burn upstream of the Site.

Photograph 1-9 through Photograph 1-11 show a historic weir/dammed area with a lade understood to have been used to direct flows towards the farm buildings. Flows are regulated by a penstock, with steady flow noted through the box culvert outlet downstream on the day of the Site visit.

Photograph 1-12 shows an existing bridge over the Rankeilour Burn which is to be replaced and will serve as the main access/egress route to/from the Site. Photograph 1-13 and Photograph 1-14 show a road bridge and railway bridge over the burn at the downstream end of the Site.

Photograph 1-15 shows the 450mm culvert under a field access on the unnamed tributary.

Figure 1-5 : Photograph Locations



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Photograph 1-1 : Rankeilour Burn upstream of Site boundary

Photograph 1-2 : Rankeilour Burn upstream of confluence with unnamed tributary

Photograph 1-3 : Unnamed tributary upstream of confluence with Rankeilour Burn

Photograph 1-4 : Road bridge at upstream end of hydraulic model boundary

Photograph 1-5 : Minor footbridge over Rankeilour Burn

Photograph 1-6 : Footbridge/field access over Rankeilour Burn

Photograph 1-7 : Road bridge over Rankeilour Burn at upstream end of Site

Photograph 1-8 : Footbridge over Rankeilour Burn

Photograph 1-9 : Ponded area upstream of dam/weir on Rankeilour Burn

Photograph 1-10 : Ponded area upstream of dam/weir on Rankeilour Burn

Photograph 1-11 : Outflow from penstock on Rankeilour Burn

Photograph 1-12 : Existing bridge over Rankeilour Burn to be replaced

Photograph 1-13 : Road bridge over Rankeilour Burn at downstream end of Site

Photograph 1-14 : Rail bridge at downstream end of hydraulic model

Photograph 1-15 : 450mm culvert under unnamed tributary field crossing

1.6 Storm and Flood Risk Terminology

Flood risks are typically expressed by the probability of the occurrence of a flood event (maximum flood height or other such indicator) of stated magnitude or greater in any one year – termed the Annual Exceedance Probability (AEP). This may be expressed as a percentage (such as 1%, 0.5%, etc.) or by the equivalent chance of occurrence (1:100, 1:200, etc.).

Where flood events have a climate change factor included, the flood event is denoted in this report by “plus CC”. For example, the 1:200 AEP flood event with climate change included is denoted “0.5% AEP plus CC” or “1:200 AEP plus CC”.

2.0 Flood Risk Review – Sources of Information

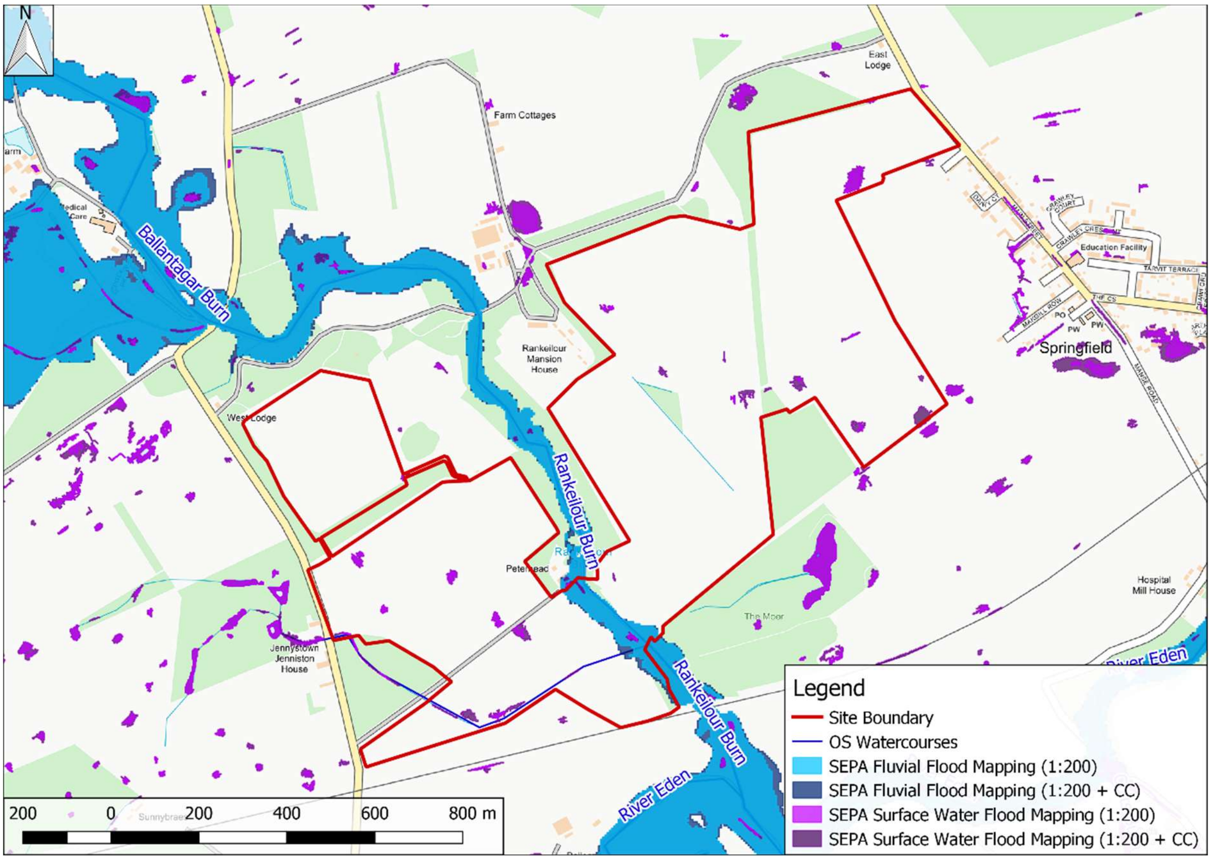
2.1 National Flood Plain Mapping and Assessment

Strategic-level information regarding the tidal, fluvial and surface water flood risk at the Site has been obtained from SEPA via the online SEPA Flood Maps[6]. Information on potential groundwater flood risk has been obtained from the SEPA Flood Risk Management Maps[7]. Information on flooding from reservoirs has been obtained from the SEPA Reservoirs Map[8].

The SEPA surface water and fluvial flood risk mapping results for the Site and surrounds are shown in Figure 2-1. The SEPA fluvial flood extents indicate that the only area at risk of fluvial flooding for the design event of 1:200 AEP + CC is the southern end of the Site in the vicinity of the proposed bridge upgrade. The proposed bridge upgrade location is shown to be in an area of existing flood risk.

The SEPA surface water flood mapping (updated 2025) extents do not indicate any major areas of flood risk, with limited areas of potential ponding in the fields. There are no significant flood risks indicated in relation to the unnamed tributary from the west.

Figure 2-1 : SEPA Flood Mapping (1:200 AEP, 1:200 AEP + CC)



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[6] Scottish Environment Protection Agency (2025) SEPA Flood Maps, available at SEPA Flood Maps, last accessed March 2025

[7] Scottish Environment Protection Agency (2016) Online Flood Risk Management Maps, available at: https://map.sepa.org.uk/floodmap/map.htm, last accessed March 2025

[8] Scottish Environment Protection Agency (2022), Reservoirs Map, available at: https://map.sepa.org.uk/reservoirsfloodmap/Map.htm, last accessed March 2025

2.2 Mapping and Terrain Data

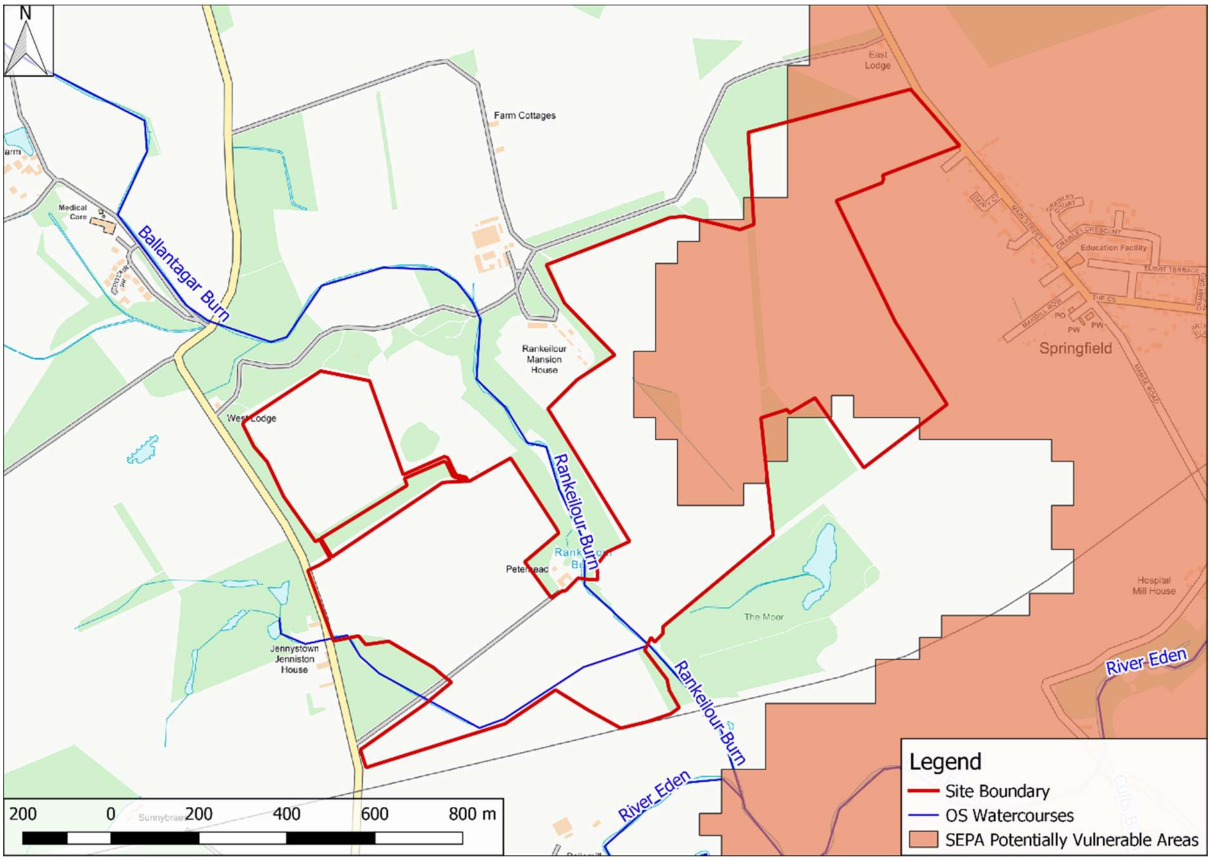
Aerial imagery, OS contour data (10m intervals), SRSP LiDAR data[3], and the localised Site topographic survey referred to in Section 1.4.1 have been used to assess the context of the Site and its immediate surroundings.

2.3 Flood History and Records

The eastern area of the Site is designated by SEPA National Flood Risk Assessment (NFRA) as a Potentially Vulnerable Area (PVA) due to flood risk in Cupar[9]. The area is designated as PVA 02/07/13 and is shown in Figure 2-2. The PVA area is also indicated to be protected by the Millfield of Cupar Flood Protection Scheme 1994, which has a 1:100 standard of protection for the River Eden at Cupar. This Flood Protection Scheme is not relevant to the Site as the Site is not determined to be at risk of flooding from the River Eden.

Some historical flooding is also noted on the SEPA NFRA website in the Springfield area, with records from 2004. There is no indication as to the source of the flooding.

Figure 2-2 : SEPA Potentially Vulnerable Areas



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[9] Scottish Environment Protection Agency (2019) Flood Risk Management Strategies, available at: https://informatics.sepa.org.uk/NFRA2018/, last accessed March 2025

2.4 Consultation

2.4.1 Fife Council

A data request with regard to historical flooding in the area or any relevant information on the watercourses was submitted to Fife Council's flooding team on 11th March 2025.

The following response was received on the 25th of March 2025:

"*Flooding has been an issue in relation to the area indicated which has affected properties and carriageways of Makgill Row and Manse Road. As you'll be aware, having viewed the SEPA flood map, there is extensive surface water concern in the land to the west of Manse Road and south of Makgill Row. What you may not be aware of is that the short stretch of open watercourse in the field north of Makgill Row can also overtop and the excess water travels overland through the private gardens to join the surface water accumulation noted above. This watercourse is a tributary of what is shown on the Ordnance Survey map as the Crawley Burn which runs through private gardens of Arthur Place/Pennyacre Nursery/Pennyacre Court etc. to it's confluence with the River Eden to the east.*

We are unaware of , and do not hold records of, any flooding within Rankeilour estate as this is private land.".

The response confirms that Fife Council do not hold any flood records for the estate itself. The flooding issues noted in the vicinity of Makgill Row/Manse Road would not be expected to pose a flood risk to the Site due to the local topography and the draining of this watercourse to the River Eden to the east.

2.4.2 SEPA

A data request with regard to historical flooding in the area or any relevant information on the watercourses was submitted to SEPA on 11th March 2025. A response was received on 21st March 2025, which confirmed that there has been historical flooding within 500 m of the Site boundary, but the source of the flooding is not known.

2.4.3 Scottish Water

Scottish Water were contacted on 11th March 2025 with regard to their ICM modelling results for the Site and surrounds. At the time of writing no response had been received. A response was received on 25th March 2025, which confirmed that Scottish Water ICM mapping does not cover the area of interest.

Scottish Water Asset Plans were purchased for the Site and surrounds. The Asset Plans confirmed that there are no Scottish Water drainage assets within the Site boundary.

3.0 Planning Context

3.1 National Planning Framework 4

National Planning Framework 4 (NPF4)[1] was introduced in February 2023 and supersedes National Planning Framework 3 (NPF3) and Scottish Planning Policy (SPP) 2014. Flood risk is addressed in Policy 22 of NPF4, which states the following:

a) Development proposals at risk of flooding or in a flood risk area will only be supported if they are for:

i. essential infrastructure where the location is required for operational reasons;

ii. water compatible uses;

iii. redevelopment of an existing building or site for an equal or less vulnerable use; or

iv. redevelopment of previously used sites in built up areas where the LDP has identified a need to bring these into positive use and where proposals demonstrate that long term safety and resilience can be secured in accordance with relevant SEPA advice.

The protection offered by an existing formal flood protection scheme or one under construction can be taken into account when determining flood risk. In such cases, it will be demonstrated by the applicant that:

- all risks of flooding are understood and addressed;
- there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes;
- the development remains safe and operational during floods;
- flood resistant and resilient materials and construction methods are used; and,
- future adaptations can be made to accommodate the effects of climate change.

Additionally, for development proposals meeting criteria part iv), where flood risk is managed at the site rather than avoided these will also require:

- the first occupied/utilised floor, and the underside of the development if relevant, to be above the flood risk level and have an additional allowance for freeboard; and,
- that the proposal does not create an island of development and that safe access/ egress can be achieved.

b) Small scale extensions and alterations to existing buildings will only be supported where they will not significantly increase flood risk.

c) Development proposals will:

i. not increase the risk of surface water flooding to others, or itself be at risk.

ii. manage all rain and surface water through sustainable urban drainage systems (SUDS), which should form part of and integrate with proposed and existing blue green infrastructure. All proposals should presume no surface water connection to the combined sewer; and,

iii. seek to minimise the area of impermeable surface.

d) Development proposals will be supported if they can be connected to the public water mains. If connection is not feasible, the applicant will need to demonstrate that water for drinking water purposes will be sourced from a sustainable water source that is resilient to periods of water scarcity.

e) Development proposals which create, expand or enhance opportunities for natural flood risk management, including blue and green infrastructure, will be supported.

NPF4 defines an area at risk of flooding as follows:

For planning purposes, at risk of flooding or in a flood risk area means land or built form with an annual probability of being flooded of greater than 0.5% (1:200 AEP) which must include an appropriate allowance for future climate change.

This risk of flooding is indicated on SEPA's future flood maps or may need to be assessed in a flood risk assessment. An appropriate allowance for climate change should be taken from the latest available guidance and evidence available for application in Scotland. The calculated risk of flooding can take account of any existing, formal flood protection schemes in determining the risk to the site.

Where the risk of flooding is less than this threshold, areas will not be considered 'at risk of flooding' for planning purposes, but this does not mean there is no risk at all, just that the risk is sufficiently low to be acceptable for the purpose of planning. This includes areas where the risk of flooding is reduced below this threshold due to a formal flood protection scheme.

3.2 Local Plan

The Adopted FIFEplan (adopted 2017)[10] is the most recent Fife Council local plan, with an updated Fife Local Development Plan currently in works. The Adopted FIFEplan sets out guidance with regard to flood risk and drainage.

Policy 12 of the Adopted FIFEplan on Flooding and the Water Environment states the following:

Development proposals will only be supported where they can demonstrate that they will not, individually or cumulatively:

1. *increase flooding or flood risk from all sources (including surface water drainage measures) on the site or elsewhere;*
2. *reduce the water conveyance and storage capacity of a functional flood plain;*
3. *detrimentally impact on ecological quality of the water environment, including its natural characteristics, river engineering works, or recreational use;*
4. *detrimentally impact on future options for flood management;*
5. *require new defences against coastal erosion or coastal flooding; and*
6. *increase coastal erosion on the site or elsewhere.*

Flood Risk Assessment

To ascertain the impact on flooding, developers may be required to provide a flood risk assessment addressing potential sources of flooding and the impact on people, properties, or infrastructure at risk.

[10] Fife Council – Adopted FIFEplan 2017, accessible at: https://www.fife.gov.uk/kb/docs/articles/planning-and-building2/planning/development-plan-and-planning-guidance/local-development-plan-fifeplan, last accessed March 2025

In medium to high flood risk areas – an annual probability of flooding greater than 0.5% (1:200 years) – a flood risk assessment is required.

In low to medium flood risk areas – annual probability of coastal or watercourse flooding is between 0.1% and 0.5% (1:1,000 to 1:200 years) – a flood risk assessment may be required at the upper end of the probability range, and for essential infrastructure and the most vulnerable uses.

Flood risk assessments should:

- *highlight the measures proposed to mitigate the flood risk and the timescales to implement those measures; and*
- *include an assessment of potential impacts on water quality and the water environment.*

Drainage Assessments, proportionate to the development proposal and covering both surface and foul water, will be required for areas where drainage is already constrained or otherwise problematic, or if there would be off-site effects.

The Adopted FIFEplan is supported by supplementary guidance document 'Design Criteria Guidance on Flooding and Surface Water Management Plan Requirements v2.1'[11]. The document specifies that Compliance Certificates and Independent Check Certificates are required for the Flood Risk Assessment and for the outline SuDS design. These are included in Appendix B.

It is of note that the document specifies that '*where flooding is predicted on the road this must be no greater than 300mm depth of ponding to permit access by emergency vehicles'*.

3.3 SEPA Guidance

The SEPA Flood Risk and Land Use Vulnerability Guidance[12] outlines how SEPA assess vulnerability of flooding of different land use with the following Categories:

- Most Vulnerable Uses;
- Highly Vulnerable Uses;
- Least Vulnerable Uses;
- Essential Infrastructure; and,
- Water Compatible Uses.

With reference to Table 1 (SEPA Land Use Vulnerability Classification) of the guidance, the Proposed Development is considered to fall into the **Essential Infrastructure** category as *'All forms of renewable, low-carbon and zero emission technologies for electricity generation and distribution and transmission electricity grid networks and primary sub stations'*.

It is noted that SEPA would expect a minimum 600mm freeboard, in line with CIRIA Guidance (CIRIA C624 Development and Flood Risk – Guidance for the Construction Industry 2004) unless a more detailed assessment of freeboard is made.

[11] Fife Council – Design Criteria Guidance on Flooding and Surface Water Management Plan Requirements v2.1, accessible at: https://www.fife.gov.uk/__data/assets/pdf_file/0012/160122/FC-Flooding-and-SWMP-Guidance-v2.1.pdf, last accessed March 2025

[12] SEPA (2024) Flood Risk and Land Use Vulnerability Guidance, July 2024, available at: https://www.sepa.org.uk/environment/land/planning/guidance-and-advice-notes/, last accessed March 2025

3.4 Climate Change & Design Event

The relevant SEPA climate change allowances[13] have been assessed for the Site, which lies in the Tay river basin region. Based on the size of the catchment exceeding $50km^2$, a peak river flow allowance of 53% should be applied to the estimation of peak flows.

The peak rainfall allowance of 39% for the Tay river basin should be applied to the outline surface water drainage design.

This climate change allowance will be applied to the 1:200 AEP event in line with NPF4 and Fife Council requirements.

[13] SEPA (2025) Climate Change Allowances for Flood Risk Assessment in Land Use Planning, Version 6, available at: climate-change-allowances-guidance_v6.pdf, last accessed April 2025

4.0 Potential Sources of Flooding

4.1 Methodology and Best Practice

This FRA report has been prepared in accordance with the advice and requirements prescribed in current best practice documents relating to management of flood risk in development published by the Construction Industry Research and Information Association (CIRIA)[14] and British Standard BS8533[15].

A screening study has been completed to identify whether there are any potential sources of flooding at the Site which may warrant further consideration. If required, any potential significant flooding issues identified in the screening study are then considered in subsequent sections of this assessment.

4.2 Screening Study

Potential sources of flooding include:

- Flooding from the sea or tidal flooding;
- Flooding from rivers or fluvial flooding;
- Flooding from surface water and overland flow;
- Flooding from groundwater;
- Flooding from sewers;
- Flooding from reservoirs, canals, and other artificial sources; and,
- Flooding from infrastructure failure.

Flood risk definitions within the screening assessment are based on qualitative technical assessment considering the information reviewed, risk to Site users and the development itself.

The flood risk from each of these potential sources is assessed in Table 4-1.

[14] CIRIA (2004), Development and flood risk: guidance for the construction industry Report C624, 2004

[15] British Standards Institute (2017) Assessing and Managing flood risk in Development: Code of Practice (2nd Edition), 2017

Table 4-1 : Flood Risk Screening

Source of Flood Risk	Description	Flood Risk Assessment
Tidal	The Site is located some 10km southeast of the coast at its closest extent, and approximately 10km southwest of the tidal reach of the River Eden. It is therefore considered that the Site is not at tidal flood risk.	No Flood Risk
Fluvial	The Site is located within the catchment of the Rankeilour Burn and an unnamed tributary from the west. The burn flows in a southerly direction through the central area of the Site, and the unnamed tributary flows in an easterly direction through the western portion of the Site. SEPA mapping indicates that a minor portion of the Site and the proposed bridge upgrade location are at flood risk from fluvial sources for the design event of 1:200 AEP + CC. No significant flood risk is indicated from the unnamed tributary to the west. Given the potential flood risks to the Site from the Rankeilour Burn, hydraulic modelling has been undertaken and is discussed in Section 5.2.	Further Review
Pluvial (i.e., direct rainfall)	The proposed drainage design included in Section 6.5 has been sized to appropriately	Negligible Risk

Source of Flood Risk	Description	Flood Risk Assessment
	manage direct rainfall on impermeable areas of the Site up to and including the 1:200 AEP event + CC. The solar panels themselves would not create impermeable areas nor a barrier to infiltration of direct rainfall. It is therefore considered that the Site is not at pluvial flood risk.	
Surface Water Flows	SEPA mapping indicates some minor areas of surface water ponding. The solar panels are to be raised approximately 800mm from ground level and are therefore not expected to be at risk. The local topography generally slopes towards the Rankeilour Burn. It is not expected that surface water flood risk will present a particular risk to the Site, but for the avoidance of doubt, rain-on-grid modelling has been undertaken and is discussed in Section 5.2.	Further Review
Groundwater	SEPA flood mapping indicates that the Site is not at risk from any wider area groundwater flood risk influences. The local topography is such that any potential groundwater surcharging would be expected to flow to the Rankeilour Burn.	Negligible Risk

Source of Flood Risk	Description	Flood Risk Assessment
	Based on these considerations, there is a negligible risk of groundwater flooding from groundwater rise at the Site.	
Sewers and Artificial Drainage Systems, and Water Supply	Scottish Water asset plans indicate that there are no formal water supply or sewer networks beneath the Site. An existing network of field drains is located on the Site. Any surcharging of these field drains would be expected to follow natural topographical gradients to the Rankeilour Burn. Based on these considerations, there is a negligible risk of flooding from drainage systems.	Negligible Risk
Infrastructure Failure (i.e., reservoirs, canals, culvert blockage, etc.)	The Site is not indicated on the SEPA mapping to lie within the breach extents of any reservoirs. There are several bridges on the Rankeilour Burn in the vicinity of the Site. A blockage scenario at the downstream end of the burn has therefore been modelled. There is a 450mm culvert on the unnamed tributary from the west. Any exceedances of this culvert would result in overland flows eastwards to the Rankeilour Burn.	Further Review

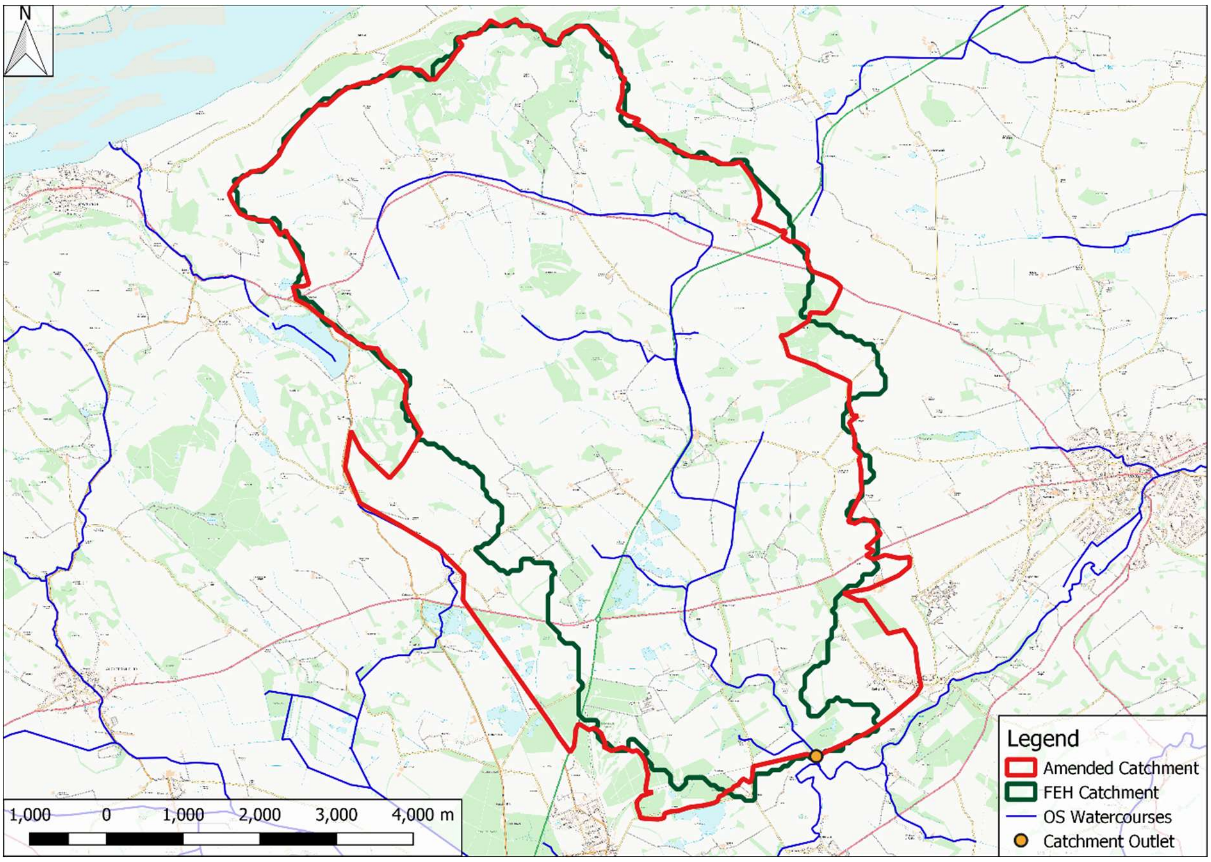
5.0 Detailed Flood Risk Review

5.1 Hydrological Assessment

5.1.1 Catchment Delineation

The FEH Web Service[16] was used to purchase a catchment at outlet NGR NO 33300 10900 for the Rankeilour Burn. The FEH-delineated catchment appeared to have some discrepancies with local features, and as such the catchment was delineated manually using 50cm spatial resolution LiDAR data from the Scottish Remote Sensing Portal. Further details on the methodology are provided in the appended Flow Estimation Methodology document (Appendix C).

Figure 5-1 : Catchment Delineation



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5.1.2 Catchment Descriptors

The catchment details, as well as the FEH-default catchment descriptors and the final amended catchment descriptors are outlined in Table 5-1 and Table 5-2. AREA, DPLBAR and FARL were changed from the default values from the FEH Web Service. These changes are described in the Flow Estimation Methodology report located in Appendix C.

[16] https://fehweb.ceh.ac.uk/Map, last accessed March 2025

Table 5-1 : Catchment Summary

Outlet NGR	Type of Estimate: Lumped (L) or Sub-catchment (S)	Watercourse Name	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA (km^2)
NO 33300 10900	L	Rankeilour Burn	333300	710900	46.88	52.14

Table 5-2 : Catchment Descriptors

Catchment ID	FARL	PROPWET	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	URBEXT2000
FEH Catchment	0.988	0.45	0.629	9.19	82.3	748	0.0031
Amended Catchment	0.928	0.45	0.629	9.77	82.3	748	0.0031

5.1.3 FEH Methodology

The catchment area for the Rankeilour Burn is relatively large at 52.14km^2 in area and is ungauged. Application of single-site statistical analysis would therefore not be feasible. Consequently, two flow estimation methods were tested: rainfall-runoff methodology in ReFH2 software (ReFH2.3 v.4.1.8985.14298) and pooled statistical analysis in WINFAP software (WINFAP v.5.2.9046). Due to a number of stations with non-flood years within the statistical pooling group, adjustment for non-flood years was carried out.

The final choice of method was selected to be the hybrid method of scaling flows estimated using the statistical method based on hydrographs output using ReFH2 methodology. Peak flow climate change uplifts as outlined in Section 3.4 were applied to the resulting flows for the design event. The full methodology is outlined in the Flow Estimation Methodology report located in Appendix C.

There are no local gauges or other sources of information on either watercourse network which would aid calibration and verification of the hydrological modelling outputs.

The catchment was treated as an individual lumped catchment and was subsequently split based on area to apply flows to the unnamed tributary within the hydraulic modelling.

The winter storm was selected due to the rural nature of the catchment.

The default ReFH2-recommended storm duration of 6 hours 30 minutes with a 30 minute timestep was selected for application to flow estimation for the hydraulic modelling.

The hyetographs for estimation of direct rainfall are defined based on the full catchment area upstream of and including the Site.

5.1.4 Peak Flow Results

The peak flow results from the rainfall-runoff and statistical methods are shown in Table 5-3. The statistical method results have ultimately been applied to the hydraulic modelling, with the hydrograph shape from the ReFH2 6 hour 30 minute duration used to scale the statistical results.

Table 5-3 : Peak Flow Estimates

Estimation Methodology	1:200 AEP event peak flow (cumecs)	1:200 AEP event + 53%CC peak flow (cumecs)
Rainfall-runoff	19.92	30.48
Statistical	16.21	24.80

5.1.5 Peak Net Rainfall Results

The peak net rainfall results from ReFH2 for the 6 hour 30 minute storm duration are shown in Table 5-4.

Table 5-4 : Peak Net Rainfall Results

Catchment	1:200 AEP event peak net rainfall (mm)	1:200 AEP event + 39%CC peak net rainfall (mm)
Lumped catchment	1.73	2.63

5.1.6 Assumptions

It is assumed that the FEH default parameters where adopted are applicable to each individual catchment.

No formal information is available regarding how the urban areas in the wider catchment are drained (i.e., roads, buildings) and it is assumed the urban areas that lie within the catchment boundary drain overland into the catchments.

The existing drainage network on the Site could not be verified based on the site inspection.

Any effect on the peak flows as a result of changes to the urban runoff parameters would be expected to be negligible due to the minor urban area of the catchment.

Further uncertainties and limitations are outlined in the Flow Estimation Methodology report located in Appendix C.

5.2 Hydraulic Modelling

This section of the report summarises the construction of the 1D-2D hydraulic model using ESTRY TUFLOW HPC software to simulate the fluvial and pluvial flooding impacts for 0.5% AEP event plus climate change.

The construction of the hydraulic model requires:

- Model extent;
- Model cell size;
- Topography;
- Hydraulic features;
- Hydraulic boundaries; and,
- Ground roughness (Manning's n).

5.2.1 Topography

The underlying base of the topography comes from two sources:

- 50cm resolution Phase 5 SRSP LiDAR
- Data collected during site visit.

5.2.2 Model Cell Size

A 3m model grid cell size was utilised. This cell size has been determined to be sufficient for incorporating important topographic details such as simulating flow paths and representation of the general topography in the modelled area. These factors were carefully considered to provide an accurate evaluation of the flood risk model grid cell size, ensuring a thorough and robust assessment of potential flood impacts.

5.2.3 Hydraulic Boundary

For the fluvial modelling, the boundary condition applied to the TUFLOW model comprise two Flow-Time (QT) boundaries placed to the north/west of the Site boundary for each modelled inflow. For the pluvial modelling, rainfall was applied over the full catchment area. These boundaries were used to assign the fluvial flows and rainfall for the 0.5% AEP plus climate change event.

The downstream boundary was applied as a Normal Depth boundary and was located approximately 400m downstream of the Site in order to ensure that this did not have an influence on calculated water levels in proximity to the Site.

5.2.4 Structures

The four road bridges and the downstream railway bridge over the Rankeilour Burn were explicitly modelled. The bridges were represented within the 1D network of the Rankeilour Burn.

The culvert under the unnamed tributary field crossing was also included as a 1D ESTRY unit, using default culvert coefficients.

The structure dimensions were based on site visit observations and topographic survey data collected.

5.2.5 Manning's n Roughness Coefficients

The definition of the extent of each of the roughness values applied to the 2D domain was determined using the OS Opendata layers[17]. This information was verified by reviewing aerial imagery of the Site and based upon site visit observations.

The material roughness across the model domain has been read into the hydraulic model using a TUFLOW standard .tmf file with Manning's n values derived from Chow (1959)[18].

Table 5-5 : Modelled Material Properties

Material ID as referenced in GIS layer	Manning's n values	Land use type
1	0.1	Buildings
2	0.03	River channel/water

[17] Ordnance Survey, Data Hub, available at: https://osdatahub.os.uk/downloads/open, last accessed March 2025
[18] Chow, V.T., (1959). Open-channel hydraulics, McGraw-Hill, New York

Material ID as referenced in GIS layer	Manning's n values	Land use type
3	0.05	Arable fields
4	0.11	Deciduous trees
5	0.02	Roads
6	0.06	Short shrubby grassland
7	0.015	Concrete

5.2.6 Software Version

In line with good modelling practice, the TUFLOW model was constructed using the latest commercially available software version at project outset: 2023-03-AE (single precision).

5.2.7 Modelling Parameters

The underlying 2D digital terrain model (DTM) was generated using the base 50cm spatial resolution DTM grid, complimented with topographic survey data for the river channels and structures. Sub-grid sampling (SGS) testing was undertaken during the initial model build. It was decided to continue using HPC with SGS functionality in 3m grid cell size.

For the rainfall modelling the Cell Wet/Dry Depth has been adjusted to 0.2mm as per the recommended value in the TUFLOW software guidance.

All modelled scenarios have been simulated for 14 hours to allow for the inflow boundaries to complete the full hydrograph and allow the watercourse to return to low levels. The computational timesteps used by HPC are adaptive over the course of the simulation, with 2D time-varying outputs generated every 5 minutes.

5.2.8 Post Development Modelling Scenario

The Proposed Development does not include any land raising, and the solar panels will be raised on plinths which will not provide a barrier to flow and as such will have a negligible impact on flood behaviour. The proposed replacement access bridge over the Rankeilour Burn is proposed to be a like-for-like replacement, which will be designed to withstand inundation for the design event.

It was therefore considered that a post-development modelling scenario was not required.

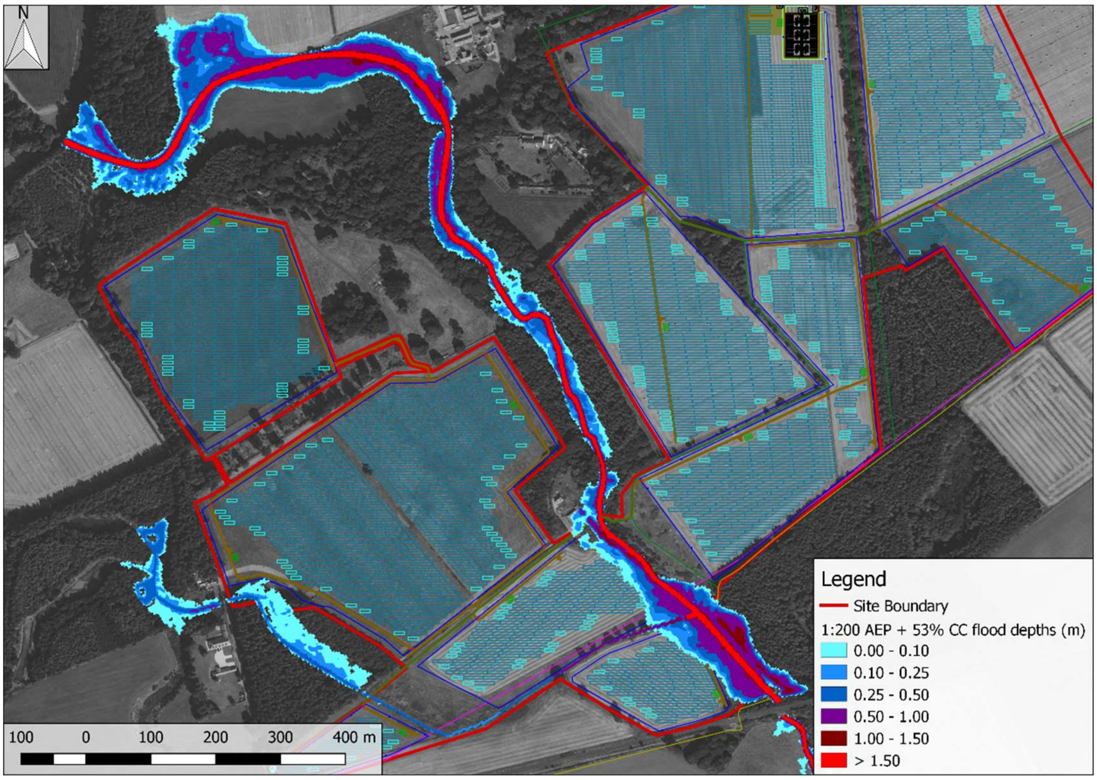
5.3 Model Results

5.3.1 Fluvial

The pre-development flood extents and depths are shown in Figure 5-2, with the Proposed Development included for reference. There is minimal flooding to the Site area, with some out-of-bank flow indicated in the southern portion of the Site in the functional floodplain of the Rankeilour Burn. The location for the proposed bridge upgrade appears to be an area of flood risk under existing conditions, as shown on the figure. However, the modelling indicates that flood free access/egress via the existing estate tracks to the west or east of this location would be feasible in times of flood.

The flooding to the solar panels in this area is generally indicated to be of depths of less than 300mm. Given that the panels are situated on plinths 800mm above ground level, it is not considered that the panels are at significant flood risk.

Figure 5-2 : Baseline 1:200 AEP event + 53% CC Fluvial Flood Extents/Depths



© Bing Satellite data (2025)

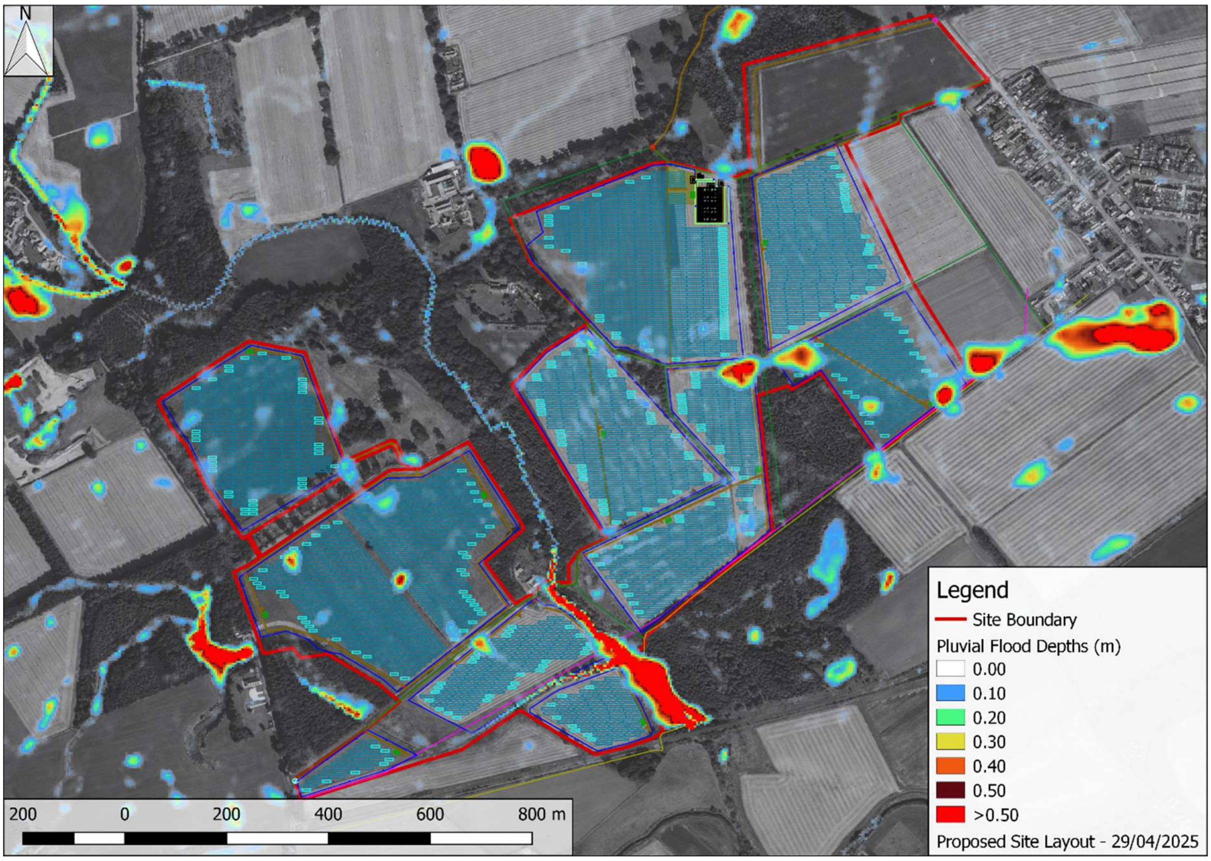
5.3.2 Pluvial

The surface water flood extents and depths as a result of direct rainfall are shown in Figure 5-3. The results indicate that the Site is not at significant flood risk due to direct rainfall. The proposed BESS/substation location is indicated to be flood-free based on existing conditions.

Some isolated pockets of flooding of up to 600 mm in depth are indicated to be located in areas proposed for solar panels. Given that the panels are to be raised 800 mm from ground level and that the water is expected to be standing water, it is not considered that the panels are at risk of flooding from this source.

The results indicate that flood-free access/egress from the Site would be viable via existing routes.

Figure 5-3 : 1:200 AEP + 39%CC Pluvial Flood Extents/Depths



© Bing Satellite data (2025)

5.3.3 Floodplain Loss

Based on the flood-compatible nature of the solar panels and the modelled flood extents, there is not indicated to be any loss in functional floodplain as a result of the development. There is therefore no requirement for compensatory storage to be provided within the Site boundary.

5.3.4 Access and Egress

At present, access/egress via the existing bridge proposed for upgrade is not indicated to be feasible for the design event. As a like-for-like replacement is proposed, access/egress via this route for the design event would not be feasible. However, there are alternative access/egress routes via the existing estate tracks to the west and east of this location.

It is therefore considered that the requirement for safe access/egress for the 1:200 AEP event + CC is satisfied.

5.3.5 Satisfying the Flood Risk Requirements

5.3.5.1 National Planning Framework 4

For planning purposes, the hydraulic modelling has demonstrated that the Site is not at risk of flooding during the 0.5% AEP event plus a suitable allowance for climate change and for planning purposes for the proposed Site is not at flood risk. As the Site is largely unmanned, there are also suitable access and egress provisions.

5.3.5.2 FIFEplan

The requirements of FIFEplan are largely in line with the requirements of NPF4. FIFEplan specifies that 'where flooding is predicted on the road this must be no greater than 300mm depth of ponding to permit access by emergency vehicles'. Given that there are flood-free access/egress routes on the Site, it is considered that this requirement is satisfied.

5.4 Model Quality Assurance

This section outlines the Quality Assurance (QA) measures undertaken in developing the hydraulic model.

Part of the general model QA process involves reviewing the TUFLOW messages generated during the model compilation stage and resolving any issues. Warnings produced by TUFLOW during the run are also investigated. Locations causing recurring warnings were identified and solutions implemented to reduce or remove the source of the issue. Model logs have also been utilised to record the key decisions taken during development of the model, allowing for traceability and to aid in the transfer of the models between different users. The main components of the model build, configuration and application were recorded and have been reviewed and signed-off by a senior hydraulic modeller.

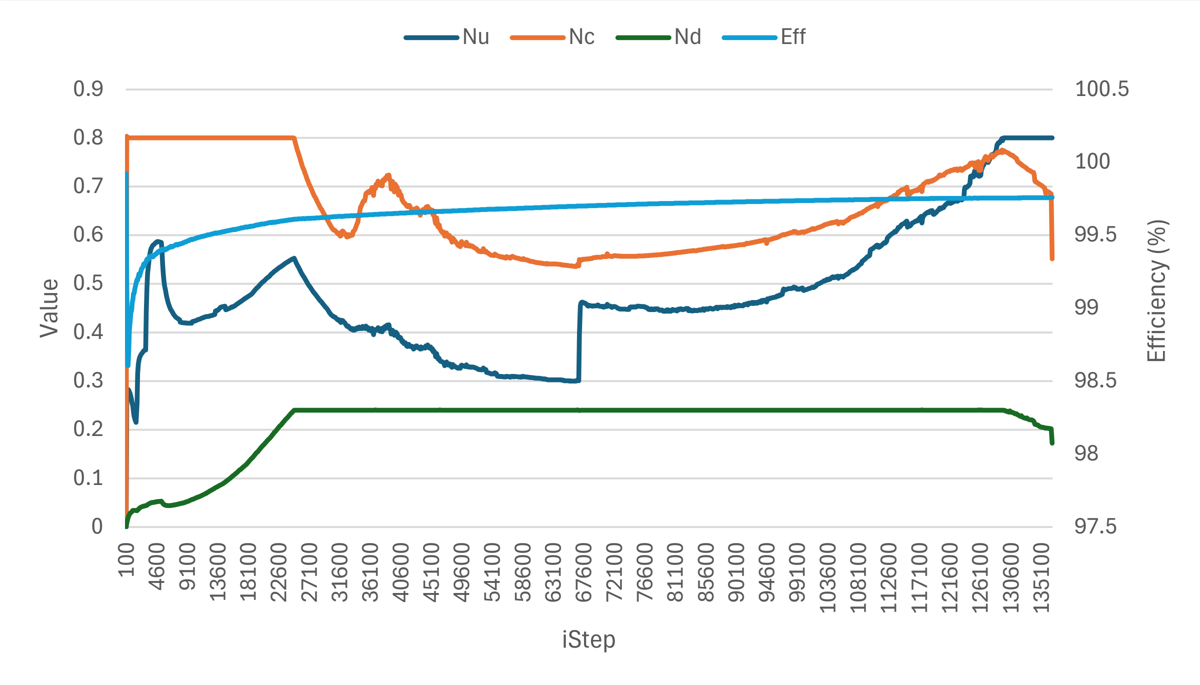
Further QA over the course of the model build was undertaken, including:

- Material roughness was checked by importing and thematically mapping the grd_check file to ensure surface resistance was applied correctly with respect to aerial images;
- The extent of the 2D domain was reviewed to ensure it was not limiting flood extents in the larger flood events within the area of interest; and,
- Minimum dT values across the 2D domain were reviewed to highlight any troublesome areas that were slowing down overall run time.

5.5 Model Stability

The model has been reviewed (Figure 5-4) and found to be stable and suitable for its intended use. TUFLOW HPC is inherently stable by nature of the adaptive time-stepping, the time-steps (dT) are consistent, and the Nu, Nc and Nd are within acceptable limits as identified by the software developers.

Figure 5-4 : TUFLOW HPC Checks



5.6 Model Sensitivity Testing

Sensitivity analysis is the study of how the variation in the output of the model (depth) can be apportioned, qualitatively or quantitatively, to difference changes in the model inputs (model variables, boundary conditions and parameters).

Sensitivity analysis is used to identify:

- The factors that potentially have the most influence on the model outputs;
- The factors that need further investigation to improve confidence in the model; and,
- Regions in space where the variation in the model output is greatest.

In line with good practice, the following parameters, and variables for the hydraulic model have been varied for the fluvial modelling in accordance with the % uplift/parameter change specified in Table 5-6.

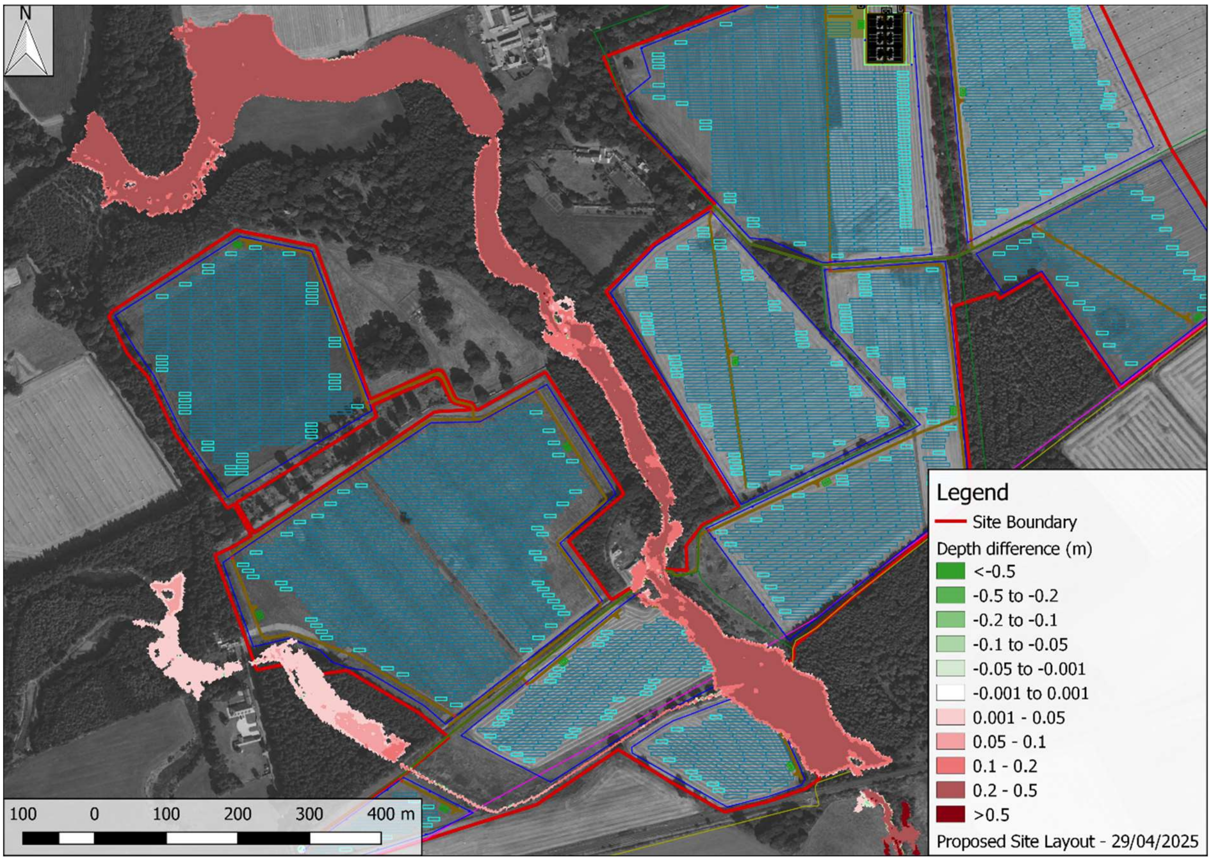
Table 5-6 : Sensitivity Analysis Variables

Parameter	Value change
Channel and floodplain roughness	+ 40 %
Blockage of railway culvert at downstream end of model	+ 50% blockage

For the 0.5% AEP plus climate change, a universal increase of 40% to the Manning's n roughness values was applied across the entirety of the model domain. The model results demonstrated a limited change in flood extents, but an increase in flood depths in the southern area of the Site of just over 200mm, as well as some increases in flood depths upstream of the Site of just over 300mm. It is therefore considered that the model is sensitive to changes in roughness, though these changes do not have a major impact on the Proposed Development.

A summary of the change in depths is shown in Figure 5-5.

Figure 5-5 : Depth Difference (40% increase in roughness)



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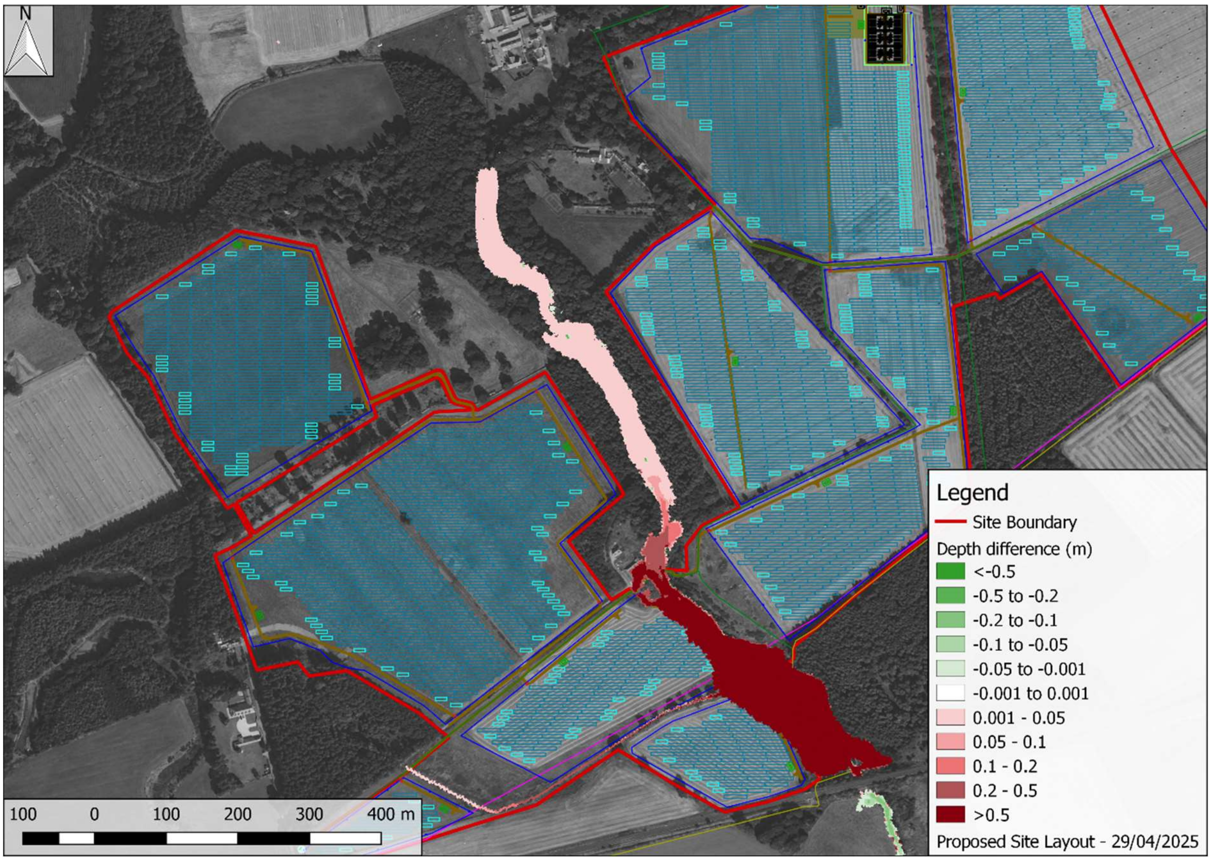
A 50% blockage sensitivity test was also undertaken on the baseline scenarios, for the 1:200 AEP event plus climate change, to quantify the impacts of a constriction to flow upstream of the railway culvert at the downstream end of the Site. The results demonstrated minor changes in flood extents due to the blockage, with significant depth increases of up to 900mm in the southern area of the Site (Figure 5-6). It is therefore considered that the downstream railway culvert has a significant impact on flood levels.

Figure 5-6 : Depth Difference (50% blockage downstream)



6.0 Drainage Impact Assessment

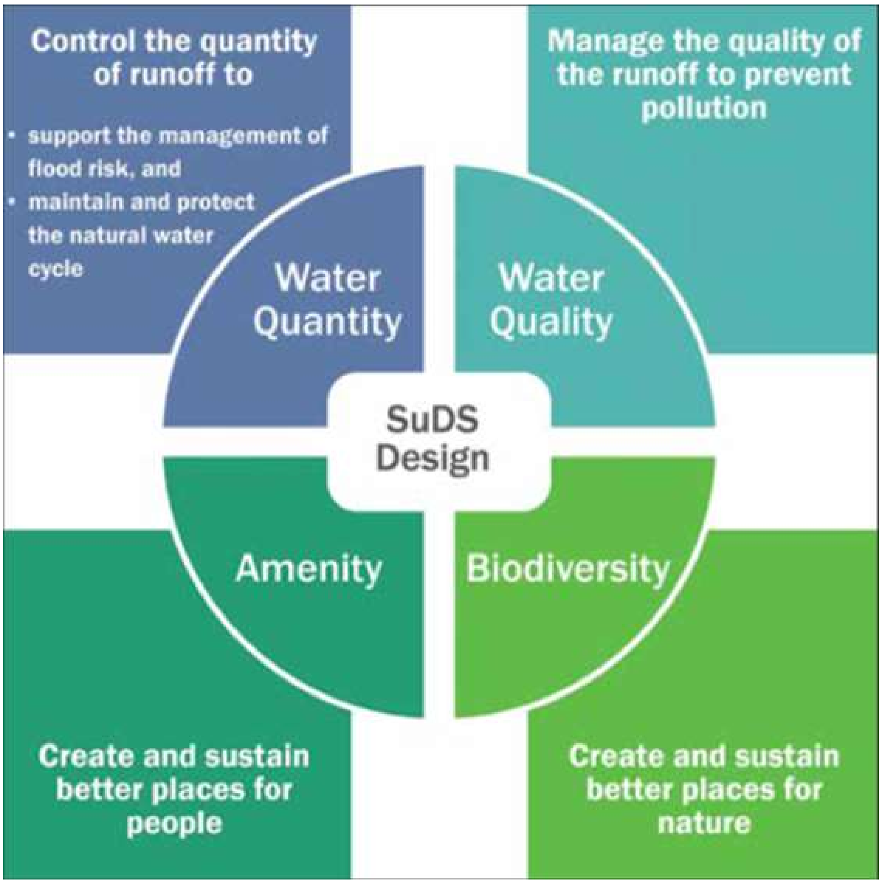
This Drainage Impact Assessment (DIA) sets out high-level principles for managing surface water runoff from impermeable areas of the Proposed Development, in line with best practice and the requirements of Fife Council.

This assessment is intended to demonstrate that, given the nature and quantum of development proposed, it will be feasible to drain the Site in line with planning requirements.

6.1 Key Principles of Surface Water Management

Current best practice document, The Sustainable Drainage System (SuDS) Manual (CIRIA Report C753F)[19], promotes sustainable water management through the use of SuDS. There are four main categories of SuDS which are referred to as the 'four pillars of SuDS design' as depicted in **Figure 6-1**.

Figure 6-1 : Four Pillars of SuDS (extract from CIRIA Report C753)



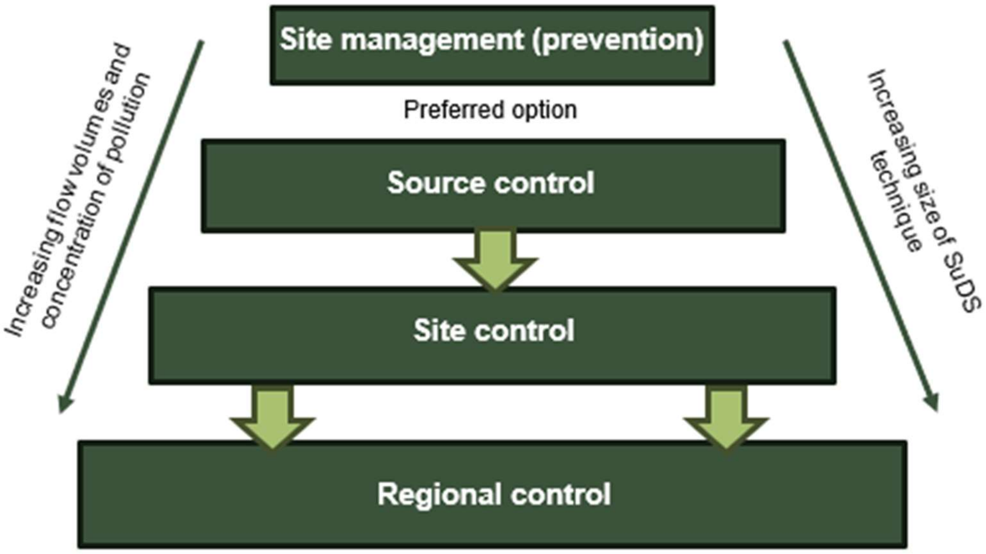
The SuDS Manual identifies a hierarchy of SuDS for managing runoff, which is commonly referred to as a 'management train.' The hierarchy of techniques is identified as:

- Prevention – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g., minimise areas of hard standing).
- Source Control – control of runoff at or very near its source (such as the use of rainwater harvesting).

[19] Report C753, The SuDS Manual; CIRIA (2015). Report C753F, December 2015.

- Site Control – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site).
- Regional Control – management of runoff from several sites, typically in a retention pond or wetland.

Figure 6-2 : SuDS Management Train



It is generally accepted that the implementation of SuDS, as opposed to conventional drainage systems, provides a number of benefits by:

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- Reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- Improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- Reducing potable water demand through rainwater harvesting;
- Improving amenity through the provision of public open spaces and wildlife habitat; and,
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

6.2 Existing Surface Water Drainage Regime

The field within which the proposed battery storage site and associated infrastructure is located is known to be underlain by a series of field drains that ultimately discharge to the Rankeilour Burn via a 6-inch (152.4mm) pipe. It was not possible to verify the condition or precise routing of the drains, or the outlet to the burn at the time of the site inspection. For the purposes of a conservative estimate of the sizing of the proposed drainage system, this system has not been accounted for in the drainage modelling.

The wider Site is not served by any formal drainage system.

6.3 Pre-Development Runoff Rates (Greenfield)

Greenfield runoff rates for the area equivalent to the proposed impermeable area resulting from the development were estimated using industry-standard ReFH2 methodology[20], with application of the latest FEH22 rainfall data and hydrological descriptors from the Flood Estimation Handbook (FEH) Web Service[21]. FEH22 rainfall data for the point at NGR NO 33239 12013 were utilised in the following analysis.

The following parameters were applied to the analysis:

- Site area: 100ha
- Proposed impermeable area: 0.1418ha

The proposed impermeable area covering the Site was determined by calculating the net area of the following proposed infrastructure, as shown in Table 6-1. The ground between the battery storage units is to be of gravelled surfacing. The ground between the solar panels is to be left as existing. The access roads are to be of crushed rock surfacing and are therefore not considered as impermeable areas.

Table 6-1 : Impermeable areas* of Proposed Development

Proposed Infrastructure	Area (m^2)	Area (ha)
BESS units (24)	624	0.0624
PCS (6)	450	0.0450
Pump house and 2 x water tanks	190	0.0190
Private substation (2)	40	0.004
DNO substation	20	0.002
Welfare unit (2)	30	0.003
Spare container	30	0.003
Spares/comms unit	15	0.0015
Transformer station	15	0.0015
Transformer	4	0.0004
TOTAL	**1,418**	**0.1418**

**Values calculated from areas of confirmed hardstanding only.*

The greenfield runoff rates for the Proposed Development resulting from the ReFH2 analysis are summarised below in Table 6-2. The 1ha ReFH2 greenfield results for the 1:2 AEP event and for the design event (1:200 AEP + 39% CC) are located in Appendix D.

[20] Wallingford Hydro Solutions (2023), ReFH 2, available at: https://www.hydrosolutions.co.uk/software/refh-2/, last accessed February 2025

[21] UK Centre for Ecology and Hydrology, Flood Estimation Handbook Web Service, available online at https://fehweb.ceh.ac.uk/, last accessed February 2025

Table 6-2 : Greenfield Runoff Rates

Annual Probability	Greenfield Runoff Rate (l/s/ha)	Impermeable Development Area Greenfield Runoff Rate* (l/s)
1:2	0.5	0.071
1:30	1.12	0.16
1:200	1.93	0.27
1:200 + 39%CC	3.07	0.44

**Based on an impermeable area of 0.1418ha.*

6.4 Proposed Discharge Arrangement

With reference to the SuDS Manual, the hierarchy of preferred disposal options for surface water runoff from development sites in decreasing order of sustainability is as follows:

- Infiltration to Ground;
- Discharge to Surface Waters; or,
- Discharge to Sewer.

Table 6-3 summarises the suitability of disposal methods in the context of the Site and the Proposed Development. Based on this, runoff from the Site is proposed to drain to a watercourse.

Table 6-3 : Suitability of Surface Water Disposal Methods

Surface Water Disposal Method (in order of preference)	Suitability Description	Method Suitable (Y / N)
Infiltration to Ground	No ground investigation has been undertaken on the Site to date. The geology and hydrogeological context at the Site have therefore been determined based on a desktop analysis using open-source information. As discussed in Section 1.4.2, the soil in this area of the Site has been described as 'imperfectly drained' brown soil and the underlying geology is suggested to be comprised of Devensian till (poor infiltration media) overlying permeable sandstone bedrock. Based on the soil conditions, formal infiltration is unlikely feasible.	N

Surface Water Disposal Method (in order of preference)	Suitability Description	Method Suitable (Y / N)
Surface Water Discharge	The Rankeilour Burn is located some 550m to the west of the proposed compound, and the local fields are drained by an existing field drain system that discharges to the Rankeilour Burn via a 6-inch (152.4mm) pipe. The precise routing, invert levels, and condition of the piped network are unknown, and it is therefore assumed that a new connection would be required. Given the limited size of the proposed impermeable area and the minor runoff rates, the proposed method of drainage is to mimic the existing regime with limited runoff to be intercepted close to source by a series of swales which will subsequently drain to the Rankeilour Burn. Any exceedance of the proposed swales would be expected to follow the natural/existing drainage regime to ultimately discharge to the Rankeilour Burn.	Y
Sewer Discharge	There are no formal sewers serving the Site, with the nearest Scottish Water surface water sewer located in Springfield to the east of the Site. A pumped system would be required to discharge to this sewer. Discharge to watercourse is therefore preferred.	N

6.5 Conceptual Surface Water Drainage Strategy

The proposed drainage strategy will manage surface water runoff as close to the source as possible.

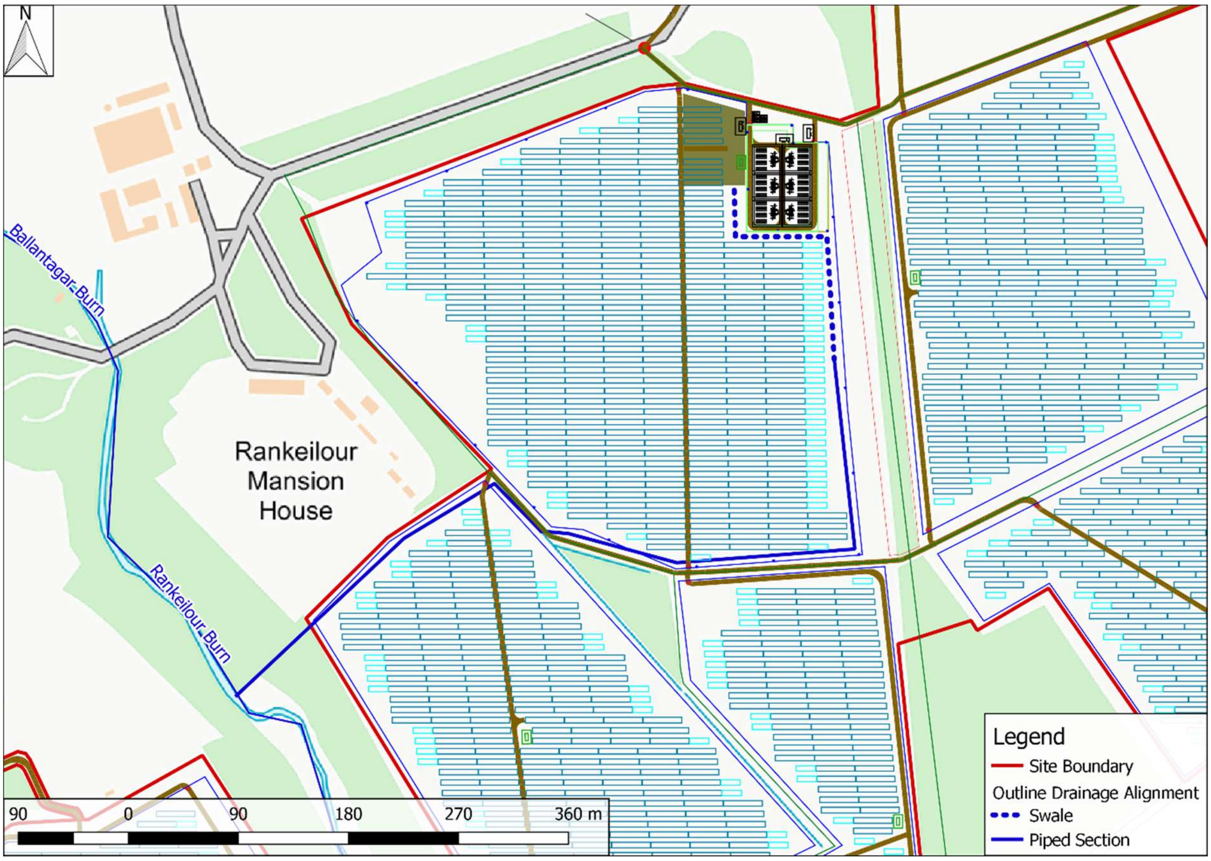
The Proposed Development would intercept precipitation and shed this onto the ground at the footings of each solar panel. This runoff would continue to infiltrate into the underlying soils and bedrock, be taken up by vegetation or evaporate in much the same way as existing conditions. During significant rainfall events, runoff would effectively flow in accordance with local topography, predominantly towards the south and southwest of the compound, following the same hydrological regime as is currently experienced on the Site.

The scheme would result in a small increase in impermeable surface area due to the construction of the Battery Energy Storage System (BESS) and associated infrastructure (as detailed in Section 6.3), which when combined account for 0.1418ha of the Site area.

This surface water drainage strategy will seek to mimic the existing runoff regime and ensure that there is no increase in peak discharge from the impermeable areas on Site. This will be achieved through the installation of a series of swales along the southern and western boundaries of the proposed compound, and along the eastern boundary of the proposed panels, downgradient of the hardstanding areas. The flows would ultimately be piped from the swale to the Rankeilour Burn.

The conceptual drainage strategy is shown in Figure 6-3.

Figure 6-3 : Conceptual Drainage Strategy



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The final routing and details of the surface water drainage strategy which could be applied at the Site are a matter of developer preference and requires collaboration between the development/landscape architects and Fife Council during the final detailing of the Site design to ensure efficient and effective integration. This would normally be undertaken during the post-planning stage or via an appropriately worded planning condition, in which individual hydraulic design parameters would be detailed as required. Notwithstanding, the following sections provide details of the intended system concept.

Prior to the detailed design stage, infiltration testing and groundwater monitoring would be recommended to further inform the system dimensions.

6.6 SuDS Attenuation Storage

The Site will incorporate a swale at the southern/western boundary of the proposed compound. The following parameters have been incorporated in the modelling of the proposed swale system:

Table 6-4 : Preliminary Drainage Model Parameters

Attribute	Swale
Impermeable area	0.142ha
Slope	1:800
Side slopes	1:3
Upstream Cover Level	47.5m AOD (as per ground level at downstream end of compound area)
Upstream Invert Level	46.5m AOD
Length	200m
Dimensions	1000m diameter, 400mm depth

The downstream cover/invert levels are to be designed in accordance with the existing ground levels at the downstream end of each section of the proposed swale feature. The proposed swale is to be stepped in order to ensure that each section has the required slope. For a conservative approach, no infiltration has been assumed.

The swale would require a piped outfall to the Rankeilour Burn. It is proposed that the swale would drain to the piped outfall through a HydroBrake, restricting flows to 1.0l/s. While this rate exceeds the calculated greenfield runoff rates above, it represents a reasonably practicable minimum rate while maintaining a minimum outlet diameter of 75mm, ensuring that the risk of blockage is reduced.

6.7 SuDS Performance Assessment: Water Levels

It is proposed that attenuation will be provided by the swale, which will discharge to the Rankeilour Burn following the existing drainage regime. In line with NPF4 and Fife Council guidance, the proposed SuDS system accommodates up to and including the 1:200 AEP event plus an allowance for climate change with no flooding.

Full results for the critical events are presented in Appendix E, and the 1:30 + CC and 1:200 + CC events are summarised in Table 6-5. The depths and volumes shown in the below table are for the downstream end of the proposed swale. Depths and volumes in each section of the swale will vary depending on the final detailed design.

Table 6-5 : Summary of SuDS Performance – Attenuation Volume

SuDS Feature	AEP Event	Peak Water Depth (m)	Maximum Storage Volume (m^3)	Flood Volume (m^3)
Swale	1:30 + 39% CC	0.317	68.37	0
	1:200 + 39% CC	0.409	112.6	0

6.8 SuDS Performance Assessment: Water Quality

The simple index method, as outlined within the SuDS Manual, provides a way of quantifying the benefit to water quality of the SuDS Management Train. The pollution hazard from the land use and the mitigation from the SuDS component are each assigned an index. The total mitigation index must be greater than the pollution hazard index for adequate treatment to be delivered.

Total SuDS mitigation index ≥ pollution hazard index

(for each contaminant type) (for each containment type)

The total SuDS mitigation is the summation of the first components mitigation index and half the mitigation index of any subsequent component.

With reference to the SuDS Manual, post-development surface water runoff generated from the development is considered to have a *'Low'* Pollution Hazard Level respectively as presented in Table 6-6.

Table 6-6 : Pollution Hazard Potential for the Proposed Development

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	Metals	Hydrocarbons
Other Roofs (typically commercial/industrial roofs)	Low	0.3	0.2	0.05
Low Traffic Roads	Low	0.5	0.4	0.4

The proposed surface water drainage system is required to provide sufficient treatment to mitigate the Pollution Hazard Indices indicated in the above table. The SuDS Mitigation Indices are therefore indicated in Table 6-7 below.

Table 6-7 : SuDS Mitigation Indices for Proposed Development

SuDS Component	Pollution Hazard Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Swale	0.7	0.4	0.6

Table 6-8 compares the SuDS Mitigation Indices, provided by the proposed 'Source Control', 'Conveyance' and 'Site Control' measures against the Pollution Hazard Indices for the combined SuDS features.

Table 6-8 : SuDS Performance: Water Quality Indices Assessment - Swale

Land Use	Pollution Hazard Level	Pollution Hazard and SuDS Mitigation Indices Comparison					
		Total Suspended Solids (TSS)		Metals		Hydrocarbons	
		Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index
Industrial Roof	Low	0.3	0.7	0.2	0.4	0.05	0.6
BESS Platform (low traffic road parameters)	Low	0.5	0.7	0.4	0.4	0.4	0.6

As the SuDS Mitigation Index provided by the proposed SuDS measures are greater than or equal to the Pollution Hazard Index, the water quality assessment criteria are satisfied for all Land Use criteria.

6.9 SuDS Operational Maintenance Requirements

A full SuDS maintenance plan would be produced as part of the detailed drainage design post-development and the precise requirement would depend on manufacture specification of the final design. At this time, it is considered that:

- The responsibility for the swale would pass to the operator of the BESS development; and,
- The responsibility for the pipework and orifice controls would pass to the operator of the BESS development.

An outline of the typical maintenance requirements of the proposed SuDS feature is outlined below.

6.9.1 Swale

A recommended operation and maintenance plan for the swale is summarised in Table 6-9. The final operation and maintenance plan for the drainage strategy should be determined based on the final detailed design.

Table 6-9 : Swale Operation and Maintenance Requirements

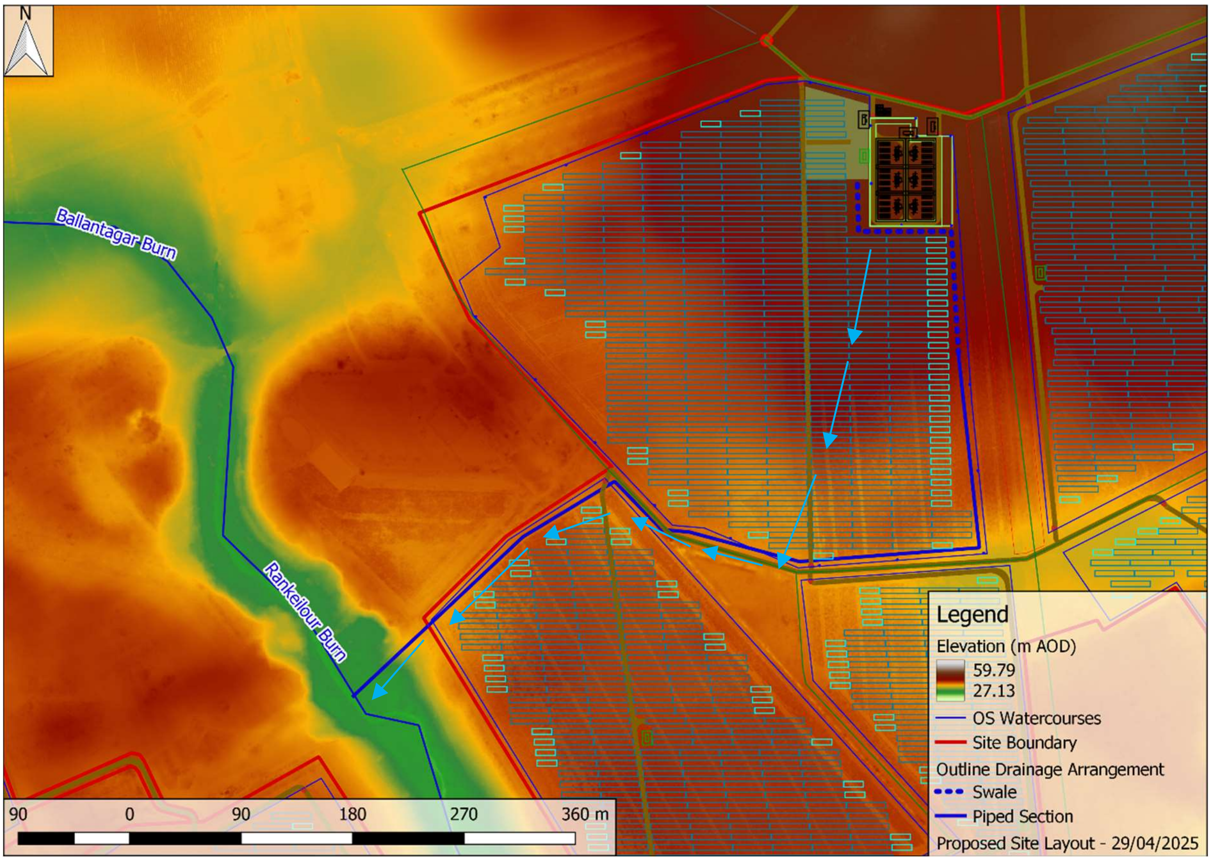
Maintenance Schedule	Required Action	Minimum Frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Manage vegetation/remove nuisance plants	Monthly at start, then as required
	Inspect outlet for blockages, and clear if required	Monthly
	Inspect swale for compaction and silt accumulation, note any remedial works required	Monthly, or as required

Maintenance Schedule	Required Action	Minimum Frequency
	Inspect outlet for silt accumulation, establish silt removal frequency	Half yearly
	Cut grass to within desired range	Monthly (during growing season), or as required
	Inspect vegetation coverage	Monthly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required if bare soil is exposed of 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits, and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

6.10 Exceedance

In the low probability event of an exceedance of the swale, or if a blockage of the orifice were to occur, flows would be expected to follow natural topographical gradients towards the existing drainage ditch system that drains to the Rankeilour Burn.

Figure 6-4 : Exceedance Flow Paths



© Contains OS data (Crown Copyright 2025) and Phase 5 elevation data from the Scottish Remote Sensing Portal

6.11 Foul Water Drainage Strategy

It is understood that the proposed platform will have no foul connections, and that the Site will be served by portable toilets and/or welfare facilities which will drain foul water to a tank which will be emptied or removed as required. There is therefore no requirement for a foul water drainage strategy for this Proposed Development.

6.12 Fire Water Drainage Strategy

The Proposed Development includes two water tanks and an associated pump house for the storage of fire water. The tanks each have a capacity of 115,000 litres (combined capacity 230,000 litres). The proposed swale would therefore be required to store the full 230m^3 of water in the event of a fire.

Modelling has therefore been undertaken to assess the impact of a fire and discharge of firewater at the beginning of a 7-day 1:10 AEP rainfall event. The rainfall in the system for this event would result in a volume of approximately 124m^3 within the swale, additional to the 230m^3 resulting from the discharge of firewater. The swale would therefore require capacity for 354m^3 with no outflow.

Modelling of the full capacity of the swale was therefore carried out to determine whether the swale has capacity for the firewater discharge. The maximum capacity of the swale with no outflow was determined to be approximately 367m^3. It is therefore considered that the swale has capacity for the firewater discharge of 230m^3 and the 124m^3 due to rainfall for the 1:10 AEP event with no outflow. The results of this modelling are included in Appendix F.

The surface water drainage system will be fitted with a penstock at the outfall to prevent contaminated water entering the larger network in the event of a storm. It is understood that there is limited drainage in the soil surrounding the Proposed Development, and as such the soil would provide a barrier to discharge into the underlying aquifer. No additional measures to prevent water discharging to ground are considered necessary in this case.

7.0 Conclusions

7.1 Flood Risk

The hydraulic modelling indicates that the Proposed Development Site is not at flood risk for the design event of 0.5% AEP plus CC, and that flood-free access/egress is possible for this event.

Fluvial flooding to the solar panels in the southern portion of the Site is generally indicated to be of depths of less than 300mm. Given that the panels are situated on plinths 800mm above ground level, it is not considered that the panels are at significant flood risk.

Some isolated pockets of surface water flooding of up to 600mm in depth are indicated to be located in areas proposed for solar panels. Given that the panels are to be raised 800 mm from ground level and that the water is expected to be standing water, it is not considered that the panels are at risk of flooding from this source.

Given that the Proposed Development is not at flood risk, does not increase flood risk elsewhere, and is accessible for the design event of 1:200 AEP plus CC, it is considered that the requirements of NPF4 and FIFEplan are fulfilled.

7.2 Surface Water Drainage Strategy

It is proposed that surface water runoff from the 0.1418ha of proposed impermeable surfaces is captured and drained to a swale located along the perimeter of the proposed compound. The proposed swale would ultimately discharge surface water at an attenuated rate to the Rankeilour Burn.

The proposed swale is shown to accommodate 0.46m^3 of surface water attenuation whilst providing adequate surface water quality treatment. The proposed swale would be outwith the substation fencing and would require check dams, or a similar cascaded approach, to slow flows and encourage storage. For a conservative approach, no infiltration has been assumed. As noted in the section on firewater, a penstock would be required on the swale outfall.

7.3 Foul Water Drainage Strategy

There will be no foul discharge as a result of the development.

7.4 Fire Water Drainage Strategy

Flow modelling of the proposed total firewater storage tank volume at the proposed Site indicated that the proposed swale has capacity for the firewater as well as the 1:10 AEP flows with no discharge from the swale.

It would be recommended that the capacity of the swale is confirmed at the detailed design stage, as any changes to the swale volume could result in a change in the capacity for the storage of firewater.

A penstock would be required on the proposed swale to ensure no discharge of contaminated water to the Rankeilour Burn.

Appendix A Proposed Development Layout

West Springfield Solar

Flood Risk Assessment & Drainage Impact Assessment

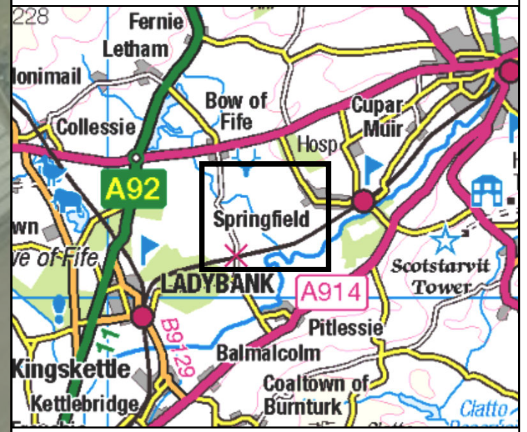
TRIO West Springfield Solar LLP

SLR Project No.: 428.013383.00001

30 April 2025

LEGEND

- Site Boundary
- Proposed Solar Array
- Battery Energy Storage System (BESS)
- Proposed Transformer Station
- Proposed Construction Compound
- Proposed Solar Fence
- Proposed BESS Fence
- Proposed Access Track
- SiteBoundary_SS250425



trio

SLR

WEST SPRINGFIELD SOLAR FARM & BESS

ENVIRONMENTAL IMPACT ASSESSMENT

SITE LAYOUT

FIGURE 1.2

Scale	Date
1:7,500 @ A3	APRIL 2025

Appendix B Third-Party Certification (FRA & DIA)

West Springfield Solar

Flood Risk Assessment & Drainage Impact Assessment

TRIO West Springfield Solar LLP

SLR Project No.: 428.013383.00001

30 April 2025

Appendix 8 - Flood Risk Assessment – Independent Check Certificate - Tier 2 Major Applications

I certify that all the reasonable skill, care and attention to be expected of a qualified and competent professional in this field has been exercised in checking the Flood Risk Assessments for the below named development with a view to ensuring that it has been accurately translated into the Flood Risk Assessment Report.

ePlanning Reference No.……………………………………………..……………………………

Name of Development …Proposed Solar Farm on the Rankielour Estate…………………………………

Name of Developer ………TRIO West Springfield Solar LLP……………………..............................

Name and Address of Checkers Organisation……………………………………………………….

……Dougall Baillie Associates…………………………………………………………………………….

……3 Glenfield Road……………………………………………………................................

……East Kilbride G75 0RA………………………………………………………………………….

Name of Checker…Scott Macphail……………………………………………………………………….

Position Held………Director…………………………………………………………………..

Engineering Qualifications[11]BEng CEng MICE MCIHT………………………………..............................

Signed ………………[redacted]……….………………………….

Date …………………………06.05.25………………………………………………………………………

[11] Minimum Qualification - Incorporated Engineer or equivalent from an appropriate Institution.

Appendix 4 - SuDS Independent Check Certificate – Tier 2 Major Applications

I certify that all the reasonable skill, care and attention to be expected of a qualified and competent professional in this field has been exercised in the below named development with a view to securing that:

1. It has been designed in accordance with the current editions of CIRIA C753: The SuDS Manual 2015, Sewers for Scotland and Fife Council's – Design Criteria Guidance Note on Flooding and Surface Water Management Plan Requirements.
2. It shall be accurately translated into construction drawings and schedules.
3. I hereby confirm that I hold professional indemnity insurance for £5 million pounds and append a copy of the certificate of insurance.

ePlanning Reference No.……………………………………………………..…………………………….

Name of Development …Proposed Solar Farm on the Rankielour Estate……………………………………….

Name of Developer ……TRIO West Springfield Solar LLP

……………………………………….............................

Name and Address of Checkers Company (this can be someone from the same company but cannot be the same person that signed the related Design Check Certificate).

…………………………………………………………

…Dougall Baillie Associates……………………………………………………….

…3 Glenfield Road…………………………………………………….................................

…East Kilbride G75 0RA………………………………………………………………………………….

Name of Checker…………Scott Macphail…………………………………………….

Position Held………………Director………………………………………………………………..

Engineering Qualifications[7]…BEng CEng MICE MCIHT…………………………………................................

Signed ………………… [redacted] ……………………..……………………..

Date ………………………..06.05.25………………………………………………………………………

[7] Minimum Qualification - Incorporated Engineer or equivalent from an appropriate Engineering Institution.

Appendix C Flow Estimation Methodology

West Springfield Solar

Flood Risk Assessment & Drainage Impact Assessment

TRIO West Springfield Solar LLP

SLR Project No.: 428.013383.00001

30 April 2025

West Springfield Solar Farm

Flow Estimation Methodology

TRIO West Springfield Solar LLP

UK House 5th Floor 164-182 Oxford Street, London W1D 1NN GB

Prepared by:

SLR Consulting Limited

The Tun, 4 Jackson's Entry, Edinburgh, EH8 8PJ

SLR Project No.: 428.013383.00001

Client Reference No: N/A

22 April 2025

Revision: 01

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
01	16 April 2025	AH	SCB	RW
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			

Basis of Report

This document has been prepared by SLR Consulting Limited (SLR) with reasonable skill, care and diligence, and taking account of the timescales and resources devoted to it by agreement with TRIO West Springfield Solar LLP as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

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Table of Contents

Tables in Text

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Appendices

Acronyms and Abbreviations

AEP	Annual Exceedance Probability
AMAX	Annual Maximum
AREA	Catchment area (km2)
BFI	Base Flow Index
BFIHOST19	Base Flow Index derived using the HOST soil classification, revised in 2019
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
GEV	Generalised Extreme Value
GL	Generalised Logistic
HOST	Hydrology of Soil Types
IF	Impervious Fraction
IRF	Impervious Runoff Factor
LF	Low flow statistics (flow duration curve)
NFY	Non-flood years
NRFA	National River Flow Archive
POT	Peaks Over a Threshold
QMED	Median Annual Flood (with return period 2 years)
ReFH	Revitalised Flood Hydrograph method
ReFH2	Revitalised Flood Hydrograph 2 method
SAAR	Standard Average Annual Rainfall (mm)
Tp	Time to peak of the instantaneous unit hydrograph
URBAN	Flood Studies Report index of fractional urban extent
URBEXT1990	FEH index of fractional urban extent
URBEXT2000	Revised index of urban extent, measured differently from URBEXT1990
WINFAP	Windows Frequency Analysis Package (software that can be used for FEH statistical method)

1.0 Introduction

SLR Consulting Ltd (SLR) was appointed by TRIO West Springfield Solar LLP to undertake hydraulic and hydrological modelling for the proposed West Springfield Solar Farm.

Peak flow estimates and accompanying hydrographs are required for the 0.5% and 0.5% + climate change events. These are required for input into a bespoke hydraulic model constructed for the Rankeilour Burn using ungauged FEH methods and a lumped modelling approach.

A lumped flow estimate is required for the Rankeilour Burn, located at National Grid Reference (NGR): NO 33300 10900.

2.0 Methodology

The flood estimates have been developed following the methods in the latest Flood Estimation Handbook[1] (FEH) Statistical and Rainfall Runoff methods and updates in the latest SEPA technical documentation[2].

The WINFAP v5.2 software[3] has been used to apply the Statistical Method using the NRFA Peak Flow Dataset v13.0.3[4]. This method requires the estimation of the Median Annual Flood (QMED) and a normalised flood frequency curve, termed flood growth curve.

The Rainfall Runoff methods are those first published by Kjeldsen[5], which were subsequently updated in 2015 and implemented within the ReFH2 software[6]. The latest ReFH2.3 model version 4.1.8879 which was released in 2024 and is calibrated for the FEH22 depth duration frequency (DDF) rainfall model.

The FEH data and methods are the regulatory recommended methods for estimating river flood frequency and design rainfall in England, Scotland and Wales.

3.0 Analysis

3.1 Catchment Delineation

The Rankeilour Burn is a tributary of the River Eden, which flows from north to south from Glenduckie Hill to its confluence with the River Eden just south of the Edinburgh to Aberdeen Railway Line. The Rankeilour Burn sources from two minor burns, the Fernie Burn and the Ballantagar Burn.

The FEH Web Service[7] was used to obtain catchment descriptors at the outlet for the Rankeilour Burn, located at NGR NO 33300 10900. The catchment boundary was then reviewed in conjunction with 50cm spatial resolution data from the Scottish Remote Sensing

[1] Flood Estimation Handbook, Centre for Ecology and Hydrology. 1999

[2] SEPA, 13th June 2022, Technical Flood Risk Guidance for Stakeholders – SEPA requirements for undertaking a Flood Risk Assessment

[3] https://www.hydrosolutions.co.uk/software/winfap-5/

[4] https://nrfa.ceh.ac.uk/peak-flow-dataset

[5] The revitalised FSR/FEH rainfall-runoff method. Supplementary Report No.1. Kjeldsen, T. R. Centre for Ecology and Hydrology. 2007.

[6] https://www.hydrosolutions.co.uk/software/refh-2/

[7] https://fehweb.ceh.ac.uk/Map

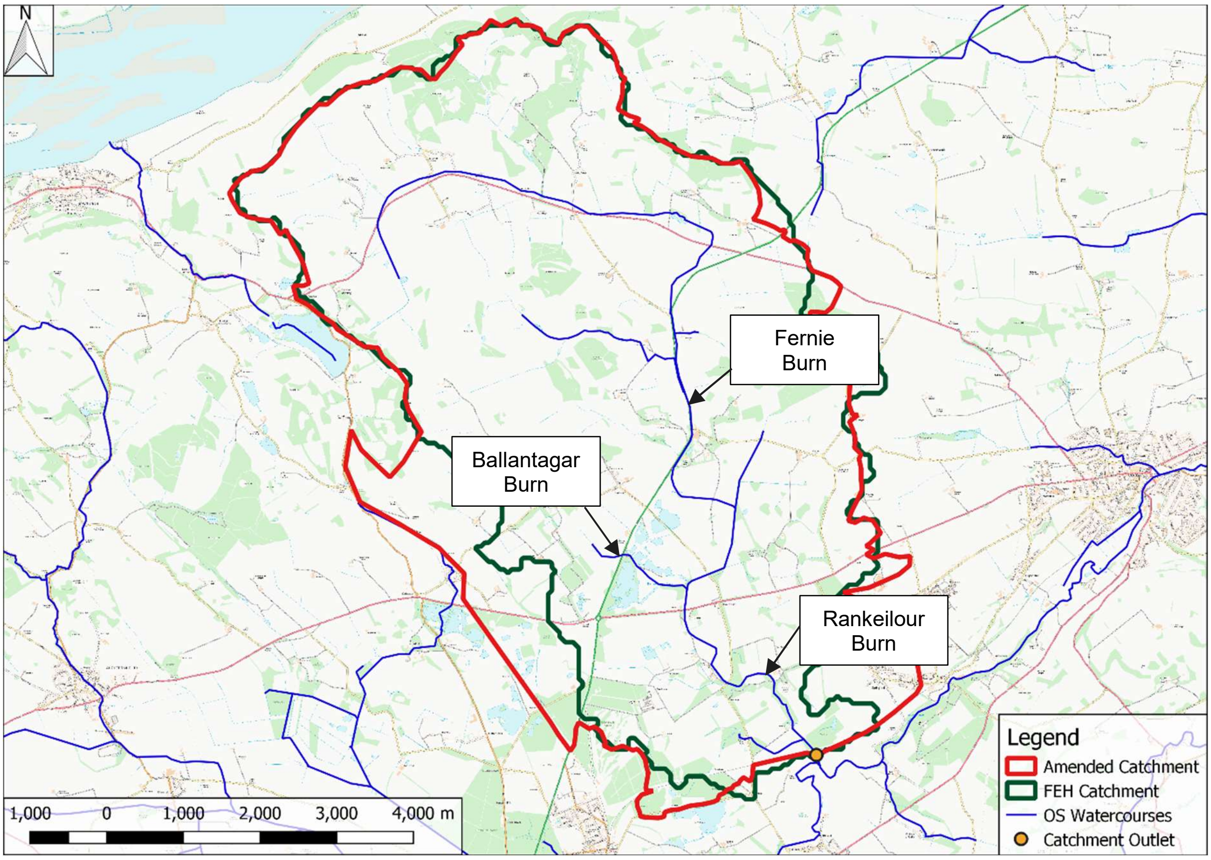
Portal[8] and amended to better reflect local features, such as the presence of railway embankments.

The catchment outlet, catchment area, and revised catchment area are summarised in Table 3-1. The catchment delineations are shown in Figure 3-1.

Table 3-1 : Catchment Location and Area

Watercourse Name	Outlet NGR	FEH Area (km^2)	Amended Area (km^2)
Rankeilour Burn	NO 33300 10900	46.88	52.14

Figure 3-1 : Catchment Delineation



3.2 Catchment Features

The catchment is predominantly rural in nature, with the dominant land use type being agricultural fields. There are some minor urban areas within the catchment, though these would be expected to have a minimal impact on flows.

[8] https://remotesensingdata.gov.scot/

British Geological Survey (BGS) mapping[9] was reviewed to assess the catchment geology. The catchment geology varies from north to south. The northern portion of the catchment is underlain by andesite, hypersthene, basalt, and conglomerate bedrock of the Ochil Volcanic Formation. This bedrock is overlain by superficial deposits comprised of Devensian till and other glaciofluvial deposits of gravel, sand, and silt.

The southern portion of the catchment is underlain by the Glenvale Sandstone Formation, overlain by glaciofluvial superficial sheet deposits of gravel, sand, and silt.

Two known aquifers are identified by SEPA within the catchment extents: the Auchtermuchty aquifer in the northern portion of the catchment, and the Falkland aquifer in the southern portion of the catchment[10]. BGS classify the bedrock beneath the site itself as a regionally important multi-layered highly productive aquifer of the Stratheden Group.

Notable features of the Rankeilour Burn catchment include the Melville Gates Quarry, Collessie Quarry, the Lower Melville Wood Landfill Site, and the Eden Springs Fishery.

The quarries do not have any major settling ponds that would be expected to significantly impact attenuation in the catchment.

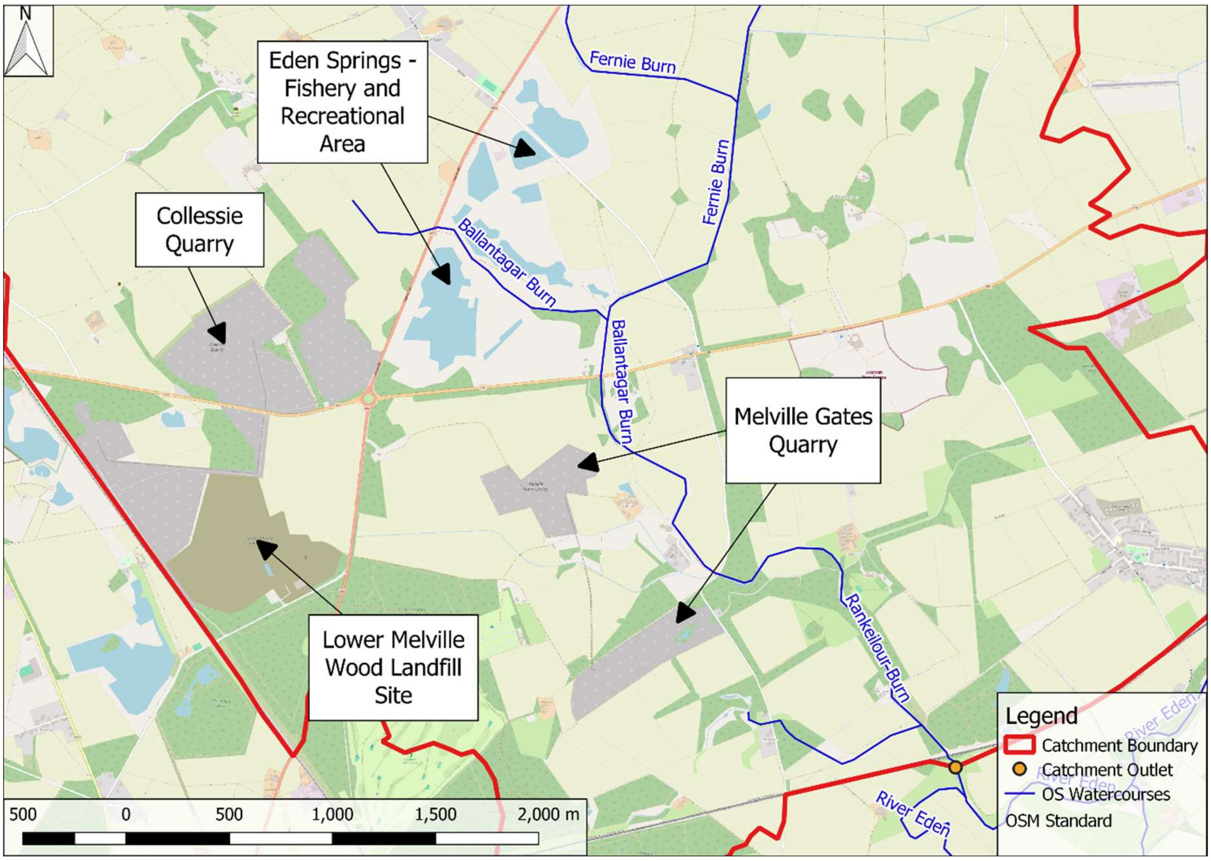
There are a number of water bodies associated with the Eden Springs Fishery and some recreational businesses, and the effects of these water bodies on attenuation in the catchment should be accounted for.

The notable catchment features are shown in Figure 3-2.

[9] BGS, GeoIndex Onshore, available at: https://mapapps2.bgs.ac.uk/geoindex/home.html?layers=BGSBedEngGeol,BGSSupEngGeol,BGSEGFSReports, BGSUSAReports, last accessed March 2025

[10] https://informatics.sepa.org.uk/WaterClassificationHub/

Figure 3-2 : Notable Catchment Features



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3.3 Catchment Descriptors

The catchment descriptors for the lumped catchment have been obtained from the FEH Web Service[7]. The key FEH catchment descriptors are provided in Table 3-2, with amended descriptors highlighted in red. Some key features have been amended from the FEH default descriptors.

The catchment SAAR6190 of 748mm indicates a low average annual rainfall. It is noted that a low SAAR can indicate that the catchment may experience non-flood years.

The BFIHOST19 of 0.629 indicates that the catchment is moderately permeable. This is reflected in the sandstone bedrock in the southern portion of the catchment.

The catchment is essentially rural, and as such the FEH-recommended URBEXT2000 value of 0.0031 has been retained.

The FEH FARL value does not account for the attenuation provided by the Eden Springs water bodies, and as such the FARL value has been amended. FARL was updated through the review of aerial mapping and the method outlined in the Flood Estimation Handbook Volume 5[11].

DPLBAR was altered for the lumped catchment due to the increase in area compared with the FEH catchment boundary. This was updated using the method outlined in the Flood Estimation Handbook Volume 5[10].

[11] https://www.ceh.ac.uk/sites/default/files/2021-11/Flood-Estimation%20Handbook-5-Catchment-Descriptors_Adrian-Bayliss.pdf

Table 3-2 : Catchment Descriptors

Descriptor	FEH Catchment	Amended Catchment
Area (km^2)	46.88	52.14
SAAR6190 (mm)	748	748
DPLBAR (km)	9.19	9.77
BFIHOST19	0.629	0.629
FARL	0.988	0.928
FPEXT	0.919	0.0919
PROPWET	0.45	0.45
URBEXT2000	0.0031	0.0031

3.4 Climate Change

An allowance for climate change uplift is to be made on the 0.5% Annual Exceedance Probability (AEP) event for this project.

The most recent advice on climate change in Scotland is provided by the Scottish Environment Protection Agency (SEPA) in their August 2024 document '*Climate Change Allowances for Flood Risk Assessment in Land Use Planning*'[12].

The catchment is located within the Tay River basin region. The lumped catchment is 52.14km^2 in area and as such the peak river flow allowance of 53% was applied directly to the flow estimation outputs.

3.5 Rainfall-Runoff Method

The FEH Rainfall-Runoff method analysis has been undertaken using the ReFH2.3 model. As the catchment is greater than 0.5km^2 in area, catchment scale equations have been used.

The default model parameters have largely been retained. As the catchment is predominantly rural, the winter storm seasonality results in higher and more conservative flow estimation. The default urbanisation parameters have also been retained, as the catchment is 'essentially rural' the flow estimates are not sensitive to urbanisation.

The default ReFH2-recommended duration for the lumped catchment of 6 hours 30 minutes with a 30-minute timestep has been applied to estimation of peak flows and net rainfall. The FEH22 design-depth-frequency (DDF) model derived from the FEH Web Service for the lumped catchment has been used for the assessment.

The final peak flow estimates from the Rainfall-Runoff method are provided in Table 3-3 for the design event, and the final peak net rainfall results for the design event are shown in Table 3-4. Summary outputs for the 1:200 AEP event are provided in Appendix A.

12 https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.sepa.org.uk%2Fmedia%2Ffxjgfjmf%2Fclimate-change-allowances-guidance.docx&wdOrigin=BROWSELINK

Table 3-3 : ReFH2 Peak Flow Estimates

Catchment	1:200 AEP event peak flow (cumecs)	1:200 AEP event + 53%CC peak flow (cumecs)
Lumped catchment	19.92	30.48

Table 3-4 : ReFH2 Peak Net Rainfall Estimates

Catchment	1:200 AEP event peak net rainfall (mm)	1:200 AEP event + 39%CC peak net rainfall (mm)
Lumped catchment	1.73	2.63

3.6 Statistical Method

The following analysis has been completed in the WINFAP v5.2 software using the NRFA Peak Flow Dataset v13.0.3. This method requires the estimation of the median annual flood (QMED) and a normalised flood frequency curve, termed flood growth curve as described in detail below.

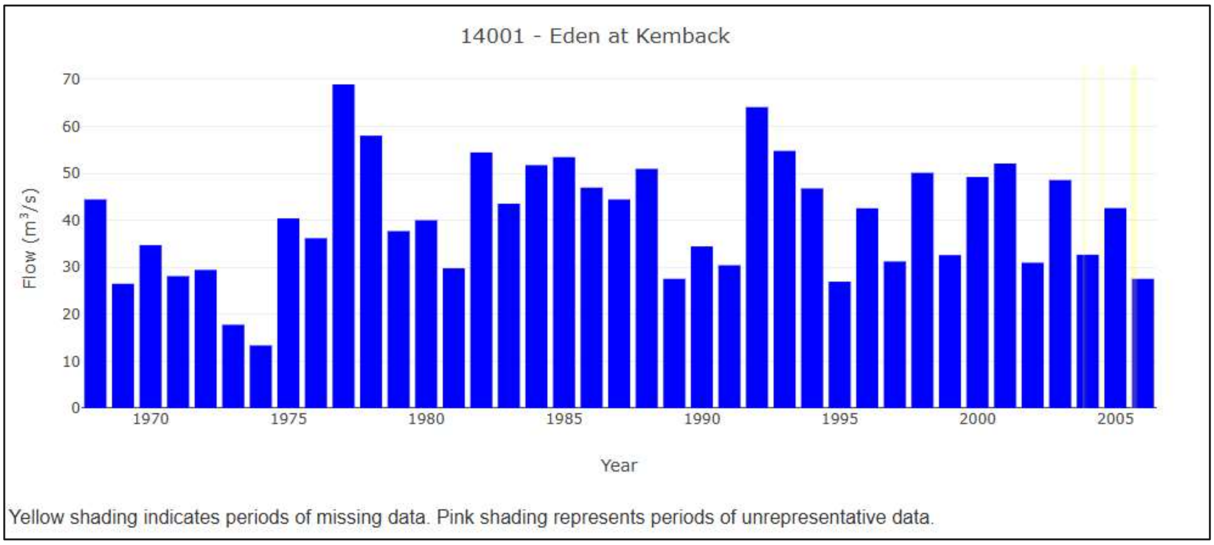
3.6.1 Local Gauging Stations

The target catchment is ungauged. The closest local river gauging station within the NRFA and SEPA hydrometric dataset[13] are stations 14009 - Eden at Strathmiglo and 14001 - Eden at Kemback. Station 14009 is not suitable for pooling or derivation of QMED.

Station 14001 is suitable for pooling and derivation of QMED. The River Eden has a catchment area of approximately 250km^2 at Kemback. The catchment has similar land use but a higher degree of urbanisation than the target catchment. Whilst this gauge was not used for single-site analysis, it has been used for QMED estimation at the target catchment.

For reference, the Eden at Kemback AMAX record is shown in Figure 3-3 below.

Figure 3-3 : Eden at Kemback Annual Maximum Flood Flow (AMAX) Record



[13] https://timeseriesdoc.sepa.org.uk/

3.6.2 QMED Estimation

The rural QMED for the lumped study catchment estimate was initially estimated from catchment descriptors ($QMED_{cds}$) which is presented in Table 3-6. As the catchments are ungauged the estimates of QMED were refined using the Donor Adjustment method[14].

Due to the largely rural nature of the study catchment (URBEXT2000 of 0.0031), the default URBEXT2000 < 0.030 condition was set for the selection of donor QMED gauges. The 6 geographically closest stations suitable for QMED estimation and the selected donor stations are provided in Table 3-5. The observed QMED values for each gauged catchment were deurbanised prior to being used for donor transfer. The closest stations show a trend of catchment descriptors underestimating QMED.

Table 3-5 : Rankeilour Burn Catchment QMED Adjustment Donor Group

NRFA Number	Station Name	Distance (km)	QMED Obs Deurbanised	QMED CDs Rural	Adjustment Ratio[1]	Decision
14001	Eden @ Kemback	4.44	39.809	34.829	1.14	Accept
15008	Dean Water @ Cookston	32.50	26.298	22.978	1.15	Accept
15013	Almond @ Almondbank	45.09	120.465	99.263	1.21	Accept
15023	Braan @ Hermitage	47.14	126.637	84.526	1.49	Accept
18001	Allan Water @ Kinbuck	48.29	68.771	67.423	1.02	Accept
18005	Allan Water @ Bridge of Allan	49.25	76.435	83.961	0.91	Reject
16004	Earn @ Forteviot Bridge	50.24	248.230	222.304	1.12	Reject
20001	Tyne @ East Linton	52.19	58.022	35.961	1.61	Accept
15025	Ericht @ Craighall	53.03	194.000	149.175	1.30	Reject
20003	Tyne @ Spilmersford	53.44	28.186	19.603	1.44	Reject

Note 1: Adjustment ratio refers to the ratio of de-urbanised QMED from flow data to $QMED_{cds}$.

Station 18005 – Allan Water @ Bridge of Allan was rejected due to there already being a station on the Allan Water in the donor group. Station 16004 – Earn @ Forteviot Bridge was not added due to high influence of large reservoirs in the upper catchment. Station 20001 – Tyne @ East Linton, was therefore added as the next closest donor.

[14] Using multiple donor sites for enhanced flood estimation in ungauged catchments, Kjeldsen, T.R., Jones, D.A., and Morris, D.G. Water Resour. Res., 50, 6646-6657. 2014

The catchment is essentially rural but has a minor influence of urban areas with an Urban Adjustment Factor (UAF) of 1.005. The urban and rural QMED results from donor transfer are therefore shown in Table 3-6. The donor-adjusted Factorial Standard Error is 1.358. It is noted that as per the observed data in the donor group, the QMED from catchment descriptors is lower than the donor transfer estimation.

Full QMED estimation details from the WINFAP outputs are available in Appendix B.

Table 3-6 : Final QMED Estimates

Catchment	$QMED_{cds}$ (m^3/s)	Donor Adjusted Rural QMED (m^3/s)	Donor Adjusted Urban QMED (m^3/s)
Rankeilour Burn @ NO 33300 10900	4.489	5.133	5.157

3.6.3 Growth Curve Derivation

Due to the study catchment being ungauged, a pooling group of hydrologically similar gauging stations, with a minimum of 500 years of total Annual Maxima (AM) data, has been used to derive the catchment peak flow growth curves. Flood growth curves have been estimated using the weighted average of the L-moments of the distributions of Annual Maxima (AM) flood flow data from the pooling group.

Following a review of the default pooling group, several stations were rejected. Station 33054 – Babingley @ Castle Rising was rejected due to significant groundwater abstractions for PWS and industry/agriculture affecting the flow regime.

Station 39042 – Leach @ Priory Mill Lechlade was rejected due to bypassing of high flows lowering the reliability of the station for pooling.

Stations 36003 – Box @ Polstead and 36007 Belchamp Brook @ Bardfield Bridge were both rejected due to a high percentage of non-flood years (>15%) which may not be representative of the target catchment.

Station 37016 – Pant @ Copford Hall was rejected due to intermittent pumping of the Ely/Ouse Transfer Scheme having a major known effect on flows at the station.

Stations 35004 – Chad Brook @ Long Melford, 76019 – Roe Beck @ Stockdalewath, 42009 – Candover Stream @ Borough Bridge, 41020 – Bevern Stream @ Clappers Bridge were added to ensure a minimum of 500 years of AM data in the pooling group.

The default pooling group and details of any stations added/removed are detailed in the Table 3-7, with full details of the pooling group stations provided in Appendix B.

Table 3-7 : Pooling Group Selection

NRFA Number (Station Name)	SDM	Pooling Group Decision	Reason/Comments
33054 (Babingley @ Castle Rising)	0.368	Reject	Significant groundwater abstractions for PWS and industry/agriculture affecting the flow regime.
41022 (Lod @ Halfway Bridge)	0.455	Accept	
26013 (Driffield Trout Stream @ Driffield)	0.464	Accept	

NRFA Number (Station Name)	SDM	Pooling Group Decision	Reason/Comments
26003 (Foston Beck @ Foston Mill)	0.466	Accept	
26015 (Driffield Canal @ Wansford Bridge)	0.471	Accept	
33032 (Heacham @ Heacham)	0.48	Accept	
30004 (Lymn @ Partney Mill)	0.542	Accept	
39042 (Leach @ Priory Mill Lechlade)	0.628	Reject	Bypassing of high flows lowering the reliability of the station for pooling.
53017 (Boyd @ Bitton)	0.671	Accept	
205005 (Ravernet @ Ravernet)	0.681	Accept	
36003 (Box @ Polstead)	0.683	Reject	High percentage of non-flood years (>15%) which may not be representative of the target catchment.
36004 (Chad Brook @ Long Melford)	0.713	Added	Gauged beyond AMAX3 with well-fitted rating, abstractions/artificial influences not indicated to have significant impact on flows.
36007 (Belchamp Brook @ Bardfield Bridge)	0.732	Reject	High percentage of non-flood years (>15%) which may not be representative of the target catchment.
37016 (Pant @ Copford Hall)	0.739	Reject	Intermittent pumping of the Ely/Ouse Transfer Scheme has a major known effect on flows at the station.
76019 (Roe Beck @ Stockdalewath)	0.755	Added	Natural, responsive catchment, with a mix of permeable and less permeable bedrock.
42009 (Candover Stream @ Borough Bridge)	0.763	Added	High permeability catchment with high groundwater influence but without overly high non-flood years. Groundwater catchment differs from surface catchment but was maintained as the groundwater catchment extents of the Rankeilour Burn are not known.
41020 (Bevern Stream @ Clappers Bridge)	0.772	Added	Catchment with negligible effects of artificial influences on flow regime and bedrock split from low to high permeability as in target catchment.

The standardised test value of H2 is 3.3461 which is categorised by WINFAP as "*heterogeneous and a review of the pooling group is desirable*". This indicates that the gauging data may not be a good fit for the study catchment. The default pooling group had an H2 value of 2.8544, which was also categorised by WINFAP as "*heterogeneous and a review of the pooling group is desirable*". Gauged data on the target watercourse would improve statistical flow estimation for the target catchment, and this is noted as a limitation of this study.

Non-flood years were prevalent within the pooling and non-flood years adjustment was required. Non-flood years adjustment was carried out using the standard methodology[15] with the WHS Non-Flood Years Adjustment Spreadsheet[16].

The goodness of fit details, which provide a statistical representation of the best growth curve distribution fit, shows that the Generalised Extreme Value (GEV) distribution has the best statistical fit as it has the lowest absolute Z value. The Generalised Logistic (GL) distribution, recommended as default by SEPA, did not have an acceptable fit in this case.

The Kappa 3 (KAP3) distribution was the second-best fit. Kjeldsen and others (2017) found that the Kappa 3 distribution, which is a compromise between the GL and GEV distributions, gave an acceptable fit for 90% of pooling groups across the UK, a better performance than other distributions including the GL. The KAP3 distribution also yielded more conservative flow estimates than the GEV distribution and was therefore selected in this case.

Non-flood years (NFY) adjustment was required, but can only be applied to the GL distribution outputs. The ratio between the NFY-adjusted GL distribution outputs and the non-adjusted GL distribution outputs was therefore assessed, and was applied to the KAP3 outputs to adjust for non-flood years. This approach increased the KAP3 flows by 1.5% for the 0.5% AEP event, and by 5% for the 0.1% AEP event. It is considered that these increases are acceptable, and sensitivity analyses on the flows will be carried out within the hydraulic modelling.

Despite the low urbanisation of the catchment, the urban results were ultimately selected.A comparison of the statistical peak flow results and the rainfall-runoff peak flow results is shown in Table 3-8

The final urban pooling group growth curve is presented in Figure 3-4, the non-flood years adjusted GL curve is presented in Figure 3-5, and is combined with the value of $QMED_{adj}$ to produce the resultant peak flow estimates for KAP3 as summarised in Table 3-9.

Table 3-8 : Comparison of Statistical and Rainfall-Runoff Peak Flows

Estimation Methodology	1:200 AEP event peak flow (cumecs)	1:200 AEP event + 53%CC peak flow (cumecs)
Rainfall-runoff	19.92	30.48
Statistical	15.96	24.41

Table 3-9 : Non-Flood Years Adjusted Statistical Peak Flow Estimates

AEP (%)	0.5	0.5 + 53% CC	0.1	0.1 + 53% CC
Peak Flow (m^3/s)	16.21	24.80	21.69	33.19

[15] https://winfapdocs.hydrosolutions.co.uk/Non-Flood-Years-Adjustment/

[16] https://www.hydrosolutions.co.uk/software/free-downloads/whs-non-flood-years-adjustment-spreadsheet/

Figure 3-4 : Pooling Group Growth Curve

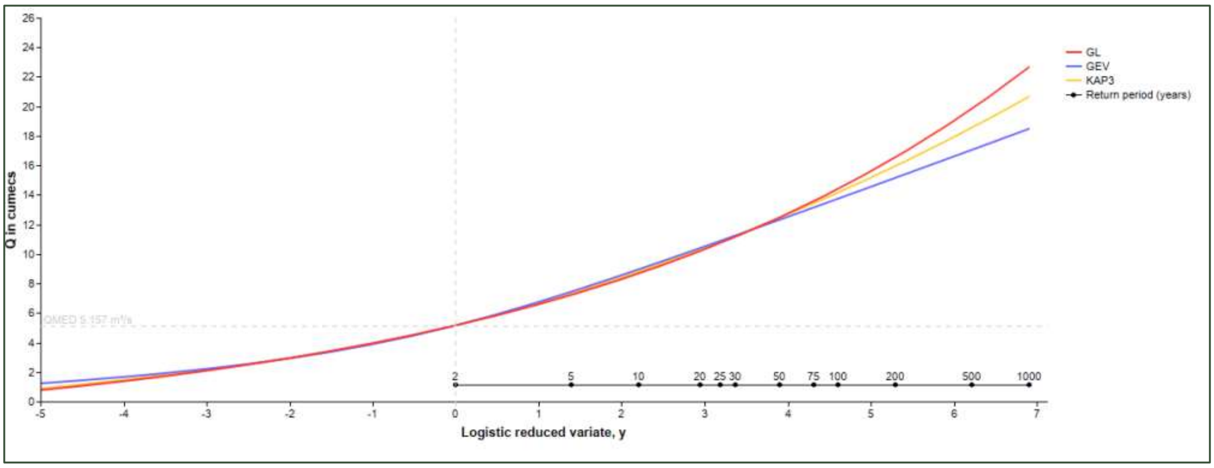
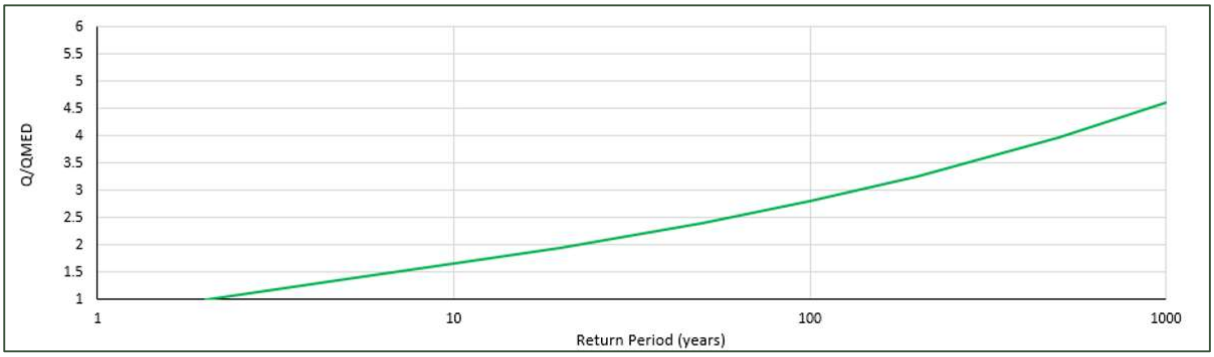


Figure 3-5 : Non-Flood Years Adjusted GL Curve



4.0 Results and Discussion

4.1 Final Peak Flows and Hydrograph

Peak flows for the lumped catchment have been estimated using both the FEH statistical and rainfall runoff methods. For the statistical analysis QMED was estimated using the catchment donor adjustment method, with growth curves estimated using pooling group analysis at the Rankeilour Burn catchment.

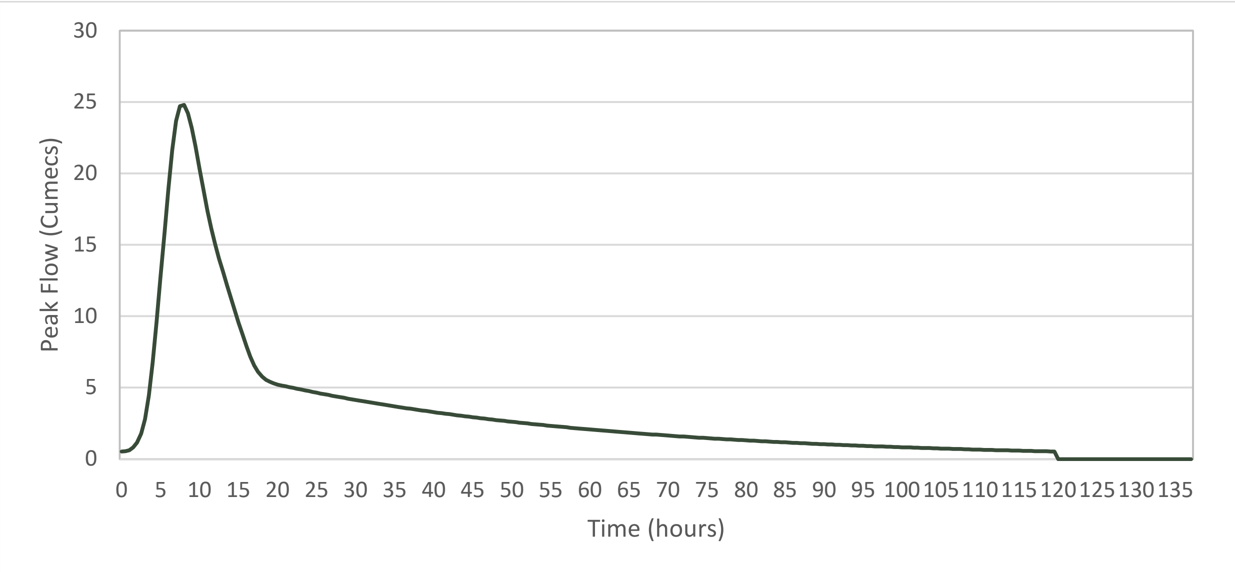
The statistical method peak flow estimates for the Rankeilour Burn lumped catchment have been adopted. These estimates allow for the increased confidence in results with incorporation of gauged data.

The final peak flows are shown in Table 4-1. The ReFH2 hydrographs for the default storm duration of 6 hours 30 minutes have been scaled to fit the statistical method peak flows as shown in Figure 4-1.

Table 4-1 : Final Peak Flows

AEP (%)	0.5	0.5 + 53% CC	0.1	0.1 + 53% CC
Peak Flow (m^3/s)	16.21	24.80	21.69	33.19

Figure 4-1 : 1:200 AEP Event + 53%CC Scaled Hydrograph



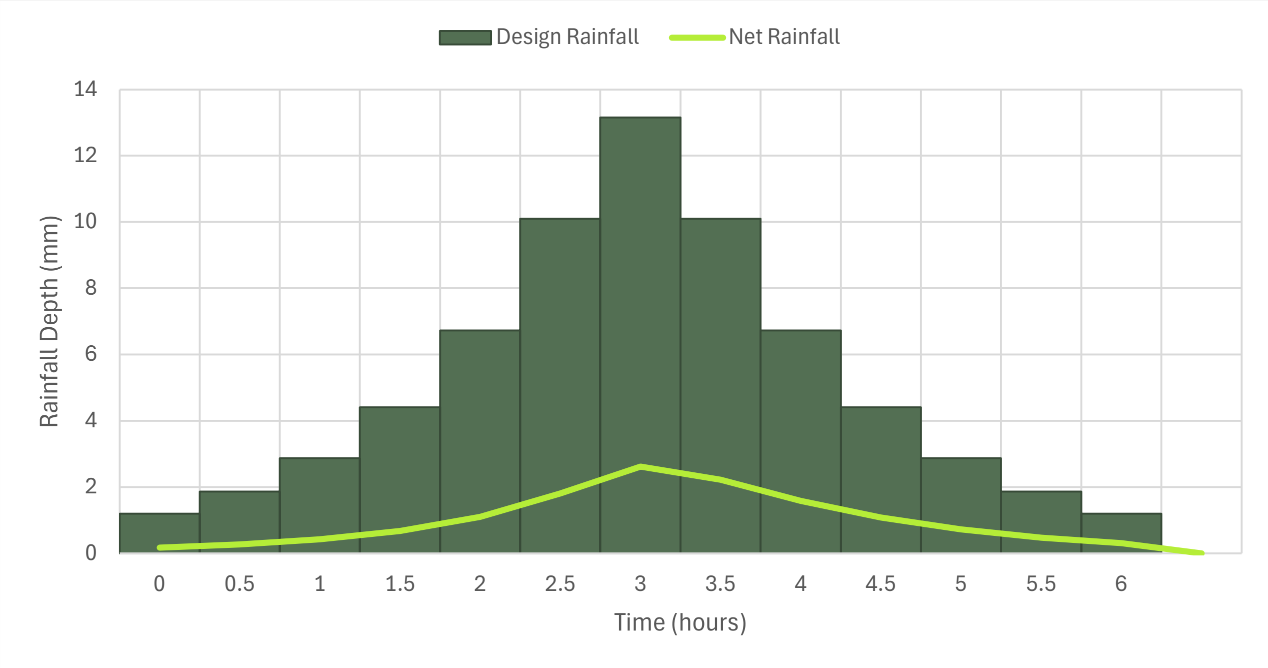
4.2 Final Peak Net Rainfall and Hyetograph

The peak net rainfall results applied to the hydraulic modelling are presented in Table 4-2. The design rainfall and net rainfall hyetograph for the 1:200 AEP event plus climate change for the default storm duration of 6 hours 30 minutes is shown in Figure 4-2 overleaf.

Table 4-2 : Peak Net Rainfall Results

Catchment	1:200 AEP event peak net rainfall (mm)	1:200 AEP event + 39%CC peak net rainfall (mm)
Lumped catchment	1.73	2.63

Figure 4-2 : Design and Net Rainfall for 1:200 AEP event + 39%CC



4.3 Discussion

4.3.1 Assumptions and Limitations

The main assumptions made during this hydrology study are as follows:

- There is higher confidence in the peak flows estimated using the statistical method.
- The rainfall-runoff method derived hydrograph shapes are representative of the runoff response of the catchment. There is no gauging data on the catchment itself to cross check these hydrographs.
- There are a lack of gauging stations from Scotland in the pooling group which derive growth curves.
- The 0.1% AEP or 1000-year growth factors have been estimated from the statistical method flood growth curves. The Environment Agency Flood Estimation Guidelines of 2022 recommend that for longer return periods (>0.5%AEP), there is higher confidence in rainfall growth curves than in flood growth curves.
- The WHS Non-Flood Years Adjustment Spreadsheet is calibrated for use with WINFAP 5.2 but is not yet calibrated for use with NRFA peak flow dataset 13.0.3. Adjustment is therefore based on the 13.0.2 dataset.
- The Non-Flood Years Adjustment Spreadsheet is only applicable to the GL distribution, which was not an acceptable fit for this pooling group, and as such the ratio of adjusted to non-adjusted GL values has been applied to the selected KAP3 distribution.

4.3.2 Uncertainty

The uncertainty in the statistical peak flow results for the target catchment have been quantified using the methodology outlined in the Flood Estimation Guidelines[17] for essentially rural catchments with six QMED donors. The confidence interval peak flow results for the 1:200 AEP event (peak flow 16.21 cumecs) are outlined in Table 4-3.

Table 4-3 : Confidence Interval Peak Flows

AEP Event	1:200 (0.5%)			
Confidence Interval	Lower 68%	Upper 68%	Lower 95%	Upper 95%
Peak Flow (cumecs)	11.19	23.34	7.78	33.72

4.3.3 Suitability of results for future studies

The flow estimates derived are suitable for the site/Rankeilour Estate only as the hydrology has been targeted towards flows at the site, and not any location upstream or downstream.

[17] Flood_estimation_guidelines.docx

Appendix A ReFH2 1:200 AEP Report

West Springfield Solar Farm

Flow Estimation Methodology

TRIO West Springfield Solar LLP

SLR Project No.: 428.013383.00001

22 April 2025

UK Design Flood Estimation

Generated on 03 April 2025 11:58:39 by ahay
Printed from the ReFH2 Flood Modelling software package, version 4.1.8985.14298

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

Site details

Checksum: 7C65-FB96

Site name: FEH_Catchment_Descriptors_333300_710900_v5_0_1

Easting: 333300

Northing: 710900

Country: Scotland

Catchment Area (km^2): 52.14 [46.88]*

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 200 year

Summary of results

Rainfall - FEH22 (mm):	73.26	Total runoff (ML):	462.46
Total Rainfall (mm):	48.55	Total flow (ML):	1251.97
Peak Rainfall (mm):	9.47	Peak flow (m^3/s):	19.92

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 - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.72	No
ARF (Areal reduction factor)	0.92	No
Seasonality	Winter	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	77.4	No
Cmax (mm)	559.97	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	3.81	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0.42	No
BL (hr)	43.31	No
BR	1.72	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0.25	No
Effective URBEXT2000	0	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.864	0.000	0.121	0.000	0.414	0.414
00:30:00	1.338	0.000	0.190	0.020	0.410	0.430
01:00:00	2.065	0.000	0.300	0.091	0.406	0.497
01:30:00	3.171	0.000	0.475	0.242	0.405	0.647
02:00:00	4.836	0.000	0.759	0.520	0.407	0.928
02:30:00	7.268	0.000	1.219	1.001	0.417	1.419
03:00:00	9.466	0.000	1.729	1.806	0.440	2.246
03:30:00	7.268	0.000	1.436	3.093	0.482	3.576
04:00:00	4.836	0.000	1.008	4.892	0.554	5.446
04:30:00	3.171	0.000	0.684	7.035	0.664	7.699
05:00:00	2.065	0.000	0.455	9.356	0.816	10.171
05:30:00	1.338	0.000	0.299	11.706	1.011	12.717
06:00:00	0.864	0.000	0.195	13.932	1.249	15.182
06:30:00	0.000	0.000	0.000	15.847	1.526	17.372
07:00:00	0.000	0.000	0.000	17.183	1.831	19.014
07:30:00	0.000	0.000	0.000	17.690	2.151	19.841
08:00:00	0.000	0.000	0.000	17.450	2.470	19.921
08:30:00	0.000	0.000	0.000	16.680	2.777	19.457
09:00:00	0.000	0.000	0.000	15.563	3.061	18.624
09:30:00	0.000	0.000	0.000	14.235	3.318	17.553
10:00:00	0.000	0.000	0.000	12.804	3.546	16.350
10:30:00	0.000	0.000	0.000	11.366	3.743	15.109
11:00:00	0.000	0.000	0.000	10.053	3.910	13.964
11:30:00	0.000	0.000	0.000	8.912	4.052	12.964
12:00:00	0.000	0.000	0.000	7.909	4.171	12.080
12:30:00	0.000	0.000	0.000	7.004	4.270	11.274
13:00:00	0.000	0.000	0.000	6.166	4.351	10.516
13:30:00	0.000	0.000	0.000	5.372	4.415	9.787
14:00:00	0.000	0.000	0.000	4.612	4.463	9.075
14:30:00	0.000	0.000	0.000	3.880	4.496	8.375
15:00:00	0.000	0.000	0.000	3.166	4.514	7.680
15:30:00	0.000	0.000	0.000	2.481	4.518	6.999
16:00:00	0.000	0.000	0.000	1.840	4.509	6.348
16:30:00	0.000	0.000	0.000	1.268	4.488	5.755

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:00:00	0.000	0.000	0.000	0.803	4.457	5.260
17:30:00	0.000	0.000	0.000	0.475	4.418	4.894
18:00:00	0.000	0.000	0.000	0.263	4.375	4.638
18:30:00	0.000	0.000	0.000	0.131	4.329	4.460
19:00:00	0.000	0.000	0.000	0.055	4.281	4.336
19:30:00	0.000	0.000	0.000	0.016	4.232	4.248
20:00:00	0.000	0.000	0.000	0.001	4.184	4.185
20:30:00	0.000	0.000	0.000	0.000	4.136	4.136
21:00:00	0.000	0.000	0.000	0.000	4.088	4.088
21:30:00	0.000	0.000	0.000	0.000	4.042	4.042
22:00:00	0.000	0.000	0.000	0.000	3.995	3.995
22:30:00	0.000	0.000	0.000	0.000	3.949	3.949
23:00:00	0.000	0.000	0.000	0.000	3.904	3.904
23:30:00	0.000	0.000	0.000	0.000	3.859	3.859
24:00:00	0.000	0.000	0.000	0.000	3.815	3.815
24:30:00	0.000	0.000	0.000	0.000	3.771	3.771
25:00:00	0.000	0.000	0.000	0.000	3.728	3.728
25:30:00	0.000	0.000	0.000	0.000	3.685	3.685
26:00:00	0.000	0.000	0.000	0.000	3.643	3.643
26:30:00	0.000	0.000	0.000	0.000	3.601	3.601
27:00:00	0.000	0.000	0.000	0.000	3.560	3.560
27:30:00	0.000	0.000	0.000	0.000	3.519	3.519
28:00:00	0.000	0.000	0.000	0.000	3.478	3.478
28:30:00	0.000	0.000	0.000	0.000	3.438	3.438
29:00:00	0.000	0.000	0.000	0.000	3.399	3.399
29:30:00	0.000	0.000	0.000	0.000	3.360	3.360
30:00:00	0.000	0.000	0.000	0.000	3.321	3.321
30:30:00	0.000	0.000	0.000	0.000	3.283	3.283
31:00:00	0.000	0.000	0.000	0.000	3.245	3.245
31:30:00	0.000	0.000	0.000	0.000	3.208	3.208
32:00:00	0.000	0.000	0.000	0.000	3.171	3.171
32:30:00	0.000	0.000	0.000	0.000	3.135	3.135
33:00:00	0.000	0.000	0.000	0.000	3.099	3.099
33:30:00	0.000	0.000	0.000	0.000	3.063	3.063
34:00:00	0.000	0.000	0.000	0.000	3.028	3.028

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
34:30:00	0.000	0.000	0.000	0.000	2.993	2.993
35:00:00	0.000	0.000	0.000	0.000	2.959	2.959
35:30:00	0.000	0.000	0.000	0.000	2.925	2.925
36:00:00	0.000	0.000	0.000	0.000	2.892	2.892
36:30:00	0.000	0.000	0.000	0.000	2.858	2.858
37:00:00	0.000	0.000	0.000	0.000	2.826	2.826
37:30:00	0.000	0.000	0.000	0.000	2.793	2.793
38:00:00	0.000	0.000	0.000	0.000	2.761	2.761
38:30:00	0.000	0.000	0.000	0.000	2.729	2.729
39:00:00	0.000	0.000	0.000	0.000	2.698	2.698
39:30:00	0.000	0.000	0.000	0.000	2.667	2.667
40:00:00	0.000	0.000	0.000	0.000	2.636	2.636
40:30:00	0.000	0.000	0.000	0.000	2.606	2.606
41:00:00	0.000	0.000	0.000	0.000	2.576	2.576
41:30:00	0.000	0.000	0.000	0.000	2.547	2.547
42:00:00	0.000	0.000	0.000	0.000	2.517	2.517
42:30:00	0.000	0.000	0.000	0.000	2.489	2.489
43:00:00	0.000	0.000	0.000	0.000	2.460	2.460
43:30:00	0.000	0.000	0.000	0.000	2.432	2.432
44:00:00	0.000	0.000	0.000	0.000	2.404	2.404
44:30:00	0.000	0.000	0.000	0.000	2.376	2.376
45:00:00	0.000	0.000	0.000	0.000	2.349	2.349
45:30:00	0.000	0.000	0.000	0.000	2.322	2.322
46:00:00	0.000	0.000	0.000	0.000	2.295	2.295
46:30:00	0.000	0.000	0.000	0.000	2.269	2.269
47:00:00	0.000	0.000	0.000	0.000	2.243	2.243
47:30:00	0.000	0.000	0.000	0.000	2.217	2.217
48:00:00	0.000	0.000	0.000	0.000	2.192	2.192
48:30:00	0.000	0.000	0.000	0.000	2.167	2.167
49:00:00	0.000	0.000	0.000	0.000	2.142	2.142
49:30:00	0.000	0.000	0.000	0.000	2.117	2.117
50:00:00	0.000	0.000	0.000	0.000	2.093	2.093
50:30:00	0.000	0.000	0.000	0.000	2.069	2.069
51:00:00	0.000	0.000	0.000	0.000	2.045	2.045
51:30:00	0.000	0.000	0.000	0.000	2.022	2.022

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
52:00:00	0.000	0.000	0.000	0.000	1.998	1.998
52:30:00	0.000	0.000	0.000	0.000	1.975	1.975
53:00:00	0.000	0.000	0.000	0.000	1.953	1.953
53:30:00	0.000	0.000	0.000	0.000	1.930	1.930
54:00:00	0.000	0.000	0.000	0.000	1.908	1.908
54:30:00	0.000	0.000	0.000	0.000	1.886	1.886
55:00:00	0.000	0.000	0.000	0.000	1.865	1.865
55:30:00	0.000	0.000	0.000	0.000	1.843	1.843
56:00:00	0.000	0.000	0.000	0.000	1.822	1.822
56:30:00	0.000	0.000	0.000	0.000	1.801	1.801
57:00:00	0.000	0.000	0.000	0.000	1.780	1.780
57:30:00	0.000	0.000	0.000	0.000	1.760	1.760
58:00:00	0.000	0.000	0.000	0.000	1.740	1.740
58:30:00	0.000	0.000	0.000	0.000	1.720	1.720
59:00:00	0.000	0.000	0.000	0.000	1.700	1.700
59:30:00	0.000	0.000	0.000	0.000	1.681	1.681
60:00:00	0.000	0.000	0.000	0.000	1.661	1.661
60:30:00	0.000	0.000	0.000	0.000	1.642	1.642
61:00:00	0.000	0.000	0.000	0.000	1.623	1.623
61:30:00	0.000	0.000	0.000	0.000	1.605	1.605
62:00:00	0.000	0.000	0.000	0.000	1.586	1.586
62:30:00	0.000	0.000	0.000	0.000	1.568	1.568
63:00:00	0.000	0.000	0.000	0.000	1.550	1.550
63:30:00	0.000	0.000	0.000	0.000	1.532	1.532
64:00:00	0.000	0.000	0.000	0.000	1.515	1.515
64:30:00	0.000	0.000	0.000	0.000	1.497	1.497
65:00:00	0.000	0.000	0.000	0.000	1.480	1.480
65:30:00	0.000	0.000	0.000	0.000	1.463	1.463
66:00:00	0.000	0.000	0.000	0.000	1.446	1.446
66:30:00	0.000	0.000	0.000	0.000	1.430	1.430
67:00:00	0.000	0.000	0.000	0.000	1.413	1.413
67:30:00	0.000	0.000	0.000	0.000	1.397	1.397
68:00:00	0.000	0.000	0.000	0.000	1.381	1.381
68:30:00	0.000	0.000	0.000	0.000	1.365	1.365
69:00:00	0.000	0.000	0.000	0.000	1.350	1.350

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
69:30:00	0.000	0.000	0.000	0.000	1.334	1.334
70:00:00	0.000	0.000	0.000	0.000	1.319	1.319
70:30:00	0.000	0.000	0.000	0.000	1.304	1.304
71:00:00	0.000	0.000	0.000	0.000	1.289	1.289
71:30:00	0.000	0.000	0.000	0.000	1.274	1.274
72:00:00	0.000	0.000	0.000	0.000	1.259	1.259
72:30:00	0.000	0.000	0.000	0.000	1.245	1.245
73:00:00	0.000	0.000	0.000	0.000	1.230	1.230
73:30:00	0.000	0.000	0.000	0.000	1.216	1.216
74:00:00	0.000	0.000	0.000	0.000	1.202	1.202
74:30:00	0.000	0.000	0.000	0.000	1.189	1.189
75:00:00	0.000	0.000	0.000	0.000	1.175	1.175
75:30:00	0.000	0.000	0.000	0.000	1.161	1.161
76:00:00	0.000	0.000	0.000	0.000	1.148	1.148
76:30:00	0.000	0.000	0.000	0.000	1.135	1.135
77:00:00	0.000	0.000	0.000	0.000	1.122	1.122
77:30:00	0.000	0.000	0.000	0.000	1.109	1.109
78:00:00	0.000	0.000	0.000	0.000	1.096	1.096
78:30:00	0.000	0.000	0.000	0.000	1.084	1.084
79:00:00	0.000	0.000	0.000	0.000	1.071	1.071
79:30:00	0.000	0.000	0.000	0.000	1.059	1.059
80:00:00	0.000	0.000	0.000	0.000	1.047	1.047
80:30:00	0.000	0.000	0.000	0.000	1.035	1.035
81:00:00	0.000	0.000	0.000	0.000	1.023	1.023
81:30:00	0.000	0.000	0.000	0.000	1.011	1.011
82:00:00	0.000	0.000	0.000	0.000	1.000	1.000
82:30:00	0.000	0.000	0.000	0.000	0.988	0.988
83:00:00	0.000	0.000	0.000	0.000	0.977	0.977
83:30:00	0.000	0.000	0.000	0.000	0.966	0.966
84:00:00	0.000	0.000	0.000	0.000	0.954	0.954
84:30:00	0.000	0.000	0.000	0.000	0.944	0.944
85:00:00	0.000	0.000	0.000	0.000	0.933	0.933
85:30:00	0.000	0.000	0.000	0.000	0.922	0.922
86:00:00	0.000	0.000	0.000	0.000	0.911	0.911
86:30:00	0.000	0.000	0.000	0.000	0.901	0.901

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
87:00:00	0.000	0.000	0.000	0.000	0.891	0.891
87:30:00	0.000	0.000	0.000	0.000	0.880	0.880
88:00:00	0.000	0.000	0.000	0.000	0.870	0.870
88:30:00	0.000	0.000	0.000	0.000	0.860	0.860
89:00:00	0.000	0.000	0.000	0.000	0.850	0.850
89:30:00	0.000	0.000	0.000	0.000	0.841	0.841
90:00:00	0.000	0.000	0.000	0.000	0.831	0.831
90:30:00	0.000	0.000	0.000	0.000	0.821	0.821
91:00:00	0.000	0.000	0.000	0.000	0.812	0.812
91:30:00	0.000	0.000	0.000	0.000	0.803	0.803
92:00:00	0.000	0.000	0.000	0.000	0.793	0.793
92:30:00	0.000	0.000	0.000	0.000	0.784	0.784
93:00:00	0.000	0.000	0.000	0.000	0.775	0.775
93:30:00	0.000	0.000	0.000	0.000	0.766	0.766
94:00:00	0.000	0.000	0.000	0.000	0.758	0.758
94:30:00	0.000	0.000	0.000	0.000	0.749	0.749
95:00:00	0.000	0.000	0.000	0.000	0.740	0.740
95:30:00	0.000	0.000	0.000	0.000	0.732	0.732
96:00:00	0.000	0.000	0.000	0.000	0.723	0.723
96:30:00	0.000	0.000	0.000	0.000	0.715	0.715
97:00:00	0.000	0.000	0.000	0.000	0.707	0.707
97:30:00	0.000	0.000	0.000	0.000	0.699	0.699
98:00:00	0.000	0.000	0.000	0.000	0.691	0.691
98:30:00	0.000	0.000	0.000	0.000	0.683	0.683
99:00:00	0.000	0.000	0.000	0.000	0.675	0.675
99:30:00	0.000	0.000	0.000	0.000	0.667	0.667
100:00:00	0.000	0.000	0.000	0.000	0.660	0.660
100:30:00	0.000	0.000	0.000	0.000	0.652	0.652
101:00:00	0.000	0.000	0.000	0.000	0.645	0.645
101:30:00	0.000	0.000	0.000	0.000	0.637	0.637
102:00:00	0.000	0.000	0.000	0.000	0.630	0.630
102:30:00	0.000	0.000	0.000	0.000	0.623	0.623
103:00:00	0.000	0.000	0.000	0.000	0.615	0.615
103:30:00	0.000	0.000	0.000	0.000	0.608	0.608
104:00:00	0.000	0.000	0.000	0.000	0.601	0.601

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
104:30:00	0.000	0.000	0.000	0.000	0.595	0.595
105:00:00	0.000	0.000	0.000	0.000	0.588	0.588
105:30:00	0.000	0.000	0.000	0.000	0.581	0.581
106:00:00	0.000	0.000	0.000	0.000	0.574	0.574
106:30:00	0.000	0.000	0.000	0.000	0.568	0.568
107:00:00	0.000	0.000	0.000	0.000	0.561	0.561
107:30:00	0.000	0.000	0.000	0.000	0.555	0.555
108:00:00	0.000	0.000	0.000	0.000	0.548	0.548
108:30:00	0.000	0.000	0.000	0.000	0.542	0.542
109:00:00	0.000	0.000	0.000	0.000	0.536	0.536
109:30:00	0.000	0.000	0.000	0.000	0.530	0.530
110:00:00	0.000	0.000	0.000	0.000	0.524	0.524
110:30:00	0.000	0.000	0.000	0.000	0.518	0.518
111:00:00	0.000	0.000	0.000	0.000	0.512	0.512
111:30:00	0.000	0.000	0.000	0.000	0.506	0.506
112:00:00	0.000	0.000	0.000	0.000	0.500	0.500
112:30:00	0.000	0.000	0.000	0.000	0.494	0.494
113:00:00	0.000	0.000	0.000	0.000	0.489	0.489
113:30:00	0.000	0.000	0.000	0.000	0.483	0.483
114:00:00	0.000	0.000	0.000	0.000	0.477	0.477
114:30:00	0.000	0.000	0.000	0.000	0.472	0.472
115:00:00	0.000	0.000	0.000	0.000	0.467	0.467
115:30:00	0.000	0.000	0.000	0.000	0.461	0.461
116:00:00	0.000	0.000	0.000	0.000	0.456	0.456
116:30:00	0.000	0.000	0.000	0.000	0.451	0.451
117:00:00	0.000	0.000	0.000	0.000	0.445	0.445
117:30:00	0.000	0.000	0.000	0.000	0.440	0.440
118:00:00	0.000	0.000	0.000	0.000	0.435	0.435
118:30:00	0.000	0.000	0.000	0.000	0.430	0.430
119:00:00	0.000	0.000	0.000	0.000	0.425	0.425
119:30:00	0.000	0.000	0.000	0.000	0.420	0.420

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
Area (km^2)	52.14 [46.88]	**Yes**
ALTBAR	88	No
ASPBAR	138	No
ASPVAR	0.18	No
BFIHOST	0.67	No
BFIHOST19	0.63	No
DPLBAR (km)	9.77 [9.19]	**Yes**
DPSBAR (mkm^{-1})	82.3	No
FARL	0.99	No
LDP	18.65	No
PROPWET	0.45	No
RMED1H	8.2	No
RMED1D	32.7	No
RMED2D	43.3	No
SAAR (mm)	748	No
SAAR4170 (mm)	789	No
SPRHOST	27.06	No
URBEXT2000	0	No
URBEXT1990	0	No
URBCONC	0	No
URBLOC	0	No
DDF parameter C	-0.02	No
DDF parameter D1	0.45	No
DDF parameter D2	0.43	No
DDF parameter D3	0.24	No
DDF parameter E	0.25	No
DDF parameter F	2.16	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.45	No
DDF parameter D2 (1km grid value)	0.44	No
DDF parameter D3 (1km grid value)	0.21	No
DDF parameter E (1km grid value)	0.25	No
DDF parameter F (1km grid value)	2.18	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

Appendix B   WINFAP Outputs

West Springfield Solar Farm

Flow Estimation Methodology

TRIO West Springfield Solar LLP

SLR Project No.: 428.013383.00001

22 April 2025

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	07-03-2025 12:04:54
Software:	WINFAP Version: 5.2.9046 (26106)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	3324084029
Site name:	FEH_Catchment_Descriptors_333300_710900_v5_0_1
Site location:	NO 33300 10900
Easting:	333300
Northing:	710900
Catchment area:	52.14 km²
SAAR:	748 mm
BFIHOST19:	0.629
FPEXT:	0.092
FARL:	0.928
URBEXT2000:	0.0031

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.25 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.00473

Growth curve settings

Distance Measure Method:	Standard
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
41022 (Lod @ Halfway Bridge)	0.455	53	16.600	0.290	**0.292**	0.168	**0.166**
26013 (Driffield Trout Stream @ Driffield)	0.464	13	2.700	0.269	**0.270**	0.281	**0.280**
26003 (Foston Beck @ Foston Mill)	0.466	62	1.779	0.249	**0.249**	0.010	**0.010**
26015 (Driffield Canal @ Wansford Bridge)	0.471	13	2.490	0.170	**0.173**	0.092	**0.088**
33032 (Heacham @ Heacham)	0.480	55	0.434	0.299	**0.300**	0.141	**0.140**
30004 (Lymn @ Partney Mill)	0.542	61	7.128	0.226	**0.227**	0.037	**0.036**
53017 (Boyd @ Bitton)	0.671	50	13.908	0.238	**0.240**	0.087	**0.084**
205005 (Ravernet @ Ravernet)	0.681	51	14.495	0.206	**0.206**	0.302	**0.302**
36004 (Chad Brook @ Long Melford)	0.713	56	4.799	0.301	**0.302**	0.181	**0.180**
76019 (Roe Beck @ Stockdalewath)	0.755	24	42.495	0.215	**0.215**	0.312	**0.311**
42009 (Candover Stream @ Borough Bridge)	0.763	53	1.065	0.292	**0.294**	0.393	**0.391**
41020 (Bevern Stream @ Clappers Bridge)	0.772	54	13.780	0.199	**0.200**	0.164	**0.162**
Total		**545**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
41022 (Lod @ Halfway Bridge)	Yes	Yes	53	4	7.55	0.87	None	0.610	
26013 (Driffield Trout Stream @ Driffield)	Yes	Yes	13	0	0.00			1.710	
26003 (Foston Beck @ Foston Mill)	Yes	Yes	62	6	9.68	0.14	None	0.826	
26015 (Driffield Canal @ Wansford Bridge)	Yes	Yes	13	0	0.00			1.908	
33032 (Heacham @ Heacham)	Yes	Yes	55	8	14.55	-0.71	None	0.669	
30004 (Lymn @ Partney Mill)	Yes	Yes	61	7	11.48	0.06	None	0.598	
53017 (Boyd @ Bitton)	Yes	Yes	50	7	14.00	0.78	None	0.273	
205005 (Ravernet @ Ravernet)	Yes	Yes	51	2	3.92	0.40	None	1.175	
36004 (Chad Brook @ Long Melford)	Yes	Yes	56	7	12.50	-1.61	None	0.857	
76019 (Roe Beck @ Stockdalewath)	Yes	Yes	24	0	0.00			0.821	
42009 (Candover Stream @ Borough Bridge)	Yes	Yes	53	3	5.66	2.45	5	1.517	
41020 (Bevern Stream @ Clappers Bridge)	Yes	Yes	54	3	5.56	1.19	None	1.035	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
41022 (Lod @ Halfway Bridge)	52.438	857	0.061	0.951	0.009	0.428
26013 (Driffield Trout Stream @ Driffield)	53.333	690	0.093	0.997	0.006	0.837
26003 (Foston Beck @ Foston Mill)	59.593	698	0.106	0.987	0.004	0.894
26015 (Driffield Canal @ Wansford Bridge)	49.390	699	0.097	0.998	0.025	0.879
33032 (Heacham @ Heacham)	56.163	688	0.116	0.983	0.006	0.932
30004 (Lymn @ Partney Mill)	60.087	686	0.060	0.979	0.006	0.529
53017 (Boyd @ Bitton)	47.580	807	0.050	0.998	0.016	0.505
205005 (Ravernet @ Ravernet)	73.722	946	0.106	0.934	0.000	0.366
36004 (Chad Brook @ Long Melford)	50.328	589	0.065	1.000	0.006	0.456
76019 (Roe Beck @ Stockdalewath)	63.087	983	0.080	1.000	0.000	0.450
42009 (Candover Stream @ Borough Bridge)	72.062	819	0.039	0.930	0.011	0.924
41020 (Bevern Stream @ Clappers Bridge)	35.480	886	0.076	0.993	0.013	0.362

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments
33054 (Babingley @ Castle Rising)	0.368	47	1.129	0.227	0.228	0.195	0.194	
39042 (Leach @ Priory Mill Lechlade)	0.628	51	3.100	0.196	0.197	0.068	0.067	
36003 (Box @ Polstead)	0.683	63	3.850	0.310	0.312	0.090	0.088	
36007 (Belchamp Brook @ Bardfield Bridge)	0.732	58	4.630	0.374	0.375	0.114	0.114	
37016 (Pant @ Copford Hall)	0.739	58	7.240	0.283	0.284	0.112	0.111	

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.249	Urban L-CV:	0.249
Rural L-Skewness:	0.173	Urban L-Skewness:	0.174

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.255	-0.173		-0.473
GEV	0.858	0.388	-0.005		-76.371
KAP3	0.929	0.313	-0.097	-0.400	-2.306

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.254	-0.174		-0.465
GEV	0.858	0.387	-0.006		-65.467
KAP3	0.929	0.312	-0.097	-0.400	-2.277

Goodness of fit

GL: 1.9319
GEV: -0.4533 *
P3: -1.4775 *
GP: -5.6507
KAP3: 1.0473 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 3.6858

The pooling group is heterogeneous and a review of the pooling group is desirable.

Standardised growth curves

Rural

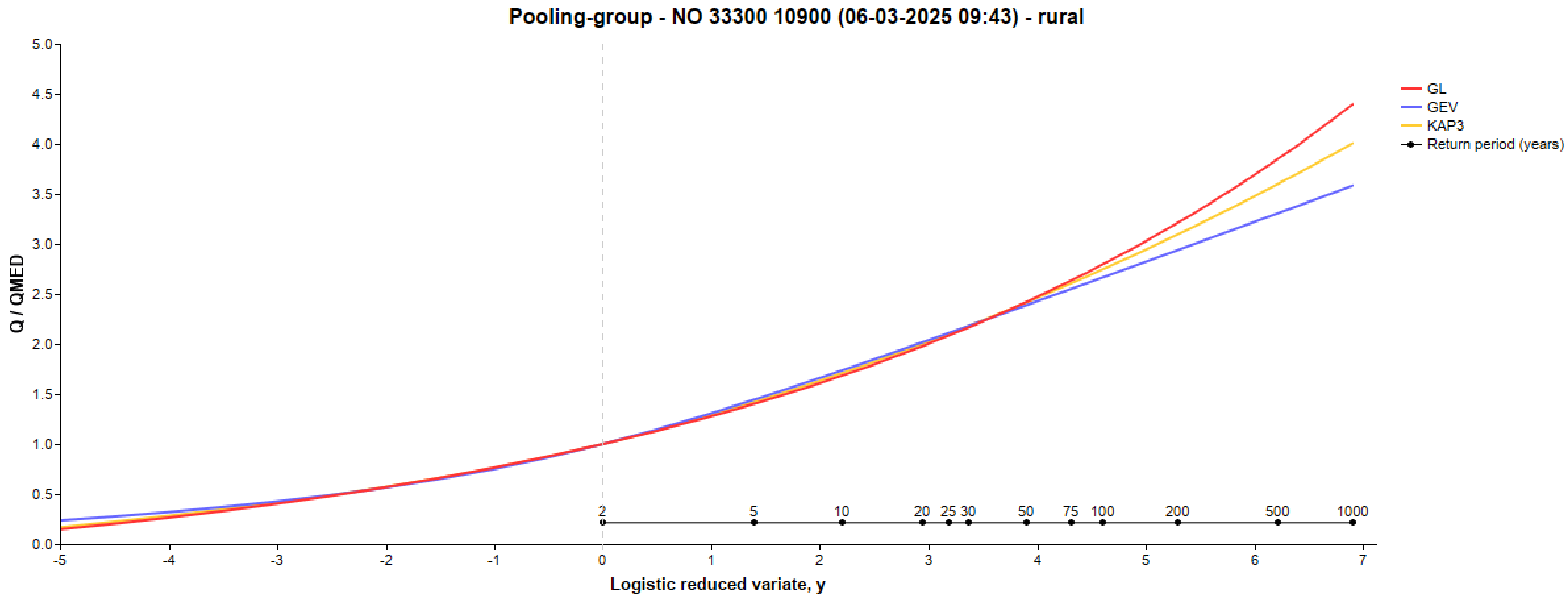
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.400	1.442	1.418
10	1.682	1.736	1.708
20	1.979	2.018	2.002
25	2.081	2.108	2.099
30	2.166	2.182	2.180
50	2.417	2.386	2.412
75	2.630	2.548	2.603
100	2.791	2.663	2.743
200	3.210	2.939	3.095
500	3.846	3.306	3.597
1000	4.397	3.584	4.007

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.399	1.441	1.417
10	1.681	1.734	1.707
20	1.978	2.017	2.001
25	2.079	2.107	2.098
30	2.164	2.180	2.179
50	2.415	2.385	2.411
75	2.629	2.547	2.602
100	2.790	2.662	2.742
200	3.209	2.939	3.094
500	3.845	3.306	3.597
1000	4.398	3.585	4.008

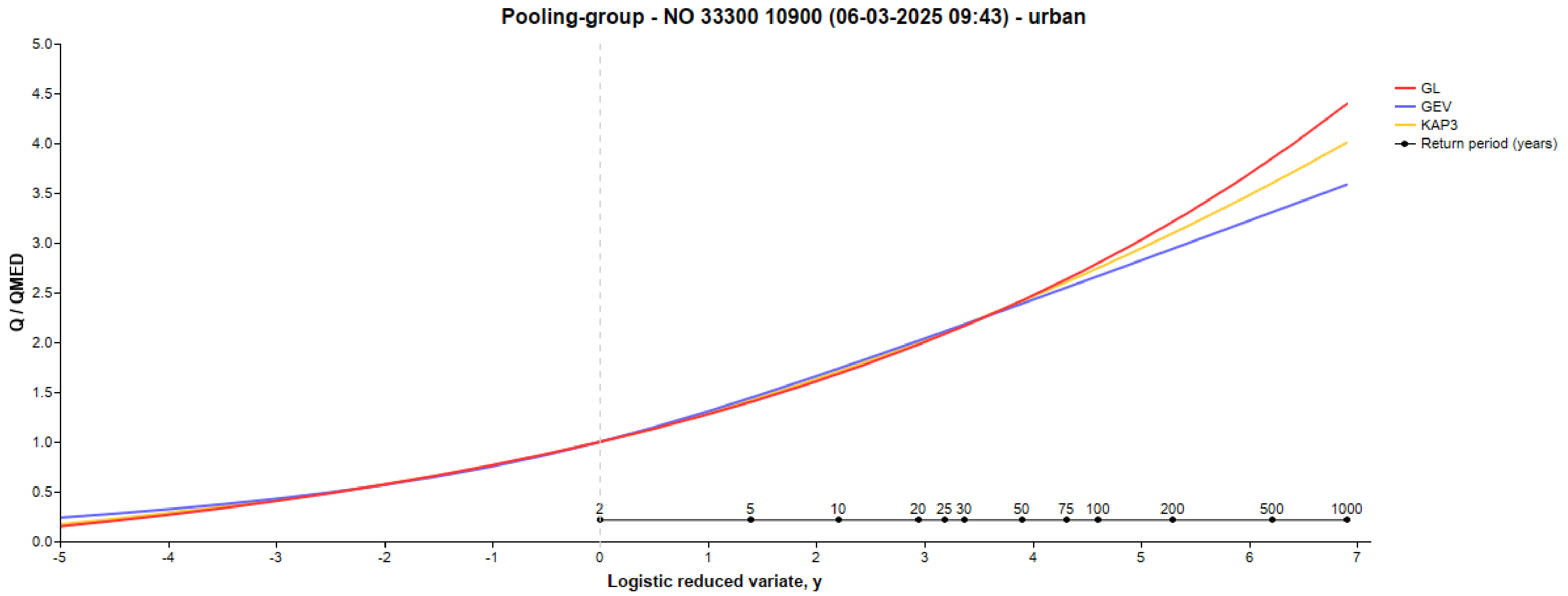
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.358
No. of donors:	6

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
14001 (Eden @ Kemback)	4.44	Yes	40.417	**39.809**	34.829	34.829
15008 (Dean Water @ Cookston)	32.50	Yes	26.832	**26.298**	22.978	22.978
15013 (Almond @ Almondbank)	45.09	Yes	120.636	**120.465**	99.263	99.263
15023 (Braan @ Hermitage)	47.14	Yes	126.650	**126.637**	84.526	84.526
18001 (Allan Water @ Kinbuck)	48.29	Yes	68.892	**68.771**	67.423	67.423
20001 (Tyne @ East Linton)	52.19	Yes	58.498	**58.022**	35.961	35.961

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
14001 (Eden @ Kemback)	Yes	Yes	39	2	5.13	0.75	None	
15008 (Dean Water @ Cookston)	Yes	Yes	53	0	0.00	-2.92	5	
15013 (Almond @ Almondbank)	Yes	Yes	37	0	0.00	1.69	10	
15023 (Braan @ Hermitage)	Yes	Yes	32	1	3.12	0.66	None	
18001 (Allan Water @ Kinbuck)	Yes	No	31	0	0.00	-0.37	None	
20001 (Tyne @ East Linton)	Yes	Yes	64	8	12.50	1.47	None	

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_333300_710900_v5_0_1 @ NO 33300 10900)	52.140	330566	715805	748	0.092	0.928	0.003	0.629
14001 (Eden @ Kemback)	308.738	330238	711373	800	0.104	0.992	0.011	0.591
15008 (Dean Water @ Cookston)	176.610	341013	746580	840	0.127	0.973	0.015	0.587
15013 (Almond @ Almondbank)	173.280	288255	731394	1394	0.031	0.996	0.001	0.422
15023 (Braan @ Hermitage)	210.715	290065	739933	1326	0.034	0.929	0.000	0.429
18001 (Allan Water @ Kinbuck)	160.287	282725	709261	1384	0.076	0.974	0.002	0.504
20001 (Tyne @ East Linton)	307.262	347346	666388	713	0.050	0.987	0.007	0.489

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
18005 (Allan Water @ Bridge of Allan)	49.25	0.006	Yes	76.971	**76.435**	83.961	83.961	281977	707779	209.820	1337	0.494	0.976	27	Yes	No
16004 (Earn @ Forteviot Bridge)	50.24	0.003	Yes	249.200	**248.230**	222.304	222.304	280553	720580	783.898	1404	0.494	0.917	35	Yes	Yes
15025 (Ericht @ Craighall)	53.03	0.000	Yes	194.000	**194.000**	149.175	149.175	308883	764204	437.405	1130	0.438	0.989	33	Yes	Yes
20003 (Tyne @ Spilmersford)	53.44	0.004	Yes	28.340	**28.186**	19.603	19.603	342843	663793	162.770	724	0.523	0.987	47	Yes	Yes

QMED

Rural: 5.133 m³/s
Urban: 5.157 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

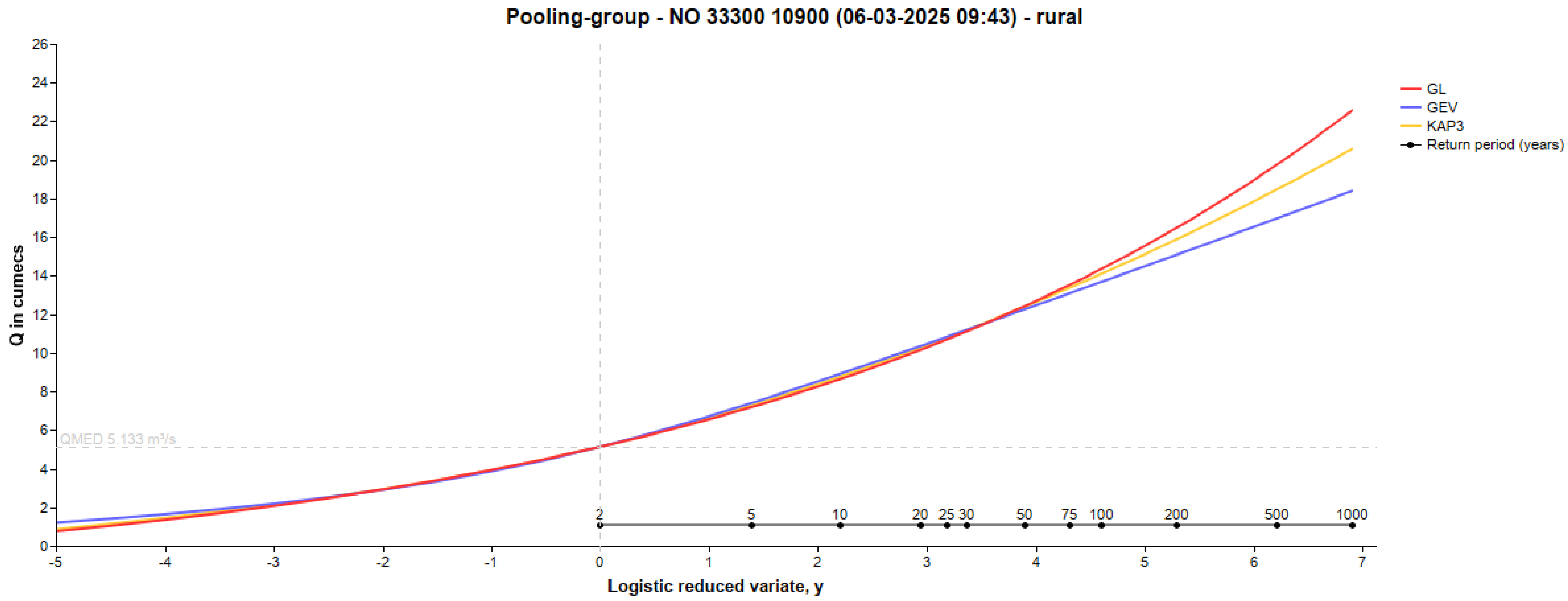
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	5.133	5.133	5.133
5	7.184	7.400	7.279
10	8.633	8.908	8.767
20	10.160	10.360	10.277
25	10.680	10.822	10.776
30	11.116	11.198	11.190
50	12.404	12.247	12.379
75	13.501	13.078	13.360
100	14.325	13.668	14.078
200	16.477	15.087	15.886
500	19.739	16.968	18.463
1000	22.570	18.395	20.568

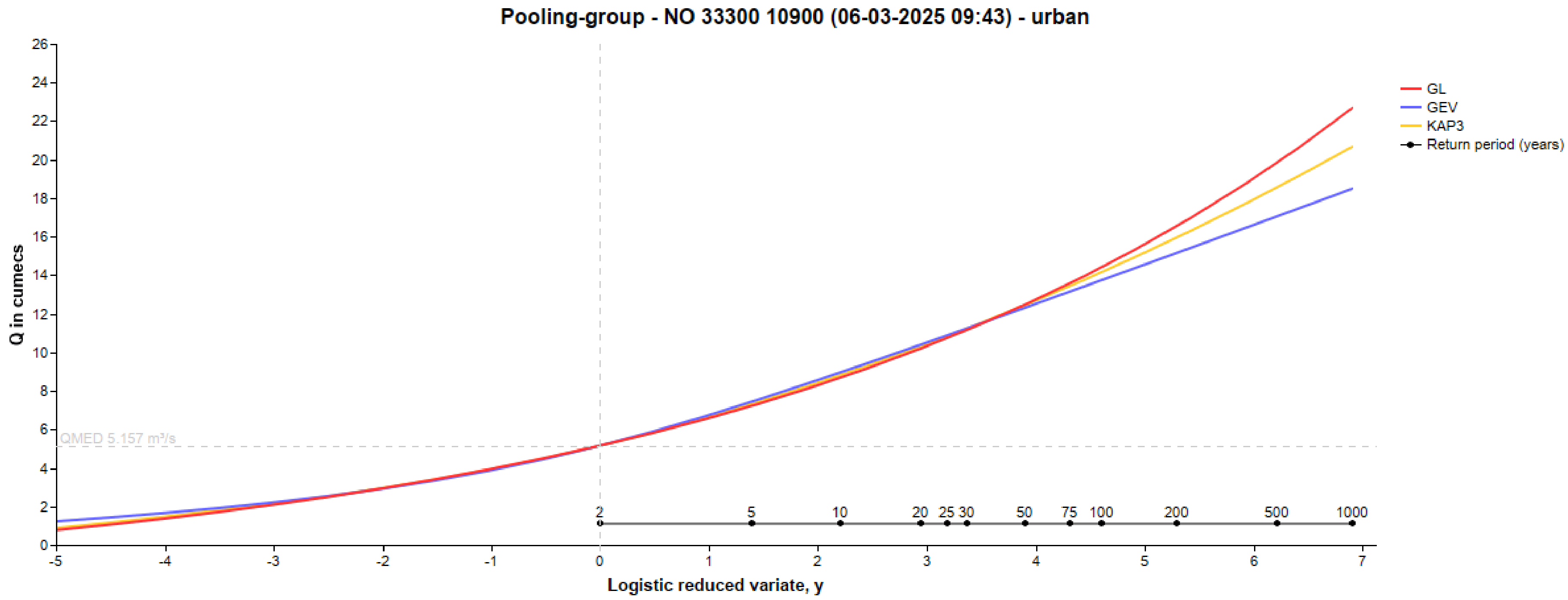
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	5.157	5.157	5.157
5	7.214	7.431	7.310
10	8.668	8.945	8.803
20	10.202	10.403	10.320
25	10.724	10.867	10.821
30	11.162	11.245	11.236
50	12.456	12.300	12.432
75	13.558	13.135	13.418
100	14.386	13.728	14.139
200	16.550	15.157	15.957
500	19.830	17.051	18.551
1000	22.679	18.489	20.670



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

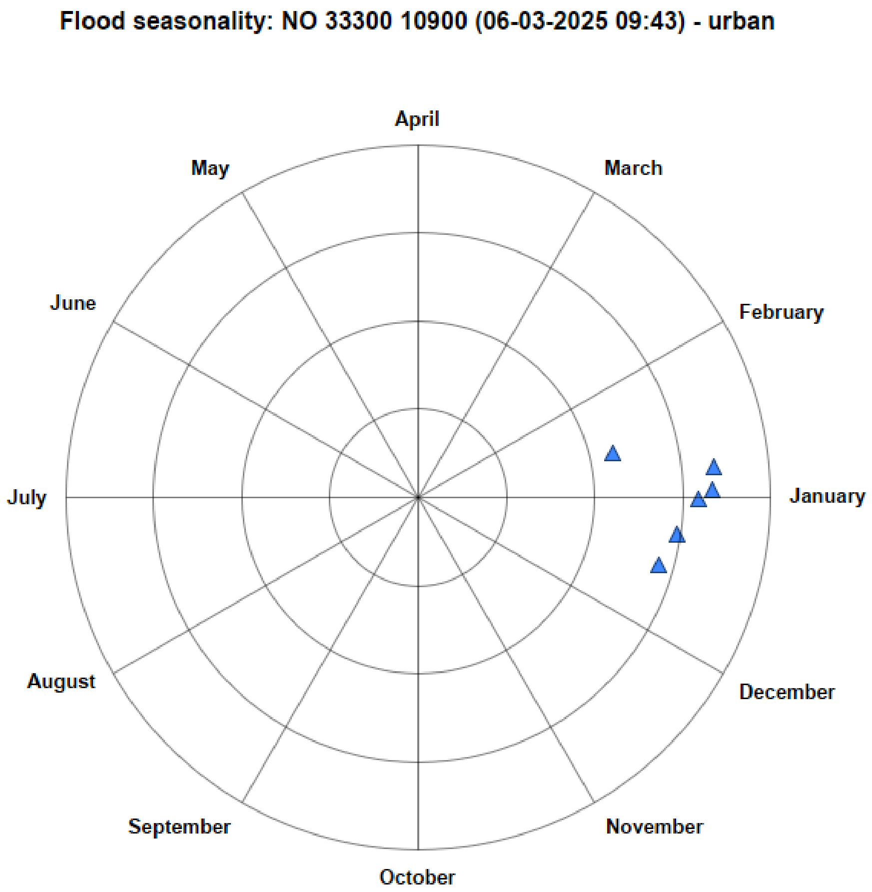


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters



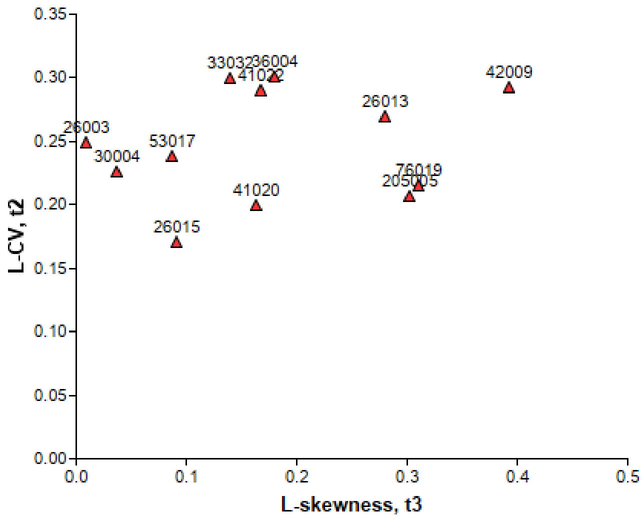
UK Design Flood Estimation

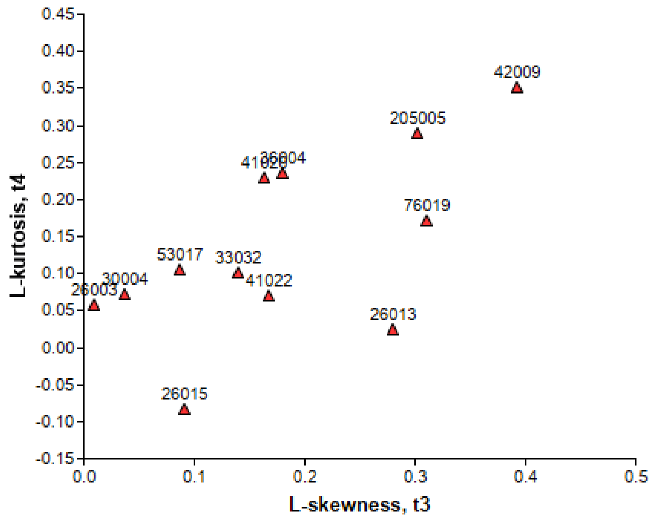
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

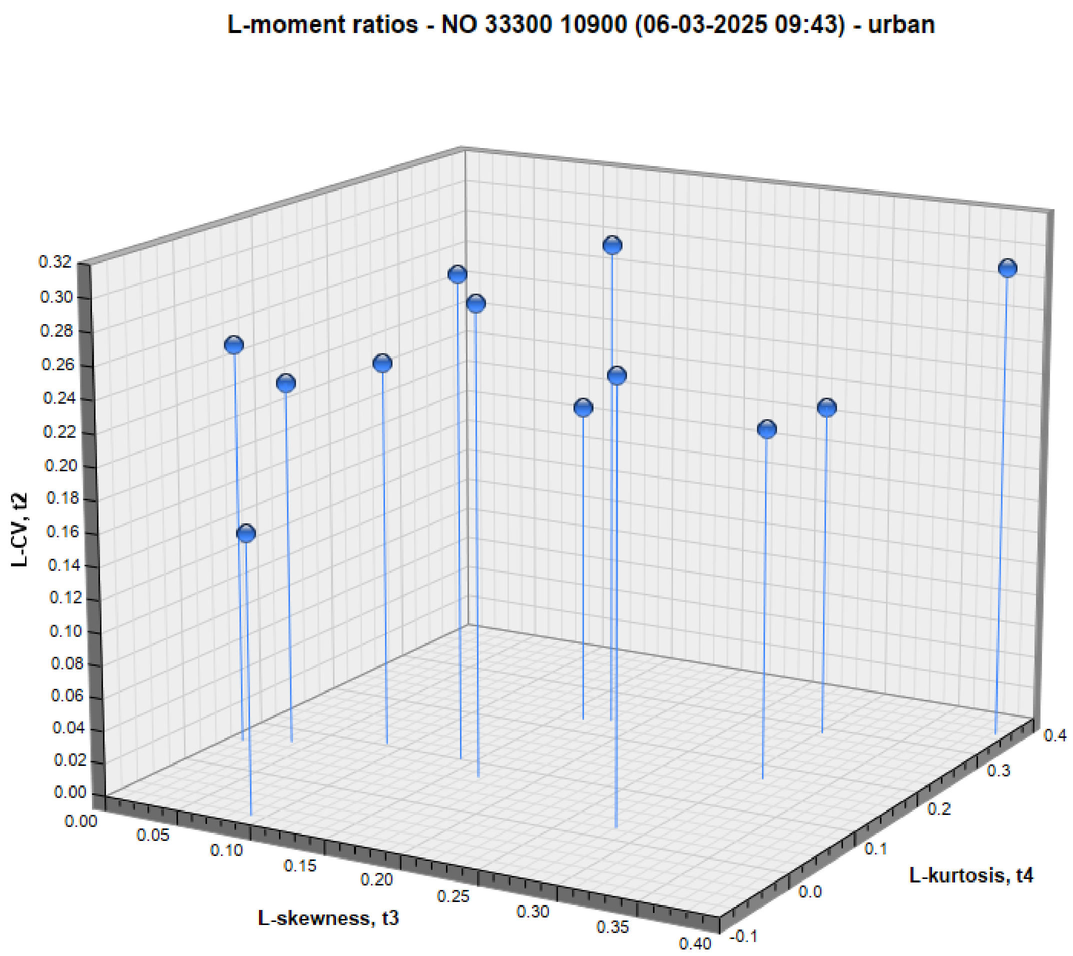
L-moment ratios - NO 33300 10900 (06-03-2025 09:43) - urban





UK Design Flood Estimation

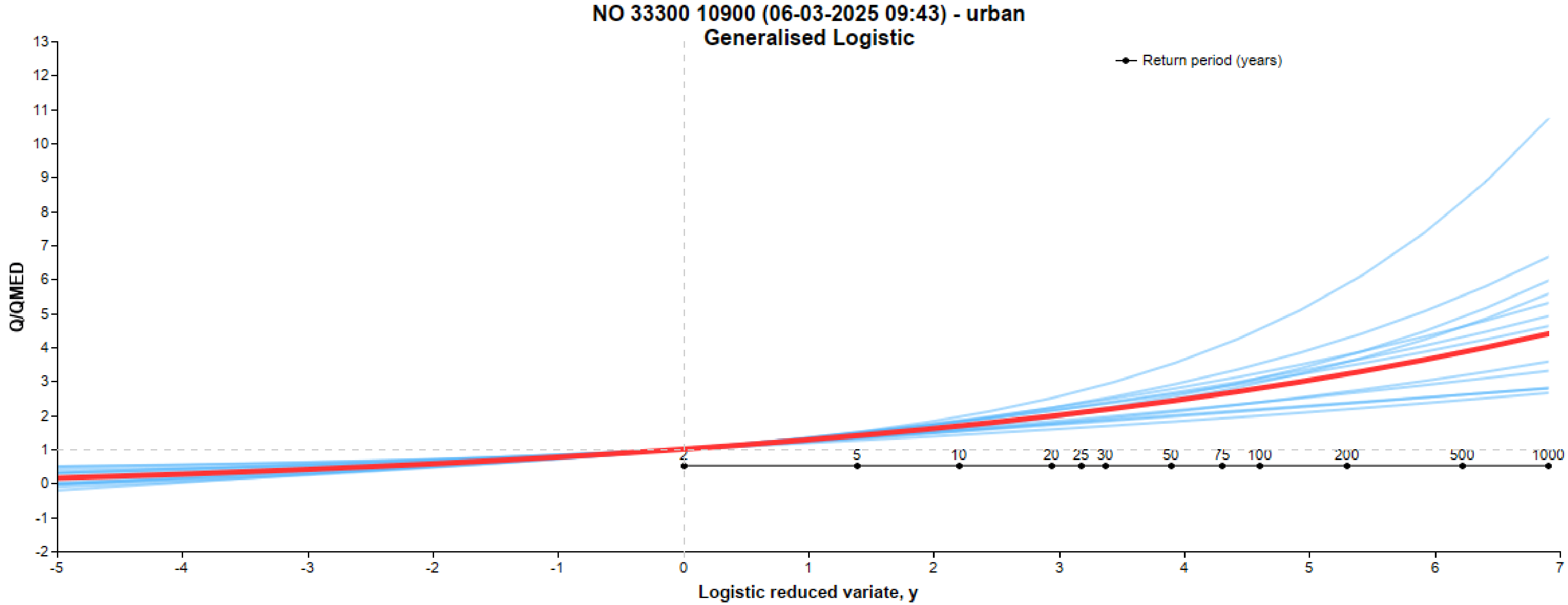
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

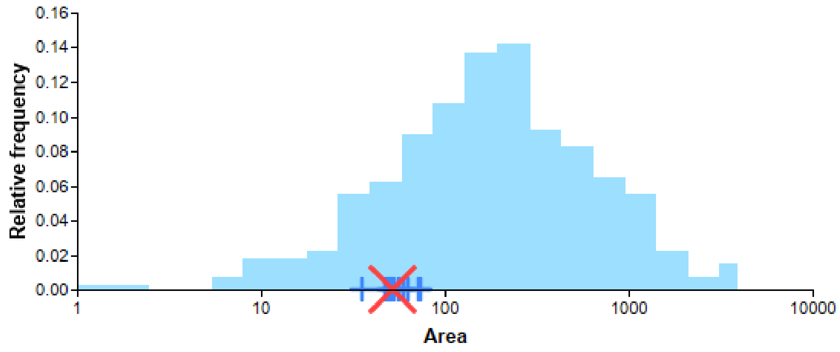
Pooling group growth curves

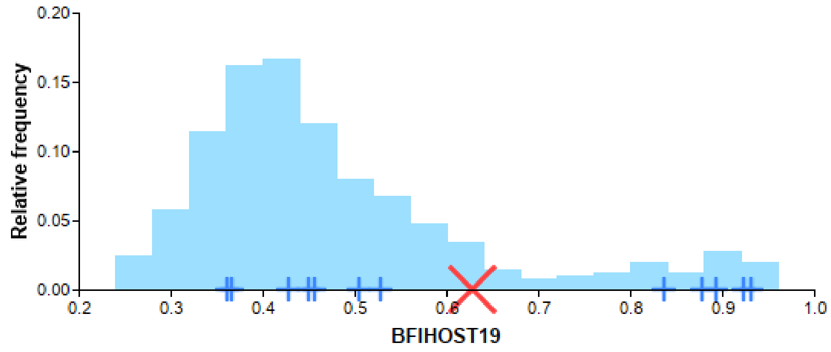


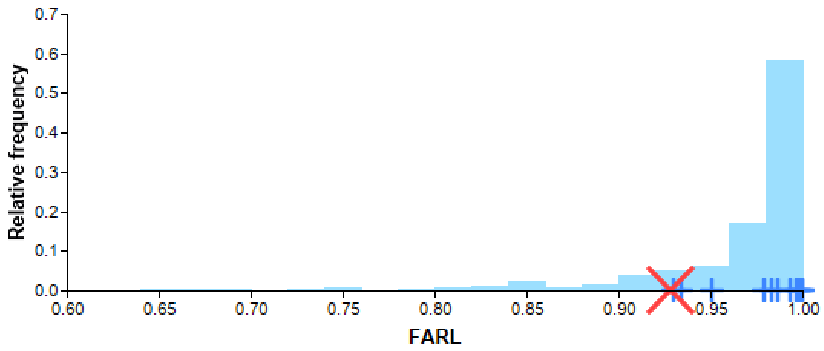
UK Design Flood Estimation

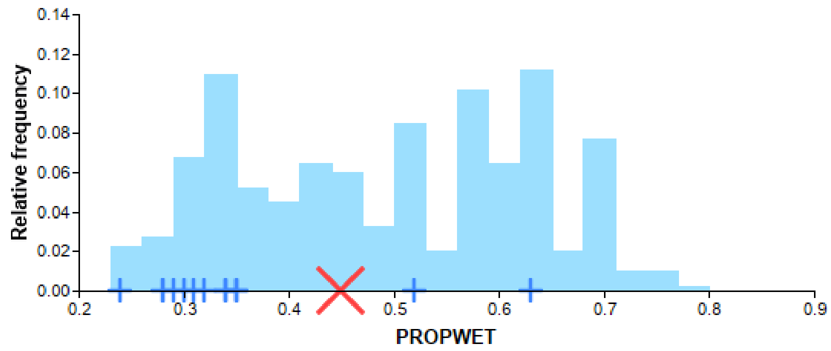
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



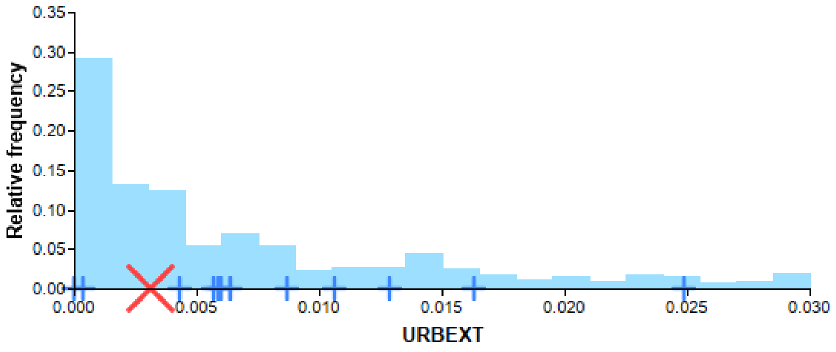


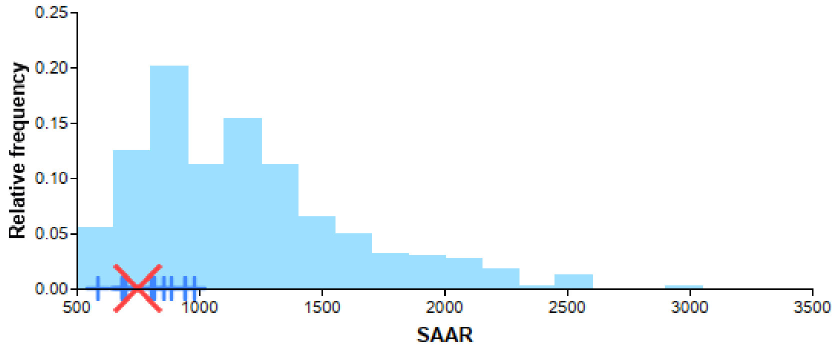


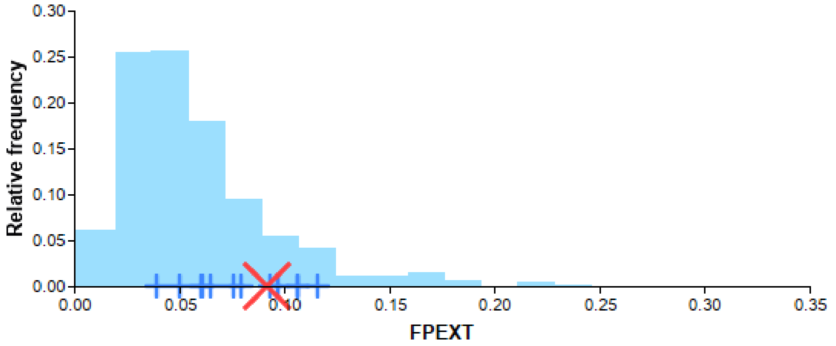


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







Making Sustainability Happen

Appendix D ReFH2 Outputs (SuDS Design)

West Springfield Solar

Flood Risk Assessment & Drainage Impact Assessment

TRIO West Springfield Solar LLP

SLR Project No.: 428.013383.00001

30 April 2025

UK Design Flood Estimation

Generated on 13 March 2025 15:11:16 by ahay
Printed from the ReFH2 Flood Modelling software package, version 4.1.8985.14298

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

Site details

Checksum: 540E-C0A0

Site name: FEH_Point_Descriptors_333239_712013_v5_0_1

Easting: 333239

Northing: 712013

Country: Scotland

Catchment Area (km^2): 0.01 [0.5]*

Using plot scale calculations: Yes

Model: 2.3

Site description: None

Model run: 200 year 1.39 CC

Summary of results

Rainfall - FEH22 (mm):	110.25	Total runoff (ML):	0.08
Total Rainfall (mm):	78.82	Total flow (ML):	0.26
Peak Rainfall (mm):	11.95	Peak flow (m^3/s):	0.00

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 - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	08:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.71	No
ARF (Areal reduction factor)	1 [1]	Yes
Seasonality	Winter	No
Climate change factor	1.39	Yes

Loss model parameters

Name	Value	User-defined?
Cini (mm)	49.84	No
Cmax (mm)	858.85	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	4.97 [4.76]	Yes
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	29.67 [17.34]	Yes
BR	2.21	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0	No
Effective URBEXT2000	0	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.0153	0.0000	0.0595	0.0000	0	0
00:30:00	1.4193	0.0000	0.0852	0.0000	2.02E-08	1.11E-06
01:00:00	1.9804	0.0000	0.1228	0.0000	1.29E-07	4.95E-06
01:30:00	2.7572	0.0000	0.1786	0.0000	4.45E-07	1.28E-05
02:00:00	3.8278	0.0000	0.2626	0.0000	1.14E-06	2.65E-05
02:30:00	5.2932	0.0000	0.3913	0.0000	2.45E-06	4.89E-05
03:00:00	7.2743	0.0000	0.5910	0.0001	4.74E-06	8.42E-05
03:30:00	9.8670	0.0000	0.9000	0.0001	8.54E-06	0.000139
04:00:00	11.9490	0.0000	1.2417	0.0002	1.47E-05	0.000223
04:30:00	9.8670	0.0000	1.1507	0.0003	2.43E-05	0.00035
05:00:00	7.2743	0.0000	0.9209	0.0005	3.9E-05	0.000526
05:30:00	5.2932	0.0000	0.7088	0.0007	6E-05	0.000744
06:00:00	3.8278	0.0000	0.5329	0.0009	8.84E-05	0.000995
06:30:00	2.7572	0.0000	0.3944	0.0011	0.000125	0.00127
07:00:00	1.9804	0.0000	0.2888	0.0014	0.00017	0.00156
07:30:00	1.4193	0.0000	0.2098	0.0016	0.000223	0.00186
08:00:00	1.0153	0.0000	0.1515	0.0019	0.000284	0.00216
08:30:00	0.0000	0.0000	0.0000	0.0021	0.000353	0.00244
09:00:00	0.0000	0.0000	0.0000	0.0023	0.000427	0.00269
09:30:00	0.0000	0.0000	0.0000	0.0024	0.000506	0.00288
10:00:00	0.0000	0.0000	0.0000	0.0024	0.000586	0.003
10:30:00	0.0000	0.0000	0.0000	0.0024	0.000665	0.00306
11:00:00	0.0000	0.0000	0.0000	0.0023	0.000741	0.00307
11:30:00	0.0000	0.0000	0.0000	0.0022	0.000813	0.00304
12:00:00	0.0000	0.0000	0.0000	0.0021	0.000879	0.00299
12:30:00	0.0000	0.0000	0.0000	0.0020	0.00094	0.00291
13:00:00	0.0000	0.0000	0.0000	0.0018	0.000994	0.00281
13:30:00	0.0000	0.0000	0.0000	0.0017	0.00104	0.00271
14:00:00	0.0000	0.0000	0.0000	0.0015	0.00108	0.0026
14:30:00	0.0000	0.0000	0.0000	0.0014	0.00112	0.0025
15:00:00	0.0000	0.0000	0.0000	0.0013	0.00115	0.00241
15:30:00	0.0000	0.0000	0.0000	0.0011	0.00117	0.00232
16:00:00	0.0000	0.0000	0.0000	0.0010	0.0012	0.00224
16:30:00	0.0000	0.0000	0.0000	0.0010	0.00121	0.00217

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:00:00	0.0000	0.0000	0.0000	0.0009	0.00123	0.0021
17:30:00	0.0000	0.0000	0.0000	0.0008	0.00124	0.00202
18:00:00	0.0000	0.0000	0.0000	0.0007	0.00124	0.00195
18:30:00	0.0000	0.0000	0.0000	0.0006	0.00125	0.00187
19:00:00	0.0000	0.0000	0.0000	0.0006	0.00125	0.0018
19:30:00	0.0000	0.0000	0.0000	0.0005	0.00125	0.00172
20:00:00	0.0000	0.0000	0.0000	0.0004	0.00124	0.00164
20:30:00	0.0000	0.0000	0.0000	0.0003	0.00123	0.00156
21:00:00	0.0000	0.0000	0.0000	0.0003	0.00122	0.00149
21:30:00	0.0000	0.0000	0.0000	0.0002	0.00121	0.00141
22:00:00	0.0000	0.0000	0.0000	0.0001	0.0012	0.00134
22:30:00	0.0000	0.0000	0.0000	0.0001	0.00118	0.00128
23:00:00	0.0000	0.0000	0.0000	0.0001	0.00117	0.00123
23:30:00	0.0000	0.0000	0.0000	0.0000	0.00115	0.00119
24:00:00	0.0000	0.0000	0.0000	0.0000	0.00113	0.00116
24:30:00	0.0000	0.0000	0.0000	0.0000	0.00111	0.00113
25:00:00	0.0000	0.0000	0.0000	0.0000	0.00109	0.0011
25:30:00	0.0000	0.0000	0.0000	0.0000	0.00108	0.00108
26:00:00	0.0000	0.0000	0.0000	0.0000	0.00106	0.00106
26:30:00	0.0000	0.0000	0.0000	0.0000	0.00104	0.00104
27:00:00	0.0000	0.0000	0.0000	0.0000	0.00102	0.00102
27:30:00	0.0000	0.0000	0.0000	0.0000	0.00101	0.00101
28:00:00	0.0000	0.0000	0.0000	0.0000	0.000989	0.000989
28:30:00	0.0000	0.0000	0.0000	0.0000	0.000973	0.000973
29:00:00	0.0000	0.0000	0.0000	0.0000	0.000957	0.000957
29:30:00	0.0000	0.0000	0.0000	0.0000	0.000941	0.000941
30:00:00	0.0000	0.0000	0.0000	0.0000	0.000925	0.000925
30:30:00	0.0000	0.0000	0.0000	0.0000	0.000909	0.000909
31:00:00	0.0000	0.0000	0.0000	0.0000	0.000894	0.000894
31:30:00	0.0000	0.0000	0.0000	0.0000	0.000879	0.000879
32:00:00	0.0000	0.0000	0.0000	0.0000	0.000865	0.000865
32:30:00	0.0000	0.0000	0.0000	0.0000	0.00085	0.00085
33:00:00	0.0000	0.0000	0.0000	0.0000	0.000836	0.000836
33:30:00	0.0000	0.0000	0.0000	0.0000	0.000822	0.000822
34:00:00	0.0000	0.0000	0.0000	0.0000	0.000808	0.000808

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
34:30:00	0.0000	0.0000	0.0000	0.0000	0.000795	0.000795
35:00:00	0.0000	0.0000	0.0000	0.0000	0.000781	0.000781
35:30:00	0.0000	0.0000	0.0000	0.0000	0.000768	0.000768
36:00:00	0.0000	0.0000	0.0000	0.0000	0.000756	0.000756
36:30:00	0.0000	0.0000	0.0000	0.0000	0.000743	0.000743
37:00:00	0.0000	0.0000	0.0000	0.0000	0.000731	0.000731
37:30:00	0.0000	0.0000	0.0000	0.0000	0.000718	0.000718
38:00:00	0.0000	0.0000	0.0000	0.0000	0.000706	0.000706
38:30:00	0.0000	0.0000	0.0000	0.0000	0.000695	0.000695
39:00:00	0.0000	0.0000	0.0000	0.0000	0.000683	0.000683
39:30:00	0.0000	0.0000	0.0000	0.0000	0.000672	0.000672
40:00:00	0.0000	0.0000	0.0000	0.0000	0.00066	0.00066
40:30:00	0.0000	0.0000	0.0000	0.0000	0.000649	0.000649
41:00:00	0.0000	0.0000	0.0000	0.0000	0.000638	0.000638
41:30:00	0.0000	0.0000	0.0000	0.0000	0.000628	0.000628
42:00:00	0.0000	0.0000	0.0000	0.0000	0.000617	0.000617
42:30:00	0.0000	0.0000	0.0000	0.0000	0.000607	0.000607
43:00:00	0.0000	0.0000	0.0000	0.0000	0.000597	0.000597
43:30:00	0.0000	0.0000	0.0000	0.0000	0.000587	0.000587
44:00:00	0.0000	0.0000	0.0000	0.0000	0.000577	0.000577
44:30:00	0.0000	0.0000	0.0000	0.0000	0.000567	0.000567
45:00:00	0.0000	0.0000	0.0000	0.0000	0.000558	0.000558
45:30:00	0.0000	0.0000	0.0000	0.0000	0.000549	0.000549
46:00:00	0.0000	0.0000	0.0000	0.0000	0.000539	0.000539
46:30:00	0.0000	0.0000	0.0000	0.0000	0.00053	0.00053
47:00:00	0.0000	0.0000	0.0000	0.0000	0.000522	0.000522
47:30:00	0.0000	0.0000	0.0000	0.0000	0.000513	0.000513
48:00:00	0.0000	0.0000	0.0000	0.0000	0.000504	0.000504
48:30:00	0.0000	0.0000	0.0000	0.0000	0.000496	0.000496
49:00:00	0.0000	0.0000	0.0000	0.0000	0.000488	0.000488
49:30:00	0.0000	0.0000	0.0000	0.0000	0.000479	0.000479
50:00:00	0.0000	0.0000	0.0000	0.0000	0.000471	0.000471
50:30:00	0.0000	0.0000	0.0000	0.0000	0.000464	0.000464
51:00:00	0.0000	0.0000	0.0000	0.0000	0.000456	0.000456
51:30:00	0.0000	0.0000	0.0000	0.0000	0.000448	0.000448

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
52:00:00	0.0000	0.0000	0.0000	0.0000	0.000441	0.000441
52:30:00	0.0000	0.0000	0.0000	0.0000	0.000433	0.000433
53:00:00	0.0000	0.0000	0.0000	0.0000	0.000426	0.000426
53:30:00	0.0000	0.0000	0.0000	0.0000	0.000419	0.000419
54:00:00	0.0000	0.0000	0.0000	0.0000	0.000412	0.000412
54:30:00	0.0000	0.0000	0.0000	0.0000	0.000405	0.000405
55:00:00	0.0000	0.0000	0.0000	0.0000	0.000398	0.000398
55:30:00	0.0000	0.0000	0.0000	0.0000	0.000392	0.000392
56:00:00	0.0000	0.0000	0.0000	0.0000	0.000385	0.000385
56:30:00	0.0000	0.0000	0.0000	0.0000	0.000379	0.000379
57:00:00	0.0000	0.0000	0.0000	0.0000	0.000372	0.000372
57:30:00	0.0000	0.0000	0.0000	0.0000	0.000366	0.000366
58:00:00	0.0000	0.0000	0.0000	0.0000	0.00036	0.00036
58:30:00	0.0000	0.0000	0.0000	0.0000	0.000354	0.000354
59:00:00	0.0000	0.0000	0.0000	0.0000	0.000348	0.000348
59:30:00	0.0000	0.0000	0.0000	0.0000	0.000342	0.000342
60:00:00	0.0000	0.0000	0.0000	0.0000	0.000337	0.000337
60:30:00	0.0000	0.0000	0.0000	0.0000	0.000331	0.000331
61:00:00	0.0000	0.0000	0.0000	0.0000	0.000325	0.000325
61:30:00	0.0000	0.0000	0.0000	0.0000	0.00032	0.00032
62:00:00	0.0000	0.0000	0.0000	0.0000	0.000315	0.000315
62:30:00	0.0000	0.0000	0.0000	0.0000	0.000309	0.000309
63:00:00	0.0000	0.0000	0.0000	0.0000	0.000304	0.000304
63:30:00	0.0000	0.0000	0.0000	0.0000	0.000299	0.000299
64:00:00	0.0000	0.0000	0.0000	0.0000	0.000294	0.000294
64:30:00	0.0000	0.0000	0.0000	0.0000	0.000289	0.000289
65:00:00	0.0000	0.0000	0.0000	0.0000	0.000284	0.000284
65:30:00	0.0000	0.0000	0.0000	0.0000	0.00028	0.00028
66:00:00	0.0000	0.0000	0.0000	0.0000	0.000275	0.000275
66:30:00	0.0000	0.0000	0.0000	0.0000	0.00027	0.00027
67:00:00	0.0000	0.0000	0.0000	0.0000	0.000266	0.000266
67:30:00	0.0000	0.0000	0.0000	0.0000	0.000261	0.000261
68:00:00	0.0000	0.0000	0.0000	0.0000	0.000257	0.000257
68:30:00	0.0000	0.0000	0.0000	0.0000	0.000253	0.000253
69:00:00	0.0000	0.0000	0.0000	0.0000	0.000248	0.000248

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
69:30:00	0.0000	0.0000	0.0000	0.0000	0.000244	0.000244
70:00:00	0.0000	0.0000	0.0000	0.0000	0.00024	0.00024
70:30:00	0.0000	0.0000	0.0000	0.0000	0.000236	0.000236
71:00:00	0.0000	0.0000	0.0000	0.0000	0.000232	0.000232
71:30:00	0.0000	0.0000	0.0000	0.0000	0.000228	0.000228
72:00:00	0.0000	0.0000	0.0000	0.0000	0.000225	0.000225
72:30:00	0.0000	0.0000	0.0000	0.0000	0.000221	0.000221
73:00:00	0.0000	0.0000	0.0000	0.0000	0.000217	0.000217
73:30:00	0.0000	0.0000	0.0000	0.0000	0.000214	0.000214
74:00:00	0.0000	0.0000	0.0000	0.0000	0.00021	0.00021
74:30:00	0.0000	0.0000	0.0000	0.0000	0.000206	0.000206
75:00:00	0.0000	0.0000	0.0000	0.0000	0.000203	0.000203
75:30:00	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
76:00:00	0.0000	0.0000	0.0000	0.0000	0.000196	0.000196
76:30:00	0.0000	0.0000	0.0000	0.0000	0.000193	0.000193
77:00:00	0.0000	0.0000	0.0000	0.0000	0.00019	0.00019
77:30:00	0.0000	0.0000	0.0000	0.0000	0.000187	0.000187
78:00:00	0.0000	0.0000	0.0000	0.0000	0.000183	0.000183
78:30:00	0.0000	0.0000	0.0000	0.0000	0.00018	0.00018
79:00:00	0.0000	0.0000	0.0000	0.0000	0.000177	0.000177
79:30:00	0.0000	0.0000	0.0000	0.0000	0.000174	0.000174
80:00:00	0.0000	0.0000	0.0000	0.0000	0.000172	0.000172
80:30:00	0.0000	0.0000	0.0000	0.0000	0.000169	0.000169
81:00:00	0.0000	0.0000	0.0000	0.0000	0.000166	0.000166
81:30:00	0.0000	0.0000	0.0000	0.0000	0.000163	0.000163
82:00:00	0.0000	0.0000	0.0000	0.0000	0.00016	0.00016
82:30:00	0.0000	0.0000	0.0000	0.0000	0.000158	0.000158
83:00:00	0.0000	0.0000	0.0000	0.0000	0.000155	0.000155
83:30:00	0.0000	0.0000	0.0000	0.0000	0.000152	0.000152
84:00:00	0.0000	0.0000	0.0000	0.0000	0.00015	0.00015
84:30:00	0.0000	0.0000	0.0000	0.0000	0.000147	0.000147
85:00:00	0.0000	0.0000	0.0000	0.0000	0.000145	0.000145
85:30:00	0.0000	0.0000	0.0000	0.0000	0.000143	0.000143
86:00:00	0.0000	0.0000	0.0000	0.0000	0.00014	0.00014
86:30:00	0.0000	0.0000	0.0000	0.0000	0.000138	0.000138

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
87:00:00	0.0000	0.0000	0.0000	0.0000	0.000135	0.000135
87:30:00	0.0000	0.0000	0.0000	0.0000	0.000133	0.000133
88:00:00	0.0000	0.0000	0.0000	0.0000	0.000131	0.000131
88:30:00	0.0000	0.0000	0.0000	0.0000	0.000129	0.000129
89:00:00	0.0000	0.0000	0.0000	0.0000	0.000127	0.000127
89:30:00	0.0000	0.0000	0.0000	0.0000	0.000125	0.000125
90:00:00	0.0000	0.0000	0.0000	0.0000	0.000122	0.000122
90:30:00	0.0000	0.0000	0.0000	0.0000	0.00012	0.00012
91:00:00	0.0000	0.0000	0.0000	0.0000	0.000118	0.000118
91:30:00	0.0000	0.0000	0.0000	0.0000	0.000116	0.000116
92:00:00	0.0000	0.0000	0.0000	0.0000	0.000114	0.000114
92:30:00	0.0000	0.0000	0.0000	0.0000	0.000113	0.000113
93:00:00	0.0000	0.0000	0.0000	0.0000	0.000111	0.000111
93:30:00	0.0000	0.0000	0.0000	0.0000	0.000109	0.000109
94:00:00	0.0000	0.0000	0.0000	0.0000	0.000107	0.000107
94:30:00	0.0000	0.0000	0.0000	0.0000	0.000105	0.000105
95:00:00	0.0000	0.0000	0.0000	0.0000	0.000103	0.000103
95:30:00	0.0000	0.0000	0.0000	0.0000	0.000102	0.000102
96:00:00	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
96:30:00	0.0000	0.0000	0.0000	0.0000	9.84E-05	9.84E-05
97:00:00	0.0000	0.0000	0.0000	0.0000	9.67E-05	9.67E-05
97:30:00	0.0000	0.0000	0.0000	0.0000	9.51E-05	9.51E-05
98:00:00	0.0000	0.0000	0.0000	0.0000	9.35E-05	9.35E-05
98:30:00	0.0000	0.0000	0.0000	0.0000	9.2E-05	9.2E-05
99:00:00	0.0000	0.0000	0.0000	0.0000	9.04E-05	9.04E-05
99:30:00	0.0000	0.0000	0.0000	0.0000	8.89E-05	8.89E-05
100:00:00	0.0000	0.0000	0.0000	0.0000	8.74E-05	8.74E-05
100:30:00	0.0000	0.0000	0.0000	0.0000	8.6E-05	8.6E-05
101:00:00	0.0000	0.0000	0.0000	0.0000	8.45E-05	8.45E-05
101:30:00	0.0000	0.0000	0.0000	0.0000	8.31E-05	8.31E-05
102:00:00	0.0000	0.0000	0.0000	0.0000	8.17E-05	8.17E-05
102:30:00	0.0000	0.0000	0.0000	0.0000	8.04E-05	8.04E-05
103:00:00	0.0000	0.0000	0.0000	0.0000	7.9E-05	7.9E-05
103:30:00	0.0000	0.0000	0.0000	0.0000	7.77E-05	7.77E-05
104:00:00	0.0000	0.0000	0.0000	0.0000	7.64E-05	7.64E-05

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
104:30:00	0.0000	0.0000	0.0000	0.0000	7.51E-05	7.51E-05
105:00:00	0.0000	0.0000	0.0000	0.0000	7.39E-05	7.39E-05
105:30:00	0.0000	0.0000	0.0000	0.0000	7.26E-05	7.26E-05
106:00:00	0.0000	0.0000	0.0000	0.0000	7.14E-05	7.14E-05
106:30:00	0.0000	0.0000	0.0000	0.0000	7.02E-05	7.02E-05
107:00:00	0.0000	0.0000	0.0000	0.0000	6.9E-05	6.9E-05
107:30:00	0.0000	0.0000	0.0000	0.0000	6.79E-05	6.79E-05
108:00:00	0.0000	0.0000	0.0000	0.0000	6.68E-05	6.68E-05
108:30:00	0.0000	0.0000	0.0000	0.0000	6.56E-05	6.56E-05
109:00:00	0.0000	0.0000	0.0000	0.0000	6.45E-05	6.45E-05
109:30:00	0.0000	0.0000	0.0000	0.0000	6.35E-05	6.35E-05
110:00:00	0.0000	0.0000	0.0000	0.0000	6.24E-05	6.24E-05
110:30:00	0.0000	0.0000	0.0000	0.0000	6.14E-05	6.14E-05
111:00:00	0.0000	0.0000	0.0000	0.0000	6.03E-05	6.03E-05
111:30:00	0.0000	0.0000	0.0000	0.0000	5.93E-05	5.93E-05
112:00:00	0.0000	0.0000	0.0000	0.0000	5.83E-05	5.83E-05
112:30:00	0.0000	0.0000	0.0000	0.0000	5.74E-05	5.74E-05
113:00:00	0.0000	0.0000	0.0000	0.0000	5.64E-05	5.64E-05
113:30:00	0.0000	0.0000	0.0000	0.0000	5.55E-05	5.55E-05
114:00:00	0.0000	0.0000	0.0000	0.0000	5.45E-05	5.45E-05
114:30:00	0.0000	0.0000	0.0000	0.0000	5.36E-05	5.36E-05
115:00:00	0.0000	0.0000	0.0000	0.0000	5.27E-05	5.27E-05
115:30:00	0.0000	0.0000	0.0000	0.0000	5.19E-05	5.19E-05
116:00:00	0.0000	0.0000	0.0000	0.0000	5.1E-05	5.1E-05
116:30:00	0.0000	0.0000	0.0000	0.0000	5.01E-05	5.01E-05
117:00:00	0.0000	0.0000	0.0000	0.0000	4.93E-05	4.93E-05
117:30:00	0.0000	0.0000	0.0000	0.0000	4.85E-05	4.85E-05
118:00:00	0.0000	0.0000	0.0000	0.0000	4.77E-05	4.77E-05
118:30:00	0.0000	0.0000	0.0000	0.0000	4.69E-05	4.69E-05
119:00:00	0.0000	0.0000	0.0000	0.0000	4.61E-05	4.61E-05
119:30:00	0.0000	0.0000	0.0000	0.0000	4.53E-05	4.53E-05
120:00:00	0.0000	0.0000	0.0000	0.0000	4.46E-05	4.46E-05
120:30:00	0.0000	0.0000	0.0000	0.0000	4.38E-05	4.38E-05
121:00:00	0.0000	0.0000	0.0000	0.0000	4.31E-05	4.31E-05
121:30:00	0.0000	0.0000	0.0000	0.0000	4.24E-05	4.24E-05

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
122:00:00	0.0000	0.0000	0.0000	0.0000	4.17E-05	4.17E-05
122:30:00	0.0000	0.0000	0.0000	0.0000	4.1E-05	4.1E-05
123:00:00	0.0000	0.0000	0.0000	0.0000	4.03E-05	4.03E-05
123:30:00	0.0000	0.0000	0.0000	0.0000	3.96E-05	3.96E-05
124:00:00	0.0000	0.0000	0.0000	0.0000	3.89E-05	3.89E-05
124:30:00	0.0000	0.0000	0.0000	0.0000	3.83E-05	3.83E-05
125:00:00	0.0000	0.0000	0.0000	0.0000	3.76E-05	3.76E-05
125:30:00	0.0000	0.0000	0.0000	0.0000	3.7E-05	3.7E-05
126:00:00	0.0000	0.0000	0.0000	0.0000	3.64E-05	3.64E-05
126:30:00	0.0000	0.0000	0.0000	0.0000	3.58E-05	3.58E-05
127:00:00	0.0000	0.0000	0.0000	0.0000	3.52E-05	3.52E-05
127:30:00	0.0000	0.0000	0.0000	0.0000	3.46E-05	3.46E-05
128:00:00	0.0000	0.0000	0.0000	0.0000	3.4E-05	3.4E-05
128:30:00	0.0000	0.0000	0.0000	0.0000	3.35E-05	3.35E-05
129:00:00	0.0000	0.0000	0.0000	0.0000	3.29E-05	3.29E-05
129:30:00	0.0000	0.0000	0.0000	0.0000	3.23E-05	3.23E-05
130:00:00	0.0000	0.0000	0.0000	0.0000	3.18E-05	3.18E-05
130:30:00	0.0000	0.0000	0.0000	0.0000	3.13E-05	3.13E-05
131:00:00	0.0000	0.0000	0.0000	0.0000	3.08E-05	3.08E-05
131:30:00	0.0000	0.0000	0.0000	0.0000	3.02E-05	3.02E-05
132:00:00	0.0000	0.0000	0.0000	0.0000	2.97E-05	2.97E-05
132:30:00	0.0000	0.0000	0.0000	0.0000	2.92E-05	2.92E-05
133:00:00	0.0000	0.0000	0.0000	0.0000	2.87E-05	2.87E-05
133:30:00	0.0000	0.0000	0.0000	0.0000	2.83E-05	2.83E-05
134:00:00	0.0000	0.0000	0.0000	0.0000	2.78E-05	2.78E-05
134:30:00	0.0000	0.0000	0.0000	0.0000	2.73E-05	2.73E-05
135:00:00	0.0000	0.0000	0.0000	0.0000	2.69E-05	2.69E-05
135:30:00	0.0000	0.0000	0.0000	0.0000	2.64E-05	2.64E-05
136:00:00	0.0000	0.0000	0.0000	0.0000	2.6E-05	2.6E-05
136:30:00	0.0000	0.0000	0.0000	0.0000	2.56E-05	2.56E-05
137:00:00	0.0000	0.0000	0.0000	0.0000	2.51E-05	2.51E-05
137:30:00	0.0000	0.0000	0.0000	0.0000	2.47E-05	2.47E-05
138:00:00	0.0000	0.0000	0.0000	0.0000	2.43E-05	2.43E-05
138:30:00	0.0000	0.0000	0.0000	0.0000	2.39E-05	2.39E-05
139:00:00	0.0000	0.0000	0.0000	0.0000	2.35E-05	2.35E-05

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
139:30:00	0.0000	0.0000	0.0000	0.0000	2.31E-05	2.31E-05
140:00:00	0.0000	0.0000	0.0000	0.0000	2.27E-05	2.27E-05
140:30:00	0.0000	0.0000	0.0000	0.0000	2.23E-05	2.23E-05
141:00:00	0.0000	0.0000	0.0000	0.0000	2.2E-05	2.2E-05
141:30:00	0.0000	0.0000	0.0000	0.0000	2.16E-05	2.16E-05
142:00:00	0.0000	0.0000	0.0000	0.0000	2.12E-05	2.12E-05
142:30:00	0.0000	0.0000	0.0000	0.0000	2.09E-05	2.09E-05
143:00:00	0.0000	0.0000	0.0000	0.0000	2.05E-05	2.05E-05
143:30:00	0.0000	0.0000	0.0000	0.0000	2.02E-05	2.02E-05
144:00:00	0.0000	0.0000	0.0000	0.0000	1.98E-05	1.98E-05
144:30:00	0.0000	0.0000	0.0000	0.0000	1.95E-05	1.95E-05
145:00:00	0.0000	0.0000	0.0000	0.0000	1.92E-05	1.92E-05
145:30:00	0.0000	0.0000	0.0000	0.0000	1.89E-05	1.89E-05
146:00:00	0.0000	0.0000	0.0000	0.0000	1.86E-05	1.86E-05
146:30:00	0.0000	0.0000	0.0000	0.0000	1.82E-05	1.82E-05
147:00:00	0.0000	0.0000	0.0000	0.0000	1.79E-05	1.79E-05
147:30:00	0.0000	0.0000	0.0000	0.0000	1.76E-05	1.76E-05
148:00:00	0.0000	0.0000	0.0000	0.0000	1.73E-05	1.73E-05
148:30:00	0.0000	0.0000	0.0000	0.0000	1.71E-05	1.71E-05
149:00:00	0.0000	0.0000	0.0000	0.0000	1.68E-05	1.68E-05
149:30:00	0.0000	0.0000	0.0000	0.0000	1.65E-05	1.65E-05
150:00:00	0.0000	0.0000	0.0000	0.0000	1.62E-05	1.62E-05
150:30:00	0.0000	0.0000	0.0000	0.0000	1.59E-05	1.59E-05
151:00:00	0.0000	0.0000	0.0000	0.0000	1.57E-05	1.57E-05
151:30:00	0.0000	0.0000	0.0000	0.0000	1.54E-05	1.54E-05
152:00:00	0.0000	0.0000	0.0000	0.0000	1.52E-05	1.52E-05
152:30:00	0.0000	0.0000	0.0000	0.0000	1.49E-05	1.49E-05
153:00:00	0.0000	0.0000	0.0000	0.0000	1.47E-05	1.47E-05
153:30:00	0.0000	0.0000	0.0000	0.0000	1.44E-05	1.44E-05
154:00:00	0.0000	0.0000	0.0000	0.0000	1.42E-05	1.42E-05
154:30:00	0.0000	0.0000	0.0000	0.0000	1.39E-05	1.39E-05
155:00:00	0.0000	0.0000	0.0000	0.0000	1.37E-05	1.37E-05
155:30:00	0.0000	0.0000	0.0000	0.0000	1.35E-05	1.35E-05
156:00:00	0.0000	0.0000	0.0000	0.0000	1.32E-05	1.32E-05
156:30:00	0.0000	0.0000	0.0000	0.0000	1.3E-05	1.3E-05

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
157:00:00	0.0000	0.0000	0.0000	0.0000	1.28E-05	1.28E-05
157:30:00	0.0000	0.0000	0.0000	0.0000	1.26E-05	1.26E-05
158:00:00	0.0000	0.0000	0.0000	0.0000	1.24E-05	1.24E-05
158:30:00	0.0000	0.0000	0.0000	0.0000	1.22E-05	1.22E-05
159:00:00	0.0000	0.0000	0.0000	0.0000	1.2E-05	1.2E-05
159:30:00	0.0000	0.0000	0.0000	0.0000	1.18E-05	1.18E-05
160:00:00	0.0000	0.0000	0.0000	0.0000	1.16E-05	1.16E-05
160:30:00	0.0000	0.0000	0.0000	0.0000	1.14E-05	1.14E-05
161:00:00	0.0000	0.0000	0.0000	0.0000	1.12E-05	1.12E-05
161:30:00	0.0000	0.0000	0.0000	0.0000	1.1E-05	1.1E-05
162:00:00	0.0000	0.0000	0.0000	0.0000	1.08E-05	1.08E-05
162:30:00	0.0000	0.0000	0.0000	0.0000	1.06E-05	1.06E-05
163:00:00	0.0000	0.0000	0.0000	0.0000	1.05E-05	1.05E-05
163:30:00	0.0000	0.0000	0.0000	0.0000	1.03E-05	1.03E-05
164:00:00	0.0000	0.0000	0.0000	0.0000	1.01E-05	1.01E-05
164:30:00	0.0000	0.0000	0.0000	0.0000	9.95E-06	9.95E-06
165:00:00	0.0000	0.0000	0.0000	0.0000	9.78E-06	9.78E-06
165:30:00	0.0000	0.0000	0.0000	0.0000	9.62E-06	9.62E-06
166:00:00	0.0000	0.0000	0.0000	0.0000	9.45E-06	9.45E-06
166:30:00	0.0000	0.0000	0.0000	0.0000	9.3E-06	9.3E-06
167:00:00	0.0000	0.0000	0.0000	0.0000	9.14E-06	9.14E-06
167:30:00	0.0000	0.0000	0.0000	0.0000	8.99E-06	8.99E-06
168:00:00	0.0000	0.0000	0.0000	0.0000	8.84E-06	8.84E-06
168:30:00	0.0000	0.0000	0.0000	0.0000	8.69E-06	8.69E-06
169:00:00	0.0000	0.0000	0.0000	0.0000	8.55E-06	8.55E-06
169:30:00	0.0000	0.0000	0.0000	0.0000	8.4E-06	8.4E-06
170:00:00	0.0000	0.0000	0.0000	0.0000	8.26E-06	8.26E-06
170:30:00	0.0000	0.0000	0.0000	0.0000	8.12E-06	8.12E-06
171:00:00	0.0000	0.0000	0.0000	0.0000	7.99E-06	7.99E-06
171:30:00	0.0000	0.0000	0.0000	0.0000	7.86E-06	7.86E-06
172:00:00	0.0000	0.0000	0.0000	0.0000	7.72E-06	7.72E-06
172:30:00	0.0000	0.0000	0.0000	0.0000	7.59E-06	7.59E-06
173:00:00	0.0000	0.0000	0.0000	0.0000	7.47E-06	7.47E-06
173:30:00	0.0000	0.0000	0.0000	0.0000	7.34E-06	7.34E-06
174:00:00	0.0000	0.0000	0.0000	0.0000	7.22E-06	7.22E-06

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
174:30:00	0.0000	0.0000	0.0000	0.0000	7.1E-06	7.1E-06
175:00:00	0.0000	0.0000	0.0000	0.0000	6.98E-06	6.98E-06
175:30:00	0.0000	0.0000	0.0000	0.0000	6.86E-06	6.86E-06
176:00:00	0.0000	0.0000	0.0000	0.0000	6.75E-06	6.75E-06
176:30:00	0.0000	0.0000	0.0000	0.0000	6.64E-06	6.64E-06
177:00:00	0.0000	0.0000	0.0000	0.0000	6.53E-06	6.53E-06
177:30:00	0.0000	0.0000	0.0000	0.0000	6.42E-06	6.42E-06
178:00:00	0.0000	0.0000	0.0000	0.0000	6.31E-06	6.31E-06
178:30:00	0.0000	0.0000	0.0000	0.0000	6.2E-06	6.2E-06
179:00:00	0.0000	0.0000	0.0000	0.0000	6.1E-06	6.1E-06
179:30:00	0.0000	0.0000	0.0000	0.0000	6E-06	6E-06
180:00:00	0.0000	0.0000	0.0000	0.0000	5.9E-06	5.9E-06
180:30:00	0.0000	0.0000	0.0000	0.0000	5.8E-06	5.8E-06
181:00:00	0.0000	0.0000	0.0000	0.0000	5.7E-06	5.7E-06
181:30:00	0.0000	0.0000	0.0000	0.0000	5.61E-06	5.61E-06
182:00:00	0.0000	0.0000	0.0000	0.0000	5.51E-06	5.51E-06
182:30:00	0.0000	0.0000	0.0000	0.0000	5.42E-06	5.42E-06
183:00:00	0.0000	0.0000	0.0000	0.0000	5.33E-06	5.33E-06
183:30:00	0.0000	0.0000	0.0000	0.0000	5.24E-06	5.24E-06
184:00:00	0.0000	0.0000	0.0000	0.0000	5.15E-06	5.15E-06
184:30:00	0.0000	0.0000	0.0000	0.0000	5.07E-06	5.07E-06
185:00:00	0.0000	0.0000	0.0000	0.0000	4.98E-06	4.98E-06
185:30:00	0.0000	0.0000	0.0000	0.0000	4.9E-06	4.9E-06
186:00:00	0.0000	0.0000	0.0000	0.0000	4.82E-06	4.82E-06
186:30:00	0.0000	0.0000	0.0000	0.0000	4.74E-06	4.74E-06
187:00:00	0.0000	0.0000	0.0000	0.0000	4.66E-06	4.66E-06
187:30:00	0.0000	0.0000	0.0000	0.0000	4.58E-06	4.58E-06
188:00:00	0.0000	0.0000	0.0000	0.0000	4.5E-06	4.5E-06
188:30:00	0.0000	0.0000	0.0000	0.0000	4.43E-06	4.43E-06
189:00:00	0.0000	0.0000	0.0000	0.0000	4.36E-06	4.36E-06
189:30:00	0.0000	0.0000	0.0000	0.0000	4.28E-06	4.28E-06
190:00:00	0.0000	0.0000	0.0000	0.0000	4.21E-06	4.21E-06
190:30:00	0.0000	0.0000	0.0000	0.0000	4.14E-06	4.14E-06
191:00:00	0.0000	0.0000	0.0000	0.0000	4.07E-06	4.07E-06
191:30:00	0.0000	0.0000	0.0000	0.0000	4E-06	4E-06

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
192:00:00	0.0000	0.0000	0.0000	0.0000	3.94E-06	3.94E-06
192:30:00	0.0000	0.0000	0.0000	0.0000	3.87E-06	3.87E-06
193:00:00	0.0000	0.0000	0.0000	0.0000	3.81E-06	3.81E-06
193:30:00	0.0000	0.0000	0.0000	0.0000	3.74E-06	3.74E-06
194:00:00	0.0000	0.0000	0.0000	0.0000	3.68E-06	3.68E-06
194:30:00	0.0000	0.0000	0.0000	0.0000	3.62E-06	3.62E-06
195:00:00	0.0000	0.0000	0.0000	0.0000	3.56E-06	3.56E-06
195:30:00	0.0000	0.0000	0.0000	0.0000	3.5E-06	3.5E-06
196:00:00	0.0000	0.0000	0.0000	0.0000	3.44E-06	3.44E-06
196:30:00	0.0000	0.0000	0.0000	0.0000	3.38E-06	3.38E-06
197:00:00	0.0000	0.0000	0.0000	0.0000	3.33E-06	3.33E-06
197:30:00	0.0000	0.0000	0.0000	0.0000	3.27E-06	3.27E-06
198:00:00	0.0000	0.0000	0.0000	0.0000	3.22E-06	3.22E-06
198:30:00	0.0000	0.0000	0.0000	0.0000	3.16E-06	3.16E-06
199:00:00	0.0000	0.0000	0.0000	0.0000	3.11E-06	3.11E-06
199:30:00	0.0000	0.0000	0.0000	0.0000	3.06E-06	3.06E-06
200:00:00	0.0000	0.0000	0.0000	0.0000	3.01E-06	3.01E-06
200:30:00	0.0000	0.0000	0.0000	0.0000	2.96E-06	2.96E-06
201:00:00	0.0000	0.0000	0.0000	0.0000	2.91E-06	2.91E-06
201:30:00	0.0000	0.0000	0.0000	0.0000	2.86E-06	2.86E-06
202:00:00	0.0000	0.0000	0.0000	0.0000	2.81E-06	2.81E-06
202:30:00	0.0000	0.0000	0.0000	0.0000	2.76E-06	2.76E-06
203:00:00	0.0000	0.0000	0.0000	0.0000	2.72E-06	2.72E-06
203:30:00	0.0000	0.0000	0.0000	0.0000	2.67E-06	2.67E-06
204:00:00	0.0000	0.0000	0.0000	0.0000	2.63E-06	2.63E-06
204:30:00	0.0000	0.0000	0.0000	0.0000	2.58E-06	2.58E-06
205:00:00	0.0000	0.0000	0.0000	0.0000	2.54E-06	2.54E-06
205:30:00	0.0000	0.0000	0.0000	0.0000	2.5E-06	2.5E-06
206:00:00	0.0000	0.0000	0.0000	0.0000	2.46E-06	2.46E-06
206:30:00	0.0000	0.0000	0.0000	0.0000	2.42E-06	2.42E-06
207:00:00	0.0000	0.0000	0.0000	0.0000	2.37E-06	2.37E-06
207:30:00	0.0000	0.0000	0.0000	0.0000	2.33E-06	2.33E-06
208:00:00	0.0000	0.0000	0.0000	0.0000	2.3E-06	2.3E-06
208:30:00	0.0000	0.0000	0.0000	0.0000	2.26E-06	2.26E-06
209:00:00	0.0000	0.0000	0.0000	0.0000	2.22E-06	2.22E-06

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
209:30:00	0.0000	0.0000	0.0000	0.0000	2.18E-06	2.18E-06
210:00:00	0.0000	0.0000	0.0000	0.0000	2.15E-06	2.15E-06
210:30:00	0.0000	0.0000	0.0000	0.0000	2.11E-06	2.11E-06
211:00:00	0.0000	0.0000	0.0000	0.0000	2.08E-06	2.08E-06
211:30:00	0.0000	0.0000	0.0000	0.0000	2.04E-06	2.04E-06
212:00:00	0.0000	0.0000	0.0000	0.0000	2.01E-06	2.01E-06
212:30:00	0.0000	0.0000	0.0000	0.0000	1.97E-06	1.97E-06
213:00:00	0.0000	0.0000	0.0000	0.0000	1.94E-06	1.94E-06
213:30:00	0.0000	0.0000	0.0000	0.0000	1.91E-06	1.91E-06
214:00:00	0.0000	0.0000	0.0000	0.0000	1.88E-06	1.88E-06
214:30:00	0.0000	0.0000	0.0000	0.0000	1.84E-06	1.84E-06
215:00:00	0.0000	0.0000	0.0000	0.0000	1.81E-06	1.81E-06
215:30:00	0.0000	0.0000	0.0000	0.0000	1.78E-06	1.78E-06
216:00:00	0.0000	0.0000	0.0000	0.0000	1.75E-06	1.75E-06
216:30:00	0.0000	0.0000	0.0000	0.0000	1.72E-06	1.72E-06
217:00:00	0.0000	0.0000	0.0000	0.0000	1.7E-06	1.7E-06
217:30:00	0.0000	0.0000	0.0000	0.0000	1.67E-06	1.67E-06
218:00:00	0.0000	0.0000	0.0000	0.0000	1.64E-06	1.64E-06
218:30:00	0.0000	0.0000	0.0000	0.0000	1.61E-06	1.61E-06
219:00:00	0.0000	0.0000	0.0000	0.0000	1.58E-06	1.58E-06
219:30:00	0.0000	0.0000	0.0000	0.0000	1.56E-06	1.56E-06
220:00:00	0.0000	0.0000	0.0000	0.0000	1.53E-06	1.53E-06
220:30:00	0.0000	0.0000	0.0000	0.0000	1.51E-06	1.51E-06
221:00:00	0.0000	0.0000	0.0000	0.0000	1.48E-06	1.48E-06
221:30:00	0.0000	0.0000	0.0000	0.0000	1.46E-06	1.46E-06
222:00:00	0.0000	0.0000	0.0000	0.0000	1.43E-06	1.43E-06
222:30:00	0.0000	0.0000	0.0000	0.0000	1.41E-06	1.41E-06
223:00:00	0.0000	0.0000	0.0000	0.0000	1.38E-06	1.38E-06
223:30:00	0.0000	0.0000	0.0000	0.0000	1.36E-06	1.36E-06
224:00:00	0.0000	0.0000	0.0000	0.0000	1.34E-06	1.34E-06
224:30:00	0.0000	0.0000	0.0000	0.0000	1.32E-06	1.32E-06
225:00:00	0.0000	0.0000	0.0000	0.0000	1.29E-06	1.29E-06
225:30:00	0.0000	0.0000	0.0000	0.0000	1.27E-06	1.27E-06
226:00:00	0.0000	0.0000	0.0000	0.0000	1.25E-06	1.25E-06
226:30:00	0.0000	0.0000	0.0000	0.0000	1.23E-06	1.23E-06

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
227:00:00	0.0000	0.0000	0.0000	0.0000	1.21E-06	1.21E-06
227:30:00	0.0000	0.0000	0.0000	0.0000	1.19E-06	1.19E-06
228:00:00	0.0000	0.0000	0.0000	0.0000	1.17E-06	1.17E-06
228:30:00	0.0000	0.0000	0.0000	0.0000	1.15E-06	1.15E-06
229:00:00	0.0000	0.0000	0.0000	0.0000	1.13E-06	1.13E-06
229:30:00	0.0000	0.0000	0.0000	0.0000	1.11E-06	1.11E-06
230:00:00	0.0000	0.0000	0.0000	0.0000	1.09E-06	1.09E-06
230:30:00	0.0000	0.0000	0.0000	0.0000	1.08E-06	1.08E-06
231:00:00	0.0000	0.0000	0.0000	0.0000	1.06E-06	1.06E-06
231:30:00	0.0000	0.0000	0.0000	0.0000	1.04E-06	1.04E-06
232:00:00	0.0000	0.0000	0.0000	0.0000	1.02E-06	1.02E-06
232:30:00	0.0000	0.0000	0.0000	0.0000	1.01E-06	1.01E-06
233:00:00	0.0000	0.0000	0.0000	0.0000	9.89E-07	9.89E-07
233:30:00	0.0000	0.0000	0.0000	0.0000	9.72E-07	9.72E-07
234:00:00	0.0000	0.0000	0.0000	0.0000	9.56E-07	9.56E-07
234:30:00	0.0000	0.0000	0.0000	0.0000	9.4E-07	9.4E-07
235:00:00	0.0000	0.0000	0.0000	0.0000	9.24E-07	9.24E-07
235:30:00	0.0000	0.0000	0.0000	0.0000	9.09E-07	9.09E-07
236:00:00	0.0000	0.0000	0.0000	0.0000	8.94E-07	8.94E-07
236:30:00	0.0000	0.0000	0.0000	0.0000	8.79E-07	8.79E-07
237:00:00	0.0000	0.0000	0.0000	0.0000	8.64E-07	8.64E-07
237:30:00	0.0000	0.0000	0.0000	0.0000	8.5E-07	8.5E-07
238:00:00	0.0000	0.0000	0.0000	0.0000	8.35E-07	8.35E-07
238:30:00	0.0000	0.0000	0.0000	0.0000	8.21E-07	8.21E-07
239:00:00	0.0000	0.0000	0.0000	0.0000	8.08E-07	8.08E-07
239:30:00	0.0000	0.0000	0.0000	0.0000	7.94E-07	7.94E-07
240:00:00	0.0000	0.0000	0.0000	0.0000	7.81E-07	7.81E-07
240:30:00	0.0000	0.0000	0.0000	0.0000	7.68E-07	7.68E-07
241:00:00	0.0000	0.0000	0.0000	0.0000	7.55E-07	7.55E-07
241:30:00	0.0000	0.0000	0.0000	0.0000	7.42E-07	7.42E-07
242:00:00	0.0000	0.0000	0.0000	0.0000	7.3E-07	7.3E-07
242:30:00	0.0000	0.0000	0.0000	0.0000	7.18E-07	7.18E-07
243:00:00	0.0000	0.0000	0.0000	0.0000	7.06E-07	7.06E-07
243:30:00	0.0000	0.0000	0.0000	0.0000	6.94E-07	6.94E-07
244:00:00	0.0000	0.0000	0.0000	0.0000	6.82E-07	6.82E-07

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
244:30:00	0.0000	0.0000	0.0000	0.0000	6.71E-07	6.71E-07
245:00:00	0.0000	0.0000	0.0000	0.0000	6.6E-07	6.6E-07
245:30:00	0.0000	0.0000	0.0000	0.0000	6.49E-07	6.49E-07
246:00:00	0.0000	0.0000	0.0000	0.0000	6.38E-07	6.38E-07
246:30:00	0.0000	0.0000	0.0000	0.0000	6.27E-07	6.27E-07
247:00:00	0.0000	0.0000	0.0000	0.0000	6.17E-07	6.17E-07
247:30:00	0.0000	0.0000	0.0000	0.0000	6.07E-07	6.07E-07
248:00:00	0.0000	0.0000	0.0000	0.0000	5.96E-07	5.96E-07
248:30:00	0.0000	0.0000	0.0000	0.0000	5.86E-07	5.86E-07
249:00:00	0.0000	0.0000	0.0000	0.0000	5.77E-07	5.77E-07
249:30:00	0.0000	0.0000	0.0000	0.0000	5.67E-07	5.67E-07
250:00:00	0.0000	0.0000	0.0000	0.0000	5.58E-07	5.58E-07
250:30:00	0.0000	0.0000	0.0000	0.0000	5.48E-07	5.48E-07
251:00:00	0.0000	0.0000	0.0000	0.0000	5.39E-07	5.39E-07
251:30:00	0.0000	0.0000	0.0000	0.0000	5.3E-07	5.3E-07
252:00:00	0.0000	0.0000	0.0000	0.0000	5.21E-07	5.21E-07
252:30:00	0.0000	0.0000	0.0000	0.0000	5.12E-07	5.12E-07
253:00:00	0.0000	0.0000	0.0000	0.0000	5.04E-07	5.04E-07
253:30:00	0.0000	0.0000	0.0000	0.0000	4.96E-07	4.96E-07
254:00:00	0.0000	0.0000	0.0000	0.0000	4.87E-07	4.87E-07
254:30:00	0.0000	0.0000	0.0000	0.0000	4.79E-07	4.79E-07
255:00:00	0.0000	0.0000	0.0000	0.0000	4.71E-07	4.71E-07
255:30:00	0.0000	0.0000	0.0000	0.0000	4.63E-07	4.63E-07
256:00:00	0.0000	0.0000	0.0000	0.0000	4.55E-07	4.55E-07
256:30:00	0.0000	0.0000	0.0000	0.0000	4.48E-07	4.48E-07
257:00:00	0.0000	0.0000	0.0000	0.0000	4.4E-07	4.4E-07
257:30:00	0.0000	0.0000	0.0000	0.0000	4.33E-07	4.33E-07
258:00:00	0.0000	0.0000	0.0000	0.0000	4.26E-07	4.26E-07
258:30:00	0.0000	0.0000	0.0000	0.0000	4.19E-07	4.19E-07
259:00:00	0.0000	0.0000	0.0000	0.0000	4.12E-07	4.12E-07
259:30:00	0.0000	0.0000	0.0000	0.0000	4.05E-07	4.05E-07
260:00:00	0.0000	0.0000	0.0000	0.0000	3.98E-07	3.98E-07
260:30:00	0.0000	0.0000	0.0000	0.0000	3.91E-07	3.91E-07
261:00:00	0.0000	0.0000	0.0000	0.0000	3.85E-07	3.85E-07
261:30:00	0.0000	0.0000	0.0000	0.0000	3.78E-07	3.78E-07

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
262:00:00	0.0000	0.0000	0.0000	0.0000	3.72E-07	3.72E-07
262:30:00	0.0000	0.0000	0.0000	0.0000	3.66E-07	3.66E-07
263:00:00	0.0000	0.0000	0.0000	0.0000	3.6E-07	3.6E-07
263:30:00	0.0000	0.0000	0.0000	0.0000	3.54E-07	3.54E-07
264:00:00	0.0000	0.0000	0.0000	0.0000	3.48E-07	3.48E-07
264:30:00	0.0000	0.0000	0.0000	0.0000	3.42E-07	3.42E-07
265:00:00	0.0000	0.0000	0.0000	0.0000	3.36E-07	3.36E-07
265:30:00	0.0000	0.0000	0.0000	0.0000	3.31E-07	3.31E-07
266:00:00	0.0000	0.0000	0.0000	0.0000	3.25E-07	3.25E-07
266:30:00	0.0000	0.0000	0.0000	0.0000	3.2E-07	3.2E-07
267:00:00	0.0000	0.0000	0.0000	0.0000	3.14E-07	3.14E-07
267:30:00	0.0000	0.0000	0.0000	0.0000	3.09E-07	3.09E-07
268:00:00	0.0000	0.0000	0.0000	0.0000	3.04E-07	3.04E-07
268:30:00	0.0000	0.0000	0.0000	0.0000	2.99E-07	2.99E-07
269:00:00	0.0000	0.0000	0.0000	0.0000	2.94E-07	2.94E-07
269:30:00	0.0000	0.0000	0.0000	0.0000	2.89E-07	2.89E-07
270:00:00	0.0000	0.0000	0.0000	0.0000	2.84E-07	2.84E-07
270:30:00	0.0000	0.0000	0.0000	0.0000	2.79E-07	2.79E-07
271:00:00	0.0000	0.0000	0.0000	0.0000	2.75E-07	2.75E-07
271:30:00	0.0000	0.0000	0.0000	0.0000	2.7E-07	2.7E-07
272:00:00	0.0000	0.0000	0.0000	0.0000	2.66E-07	2.66E-07
272:30:00	0.0000	0.0000	0.0000	0.0000	2.61E-07	2.61E-07
273:00:00	0.0000	0.0000	0.0000	0.0000	2.57E-07	2.57E-07
273:30:00	0.0000	0.0000	0.0000	0.0000	2.53E-07	2.53E-07
274:00:00	0.0000	0.0000	0.0000	0.0000	2.48E-07	2.48E-07
274:30:00	0.0000	0.0000	0.0000	0.0000	2.44E-07	2.44E-07
275:00:00	0.0000	0.0000	0.0000	0.0000	2.4E-07	2.4E-07
275:30:00	0.0000	0.0000	0.0000	0.0000	2.36E-07	2.36E-07
276:00:00	0.0000	0.0000	0.0000	0.0000	2.32E-07	2.32E-07
276:30:00	0.0000	0.0000	0.0000	0.0000	2.28E-07	2.28E-07
277:00:00	0.0000	0.0000	0.0000	0.0000	2.24E-07	2.24E-07
277:30:00	0.0000	0.0000	0.0000	0.0000	2.21E-07	2.21E-07
278:00:00	0.0000	0.0000	0.0000	0.0000	2.17E-07	2.17E-07
278:30:00	0.0000	0.0000	0.0000	0.0000	2.13E-07	2.13E-07
279:00:00	0.0000	0.0000	0.0000	0.0000	2.1E-07	2.1E-07

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
279:30:00	0.0000	0.0000	0.0000	0.0000	2.06E-07	2.06E-07
280:00:00	0.0000	0.0000	0.0000	0.0000	2.03E-07	2.03E-07
280:30:00	0.0000	0.0000	0.0000	0.0000	1.99E-07	1.99E-07
281:00:00	0.0000	0.0000	0.0000	0.0000	1.96E-07	1.96E-07
281:30:00	0.0000	0.0000	0.0000	0.0000	1.93E-07	1.93E-07
282:00:00	0.0000	0.0000	0.0000	0.0000	1.9E-07	1.9E-07
282:30:00	0.0000	0.0000	0.0000	0.0000	1.86E-07	1.86E-07
283:00:00	0.0000	0.0000	0.0000	0.0000	1.83E-07	1.83E-07
283:30:00	0.0000	0.0000	0.0000	0.0000	1.8E-07	1.8E-07
284:00:00	0.0000	0.0000	0.0000	0.0000	1.77E-07	1.77E-07
284:30:00	0.0000	0.0000	0.0000	0.0000	1.74E-07	1.74E-07
285:00:00	0.0000	0.0000	0.0000	0.0000	1.71E-07	1.71E-07
285:30:00	0.0000	0.0000	0.0000	0.0000	1.69E-07	1.69E-07
286:00:00	0.0000	0.0000	0.0000	0.0000	1.66E-07	1.66E-07
286:30:00	0.0000	0.0000	0.0000	0.0000	1.63E-07	1.63E-07
287:00:00	0.0000	0.0000	0.0000	0.0000	1.6E-07	1.6E-07
287:30:00	0.0000	0.0000	0.0000	0.0000	1.58E-07	1.58E-07
288:00:00	0.0000	0.0000	0.0000	0.0000	1.55E-07	1.55E-07
288:30:00	0.0000	0.0000	0.0000	0.0000	1.52E-07	1.52E-07
289:00:00	0.0000	0.0000	0.0000	0.0000	1.5E-07	1.5E-07
289:30:00	0.0000	0.0000	0.0000	0.0000	1.47E-07	1.47E-07
290:00:00	0.0000	0.0000	0.0000	0.0000	1.45E-07	1.45E-07
290:30:00	0.0000	0.0000	0.0000	0.0000	1.42E-07	1.42E-07
291:00:00	0.0000	0.0000	0.0000	0.0000	1.4E-07	1.4E-07
291:30:00	0.0000	0.0000	0.0000	0.0000	1.38E-07	1.38E-07
292:00:00	0.0000	0.0000	0.0000	0.0000	1.35E-07	1.35E-07
292:30:00	0.0000	0.0000	0.0000	0.0000	1.33E-07	1.33E-07
293:00:00	0.0000	0.0000	0.0000	0.0000	1.31E-07	1.31E-07
293:30:00	0.0000	0.0000	0.0000	0.0000	1.29E-07	1.29E-07
294:00:00	0.0000	0.0000	0.0000	0.0000	1.27E-07	1.27E-07
294:30:00	0.0000	0.0000	0.0000	0.0000	1.24E-07	1.24E-07
295:00:00	0.0000	0.0000	0.0000	0.0000	1.22E-07	1.22E-07
295:30:00	0.0000	0.0000	0.0000	0.0000	1.2E-07	1.2E-07
296:00:00	0.0000	0.0000	0.0000	0.0000	1.18E-07	1.18E-07
296:30:00	0.0000	0.0000	0.0000	0.0000	1.16E-07	1.16E-07

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
297:00:00	0.0000	0.0000	0.0000	0.0000	1.14E-07	1.14E-07
297:30:00	0.0000	0.0000	0.0000	0.0000	1.12E-07	1.12E-07
298:00:00	0.0000	0.0000	0.0000	0.0000	1.11E-07	1.11E-07
298:30:00	0.0000	0.0000	0.0000	0.0000	1.09E-07	1.09E-07
299:00:00	0.0000	0.0000	0.0000	0.0000	1.07E-07	1.07E-07
299:30:00	0.0000	0.0000	0.0000	0.0000	1.05E-07	1.05E-07
300:00:00	0.0000	0.0000	0.0000	0.0000	1.03E-07	1.03E-07
300:30:00	0.0000	0.0000	0.0000	0.0000	1.02E-07	1.02E-07
301:00:00	0.0000	0.0000	0.0000	0.0000	1E-07	1E-07
301:30:00	0.0000	0.0000	0.0000	0.0000	9.83E-08	9.83E-08
302:00:00	0.0000	0.0000	0.0000	0.0000	9.67E-08	9.67E-08
302:30:00	0.0000	0.0000	0.0000	0.0000	9.5E-08	9.5E-08
303:00:00	0.0000	0.0000	0.0000	0.0000	9.35E-08	9.35E-08
303:30:00	0.0000	0.0000	0.0000	0.0000	9.19E-08	9.19E-08
304:00:00	0.0000	0.0000	0.0000	0.0000	9.04E-08	9.04E-08
304:30:00	0.0000	0.0000	0.0000	0.0000	8.88E-08	8.88E-08
305:00:00	0.0000	0.0000	0.0000	0.0000	8.74E-08	8.74E-08
305:30:00	0.0000	0.0000	0.0000	0.0000	8.59E-08	8.59E-08
306:00:00	0.0000	0.0000	0.0000	0.0000	8.45E-08	8.45E-08

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.8	No
BFIHOST19	0.83	No
PROPWET	0.45	No
SAAR (mm)	735	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

Appendix E Causeway Flow Results

West Springfield Solar

Flood Risk Assessment & Drainage Impact Assessment

TRIO West Springfield Solar LLP

SLR Project No.: 428.013383.00001

30 April 2025

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	30	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	5.00	47.500		60.927	53.421	1.000
2		47.000	1200	63.682	53.384	0.750

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
Swale	1	2	200.000	0.600	46.500	46.250	0.250	800.0	1000	7.84	50.0

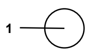
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
Swale	1.172	1031.3	19.2	0.600	0.350	0.142	0.0	46	0.369

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
Swale	200.000	800.0	1000	Swale	47.500	46.500	0.600	47.000	46.250	0.350

Link	US Node	Node Type	DS Node	Dia (mm)	Node Type	MH Type
Swale	1	Junction	2	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
1	60.927	53.421	47.500	1.000		0	Swale	46.500	1000
2	63.682	53.384	47.000	0.750	1200	1 	Swale	46.250	1000

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	30 year (l/s)	0.1
Rainfall Events	Singular	Drain Down Time (mins)	240	Check Discharge Volume	✓
Summer CV	0.750	Additional Storage (m³/ha)	20.0	200 year 360 minute (m³)	6
Winter CV	0.840	Starting Level (m)			
Analysis Speed	Normal	Check Discharge Rate(s)	✓		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
10	0	0	0
30	0	0	0
30	39	0	0
200	0	0	0
200	39	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Betterment (%)	0
Greenfield Method	ReFH2	Q 1 year (l/s)	
Region	Scotland	Q 30 year (l/s)	
Include Baseflow	x	Q 100 year (l/s)	
Positively Drained Area (ha)	0.142		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	200
Greenfield Method	ReFH2	Storm Duration (mins)	360
Region	Scotland	Betterment (%)	0
Include Baseflow	x	Runoff Volume (m³)	6
Positively Drained Area (ha)	0.142		

Node 2 Offline Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Loop to Node		Sump Available	✓
Invert Level (m)	46.250	Product Number	CTL-SHE-0055-1000-0400-1000
Design Depth (m)	0.400	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	1.0	Min Node Diameter (mm)	1200

Results for 2 year Critical Storm Duration. Lowest mass balance: 92.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	13	46.512	0.012	1.2	0.0000	0.0000	OK
15 minute winter	Swale:10%	13	46.511	0.036	14.2	0.0000	0.0000	OK
480 minute winter	2	352	46.383	0.133	2.7	0.1502	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	Swale	Swale:10%	-1.2	-0.063	-0.001	0.5224	
15 minute winter	1	Swale	2	9.4	0.301	0.009	6.1995	
480 minute winter	2	Hydro-Brake®		1.0				28.9

Results for 10 year Critical Storm Duration. Lowest mass balance: 92.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	13	46.530	0.030	2.8	0.0000	0.0000	OK
15 minute winter	Swale:10%	12	46.528	0.053	26.9	0.0000	0.0000	OK
480 minute winter	2	384	46.464	0.214	4.2	0.2422	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	Swale	Swale:10%	-2.8	-0.092	-0.003	0.9328	
15 minute winter	1	Swale	2	22.0	0.405	0.021	11.9680	
480 minute winter	2	Hydro-Brake®		1.0				34.3

Results for 30 year Critical Storm Duration. Lowest mass balance: 92.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	12	46.540	0.040	3.6	0.0000	0.0000	OK
15 minute winter	Swale:10%	12	46.538	0.063	35.2	0.0000	0.0000	OK
600 minute winter	2	480	46.508	0.258	4.6	0.2917	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	Swale	Swale:10%	-3.6	-0.106	-0.004	1.1893	
15 minute winter	1	Swale	2	29.8	0.447	0.029	15.9675	
600 minute winter	2	Hydro-Brake®		1.0				39.0

Results for 30 year +39% CC Critical Storm Duration. Lowest mass balance: 92.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	1	660	46.568	0.068	0.2	0.0000	0.0000	OK
720 minute winter	Swale:10%	660	46.568	0.093	5.6	0.0000	0.0000	OK
720 minute winter	2	690	46.567	0.317	5.6	0.3590	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
720 minute winter	1	Swale	Swale:10%	-0.2	-0.008	0.000	1.9969	
720 minute winter	1	Swale	2	5.6	0.107	0.005	66.3761	
720 minute winter	2	Hydro-Brake®		1.0				45.2

Results for 200 year Critical Storm Duration. Lowest mass balance: 92.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	1	690	46.584	0.084	0.3	0.0000	0.0000	OK
720 minute winter	Swale:10%	690	46.584	0.109	6.1	0.0000	0.0000	OK
720 minute winter	2	690	46.584	0.334	6.0	0.3772	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
720 minute winter	1	Swale	Swale:10%	-0.3	-0.008	0.000	2.5026	
720 minute winter	1	Swale	2	6.0	0.110	0.006	73.0974	
720 minute winter	2	Hydro-Brake®		1.0				46.2

Results for 200 year +39% CC Critical Storm Duration. Lowest mass balance: 92.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	1	915	46.659	0.159	0.4	0.0000	0.0000	OK
960 minute winter	Swale:10%	915	46.659	0.184	6.9	0.0000	0.0000	OK
720 minute winter	2	705	46.659	0.409	6.9	0.4626	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute winter	1	Swale	Swale:10%	-0.4	-0.020	0.000	5.1917	
960 minute winter	1	Swale	2	5.7	0.120	0.005	107.4083	
720 minute winter	2	Hydro-Brake®		1.0				50.5

Appendix F Firewater Modelling Results

West Springfield Solar

Flood Risk Assessment & Drainage Impact Assessment

TRIO West Springfield Solar LLP

SLR Project No.: 428.013383.00001

30 April 2025

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	30	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	5.00	47.500		60.927	53.421	1.000
2		47.000	1200	63.682	53.384	0.750

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
Swale	1	2	200.000	0.600	46.500	46.250	0.250	800.0	1000	7.84	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
Swale	1.172	1031.3	19.2	0.600	0.350	0.142	0.0	46	0.369

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
Swale	200.000	800.0	1000	Swale	47.500	46.500	0.600	47.000	46.250	0.350

Link	US Node	Node Type	DS Node	Dia (mm)	Node Type	MH Type
Swale	1	Junction	2	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
1	60.927	53.421	47.500	1.000		0	Swale	46.500	1000
2	63.682	53.384	47.000	0.750	1200	1	Swale	46.250	1000

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	30 year (l/s)	0.1
Rainfall Events	Singular	Drain Down Time (mins)	240	Check Discharge Volume	✓
Summer CV	0.750	Additional Storage (m³/ha)	20.0	200 year 360 minute (m³)	6
Winter CV	0.840	Starting Level (m)			
Analysis Speed	Normal	Check Discharge Rate(s)	✓		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
10	0	0	0
30	0	0	0
30	39	0	0
200	0	0	0
200	39	0	0
1000	0	0	0
1000	50	0	0
1000	100	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Betterment (%)	0
Greenfield Method	ReFH2	Q 1 year (l/s)	
Region	Scotland	Q 30 year (l/s)	
Include Baseflow	x	Q 100 year (l/s)	
Positively Drained Area (ha)	0.142		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	200
Greenfield Method	ReFH2	Storm Duration (mins)	360
Region	Scotland	Betterment (%)	0
Include Baseflow	x	Runoff Volume (m³)	6
Positively Drained Area (ha)	0.142		

Node 2 Offline Depth/Flow Control

Flap Valve	x	Invert Level (m)	46.250	Design Flow (l/s)	1.0
Loop to Node		Design Depth (m)	0.400		

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.010	0.000	1.000	0.000

Results for 2 year Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	1	9600	46.617	0.117	0.1	0.0000	0.0000	OK
10080 minute winter	Swale:10%	9660	46.617	0.142	0.4	0.0000	0.0000	OK
10080 minute winter	2	10200	46.617	0.367	0.3	0.4153	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute winter	1	Swale	Swale:10%	-0.1	-0.001	0.000	3.6129	
10080 minute winter	1	Swale	2	0.3	0.021	0.000	87.7094	
10080 minute winter	2	Depth/Flow		0.0				0.0

Results for 10 year Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	1	9840	46.676	0.176	0.1	0.0000	0.0000	OK
10080 minute winter	Swale:10%	10140	46.676	0.201	0.5	0.0000	0.0000	OK
10080 minute winter	2	10320	46.676	0.426	0.3	0.4815	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute winter	1	Swale	Swale:10%	-0.1	-0.001	0.000	5.9005	
10080 minute winter	1	Swale	2	0.3	0.021	0.000	116.2018	
10080 minute winter	2	Depth/Flow		0.0				0.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	1	10020	46.711	0.211	0.1	0.0000	0.0000	OK
10080 minute winter	Swale:10%	10080	46.711	0.236	0.6	0.0000	0.0000	OK
10080 minute winter	2	10200	46.711	0.461	0.4	0.5218	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute winter	1	Swale	Swale:10%	-0.1	-0.001	0.000	7.4960	
10080 minute winter	1	Swale	2	0.4	0.021	0.000	135.3768	
10080 minute winter	2	Depth/Flow		0.0				0.0

Results for 30 year +39% CC Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
8640 minute winter	1	8700	46.790	0.290	0.0	0.0000	0.0000	OK
10080 minute winter	Swale:10%	10080	46.790	0.315	0.8	0.0000	0.0000	OK
10080 minute winter	2	10320	46.790	0.540	0.5	0.6103	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
8640 minute winter	1	Swale	Swale:10%	0.0	-0.002	0.000	11.5279	
8640 minute winter	1	Swale	2	0.6	0.021	0.001	182.2241	
10080 minute winter	2	Depth/Flow		0.0				0.0

Results for 200 year Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
8640 minute winter	1	8700	46.790	0.290	0.0	0.0000	0.0000	OK
8640 minute winter	Swale:10%	8580	46.790	0.315	0.9	0.0000	0.0000	OK
8640 minute winter	2	8880	46.790	0.540	0.6	0.6103	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
8640 minute winter	1	Swale	Swale:10%	0.0	-0.002	0.000	11.5279	
8640 minute winter	1	Swale	2	0.6	0.021	0.001	182.2241	
8640 minute winter	2	Depth/Flow		0.0				0.0

Results for 200 year +39% CC Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	1	10260	46.893	0.393	0.1	0.0000	0.0000	OK
10080 minute winter	Swale:10%	10260	46.893	0.418	1.1	0.0000	0.0000	SURCHARGED
10080 minute winter	2	10020	46.893	0.643	0.7	0.7277	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute winter	1	Swale	Swale:10%	-0.1	-0.001	0.000	18.0147	
10080 minute winter	1	Swale	2	0.7	0.021	0.001	254.6201	
10080 minute winter	2	Depth/Flow		0.0				0.0

Results for 1000 year Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	1	10140	46.863	0.363	0.0	0.0000	0.0000	OK
10080 minute winter	Swale:10%	10260	46.863	0.388	1.0	0.0000	0.0000	OK
10080 minute winter	2	10200	46.863	0.613	0.6	0.6934	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute winter	1	Swale	Swale:10%	0.0	-0.001	0.000	15.9852	
10080 minute winter	1	Swale	2	0.6	0.021	0.001	232.2628	
10080 minute winter	2	Depth/Flow		0.0				0.0

Results for 1000 year +50% CC Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	1	9840	47.000	0.500	0.1	0.0000	0.0000	SURCHARGED
10080 minute winter	Swale:10%	9840	47.000	0.525	1.5	0.0000	0.0000	SURCHARGED
10080 minute winter	2	9840	47.000	0.750	0.9	0.8483	1.1367	FLOOD

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute winter	1	Swale	Swale:10%	-0.1	-0.001	0.000	26.0218	
10080 minute winter	1	Swale	2	0.9	0.022	0.001	341.0824	
10080 minute winter	2	Depth/Flow		0.0				0.0

Results for 1000 year +100% CC Critical Storm Duration. Lowest mass balance: 88.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	1	6240	47.000	0.500	0.1	0.0000	0.0000	SURCHARGED
10080 minute winter	Swale:10%	6240	47.000	0.525	2.0	0.0000	0.0000	SURCHARGED
10080 minute winter	2	6240	47.000	0.750	2.0	0.8483	125.9833	FLOOD

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute winter	1	Swale	Swale:10%	-0.1	-0.001	0.000	26.0300	
10080 minute winter	1	Swale	2	2.0	0.030	0.002	341.1197	
10080 minute winter	2	Depth/Flow		0.0				0.0

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