

LAND AT WHITE HORSE BUSINESS PARK, NORTH BRADLEY, TROWBRIDGE

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

CASTLEWOOD PROPERTIES VENTURES LTD

05 JULY 2023



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1.0 Introduction

Context

- 1.1. This report has been prepared by Abley Letchford Partnership Limited on behalf of Castlewood Properties Ventures Ltd in relation to the proposed development at the site.
- 1.2. The site is located circa 2.2km south of Trowbridge town centre and is accessed via a junction on the A363 Bradley Road.
- 1.3. This Flood Risk Assessment is to accompany the Outline planning application for up to 100 residential dwellings.
- 1.4. **Appendix 1** shows the location of the Site.

Requirement for a Flood Risk Assessment (FRA)

- 1.5. The requirement for an FRA is set out in Section 14 of the revised National Planning Policy Framework (NPPF) as revised in August 2022.
- 1.6. The footnote accompanying Paragraph 167 states:
'A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.'
- 1.7. The site is a Greenfield site, extends greater than 1 hectare in total; therefore, a site-specific flood risk assessment is required.

Report Aim and Formation

- 1.8. The principal aims of this report is to demonstrate that the proposed development complies with national and local planning policy in respect to flood risk and the provision of a suitable drainage strategy will be achieved at the development.
- 1.9. This report will also outline the impacts the development could have on flood risk to the surrounding area and outlines the mitigation systems that will be implemented to minimise this risk.
- 1.10. The drainage design ensures that the guiding principles of Sustainable Drainage Systems (SuDS) are central to the design of the surface water drainage strategy for the proposed development.

Report Structure

- 1.11. This report addresses the requirements of revised NPPF and considers the following aspects:
 - Section 2: Policy and Sources of Information – a review of policy relevant to the assessment and sources of information.



- Section 3: Baseline Environmental Conditions – a description of the site location, its topography and hydrology and the development proposals.
- Section 4: Overview of Flood Risk – the effect of flooding within the existing site layout from all sources.
- Section 5: Proposed Development and Sequential Test – an overview of the flood risk vulnerability.
- Section 6: Drainage Strategy – flood risk from the Site and appropriate mitigation measures to protect the site in the post development scenario including surface and foul water drainage strategies.
- Section 7: Summary and Conclusions – a review of the suitability of the development proposals in the context of site vulnerability and the requirements of the NPPF.

Basis of Report

- 1.12. Abley Letchford Partnership Ltd follows accepted procedure in providing professional services, but given the residual risk associated with any prediction and the variability which can be experienced in flood condition, Abley Letchford Partnership Ltd takes no liability for and gives no warranty against actual flooding of any property (client's or third party) or the consequences of flooding in relation to the performance of the service. This report has been prepared for the purposes of planning approval only and is to assist our client and the local Planning Authority to make an informed decision on the flood risks associated with the development of the Site under consideration.



2.0 Policy and Sources of Information

Introduction

- 2.1. This chapter provides a review of policy relevant to the assessment and sources of information.

National Planning Policy

- 2.2. National Planning Policy in relation to Flood Risk is set out in Section 14 of the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) ID: 7 for Flood Risk and Coastal Change. Flood Risk is discussed in Paragraphs 159-169 of the NPPF.
- 2.3. Paragraphs 159-162 discuss the sequential approach. Paragraph 160 refers to a Strategic Flood Risk Assessment (SFRA) that would form the basis of applying the Sequential Test for local authorities to allocate development, whilst Paragraphs 163-164 relates to the Exception Test.
- 2.4. Paragraph 167 discusses the determination of planning applications stating:
- ‘When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood risk assessment. Development should only be allowed in areas at risk of flooding where, considering this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:*
- a) within the site, the most vulnerable development is in areas of lowest flood risk, unless there are overriding reasons to prefer a different location.*
 - b) the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment.*
 - c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
 - d) any residual risk can be safely managed; and*
 - e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.’*

2.5. The development would be classed as Major development providing more than 10 homes and the site is greater than 0.5 hectares. Paragraph 169 states:

‘Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

 - a) Take account of advice from the Lead Local Flood Authority;*
 - b) Have appropriate proposed minimum operational standards;*
 - c) Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
 - d) Where possible, provide multifunctional benefits.’*



Environment Agency

- 2.6. The Flood and Water Management Act (2010) provides the Environment Agency a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas. The Environment Agency is a statutory consultee in relation to flood risk and planning dependent upon criteria.
- 2.7. Environment Agency Standing Advice has been consulted and reviewed within this Flood Risk Assessment.
- 2.8. The EA Flood Map for Planning, EA Long Term Flood Risk Mapping and the Catchment Data Explorer websites have been interrogated in respect to flood risk extents and sources.

Local Authorities

- 2.9. Planning guidance published by Wiltshire Council (WC) regarding flood risk were referred to, i.e. Wiltshire Local Plan, the Wiltshire Core Strategy (2015), Strategic Flood Risk Assessments published in 2009 and 2013 and Wiltshire Council's Betterment Policy (2019) following an update.
- 2.10. North Bradley falls in the Trowbridge Community Area covered by Core Policy 29 in the Wiltshire Core Strategy which states *"Development in the Trowbridge Community Area should be in accordance with the Settlement Strategy set out in Core Policy 1."*
- 2.11. Key outcomes from the Wiltshire Core Strategy include the following:
 - The natural function of floodplains will have been maintained and enhanced and sequential approach to flood risk will have been followed, with development being located first in areas of lowest risk.
 - The use of appropriate surface water management will have become a pre-requisite for development to ensure that flood risk is not increased elsewhere. Sustainable drainage systems (SuDS) will have been used in most cases.
 - Proposals for new development will have reduced the overall risk of flooding through the appropriate implementation of climate change adaptation measures.
- 2.12. Core Policy 52: Green Infrastructure – As part of this policy functions include providing routes e.g. footpaths and cycleways which link areas of open space within settlements; providing sustainable drainage, flood storage and urban cooling.
- 2.13. Core Policy 67: Flood Risk – The Strategic Housing and Economic Land Availability Assessment (SHELAA) demonstrate that there is sufficient land available in Flood Zone 1, the zone of least risk, to meet the proposed housing requirement. The strategy therefore favours housing development in Flood Zone 1 over areas of higher risk as identified by the Strategic Flood Risk Assessment.
- 2.14. The Core Strategy supports a sustainable approach to surface water drainage, and development will be expected to incorporate Sustainable Drainage Systems (SuDS) via the use of rainwater harvesting, permeable paving, basins, wetlands and swales, wherever possible.



- 2.15. The provision of green infrastructure, including woodland, should also be considered as a measure to reduce surface water run-off. Prospective developers will be expected to follow the 'surface water management train' approach recommended by the Environment Agency.
- 2.16. This involves a three-step process, considering first reducing the quantity of run-off, then slowing velocity of run-off to allow settlement filtering and infiltration, and finally providing passive treatment to collected surface water before discharge into the groundwater to a watercourse. It is considered that all developments will be able to incorporate measures to reduce the quantity of run-off, but site-specific geological or soil conditions may mean that measures to reduce run-off velocity and provide passive treatment would not be appropriate. Where this is the case, proposals will be expected to demonstrate why the use of such measures is not appropriate on the site in question.
- 2.17. The Core Strategy also states that where for all new development Sustainable Drainage Systems (SuDS) are implemented, where appropriate considering current policy and good practice guidance and emerging SuDS standards. Where appropriate, SuDS should be used to help cope with intense rainfall events.
- 2.18. The Strategic Flood Risk Assessments (SFRA) published in June 2009 and July 2013 provided an overview of flood risk throughout the County, providing the framework within which future development planning applications are to be reviewed. The site does not fall within a Critical Drainage Area.
- 2.19. Proposed surface water discharges and volume controls will need to accord with WC's updated Betterment Policy published in October 2019. This policy covers the control of surface water discharges from new development requires post development discharges to provide at least 20% betterment over pre-development discharges for both peak flow and volume. This aligns with national policy, as outlined in the SuDS Technical Standards, which requires the following peak flow and volume control:

Peak flow control

S2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer, or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Volume control

S4 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer, or surface water body for the 1 in 1 year rainfall event and the 1 in 100, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

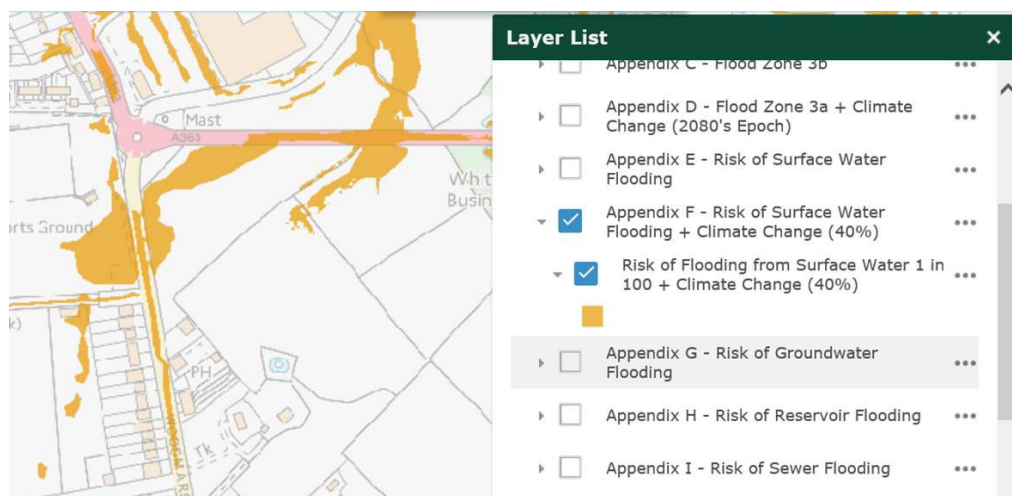


S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

2.20. As Lead Local Flood Authority, Wiltshire Council's advice was sought. WC provided the following response which is contained in **Appendix 2**:

- Development constitutes Major Development. Paragraph 165 of the NPPF applies. This is now Paragraph 169 of the revised NPPF (2021).
- The applicant would need to evidence application of the surface water disposal hierarchy - 1st Re-use, 2nd Infiltration, 3rd watercourse/surface water body, 4th surface water sewer, 5th combined sewer.
- The drainage strategy should take account of climate change in accordance with EA guidance and urban creep.
- With regards the control of surface water discharges from greenfield sites, Wiltshire Council requires post development discharges to provide 20% betterment over pre-development discharges for both peak flow and volume. For more information refer to Wiltshire Council's betterment policy.
- Wiltshire Council is the land drainage authority under the Land Drainage Act 1991. Land drainage consent is required if a development proposes to discharge flow into an ordinary watercourse or carry out work within 8m of an ordinary watercourse. An ordinary watercourse is a watercourse that does not form part of a main river. The term watercourse includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows.
- According to our L1 SFRA mapping the site is at risk of surface water flooding in the 100 year plus climate change scenario (see screen shot below). The current layout shows the ponds located where surface water flooding is predicted to occur. The site-specific FRA and drainage strategy should demonstrate that the ponds have sufficient capacity to accommodate the existing flooding and proposed runoff.



- The site layout should be developed following a sequential approach i.e. putting the most vulnerable development in the lowest flood risk areas.

Wessex Water

- 2.21. Information with regards to sewer and water main flooding contained within the SFRA has been consulted as part of this FRA. All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system and is shown on the DG5 Flood Register.
- 2.22. WW were contacted for a development enquiry. Their response dated 14th November 2019 provided sewer records and approximate locations of WW apparatus within the vicinity of the site. In January 2020 WW was provided with the site drainage strategy for comment. Their response is provided in February 2020. See Wessex Water Responses contained within **Appendix 2**.

Foul Drainage

- 2.23. Wessex Water (WW) can accept foul flows from the development and there are 150mm public foul sewers located to the northeast in the A363 Bradley Road and to the west in Woodmarsh. Developers may connect to the nearest public sewer on a size for size basis and WW fund any necessary capacity improvements from infrastructure charges income.
- 2.24. Upon granting of planning WW will need to undertake further review of the foul sewer networks as cumulative development in the catchment may exceed capacity in local systems. WW is aware of allocated residential sites to the south of this site. WW welcomes the opportunity to agree an overall drainage strategy for this area (See Strategic Planning Note below).
- 2.25. On review of the Drainage Strategy in February 2020, WW were content with the strategy to discharge foul flows north-east to manhole ST85558805.

Surface Water Drainage

- 2.26. Surface water is to be disposed of in accordance with the SuDS Hierarchy and NPPF Guidelines and should be directed to local land drainage systems.



- 2.27. Surface water arrangements and supporting flood risk measures to be agreed with the Lead Local Flood Authority – Wiltshire Council. There must be no surface water connections to the public foul sewer system. Land drainage run-off shall not be permitted to discharge either directly or indirectly into the public sewerage system.
- 2.28. On review of the Drainage Strategy in February 2020, the strategy to discharge to local watercourse at a restricted rate via attenuation basins is acceptable to WW.

Strategic Planning

- 2.29. Through the planning process WW will seek to promote a co-ordinated scheme of works that will deliver a strategic solution for the wider planning allocation, providing water and sewerage capacity for all allocated sites. A network capacity appraisal will be required to confirm the scope of any improvements necessary to accommodate additional loadings from multiple development applications and if WW is unable to provide this capacity in the short term WW advise agreement will need to be reached with developers and the Local Planning Authority upon the timetable for a scheme of works to meet future catchment growth, upon any grant of planning permission. WW welcome the opportunity to further discuss proposals and programme through the planning and development process so WW may review and plan any networks upgrades as necessary.
- 2.30. In February 2020, WW comment that they are aware of allocated development on the adjoining site to the south. WW may seek a degree of flexibility to accommodate foul flows from the adjacent site. If there is a viable option where the proposed on-site pumping station serves both sites. Under Section 112 of the Water Industry Act WW can seek to amend designs to achieve a more sustainable solution particularly if this can avoid two separate pumping stations on adjacent sites.
- 2.31. Changes may include increasing storage at the on-site pumping station and provided a length of foul sewer to link sites. The extra over expenses reasonably incurred in complying with an undertaker's Section 112 requirements would be repayable to the Developer.
- 2.32. There is scope to incorporate these changes into the Drainage Strategy if required.

Other Sources of Information

- 2.33. A desktop study of the Site was carried out using the Environment Agency, and the GOV.UK websites to ascertain local features, hydrology and soil characteristics.
- 2.34. Flood mapping and site characteristics, as published on the Environment Agency's (EA) and the GOV.uk websites, have been used as information sources. Guidance set out within the revised NPPF, the SFRA and EA Guidance has also been used as the base for this site-specific FRA. In addition, Watermans have undertaken a flood modelling exercise to further refine the limits of the flood events, this can be found in **Appendix 1**.



3.0 Baseline Environmental Conditions

Introduction

- 3.1. This chapter provides a description of the site location, its topography and hydrology along with the development proposals.

Site Location

- 3.2. The site is a collection of open agricultural fields used primarily for grazing, with established hedge and tree lined boundaries.
- 3.3. The site area is approximately 8.37 hectares (ha).
- 3.4. The site lies approximately 2.2km to the south of Trowbridge, with Woodmarsh to the west and A363 Bradley Road to the north.
- 3.5. The site lies within the administrative area of Wiltshire Council (WC)
- 3.6. The site is located immediately south of Wiltshire Housing Site Allocation Site H2.1 Elm Grove Farm on the opposite side of the A363 Bradley Road.
- 3.7. The grid reference for the site is ST856558. The nearest postcode is BA14 0RQ.

Development Proposals

- 3.8. The presented development proposals comprise a change from agricultural use to up to 100 residential dwellings together with associated surface water attenuation features, landscaping, footways and infrastructure which includes a foul water pumping station.
- 3.9. The Illustrative Masterplan and Parameter Plan are included within **Appendix 1**. These show the layout and location of the proposed development.
- 3.10. The site is accessed via a proposed junction onto A363 Bradley Road and separate link road from a proposed development to the south. A drawing depicting the proposed site access off A363 Bradley Road is included within **Appendix 1**.

Existing Site Drainage

- 3.11. A site walkover identified an open field ditch within the site itself along the central hedge line and headwall for a culverted crossing beneath the A363 Bradley Road. Additional field ditches are present along the southern and eastern boundaries. The nearest open watercourse is approximately 0.2km north east beyond Drynham Lane, which is unnamed.
- 3.12. The unnamed watercourse progresses north eastwards, skirting around Lower Studley and Longfield, before eventually joining the River Biss.
- 3.13. There are no on-site surface water manholes except for inspection chambers associated with the Wessex Water water main crossing the site.



Topography

- 3.14. The topography of the site generally falls in a north-easterly direction towards A363 Bradley Road. The approximate site gradients towards A363 Bradley Road range between 1:35 and 1:60.
- 3.15. The topographical survey indicates that the low point of the site is in the north eastern corner of the site at 41.5m. The high point of the site can be located in the south western corner at 49.99m.

Geology and Hydrogeology

- 3.16. The British Geological Survey record plans for the area indicates the site is located above the Oxford Clay Formation – Mudstone. A nearby trial identifies stiff dark grey silty Oxford Clay/weak mudstone at a depth of 6m. Groundwater was hit at 1.5m onwards.
- 3.17. The Cranfield University Soilscape maps indicate the site overlies slowly permeable loamy and clayey soils.
- 3.18. The site is underlain by Unproductive strata, i.e. rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
- 3.19. Environment Agency (EA) records show the site lies outside of any Groundwater Source Protection Zone, Principal aquifer designation or Groundwater Vulnerability Area.
- 3.20. Infiltration testing has not been undertaken at the time of writing. However, given the recorded geology of the site and flooding from pluvial sources (discussed later in the report), the use of infiltration type drainage within the site would appear to be unviable. A Phase 1 and Phase 2 Ground Investigation would confirm this position.



4.0 Overview of Flood Risk

Introduction

- 4.1. This chapter examines the effect of flooding within the existing site layout from all sources, including fluvial, pluvial and external sources.

Flood Risk to the Site from Fluvial Flooding Sources

- 4.2. According to the EA Flood Map, the existing site is located entirely within Flood Zone 1. This zone comprises land where flooding from rivers and the sea (fluvial) is very unlikely. There is less than a 0.1% (1 in 1000) chance of flooding occurring each year. See **Appendix 1**
- 4.3. The nearest watercourse designated as Main River by the EA is the River Biss which routes approximately 855m south east of the of the site.

Flood Risk to the Site from Pluvial Flooding Sources

- 4.4. In addition, the EA's Risk of Flooding from Surface Water mapping identifies where land is subject to onsite surface water flood risk (pluvial) as depicted in **Figure 1**. These locations appear to coincide with an on-site open ditch and topographical low points within the site itself.
- Dark blue indicates high risk that each year has a chance of flooding of greater than 3.3%.
 - Medium blue indicates medium risk that each year has a chance of flooding 1% and 3.3%.
 - Light blue indicates low risk that each year this area has a chance of flooding between 0.1% and 1%.
 - Areas not covered indicate a chance of flooding of less than 0.1%.
 - This has been further advanced by Watermans hydraulic model and assessments.
- 4.5. The overland flow (pluvial flooding) appears to occur when the existing road gullies on Woodmarsh are inundated in events of sustained rainfall events that there is no place for the water to go but across the site.
- 4.6. The same scenario occurs on the A363 Bradley Road and the pluvial flooding appears to combine to form one extent of overland flow, the majority of which follows the route of the existing surface water conveyance route. All other areas appear to be generated by the site's own catchment.
- 4.7. Proposed buildings and users will be located away from the existing extent of pluvial flooding, ground reprofiling will be undertaken to mitigate the risk.
- 4.8. In addition, the remaining greenfield areas will be managed with grass and vegetation providing a surface treatment more conducive to reductions in overland flow.
- 4.9. Not only will these measures assist in management of surface water on site, but also contribute to a reduction in flood risk downstream of the site, as the discharge rate from site is controlled, restricted and attenuated on site. However, cognisance will be taken to ensure downstream receptors are suitably recharged.

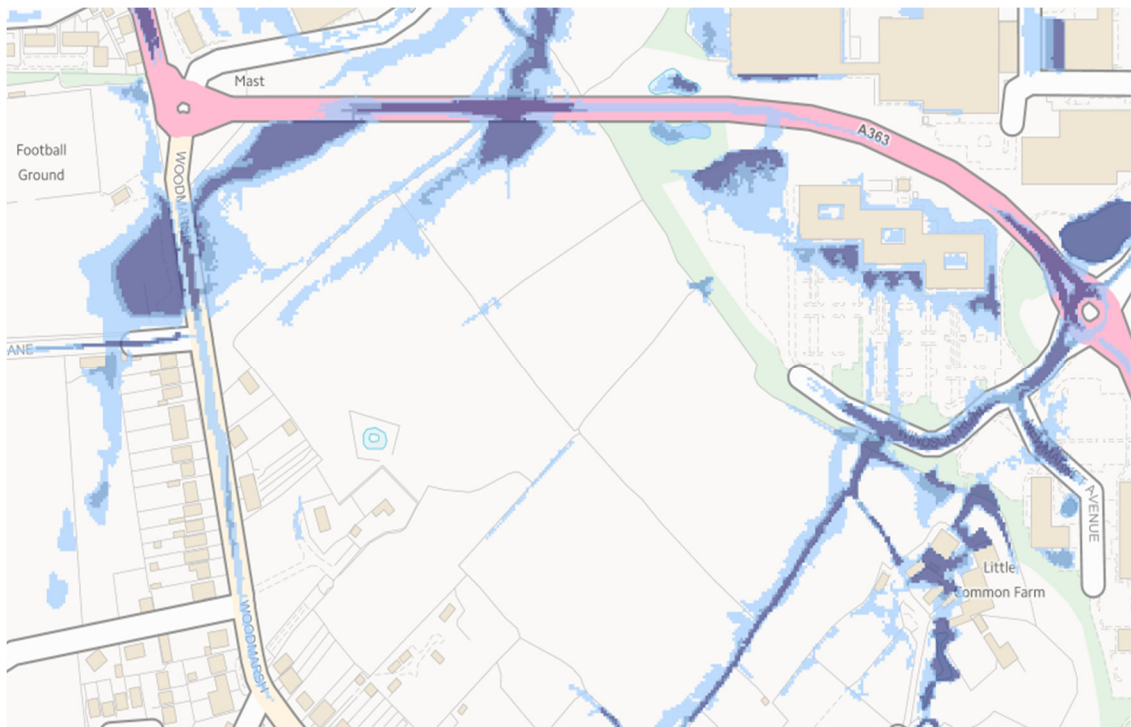


Figure 1 – EA Mapping for Pluvial Flooding

Flood Risk from Groundwater

- 4.10. Groundwater flooding has the potential to occur after prolonged periods of unusually high rainfall. During such periods, more water than usual infiltrates through the ground, raising the water table above its normal depth below the surface. Where the water table is at a shallow depth in any case, the water table can reach the surface. This can cause groundwater to merge with rainfall and cause localised flooding.
- 4.11. The Magic Map online viewer shows that the groundwater vulnerability of a site. It shows that the site is classed as 'unproductive'.
- 4.12. There is no known evidence of flooding from groundwater impacting the site. The risk of flooding from groundwater sources is therefore considered low.

Flood Risk from Sewers

- 4.13. When exceeded, surcharged sewer networks can lead to flooding from backed up manholes and gully connections.
- 4.14. There is no known evidence of flooding from the nearby public sewers. The risk of flooding from sewers is therefore considered low.

Flood Risk to the Site from Other Sources

- 4.15. The SFRA, EA flood risk maps and local available documents indicate the site does not fall within the extent of flooding from reservoirs, canals or other artificial sources.



- 4.16. In Wessex Water's Development Enquiry there was no reference to any flood risk issues as a result of sewer flooding.
- 4.17. All proposed surface and foul water drainage systems will be designed to accommodate flows to modern standards and thus present negligible risk of flooding. In the unlikely event of a failure following a heavy rainfall event, flood depths would typically be restricted to very shallow depths. This would usually be contained within carriageways directing any flood water away from buildings and people.
- 4.18. Wiltshire Council's SFRA states that due to the nature of the underlying geology groundwater is not deemed to be a significant cause of flooding in the West Wiltshire District which Trowbridge falls within.

Flood Risk Summary

- 4.19. A summary from flooding from all sources is shown in **Table 1**.
- 4.20. Based upon the above information, the site is deemed to be at low risk of flooding. The Site Layout is therefore in accordance with national and local planning policy concerning flood risk and as such is suitable for the proposed development.

Table 1 – Summary of Flood Risk

Source of Flooding	High	Medium	Low	Comments
Tidal			✓	The site is inland.
Fluvial			✓	The site is located within Flood Zone 1.
Pluvial			✓	Most of the site is at a 'Very Low' of risk of surface water flooding.
Groundwater			✓	No evidence of groundwater levels emanating at the surface.
Sewers			✓	There are no records of sewer flooding at the site.
Reservoirs, canals and other artificial sources			✓	EA and SFRA mapping do not indicate the site to be at risk.
Design flood			✓	The site is located outside of the modelled 1 in 100 annual probabilities plus climate change allowance maximum flood extent.



5.0 Proposed Development and the Sequential Test

Proposed Development

- 5.1. Details of the proposed development are included in **Appendix 1**.

Flood Risk Vulnerability

- 5.2. Annex 3 of the NPPF sets out the flood risk vulnerability classification of a site. This is based upon its proposed usage. Table 3 of the NPPF PPG 'Flood Risk and Coastal Change' is used to determine whether the proposed development is suitable for the Flood Zone that the site is located within and whether the Exception Test is required for the proposed development.
- 5.3. The proposed residential development is classed as 'More Vulnerable' development.
- 5.4. The location of the 'More Vulnerable' development is located within Flood Zone 1 and within areas with a 'Low' or 'Very Low' risk of surface water flooding.

NPPF Sequential Test

- 5.5. NPPF states that Local Planning Authorities allocating land for development should apply the Sequential Test to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- 5.6. PPG ID: 7 (Table 1) appropriate uses have been identified for the Flood Zones. By applying the Flood Risk Vulnerability Classification in Table 2 and 3 of PPG ID: 7.
- 5.7. The proposed development is classed as 'More Vulnerable' development. These uses are considered appropriate within Flood Zone 1 and areas with a 'Low' and 'Very Low' risk of surface water flooding without the need for the Sequential Test or the Exception Test to be undertaken.
- 5.8. A site-specific FRA is required for all development in Flood Zones 2 and 3, and for all developments over 1ha in Flood Zone 1 under the NPPF.



6.0 Drainage Strategy

Introduction

- 6.1. This chapter provides details on the surface water drainage strategy and measures to drain the proposed development site.

Methodology

- 6.2. The proposed drainage strategy has been designed to achieve the requirements of the revised NPPF this site-specific FRA will demonstrate the following that
- a. within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location
 - b. the development is appropriately flood resistant and resilient;
 - c. it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
 - d. any residual risk can be safely managed; and
 - e. safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Management Strategy

- 6.3. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. Changes of land uses can have significant downstream impacts where existing drainage systems may not have sufficient capacity for any additional surface water flow.
- 6.4. A surface water management strategy for the development will be required to manage and reduce the flood risk posed by the surface water runoff from the site.
- 6.5. There are three possible options to discharge the surface water runoff in accordance with requirement H3 of the Building Regulations 2010. Rainwater shall discharge to one of the following, listed in order of priority:
- An adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable
 - A watercourse; or where that is not reasonably practicable
 - A sewer.
- 6.6. The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates to the pre-development scenario, unless specific off-site arrangements are made and result in the same net effect.



- 6.7. From desktop study information, it is unlikely that infiltration is practicable. Therefore, the surface water drainage will be designed to attenuate runoff with controlled discharge to the local watercourses i.e. the existing open field ditch on site which would be feasible point of discharge. Implementation of SuDS will ensure that flood risk downstream is not increased because of the proposed development.
- 6.8. Wiltshire Council has permissive rights over any ordinary watercourses/land drainage ditches. If any work is required within the watercourse then approval from WC is required.
- 6.9. Details of any crossings and proposed culverts will require the approval of the Land Drainage Authority as appropriate.
- 6.10. Timber bridges are deemed to be appropriate for footway/cycleway crossings of watercourses with oversized box culverts appropriate for road crossings, providing that it can be demonstrated that other alternatives which retain the open watercourse are not possible, thereby justifying that culverting is the only viable option.

Sustainable Drainage Systems (SuDS)

- 6.11. Sustainable water management measures should be used to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from the surface water runoff.
- 6.12. The Construction Industry Research and Information Association, CIRIA's C690
 - 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 surfaces)
 - Source Control – control of runoff at or very near its source (such as the use of rainwater harvesting)
 - Site Control – management of water from several sub-catchments (including routing water from roofs and car parks to one or several soakaways for the entire site)
 - Regional Control – management of runoff from several sites, typically in a detention basin or wetland.
- 6.13. In 2015 CIRIA published the SuDS Manual (C753) providing the best practice guidance on the planning, design, construction, operation and maintenance of SuDS.
- 6.14. The four main categories of benefits that can be achieved by SuDS, referred to as the four pillars of SuDS design, are:
 - Water quantity – control the quantity of runoff to support the management of flood risk, and maintain and protect the natural water cycle
 - Water quality – manage the quality of the runoff to prevent pollution
 - Amenity – create and sustain better places for people
 - Biodiversity – create and sustain better places for nature.

6.15. Given that infiltration type SuDS devices are not considered feasible, the following SuDS components are applicable to the site include:

- Pervious surfacing systems – structural surfaces that allow water to penetrate into a granular layer thus providing storage and treatment, e.g. pervious paving.
- Conveyance systems – components that convey flows to downstream storage systems, e.g. swales and filter drains.
- Storage systems – components that control flow, and possibly volumes, by storing water and releasing it slowly, e.g. attenuation basins and wetlands.
- Treatment systems – components that remove or facilitate the degradation of contaminants present in runoff, e.g. filter strips and proprietary treatment systems.

Greenfield Run Off Rates

6.16. The development site is approximately 8.37ha Greenfield site, of which 1.929ha is developed with the remainder of the site as open space, gardens and other soft landscaped areas.

6.17. The developable area has been split into 3 catchments and served by 3 proposed drainage networks.

Table 2 – Catchment Areas

Catchment	Developable Area (ha)	Assumed Impermeable Area (ha)	Percentage covered in Impermeable Surfaces (P_{imp})
1	1.869	1.210	65%
Access	0.060	0.06	100%
Total	1.929	1.270	

6.18. It is assumed that majority of rainfall currently occurs as overland flow at source routed towards the ditches on the field boundaries within the site. Some water will infiltrate into the underlying soil.

6.19. An assessment of existing surface water runoff has been undertaken, in order to determine the potential surface water options and attenuation requirements for the site.

6.20. To quantify any potential increase in surface water runoff, the existing Greenfield runoff rate from the site must initially be determined.

6.21. The following parameters have been incorporated into the runoff calculations:

- Catchment Area: 1ha
- Average Annual Rainfall (SAAR): 731mm
- Soil: 0.470
- Region No.: 8

6.22. Greenfield run-off calculations for the existing site provide the following discharge rates:

Table 3 – Greenfield Runoff Rates & Volume

Area	1:1 Storm Event	QBar Storm Event	1:30 Storm Event	1:100 Storm Event
1.00ha	4.0 l/s	5.1 l/s	9.9 l/s	12.3 l/s
1.27ha	5.1 l/s	6.5 l/s	12.6 l/s	15.6 l/s
Greenfield Runoff Volume (m ³)	101.7m ³	-	237.6m ³	323.4m ³

Surface Water Treatment Improvements

- 6.23. CIRIA report C753 The SuDS Manual outlines the methodology for assessing water quality risks associated with new development. This is a simple index approach which provides a high level scoping analysis of land usage and gives guidelines for appropriate treatment stages.
- 6.24. This process identifies features necessary to provide adequate substance removal in line with Environment Agency requirements. This is a three-step process of Allocation, Mitigation and Review.
- 6.25. Surfaces generating runoff are 'graded' on their potential to contribute to various harmful pollutants and gives each surface a risk of pollution from each element.
- 6.26. Historically, PPG3 documentation would recommend that pollutants were removed utilising oil separators, but since it has been superseded, more recent guidance has shifted to the use of SuDS features to remove pollutants; thereby providing significant improvements in treatment. The use of non-mechanical features also reduces the requirements for maintenance and increase natural biodiversity.
- 6.27. Without adequate treatment, the pollutants would cause damage if they were to enter the watercourse or water table in large volumes. The use of SuDS features slow down and degrade these pollutants which is critical to the provision of an acceptable drainage scheme.
- 6.28. The final drainage solution will therefore provide a comprehensive treatment train under all events, thus providing a realistic strategy which mimics the cleansing effectiveness as the concentration of the pollutant decreases along the SuDS Management Train.

Surface Water Drainage Strategy

- 6.29. Based on the proposed site layout for the developed site, it has been conservatively estimated that the impermeable area for residential housing and associated hardstanding will be approximately 65% P_{imp} of the developable area.
- 6.30. The conservative estimates of 65% P_{imp} make allowances for urban creep allowance of 10% in accordance with The SuDS Manual (CIRIA 753) and assist with WC's Betterment Policy.



- 6.31. A surface water management strategy for the proposed development has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. The drainage system for the proposed development will manage and reduce the flood risk posed by the surface water runoff from the site.
- 6.32. To achieve the above, proposed discharge rates would be restricted to Greenfield discharge rates for all storms up to and including the 1 in 100 year storm event plus a 45% allowance for climate change. This will require on-site attenuation to hold back flows controlled by an on-site flow control device, such as a Hydrobrake manhole.
- 6.33. All discharge flows will be restricted to QBAR (minus 20% in accordance with WCC betterment policy) for all storm events up to and including the 1 in 100 year storm event plus 45% allowance for climate change. This would negate the requirement for Long Term Storage and again flows would be attenuated on site and discharged utilising an on-site flow control device such as a Hydrobrake.
- 6.34. There are two attenuation basin features 1 and 2, each providing attenuation for the proposed development, shown in the Drainage Strategy drawing A201-005 P5 Preliminary Drainage Strategy in **Appendix 3**.
- 6.35. The Drainage Strategy and Microdrainage Simulation Report in **Appendix 3** demonstrates that surface water from the proposed development can be managed such that flood risk to and from the site following development is not increased in accordance with WC's Betterment Policy for both discharge rate and discharge volume.
- 6.36. A summary of the attenuation volumes is set out in **Table 4**:

Table 4 – Attenuation Volume Requirements

Basin	Calculated Attenuation Volume Required (m ³)
1	1,124
2	282
Total	1,406

- 6.37. There is scope to utilise source control techniques and further refinements of the design which will assist with the reduction of the attenuation storage, which could be investigated at detailed design stage. The drainage strategy drawing indicates possible locations for roadside swales and permeable paving.
- 6.38. As groundwater was encountered at 1.5m deep, the base levels of each basin do not exceed this level. However, site-specific ground water monitoring is recommended in order to confirm the drainage strategy. The attenuation basins are proposed to be lined with an impermeable geotextile membrane.
- 6.39. Surface water run-off from the development site to the existing watercourse is to be restricted to the Greenfield QBAR runoff rate. Discharge from the development features will be managed using flow controls within manholes or headwalls.



- 6.40. It is proposed to provide a network of trapped gullies, pipes and Sustainable Drainage (SuDS) features to collect the surface water runoff from hardstanding areas such as roads, roofs and driveways. The traditional system will work in combination with such features as pervious paving, swales and basins to provide attenuation storage and high-quality water benefits.
- 6.41. Sustainable water management measures will be introduced to control the surface water runoff from the proposed development site thereby, managing the flood risk to the site and surrounding areas from the surface water run-off.

Maintenance and Adoption

- 6.42. SuDS serving single properties, for example, pervious paved driveways to single dwellings, will be owned and maintained by the owner of that property.
- 6.43. SuDS within the public open space will be offered to Wiltshire Council for maintenance and adoption. Wiltshire Council is the lead drainage authority.
- 6.44. Any SuDS not adopted by Wiltshire Council will be maintained by a private management that will be appointed to maintain other private assets such as landscaping.
- 6.45. Suitable adoption and maintenance regimes for SuDS should be submitted in support of the reserved matters application.

Flood Flow Conveyance and Site Finished Floor Levels

- 6.46. The Illustrative Masterplan for the proposed development site provides space in the northern portion of the site for surface water attenuation basins prior to restricted discharge into the unnamed ordinary watercourse adjacent to A363 Bradley Road.
- 6.47. The surface water mapping shows pluvial flooding (overland) attributed to the unnamed ordinary water courses crossing the site. It is assumed in heavy rainfall events it accumulates in the northern portion of the site before it flows into the culverted section beneath A363 Bradley Road.
- 6.48. A wider hydraulic assessment of the watercourse that bisects the site is recommended. The conclusions of the assessment will inform how the development will affect which areas will flood in the post development scenario. The hydraulic assessment will inform on the existing flood levels where any ditch crossings/dwellings are proposed. The minimum finished floor level (FFL) would be based upon the existing flood level plus a 300mm additional allowance for freeboard.
- 6.49. It is envisaged that the post development scenario will reduce extent of pluvial flooding shown earlier in the report.

Safe Access and Egress

- 6.50. The main access road to the development is via the A363 Bradley Road to the north. A future southern link for proposed development to the south east of the development site.



- 6.51. Safe access and egress is to be designed to meet requirements in accordance with WC's SFRA: The development should be safe throughout its life, to achieve this dry pedestrian egress should be possible above the 1 in 100 year fluvial flood level and emergency vehicular access should be possible during times of extreme flood (an extreme flood event is an event with an annual probability of between 1% (1 in 100 year) and 0.1% (1 in 1000 year)). The site access and access road will be designed at 300mm above the 1 in 100 year fluvial flood level. Therefore, dry pedestrian egress can be afforded off A363 Bradley Road.
- 6.52. There is no requirement to provide safe access and egress to public open space.

Foul Water Drainage Strategy

- 6.53. It is intended that the foul water from the development will ultimately discharge to the existing Wessex Water 150mm diameter foul water sewer in A363 Bradley Road to the north of the site.
- 6.54. This will be achieved via a pumped system within the proposed development that will discharge into proposed manhole on A363 Bradley Road. From this manhole, a connection into the existing Wessex Water foul water network can be made.
- 6.55. Upon granting of planning Wessex Water will need to undertake further review of the foul sewer networks as cumulative development in the catchment may exceed capacity in local systems. If this is the case, Thames Water will be required to make appropriate upgrade and off-site reinforcement to serve the site. Wessex Water will need to undertake modelling work and, if required, design a solution and build the necessary improvements which will be completed at Wessex Water's cost.
- 6.56. The proposed foul water sewers will be designed in collaboration with Wessex Water as approving body in accordance with Sewers for Adoption 7th edition.
- 6.57. It is proposed to offer the proposed sewers to Wessex Water for adoption under S104 Agreement of the Water Industry Act.
- 6.58. Connections to existing adopted sewers will be made via a S106 Agreement with Wessex Water as part of the adoption process.

7.0 Summary and Conclusions

Introduction

- 7.1. This chapter summarises the previous chapters and assesses the suitability of the development proposals in the context of on and off-site vulnerability.

Summary

- 7.2. This report presents a Flood Risk Assessment, in accordance with the revised NPPF and PPG, in respect of the proposed development to change from its existing agricultural use to up to 100 residential dwellings on land south of Trowbridge in Wiltshire.
- 7.3. This report details the flood risk at the site and how this could be managed and mitigated to allow the site to be developed in support of the planning application.

Assessment of Flood Risk

- 7.4. The FRA has demonstrated the following:
- There are Ordinary Watercourses in the form of unnamed field ditches within the site which will not present a residual risk of flooding to the site greater than that of the existing. This will need to be confirmed by a hydraulic assessment.
 - The detailed Fluvial flood map, for fluvial sources, provided by the Flood maps for Planning–GOV.UK website indicate that the site area is entirely located with Flood Zone 1; assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%).
 - Whilst the detailed flood map provided by the EA Flood Map indicates northern portion of the site is affected by pluvial flooding, any future risk of pluvial flooding will be mitigated by the drainage and flood attenuation features provided to the north of the development.
 - Wiltshire Council's SFRA did not deem groundwater flooding to be a significant issue, it is recommended that site-specific groundwater monitoring is undertaken to inform the design of the surface water attenuation basin features.
 - The detailed flood map provided by the EA Flood Mapping indicates no risk from secondary flooding sources, such as reservoirs, within the site.

In PPG ID: 7, the appropriate uses have been identified for the Flood Zones. The proposed development is classified as 'more vulnerable'. All development types of this classification are deemed acceptable in terms of flood risk.

Site Drainage

- 7.5. The FRA has considered the potential impact of the development on surface water runoff rates. The surface water management strategy for the proposed development will manage and the flood risk posed by the surface water runoff from the site.



- 7.6. The proposed areas of hardstanding surfaces will be directed to the existing watercourses following the existing topography of the site. Attenuation will be provided with a limited discharge rate thereby mimicking the existing drainage situation as closely as practicable.

Conclusions

- 7.7. It is concluded that this Flood Risk Assessment demonstrates that the development satisfied the NPPF and can be justified in the proposed location. Any increase in surface water run-off can be managed using SuDS techniques like pervious paving used widely to provide source control as well as attenuation features proposed to provide storage in extreme storm events.
- 7.8. The above provides the minimum of two treatment stages which is in accordance with the recommendations of CIRIA C753.
- 7.9. All surface water drainage systems will be designed to restrict discharge rates, in line with WCC Betterment Policy, to greenfield QBAR runoff rate and store the balance of water for all events up to and including the 1 in 100 year event including allowance for a 45% increase in rainfall intensities as a result of climate change.
- 7.10. This site-specific Flood Risk Assessment has:
- produced an assessment that meets the criteria set out in NPPF;
 - assessed the risk posed to the site from flood events;
 - assessed the risk posed to the site from the site storm water generation and the site storm water runoff management; and
 - assessed the risk the site poses to increase in flooding elsewhere
 - included an allowance for urban creep as set in CIRIA guidance; and
 - accorded with WC's Betterment policy.



Appendices



Appendix 1 - Plans

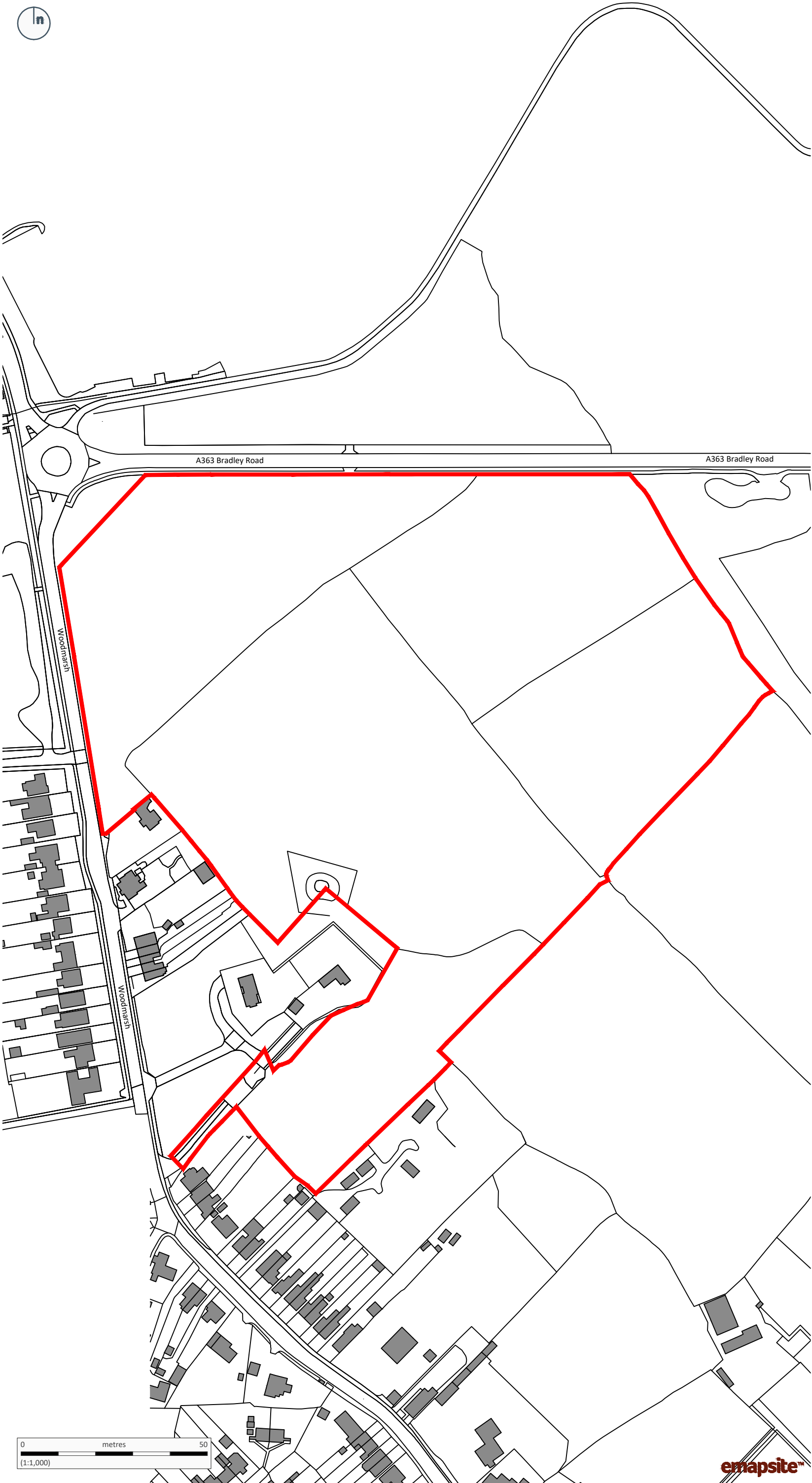
Site Location Plan

Sketch Layout

Parameter Plan

Proposed Site Access

Watermans Flood Map



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KEY

Application boundary

CLIENT
Castlewood Property Ventures Ltd

PROJECT
Land off the A363 White Horse Business Park

DRAWING
Redline Plan

PROJECT NUMBER
CASR3002

DRAWING NUMBER	CHECKED BY
1001	JB

REVISION	STATUS
A	FINAL

DATE	SCALE
October 2021	1:2,000 @ A3

emapsite™

Turley



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PROJECT

Land off the A363 White Horse Business Park

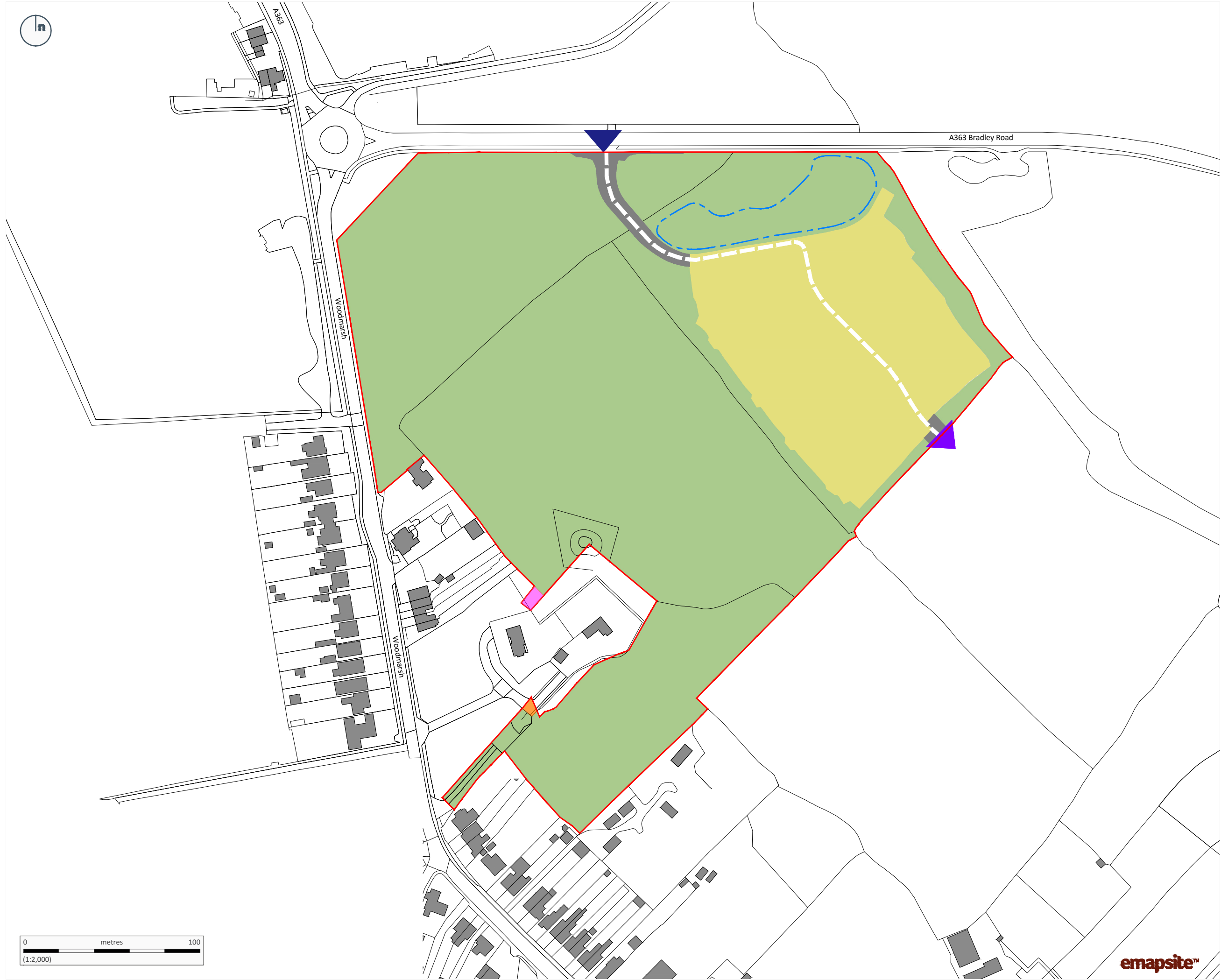
PROJECT NUMBER
CASR3002

REVISION	STATUS
D	Draft

DATE 15/05/2023 SCALE 1:2000 @ A3

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- Residential land (Up to 2.5 storey)
- Green infrastructure
- Highways
- Indicative attenuation features
- Indicative primary highways route
- Proposed access points
- Future access points to adjacent development
- Land safeguarded for access
- Land to be retained as is

CLIENT
Castlewood Properties Limited

PROJECT
Land off the A363 White Horse Business Park

DRAWING
Parameter Plan - Land Use

PROJECT NUMBER
CASR3002

DRAWING NUMBER 5000 **CHECKED BY** DH

REVISION K **STATUS** DRAFT

DATE May 2023 **SCALE** 1:2000 @ A3

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Appendix 2 - Responses

Wiltshire Council Correspondence

Wessex Water Correspondence

Wiltshire Council LLFA Comments

Response to LLFA Comments

Charles Graham

From: VanNiekerk, Carli <Carli.VanNiekerk@wiltshire.gov.uk>
Sent: 18 February 2020 15:43
To: Charles Graham
Subject: RE: A201 Land South of Bradley Road, North Bradley, Trowbridge, Wiltshire BA14 0RQ

Follow Up Flag: Follow up
Flag Status: Flagged

Mr Graham,

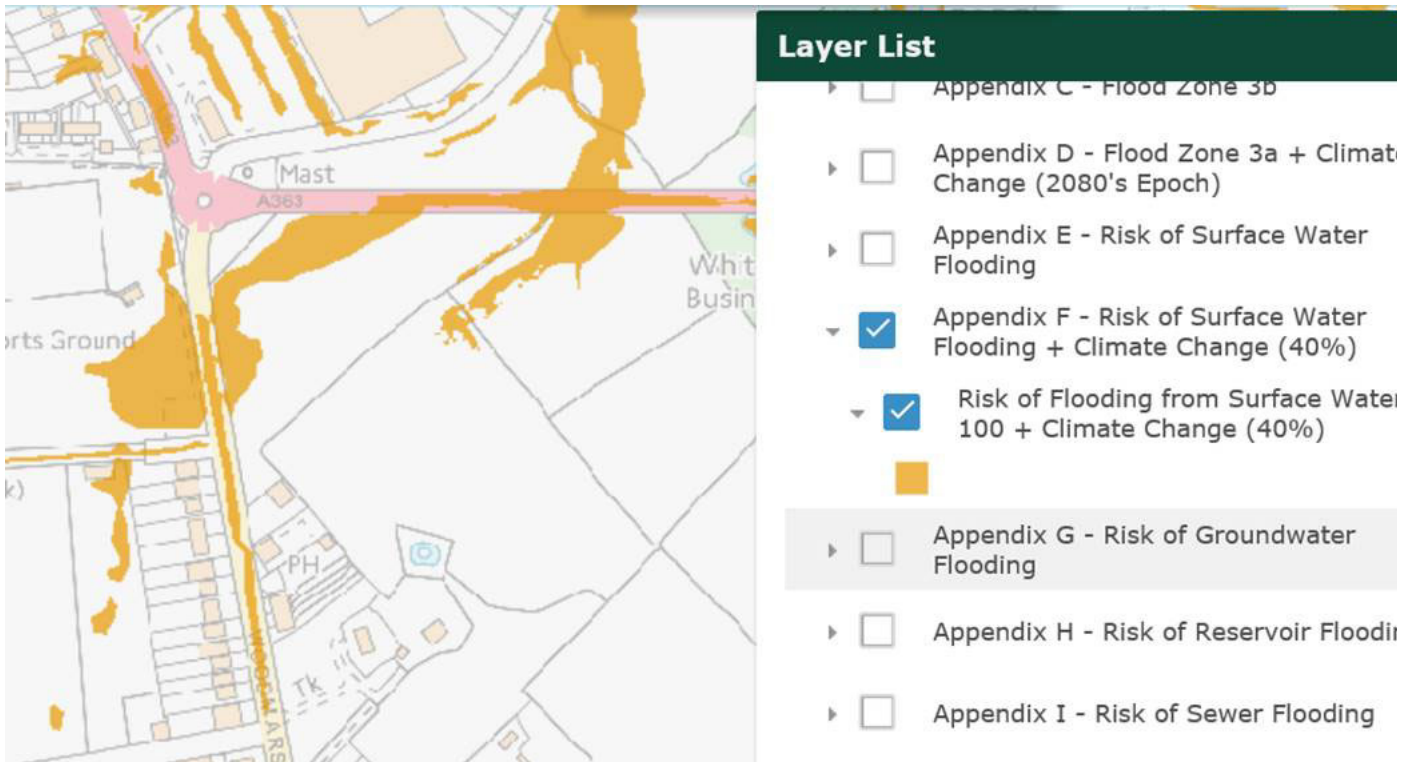
I'm happy to provide advice, but please also note that there is a formal pre-application process that you can follow to get comments from all consultees. With SuDS there is a cross over with ecology, urban design and landscape, so it would be useful to get their comments as well.

I see that there has been 2 planning applications for this site in the past, see table below. I could not find drainage or flood risk comments for either.

Reference	Proposed development	Outcome
W/02/00350/FUL	Alterations to access	Approve with Conditions
W/07/01620/FULES	New football stadium, covered pitches and clubhouse facilities, training pitch and associated facilities	Withdrawn

- The proposed development constitutes major development, therefore para 165 of the NPPF applies:
165. Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:
 - a) take account of advice from the lead local flood authority;*
 - b) have appropriate proposed minimum operational standards;*
 - c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
 - d) where possible, provide multifunctional benefits.*
- The applicant would need to evidence application of the surface water disposal hierarchy - 1st Re-use, 2nd Infiltration, 3rd watercourse/surface water body, 4th surface water sewer, 5th combined sewer.
- The drainage strategy should take account of climate change in accordance with [EA guidance](#) and urban creep.
- With regards the control of surface water discharges from greenfield sites, Wiltshire Council requires post development discharges to provide 20% betterment over pre development discharges for both peak flow and volume. For more information refer to Wiltshire Council's betterment policy update which can be found [here](#).
- Wiltshire Council is the land drainage authority under the Land Drainage Act 1991. Land drainage consent is required if a development proposes to discharge flow into an ordinary watercourse or carry out work within 8m of an ordinary watercourse. An ordinary watercourse is a watercourse that does not form part of a main river. The term watercourse includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows. Wiltshire Council's land drainage bylaws can be downloaded [here](#). The land drainage consent application form and guidance notes can be found on our website [here](#).
- According to our [L1 SFRA mapping](#) the site is at risk of surface water flooding in the 100 year plus climate change scenario (see screen shot below). The current layout shows the ponds located where surface water flooding is predicted to occur. The site specific FRA and drainage strategy should demonstrate that the ponds have sufficient capacity to accommodate the existing flooding and proposed runoff.

- The site layout should be developed following a sequential approach i.e. putting the most vulnerable development in the lowest flood risk areas.
- Finally, the table below outlines the level of information required at each application stage. Provision of the correct information will expedite the processing of your application by the LLFA.



Pre-app	Outline	Full	Reserved matters	Discharge of conditions	Document to be submitted
✓	✓	✓			Flood Risk Assessment / Statement
✓	✓	✓			Drainage Strategy / Statement & sketch layout plan
	✓				Preliminary layout drawings
	✓				Preliminary "Outline" hydraulic calculations
	✓				Preliminary landscape proposals
	✓				Ground investigation report (for infiltration)
	✓	✓			Evidence of third party agreement for discharge to their system (in principle/ consent to discharge)
		✓		✓	Maintenance program and on-going maintenance responsibilities
		✓	✓		Detailed development layout
		✓	✓	✓	Detailed flood & drainage design drawings
		✓	✓	✓	Full Structural, hydraulic & ground investigations

		✓	✓	✓	Geotechnical factual and interpretive reports, including infiltration results
		✓	✓	✓	Evidence of measures to prevent pollution of the receiving groundwater and/or surface waters
		✓	✓	✓	Drawings showing conveyance routes for flows exceeding the 1 in 100 year plus climate change
		✓	✓	✓	Detailed landscaping details
		✓	✓	✓	Discharge agreements (temporary and permanent)
		✓	✓	✓	Development Management & Construction Phasing Plan

Kind regards

Carli van Niekerk CEng MICE
Principal Drainage Engineer (Planning)
 Weather and Drainage/Highways Asset Management and Commissioning

Wiltshire Council

Tel: 01225 713273
 Email: carli.vanniekerk@wiltshire.gov.uk
 Web: www.wiltshire.gov.uk
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From: Drainage <Drainage@wiltshire.gov.uk>
Sent: 11 February 2020 10:32
To: VanNiekerk, Carli <Carli.VanNiekerk@wiltshire.gov.uk>
Subject: FW: A201 Land South of Bradley Road, North Bradley, Trowbridge, Wiltshire BA14 0RQ

From: Charles Graham <cgraham@alpce.co.uk>
Sent: 27 January 2020 16:01
To: Drainage <Drainage@wiltshire.gov.uk>
Subject: A201 Land South of Bradley Road, North Bradley, Trowbridge, Wiltshire BA14 0RQ

Dear Sir or Madam,

We have been in correspondence with Wessex Water regarding the Foul water drainage of a proposed site comprising 99no residential dwellings and 1no Care Home facility south of Bradley Road, Trowbridge, BA14 0RQ.

Please could Wiltshire Council as Lead Local Flood Authority provide any advice on surface water arrangements/flood risk measures. We have devised a preliminary drainage strategy (attached) for comment.

Any advice/comments would be greatly appreciated.

Kind Regards

Mr Charles Graham
Engineer

Tel: 01488 684390

Abley Letchford Partnership Ltd
Consulting Engineers

3 Tealgate, Charnham Park
Hungerford, RG17 0YT

www.alpce.co.uk



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Charles Graham

From: Alison Kurobasa <Alison.Kurobasa@wessexwater.co.uk>
Sent: 04 February 2020 13:30
To: Charles Graham
Subject: WWDevResp ST85NE/ 406 : Prelim Drainage Strategy - Land South of Bradley Road, North Bradley, Wiltshire
Attachments: A201-005 P1 Preliminary Drainage Strategy.pdf

Hello Charles

Thank you for sending through a copy of your preliminary drainage strategy for our comment.

The site shall be served by separate systems of drainage.

Foul Sewerage

We welcome the strategy to discharge foul flows north-east to manhole ST85558805 which is our preferred point of connection.

A pumped connection would be acceptable with a break chamber as you have indicated.

Wessex Water will adopt a foul pumping station and sewers through a formal S104 agreement, subject to satisfactory engineering proposals constructed to current adoptable standards.

No dwellings within 15metres of the pumping station and satisfactory access arrangements appear achievable.

The route of the rising main will require a 6m easement (3m either side) and must not conflict with the attenuation basin earthworks.

Strategic Planning

We are aware of allocated development on an adjoining site to the south and we may seek a degree of flexibility to accommodate foul flows from the adjacent site. If there is a viable option where your single pumping station serves both sites, we would look to explore this. Under Section 112 of the Water Industry Act we can seek to amend designs to achieve a more sustainable solution particularly if this can avoid two separate pumping stations on adjacent sites.

Changes may include increasing storage at your pumping station and providing a length of foul sewer to link sites. The extra over expenses reasonably incurred in complying with an undertaker's Section 112 requirements would be repayable to the developer.

We fully appreciate the complexities of different developers and sites coming forward at different times and will continue to monitor site layouts and drainage strategies as they progress through the planning process and work with developers and the planning authority to promote a sustainable foul drainage solution.

Surface Water Drainage

The strategy to discharge to local watercourse at a restricted rate via attenuation basins is acceptable to us but will require the approval of the Lead Local Flood Authority.

I hope that you will find the above comments of use, however, please do not hesitate to contact me if you require further information or clarification.

ALISON KUROBASA
PLANNING LIAISON

Wessex Water
Claverton Down Bath BA2 7WW
wessexwater.co.uk

Direct Dial: 01225526611
Planning Liaison: 01225526288

We have recently developed a new online service for obtaining Wessex Water Asset Maps. This service allows you to quickly and easily receive a copy via email <https://maps.wessexwater.co.uk/webapps/request-a-map/>

From: Charles Graham <cgraham@alpce.co.uk>

Sent: 29 January 2020 15:23

To: Alison Kurobasa <Alison.Kurobasa@wessexwater.co.uk>

Subject: RE: WWDevResp ST85NE/ 406 : Land South of Bradley Road, North Bradley, Wiltshire

Hi Alison,

Thank you for the comments in your email dated 14 November 2019.

We have produced the attached preliminary drainage strategy for the site and would welcome any further comments/advice to ensure we are in line with Wessex Water's requirements with regard to the surface and foul water drainage.

We look forward to hearing from you.

Many thanks

Kind Regards

Mr Charles Graham
Engineer

Tel: 01488 684390

Abley Letchford Partnership Ltd
Consulting Engineers



From: Alison Kurobasa <Alison.Kurobasa@wessexwater.co.uk>

Sent: 14 November 2019 16:00

To: Colin Sumbler <csumbler@alpce.co.uk>

Subject: WWDevResp ST85NE/ 406 : Land South of Bradley Road, North Bradley, Wiltshire

For the attention of Mr Colin Sumbler

Site: Land South of Bradley Road, North Bradley, Wiltshire
Proposal: 149 Dwellings

Thank you for your development enquiry. Please find attached an extract from our records showing the approximate location of our apparatus within the vicinity of the site.

The manhole details are as follows:

Woodmarsh 150mm foul sewer: MH ST8555601; CL 44.639, IL 43.359. MH ST8555701; CL 44.388, IL 43.198.

Bradley Road 150mm foul sewer: MH ST85559803; CL 43.360, IL 42.010. MH ST85558805; CL 42.890, IL 41.340. MH ST85558804; CL 43.330, IL 41.180

Bradley Road 600mm SW sewer: MH ST85558802; CL 43.050, IL 40.250. MH ST85558801: CL 44.000, IL 39.900

Proposed Sewerage

Separate systems of drainage must be provided to serve development proposals:

Foul Drainage

We can accept foul only flows from the development and there are 150mm public foul sewers located to the north east in Bradley Road and to the west in Woodmarsh. Developers may connect to the nearest public sewer on a size for size basis and Wessex Water fund any necessary capacity improvements from infrastructure charges income. Upon grant of planning Wessex Water will need to undertake further review of the foul sewer networks as cumulative development in the catchment may exceed capacity in local systems. We are aware of allocated residential sites to the south of this site and Wessex Water would welcome the opportunity to agree an overall drainage strategy for this area (see Strategic Planning note below).

Surface Water Drainage

Surface water to be disposed of in accordance with Suds Hierarchy and NPPF Guidelines and should be directed to local land drainage systems.

Surface water arrangements and supporting flood risk measures to be agreed with the Lead Local Flood Authority.

There must be no surface water connections to the public foul sewer system.

Land drainage run-off shall not be permitted to discharge either directly or indirectly to the public sewerage system

Existing Water Main Crossing the Site

There is an existing 450 Ductile Iron water main crossing the site. This is a strategic trunk main which must be accurately located on site and marked on deposited drawings. There must be no building or tree planting within 6 metres either side of this water main. Wessex Water require unrestricted access to carry out their statutory duties. Consideration must be given to maintaining ground levels above the trunk main and the developer will need to agree protection measures throughout the construction works and thereafter. Connection to this main for site supply will not be possible.

There will be significant costs involved in diverting a trunk main of this size. Diversions of public apparatus are at the developer's cost. For a high level budget cost please visit our website and use the charges calculator which has been created for developers to interactively generate a budget quotation for their project: <https://www.wessexwater.co.uk/services/building-and-developing/charging-arrangements> (I have attached an excel version but please be aware that this may become out of date, the online version will always be updated with the current charging arrangements).

Water Supply

A water supply is available from the local distribution mains in Woodmarsh and Bradley Road.

Wessex Water will need to undertake further review of cumulative development in the catchment may exceed capacity in local systems (see Strategic Planning note below).

A connection via development to the north of the site through to the water main in the bypass would be preferable.

Buildings above two storeys will require on site boosted storage.

Strategic Planning

Through the planning process we will seek to promote a co-ordinated scheme of works that will deliver a strategic solution for the wider planning allocation, providing water and sewerage capacity for all allocated development sites. A network capacity appraisal will be required to confirm the scope of any improvements necessary to accommodate additional loadings from multiple development applications and if we are unable to provide this capacity in the short term we advise that we will need to reach agreement with developers and the Local Planning Authority upon the timetable for a scheme of works to meet future catchment growth, upon any grant of planning permission. We welcome the opportunity to further discuss your proposals and programme throughout the planning and development process so we may review and plan any network upgrades as necessary.

I trust that you find the above of use, however please do not hesitate to contact me if you require further information or clarification.

ALISON KUROBASA
PLANNING LIAISON

Wessex Water
Claverton Down Bath BA2 7WW
wessexwater.co.uk

From: Colin Sumbler <csumbler@alpce.co.uk>
Sent: 08 November 2019 09:40
To: Teddy Takyi-Amuah <Teddy.Takyi-Amuah@wessexwater.co.uk>
Subject: RE: North Bradley, Trowbridge

Good morning Teddy,
Thanks for getting back to me.

With regards to flows from the proposed development, it is anticipated that up to 149 dwellings will be delivered.

Regards

Mr Colin Sumbler
Principal Engineer

Tel: 01488 684390
Mobile: 07719 322220

Abley Letchford Partnership Ltd
Consulting Engineers



From: Teddy Takyi-Amuah <Teddy.Takyi-Amuah@wessexwater.co.uk>
Sent: 08 November 2019 08:22
To: Colin Sumbler <csumbler@alpce.co.uk>
Subject: RE: North Bradley, Trowbridge

Hello Colin,

RE : SITE AT NORTH BRADLEY

Many thanks for your email and the opportunity to work together on the above proposal . Please accept this response as an acknowledgement of receipt. I will be back in touch once I have fully reviewed your emails and attachments in detail. Are you able to confirm any potential flows for any services required in the interim ?

Kind regards,

Teddy Takyi-Amuah,

From: Colin Sumbler <csumbler@alpce.co.uk>
Sent: 07 November 2019 12:53
To: Teddy Takyi-Amuah <Teddy.Takyi-Amuah@wessexwater.co.uk>
Cc: Planning Liaison <planning.liaison@wessexwater.co.uk>; Leigh Abley <labley@alpce.co.uk>
Subject: North Bradley, Trowbridge

Good afternoon Teddy,
My colleague Leigh Abley gave me your contact details suggesting you may be able to assist.

We write in connection to the above site and would welcome the opportunity to engaging with you in respect to surface and foul water disposal as well as a potential water main diversion. With your assistance the emerging master plan and forthcoming outline planning application will benefit.

Are you able to provide some information on the invert levels of the public sewers (surface and foul) clouded pink on the attached plan? With this we can assess if a foul pump station will be required.

Additionally, can you confirm the size of the water main that crosses the site and provide a high level diversion estimate for the water main diversion (circa 220m) also identified on the attached plan ?

I look forward to hearing from you

Regards

Mr Colin Sumbler
Principal Engineer

Tel: 01488 684390
Mobile: 07719 322220

[Abley Letchford Partnership Ltd](http://www.alpce.co.uk)
Consulting Engineers

3 Tealgate, Charnham Park
Hungerford, RG17 0YT

www.alpce.co.uk



Registered in England No. 8903427
Bremhill Grove Farmhouse, East Tytherton, Chippenham SN15 4LX

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Wessex Water Services Limited, Registered in England No 2366648. Registered Office – Wessex Water Operations Centre, Claverton Down Road, Claverton Down, Bath, BA2 7WW

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From: Caroline Murray <Caroline.Murray@wessexwater.co.uk>
Sent: 10 July 2020 14:39
To: Cox, David
Cc: Davies, Stella; Alison Morgan; calmengineering; Drainage
Subject: Combined Consultation Response for 20/03641/OUT
Attachments: Combined Response M3D6545.asd.doc

David,

Please find attached drainage response

Best Regards

Caroline

Caroline Murray MEng CEng MICE



60 Dovers Park, BATHFORD, BA1 7UD
calmengineering@outlook.com

For and on behalf of Wiltshire Council, the Lead Local Flood Authority (statutory consultee), and Wessex Water, the Water and Sewerage Undertaker (non-statutory consultee)

This is a pilot scheme between the two entities to consider improvements in efficiency and service in providing a joint response. This response has been signed off by both parties as their responsibilities dictate. Any queries or feedback to be directed to the sender.

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Wiltshire Council Planning Consultation Response

05 June 2020

Wiltshire Council Drainage Engineer
Technical Services Drainage Engineer
Wiltshire Council

Officer's Name: David Cox
Officer's Title: Senior Planning Officer
Direct Line: 01225 716774

Application No: 20/03641/OUT
Outline application for up to 100 dwellings and a care home (Class C2 Use) of up to 64 beds (up to 3,750 sqm), as well as vehicular access from the A363. Matters to be considered: Access in to the site
Land South of White Horse Business Park, Trowbridge, Wilts
Eastings: 385918 Northings: 155611
Neil Cowley

Please note the particulars in connection with the above planning application are available to view on the planning website <http://www.wiltshire.gov.uk/planninganddevelopment.htm>

I would welcome any comments that you have about this particular application by **10 July 2020**. If I do not receive your observations and comments by this date I will assume you have none. If you require an extension of time please contact the Planning Officer above who will do their best to accommodate this.

Recommendations:

☐	No Comment
☐	Support
☐	Support subject to conditions (please set out below)
☒	Object (for reasons set out below)
☐	No objections

Matters Considered:

The matters considered below have been undertaken in consultation with Wessex Water to enable a co-ordinated response to this application looking at flood risk and surface water drainage only. Water supply and foul drainage will be covered in a separate response from Wessex Water.

The application has been supported with a Site Specific Flood Risk Assessment (FRA). It should be noted that our comments below are reliant on the accuracy and completeness of the FRA and we do not take any responsibility for incorrect data or interpretation made by the authors. The developer, or agent working on their behalf, retains the responsibility for the checking of the design, calculations and details contained in the FRA and additional submitted information.

Summary of proposal

This is an outline planning application for up to 100 residential dwellings and a 64 bed care home facility. The site is currently greenfield and is immediately south of housing allocation site H2.1 Elm Grove Farm.

The site is approximately 8.37ha and is within Flood Zone 1. The development proposals will significantly increase the impermeable areas of the site and therefore the surface water runoff. A Flood Risk Assessment (FRA) has been provided as part of the application in accordance with NPPF guidance. Pre-app advice was sought and the applicant has outlined in detail the key requirements under the policies set out by Wiltshire Council within the FRA. However, many of these key requirements have not been translated into the drainage strategy and mitigation works proposed.

There is not enough evidence to support the proposals to enable an assessment of whether the layout is appropriate and the drainage proposals are deliverable and acceptable from a flood risk perspective.

Flood Risk

In accordance with the FRA and the mapping provided by the Environment Agency, the site is at risk of surface water flooding along the northern areas of the site and along the Bradley Road. This would appear to be partly related to the constraints of the culvert beneath the road, into which the site is proposed to discharge.

The proposed ponds are to be sited in the areas where this flooding occurs to accommodate the existing runoff volumes and those from the development, as per the wording within the FRA. If this is proposed then they will need to be sized to accommodate this additional volume of runoff from offsite and it is difficult to see how and where this has been allowed for in the current submission calculations. It is mentioned earlier in the FRA that this would be incorporated in the design, but there appears to be no assessment of the areas contributing to the existing surface water volumes and runoff currently crossing the site and naturally ponding in the areas where the proposed attenuation features are going to be.

There is a swale proposed along the western boundary of the site which is proposed to intercept flow pathways from off site and divert these to the watercourses and ditches to discharge from the site via the culvert under the Bradley Road to the north. Whilst in principle this would seem a plausible idea, there are two issues with this:

1. it is situated directly over a major water main and so there would be issues with ensuring adequate cover were maintained to this watermain;
2. it is unclear how and where the overland flow routes come from and what catchment is expected to drain via this route and what impact this will have on the ditch system and the culvert under the Bradley Road.

As an additional note, the foul and surface water sewer layout also encroaches upon this same watermain. This would currently be unacceptable to Wessex Water and so would need to be rerouted.

It states in the FRA that groundwater was recorded 1.5m below the surface of the ground, although the FRA states no significant groundwater flood risk. No Ground Investigation Reports appear to have been submitted as part of the application. There is a concern here that the ground water table may be too high to sustain the required depth of attenuation features and so more land take may be required to make this option feasible. There is therefore a query over whether the layout is achievable without further ground investigation to support the application.

Existing Drainage

Open field ditches/ watercourses exist along the central hedge line and the southern and eastern boundaries. These then converge into a culvert beneath the Bradley Road. It is not clear from the report whether these then discharge to the watercourse 0.2km north east beyond Drynham Lane and whether there is suitable connectivity to this final discharge point for the site. 5.53 states that no hydraulic assessment of the watercourse and ditch systems across the site has been undertaken. We would have concerns that this has not been considered as part of the FRA at this stage. We would expect this to have been developed enough for flood levels to be understood, for flow routes and volumes to be quantified and for appropriate mitigation measures to have been proposed to manage the risk from these waterbodies. We feel that this has not been adequately addressed within the FRA, although we fully support their retention within the scheme.

The FRA makes no mention of the pond in the southwestern corner which is partially on the site? What is this? What does it drain? Is there a risk from this feature? We would like to see a better description and plan indicating the existing features on the site, what drains to them and hydraulically, how they perform. Without this, we cannot adequately assess the flood risk.

Sequential Approach

The FRA states that the sequential approach has been applied to the layout of the development but in fact, the proposed care home is located in the northern most point of the site – within the area at risk of pluvial flooding in a 1 in 100 year event. It is unclear how and where existing flow routes are and how the system is designed to intercept these flows to ensure that this risk is mitigated. The swale along the southern extent of the site does not say enough about how flows get directed to here to enable this to be assessed as an appropriate measure.

Discharge Hierarchy

As stated in our pre-application advice, there should be evidence of the application of the surface water disposal hierarchy; (1) reuse, (2) infiltration, (3) watercourse/ surface water body, (4) surface water sewer. The FRA confirms that no infiltration tests have been undertaken, but the underlying geology and the presence of the ditches would

suggest poor permeability. This would need to be proven. However, reuse has not been considered as part of the proposals. On a site of this size we would expect justifiable reasons as to why this has been discounted.

The applicant must submit evidence demonstrating how the surface water disposal hierarchy has been applied and how all other options have been exhausted.

Runoff Rates & Attenuation

The FRA states that all surface water runoff will be limited to Qbar for all events up to the 1 in 100 year plus 40% climate change event. This does not currently allow for a 20% betterment as defined in the Wiltshire betterment policy.

With regards the control of surface water discharges from greenfield sites, Wiltshire Council requires post development discharges to provide 20% betterment over pre development discharges for both peak flow and volume. To demonstrate compliance, the applicant must provide pre and post development runoff rates for a range of return periods (1, 30 and 100 year), and pre and post development runoff volumes for the 100 year, 6 hour rainfall event. This takes account of national policy, as outlined in the [SuDS Technical Standards](#).

The developable impermeable areas quoted in section 5.17 and the proceeding Table 2 do not seem to correlate (3.38ha of developable area vs 3.25ha). It is recognised that the general principles relating to the estimates of impermeable areas within the development and the inclusion of urban creep is appropriate and acceptable.

Discharge from the site is to be controlled by hydro brakes and other such flow control devices. The proposals are to use a network of trapped gullies and pipes as well as SuDS features – but there does not appear to have been any allowance made for these SuDS features in the layout. We would like to encourage further consideration of above ground features for conveyance and treatment of surface water runoff throughout the site.

SuDS

For the purposes of the drainage strategy, the site has been split into discrete catchments, which is in line with the CIRIA guidance for larger site developments. This results in the requirement for 3 attenuation features proposed along the northern boundary of the site. There is a very limited scope of features utilised on such a large site. 5.14 of the FRA does make note of the four pillars of SuDS but this does not appear to translate into the drainage strategy proposed. There seems to be a focus on water quantity and not on the other key pillars of SuDS. In order to truly see the benefits of SuDS, we would expect a full suite of options to be considered and included at this stage.

National planning policy requires SuDS to provide multifunctional benefits, where possible. There are four main categories of benefits that can be achieved by SuDS: water quantity, water quality, amenity and biodiversity. These are referred to as the four pillars of SuDS design. The current proposal only provides one of the four main categories – water quantity. The applicant must also consider water quality/ amenity and biodiversity benefits, in line with Core Policies 52: Green Infrastructure and Core Policy 67: Flood Risk.

The comments from the Council's Drainage team address only water quantity and quality benefits. The Council's Landscape and Design team must be consulted to comment on amenity and biodiversity benefits, to ensure high quality SuDS that provide multifunctional benefits.

There is a suggestion in the FRA that source control techniques would be investigated at detailed design stage, but by setting the layout based on no source control measures, no above ground conveyance features, no biodiversity features, tree pits or other such measures, the current layout will limit the potential space for these techniques to be designed in. Given the Wiltshire policy to include trees as part of flood attenuation (as mentioned in the FRA), is there a missed opportunity to incorporate tree pits as a bioretention technique for source control?

Summary

The drainage proposal fails to take the opportunities available for improving the character and quality of the area through the provision of amenity, biodiversity and climate change resilience. Therefore, in line with paragraph 130 of the National Planning Policy Framework, and the [National Design Guide](#), the drainage team objects to the planning application.

The applicant should note that new Sewerage Sector Guidance (published 1st April 2020) enables Water Companies to adopt SuDS features as part of the surface water drainage network. Policies and Guidance on this can be found at <https://www.wessexwater.co.uk/services/building-and-developing/sector-guidance-on-sewerage-and-water-adoption-agreements>.

If the intention is to offer the drainage scheme up for adoption the applicant will need to consult with Wessex Water, prior to the submission of any drainage scheme details to the local planning authority, to ensure compliance under the new adoption codes and to formally commence the adoption process. Applicants should contact Wessex Water through planning.liaison@wessexwater.co.uk for further information/ discussion.

The Lead Local Flood Authority will support any applications brought forward through the Wessex Water adoption process.

Conditions:

Informatives:

1. The surface water drainage strategy should include/demonstrate the following:
 - Existing greenfield runoff rates for the site.
 - Post development runoff rates in accordance with Wiltshire Council's betterment policy update, which can be found [here](#).
 - A detailed plan showing the existing drainage features on the site and how the proposed drainage strategy will be implemented.
 - A detailed topographical survey that clearly identifies the existing drainage features on the site as well as level contours to show overland flow routes.
 - If infiltration is proposed, soakage tests in accordance with BRE 365 to demonstrate that infiltration is feasible.
 - Calculations to demonstrate the attenuation requirements for the 1 in 100 year plus climate change event to support the proposed strategy.
 - Consent for any outfalls from the proposed drainage systems into a public sewer or other drainage system not owned by the applicant.
 - Evidence that the impact upon existing drainage systems is mitigated by discharging the flow throughout the management train rather than relying upon a single point of discharge.
 - SuDS source control measures to manage water quantity and maintain water quality have been implemented wherever possible and throughout the management train so the development is not reliant upon large attenuation features close to the points of discharge.
 - SuDS have been selected to provide a wide range of benefits including amenity, biodiversity and maintaining water quality.
 - Adequate measures during construction to control pollution to existing watercourses and groundwater.
 - The strategy mimics the existing drainage characteristics of the site by retaining and utilising any existing drainage features.
 - Existing flood flow routes through the site have been maintained or where they will be affected, adequate measures to intercept and safely control flows through the site have been provided to ensure flood risk is not increased elsewhere.
 - If infiltration is proposed, it is implemented in manner that does not create an offsite impact, particularly if there are reports of groundwater flooding in the area.
 - Surface water can be safely managed within the proposed development, up to and including a 1 in 100 year plus climate change event.
 - All proposed drainage features are outside flood zones 2 and 3 and where they are adjacent to an ordinary watercourse, they are not located within the EA surface water flood maps. Where drainage features are located adjacent to flood zones 2 and 3, they must be above the 1 in 100 year plus climate change flood level. This information can be provided by the EA.
 - Exceedance routes that minimise the risks to people and property.
 - Details of how the proposed and existing drainage features on the site will be maintained and managed after completion with confirmation from the relevant authority that they will adopt any systems that are being offered for adoption.
2. The applicant should note that if the intention is to offer the roads for adoption, the LLFA does not provide for the approval of drainage suitable for adoption by the Highway Authority. Further approval should be ascertained from the Highway Authority.

To find out more about the processes required to secure road adoption, contact the Highway Authority at HighwaysDevelopment@wiltshire.gov.uk

3. There must be no interruption to the existing surface water and/or land drainage arrangements of the surrounding land as a result of the operations on the site. Provisions must be made to ensure that all existing drainage systems continue to operate effectively.

Caroline Murray MEng CEng MICE



calmengineering@outlook.com

For and on behalf of Wiltshire Council, the Lead Local Flood Authority (statutory consultee), and Wessex Water, the Water and Sewerage Undertaker (non-statutory consultee)

This is a pilot scheme between the two entities to consider improvements in efficiency and service in providing a joint response. This response has been signed off by both parties as their responsibilities dictate. Any queries or feedback to be directed to the sender.

A201: North Bradley, Trowbridge

Response to LLFA Comments

In accordance with the FRA and the mapping provided by the Environment Agency, the site is at risk of surface waterflooding along the northern areas of the site and along the Bradley Road. This would appear to be partly related to the constraints of the culvert beneath the road, into which the site is proposed to discharge.

The proposed ponds are to be sited in the areas where this flooding occurs to accommodate the existing runoff volumes and those from the development, as per the wording within the FRA. If this is proposed then they will need to be sized to accommodate this additional volume of runoff from offsite and it is difficult to see how and where this has been allowed for in the current submission calculations. It is mentioned earlier in the FRA that this would be incorporated in the design, but there appears to be no assessment of the areas contributing to the existing surface water volumes and runoff currently crossing the site and naturally ponding in the areas where the proposed attenuation features are going to be.

The attenuation features have not been designed to cater for any overland flow from off-site. The two remaining attenuation basins have been positioned outside of the modelled flood extents.

There is a swale proposed along the western boundary of the site which is proposed to intercept flow pathways from off site and divert these to the watercourses and ditches to discharge from the site via the culvert under the Bradley Road to the north. Whilst in principle this would seem a plausible idea, there are two issues with this:

1. it is situated directly over a major water main and so there would be issues with ensuring adequate cover were maintained to this watermain; **The proposed swale will be very shallow in nature and has been realigned to cross the water main perpendicularly.**
2. it is unclear how and where the overland flow routes come from and what catchment is expected to drain via this route and what impact this will have on the ditch system and the culvert under the Bradley Road. **It is believed that the flow derives from any very infrequent over-topping of the existing pond.**

As an additional note, the foul and surface water sewer layout also encroaches upon this same watermain. This would currently be unacceptable to Wessex Water and so would need to be rerouted. It states in the FRA that groundwater was recorded 1.5m below the surface of the ground, although the FRA states no significant groundwater flood risk. No Ground Investigation Reports appear to have been submitted as part of the application. There is a concern here that the ground water table may be too high to sustain the required depth of attenuation features and so more land take may be required to make this option feasible. There is therefore a query over whether the layout is achievable without further ground investigation to support the application. **The sewer layout has been adjusted to avoid any potential clashes with the existing water main. The attenuation features are partially above ground in order to achieve an outfall into the existing ditch system and therefore groundwater should not present a risk to the proposals.**

Existing Drainage

Open field ditches/ watercourses exist along the central hedge line and the southern and eastern boundaries. These then converge into a culvert beneath the Bradley Road. It is not clear from the report whether these then discharge to the watercourse 0.2km north east beyond Drynham Lane and whether there is suitable connectivity to this final discharge point for the site. 5.53 states that no hydraulic assessment of the watercourse and ditch systems across the site has been undertaken. We would have concerns that this has not been considered as part of the FRA at this stage.

We would expect this to have been developed enough for flood levels to be understood, for flow routes and volumes to be quantified and for appropriate mitigation measures to have been proposed to manage the risk from these waterbodies. We feel that this has not been adequately addressed within the FRA, although we fully support their retention within the scheme.

Modelling of the overland flow and ditch network has been undertaken by Watermans, 100 year results of this modelling are now included within the FRA.

The FRA makes no mention of the pond in the southwestern corner which is partially on the site? What is this? What does it drain? Is there a risk from this feature? We would like to see a better

description and plan indicating the existing features on the site, what drains to them and hydraulically, how they perform. Without this, we cannot adequately assess the flood risk.

The function of this pond is unknown but is not believed to be connected to the land drainage network, this feature is also included within the flood extents modelling.

Sequential Approach

The FRA states that the sequential approach has been applied to the layout of the development but in fact, the proposed care home is located in the northern most point of the site – within the area at risk of pluvial flooding in a 1 in 100 year event. It is unclear how and where existing flow routes are and how the system is designed to intercept these flows to ensure that this risk is mitigated. The swale along the southern extent of the site does not say enough about how flows get directed to here to enable this to be assessed as an appropriate measure.

The Care Home no longer forms part of the application and all other features are sited outside of the 100 year flood extents.

Discharge Hierarchy

As stated in our pre-application advice, there should be evidence of the application of the surface water disposal hierarchy; (1) reuse, (2) infiltration, (3) watercourse/ surface water body, (4) surface water sewer. The FRA confirms that no infiltration tests have been undertaken, but the underlying geology and the presence of the ditches would suggest poor permeability. This would need to be proven. However, reuse has not been considered as part of the proposals. On a site of this size we would expect justifiable reasons as to why this has been discounted.

The applicant must submit evidence demonstrating how the surface water disposal hierarchy has been applied and how all other options have been exhausted.

Re-use of rainwater has not been investigated but the use of Water butts and other similar methods have not been discounted. Infiltration is not an option on this site due to the underlying soils however the existing watercourses are being utilised for the discharge of the attenuated development flow.

Runoff Rates & Attenuation

The FRA states that all surface water runoff will be limited to Q_{bar} for all events up to the 1 in 100 year plus 40% climate change event. This does not currently allow for a 20% betterment as defined in the Wiltshire betterment policy. With regards the control of surface water discharges from greenfield sites, Wiltshire Council requires post development discharges to provide 20% betterment over pre development discharges for both peak flow and volume. To demonstrate compliance, the applicant must provide pre and post development runoff rates for a range of return periods (1, 30 and 100 year), and pre and post development runoff volumes for the 100 year, 6 hour rainfall event.

This takes account of national policy, as outlined in the [SuDS Technical Standards](#).

The site has now been modelled with a discharge rate taking account of the 20% betterment.

The developable impermeable areas quoted in section 5.17 and the proceeding Table 2 do not seem to correlate (3.38ha of developable area vs 3.25ha). It is recognised that the general principles relating to the estimates of impermeable areas within the development and the inclusion of urban creep is appropriate and acceptable. Quoted Areas and table have been adjusted to suit.

Discharge from the site is to be controlled by hydro brakes and other such flow control devices. The proposals are to use a network of trapped gullies and pipes as well as SuDS features – but there does not appear to have been any allowance made for these SuDS features in the layout. We would like to encourage further consideration of above ground features for conveyance and treatment of surface water runoff throughout the site. The strategy drawing now indicates the possible location of permeable paving and roadside swales to provide a degree of treatment at source.

SuDS

For the purposes of the drainage strategy, the site has been split into discrete catchments, which is in line with the CIRIA guidance for larger site developments. This results in the requirement for 3 attenuation features proposed along the northern boundary of the site. There is a very limited scope of features utilised on such a large site. 5.14 of the FRA does make note of the four pillars of SuDS but this does not appear to translate into the drainage strategy proposed. There seems to be a focus on water quantity and not on the other key pillars of SuDS. In order to truly see the benefits of SuDS, we would expect a full suite of options to be considered and included at this stage. Indication of swales and permeable paving now shown on the Strategy drawing.

National planning policy requires SuDS to provide multifunctional benefits, where possible. There are four main categories of benefits that can be achieved by SuDS: water quantity, water quality, amenity and biodiversity. These are referred to as the four pillars of SuDS design. The current proposal only provides one of the four main categories – water quantity. The applicant must also consider water quality/ amenity and biodiversity benefits, in line with Core Policies 52: Green Infrastructure and Core Policy 67: Flood Risk. The comments from the Council's Drainage team address only water quantity and quality benefits. The Council's Landscape and Design team must be consulted to comment on amenity and biodiversity benefits, to ensure high quality SuDS that provide multifunctional benefits. There is a suggestion in the FRA that source control techniques would be investigated at detailed design stage, but by setting the layout based on no source control measures, no above ground conveyance features, no biodiversity features, tree pits or other such measures, the current layout will limit the potential space for these techniques to be designed in. Given the Wiltshire policy to include trees as part of flood attenuation (as mentioned in the FRA), is there a missed opportunity to incorporate tree pits as a bioretention technique for source control? **Water quality benefits will be provided by the permeable paving and swales prior to additional treatment within the attenuation basins. Tree pits with Bio retention capabilities could be incorporated into the layout, it should be noted that the site layout proposals are at an early stage with scope to formalise further through the planning process. Amenity and Biodiversity benefits can be addressed through landscaping features and species.**



Appendix 3 - Drainage Strategy

Drainage Strategy Plan

UKSUDS Greenfield Runoff Estimate

Greenfield Volumes

Source Control Microdrainage Calculations

Greenfield runoff rate estimation for sites

www.ukstds.com | Greenfield runoff tool

Calculated by:

Site name:

Site location:

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:

Longitude:

Reference:

Date:

Runoff estimation approach

Site characteristics

Total site area (ha):

Methodology

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics Default Edited

SOIL type:

HOST class:

SPR/SPRHOST:

Hydrological characteristics Default Edited

SAAR (mm):

Hydrological region:

Growth curve factor 1 year:

Growth curve factor 30 years:

Growth curve factor 100 years:

Growth curve factor 200 years:

Notes

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates Default Edited

Q_{BAR} (l/s):

1 in 1 year (l/s):

1 in 30 years (l/s):

1 in 100 year (l/s):

1 in 200 years (l/s):

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

<u>Greenfield Runoff Volume</u>	
FSR Data	
Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.359
Areal Reduction Factor	1.00
Area (ha)	1.270
SAAR (mm)	895
CWI	110.548
Urban	0.000
SPR	37.000
Results	
Percentage Runoff (%)	33.39
Greenfield Runoff Volume (m³)	101.688

Greenfield Runoff Volume

FSR Data

Return Period (years)	30
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.359
Areal Reduction Factor	1.00
Area (ha)	1.270
SAAR (mm)	895
CWI	110.548
Urban	0.000
SPR	37.000

Results

Percentage Runoff (%)	35.95
Greenfield Runoff Volume (m³)	237.558

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.359
Areal Reduction Factor	1.00
Area (ha)	1.270
SAAR (mm)	895
CWI	110.548
Urban	0.000
SPR	37.000

Results

Percentage Runoff (%)	37.92
Greenfield Runoff Volume (m³)	323.374

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Search House Charnham Lane Hungerford RG17 0EY	A201 North Bradley, Trowbridge Required Attenuation 50% AEP	
Date 05/07/2023 File	Designed by Georgios Roinas Checked by Leigh Abley	
XP Solutions	Source Control 2020.1.3	

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.101	0.055	1.7	108.0	O K
30 min Summer	99.116	0.070	2.5	138.3	O K
60 min Summer	99.131	0.085	3.5	169.6	O K
120 min Summer	99.158	0.112	5.1	222.7	O K
180 min Summer	99.172	0.126	5.8	251.3	O K
240 min Summer	99.180	0.134	6.2	268.4	O K
360 min Summer	99.189	0.143	6.3	286.8	O K
480 min Summer	99.195	0.149	6.4	297.4	O K
600 min Summer	99.198	0.152	6.4	303.7	O K
720 min Summer	99.199	0.153	6.4	307.5	O K
960 min Summer	99.201	0.155	6.4	309.9	O K
1440 min Summer	99.198	0.152	6.4	305.4	O K
2160 min Summer	99.192	0.146	6.3	292.7	O K
2880 min Summer	99.186	0.140	6.3	279.4	O K
4320 min Summer	99.175	0.129	5.9	258.6	O K
5760 min Summer	99.168	0.122	5.6	243.0	O K
7200 min Summer	99.162	0.116	5.3	231.2	O K
8640 min Summer	99.157	0.111	5.1	222.1	O K
10080 min Summer	99.154	0.108	4.9	214.7	O K
15 min Winter	99.101	0.055	1.7	108.0	O K
30 min Winter	99.116	0.070	2.5	138.4	O K
60 min Winter	99.131	0.085	3.5	169.8	O K
120 min Winter	99.158	0.112	5.1	223.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	34.327	0.0	64.0	23
30 min Summer	22.161	0.0	90.2	37
60 min Summer	13.838	0.0	144.2	66
120 min Summer	9.461	0.0	205.9	124
180 min Summer	7.397	0.0	245.7	182
240 min Summer	6.153	0.0	275.0	242
360 min Summer	4.684	0.0	317.0	318
480 min Summer	3.820	0.0	346.1	382
600 min Summer	3.247	0.0	368.3	446
720 min Summer	2.835	0.0	386.1	512
960 min Summer	2.280	0.0	413.3	650
1440 min Summer	1.670	0.0	449.5	922
2160 min Summer	1.228	0.0	536.5	1320
2880 min Summer	0.995	0.0	577.7	1704
4320 min Summer	0.751	0.0	644.2	2464
5760 min Summer	0.623	0.0	744.3	3176
7200 min Summer	0.544	0.0	811.0	3896
8640 min Summer	0.490	0.0	873.3	4664
10080 min Summer	0.451	0.0	929.4	5352
15 min Winter	34.327	0.0	64.0	23
30 min Winter	22.161	0.0	90.2	37
60 min Winter	13.838	0.0	144.2	66
120 min Winter	9.461	0.0	205.9	122

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XP Solutions	Source Control 2020.1.3	

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
180 min Winter	99.172	0.126	5.8	252.5	O K
240 min Winter	99.181	0.135	6.2	270.2	O K
360 min Winter	99.190	0.144	6.3	288.9	O K
480 min Winter	99.194	0.148	6.4	297.1	O K
600 min Winter	99.197	0.151	6.4	302.2	O K
720 min Winter	99.198	0.152	6.4	304.2	O K
960 min Winter	99.197	0.151	6.4	302.5	O K
1440 min Winter	99.191	0.145	6.3	289.9	O K
2160 min Winter	99.181	0.135	6.2	268.9	O K
2880 min Winter	99.172	0.126	5.8	251.4	O K
4320 min Winter	99.159	0.113	5.1	224.6	O K
5760 min Winter	99.149	0.103	4.6	206.1	O K
7200 min Winter	99.143	0.097	4.2	193.0	O K
8640 min Winter	99.138	0.092	4.0	183.2	O K
10080 min Winter	99.134	0.088	3.7	175.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	7.397	0.0	245.7	178
240 min Winter	6.153	0.0	275.0	234
360 min Winter	4.684	0.0	317.0	342
480 min Winter	3.820	0.0	346.1	390
600 min Winter	3.247	0.0	368.3	464
720 min Winter	2.835	0.0	386.1	542
960 min Winter	2.280	0.0	413.5	694
1440 min Winter	1.670	0.0	449.8	982
2160 min Winter	1.228	0.0	536.6	1388
2880 min Winter	0.995	0.0	577.7	1788
4320 min Winter	0.751	0.0	644.4	2552
5760 min Winter	0.623	0.0	744.4	3288
7200 min Winter	0.544	0.0	811.1	4032
8640 min Winter	0.490	0.0	873.7	4752
10080 min Winter	0.451	0.0	930.5	5456

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Search House Charnham Lane Hungerford RG17 0EY	A201 North Bradley, Trowbridge Required Attenuation 50% AEP	
Date 05/07/2023	Designed by Georgios Roinas	
File	Checked by Leigh Abley	
XP Solutions	Source Control 2020.1.3	

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	1.000
FEH Rainfall Version	2013	Cv (Winter)	1.000
Site Location	GB 385742 155746 ST 85742 55746	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.270

Time (mins) Area			Time (mins) Area		
From:	To:	(ha)	From:	To:	(ha)
0	4	0.635	4	8	0.635

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Search House Charnham Lane Hungerford RG17 0EY	A201 North Bradley, Trowbridge Required Attenuation 50% AEP	
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XP Solutions	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 99.046

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1967.4	0.400	2160.6	0.800	2362.9
0.200	2062.9	0.600	2260.6	0.954	2443.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0124-6500-0654-6500
Design Head (m)	0.654
Design Flow (l/s)	6.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	124
Invert Level (m)	99.046
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.654	6.5	Kick-Flo®	0.468	5.6
Flush-Flo™	0.214	6.5	Mean Flow over Head Range	-	5.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.4	0.800	7.1	2.000	11.0	4.000	15.3	7.000	19.9
0.200	6.5	1.000	7.9	2.200	11.5	4.500	16.2	7.500	20.6
0.300	6.4	1.200	8.6	2.400	12.0	5.000	17.0	8.000	21.3
0.400	6.1	1.400	9.3	2.600	12.4	5.500	17.8	8.500	22.0
0.500	5.7	1.600	9.9	3.000	13.3	6.000	18.5	9.000	22.6
0.600	6.2	1.800	10.4	3.500	14.3	6.500	19.3	9.500	23.2

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Search House Charnham Lane Hungerford RG17 0EY	A201 North Bradley, Trowbridge Required Attenuation 3.3% AEP	
Date 05/07/2023 File	Designed by Georgios Roinas Checked by Leigh Abley	
XP Solutions	Source Control 2020.1.3	

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.170	0.124	5.7	248.0	O K
30 min Summer	99.207	0.161	6.4	322.6	O K
60 min Summer	99.245	0.199	6.5	401.1	O K
120 min Summer	99.283	0.237	6.5	479.1	O K
180 min Summer	99.305	0.259	6.5	526.3	O K
240 min Summer	99.321	0.275	6.5	558.5	O K
360 min Summer	99.339	0.293	6.5	597.0	O K
480 min Summer	99.348	0.302	6.5	616.5	O K
600 min Summer	99.352	0.306	6.5	624.7	O K
720 min Summer	99.353	0.307	6.5	626.0	O K
960 min Summer	99.351	0.305	6.5	622.6	O K
1440 min Summer	99.342	0.296	6.5	604.2	O K
2160 min Summer	99.325	0.279	6.5	566.7	O K
2880 min Summer	99.306	0.260	6.5	528.4	O K
4320 min Summer	99.273	0.227	6.5	458.7	O K
5760 min Summer	99.245	0.199	6.5	401.9	O K
7200 min Summer	99.225	0.179	6.5	359.1	O K
8640 min Summer	99.209	0.163	6.4	326.1	O K
10080 min Summer	99.196	0.150	6.4	300.9	O K
15 min Winter	99.170	0.124	5.7	248.1	O K
30 min Winter	99.207	0.161	6.4	322.8	O K
60 min Winter	99.245	0.199	6.5	401.3	O K
120 min Winter	99.283	0.237	6.5	479.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	79.260	0.0	187.7	23
30 min Summer	51.956	0.0	256.8	37
60 min Summer	32.705	0.0	375.4	66
120 min Summer	19.976	0.0	463.0	126
180 min Summer	14.936	0.0	521.0	184
240 min Summer	12.120	0.0	564.3	244
360 min Summer	8.975	0.0	626.4	362
480 min Summer	7.216	0.0	669.9	482
600 min Summer	6.073	0.0	702.5	600
720 min Summer	5.265	0.0	727.8	690
960 min Summer	4.186	0.0	764.0	794
1440 min Summer	3.003	0.0	800.1	1038
2160 min Summer	2.142	0.0	947.8	1432
2880 min Summer	1.688	0.0	993.1	1844
4320 min Summer	1.214	0.0	1059.3	2632
5760 min Summer	0.969	0.0	1165.7	3352
7200 min Summer	0.821	0.0	1232.6	4104
8640 min Summer	0.722	0.0	1295.5	4760
10080 min Summer	0.651	0.0	1351.8	5456
15 min Winter	79.260	0.0	187.7	22
30 min Winter	51.956	0.0	256.8	37
60 min Winter	32.705	0.0	375.4	66
120 min Winter	19.976	0.0	463.0	124

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XP Solutions	Source Control 2020.1.3	

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
180 min Winter	99.305	0.259	6.5	526.4	O K
240 min Winter	99.321	0.275	6.5	558.3	O K
360 min Winter	99.339	0.293	6.5	596.7	O K
480 min Winter	99.348	0.302	6.5	616.1	O K
600 min Winter	99.352	0.306	6.5	624.6	O K
720 min Winter	99.353	0.307	6.5	626.3	O K
960 min Winter	99.349	0.303	6.5	617.0	O K
1440 min Winter	99.336	0.290	6.5	590.0	O K
2160 min Winter	99.310	0.264	6.5	536.0	O K
2880 min Winter	99.284	0.238	6.5	481.0	O K
4320 min Winter	99.237	0.191	6.5	385.3	O K
5760 min Winter	99.203	0.157	6.4	314.9	O K
7200 min Winter	99.182	0.136	6.2	271.9	O K
8640 min Winter	99.170	0.124	5.7	248.2	O K
10080 min Winter	99.162	0.116	5.3	230.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	14.936	0.0	521.1	182
240 min Winter	12.120	0.0	564.4	240
360 min Winter	8.975	0.0	626.6	356
480 min Winter	7.216	0.0	670.3	468
600 min Winter	6.073	0.0	703.0	580
720 min Winter	5.265	0.0	728.5	688
960 min Winter	4.186	0.0	765.3	880
1440 min Winter	3.003	0.0	803.3	1094
2160 min Winter	2.142	0.0	948.2	1536
2880 min Winter	1.688	0.0	993.8	1960
4320 min Winter	1.214	0.0	1060.9	2728
5760 min Winter	0.969	0.0	1165.8	3456
7200 min Winter	0.821	0.0	1232.9	4104
8640 min Winter	0.722	0.0	1296.1	4760
10080 min Winter	0.651	0.0	1353.2	5544

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XP Solutions	Source Control 2020.1.3	

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	1.000
FEH Rainfall Version	2013	Cv (Winter)	1.000
Site Location	GB 385742 155746 ST 85742 55746	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.270

Time (mins)		Area	Time (mins)		Area
From:	To:	(ha)	From:	To:	(ha)
0	4	0.635	4	8	0.635

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Search House Charnham Lane Hungerford RG17 0EY	A201 North Bradley, Trowbridge Required Attenuation 3.3% AEP	
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XP Solutions	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 99.046

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1967.4	0.400	2160.6	0.800	2362.9
0.200	2062.9	0.600	2260.6	0.954	2443.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0124-6500-0654-6500
Design Head (m)	0.654
Design Flow (l/s)	6.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	124
Invert Level (m)	99.046
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.654	6.5	Kick-Flo®	0.468	5.6
Flush-Flo™	0.214	6.5	Mean Flow over Head Range	-	5.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.4	0.800	7.1	2.000	11.0	4.000	15.3	7.000	19.9
0.200	6.5	1.000	7.9	2.200	11.5	4.500	16.2	7.500	20.6
0.300	6.4	1.200	8.6	2.400	12.0	5.000	17.0	8.000	21.3
0.400	6.1	1.400	9.3	2.600	12.4	5.500	17.8	8.500	22.0
0.500	5.7	1.600	9.9	3.000	13.3	6.000	18.5	9.000	22.6
0.600	6.2	1.800	10.4	3.500	14.3	6.500	19.3	9.500	23.2

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XP Solutions	Source Control 2020.1.3	

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
15 min Summer	99.275	0.229	6.5	464.1	O K
30 min Summer	99.348	0.302	6.5	615.7	O K
60 min Summer	99.423	0.377	6.5	774.9	O K
120 min Summer	99.492	0.446	6.5	925.3	O K
180 min Summer	99.537	0.491	6.5	1024.6	O K
240 min Summer	99.570	0.524	6.5	1098.1	O K
360 min Summer	99.617	0.571	6.5	1202.1	O K
480 min Summer	99.647	0.601	6.5	1270.6	O K
600 min Summer	99.667	0.621	6.5	1315.8	O K
720 min Summer	99.680	0.634	6.5	1345.1	O K
960 min Summer	99.692	0.646	6.5	1371.6	O K
1440 min Summer	99.685	0.639	6.5	1356.8	O K
2160 min Summer	99.653	0.607	6.5	1283.3	O K
2880 min Summer	99.622	0.576	6.5	1212.9	O K
4320 min Summer	99.563	0.517	6.5	1081.8	O K
5760 min Summer	99.509	0.463	6.5	963.0	O K
7200 min Summer	99.463	0.417	6.5	861.9	O K
8640 min Summer	99.425	0.379	6.5	780.5	O K
10080 min Summer	99.394	0.348	6.5	712.7	O K
15 min Winter	99.275	0.229	6.5	464.0	O K
30 min Winter	99.348	0.302	6.5	615.7	O K
60 min Winter	99.423	0.377	6.5	774.8	O K
120 min Winter	99.492	0.446	6.5	925.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
15 min Summer	147.775	0.0	374.4	23
30 min Summer	98.350	0.0	484.4	38
60 min Summer	62.306	0.0	728.0	68
120 min Summer	37.667	0.0	869.7	126
180 min Summer	28.108	0.0	952.6	186
240 min Summer	22.841	0.0	1001.1	246
360 min Summer	17.035	0.0	1023.6	366
480 min Summer	13.795	0.0	1009.8	484
600 min Summer	11.669	0.0	997.2	604
720 min Summer	10.150	0.0	986.0	724
960 min Summer	8.091	0.0	965.5	962
1440 min Summer	5.800	0.0	925.2	1440
2160 min Summer	4.089	0.0	1774.4	1776
2880 min Summer	3.176	0.0	1796.7	2136
4320 min Summer	2.215	0.0	1674.4	2944
5760 min Summer	1.721	0.0	2077.5	3752
7200 min Summer	1.428	0.0	2153.0	4536
8640 min Summer	1.233	0.0	2226.8	5280
10080 min Summer	1.096	0.0	2294.0	6048
15 min Winter	147.775	0.0	374.4	23
30 min Winter	98.350	0.0	484.5	37
60 min Winter	62.306	0.0	728.0	66
120 min Winter	37.667	0.0	869.8	124

Abley Letchford Partnership Ltd		Page 2
Search House Charnham Lane Hungerford RG17 0EY	A201 North Bradley, Trowbridge Required Attenuation 1% AEP plus 45% CC	
Date 05/07/2023 File	Designed by Georgios Roinas Checked by Leigh Abley	
XP Solutions	Source Control 2020.1.3	

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
180 min Winter	99.537	0.491	6.5	1024.2	O K
240 min Winter	99.570	0.524	6.5	1097.6	O K
360 min Winter	99.617	0.571	6.5	1201.8	O K
480 min Winter	99.647	0.601	6.5	1270.7	O K
600 min Winter	99.668	0.622	6.5	1316.3	O K
720 min Winter	99.681	0.635	6.5	1346.3	O K
960 min Winter	99.693	0.647	6.5	1374.3	O K
1440 min Winter	99.688	0.642	6.5	1363.7	O K
2160 min Winter	99.651	0.605	6.5	1278.6	O K
2880 min Winter	99.614	0.568	6.5	1196.3	O K
4320 min Winter	99.539	0.493	6.5	1029.0	O K
5760 min Winter	99.461	0.415	6.5	857.3	O K
7200 min Winter	99.398	0.352	6.5	721.2	O K
8640 min Winter	99.345	0.299	6.5	608.9	O K
10080 min Winter	99.301	0.255	6.5	517.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	28.108	0.0	953.0	184
240 min Winter	22.841	0.0	1002.0	242
360 min Winter	17.035	0.0	1025.6	360
480 min Winter	13.795	0.0	1012.0	476
600 min Winter	11.669	0.0	999.5	594
720 min Winter	10.150	0.0	988.4	708
960 min Winter	8.091	0.0	968.2	936
1440 min Winter	5.800	0.0	929.0	1384
2160 min Winter	4.089	0.0	1776.0	1968
2880 min Winter	3.176	0.0	1802.1	2224
4320 min Winter	2.215	0.0	1710.1	3156
5760 min Winter	1.721	0.0	2078.3	3976
7200 min Winter	1.428	0.0	2154.1	4760
8640 min Winter	1.233	0.0	2228.2	5528
10080 min Winter	1.096	0.0	2296.8	6248

Abley Letchford Partnership Ltd		Page 3
Search House Charnham Lane Hungerford RG17 0EY	A201 North Bradley, Trowbridge Required Attenuation 1% AEP plus 45% CC	
Date 05/07/2023 File	Designed by Georgios Roinas Checked by Leigh Abley	
XP Solutions	Source Control 2020.1.3	

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
FEH Rainfall Version	2013	Cv (Winter)	1.000
Site Location	GB 385742 155746 ST 85742 55746	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 1.270

Time (mins) Area			Time (mins) Area		
From:	To:	(ha)	From:	To:	(ha)
0	4	0.635	4	8	0.635

Abley Letchford Partnership Ltd		Page 4
Search House Charnham Lane Hungerford RG17 0EY	A201 North Bradley, Trowbridge Required Attenuation 1% AEP plus 45% CC	
Date 05/07/2023 File	Designed by Georgios Roinas Checked by Leigh Abley	
XP Solutions	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 99.046

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1967.4	0.400	2160.6	0.800	2362.9
0.200	2062.9	0.600	2260.6	0.954	2443.2

Hydro-Brake® Optimum Outflow Control

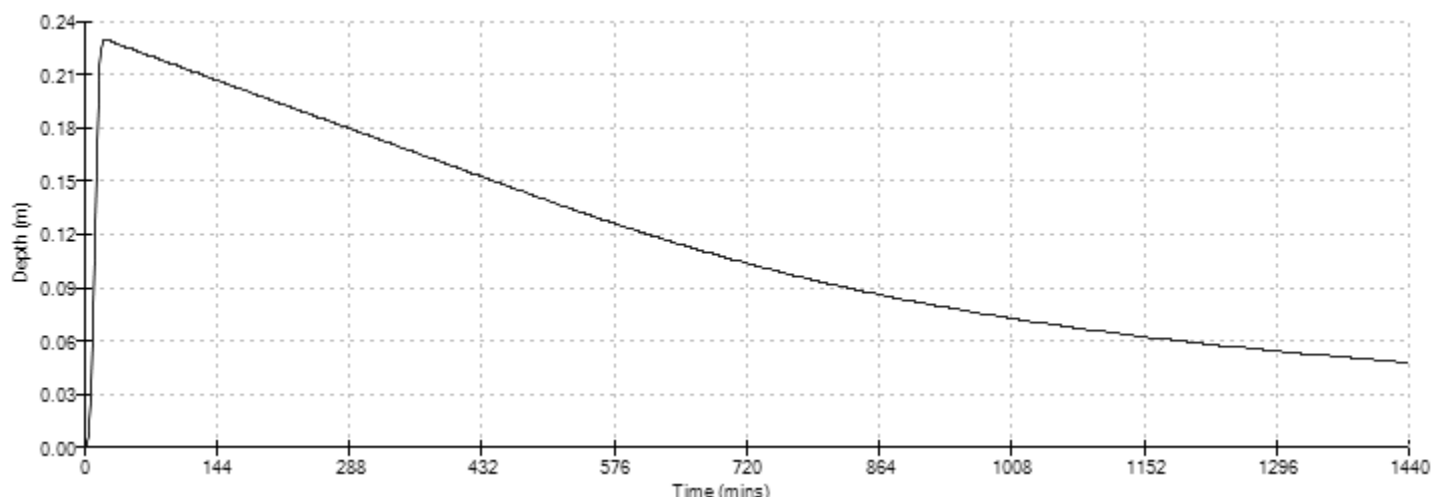
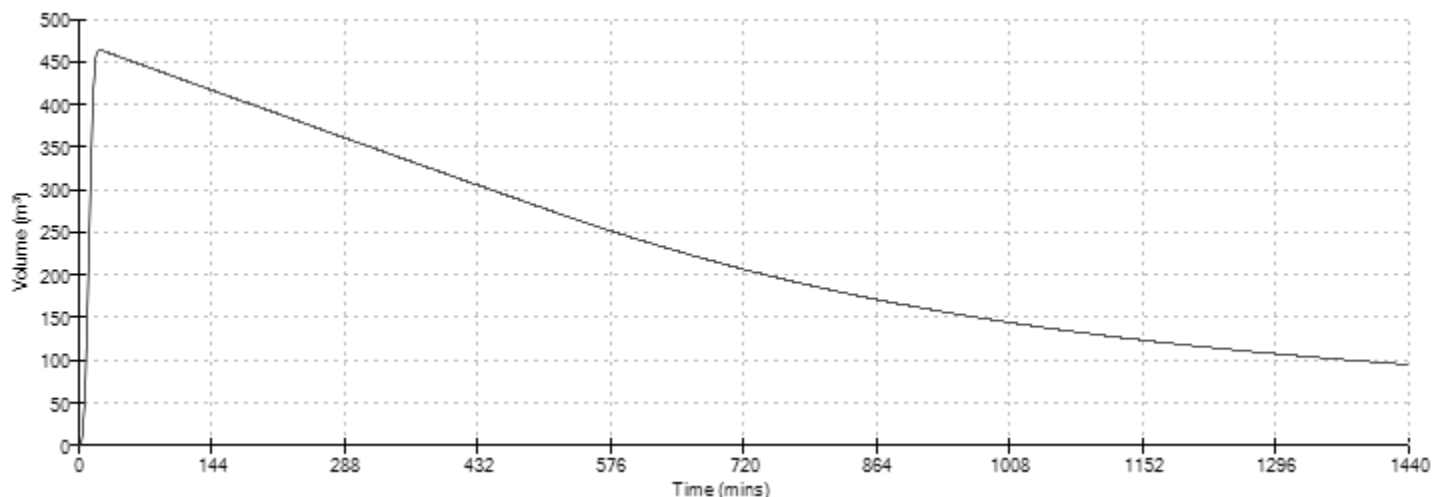
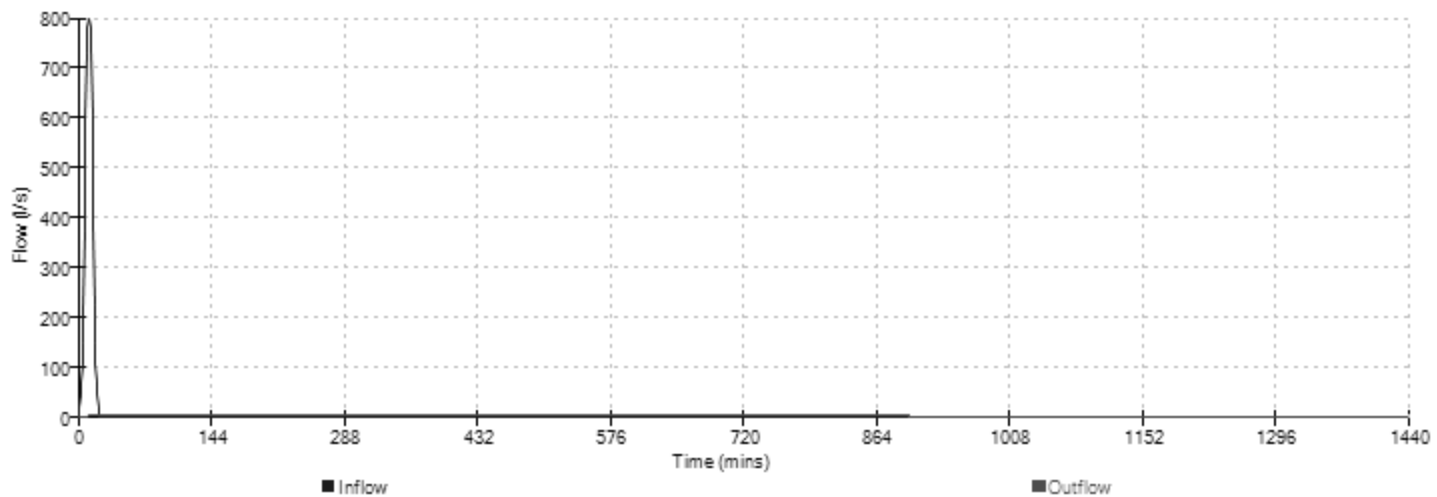
Unit Reference	MD-SHE-0124-6500-0654-6500
Design Head (m)	0.654
Design Flow (l/s)	6.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	124
Invert Level (m)	99.046
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.654	6.5	Kick-Flo®	0.468	5.6
Flush-Flo™	0.214	6.5	Mean Flow over Head Range	-	5.5

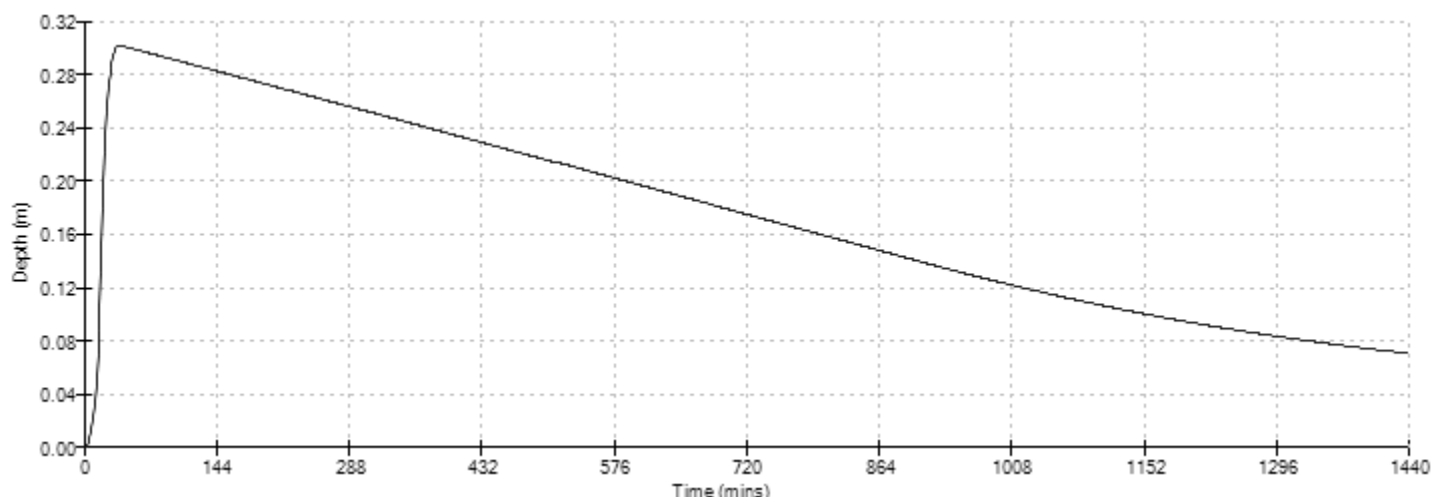
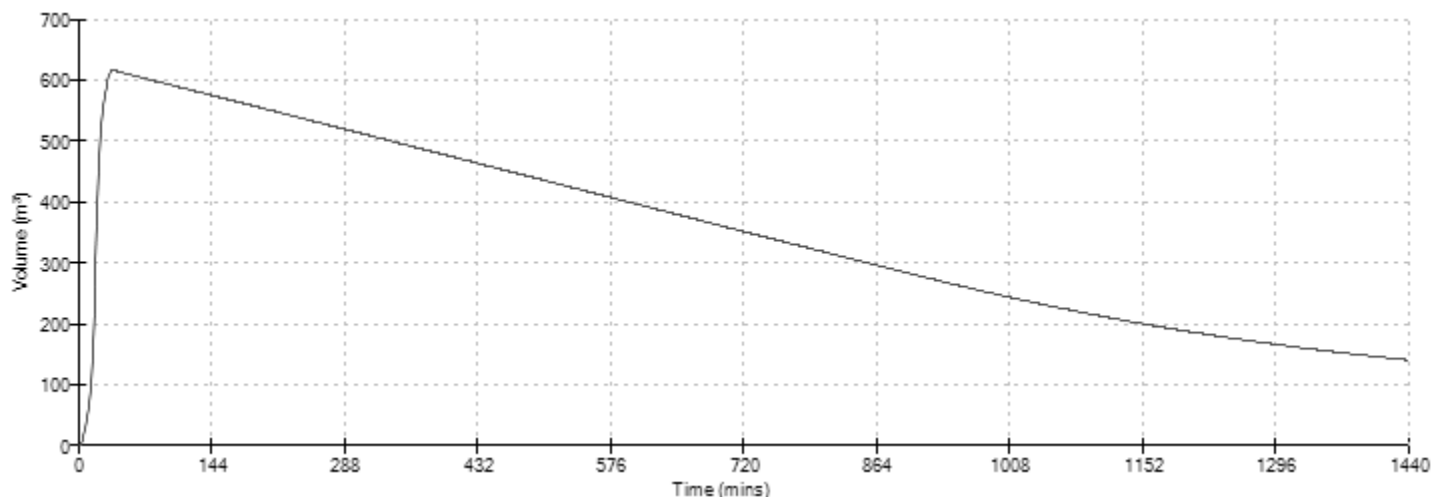
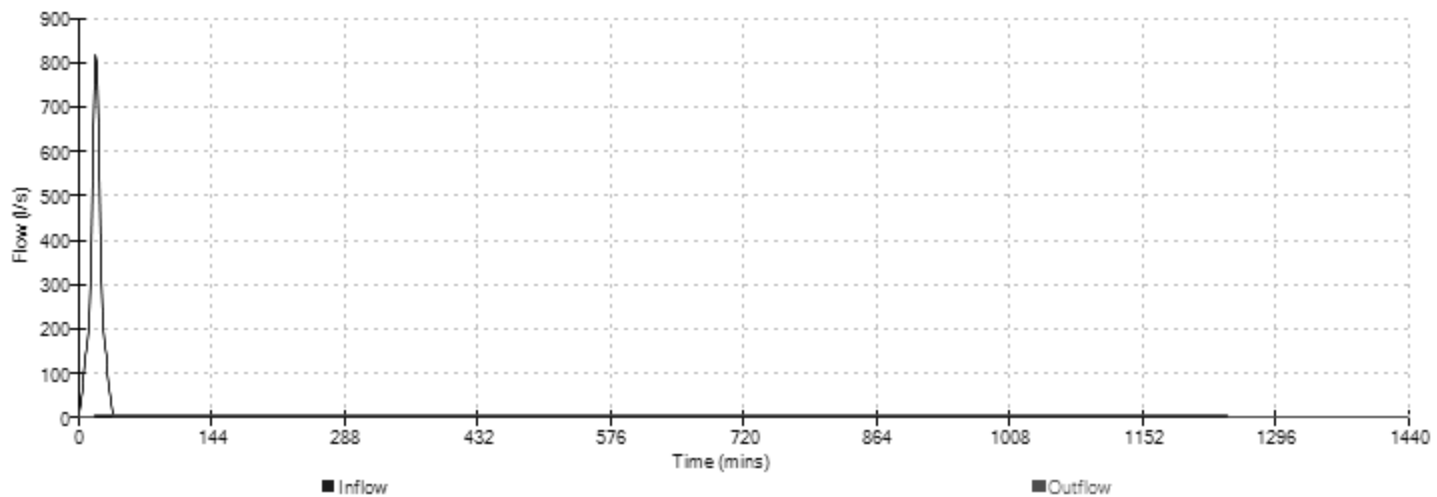
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.4	0.800	7.1	2.000	11.0	4.000	15.3	7.000	19.9
0.200	6.5	1.000	7.9	2.200	11.5	4.500	16.2	7.500	20.6
0.300	6.4	1.200	8.6	2.400	12.0	5.000	17.0	8.000	21.3
0.400	6.1	1.400	9.3	2.600	12.4	5.500	17.8	8.500	22.0
0.500	5.7	1.600	9.9	3.000	13.3	6.000	18.5	9.000	22.6
0.600	6.2	1.800	10.4	3.500	14.3	6.500	19.3	9.500	23.2

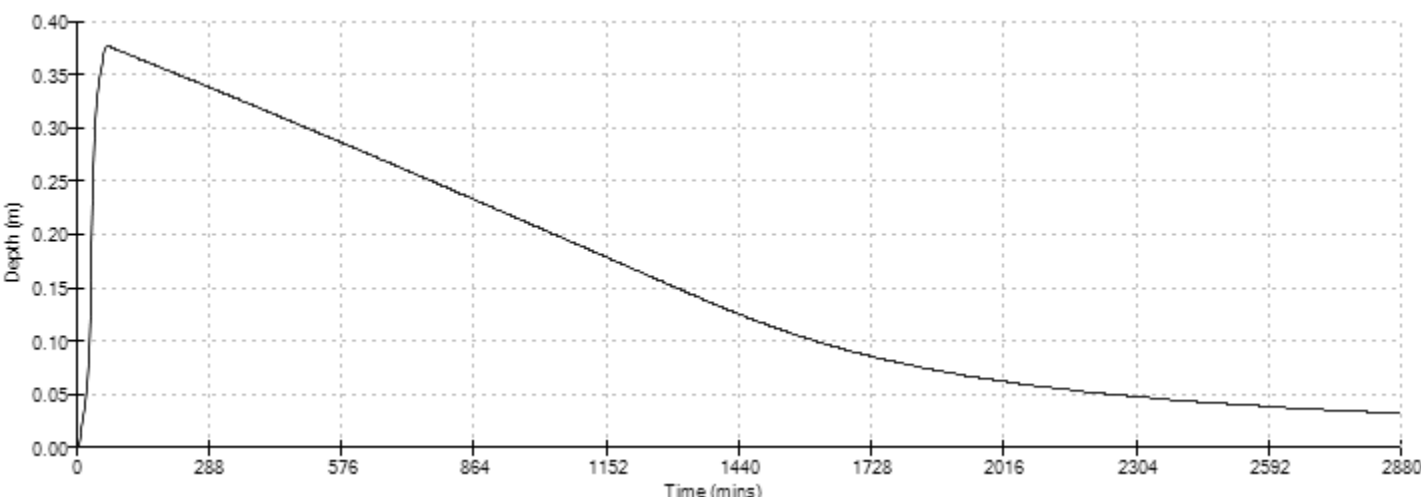
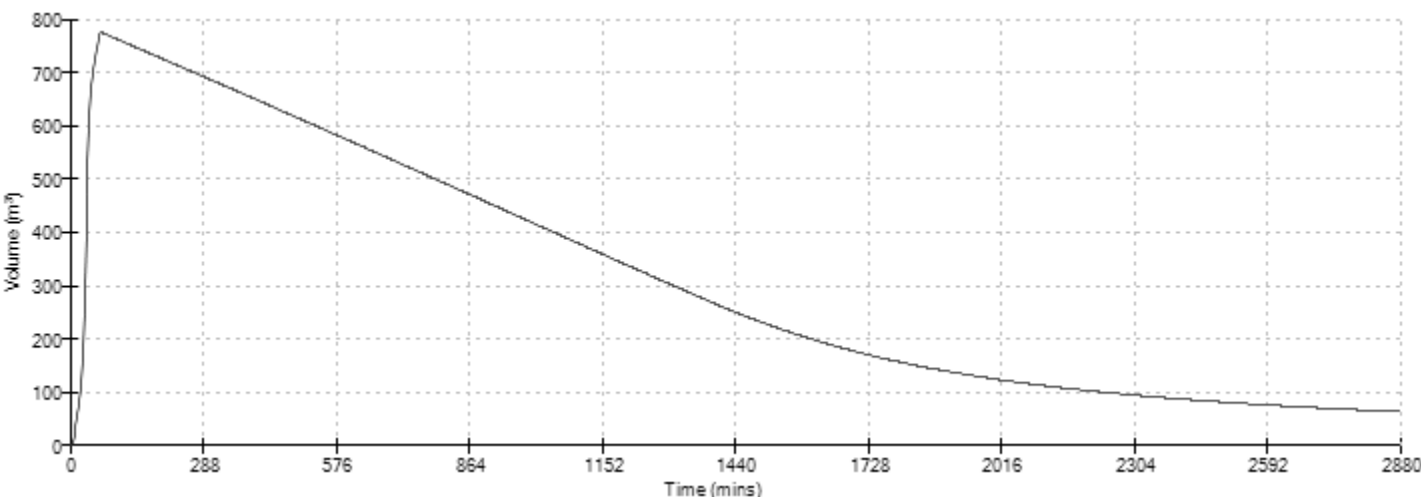
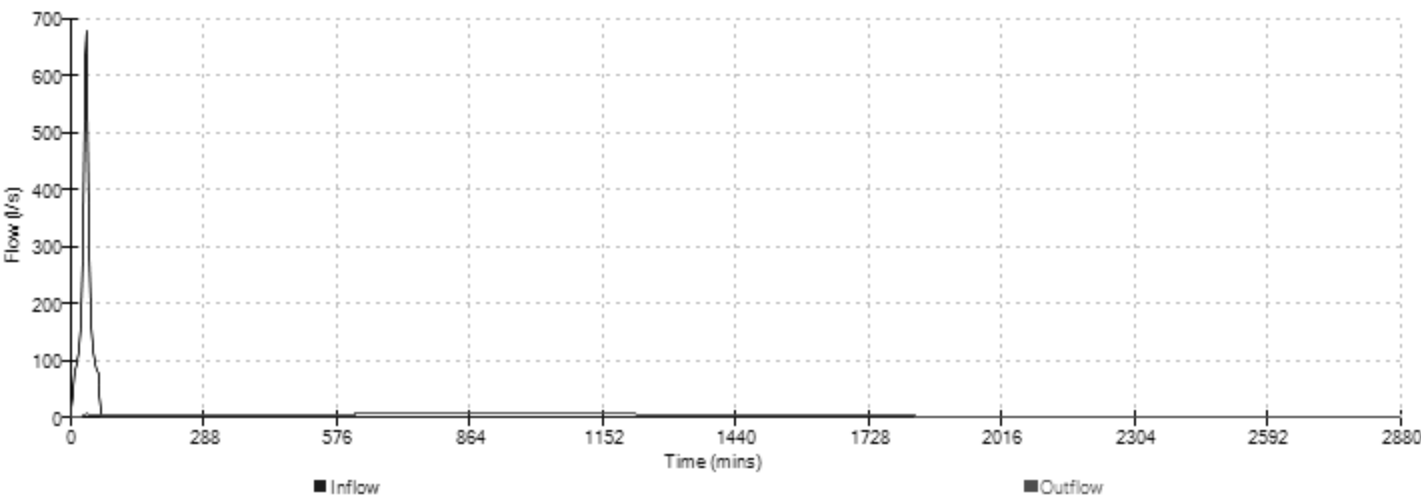
Event: 15 min Summer



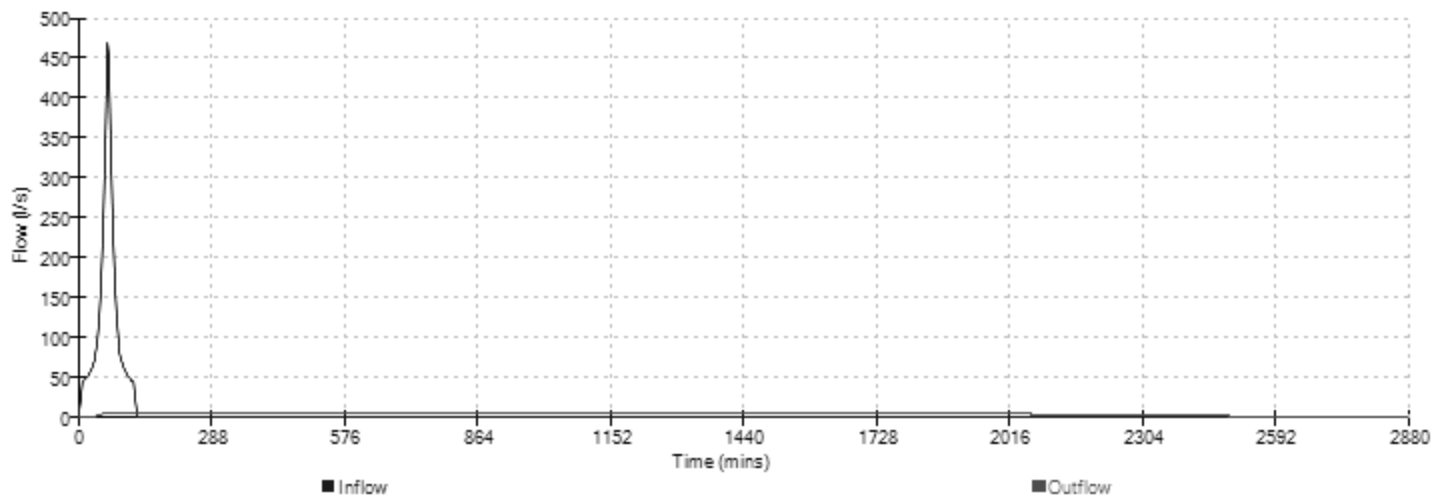
Event: 30 min Summer



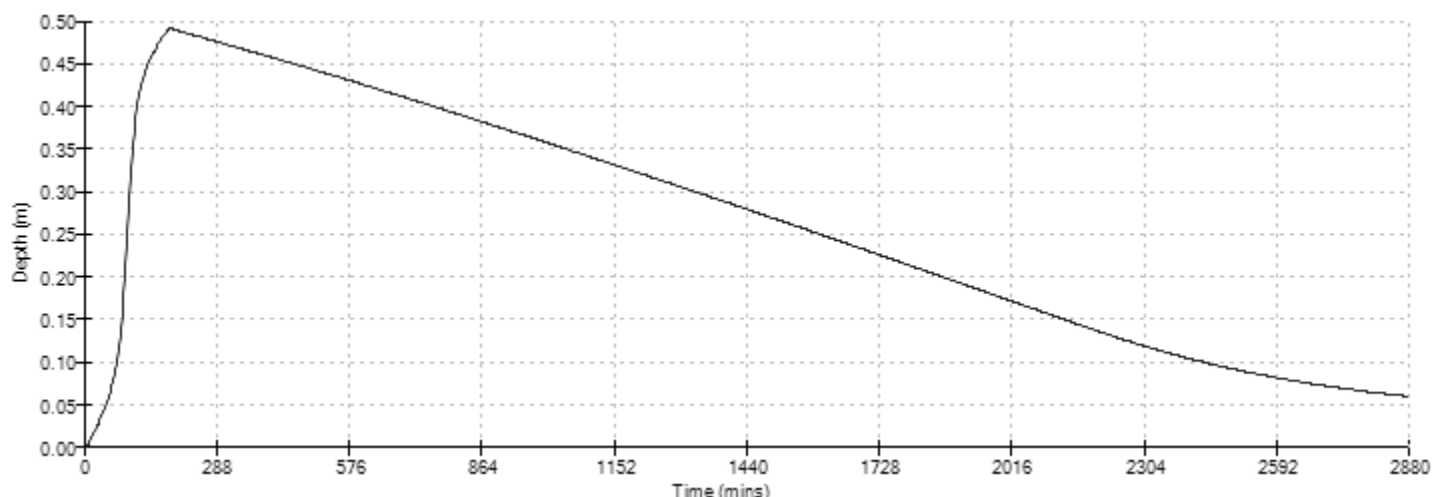
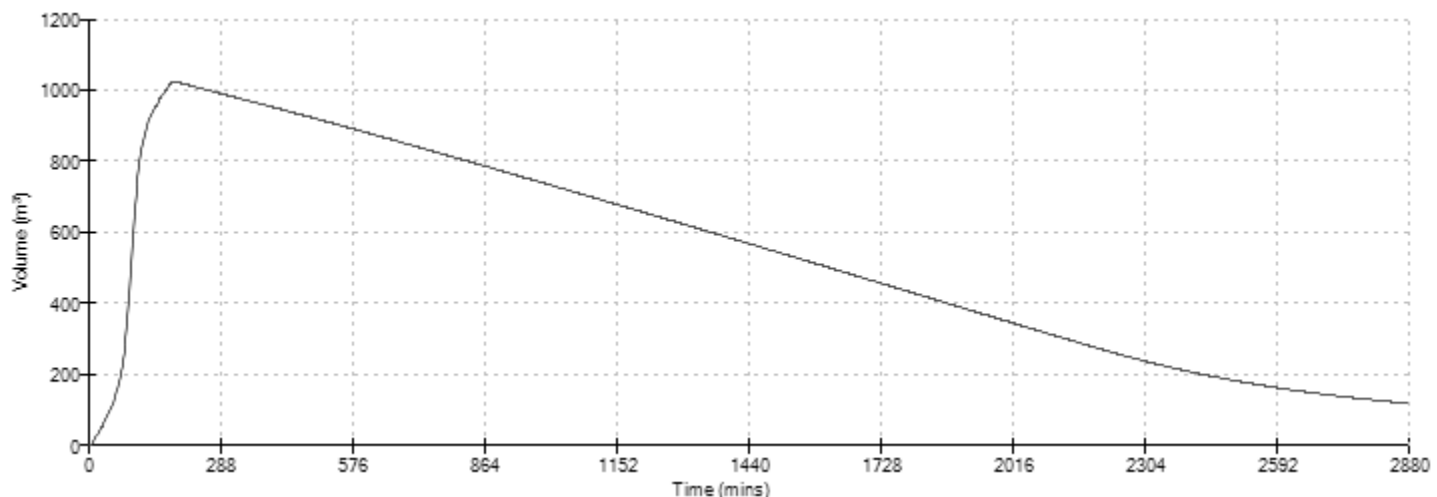
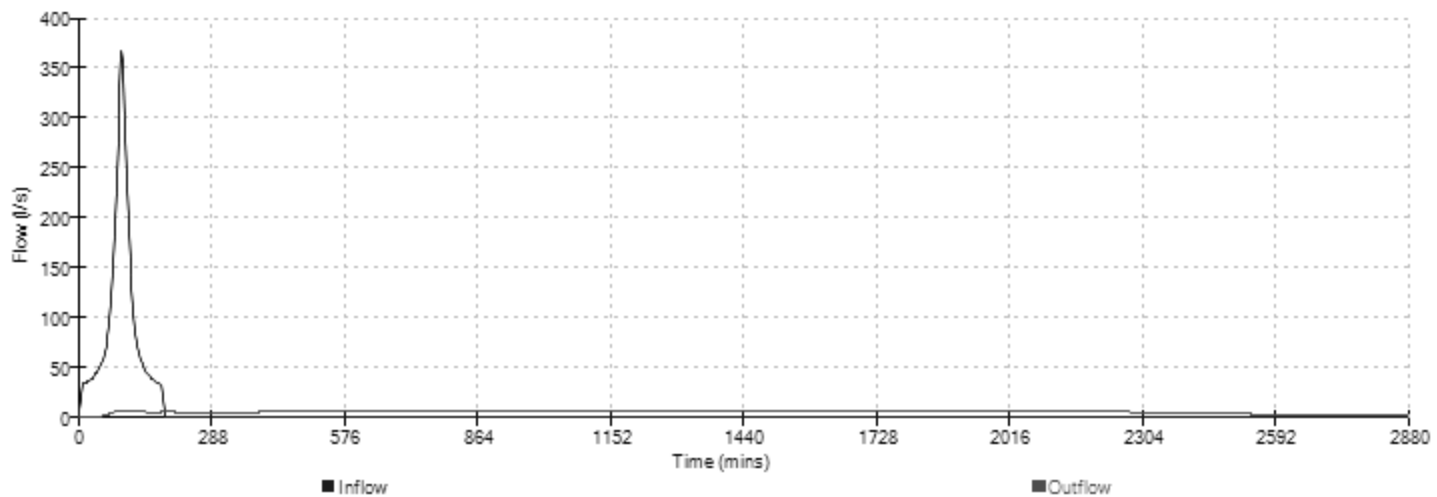
Event: 60 min Summer



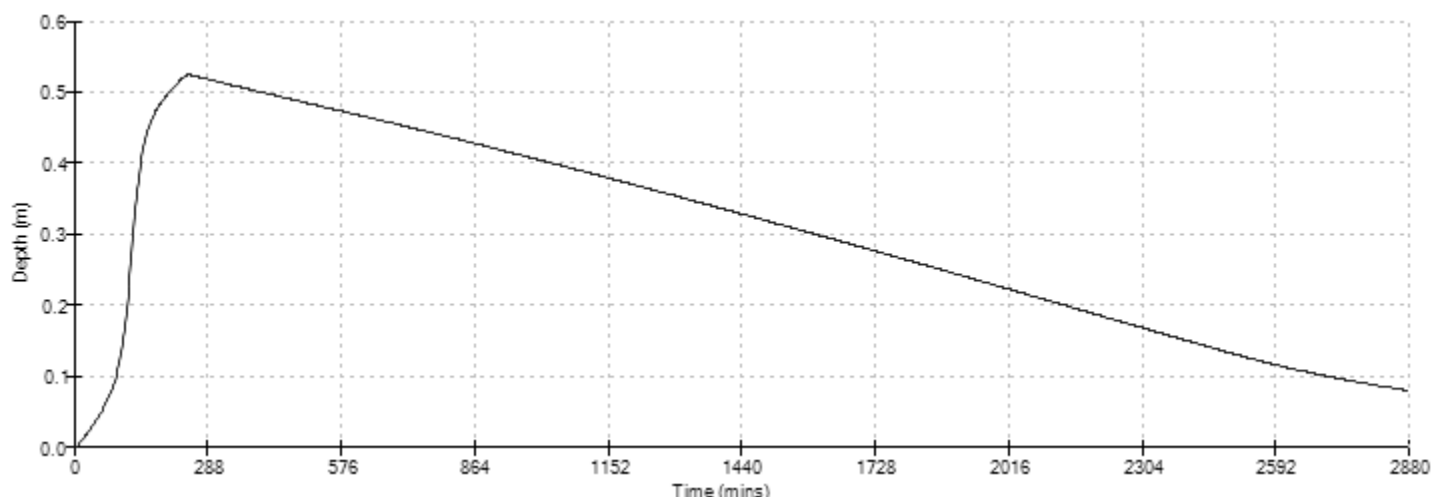
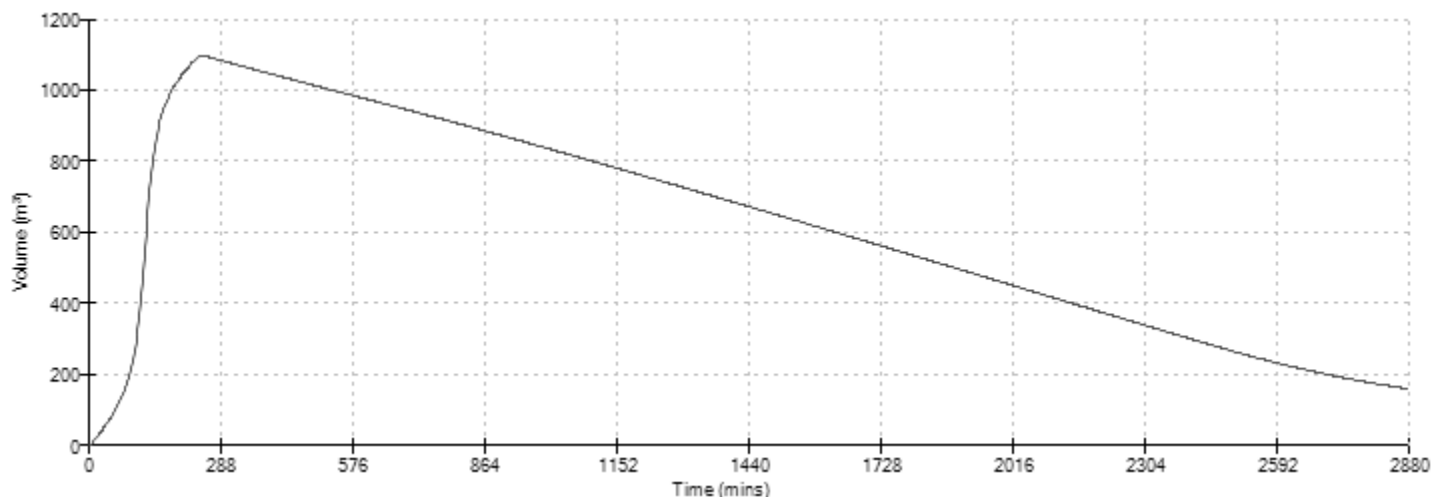
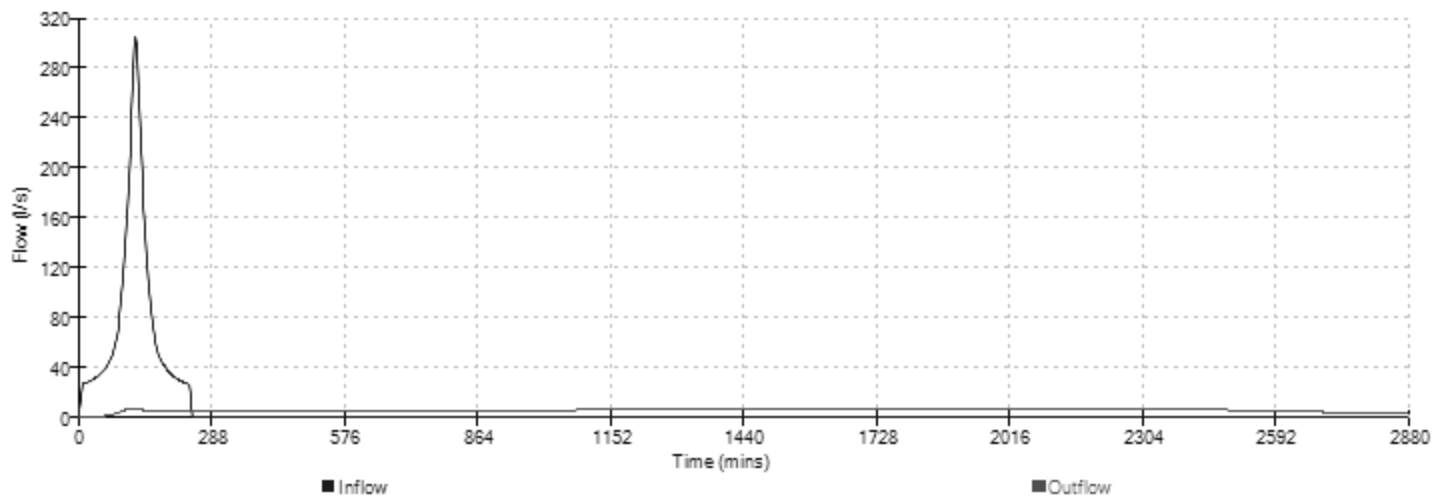
Event: 120 min Summer



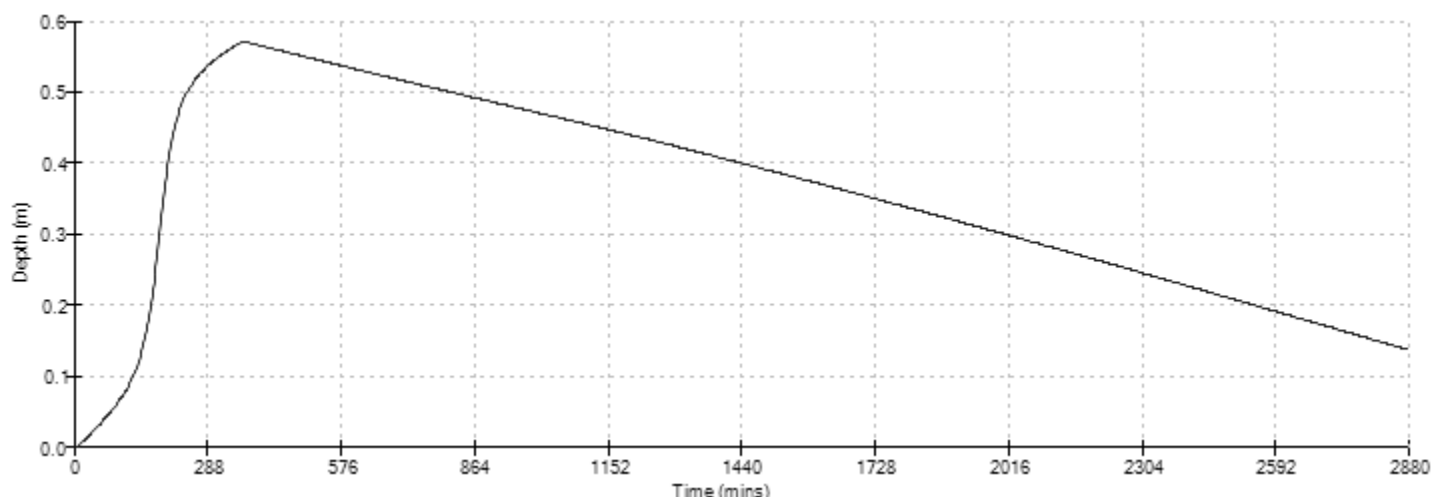
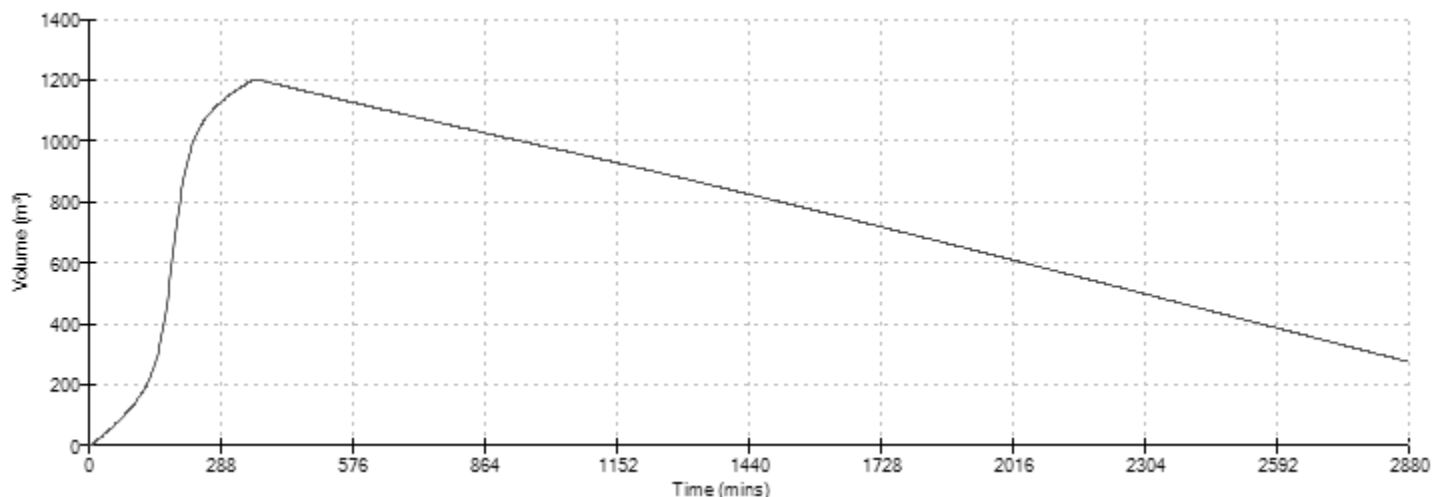
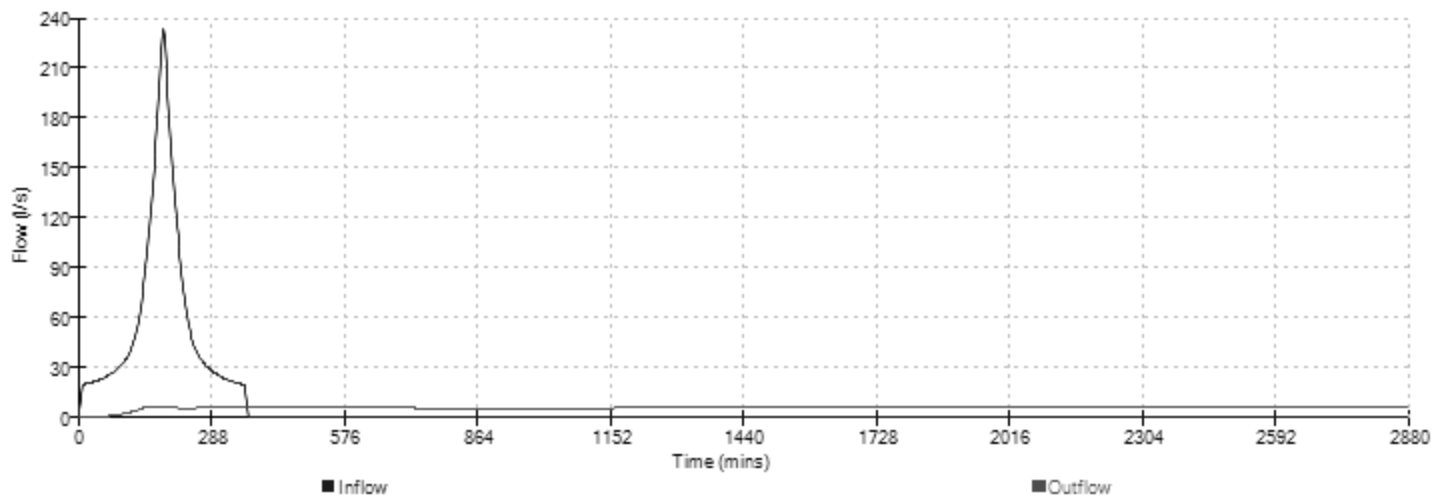
Event: 180 min Summer



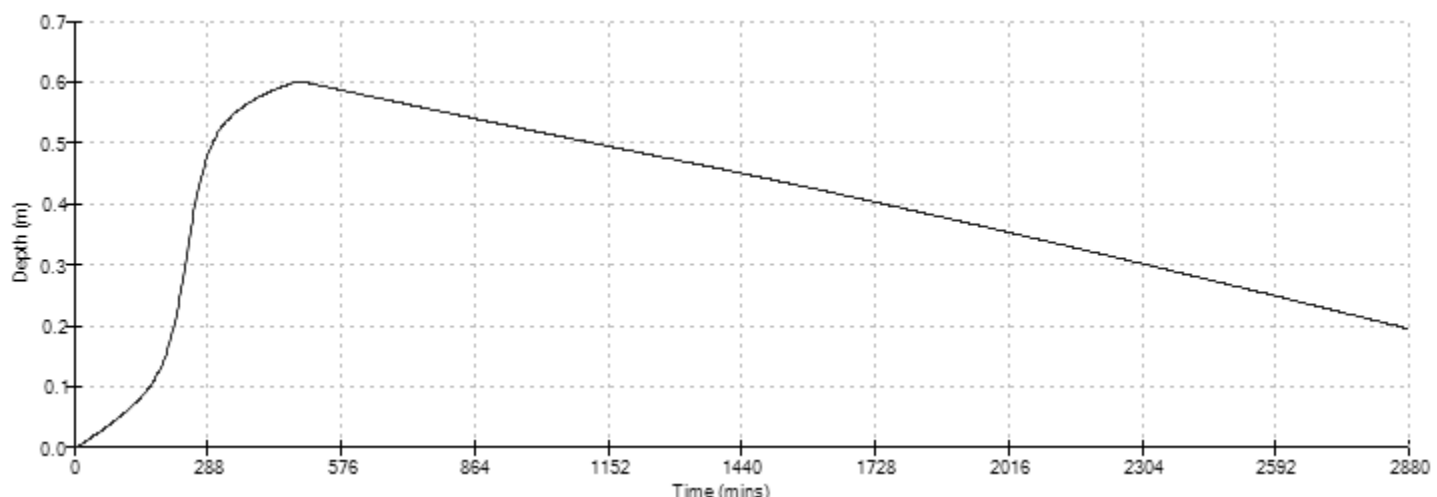
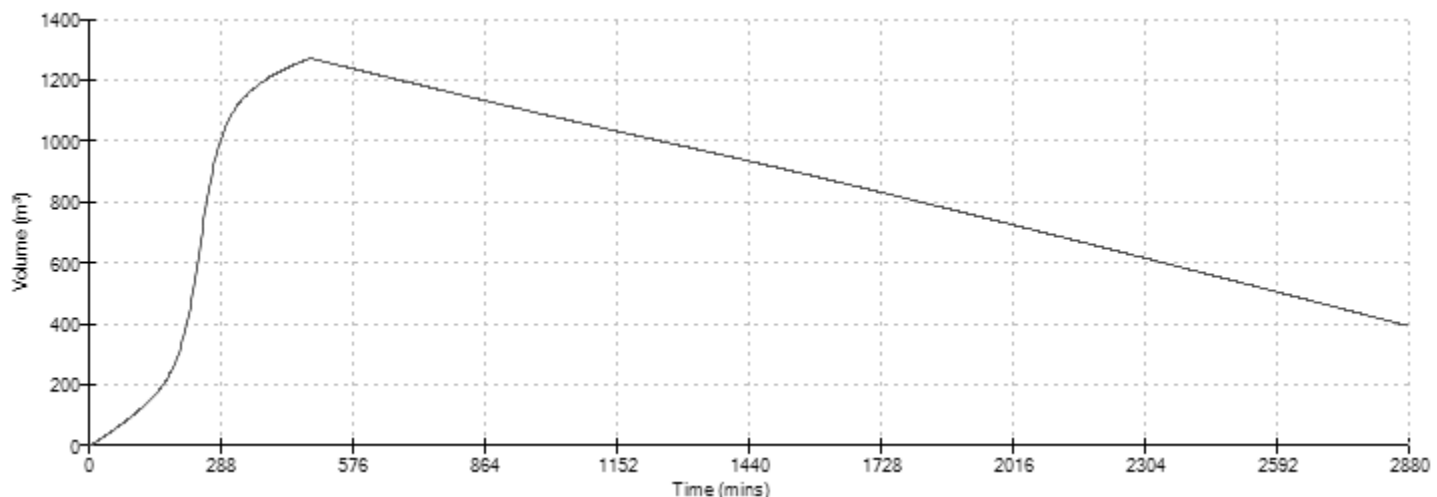
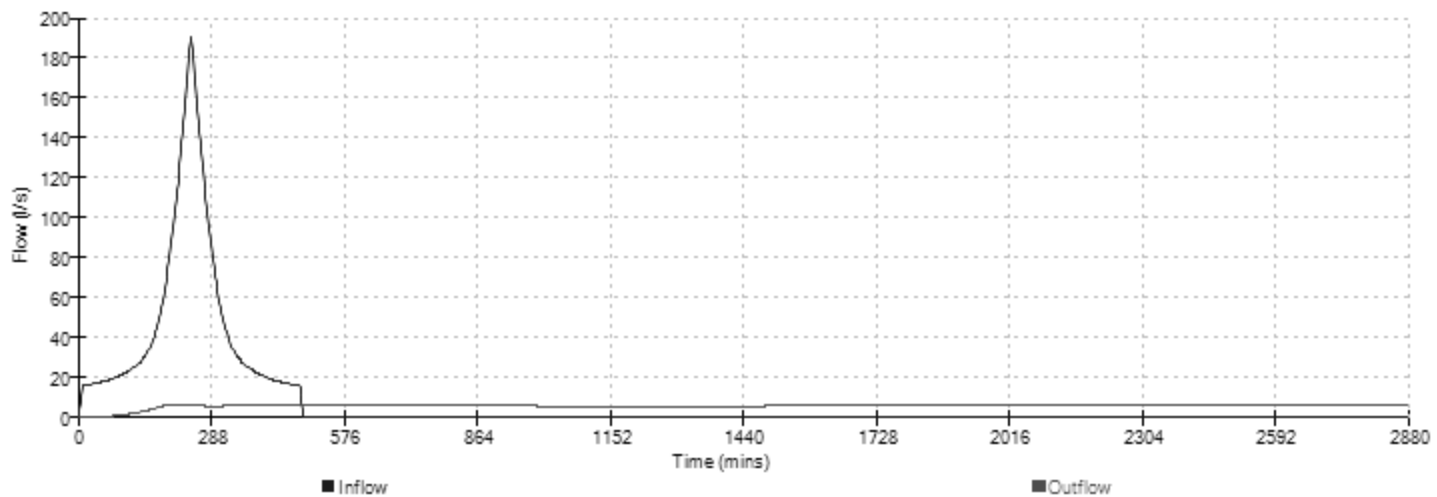
Event: 240 min Summer



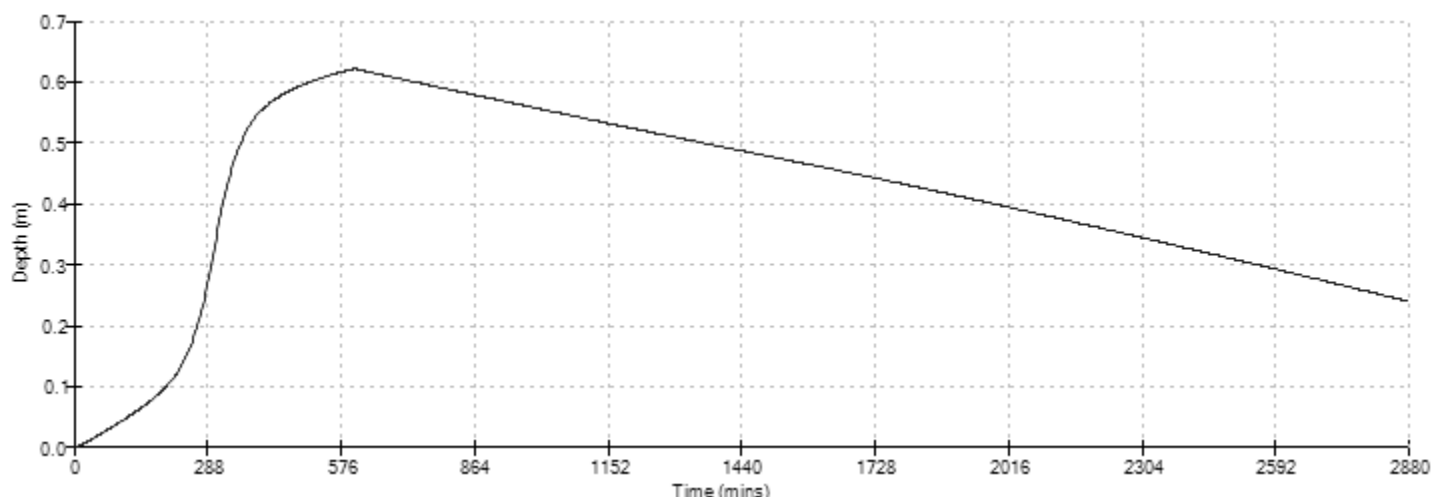
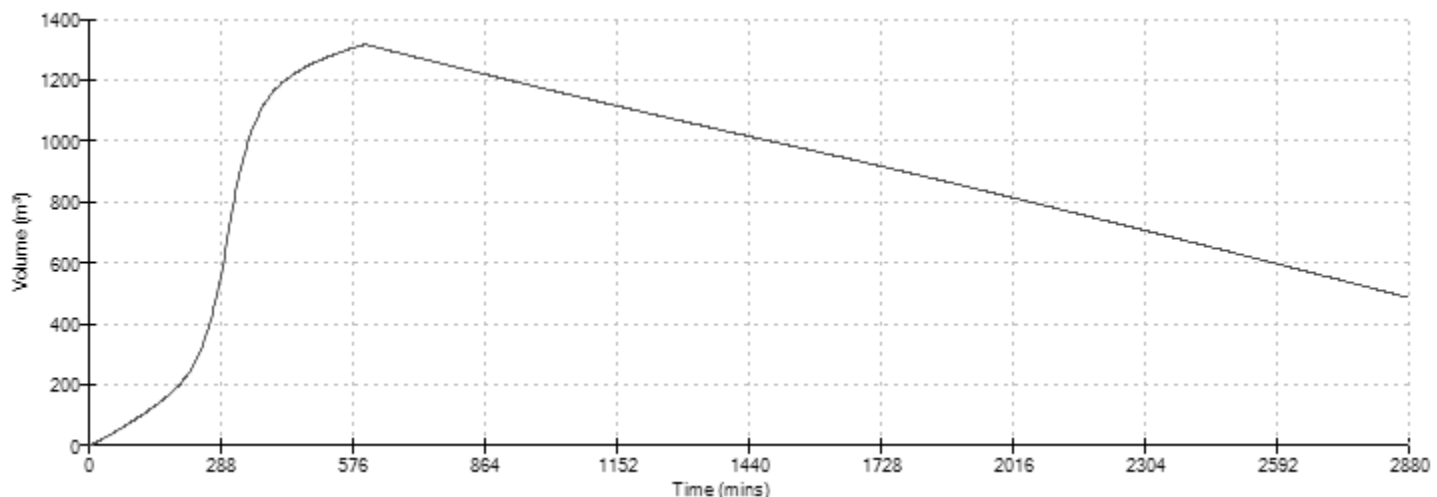
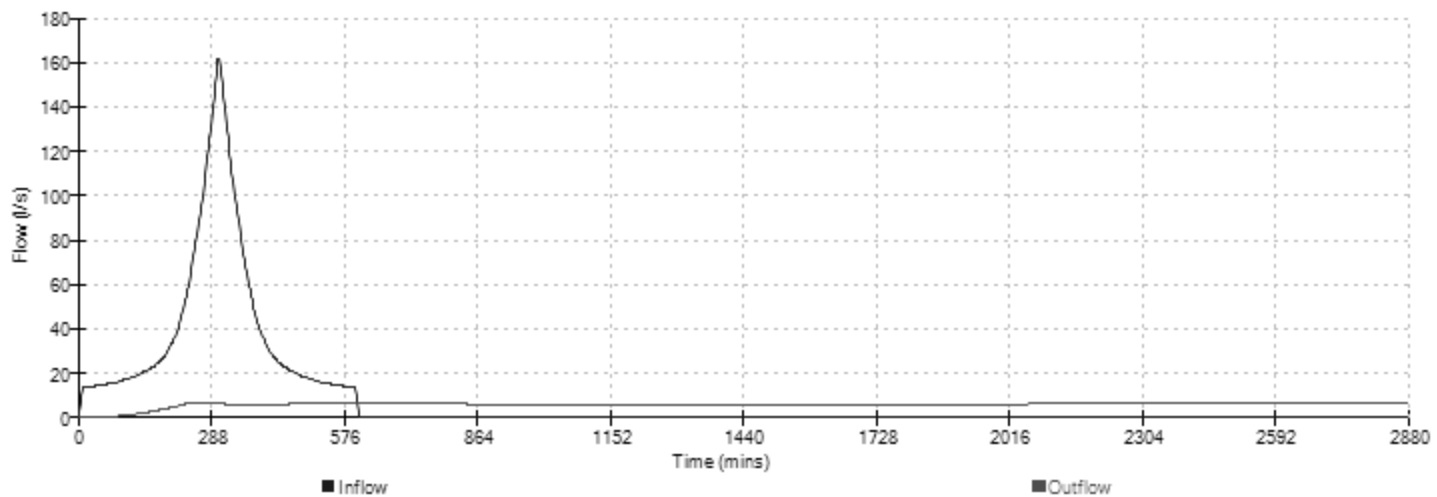
Event: 360 min Summer



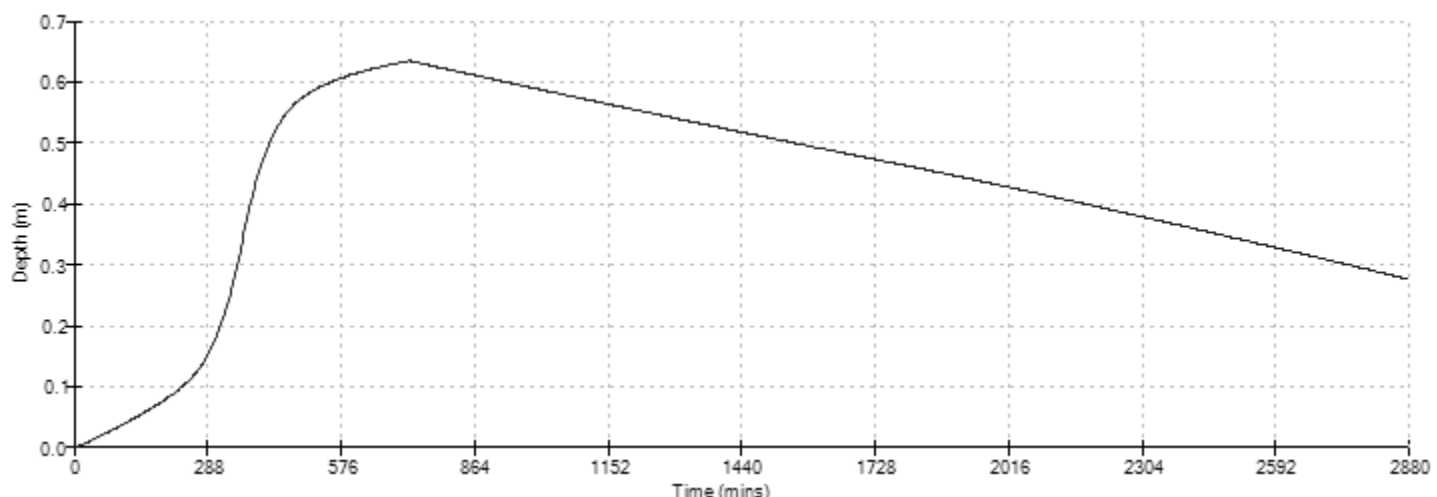
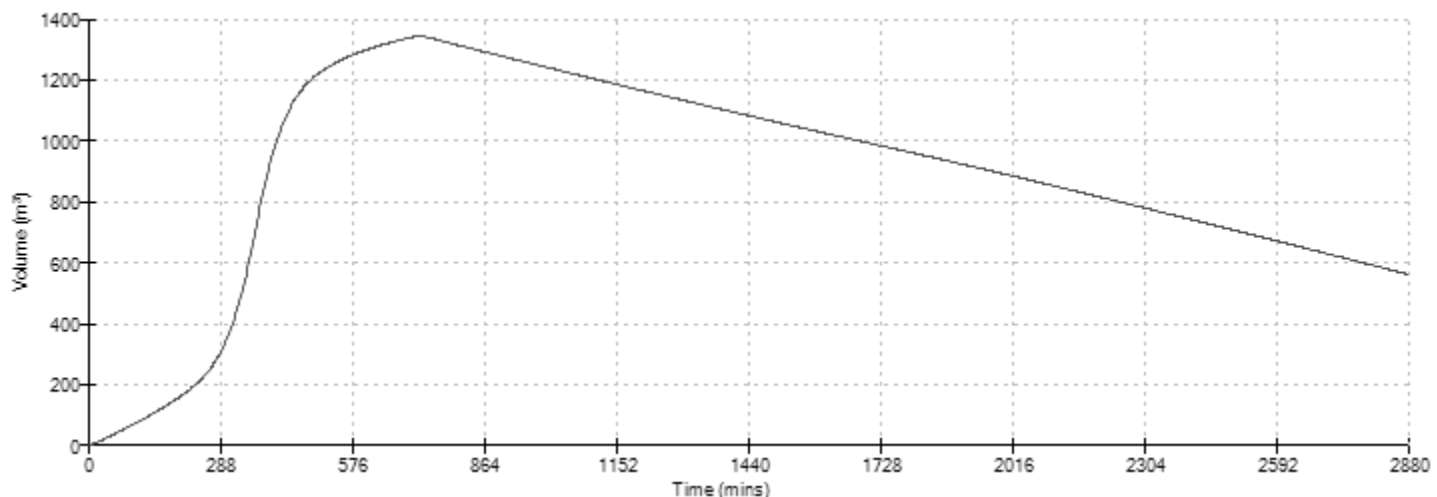
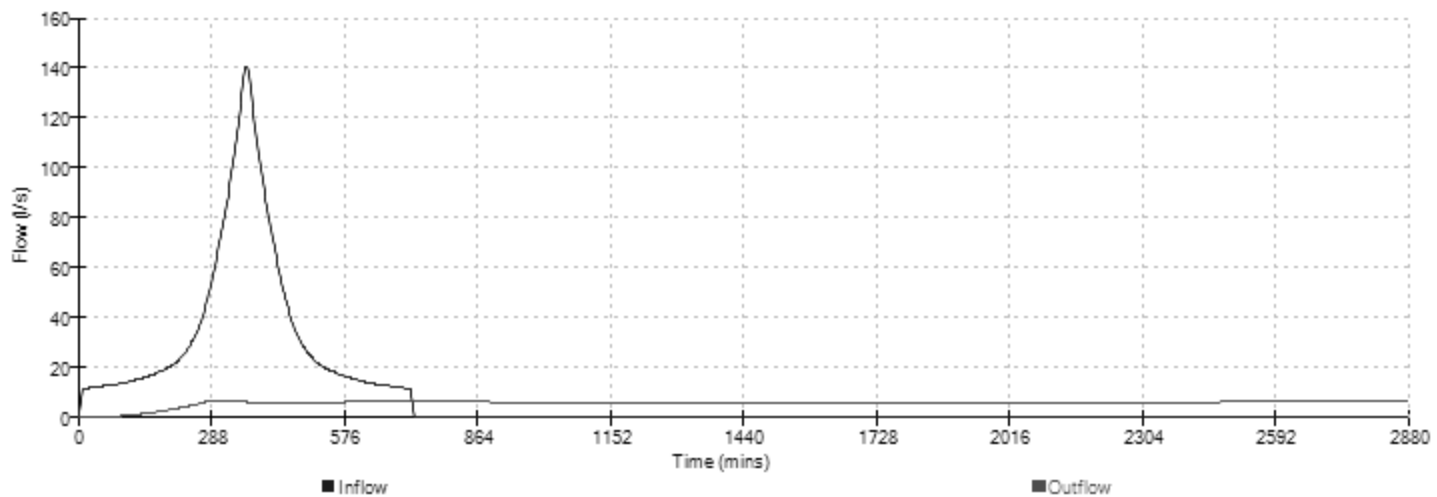
Event: 480 min Summer



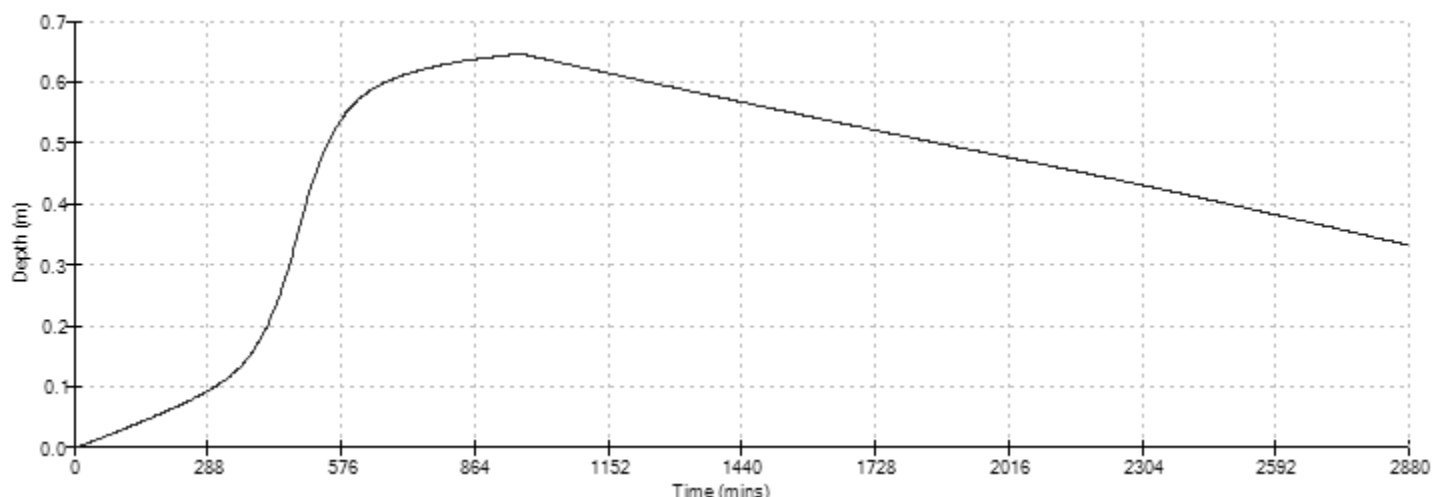
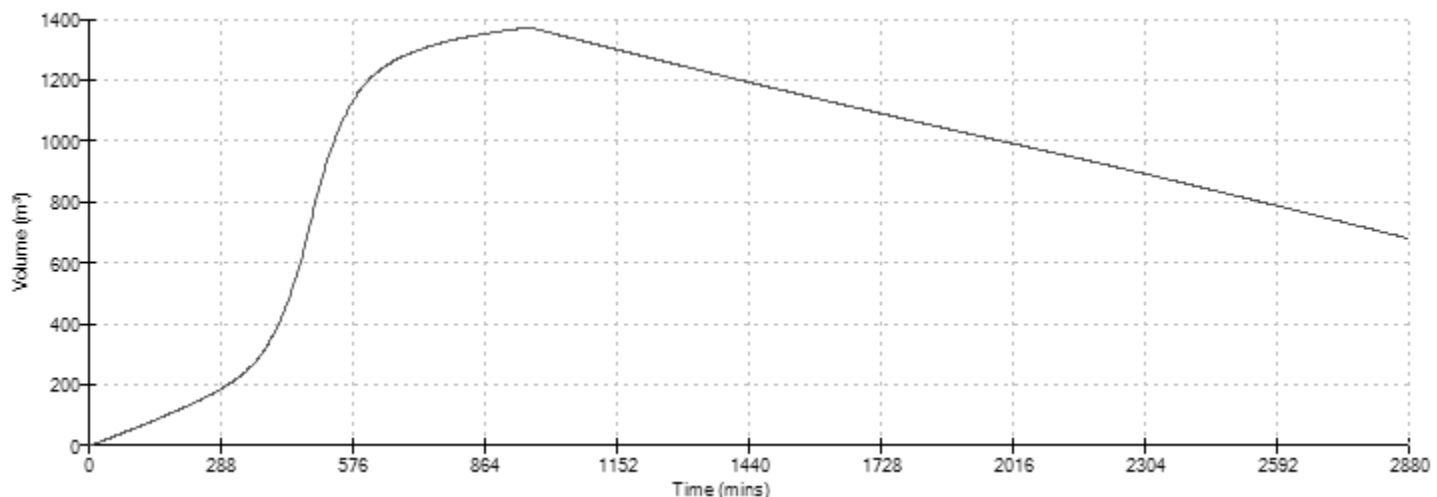
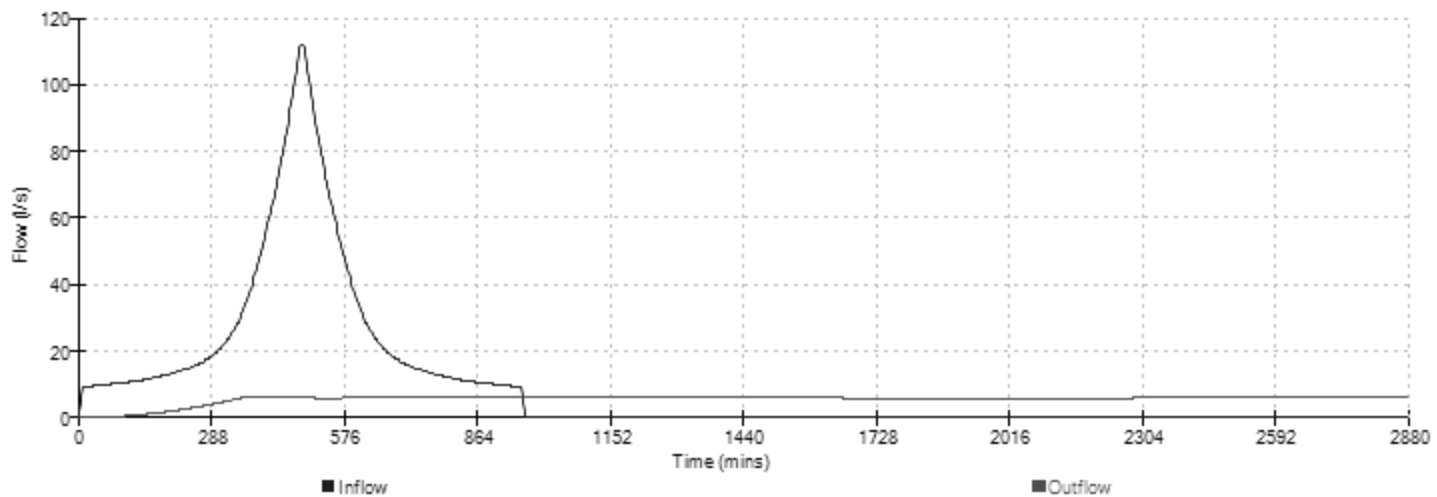
Event: 600 min Summer



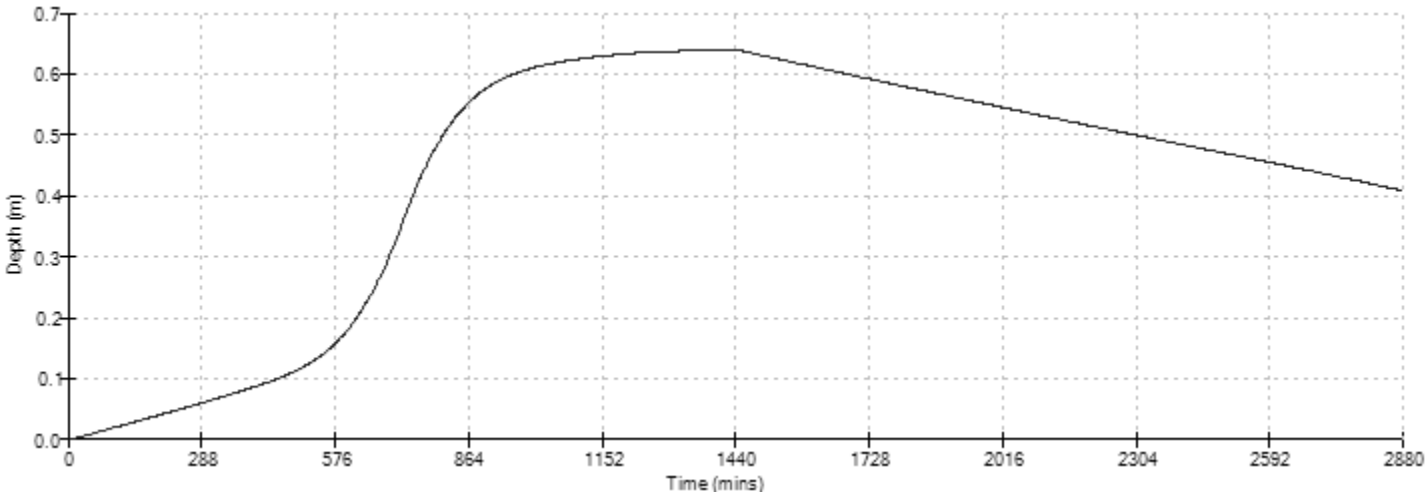
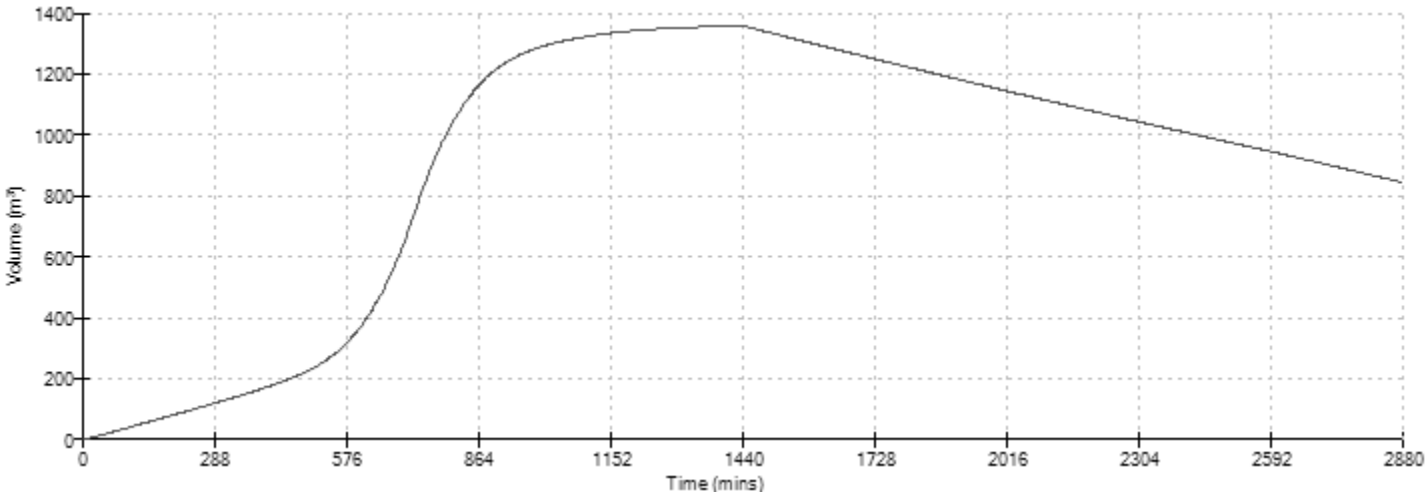
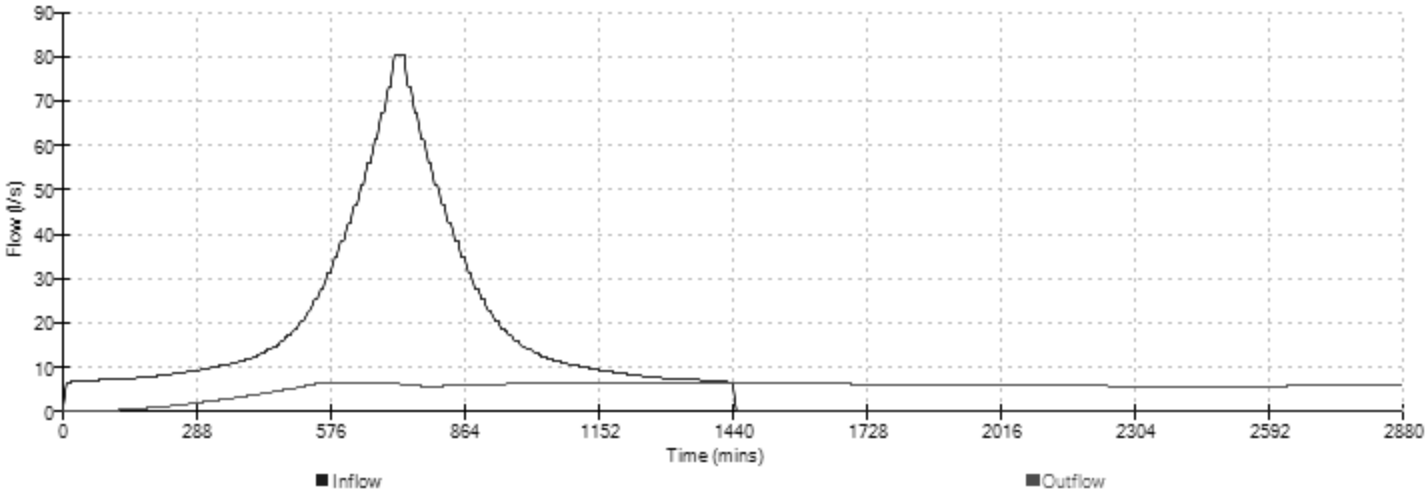
Event: 720 min Summer



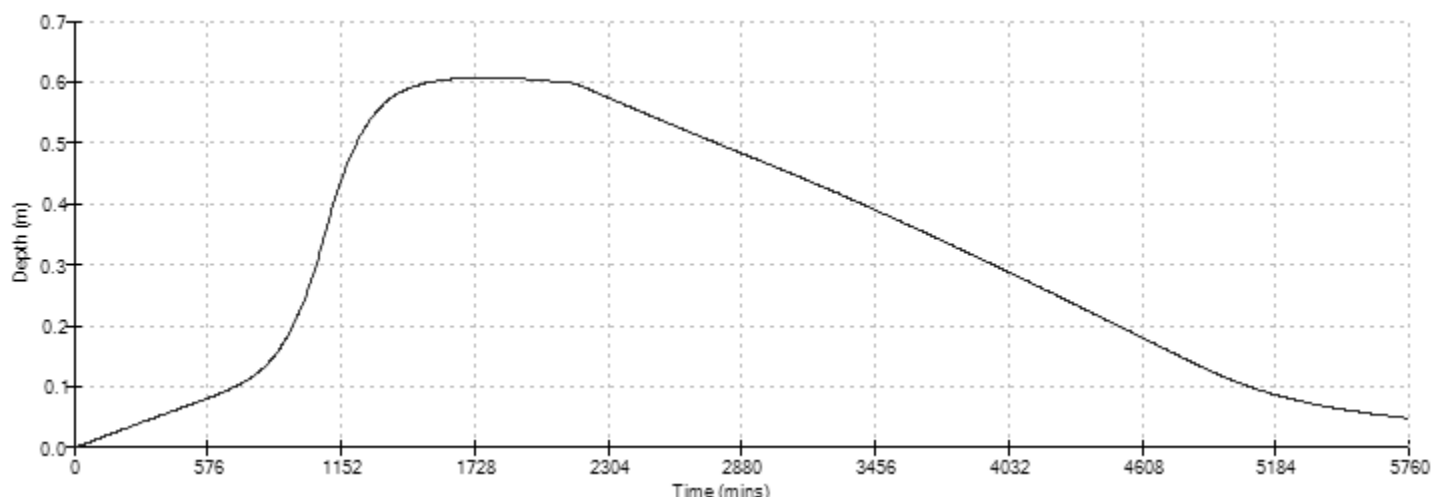
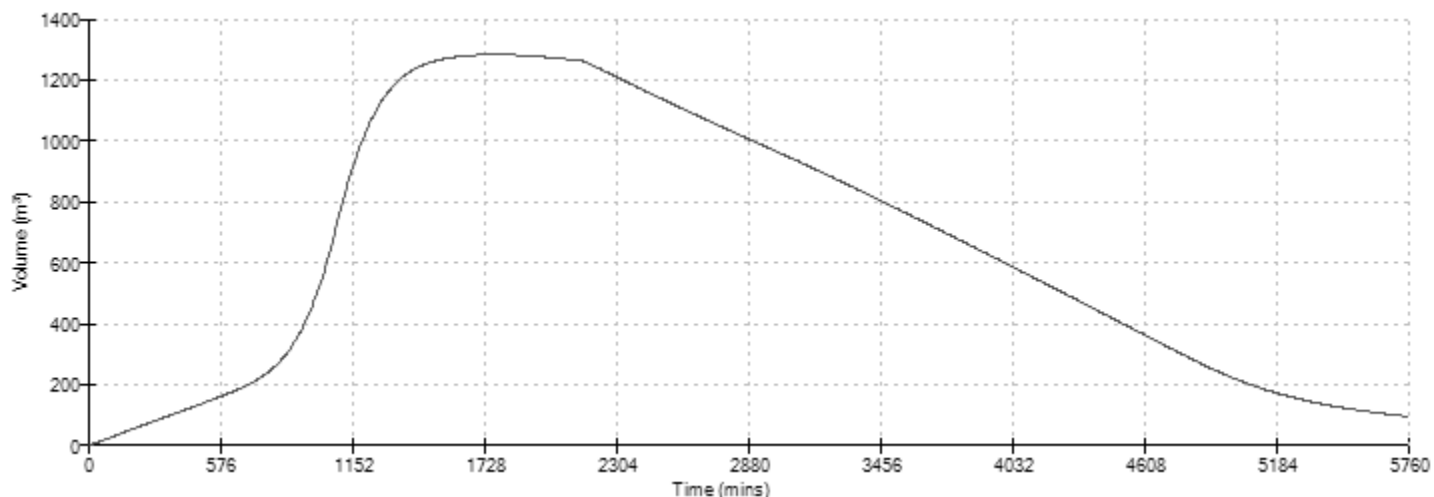
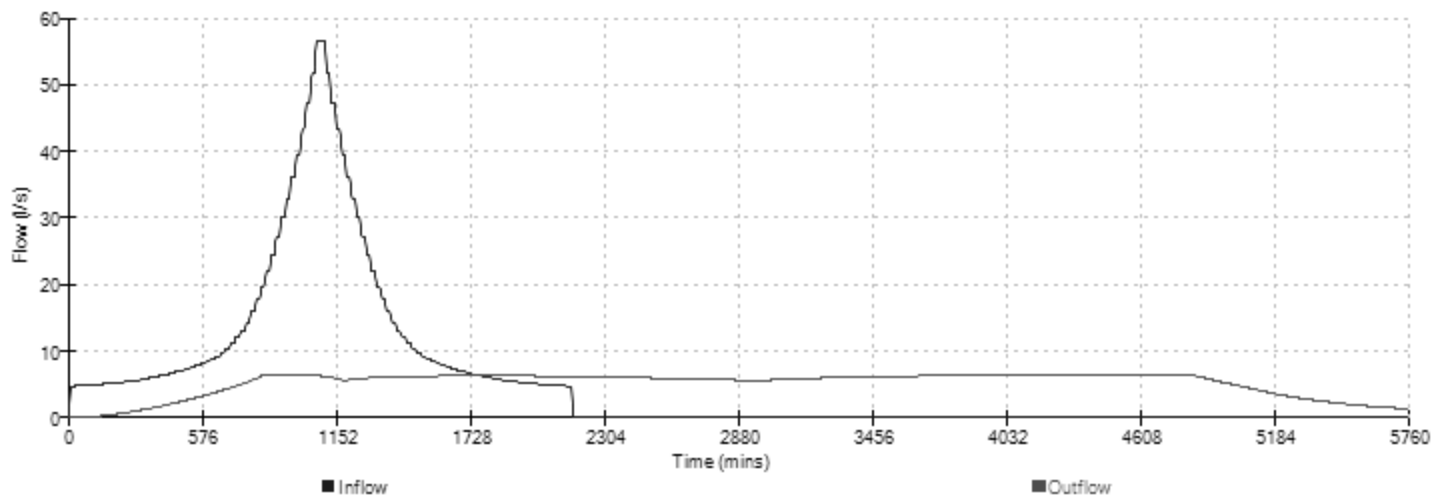
Event: 960 min Summer



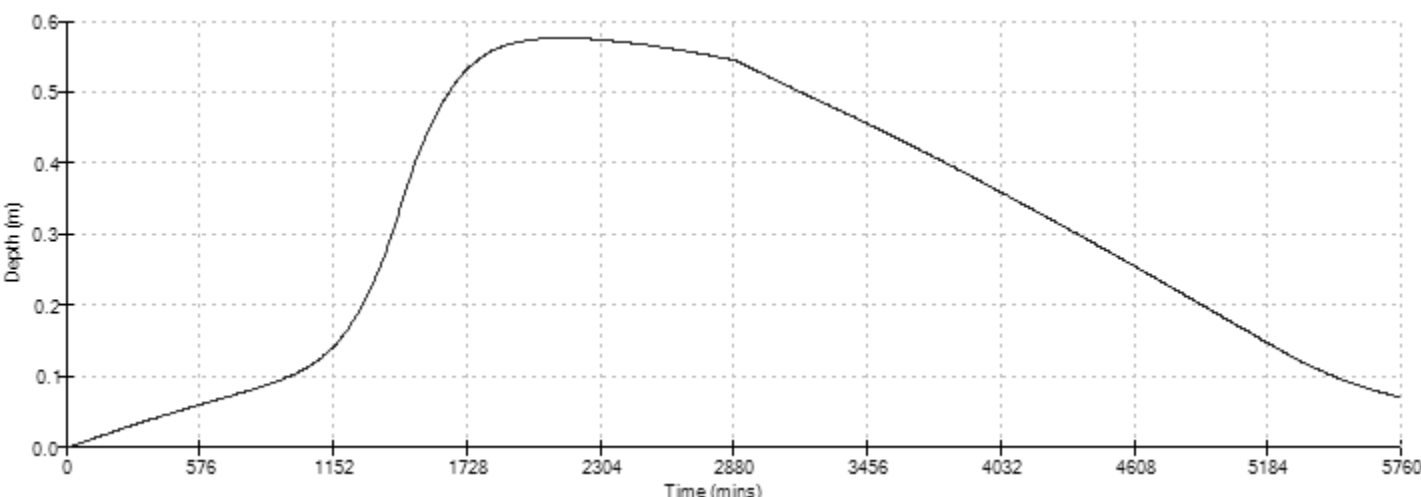
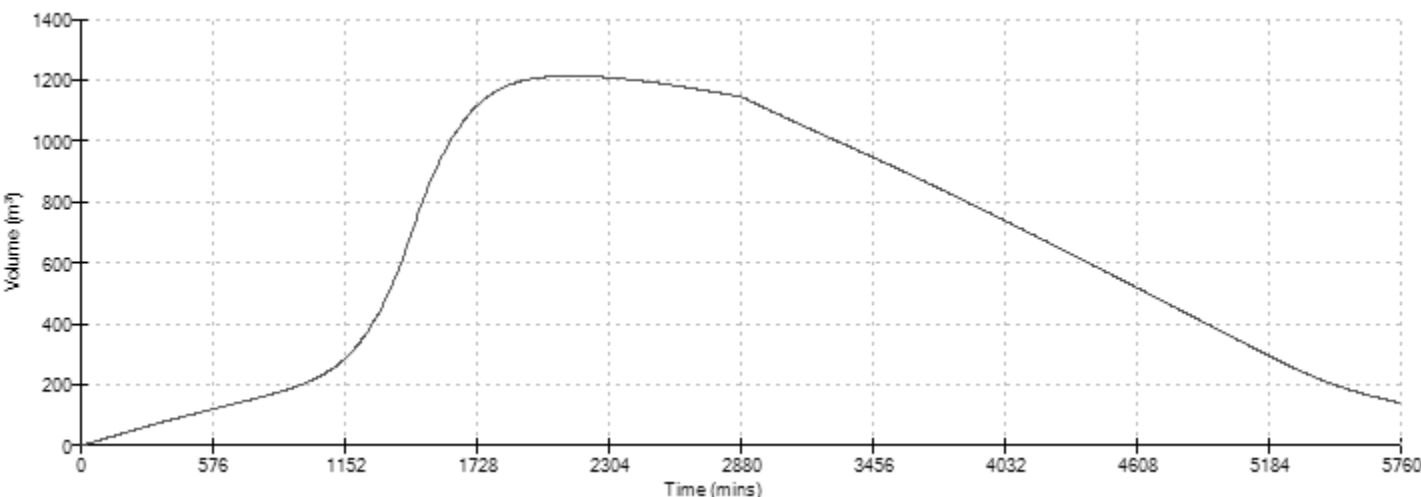
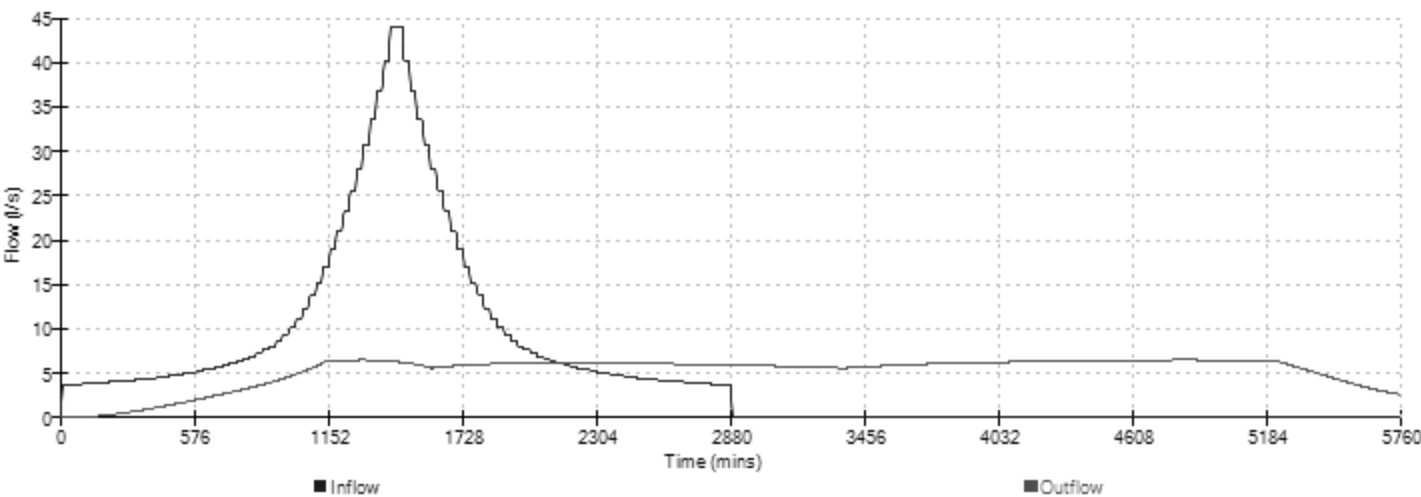
Event: 1440 min Summer



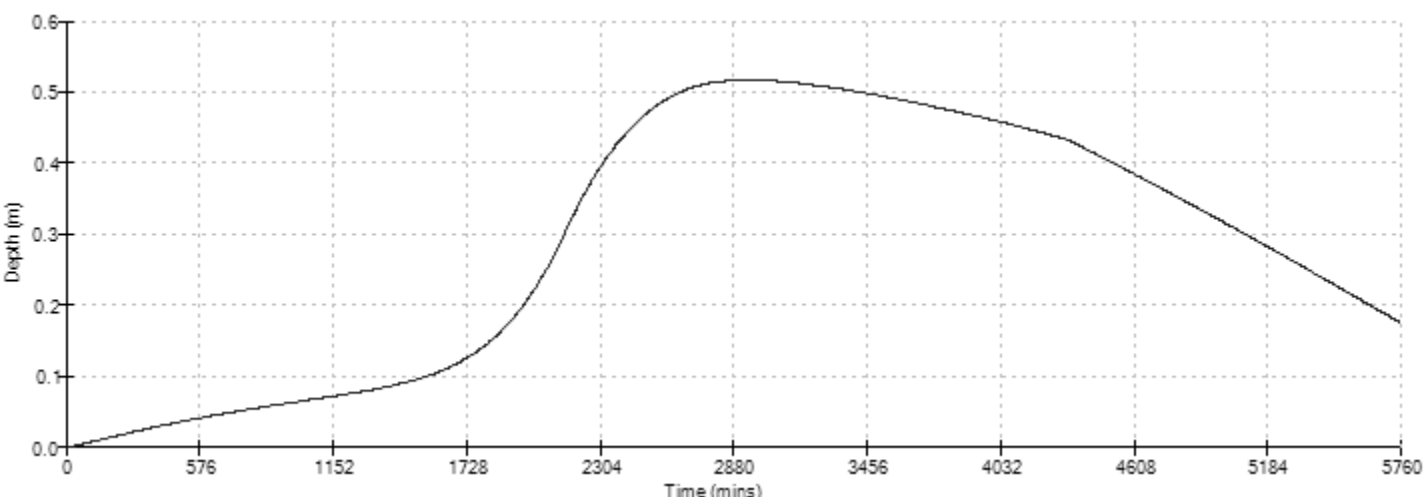
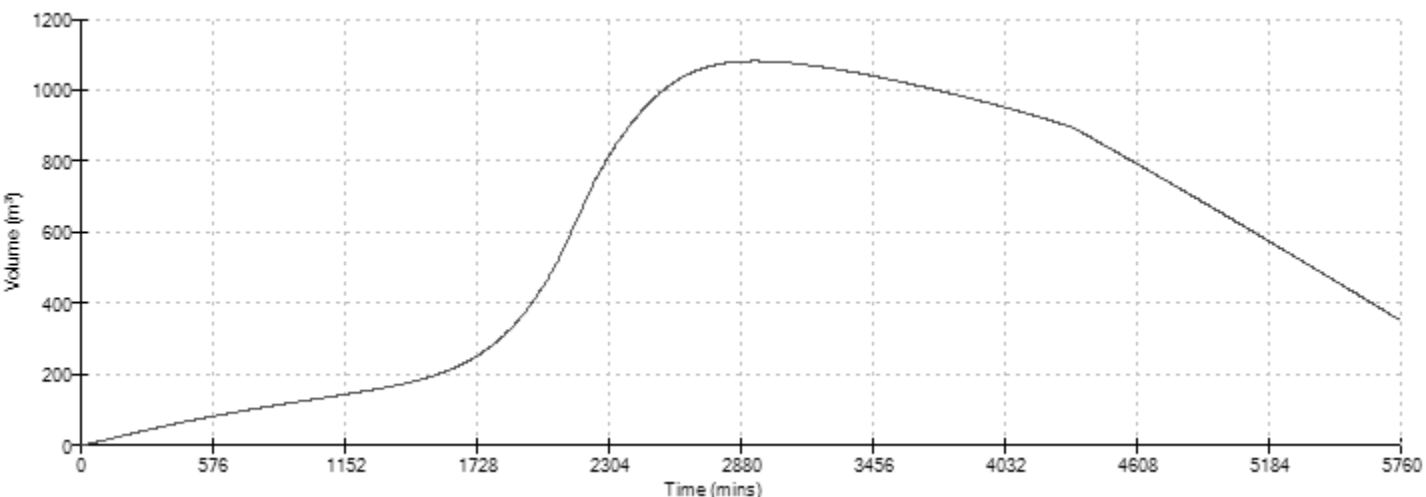
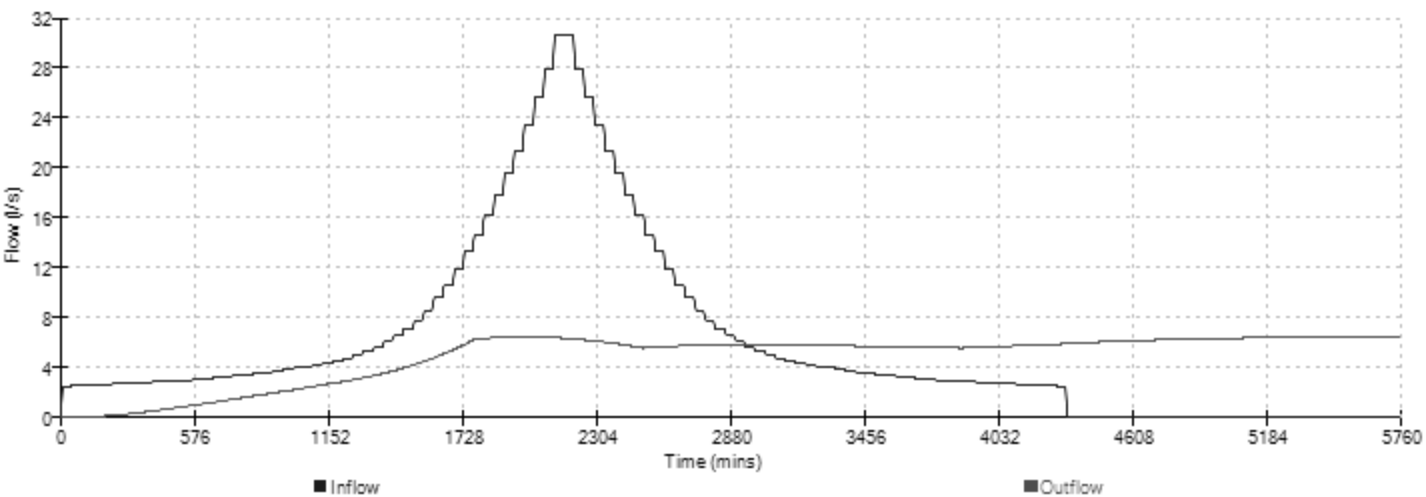
Event: 2160 min Summer



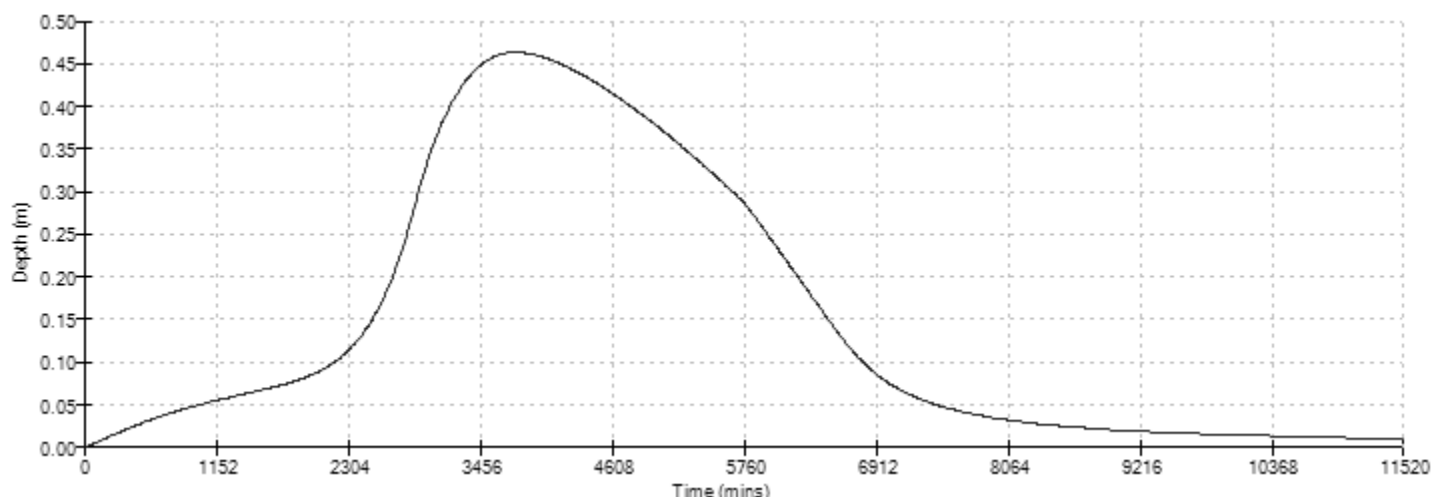
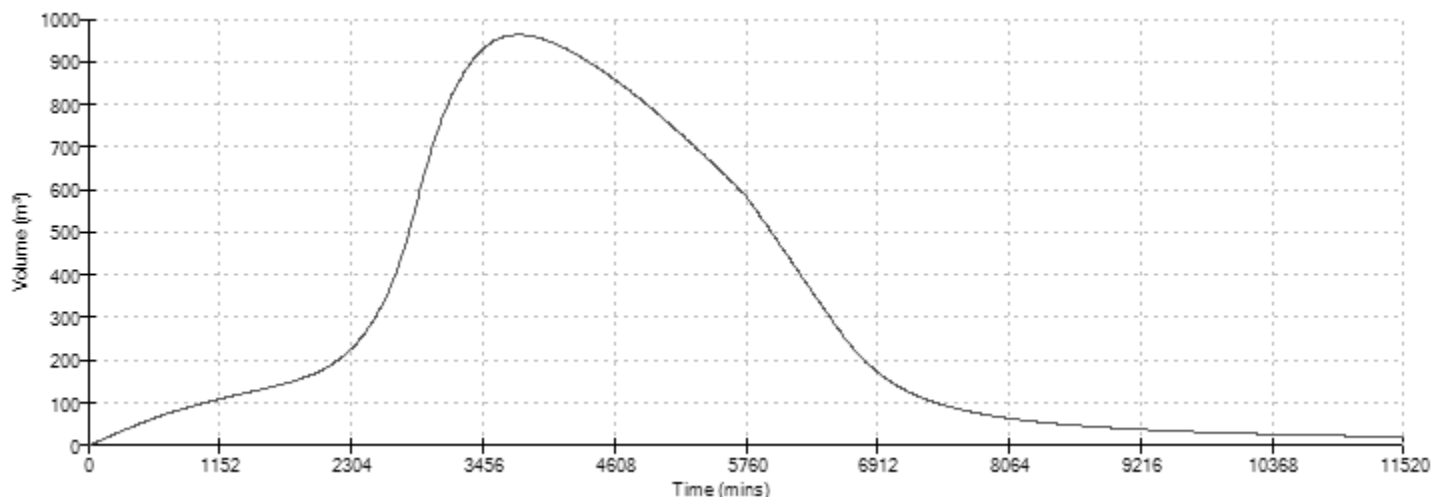
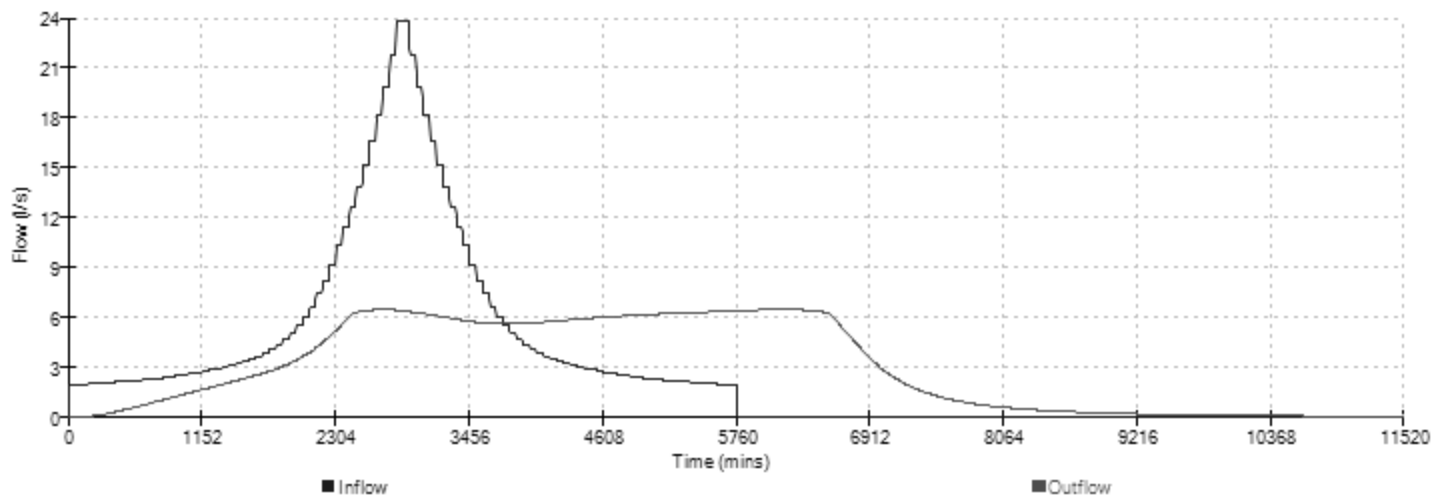
Event: 2880 min Summer



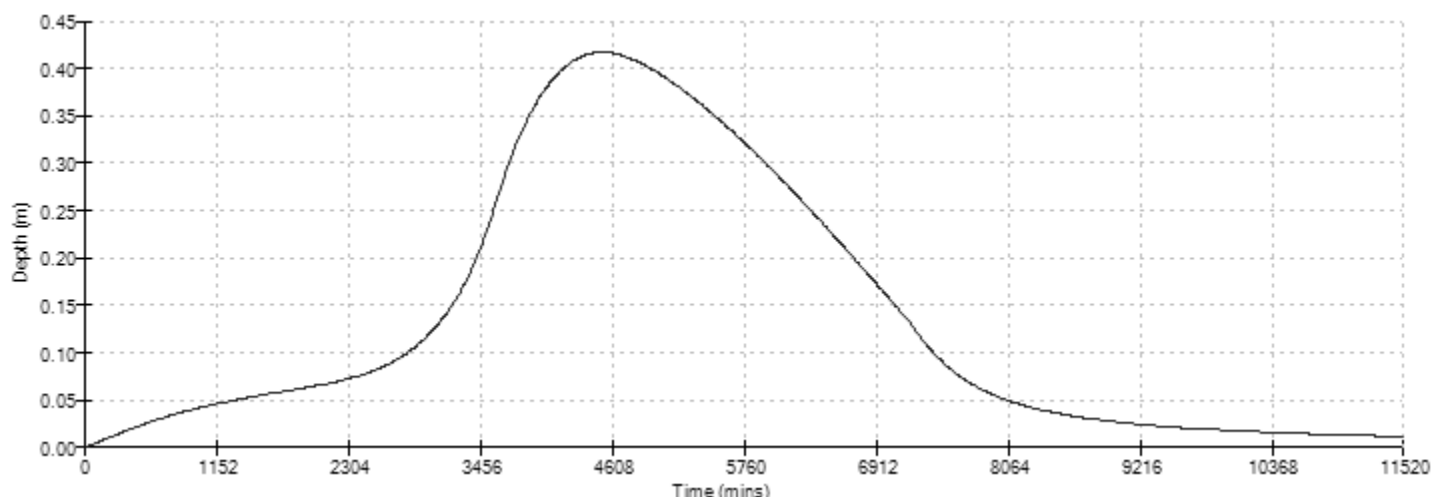
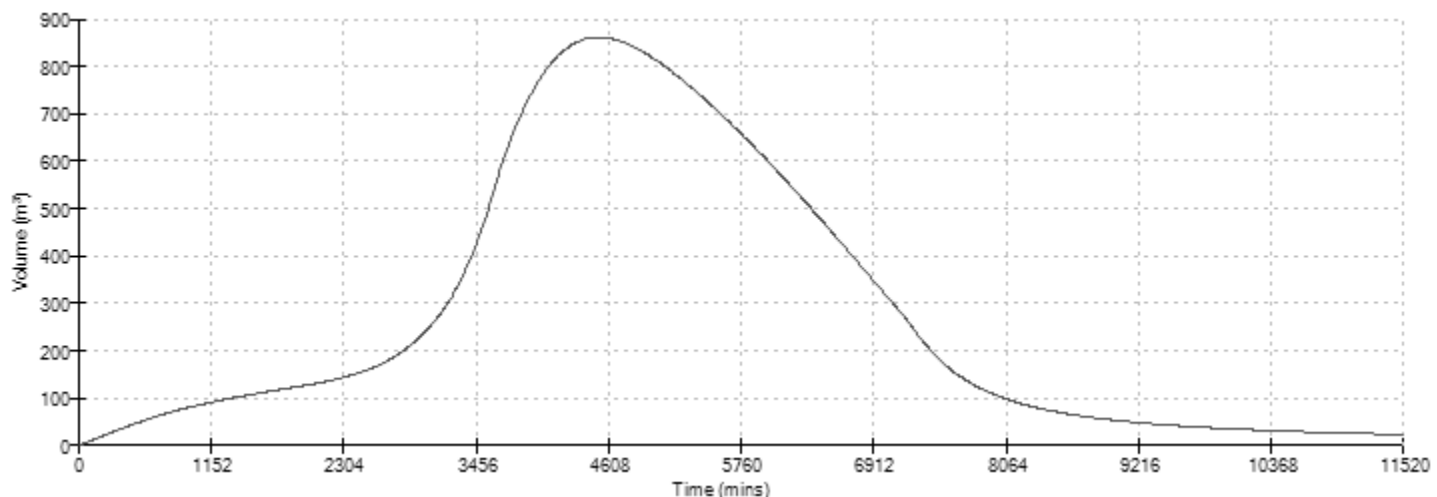
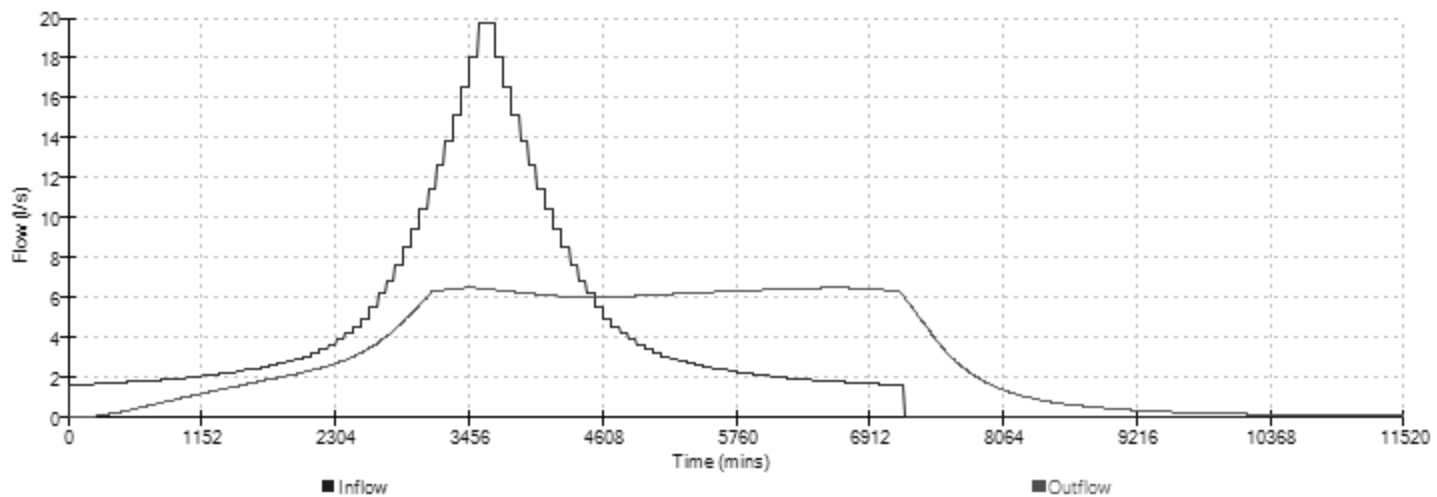
Event: 4320 min Summer



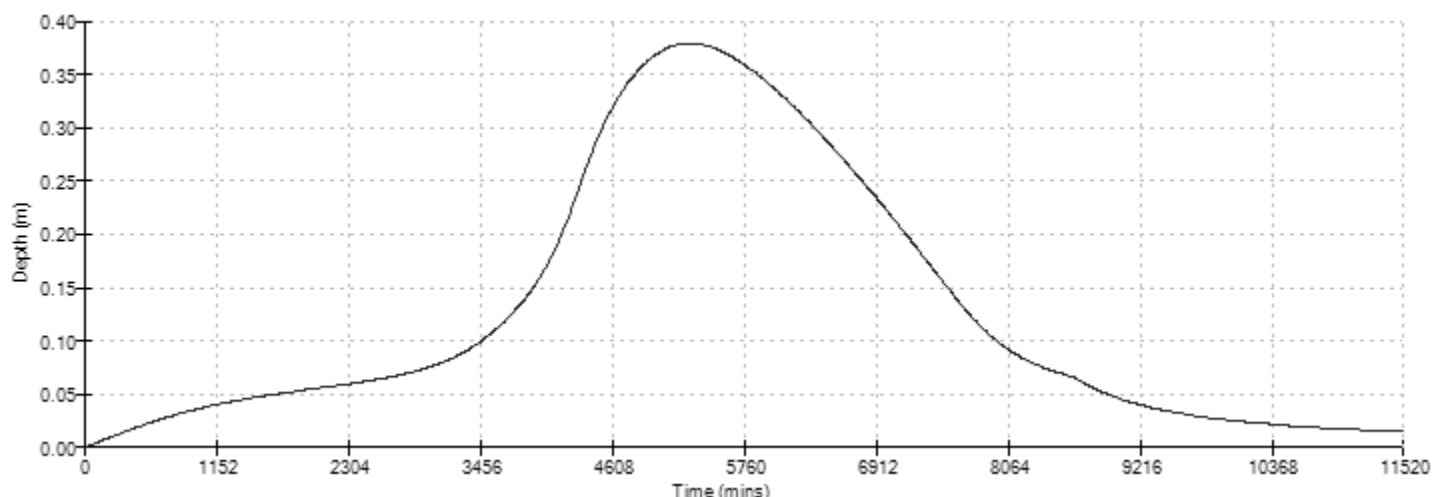
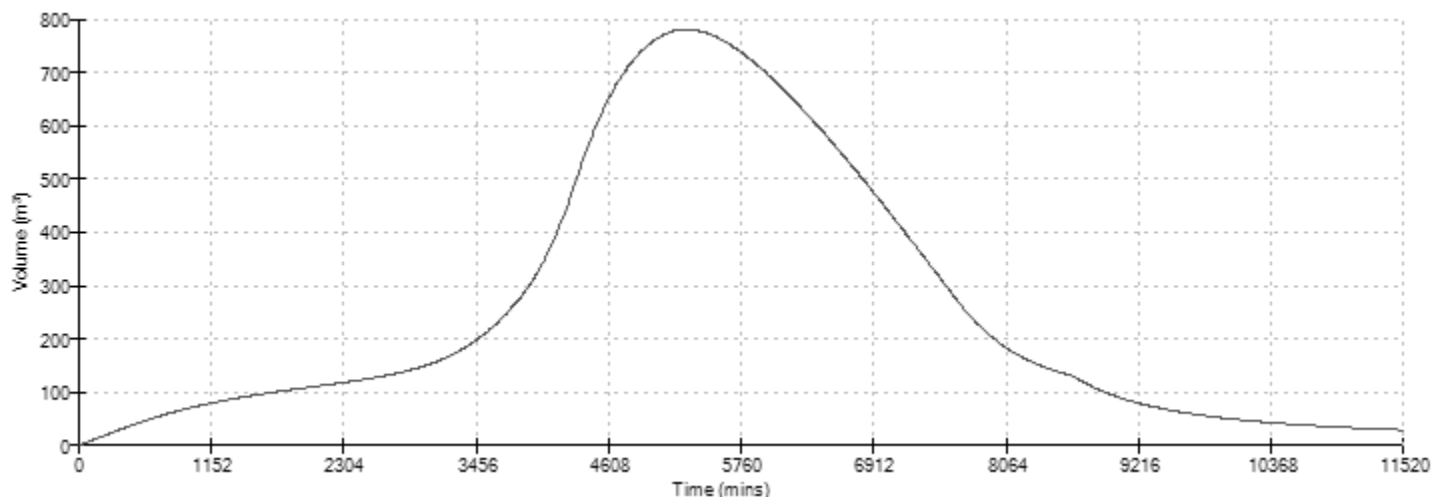
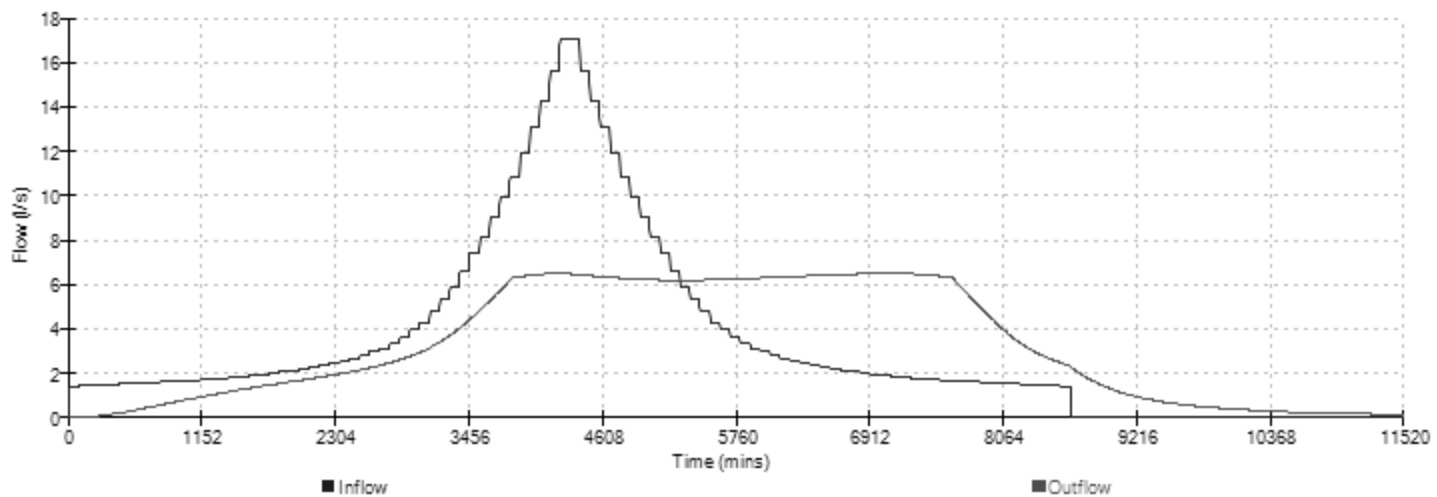
Event: 5760 min Summer



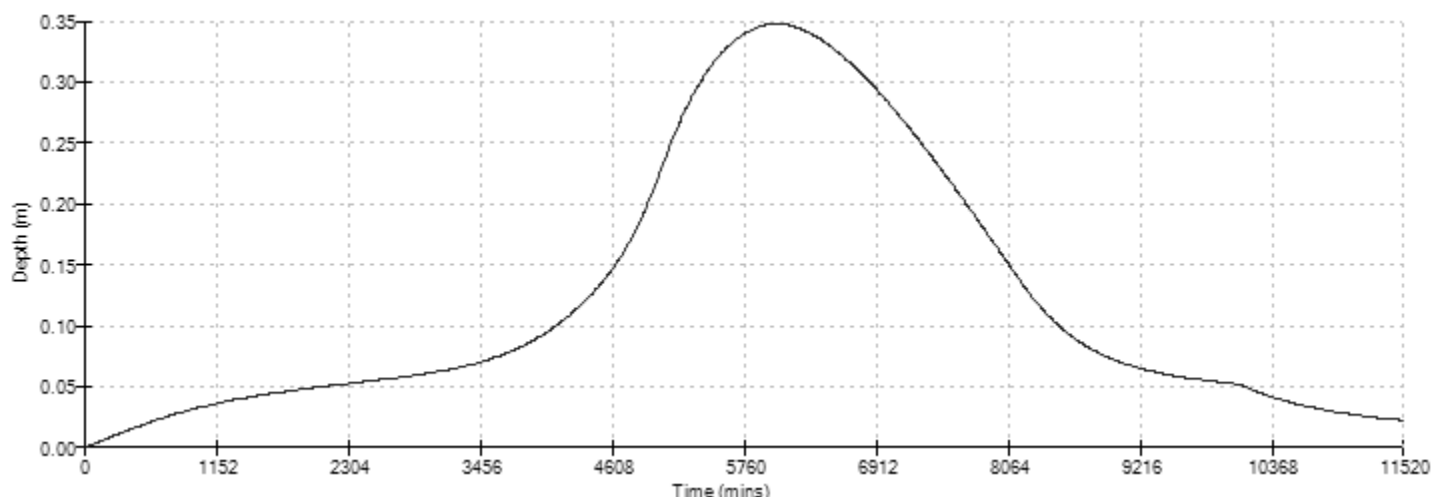
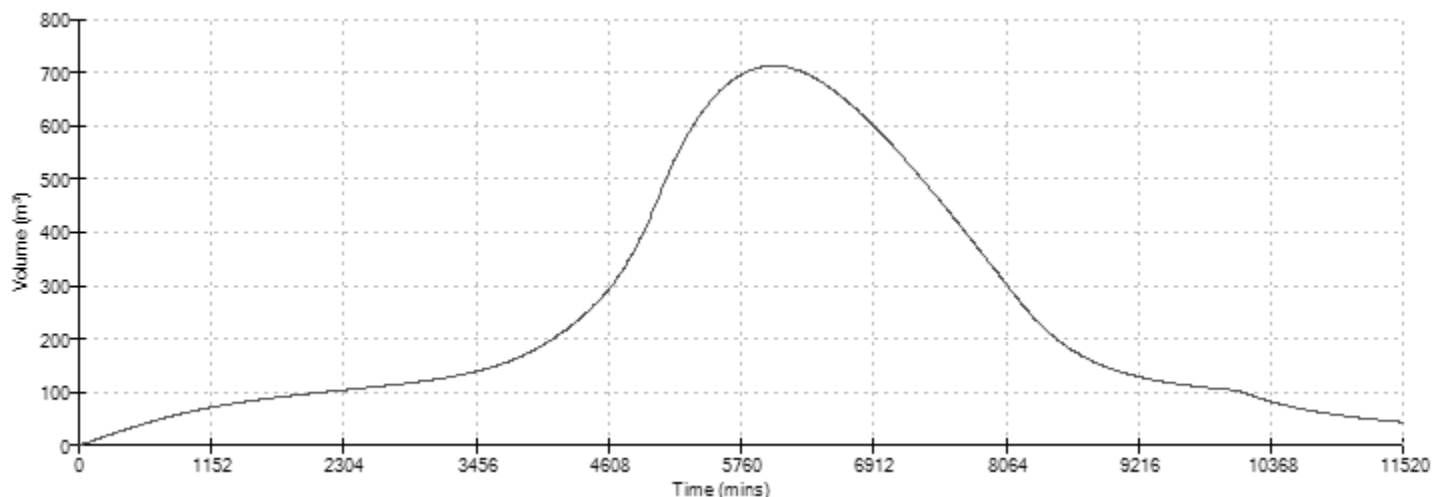
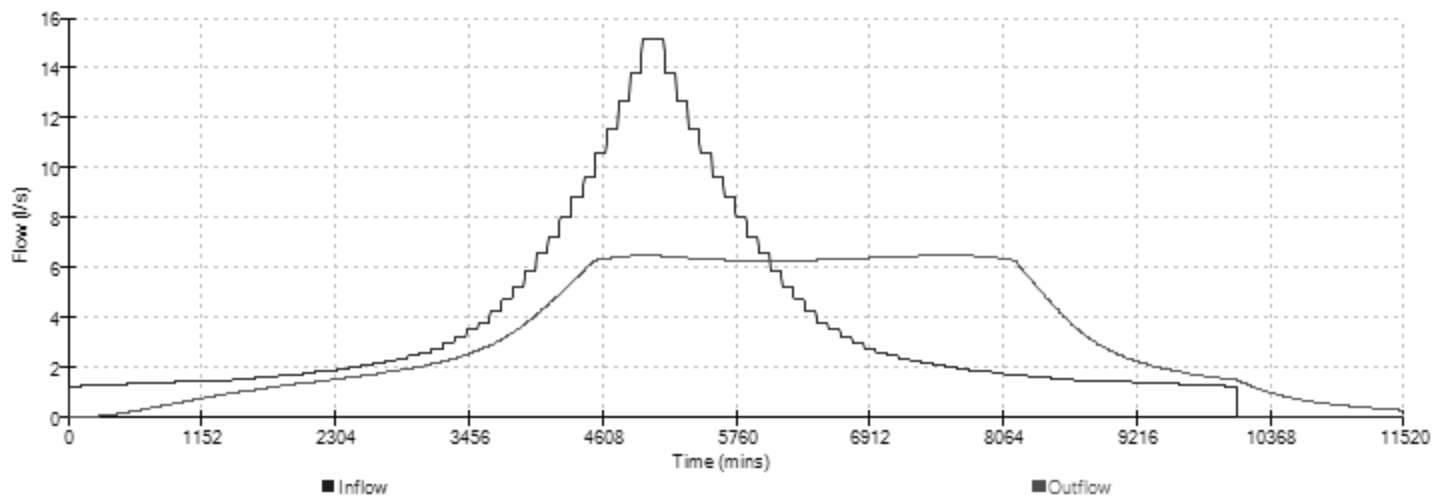
Event: 7200 min Summer



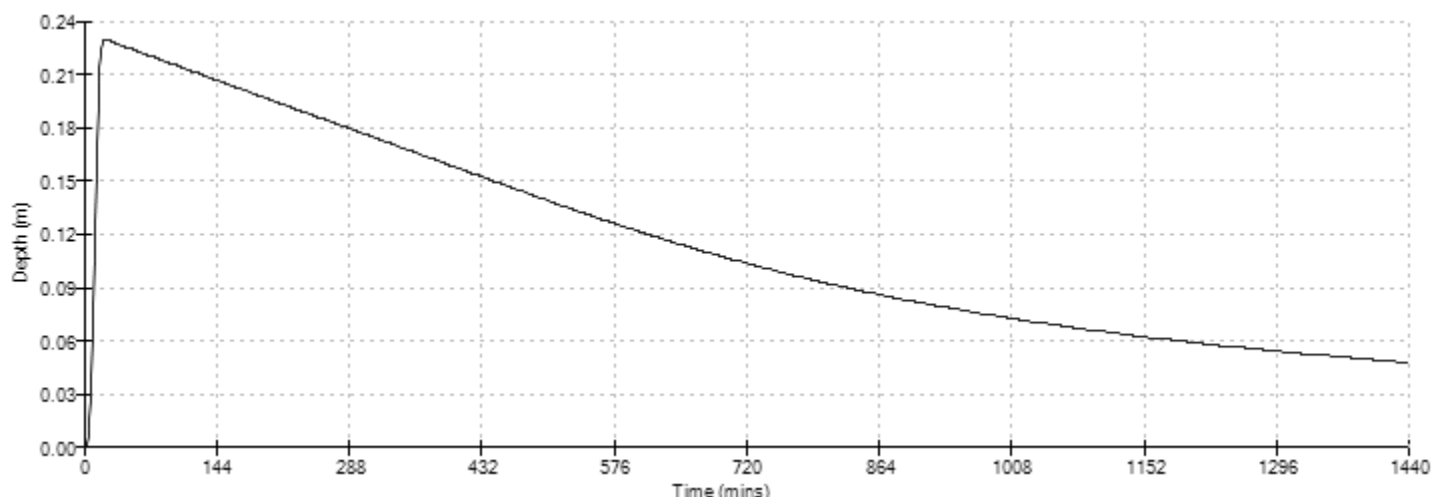
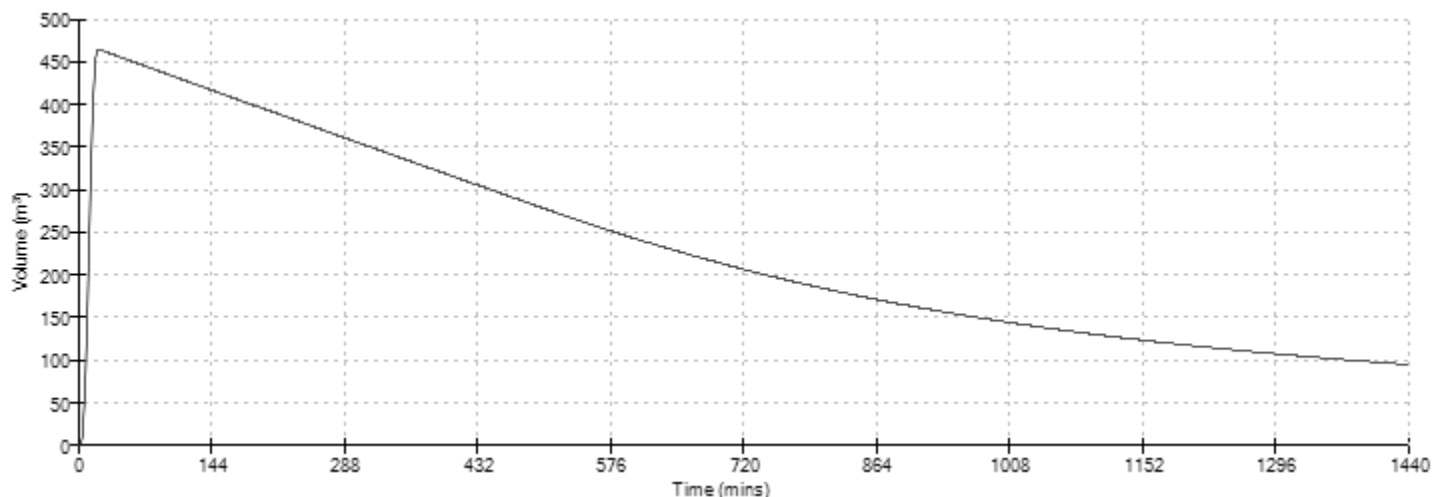
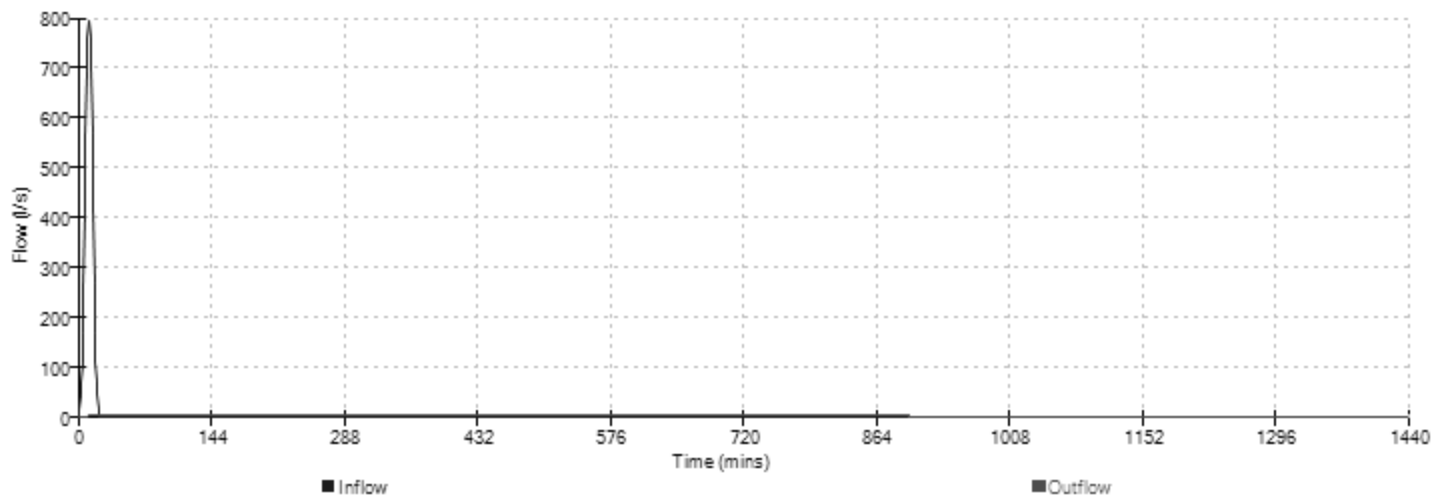
Event: 8640 min Summer



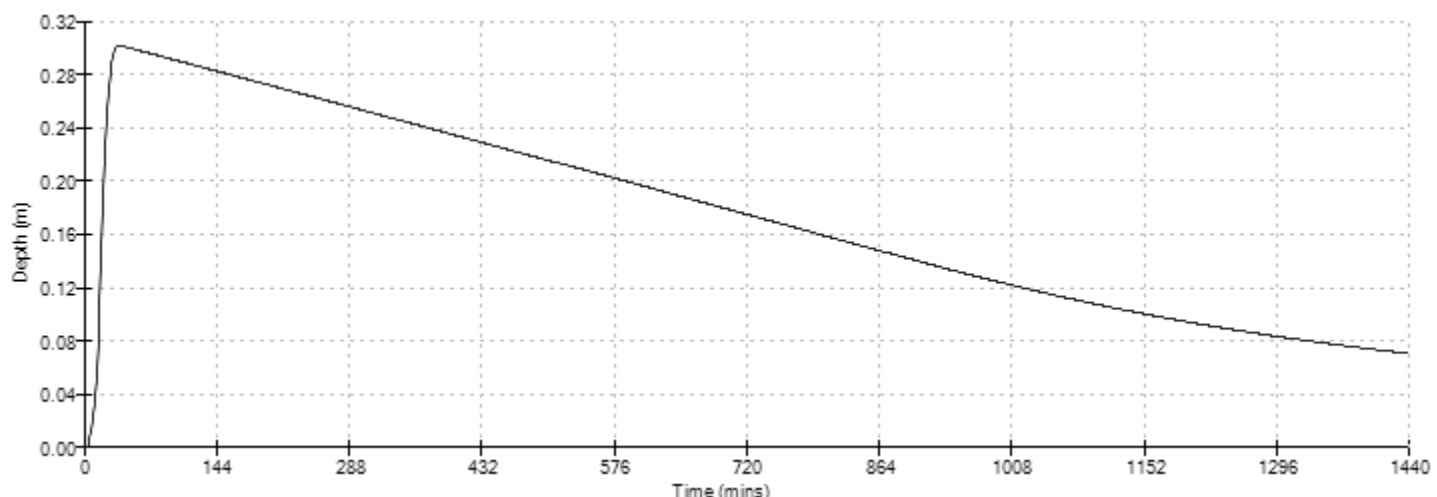
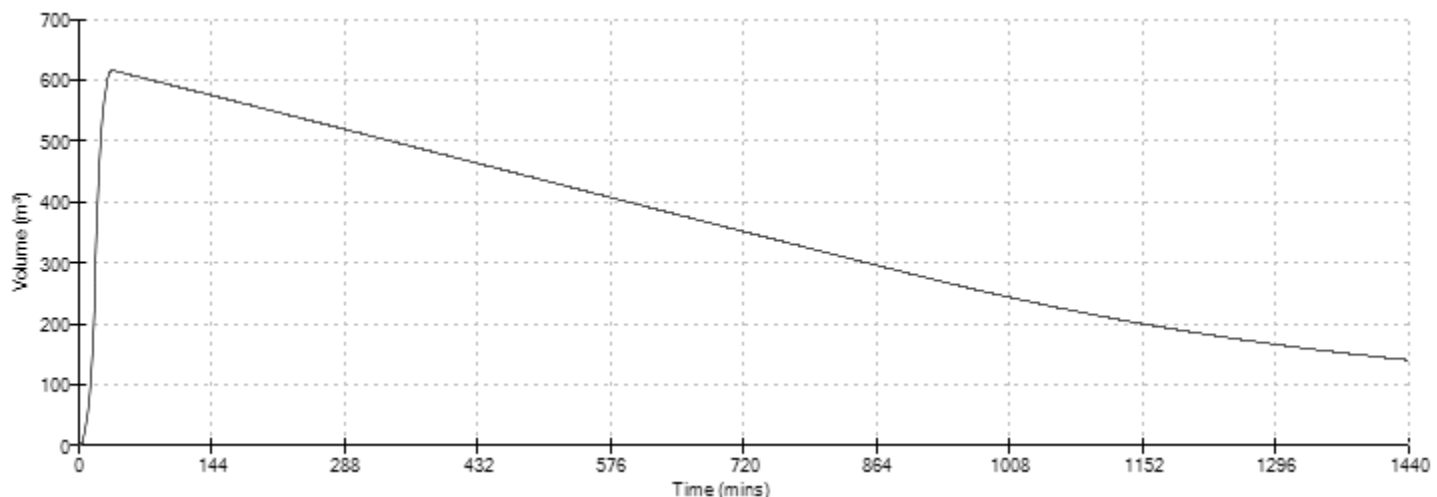
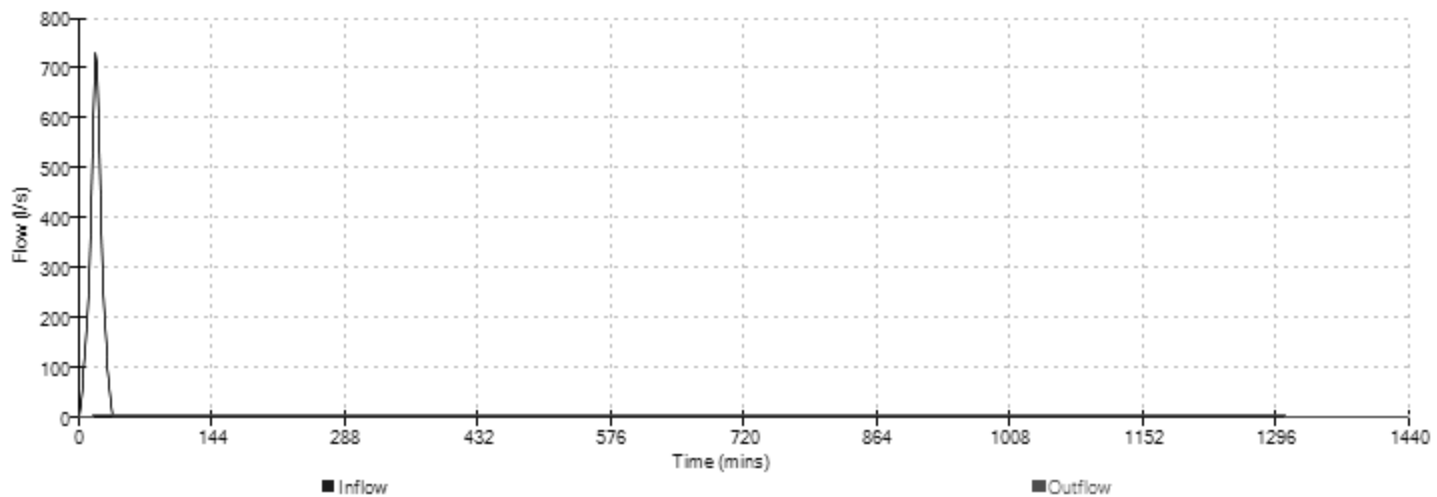
Event: 10080 min Summer



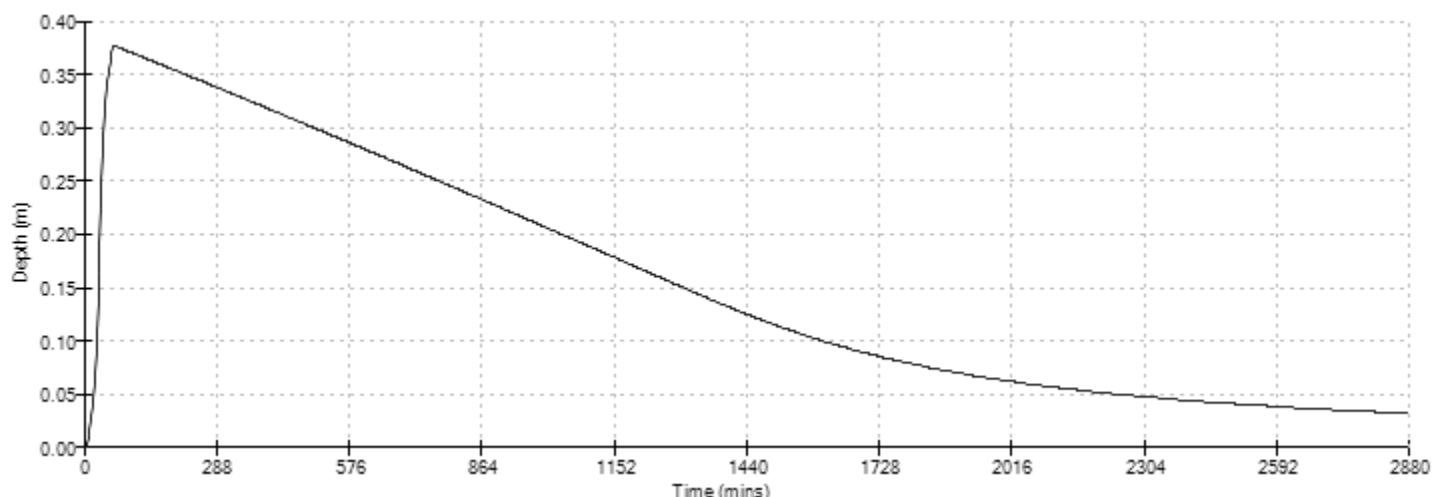
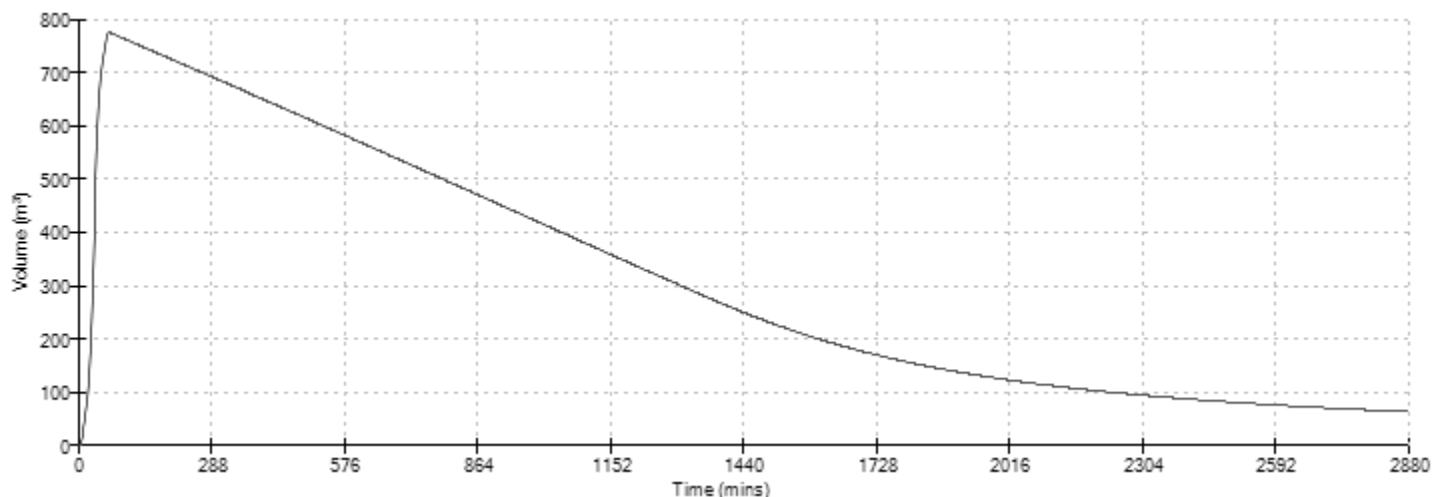
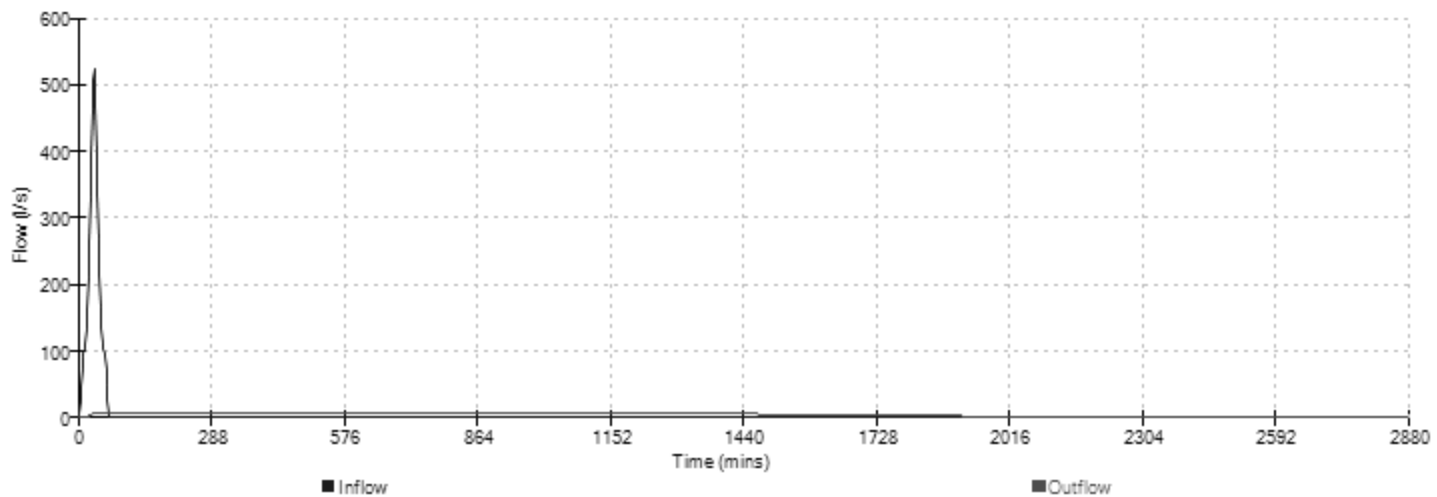
Event: 15 min Winter



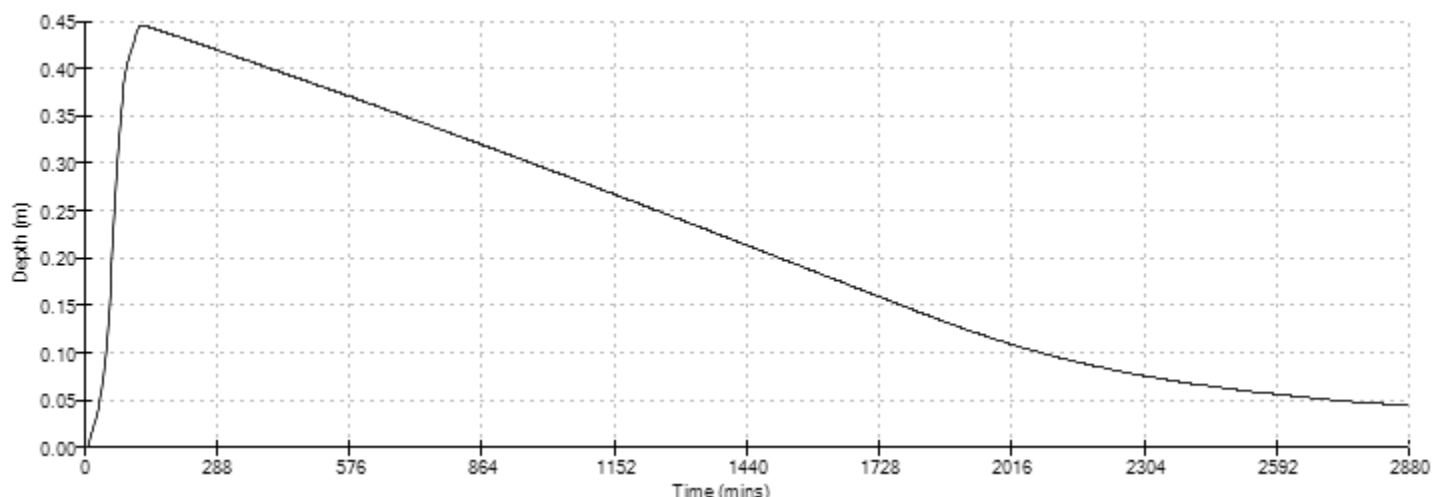
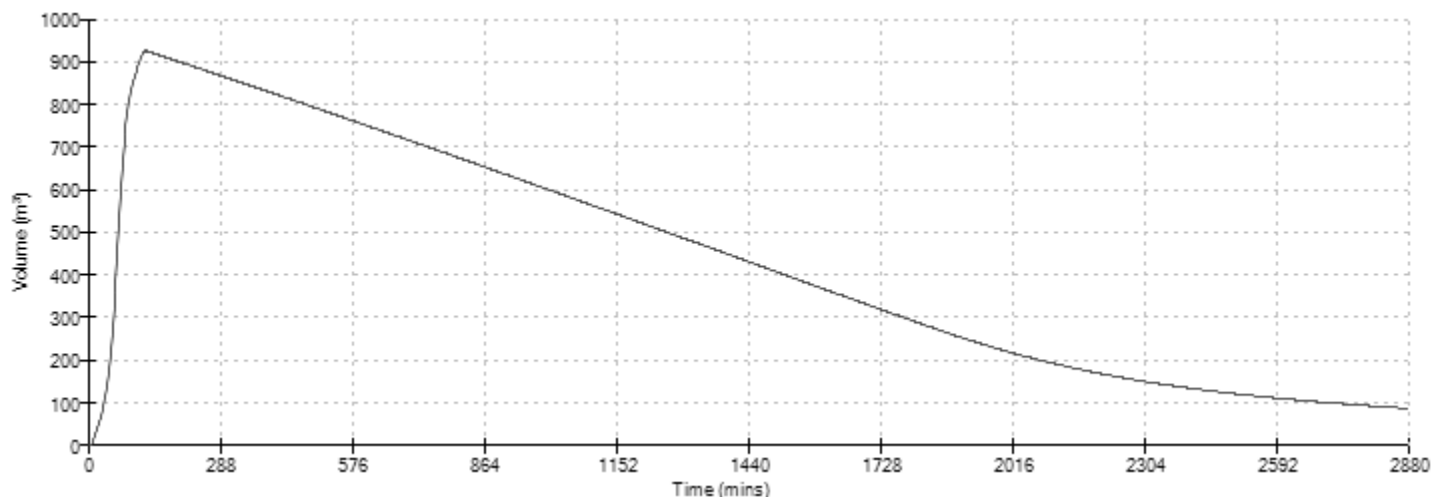
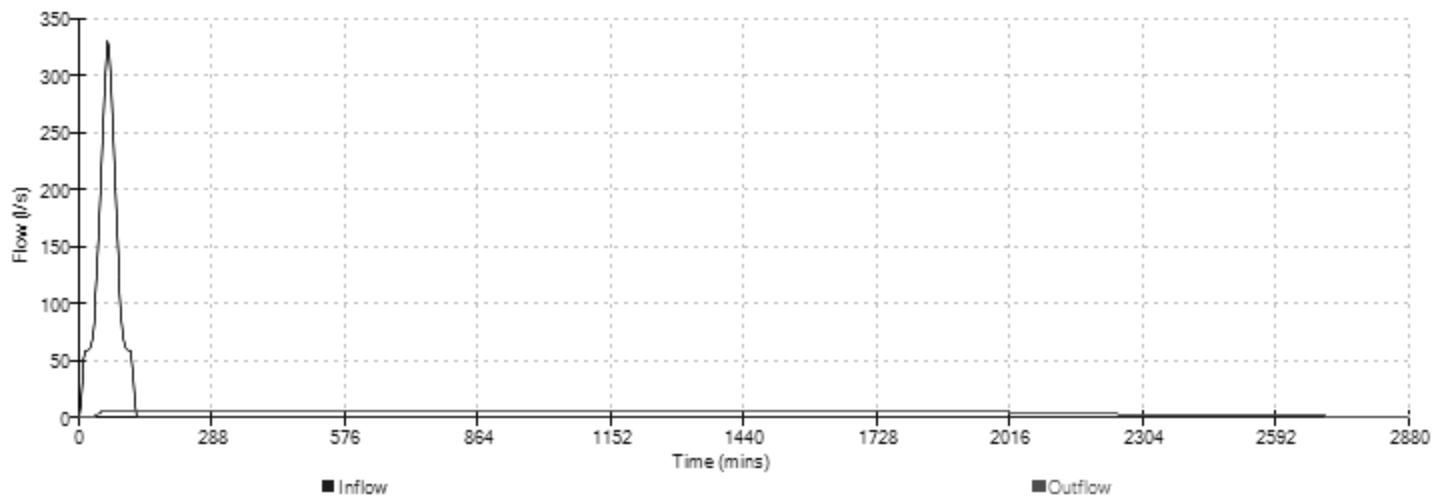
Event: 30 min Winter



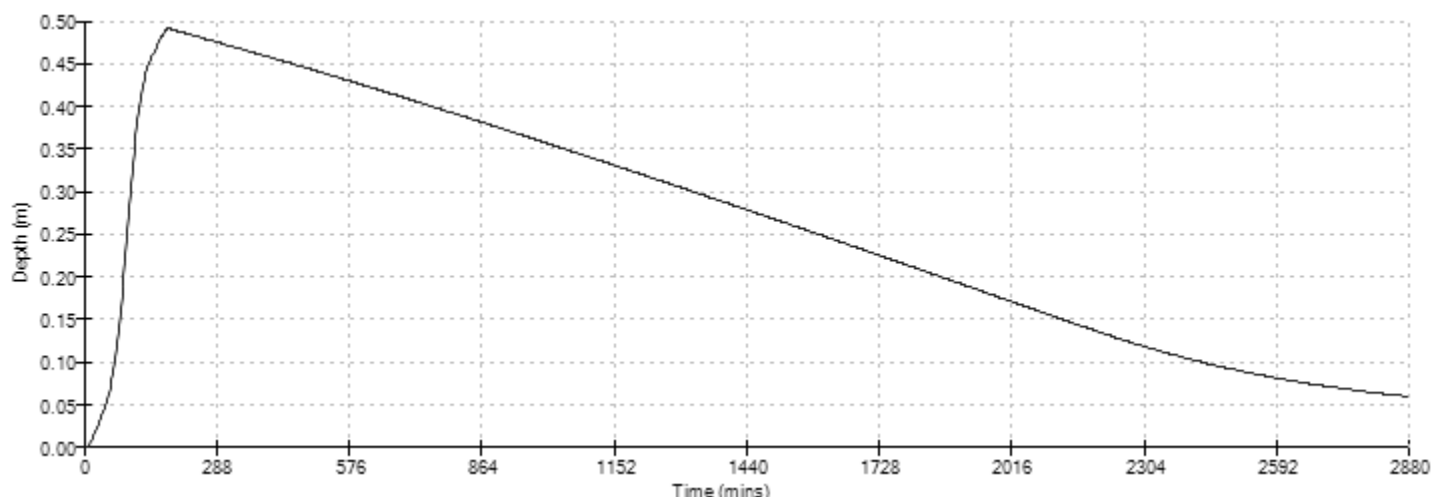
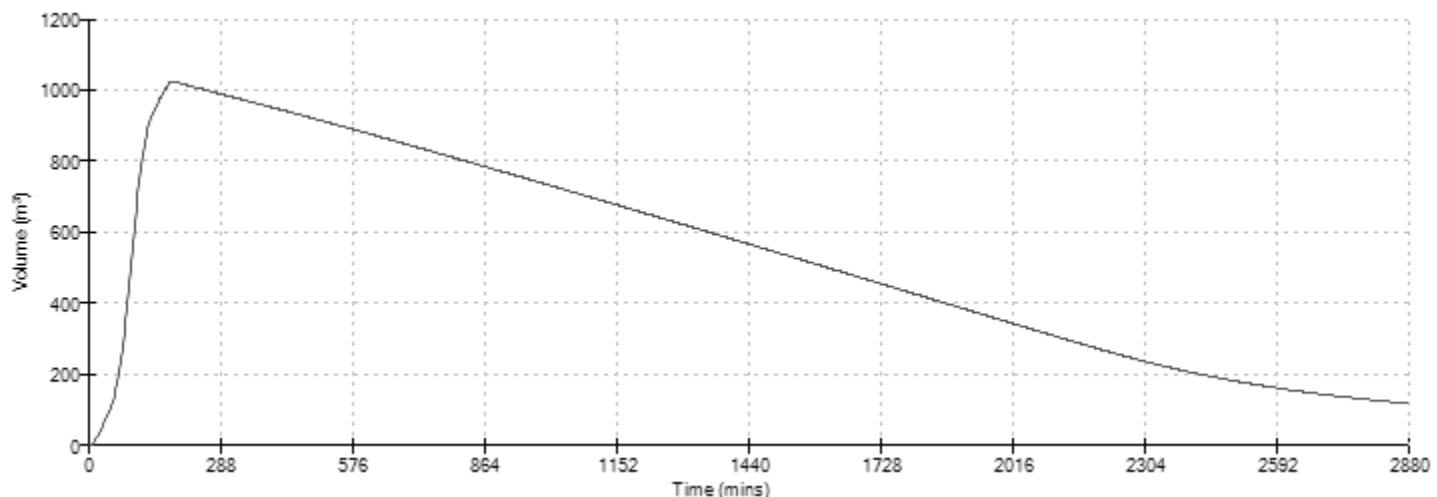
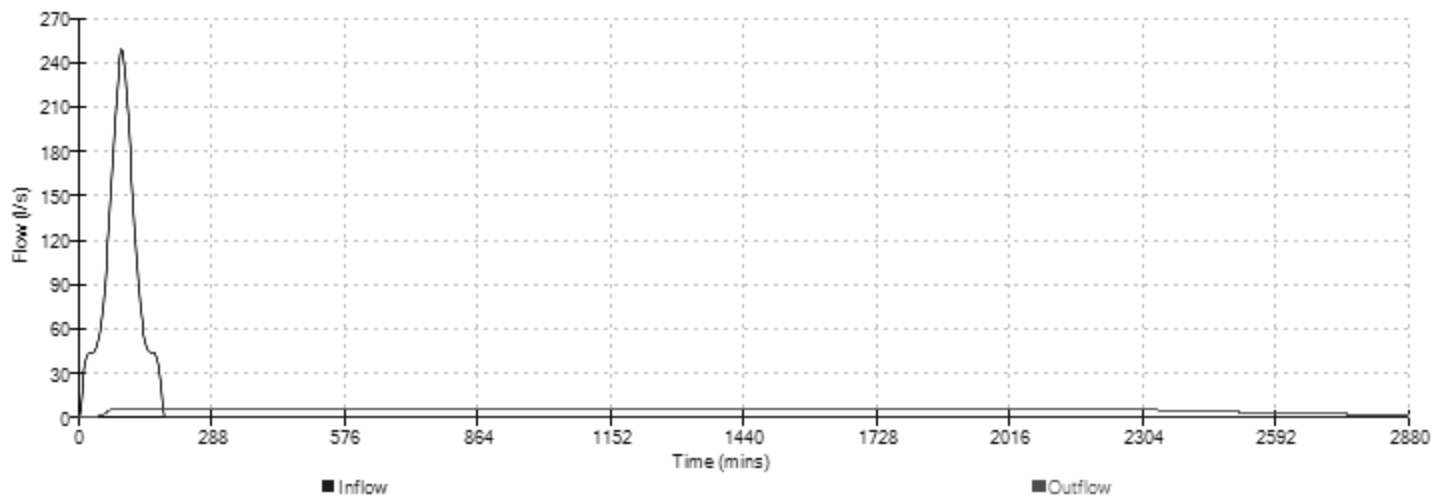
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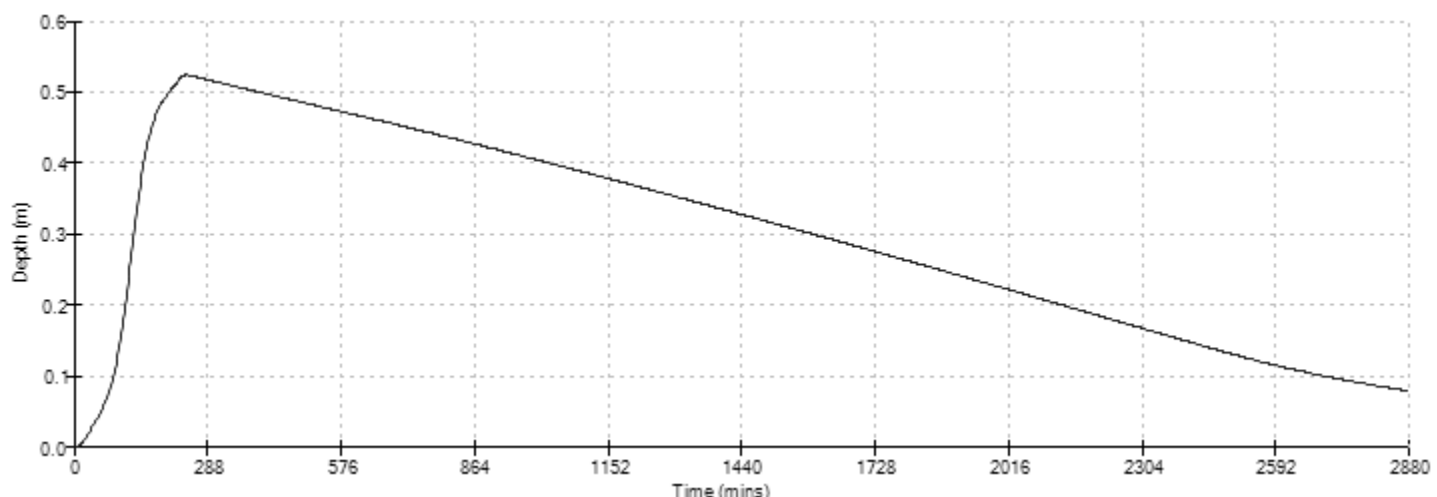
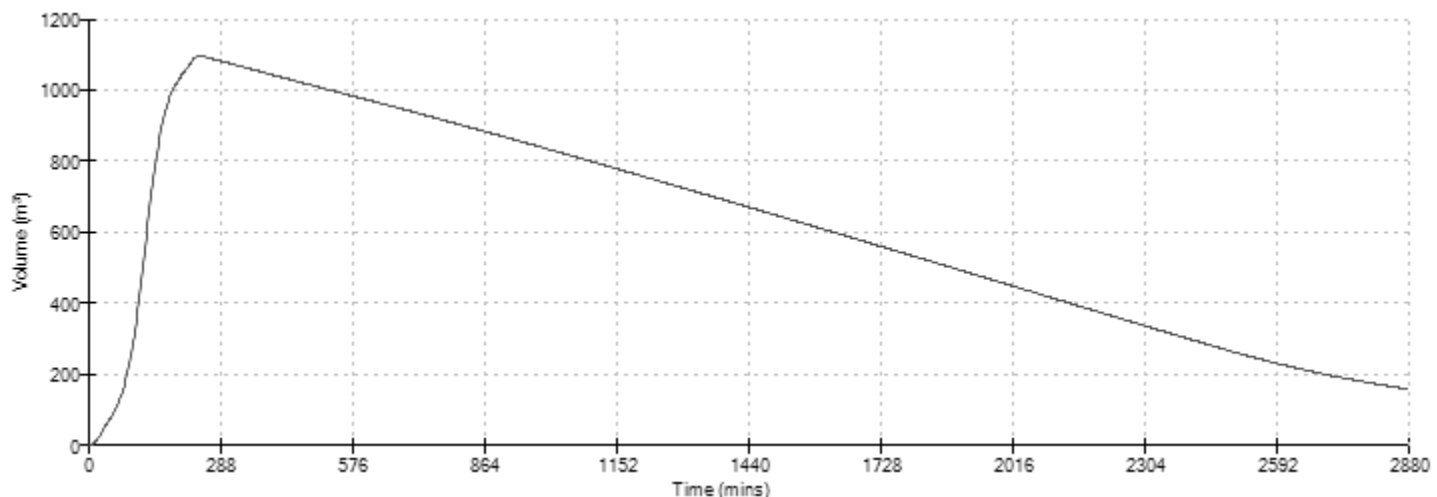
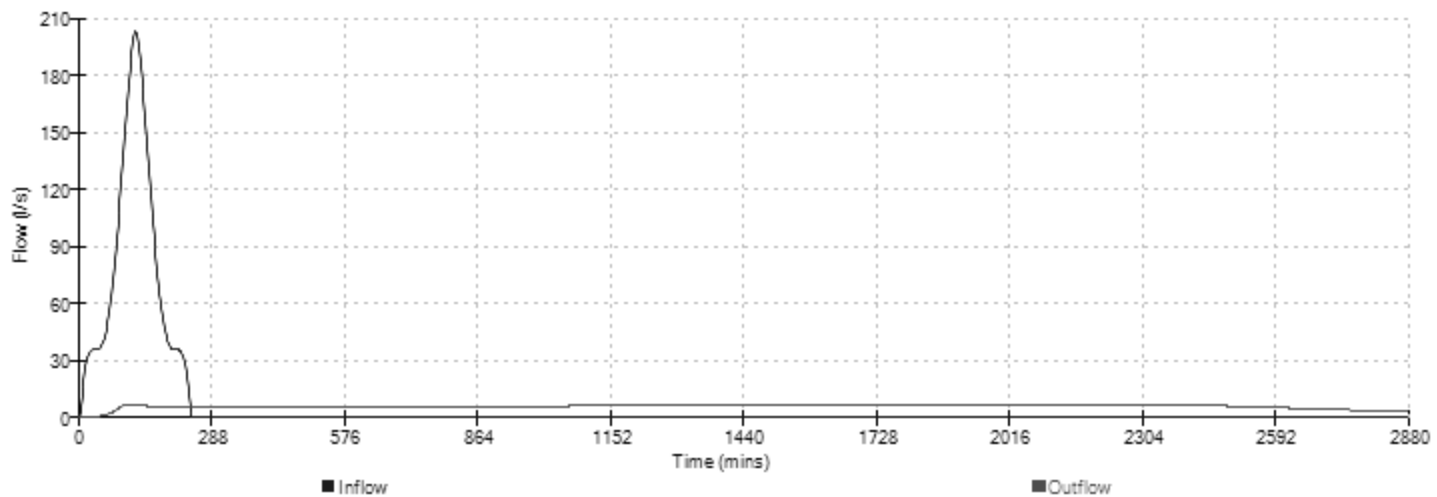
Event: 120 min Winter



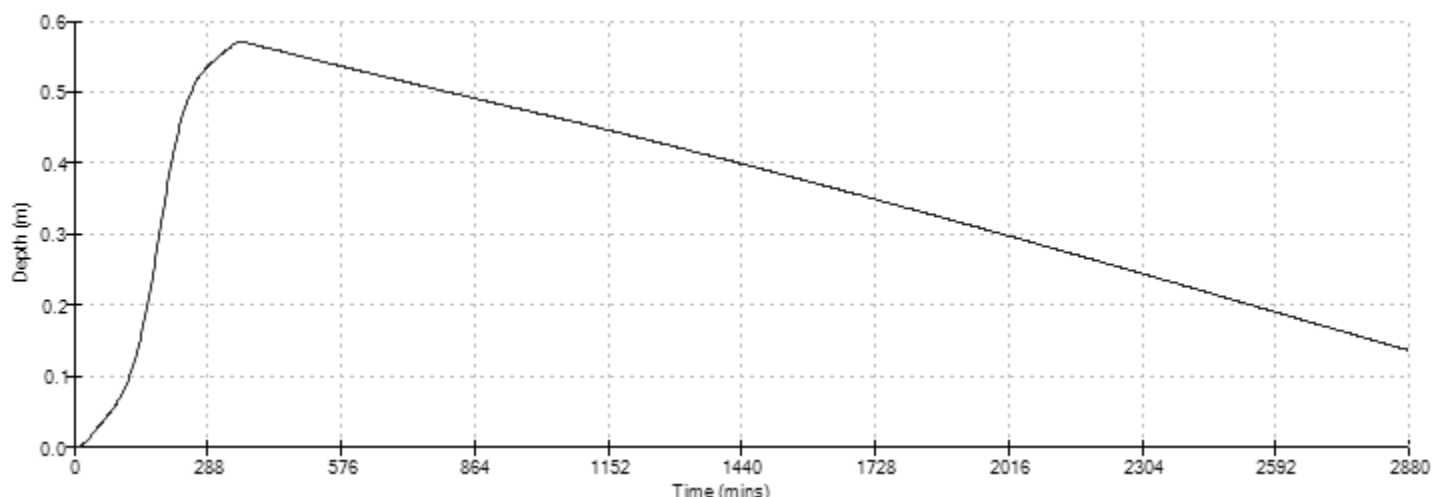
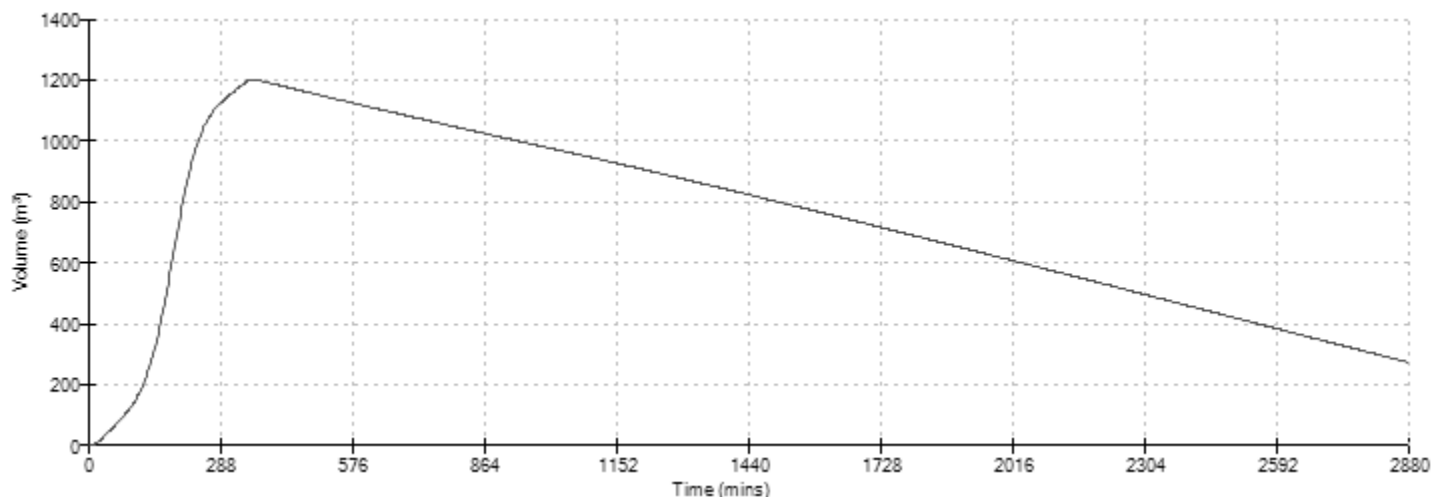
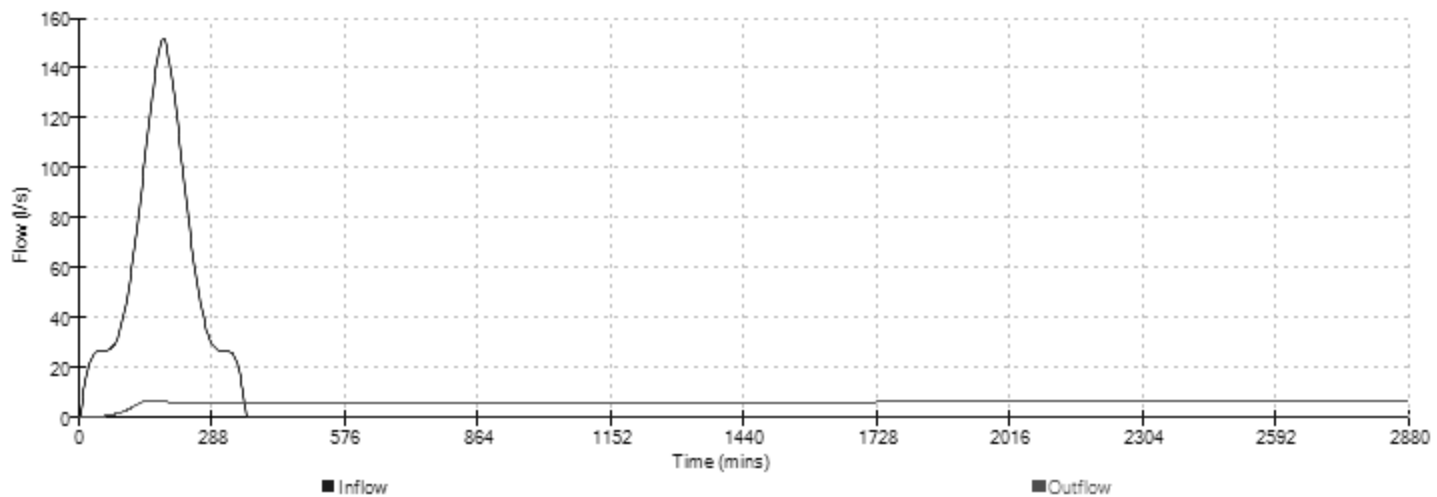
Event: 180 min Winter



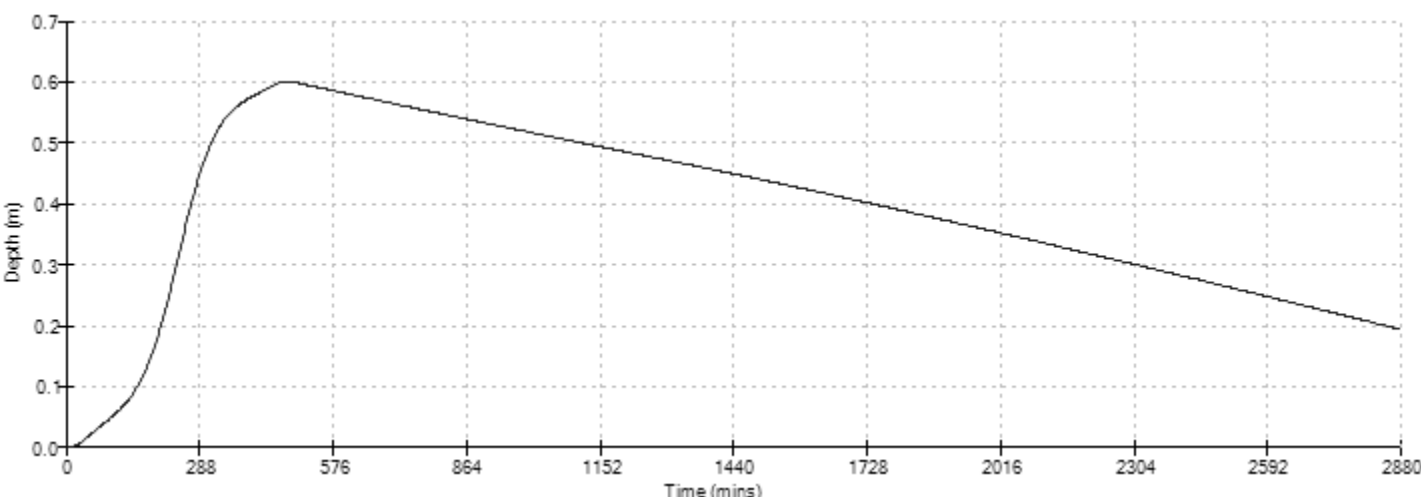
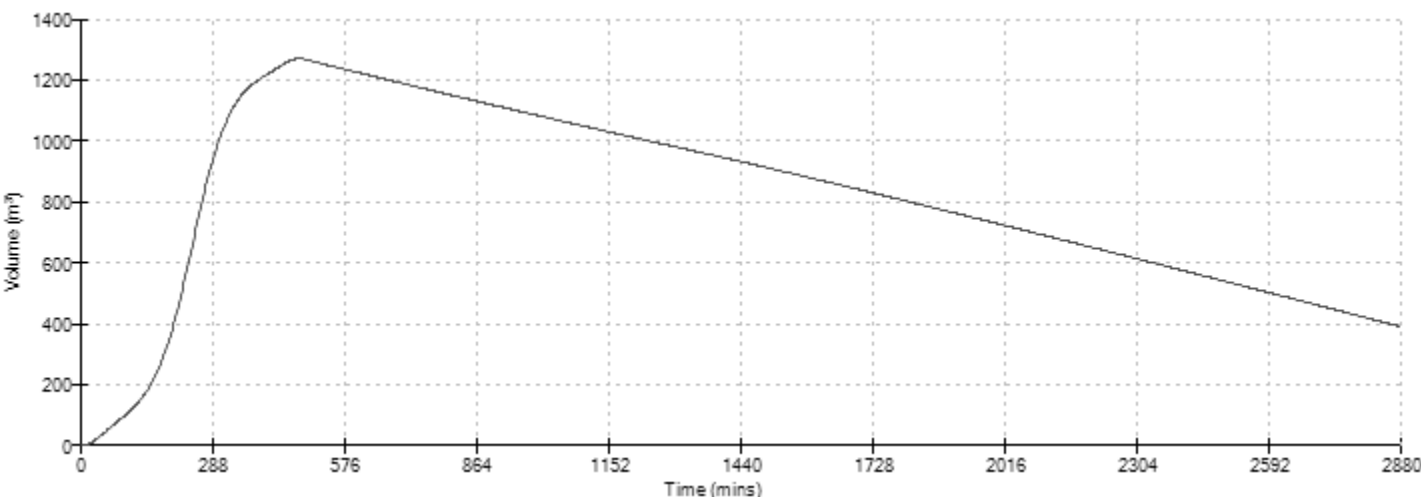
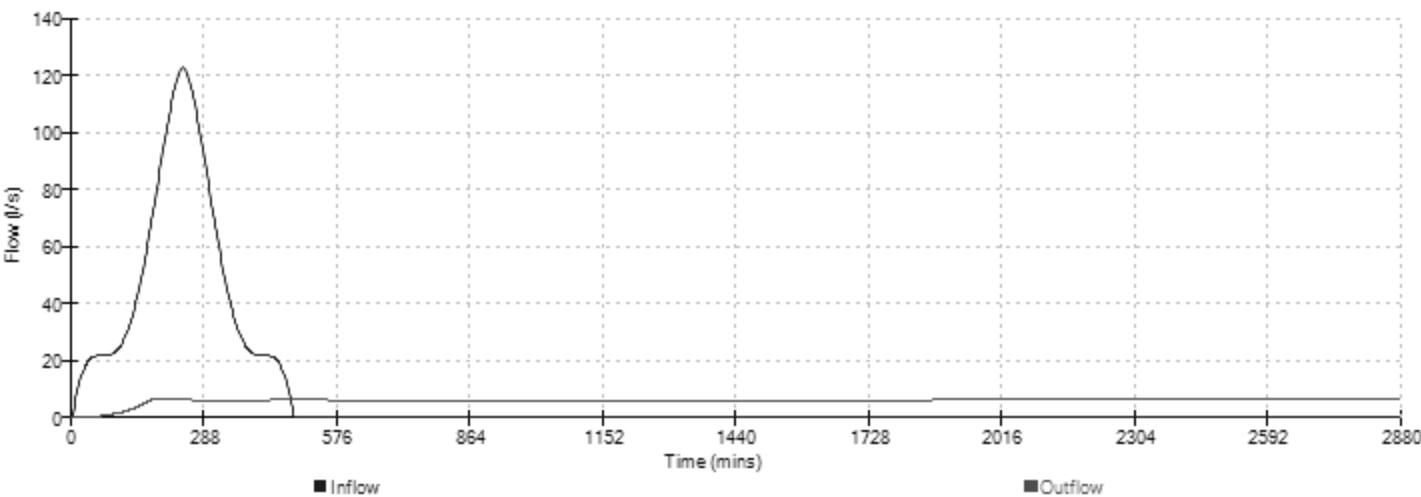
Event: 240 min Winter



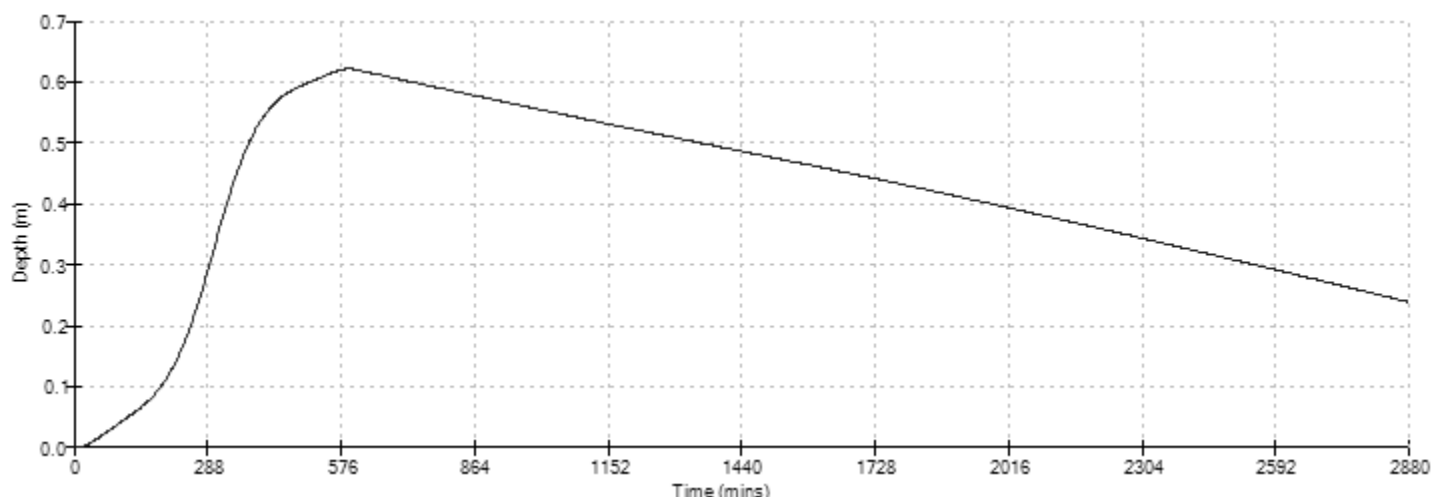
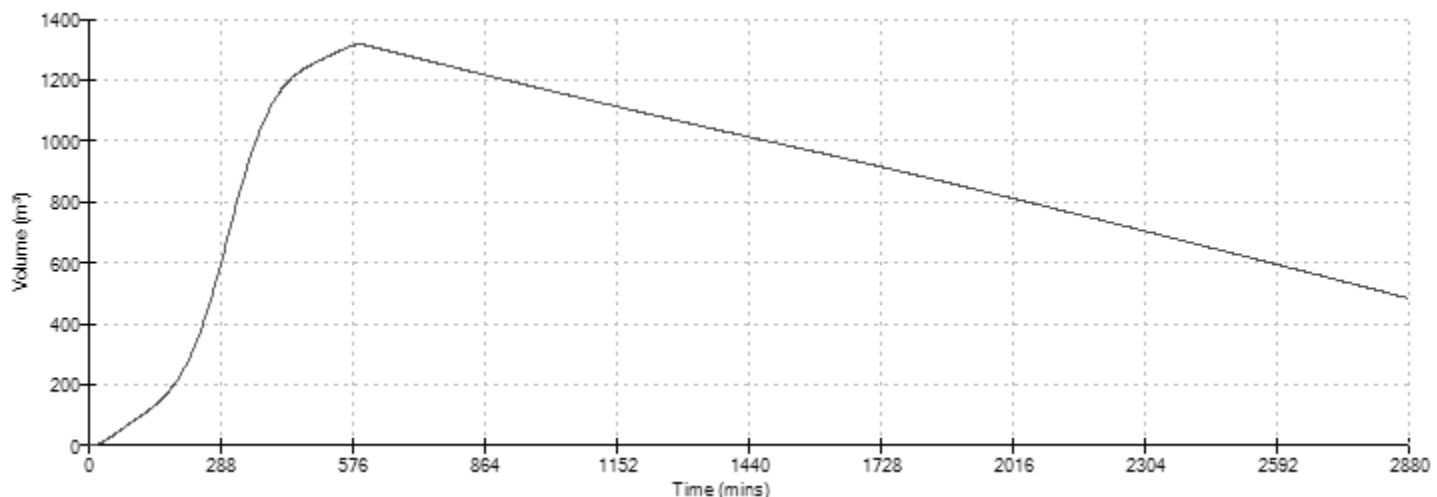
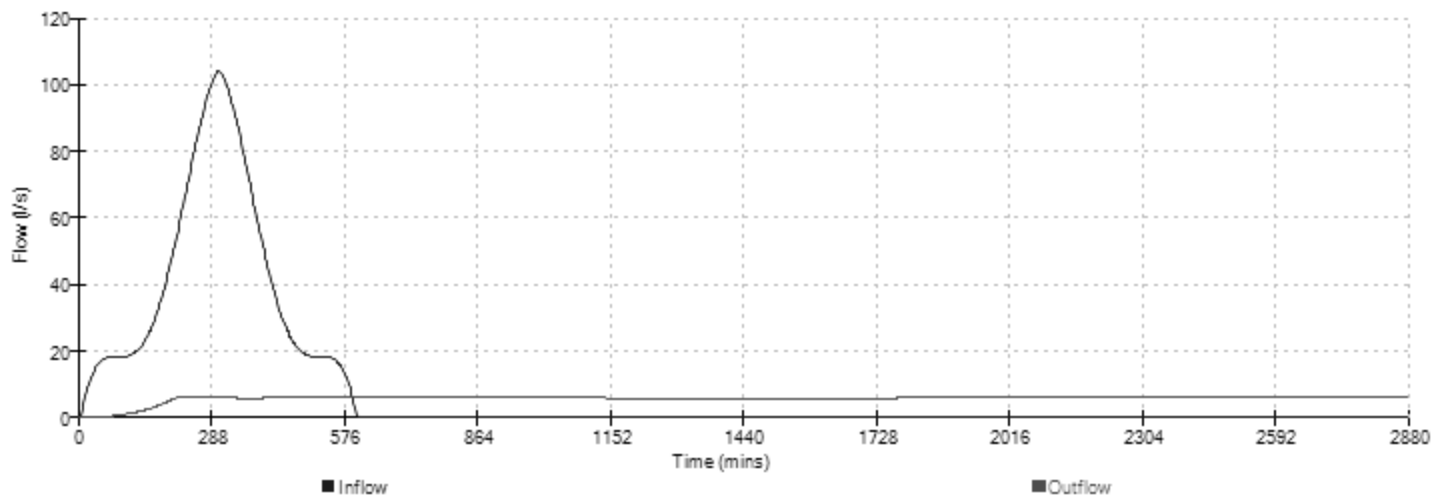
Event: 360 min Winter



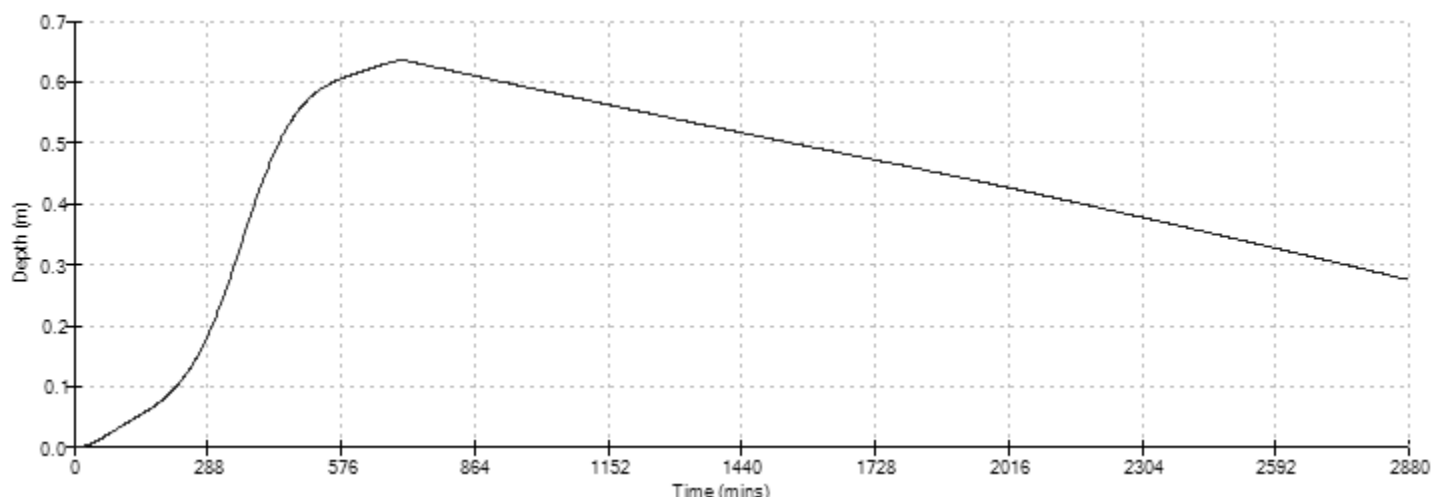
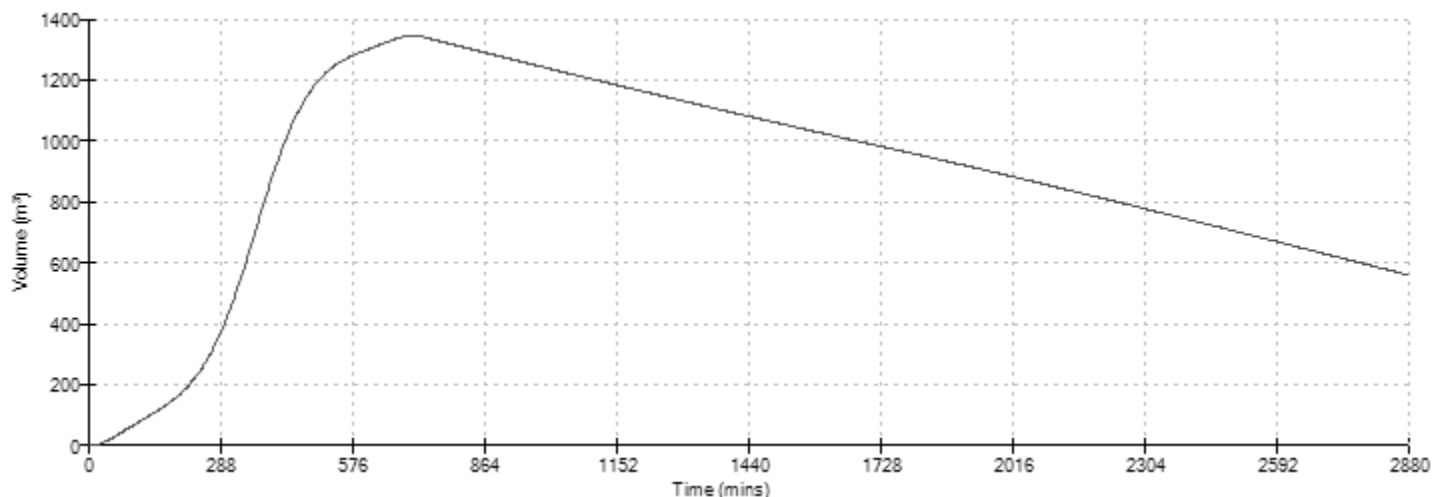
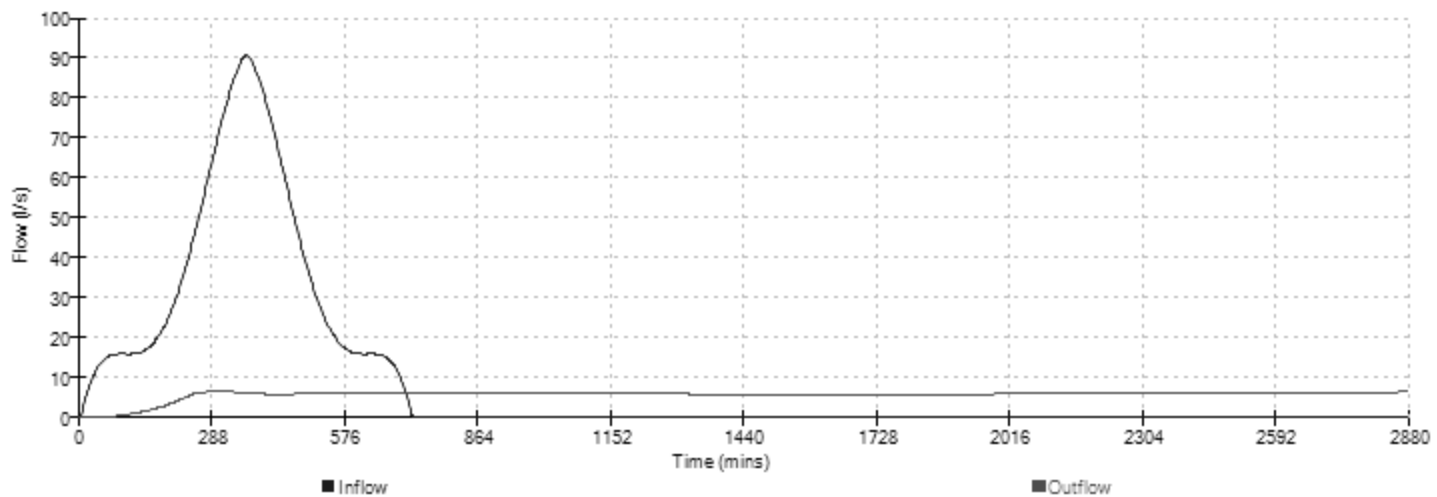
Event: 480 min Winter



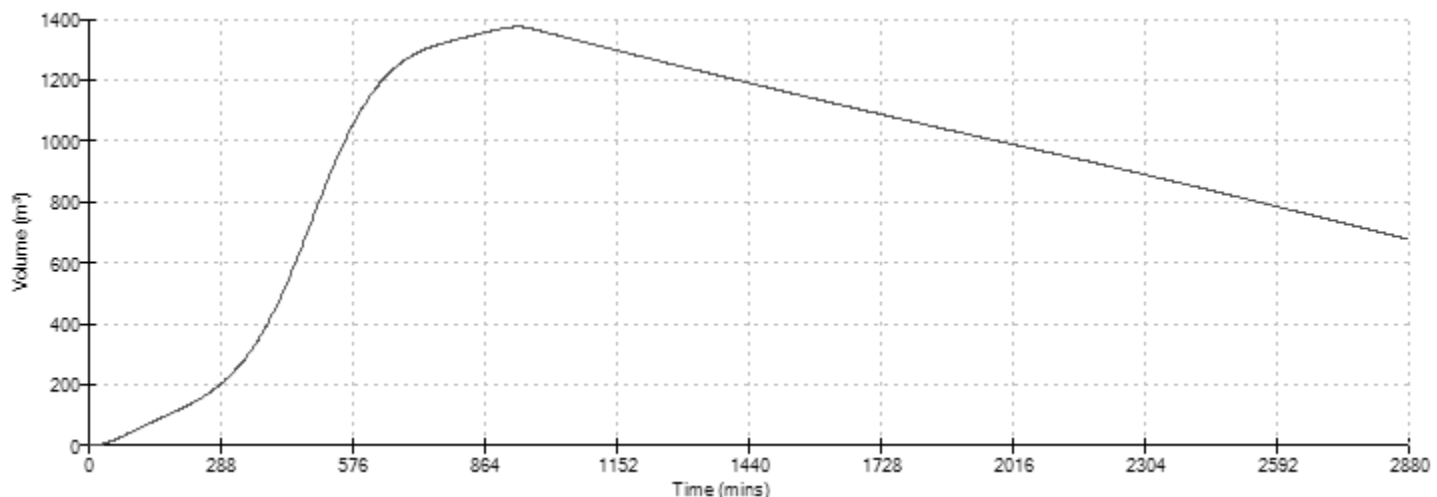
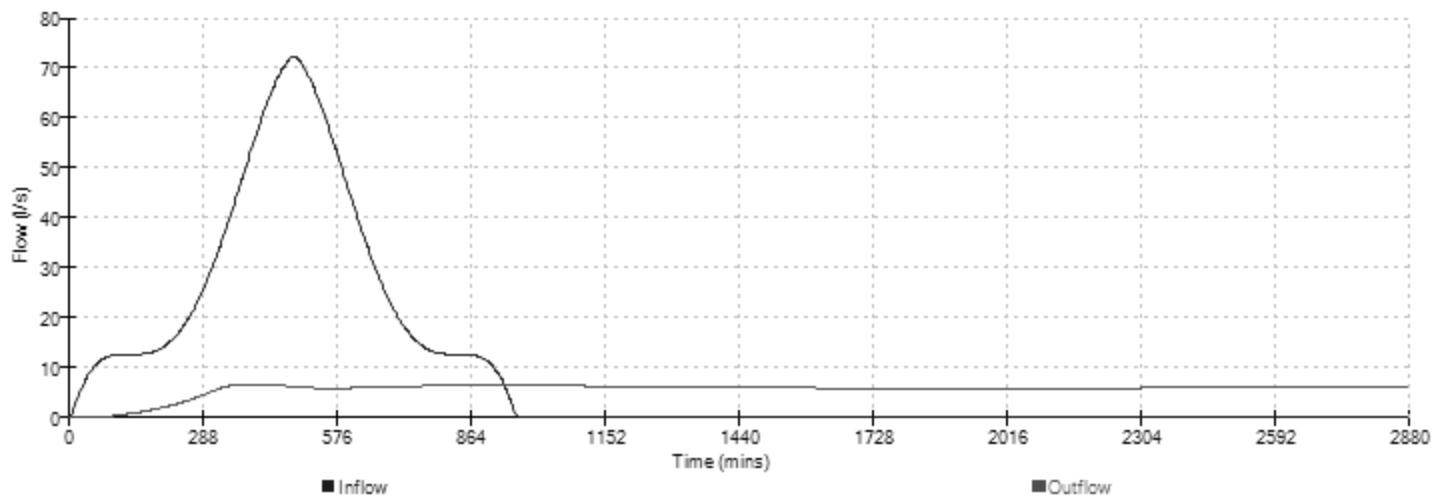
Event: 600 min Winter



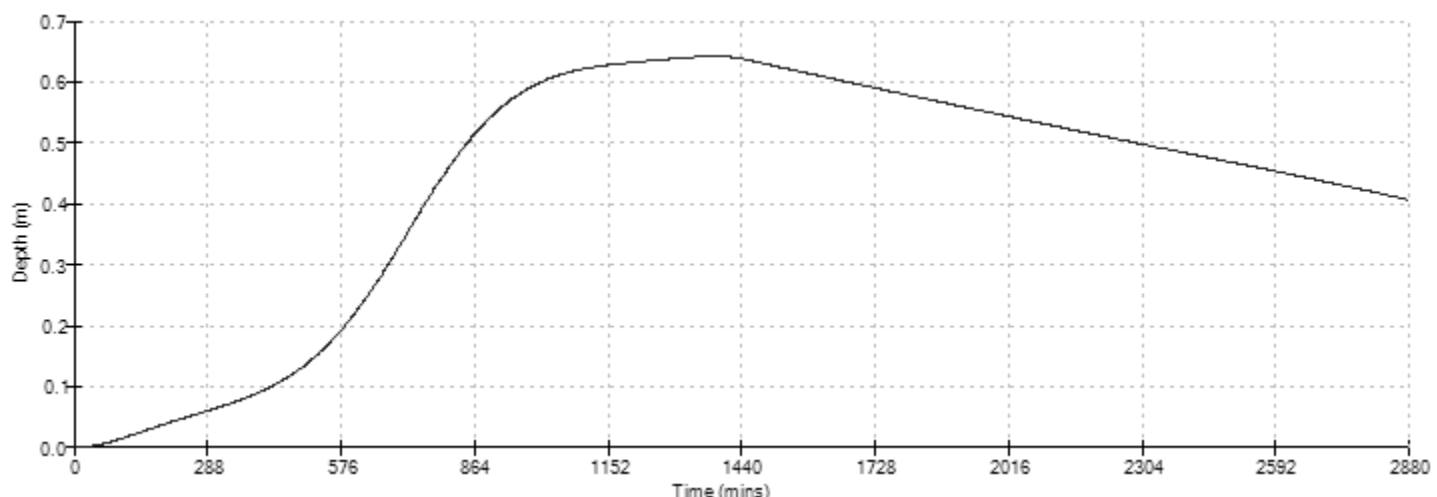
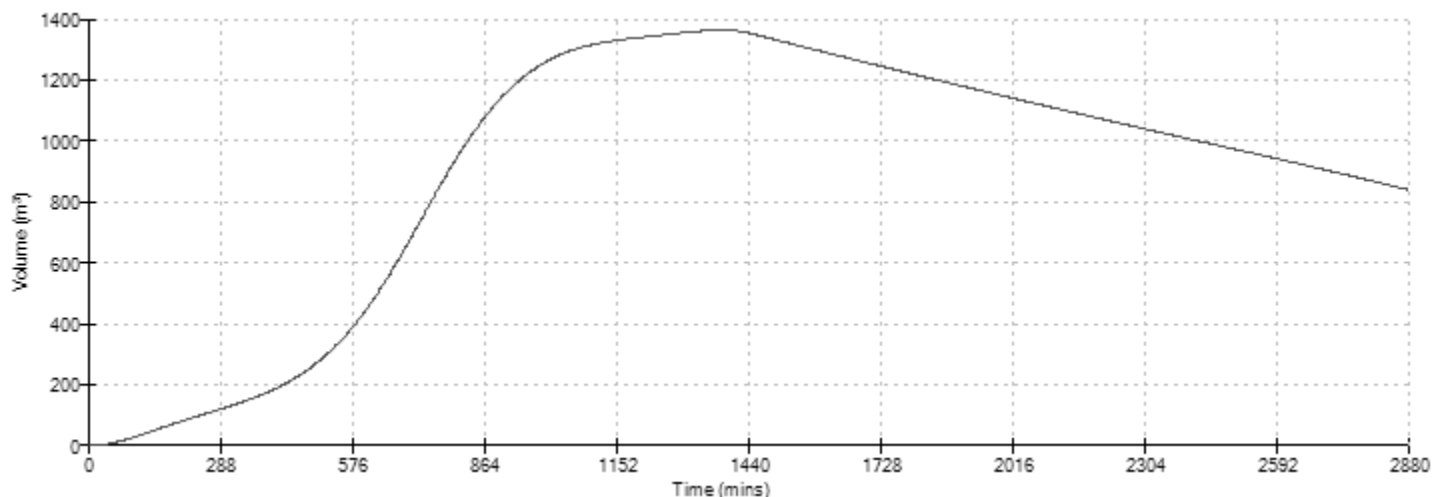
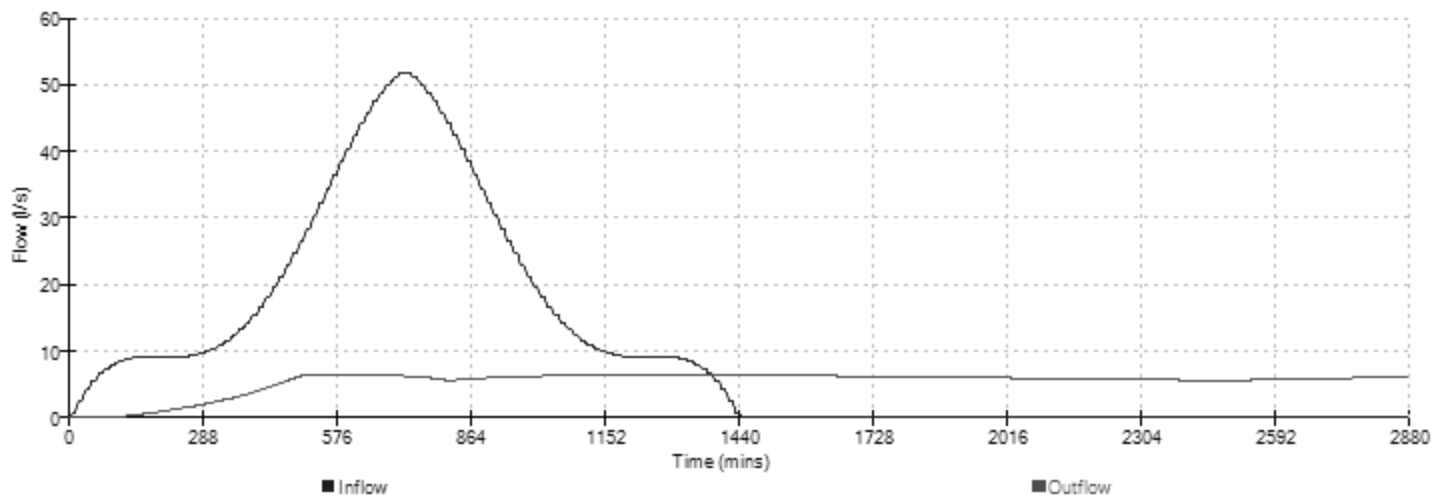
Event: 720 min Winter



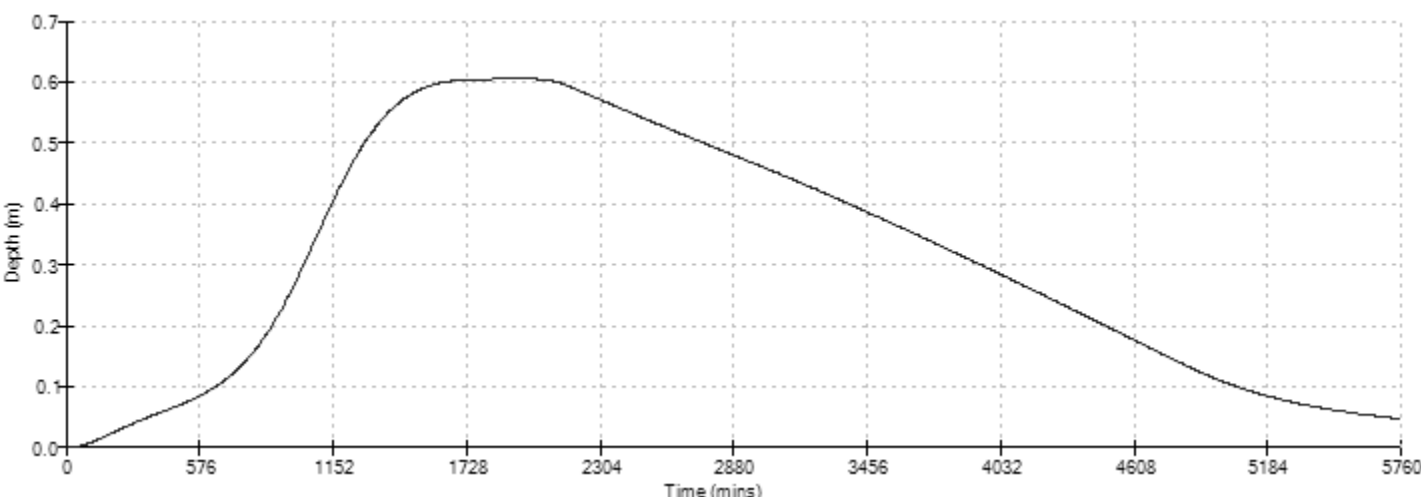
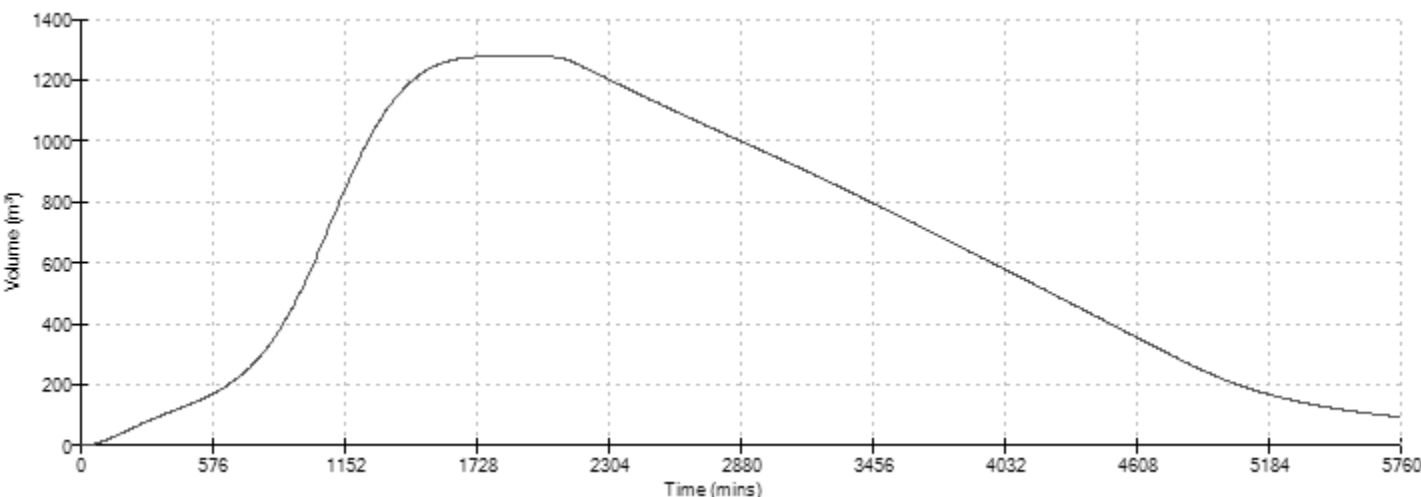
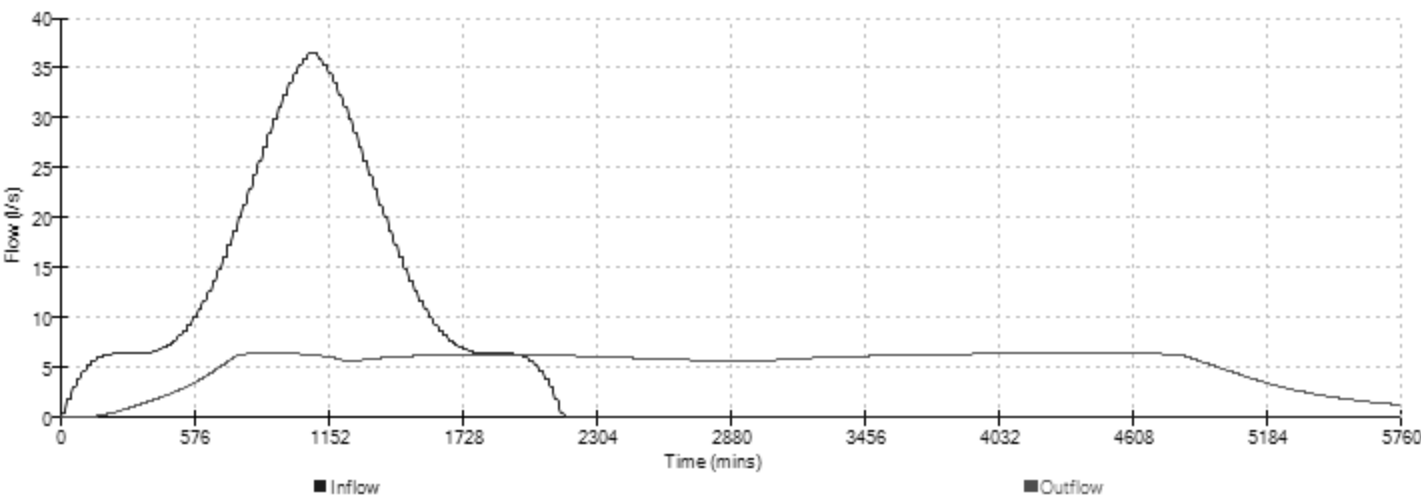
Event: 960 min Winter



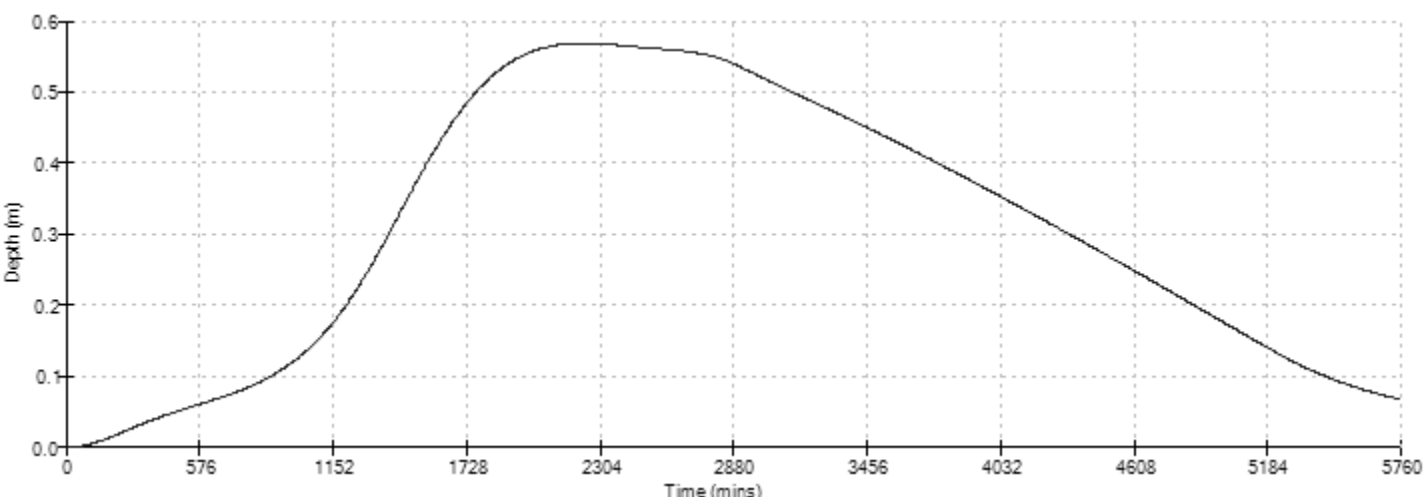
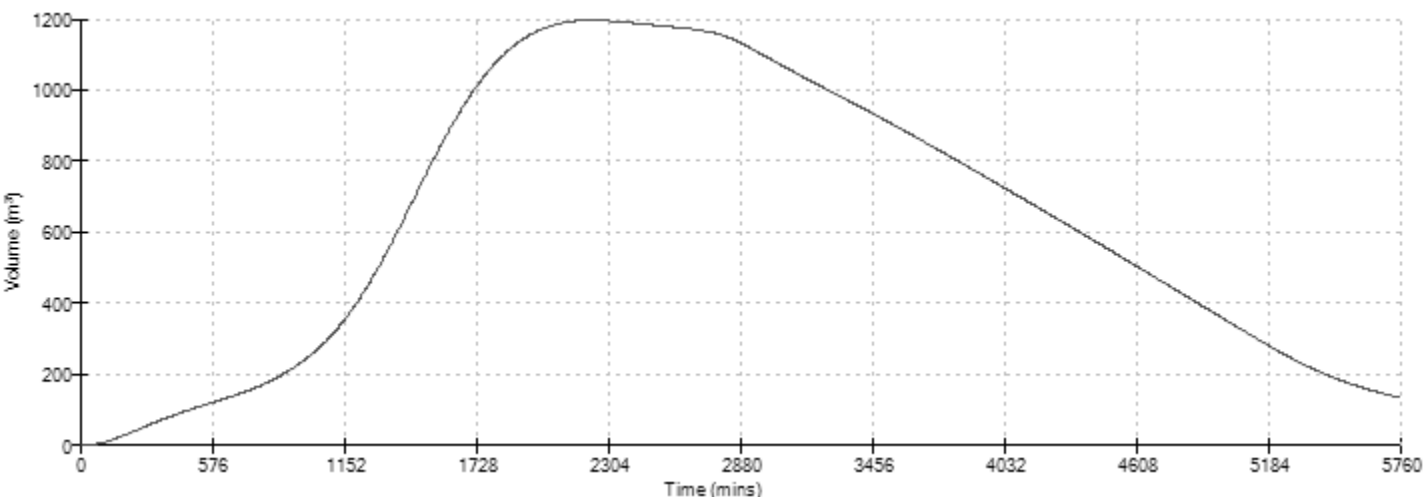
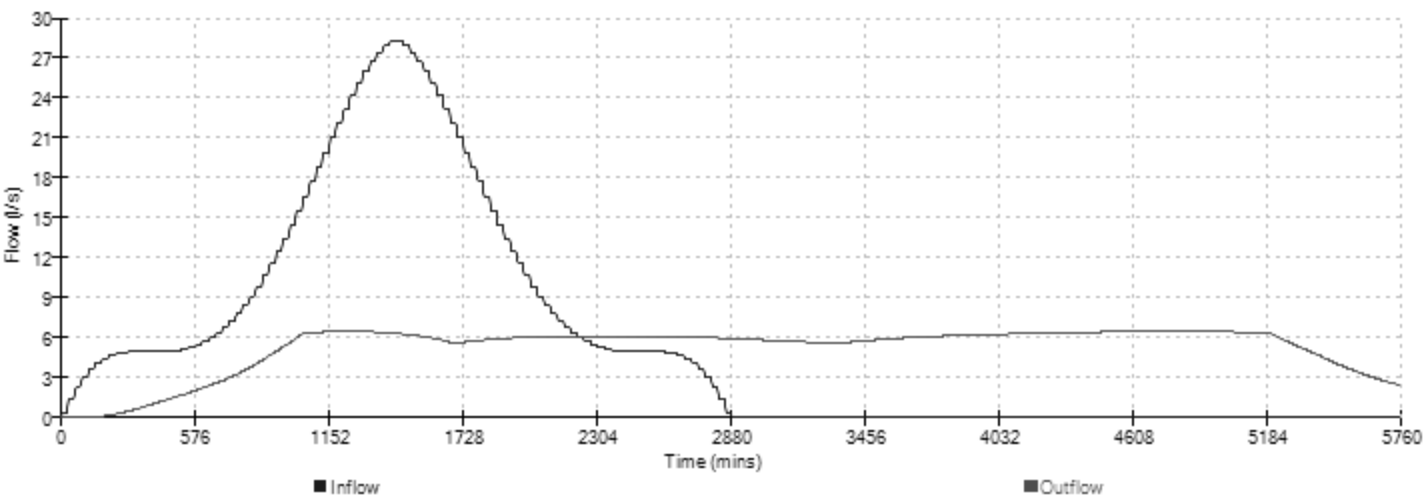
Event: 1440 min Winter



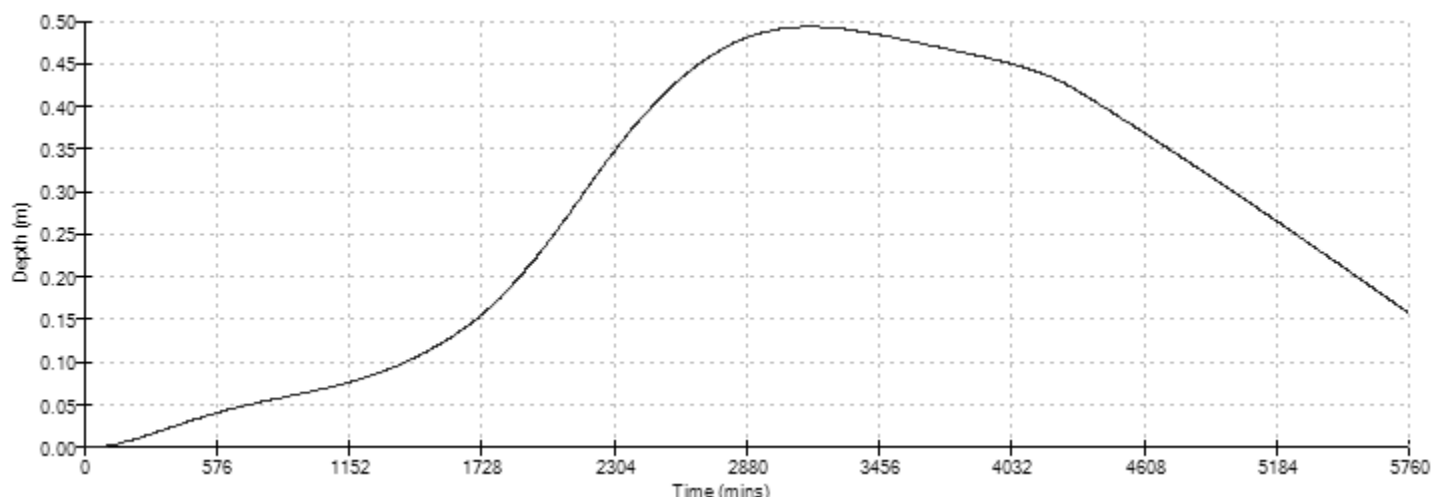
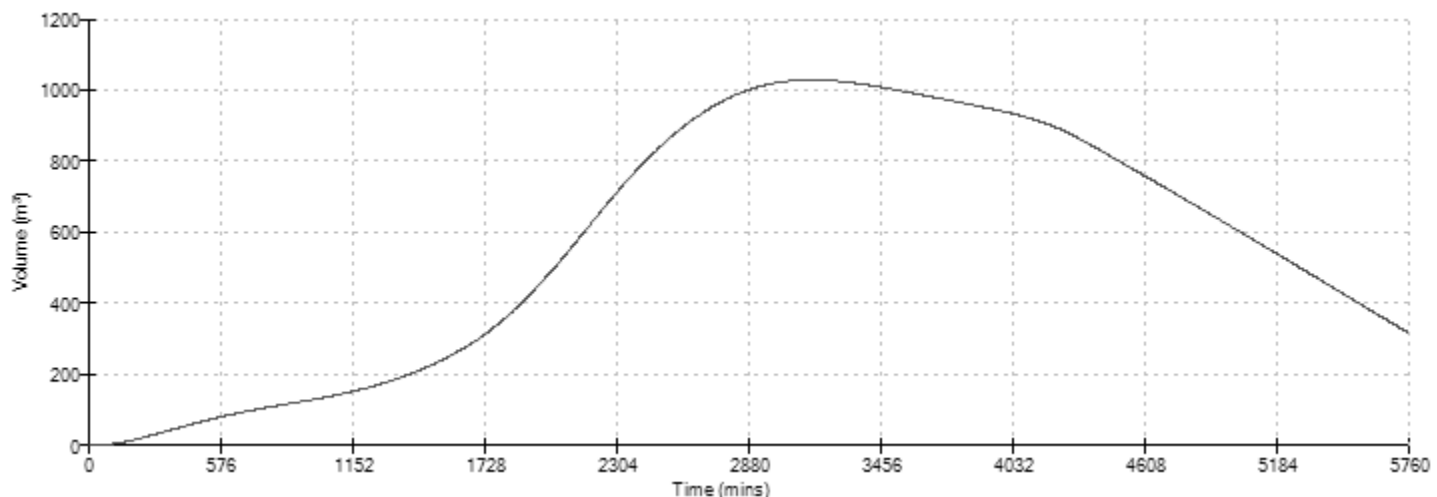
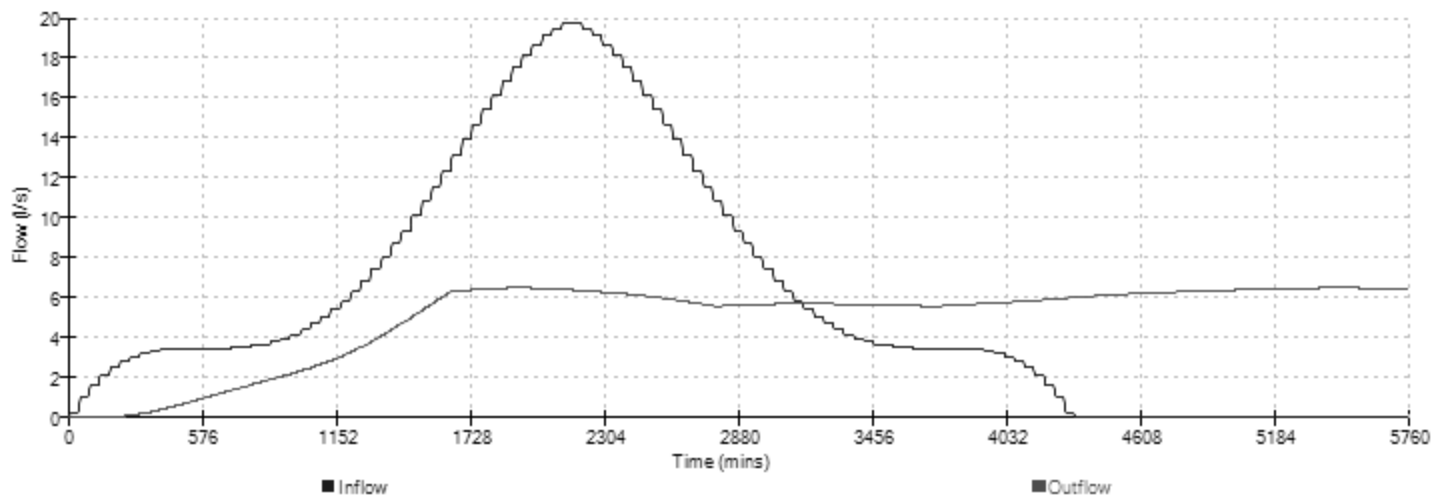
Event: 2160 min Winter



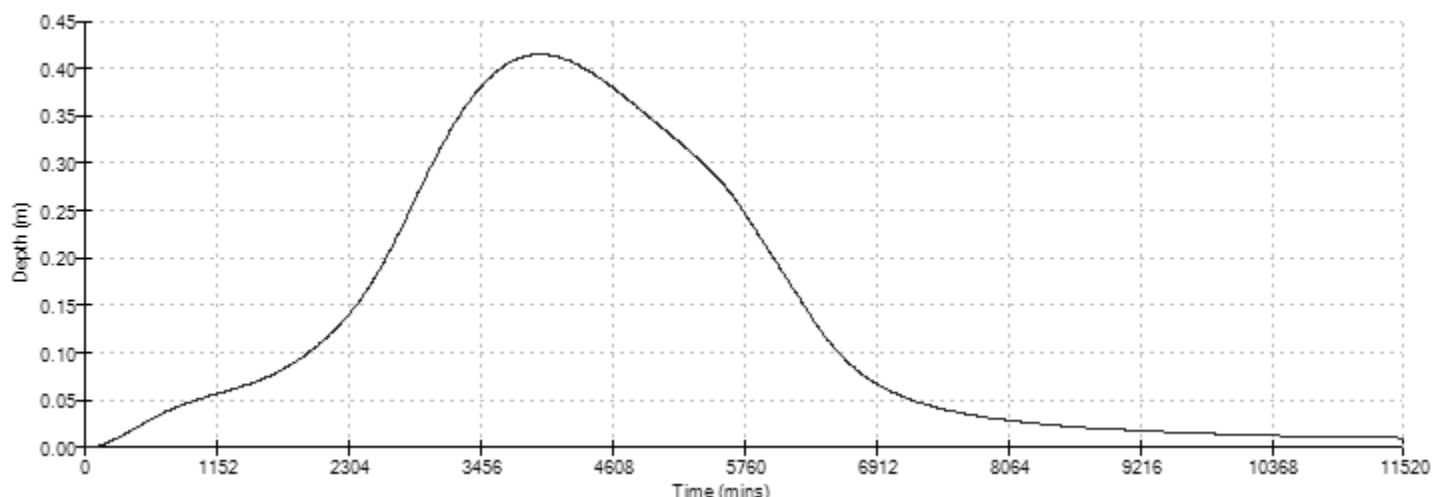
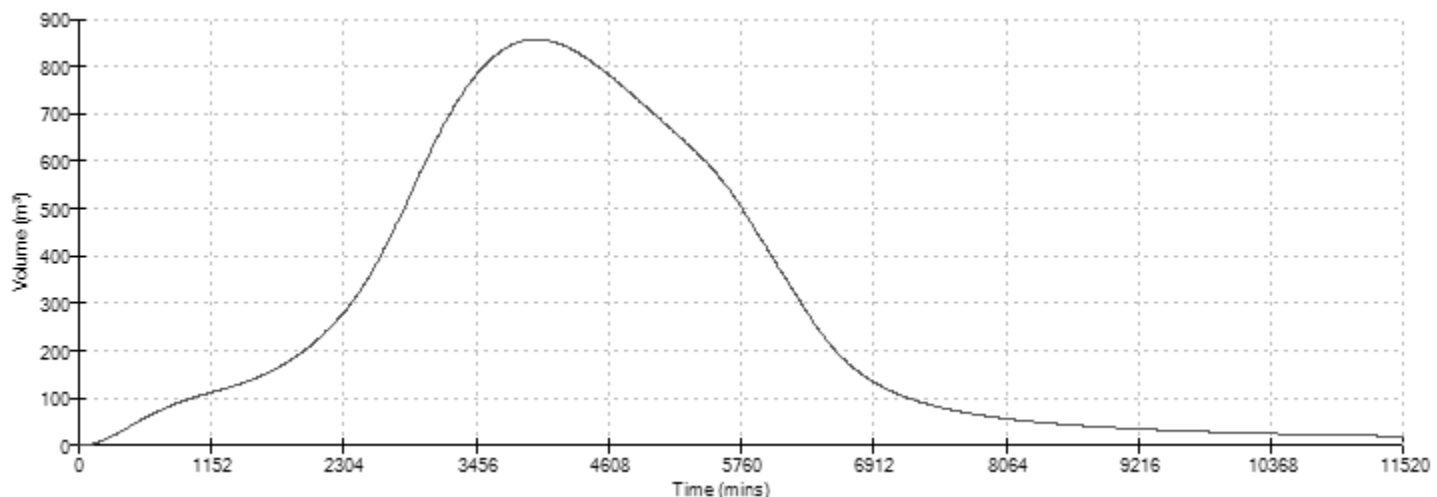
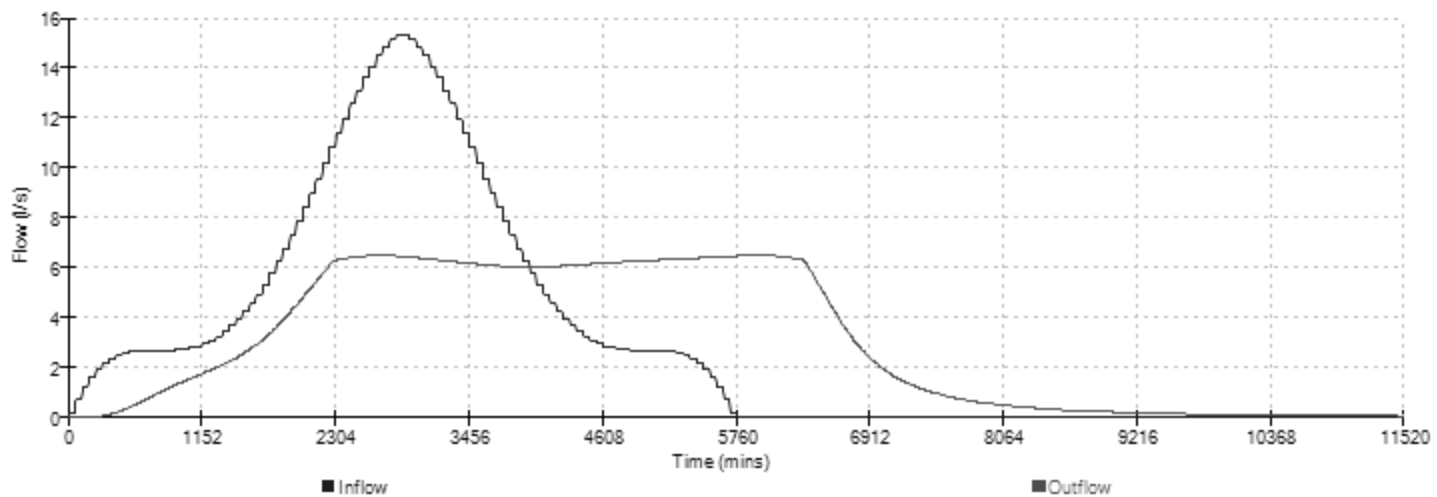
Event: 2880 min Winter



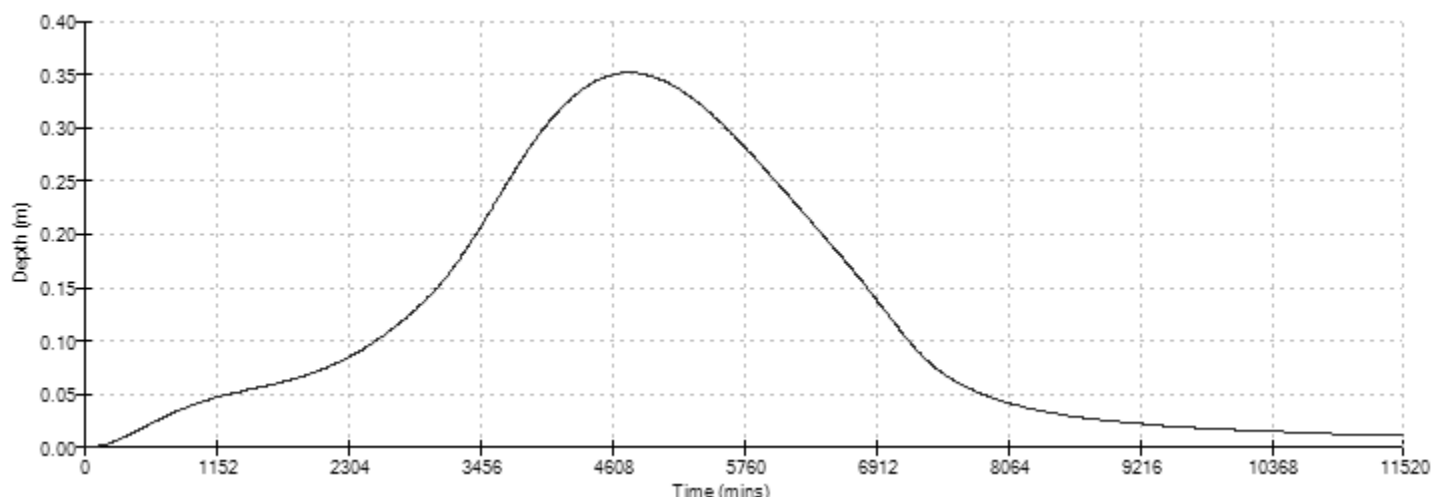
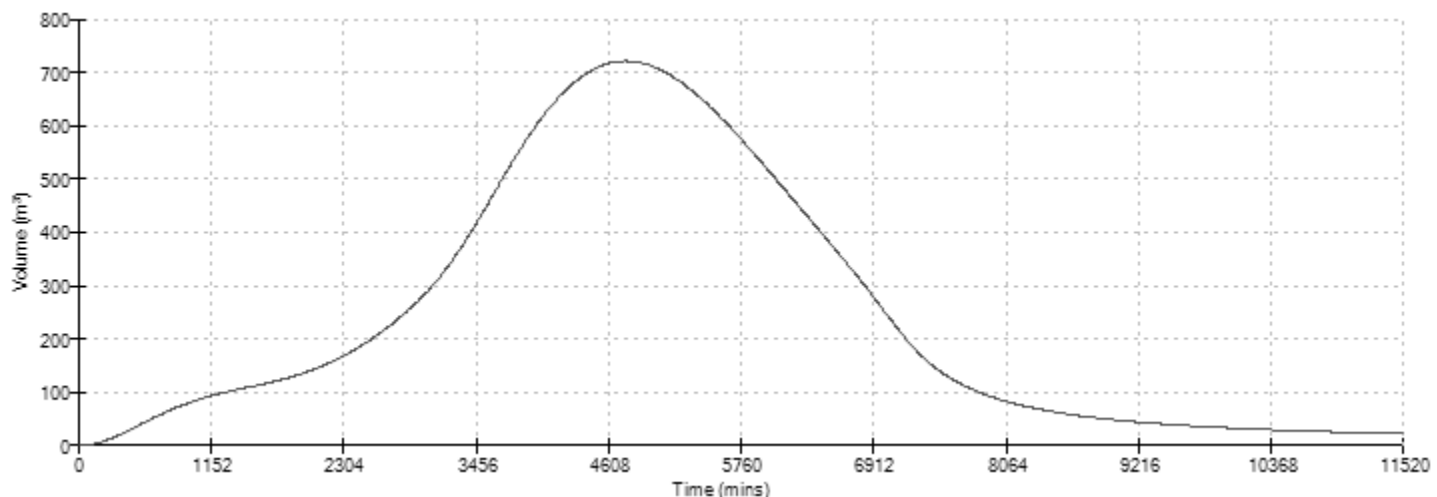
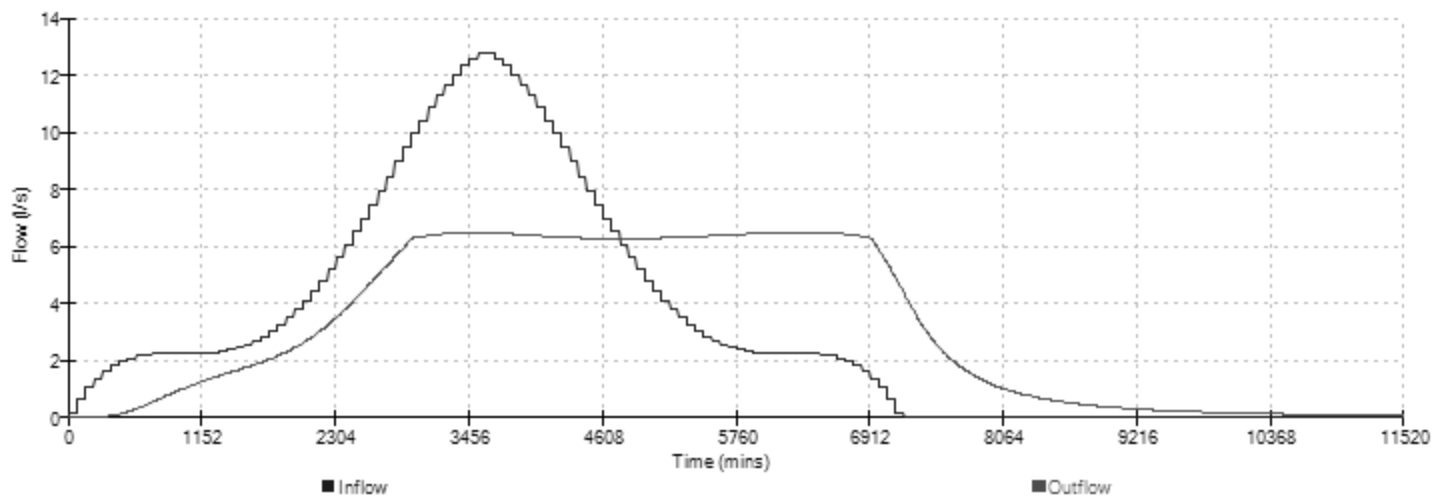
Event: 4320 min Winter



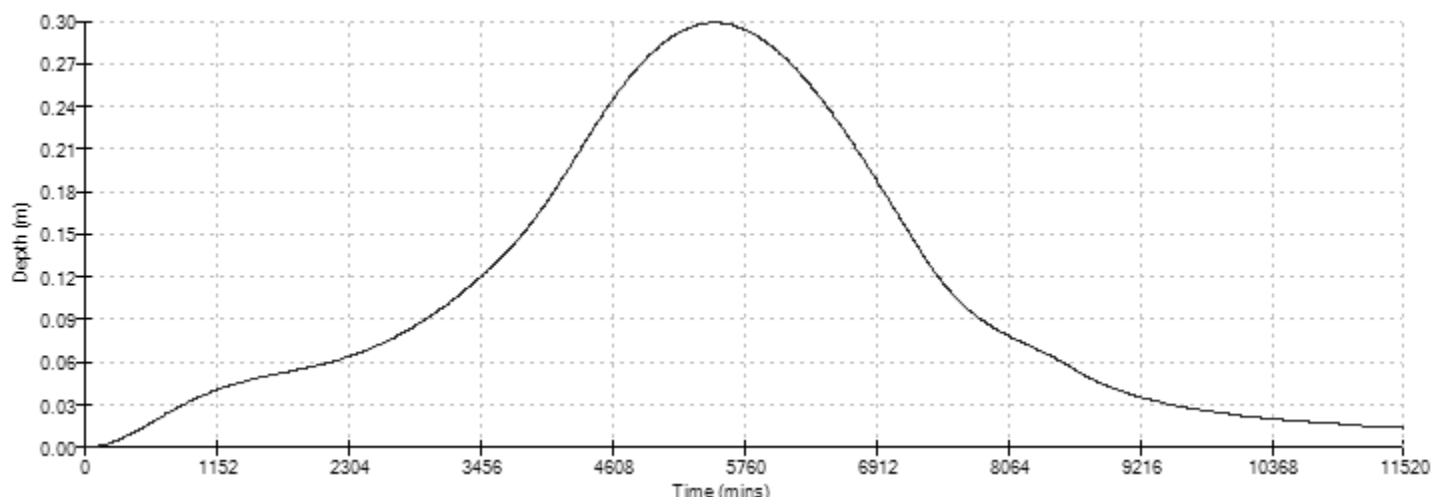
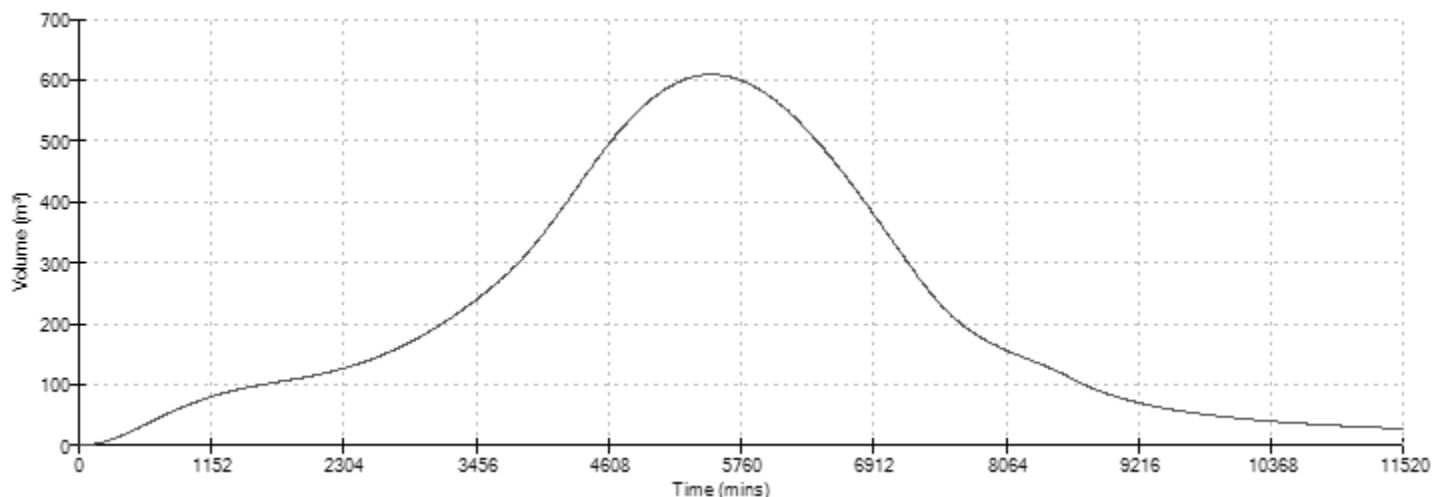
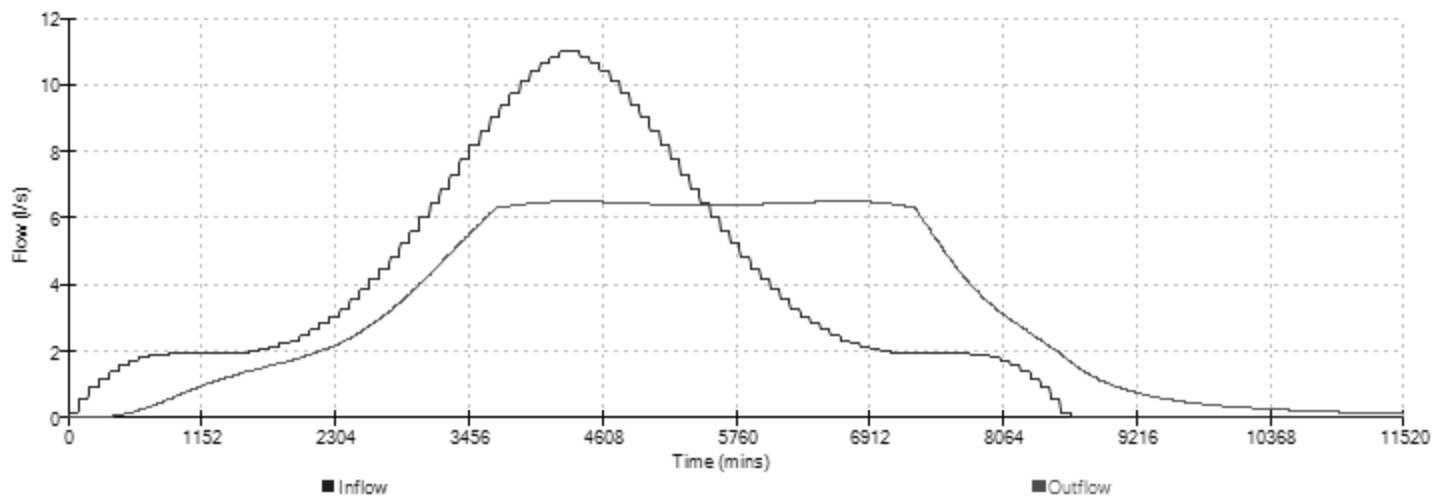
Event: 5760 min Winter



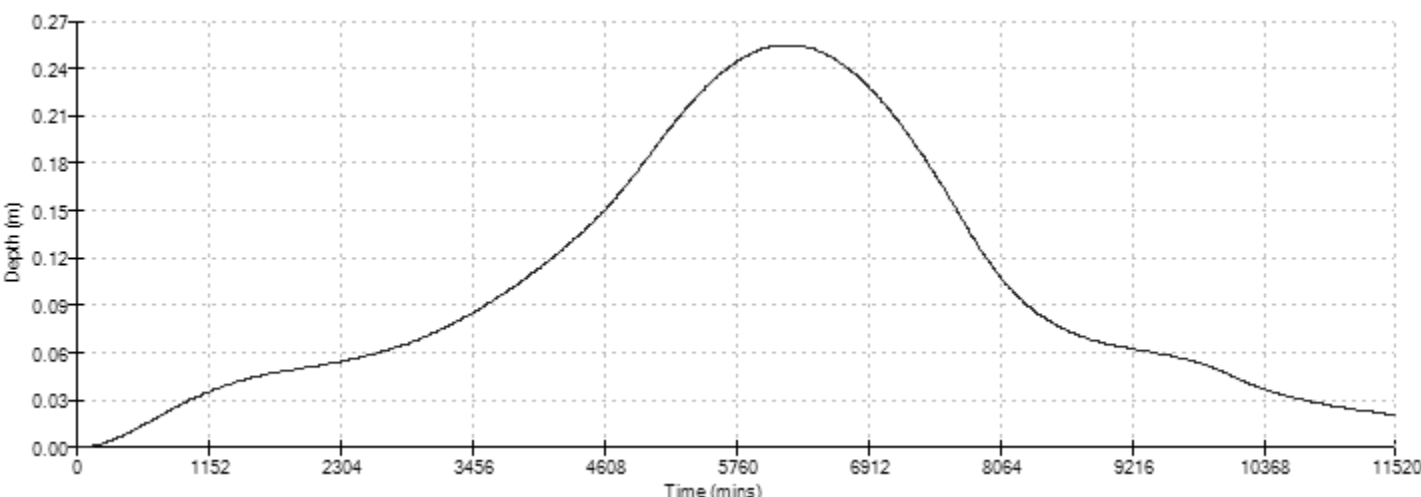
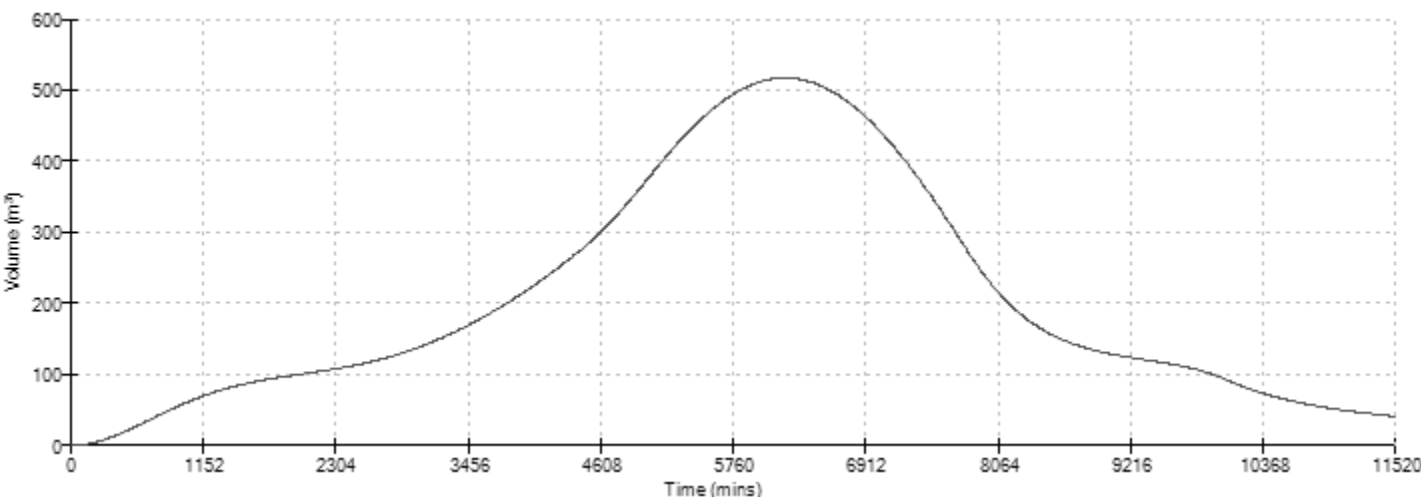
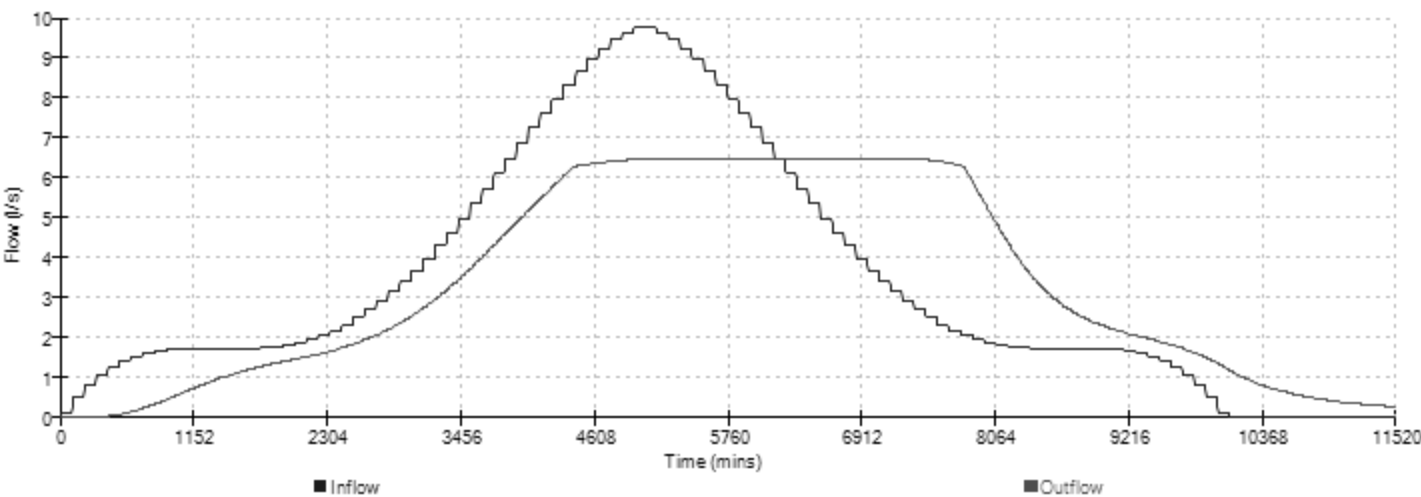
Event: 7200 min Winter



Event: 8640 min Winter



Event: 10080 min Winter



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