FENWICK SOLAR FARM

Fenwick Solar Farm
EN010152

Environmental Statement

Volume III Appendix 9-4: Framework Drainage Strategy

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1. Introduction and Background

1.1 Scheme Description

1.1.1 This Framework Drainage Strategy has been prepared for Fenwick Solar Farm ('the Scheme') as part of the Environmental Statement (ES) submitted with the Development Consent Order Application.

1.1.2 The Scheme is located approximately 6 km north of City of Doncaster, South Yorkshire, UK, and falls within City of Doncaster Council's administrative area.

1.1.3 The Scheme comprises the construction, operation and maintenance, and decommissioning of a solar photovoltaic (PV) electricity generating facility with a total capacity exceeding 50 megawatts (MW) together with energy storage (referred to as the Battery Energy Storage System (BESS)) and an export connection to the National Grid via National Grid's Thorpe Marsh Substation. The Order limits, shown on **ES Volume II Figure 1-2: Site Boundary Plan [EN010152/APP/6.2]**, identify the maximum extent of land anticipated to be acquired or used for the construction, operation and maintenance, and decommissioning phases of the Scheme. Further information on the Scheme is included within **ES Volume I Chapter 2: The Scheme [EN010152/APP/6.1]**.

1.1.4 The Order limits comprise:

a. The 'Solar PV Site' – the total area covered by the ground-mounted Solar PV Panels, planting and mitigation areas, Field Stations, Battery Energy Storage System (BESS) Area, On-Site Substation, and associated infrastructure;

b. The 'Grid Connection Corridor'– the area outside the Solar PV Site in which the 400 kilovolt (kV) and associated cables (the Grid Connection Cables) would be installed between the On-Site Substation to the Existing National Grid Thorpe Marsh Substation (approximately 6 km south of the Solar PV Site); and

c. The 'Existing National Grid Thorpe Marsh Substation' – the Existing Thorpe Marsh substation (owned and operated by National Grid) where the 400 kV Grid Connection Cables would connect to the National Electricity Transmission System (NETS).

1.1.5 The Order limits also include a section of highway at the junction of the A19 and Station Road in the town of Askern to allow for abnormal indivisible load (AIL) vehicle access and escort. This area is approximately 1 ha and is centred on the approximate National Grid Reference SE 56598 13647. At this location, the works will be limited to temporary traffic signal and banksman control for the period of AIL delivery whilst it is escorted to site. There are no changes to the hardstanding in this area and therefore it is not considered further within this drainage strategy.

1.1.6 The Site is the collective term for all land within the Order limits comprising the Solar PV Site, Grid Connection Corridor, and Existing National Grid Thorpe Marsh Substation.

1.1.7 This Framework Drainage Strategy solely relates to the drainage design of the Solar PV Site and relates to handling surface water generated by new impermeable areas within this part of the Order limits, i.e. the BESS Area and On-Site Substation. Therefore, these are the only areas that require a drainage strategy, as the remainder of the Order limits is greenfield, as discussed in Section 3.1.1. The strategy only considers the drainage of the Solar PV Site during Scheme operation.

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

1.1.9 The Solar PV Site covers an area of approximately 407 hectares (ha) comprised predominantly of agricultural fields. The topography of the area is relatively flat, with existing ground levels under 10 metres (m) Above Ordnance Datum (AOD) according to online Ordnance Survey (OS) mapping. There are flood plains associated with the River Went at the northern extent of the Solar PV Site. In addition, there are numerous other Ordinary Watercourses within the Order limits that fall under the jurisdiction of the Lead Local Flood Authority, City of Doncaster Council, or Danvm Internal Drainage Board.

1.1.10 There are no Sites of Specific Scientific Interest (SSSI), Special Areas of Conservation (SAC), or Special Protected Areas (SPA) located within the Solar PV Site (taken from DEFRA's MAGIC Map system). The nearest SSSIs to the Order limits are Forlom Hope Meadow, Shirley Pool, and Went Ings Meadows which are within approximately 6.0 kilometres (km), 4.4 km, and 5.5 km respectively from the Solar PV Site.

1.1.11 A **Framework Construction Environment Management Plan (CEMP) [EN010152/APP/7.7]** incorporates measures aimed at preventing flood risk during the construction works.

1.1.12 In preparation of this Framework Drainage Strategy, the following stakeholders were consulted and the outcomes incorporated where applicable:

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

b. The Environment Agency; and

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

1.2 Flood Risk

1.2.1 The potential flood risk to the Scheme is summarised in Table 1. For further detail on the Scheme's potential flood risk, refer to the Flood Risk Assessment provided at **ES Volume III Appendix 9-3: Flood Risk Assessment [EN010152/APP/6.3]**.

Table 1: Flood Risk Summary for Solar PV Site

Flood Risk Source	Baseline Flood Risk Level	Post-Mitigation Flood Risk Level	Comments
Fluvial	Low	Low	Discharge from impermeable areas detailed in the Framework Drainage Strategy are to be restricted to Greenfield rates, mitigating increases to peak river flow rates. The Environment Agency's Flood Map for Planning (Ref. 1) shows the majority of the south and west areas are within Flood Zone 1, including the BESS Area and On-Site Substation.
Tidal	Low	Low	The closest tidal source to the Solar PV Site is the River Don (3.6 km south) and the Humber Estuary (14 km northeast). Due to the distance from the tidal sources, the flood risk to the Solar PV Site from tidal flooding is considered to be low.
Tidal/Fluvial Residual Risk	High	Low	Due to the presence of flood defences along sections of the River Went and River Don, there is a residual risk of flooding to the Solar PV Site if there was overtopping or a breach of the flood defences. Overall, the likelihood of a breach occurring is low as the flood defences in the area are maintained by the Environment Agency. However, based on the hydraulic modelling results, the fluvial/tidal residual risk in the event of a breach and the consequences of this risk are considered to be high. **Framework CEMP [EN010152/APP/7.7]** and **Framework Operational Environmental Management Plan (OEMP) [EN010152/APP/7.9]** include flood risk mitigation measures. The On-Site Substation and BESS Area will be bunded to provide additional protection from this risk.

Flood Risk Source	Baseline Flood Risk Level	Post-Mitigation Flood Risk Level	Comments
Pluvial (surface water)	Very Low to High	Very Low to High	Increased surface water runoff is proposed to be managed to mimic the pre-Scheme conditions for up to and including the 1 in 100 year + 40% climate change event. All Field Stations and the On-Site Substation are shown to be outside of the surface water flood extents. The BESS Area is partially located within the surface water flood extents.
Groundwater	Low	Low	No change to flood risk level.
Sewers	Very Low	Very Low	No change to flood risk level.
Artificial Sources	Low	Low	No change to flood risk level.

1.3 Existing Surface Water Drainage

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

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

1.3.3 For existing land/field drains the relevant water company and Danvm Drainage Commissioners, part of the Yorkshire and Humber Drainage Board, will be contacted during detailed design to agree impacts from the proposed work. This will be undertaken during the next phase of the Scheme following any future consent.

1.4 Geology and Hydrogeology

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

1.4.2 Groundwater vulnerability for the Solar PV Site is generally low, however, there are small areas of medium/medium to high vulnerability where the Breighton Sand Formation and the alluvial deposits are mapped in the Solar PV Site and the surrounding 1 km Study Area. It should be noted that there is a Principal and Secondary B Aquifer underlaying the Solar PV Site.

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

2. Planning Policy and Guidance

2.1 Lead Local Flood Authority

2.1.1 The Lead Local Flood Authority for the Scheme is City of Doncaster Council. As the LLFA, City of Doncaster Council determine the climate change allowances for the Don and Rother catchment, as shown in Table 2.

Table 2: Upper end climate change allowance for 2070s epoch (2061-2125)

Rainfall Event	Peak rainfall climate change allowance
1 in 30-year	35%
1 in 100-year	40%

2.2 Sustainable Drainage Systems (SuDS)

2.2.1 City of Doncaster Council (formerly Doncaster Metropolitan Borough Council) Level 1 Strategic Flood Risk Assessment (SFRA) (Ref. 5) states the design criteria for runoff destination should be in this order of preference:

a. To ground;

b. To surface water body;

c. To road drain or surface water sewer;

d. To combined sewer.

2.2.2 Section 3 below describes how the majority of the Solar PV Site will continue to operate as a greenfield site and will be able to infiltrate and runoff as it does currently. In the case of the BESS Area and the On-Site Substation that include impermeable land, infiltration is not being considered an option for formal site discharge at this stage. This is due to the incorporation of water quality mitigation (described in Section 7 below) and the lack of infiltration testing at this time. The next preferred option is to discharge to a surface water body, such as a swale or pipe discharging to a watercourse.

2.2.3 City of Doncaster Council Solar Farm Drainage Strategy Advice (Ref. 7) states if the proposed solar farm is near a watercourse, a swale feature should be incorporated into the design.

2.2.4 The non-statutory technical standards for sustainable drainage systems (Ref. 6), states that the runoff rate of a development cannot exceed the greenfield runoff rate for a given return period. Furthermore, it states the drainage system must be designed so that flooding does not occur in a 1 in 30-year event, and that in a 1 in 100-year event, the exceedance flows are managed to minimise the risk to people and property.

2.2.5 CIRIA SuDS Manual (Ref. 8) details the Simple Index Approach used to determine the pollution hazard level of the proposed design and ensure it provides adequate water quality mitigation.

2.3 Fire Water

2.3.1 There is a requirement for fire water to be held alongside the BESS Area to be readily available in the unlikely event of a BESS system thermal runaway incident. The water may be required to cool surrounding BESS Containers or BESS equipment to ensure a fire is contained to a single BESS Container. Industry practice provides that water should not be discharged directly on battery systems within BESS Containers: revised NFCC guidance (2024) acknowledges that it is increasingly common for BESS systems to be designed and manufactured without any suppression system, and some may be specifically designed so that a fire can be contained within the BESS cabinet or enclosure i.e. a ‘let it burn’ strategy.

2.3.2 The design includes four water tanks and six fire hydrants within the BESS Area as shown in **ES Volume III Appendix 2-2: BESS and On-Site Substation [EN010152/APP/6.3]**. The water supply for the fire water tanks is assumed to be supplied from the existing water mains.

2.3.3 National Fire Chiefs Council (NFCC) guidance (Ref. 9) has been used to determine the volume storage of fire water runoff for the purposes of this Framework Drainage Strategy. The NFCC guidance states firefighting supplies "*should be capable of delivering no less than 1,900 litres per minute for at least 2 hours*". On top of this supply requirement, a 30% additional capacity has been applied for storage in the swale. This equates to a flow of 41.2 l/s.

2.3.4 There is the possibility that a fire breaks out at the same time as a storm event and that the system may already contain surface water, therefore reducing the capacity for fire water storage. Therefore, the swale should be sized to serve both purposes. It is considered extremely unlikely for a fire to occur during a 1 in 30-year (+35%), or 1 in 100 (+40%) event. Therefore, an allowance has been made that a 1 in 2-year event could occur at the same time as a fire. In this event, any exceedance should be held within the BESS Area for necessary testing and treatment prior to release or tankering offsite.

2.3.5 The separate hold of fire water for the On-Site Substation is not considered necessary, as the likelihood and nature of a fire is not considered as significant.

2.4 Design Criteria

2.4.1 Following these standards and guidance, this Framework Drainage Strategy has been designed for the following events:

a. 1 in 2-year storm event, stored within the system;

b. 1 in 30-year (+35%) storm event, stored within the system;

c. 1 in 100-year (+40%) storm event, held on site; and

d. 1 in 2-year storm event + fire, held on site (BESS Area).

2.4.2 For those events where flooding on site is allowable, it will be held on site until it can be discharged at the greenfield runoff rate.

3. Drainage Areas

3.1.1 The Solar PV Site is currently greenfield. Therefore, rainfall currently permeates into the ground with some portion running over the surface as runoff. This runoff either enters a watercourse or is trapped in a local depression and infiltrates/evaporates over time, and so does not need to be considered in this drainage strategy. The topography of the Solar PV Site is relatively flat, with existing ground levels under 10 m AOD according to online OS mapping. This Framework Drainage Strategy aims to mimic the natural drainage conditions of the Solar PV Site as far as possible.

3.1.2 The solar PV panels would be held above ground typically on narrow (<100 mm) diameter legs that sit on piles or small concrete plinths. The small size of the footings prevents sealing the ground around the solar PV panels with an impermeable surface and would allow any rainwater to infiltrate into the ground as it does currently. In order to limit the potential for channelisation from rainfall dripping off the end of the panels, the areas between, under and surrounding the solar PV panels would be planted with native grassland and the ground shaped by shallow raking. This planting and shaping would intercept and absorb rainfall running off the panels, preventing it from concentrating and potentially forming channels in the ground. Grassland maintenance is described within the **Framework Landscape and Ecological Management Plan (LEMP) [EN010152/APP/7.14]**.

3.1.3 The BESS Area would be located on the southwest side of the Solar PV Site with an area of up to 50,000m^2. The indicative layout of the BESS Area comprises of four rows of battery storage container units, with impermeable roads in between, as shown in **ES Volume III Appendix 2-2: BESS and On-Site Substation [EN010152/APP/6.3]**. The access roads around the perimeter and between the rows are considered impermeable as they are assumed to be compacted MOT Type 1 material. The whole gravel area that surrounds the containers and control units is also considered 100% impermeable. This is because the gravel is used as attenuation storage for surface water, but also has a second purpose as storage for fire fighting water. This water may contain contaminants and is therefore not allowed to infiltrate into the ground. This is further detailed in Section 5. There are also four fire water tanks and six fire hydrants located within the BESS Area, which have been considered 100% impermeable, and the runoff of which is accounted for in this strategy. This accounts for a total impermeable area of 33,633m^2. A Volumetric Runoff Coefficient (Cv) of 1.0 has been used.

3.1.4 The On-Site Substation would have an area of up to 20,000 m^2. Hard standing areas and structures within the On-Site Substation are considered 100% impermeable, except for bunded structures which are assumed to manage flow independently. The remaining area will be covered in gravel and will remain permeable. Therefore, a volumetric runoff coefficient (Cv) of 1.0 has been used.

4. Greenfield Runoff Rate

4.1.1 The equivalent greenfield runoff rates for the BESS Area and On-Site Substation have been calculated for the Solar PV Site using HR Wallingford's UKSuDS Greenfield Runoff Rate Estimation tool, based on the proposed contributing impermeable area. Refer to Annex B for the calculated rates. FEH 2022 data was used for this assessment.

Table 3: Greenfield Discharge Rates

Return Period (Years)	BESS Area Discharge Rate (l/s)	On-Site Substation Discharge Rate (l/s)
2	21.54	8.62
10	36.46	14.58
30	47.04	18.82
30 + 35% CC	64.59	25.84

Return Period (Years)	BESS Area Discharge Rate (l/s)	On-Site Substation Discharge Rate (l/s)
100	60.59	24.23
100 + 40% CC	87.40	34.96

4.1.2 In order to provide a simple flow control for the site, the minimum discharge rate was used, which was a 1 in 2-year event greenfield rate for all design storms.

5. BESS Area Drainage Strategy

5.1 Attenuation Strategy

5.1.1 The drainage strategy for the BESS Area consists of four gravel-filled attenuation basins situated below the BESS Containers, that discharge into a swale running along the western side of the BESS Area. The swale discharges to a local waterway via a flow control device, limiting flow to the greenfield runoff rate, as shown in Plate 1.

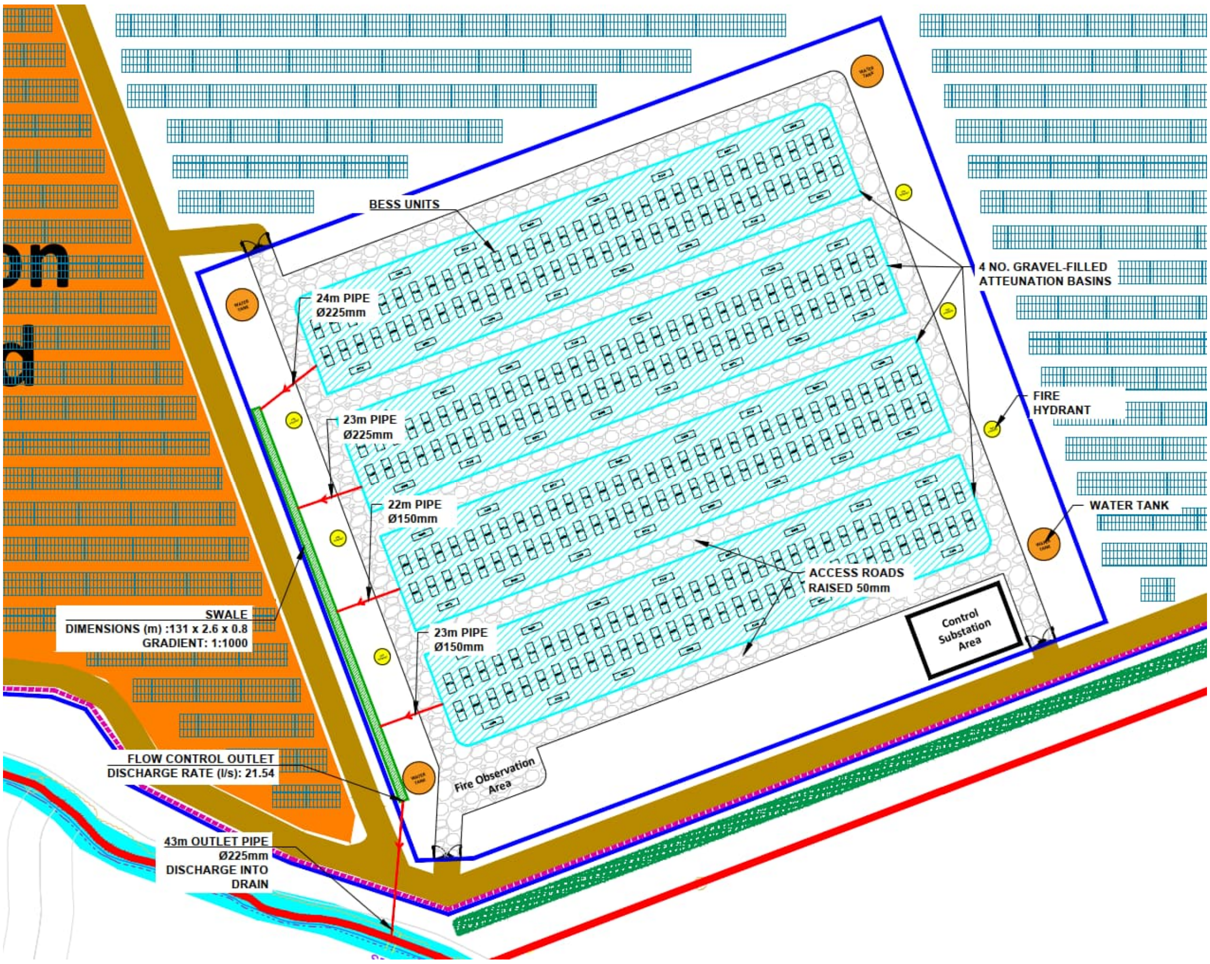


Plate 1: BESS Area Proposed Design

5.1.2 The topography of the proposed BESS Area has been inferred from LIDAR and a topographical survey. The information suggests the area is relatively flat with some uneven patches and random falls in different directions. The general direction of fall is to the south, although a sizable depression is located to the north of the proposed BESS Area.

5.1.3 This Framework Drainage Strategy has assumed the area will be levelled to 5.55 m AOD. This level should be achievable with a reasonable cut fill balance while also providing adequate fall to the attenuation system and discharge into the nearby watercourse to the south of the BESS Area.

5.1.4 Attenuation for the BESS Area is proposed to be provided by utilising four gravel-filled attenuation basins within which the BESS Containers will be located, as shown on Plate 1. These gravel-filled attenuation basins will have an average surface area of 5521 m^2 and depth of 0.41 m. The porosity was assumed to be 30%, resulting in an effective volume of approximately 679m^3. The runoff from the structures and adjacent inner roads will discharge directly into the gravel.

5.1.5 The surrounding roads of the gravel-filled attenuation basins are to be raised to contain exceedance that occurs in the 1 in 100-year rainfall event and 1 in 2-year plus fire water event. 50 mm (5.60m AOD) has been used as a minimum height with the final raising height to be decided at detailed design.

5.1.6 The gravel-filled attenuation basins will discharge via pipes into a swale that runs north to south on the western side of the BESS Containers. The swale will be 131 x 2.6 x 0.8m, with 1:1.5 sides, and volume of 146m^3. There will be multiple inlets along its length from the gravel-filled attenuation basins, before discharging the water via an outlet at the southern end. The main function of the swale is to provide water quality improvement, as further discussed in Section 7. The length of the swale is primarily determined by the need to convey discharge from the gravel-filled attenuation basins to the local watercourse.

5.2 Discharge Strategy

5.2.1 The outlet of the swale will discharge into the local drainage watercourse, Ell Wood and Fenwick Grange Drain, that runs in an easterly direction along the southern side of the BESS Area. A flow control device at the outlet of the swale will limit the discharge to the greenfield runoff rate for the site, which is 21.54 l/s.

5.2.2 The design has also considered the management of fire water and the likely contaminants associated with it. This means that infiltration is not allowed from the gravel-filled attenuation basins. To prevent potential contamination to the surrounding ground, the gravel-filled attenuation basins will be non-infiltrating, underlain with an impermeable liner.

5.2.3 Penstocks will also be in place at the outlets from the gravelled areas to hold any fire water in that cell of the system. This allows the stored water to be tested before release or, if necessary, removed by tanker and treated offsite.

5.3 Results

5.3.1 This design has been modelled using the InfoDrainage software, version 2024.2. The model was set up using FEH 2022 point descriptors, for 1 in 2-year, 1 in 30-year (+35%) and 1-in-100 year (+40%) rainfall events.

5.3.2 In the event of a fire, fire water was modelled as a constant flow of 41.2 l/s for 2 hours into one of the gravel strips, with a coincidental 1 in 2-year rainfall event. It was not considered necessary to design for fire water during a 1 in 30-year (+35%) or 1 in 100-year (+40%) event.

5.3.3 The results for the northern gravel-filled attenuation basin were used as they are most critical. For the 1 in 2-year and 1 in 30-year (+35%) event, runoff was held within the system, with a lowest available storage proportion for a gravel-filled attenuation basin of 62% and 2% respectively. The lowest available storage proportion for the swale was 90% for the 1 in 2-year event, and 68% for the 1 in 30-year (+35%) event.

5.3.4 For a 1 in 100-year (+40%) event, there was a flooded volume of up to 218 m^3 per gravel-filled attenuation basin, which equates to 40 mm across the surface area. Given the surrounding roads are raised to 50 mm this leaves 10 mm freeboard. The total flooded volume across the site was 524 m^3, which would be fully held on site, before discharging into the drain via the swale. The lowest available storage proportion for the swale for this event was 52%.

5.3.5 In the event of fire water being discharged to one gravel-filled attenuation basin at the same time as a 1 in 2-year event, with the use of penstocks to shut off discharge to the swale there was no flooding, with a lowest available storage proportion of 6%. Furthermore, given the surrounding roads are raised 50 mm, this gives a degree of protection in the event that fire water is discharged for a period longer than 2 hours, with flooding contained within the gravel-filled attenuation basin for over 4 hours of discharge.

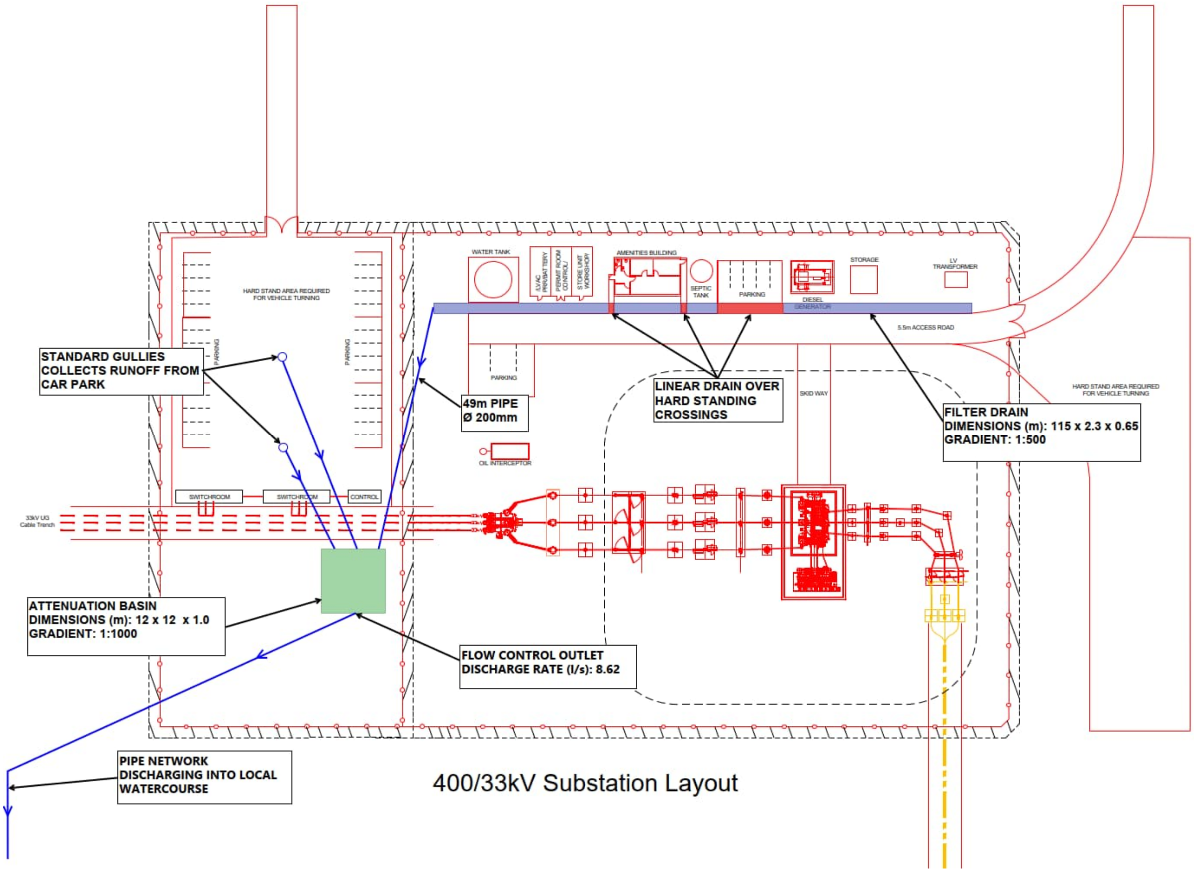
5.3.6 As attenuation is primarily provided by the gravel-filled attenuation basins, the main function of the swale is water quality improvement and conveyance to the drain. The swale does not flood in any event, with a lowest available storage proportion of 52% during a 1 in 100-year (+40%) event.

6. On-Site Substation Drainage Strategy

6.1 Attenuation Strategy

6.1.1 The drainage strategy for the On-Site Substation consists of a filter drain running along the northern edge of the site, which discharges into an attenuation basin in the southwestern corner. Runoff from the hard-standing car park is collected by standard gullies and discharges to the attenuation basin. The attenuation basin discharges to a local watercourse via a pipe network, with a flow control device limiting flow to the greenfield runoff rate, as shown in Plate 2.

Plate 2: On-Site Substation Proposed Design



6.1.2 Attenuation for the On-Site Substation is proposed to be provided by a filter drain connecting into an attenuation basin.

6.1.3 A filter drain is proposed in between the access road and structures north of the road, running in a westerly direction. Runoff from the road and structures would discharge directly into the filter drain. At paved access points, a suitable system will be used to carry the drainage under the paving. This will have to be sized appropriately at detailed design. It is currently assumed to be a linear drain in a trench that is 115 x 2.3 x 0.65 m, with a 225 mm diameter under-drain running along the length to the outlet. Fine gravel of 34% porosity and 18.75 m/hr conductivity will be used, providing a volume of 62 m^3.

6.1.4 The attenuation basin will be located in the southwest of the On-Site Substation site, with an inflow from the filter drain and hardstanding car parking area via two gullies in the northwest of the site. The location of the gullies are to be decided at detailed design, dependent on the design of the car parking area. The attenuation basin is currently assumed to be 12.0 x 12.0 x 1.0 m, with a volume of 91 m^3. If the carpark design requires this to be updated, then that will be done at detailed design.

6.2 Discharge Strategy

6.2.1 The outlet of the attenuation basin will discharge into the Ell Wood and Fenwick Grange Drain via a pipe network. A flow control outlet will be used, limiting discharge to the greenfield runoff rate of 8.62 l/s.

6.3 Results

6.3.1 This design has been modelled using the InfoDrainage software, version 2024.2. The model was set up using FEH 2022 point descriptors, for 1 in 2-year, 1 in 30-year (+35%) and 1-in-100 year (+40%) rainfall events.

6.3.2 For a 1 in 2-year, the lowest available storage proportion for the attenuation basin was 78%, with 82% of the filter drain available. For a 1 in 30-year (+35%) event, the attenuation basin has a lowest available storage proportion of 31% and the filter drain has 50% available.

6.3.3 For a 1 in 100-year (+40%), storage of water on the surface is allowable providing it remains on site. The attenuation basin does not flood, with a minimum available storage proportion of 7%. The filter drain has a flooded volume of 3.4 m^3 corresponding to a flooded depth of 13 mm.

6.3.4 These volumes will be held within the surrounding gravelled area and will drain back into the drainage system when there is capacity.

6.3.5 The results show that raising the roads by 50 mm above the rest of the site contains all storm event water levels. This is provided as a minimum raising in order for the system to operate correctly, the final road level will be decided at detailed design with a suitable allowance for freeboard.

7. Water Quality

7.1.1 Firefighting water, and its potential contaminants, have not been included in this section as any fire water applied to the BESS Area in the event of an incident would be contained within the gravel-filled attenuation basins and removed from the BESS Area via controlled methods (e.g. tanker) if found to be polluted.

7.1.2 The On-Site Substation area has fewer potential sources of fire which are more easily extinguished and contain less damaging contaminants. A specific fire water plan is not considered necessary for this area and fire water management has not been considered.

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

Total SuDS Mitigation Index ≥ Pollution Hazard Index

7.1.4 The impermeable areas within the Solar PV Site relate to the BESS Area and the On-Site Substation. In accordance with the SuDS Manual this land use is best defined as ‘commercial/industrial’ roofs. The service roads within the BESS Area were assumed to be impermeable, whilst the access roads within the wider Solar PV Site would be permeable. Regardless of construction type the roads would be lightly trafficked and would be a potential source of low level pollution. Table 4 details the pollution hazard indices associated with these land uses. The larger indices are for the access roads and should be used in the assessment.

Table 4: Pollution Hazard Indices for BESS Area and On-Site Substation

Land Use	Pollution Hazard Indices			
	Pollution Hazard Level	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
Other roof (typically commercial/industrial roofs)	Low	0.3	0.2	0.05
Low traffic roads non-residential car parking with infrequent change (i.e. <300 traffic movements/day)	Low	0.5	0.4	0.4

7.1.5 Table 5 lists the mitigation indices associated with the swale and attenuation basin. These values demonstrate the Simple Index Approach (SIA) condition is met for each of the pollutants as the mitigation indices are higher than the hazard indices. Therefore, the proposed swales surrounding the BESS Area and On-Site Substation would be sufficient to treat the runoff from these areas.

Table 5: Mitigation Indices for BESS Area Swale and On-Site Substation Attenuation Basin

Type of Sustainable Drainage Systems (SuDS) Component	Mitigation Indices		
	Total Suspended Solids (TSS)	**Metals**	**Hydrocarbons**
BESS Area Swale	0.5	0.6	0.6
On-Site Substation Bioretention System	0.8	0.8	0.8

8. Maintenance Approach

8.1.1 Operation and maintenance of all drainage components would be the responsibility of the asset owners (the Applicant).

8.1.2 Regular maintenance and monitoring, in accordance with industry good practice, e.g. CIRIA SuDS Manual, is paramount for ensuring effective water treatment benefits of the proposed SuDS drain. A bespoke maintenance plan will be developed during detailed design. It is proposed that monthly inspections would be undertaken to remove any litter from the surface of the gravel-filled attenuation basins and ensure that this system is not blocked or damaged. Geotextiles will be replaced following manufacturer guidance and overlying filter material should be cleaned, as required and at a frequency determine during detailed design.

9. Foul Drainage Strategy

9.1.1 Foul drainage from offices on site will be directed to an on-site cesspit. The tank will be emptied by road tanker as and when required and treated elsewhere. It is not proposed to have a permanent discharge to sewer.

10. References

Ref. 1 Environment Agency (2023). Flood Map for Planning. Available at: https://flood-map-for-planning.service.gov.uk/ [Accessed 26 September 2024].

Ref. 2 City of Doncaster Council (2023). Local Flood Risk Management Strategy 2023-2029. Available at: https://www.doncaster.gov.uk/services/transport-streets-parking/flood-risk-management. [Accessed 07 August 2023].

Ref. 3 Environment Agency (2023). Long Term Flood Risk Map. Available at: https://check-long-term-flood-risk.service.gov.uk/map. [Accessed 07 August 2023].

Ref. 4 Soilscapes website. Available at: http://www.landis.org.uk/soilscapes/. [Accessed 18 December 2023]

Ref. 5 Doncaster MBC Level 1 Strategic Flood Risk Assessment. Available at: https://dmbcwebstolive01.blob.core.windows.net/media/Default/Planning/Documents/Natural%20Environment/Flooding/SFRA%20Level%201%20(2015)/SFRA%20Level%201%20-%20Main%20Report.pdf [Accessed 13 May 2024]

Ref. 6 Non-statutory technical standards for sustainable drainage systems. https://assets.publishing.service.gov.uk/media/5a815646ed915d74e6231b43/sustainable-drainage-technical-standards.pdf [Accessed 13 May 2024]

Ref. 7 City of Doncaster Council Solar Farm Drainage Strategy Advice. Available at: https://www.doncaster.gov.uk/Documents/DocumentView/Stream/Media/Default/Environmental/Solar%20Farm%20Drainage%20Strategy%20Advice.pdf [Accessed 13 May 2024]

Ref. 8 Woods Ballard, B, Wilson, Udale-Clarke, H, Illman, S, Scott, T, Ashley, R, Kellagher, R (2015) *The SuDS Manual*. CIRIA, London, UK

Ref. 9 National Fire Chiefs Council. Grid Scale Battery Energy Storage System planning – Guidance for FRS. Available at: https://nfcc.org.uk/wp-content/uploads/2023/10/Grid-Scale-Battery-Energy-Storage-System-planning-Guidance-for-FRS.pdf [Accessed 13 May 2024]

Annex A InfoDrainage Models

A.1 BESS Area

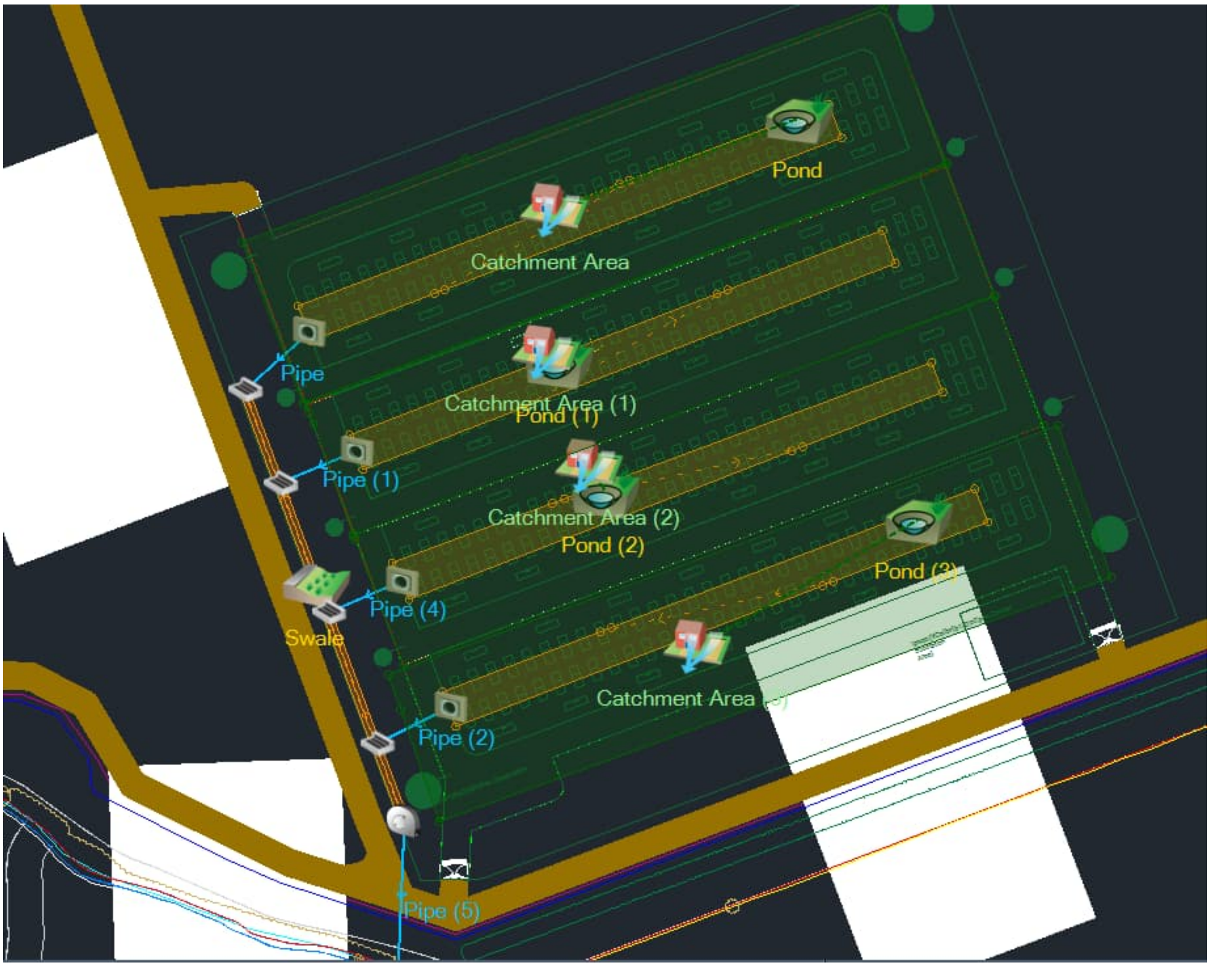


Plate A1: BESS Area Infodrainage Model

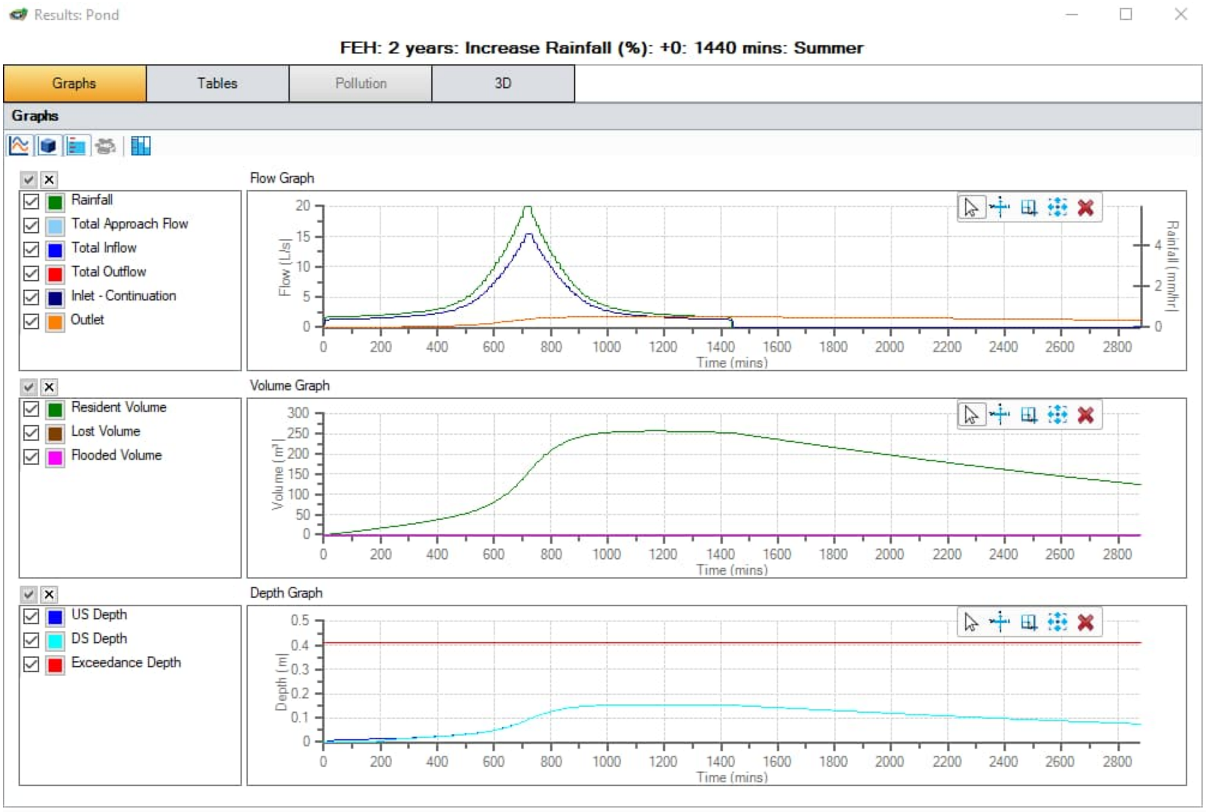


Plate A2: 1 in 2-year critical event

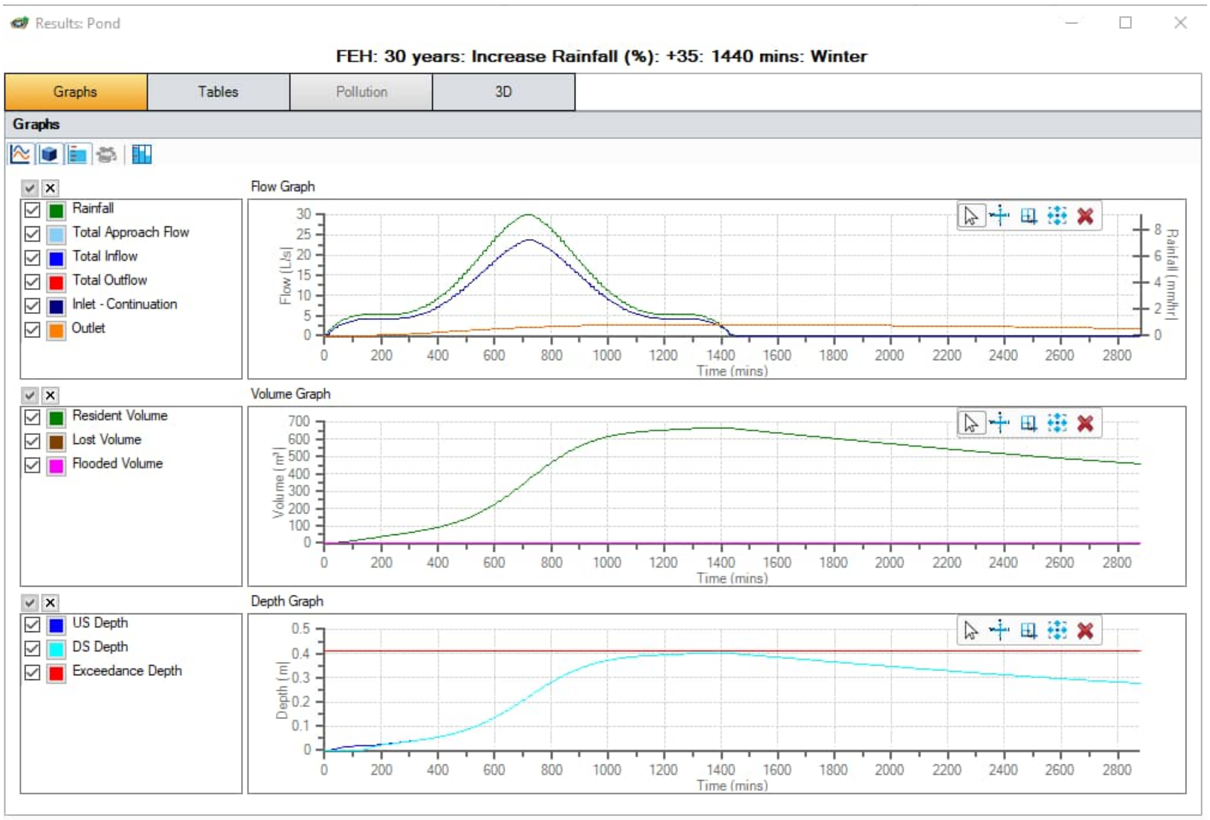


Plate A3: 1 in 30-year (+35%) critical event

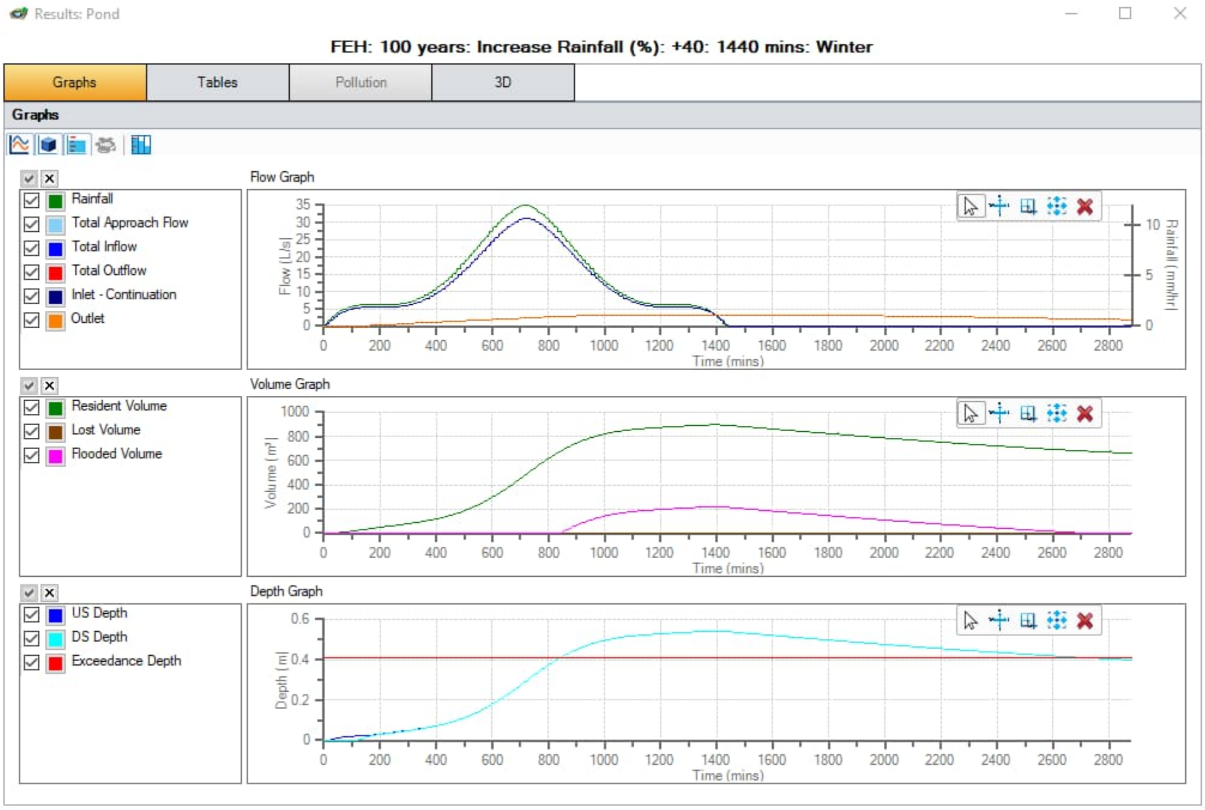


Plate A4: 1 in 100-year (+40%) critical event

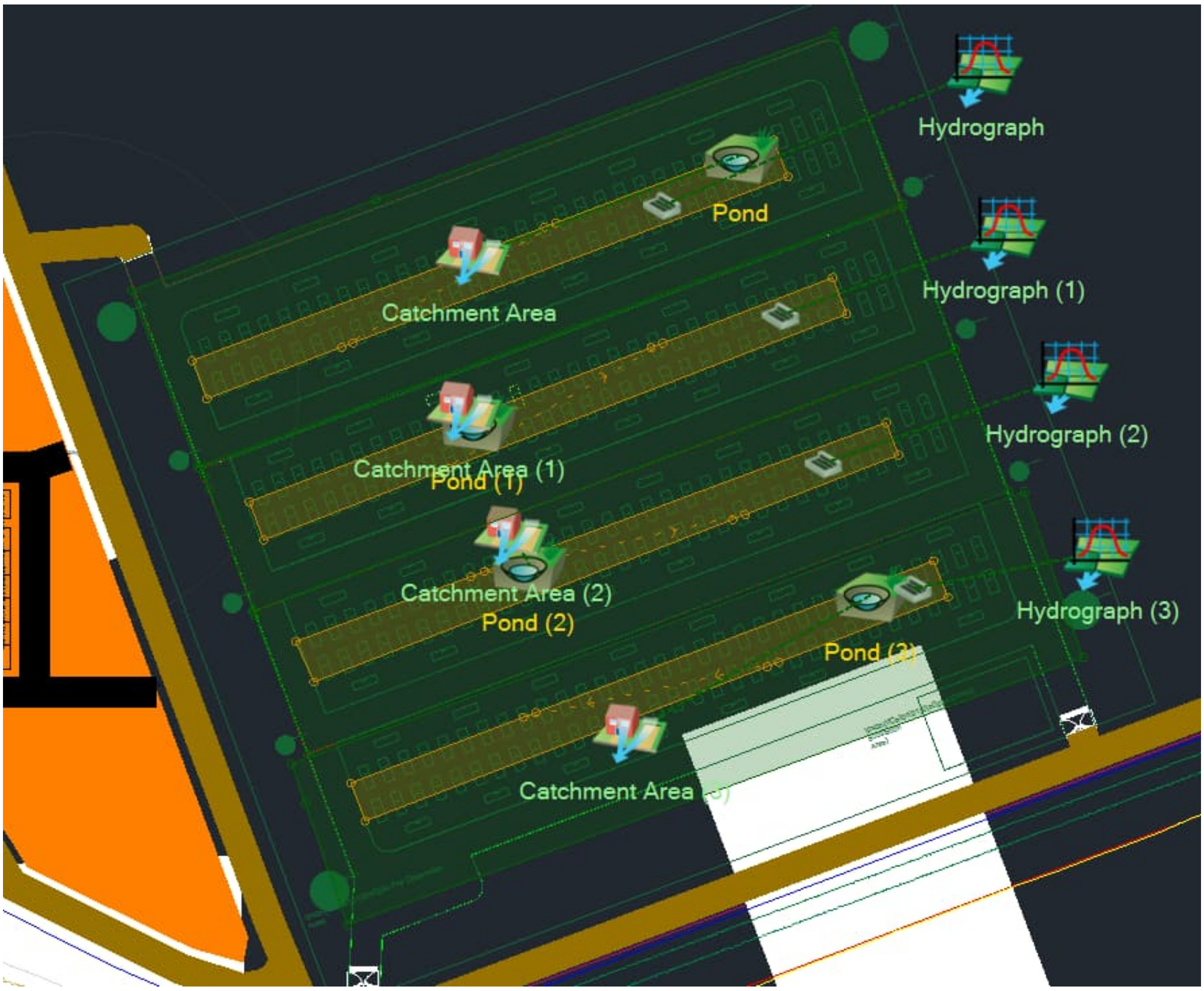


Plate A5: BESS with fire water Infodrainage model

For this model a hydrograph representing the fire water was an inflow for each basin, and there was no outlet to the swale, to model the penstock shutting off the system.

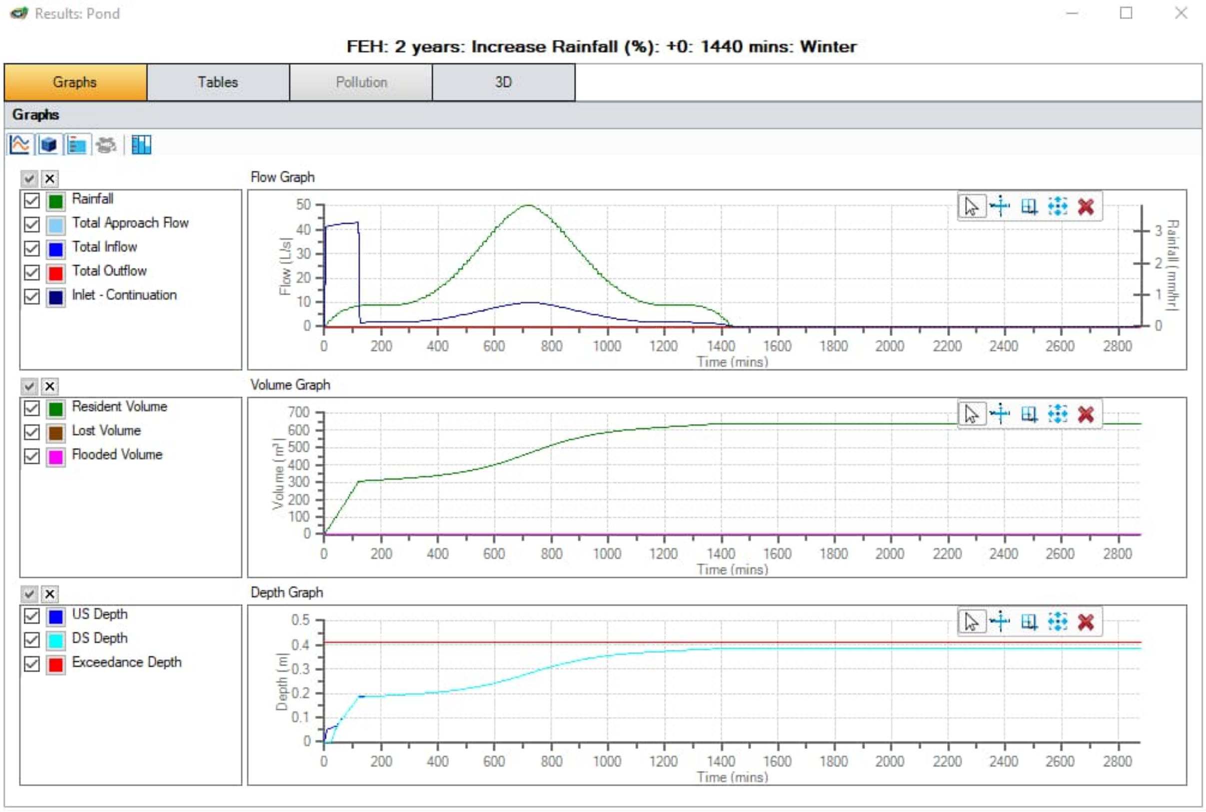


Plate A6: 1 in 2-year + fire water critical event

A.2 On-Site Substation

Plate A7: Substation Infodrainage Model

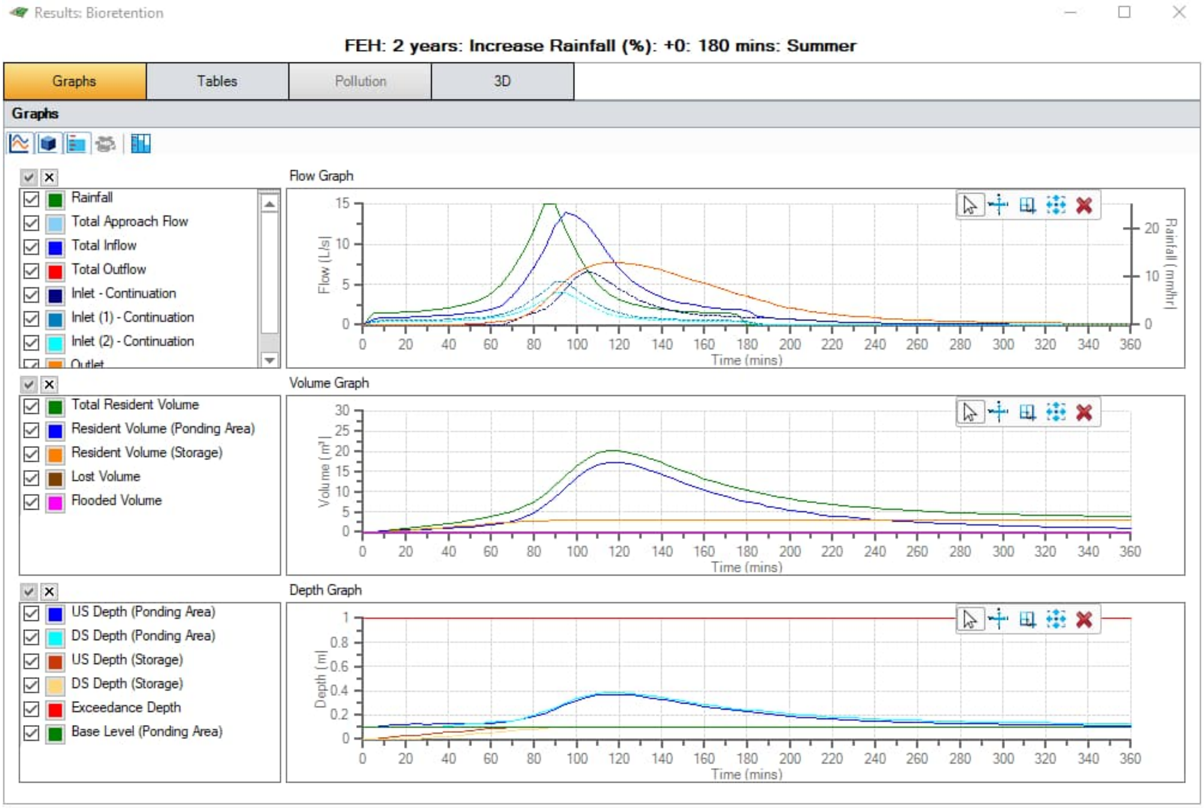


Plate A8: Attenuation basin - 1 in 2-year critical event

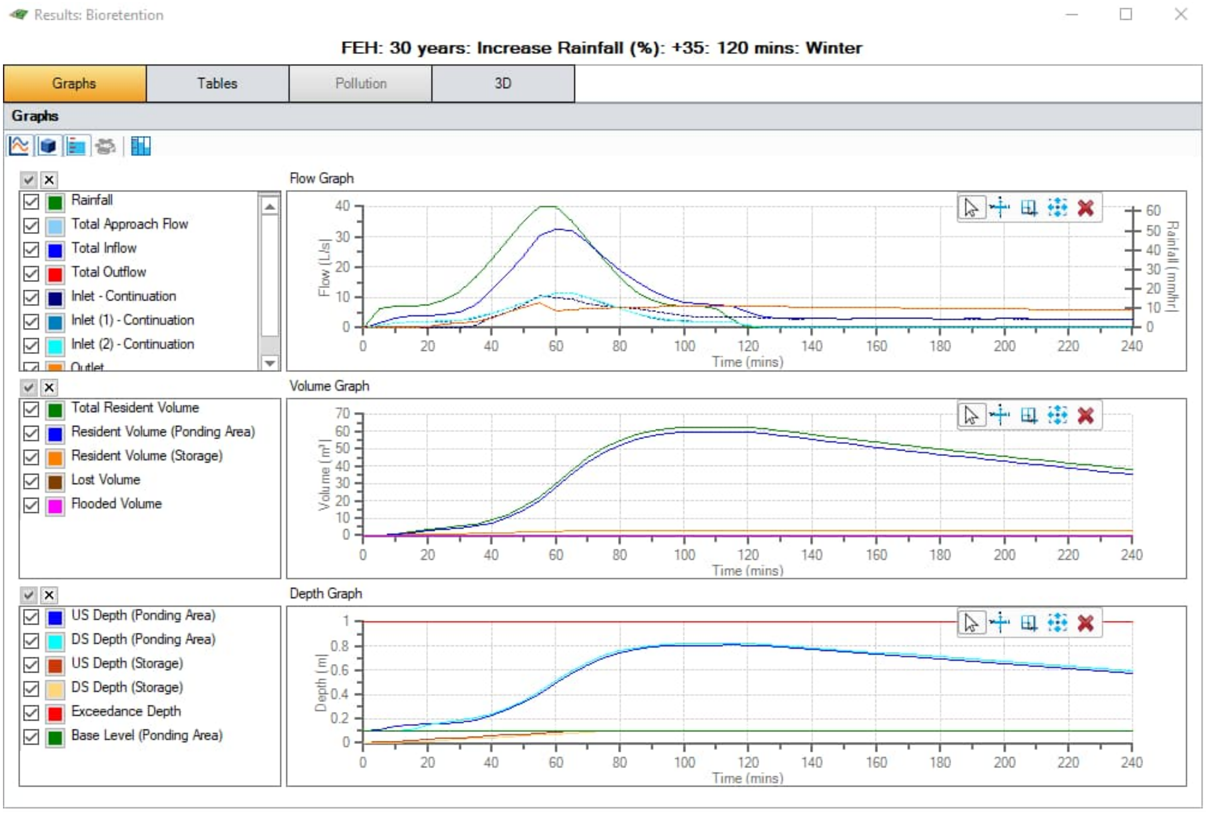


Plate A9: Attenuation basin - 1 in 30-year (+35%) critical event

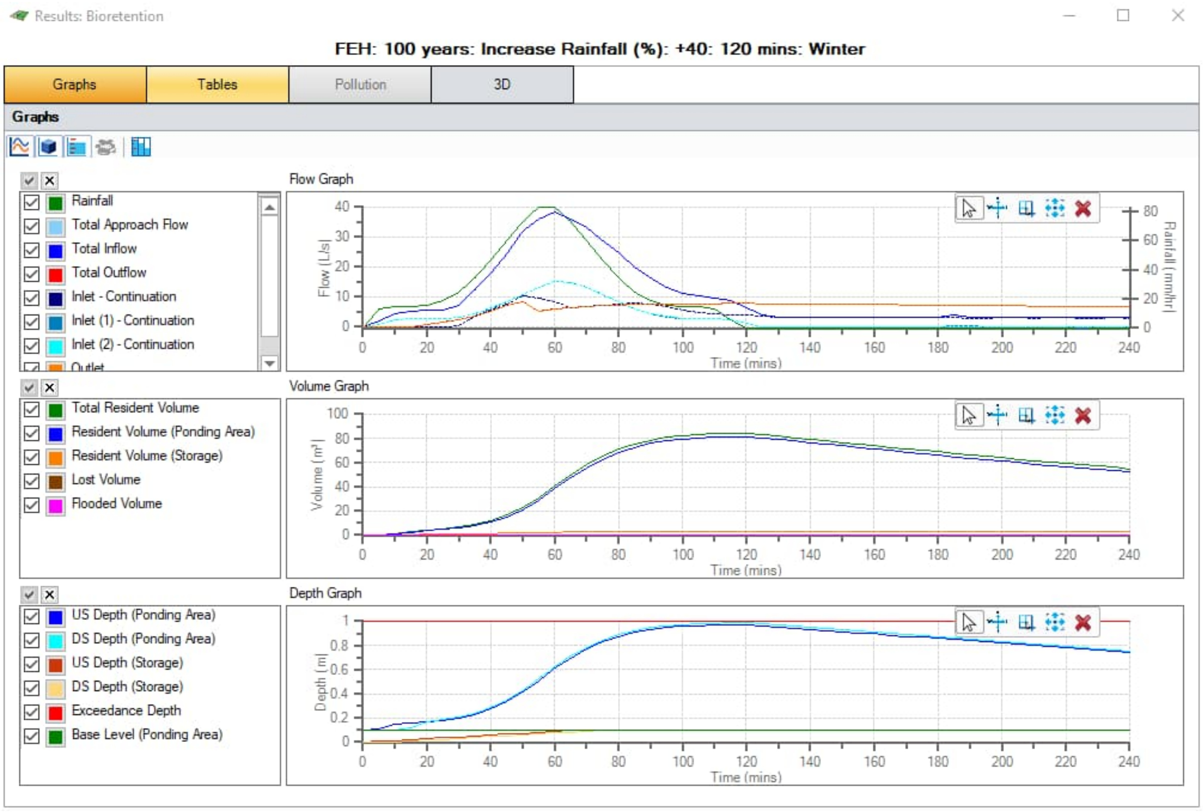


Plate A10: Attenuation basin - 1 in 100-year (+40%) critical event

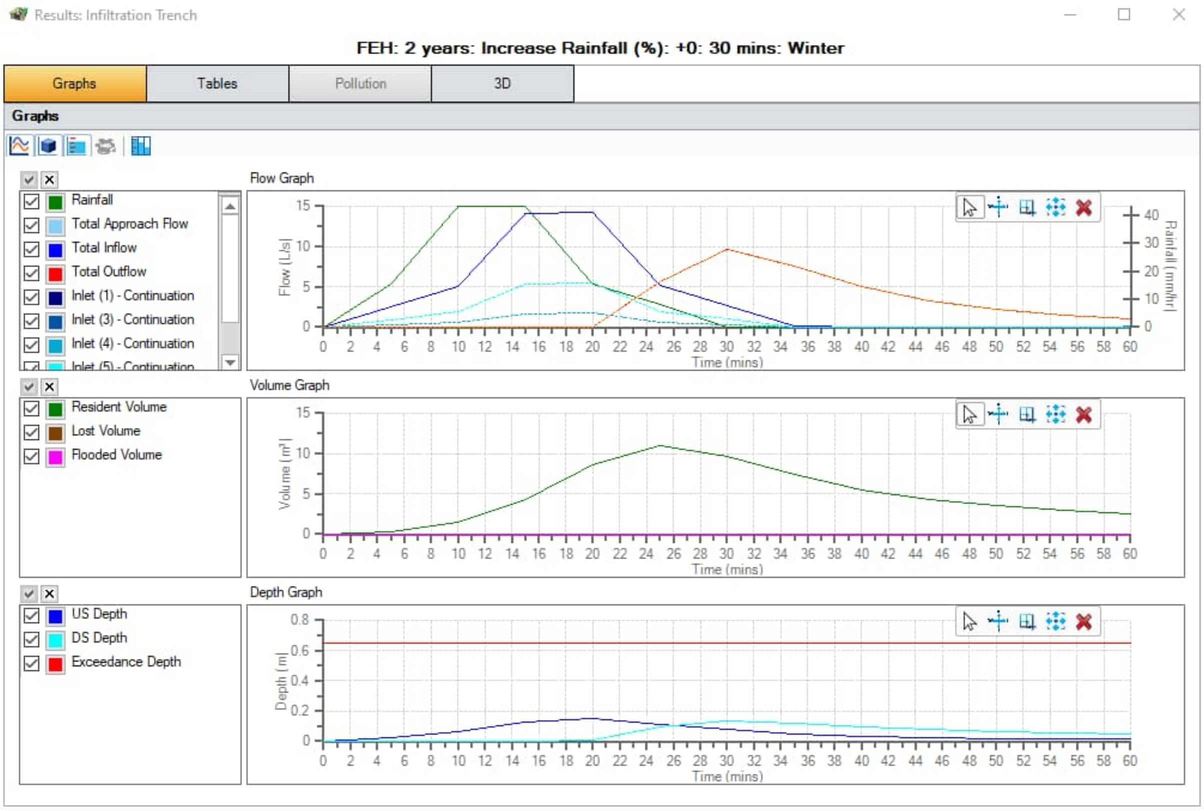


Plate A11: Filter drain - 1 in 2-year critical event

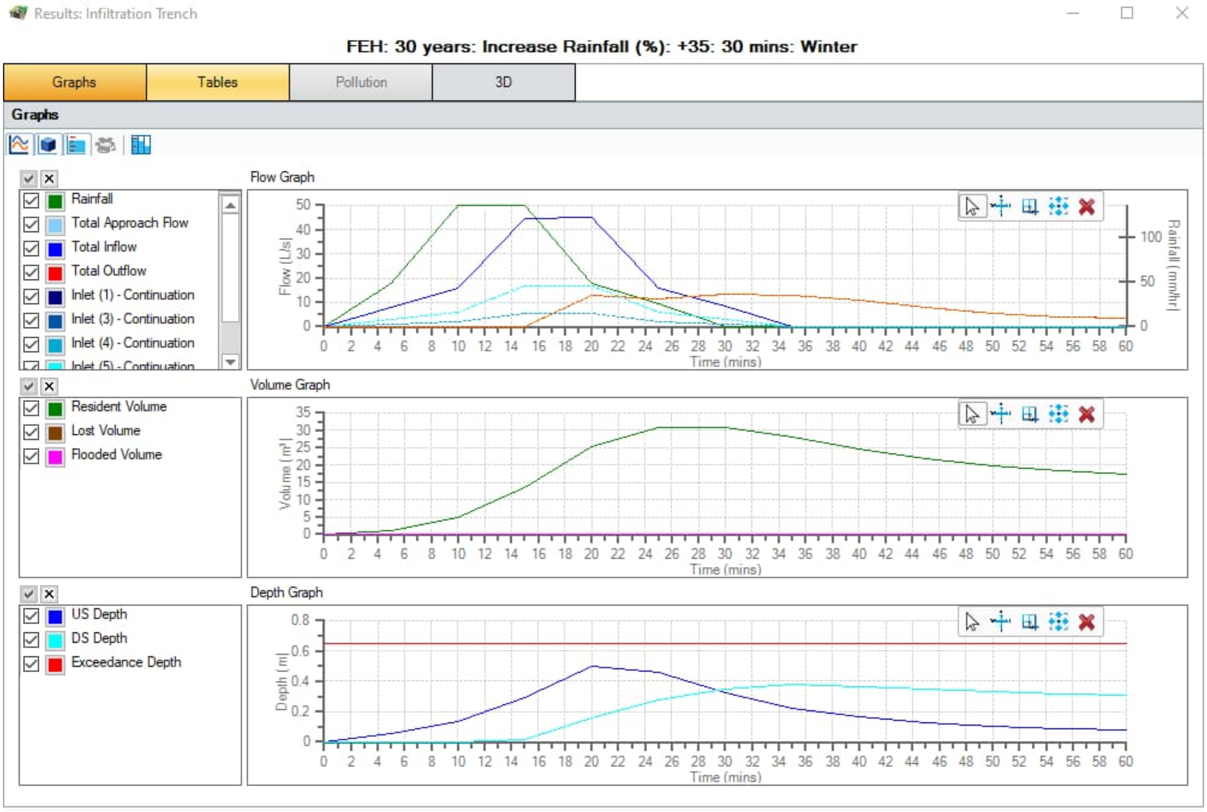


Plate A12: Filter drain - 1 in 30-year (+35%) critical event

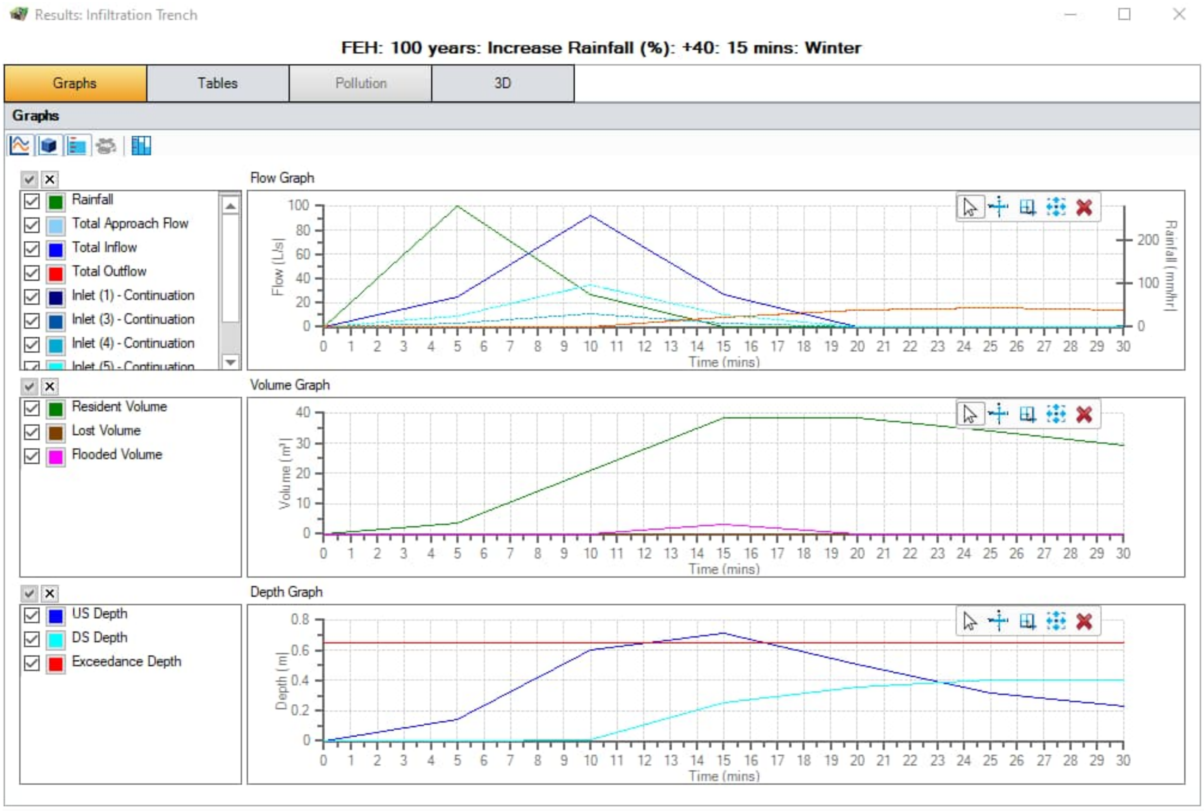


Plate A13: Filter drain - 1 in 100-year (+40%) critical event

Annex B Greenfield Runoff Rates

Calculating REFH2 Runoff Rates

FEH Point Descriptor File

FEH_Point_Descriptors_459993_415339_v5_0_1.xml

ArcHydro Shapefiles (if multiple catchments required)

Catchments	NA
Drainage Lines	NA

REFH Rainfall Used: 2022

METHOD

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

Page 1: Catchment/Point Data

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

2 Set catchment area to 0.5km² (50ha)

Page 2: Rainfall Events

3 Set ARF to 1.0

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

Page 3: Event Modelling

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

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

Tp	2.469
BL	32.399

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

Catchment areas from ArcHydro Analysis			
Catchment	Catchment area (m²)	Catchment area (km²)	Catchment area (ha)
1 - BESS	50000	0.05000	5.000
2 - Substation	20000	0.02000	2.000
3		0.00000	0.000
4		0.00000	0.000

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

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

FOR GREENFIELD RUNOFF RATES

9 Export peak flows for all return periods
Note: only as-rural peak flows (Column E in exported csv file) are applicable

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

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

FOR GREENFIELD RUNOFF VOLUME (if required)

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

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

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

FOR POST-DEVELOPMENT RUNOFF RATES (if required)

15 Revert back to default duration

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

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

Catchment	Impermeable area (m^2)	Impermeable area (km^2)	Impermeable area (ha)
1 - BESS	33633.198	0.03363	3.363
2 - Substation	2978.732	0.00298	0.298
3		0.00000	0.000
4		0.00000	0.000

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

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

20 Open exported csv and copy columns A, B and C into the table in 'Post-Development - Peak Flows' sheet to convert the flows from m^3/s to l/s/ha and l/s

FOR POST-DEVELOPMENT RUNOFF VOLUME (if required)

21 Set duration to 6hrs5mins with 5 min data interval

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

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

BESS Catchment (5ha) Peak Flows				
Description	Return period (yrs)	As-rural peak flow (m^3/s)	As rural peak flow (l/s/ha)	As rural peak flow (l/s)
2 year	2	0.0215	4.31	21.54
10 year	10	0.0365	7.29	36.46
30 year	30	0.0470	9.41	47.04
30 year 1.35 CC	30	0.0646	12.92	64.59
100 year	100	0.0606	12.12	60.59
100 year 1.4 CC	100	0.0874	17.48	87.40

Substation Catchment (2ha) Peak Flows				
Description	Return period (yrs)	As-rural peak flow (m^3/s)	As rural peak flow (l/s/ha)	As rural peak flow (l/s)
2 year	2	0.00862	4.31	8.62
10 year	10	0.01458	7.29	14.58
30 year	30	0.01882	9.41	18.82
30 year 1.35 CC	30	0.02584	12.92	25.84
100 year	100	0.02423	12.12	24.23
100 year 1.4 CC	100	0.03496	17.48	34.96

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