

**BRADLEY VILLA FARM, BRADLEY ROAD, BRADLEY,
HUDDERSFIELD, HD2 2JX**

**FLOOD RISK ASSESSMENT
FINAL REPORT V1.1**

January 2021

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Report Title	Bradley Villa Farm, Bradley Road, Bradley, Huddersfield, HD2 2JX Flood Risk Assessment Final Report v1.1
Client	Redrow Homes Yorkshire
Date of issue	13 January 2021

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1 INTRODUCTION

1.1 Background

Weetwood Services Ltd ('Weetwood') has been instructed by Redrow Homes Yorkshire to prepare a Flood Risk Assessment (FRA) report for the proposed development of land at Bradley Villa Farm, Bradley, Huddersfield ("the site").

The assessment has been undertaken in accordance with the requirements of the revised National Planning Policy Framework (NPPF) updated on 19 June 2019 and the National Planning Practice Guidance (NPPG) updated on 1 October 2019.

The site is allocated for housing (site reference HS11) in the adopted Kirklees Local Plan (2019). Flood Risk and Drainage Assessment (FRDA) reports have been prepared by Weetwood¹ for the "Phase 1" element of the site (referred to as "Parcel R" in **Figure 1**; for consistency within this report, it will be referred to as Parcel R) and by Alan Wood and Partners² for "Parcel A" (see **Figure 1**). Both assessments are reported separately and referenced in **Section 1.3** and in Footnotes 1 and 2. For completeness, both parcels of land are included within this report including a summary of the proposed surface water drainage strategies outlined within the FRDA reports.

1.2 Structure of the Report

The report is structured as follows:

Section 1	Introduction and report structure
Section 2	Provides background information relating to the development site
Section 3	Presents national and local flood risk and drainage planning policy
Section 4	Assesses the potential sources of flooding to the development site
Section 5	Presents flood risk mitigation measures based on the findings of the assessment
Section 6	Addresses the effect of the proposed development on surface water runoff and presents an illustrative surface water drainage scheme
Section 7	Presents a summary of key findings and the recommendations

1.3 Relevant Documents

The assessment has been informed by the following documents:

- Calder Catchment Strategic Flood Risk Assessment (SFRA), Volume I, Kirklees Council, Calderdale Metropolitan Borough Council and Wakefield Council, April 2016
- Calder Catchment Strategic Flood Risk Assessment (SFRA), Volume II, Kirklees Council, July 2016
- Bradley Golf Course Flood Risk and Drainage Plan Report for Kirklees Council, Revision P1, RES Environmental Ltd, March 2018
- Bradley Villa Farm (Phase 1), Bradley Road, Bradley, Huddersfield, HD2 2JX, Flood Risk and Drainage Assessment, Final Report v1.1, Weetwood, January 2021
- Flood Risk and Drainage Assessment for Cushman and Wakefield Debenham Tie Leung Limited, Proposed Development – Land at Tithe House Way, Bradley Park (Phase 1), Huddersfield, West Yorkshire, HD2 1RD, Alan Wood and Partners, December 2019 (Issue G)

¹ Bradley Villa Farm (Phase 1), Bradley Road, Bradley, Huddersfield, HD2 2JX, Flood Risk and Drainage Assessment, Final Report v1.1, Weetwood, January 2021

² Flood Risk and Drainage Assessment for Cushman and Wakefield Debenham Tie Leung Limited, Proposed Development – Land at Tithe House Way, Bradley Park (Phase 1), Huddersfield, West Yorkshire, HD2 1RD, Alan Wood and Partners, December 2019 (Issue G)

2 SITE DETAILS AND PROPOSED DEVELOPMENT

2.1 Site Location

The approximately 71 hectare (ha) greenfield site is located at Bradley Villa Farm and Bradley Park Golf Course, Bradley, Huddersfield at Ordnance Survey National Grid Reference SE 158 208, as indicated by the red line on **Figure 1**. The purple and orange lines on **Figure 1** indicates Parcels R and A respectively.

The site is located to the north of Bradley Road, to the east of Bradford Road, to the west of Bradley Park Waste Management and a residential estate and to the south of woodland and the M62. Bradley Park Golf Course and Driving Range is located within the site outline.

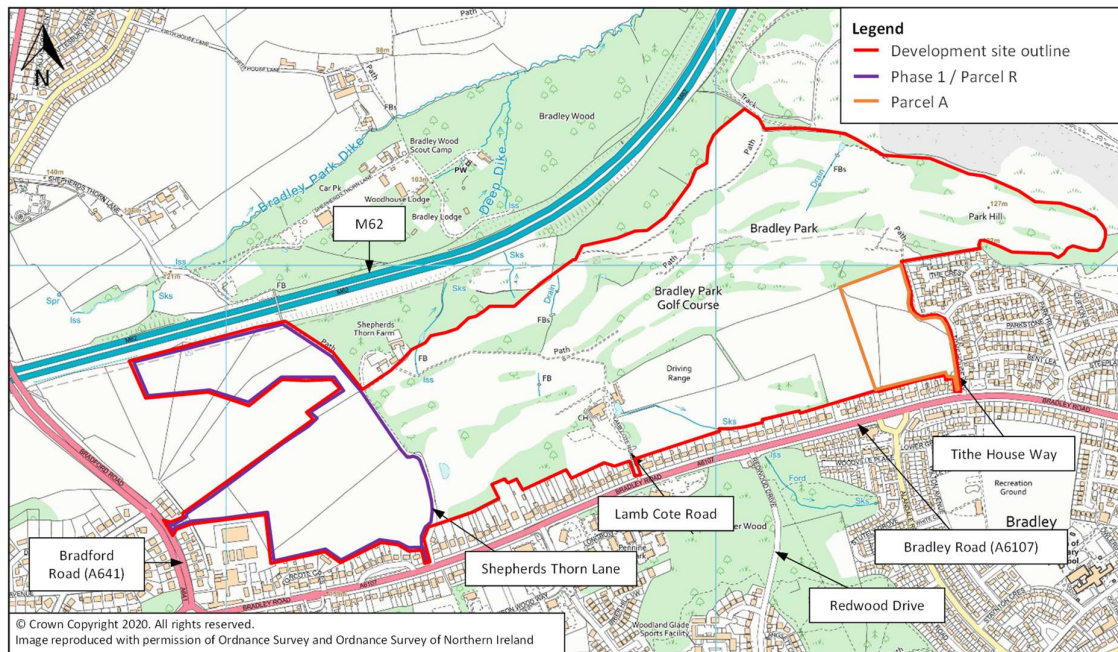


Figure 1: Site Location

2.2 Existing and Proposed Development

The development proposals are for a residential led mixed-use garden suburb development comprising circa 1,958 dwellings, a two-form entry primary school, a local centre, landscaping/greenspace and associated infrastructure. A concept masterplan is provided in **Appendix A**.

The NPPG classifies residential and educational development as More Vulnerable to flood risk.

2.3 Waterbodies in the Vicinity of the Site

Bradley Park Dike flows predominantly in a north-easterly direction a minimum of approximately 330 m to the north of the site. Based on OS mapping, it is assumed that Bradley Park Dike flows into the Calder and Hebble Navigation Kirklees Cut approximately 500 m to the north of the eastern portion of the site.

Deep Dike issues within the western portion of the site near to the northern boundary and flows in a north-easterly direction towards Bradley Park Dike approximately 380 m to the north of the site.

The River Calder, a designated main river, is located approximately 520 m to the north of the site. The Calder and Hebble Navigation Kirklees Cut spurs off the right bank of the River Calder approximately 500 m north of the site.

Two unnamed watercourses are indicated to emerge on site (for the purposes of this report, these are referred to as Unnamed Watercourse 1 (UW1) and UW2; it is unclear from OS mapping where UW1 and UW2 flow to although UW1 appears to flow into a pond.

The FRDA report prepared by Alan Wood and Partners² states that a previous drainage assessment concluded that the pond does not appear to have any outfalls, and that based on Flood Risk from Surface Water mapping (see **Figure 4**), flow from this pond may follow a route along the northern boundary of the site and then adjacent to the M62 potentially discharging to Bradley Park Dike via a culvert under the M62 to the north.

The FRDA report states that UW2 leaves the site via a culverted course between dwellings on Bradley Road near to Redwood Drive, eventually connecting into a watercourse located in Screamer Wood adjacent to Redwood Drive.

In addition, the report identifies a culverted land drain located in the south-eastern corner of Parcel A.

Larger rivers and streams are usually designated as 'main river'; other rivers are called 'ordinary watercourses'. All ordinary watercourses are shown in **Figure 2**.

The Environment Agency carries out maintenance, improvement and construction work on main rivers to manage flood risk. Lead local flood authorities, district councils and internal drainage boards carry out flood risk management work on ordinary watercourses.

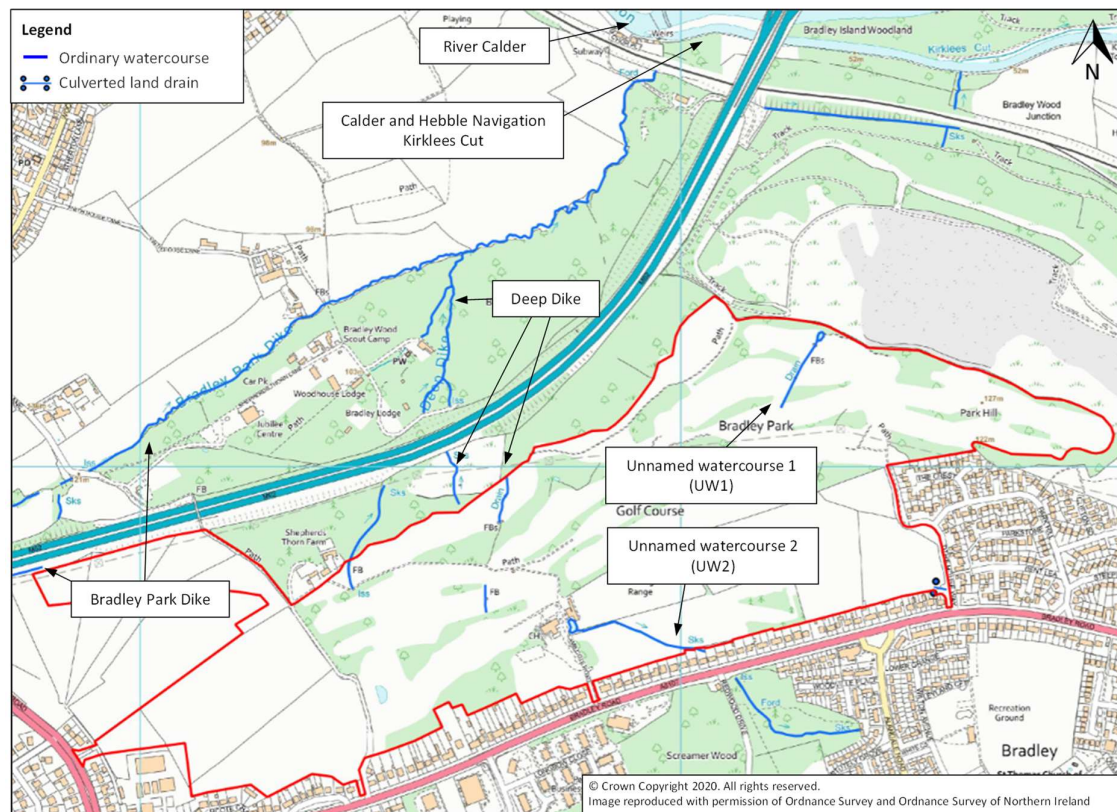


Figure 2: Location of Ordinary Watercourses

2.4 Ground Conditions

A geo-environmental appraisal of Parcel R was undertaken in March 2019 by Lithos³. Fieldwork was undertaken between 12 and 14 February 2019 and included 41 No. trial pits up to depths of 3.1 m and soakaway tests within six trial pits.

The appraisal report described ground conditions as follows:

- Topsoil: Slightly sandy slightly gravelly clay up to a typical depth of 300 mm
- Cohesive residual soil: Slightly sandy slightly gravelly clay up to a depth of 1.9 m
- Granular residual soil: Slightly clayey sands and gravel/cobble encountered below the cohesive residual soils up to a depth of 3.0 m
- Bedrock: Encountered at the base of each trial pit up to a depth of 3.1 m

Groundwater seepages were encountered in six trial pits between depths of 1.2 m and 2.4 m.

Soakaway tests were carried out in general accordance with BRE 365⁴ to determine infiltration rates. Water levels did not fall sufficiently to enable an infiltration rate to be determined in five of the trial pits. The report concluded that soakaways are unlikely to provide a suitable drainage solution for the discharge of surface water runoff at the site.

A Phase 1 geo-environmental appraisal was undertaken for Parcel A in October 2018 by Alan Wood and Partners⁵. The report indicates that the underlying bedrock formation comprises Pennine Lower Coal Measures Formation (mudstone, siltstone and sandstone) and that no superficial deposits were recorded.

As part of the Parcel A FRDA report fieldwork was undertaken comprising of four trial pits. Ground conditions are described as predominantly clayey up to a depth of 0.8 m bgl underlain by Pennine Lower Coal Measures.

British Geological Survey mapping of surface geology⁶ indicates that the underlying bedrock at the site comprises of a combination of Pennine Lower Coal Measures Formation (mudstone, siltstone and sandstone) and Thick Stone (sandstone). No superficial deposits are recorded.

The National Geoscience Data Centre's Single Onshore Borehole Index⁷ holds records of two on-site boreholes and a number of boreholes in the vicinity of the site, in particular along the course of the M62. Records indicate that ground conditions comprise of layers of clay, sandstone, siltstone and shale.

According to the MAGIC website⁸ the underlying bedrock is classified as a Secondary A aquifer. The site is not shown to be located within a designated groundwater source protection zone.

2.5 Site Levels

LiDAR data has been used to develop a digital terrain model of the site and surrounding area as illustrated in **Figure 3**. Ground levels range between approximately 93.8 metres Above Ordnance Datum (m AOD) to 168.5 m AOD with levels generally falling in a north-easterly/easterly direction. The south-eastern portion of the site falls in a south-easterly direction.

2.6 Access and Egress

The site is accessed via Bradford Road and via Shepherds Thorn Lane, Lamb Cote Road and Tithe House Way off Bradley Road. Approximate ground levels at the site access points are as follows:

³ Land at Bradley Villa Park, Huddersfield. Geoenvironmental Appraisal. Lithos, March 2019

⁴ BRE Digest 365 Soakaway Design, Building Research Establishment, 2016

⁵ Phase 1 Geo-Environmental Assessment Report and Coal Mining Risk Assessment, Tithe House Way, Bradley Park, Huddersfield, HD2 1RD, Alan Wood and Partners, October 2018

⁶ <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

⁷ <https://www.bgs.ac.uk/products/onshore/SOBI.html>

⁸ <https://magic.defra.gov.uk/MagicMap.aspx>

- Bradford Road: 168.5 m AOD
- Shepherds Thorn Lane: 157.9 m AOD
- Lamb Cote Road: 137.8 m AOD
- Tithe House Way: 108.9 m AOD

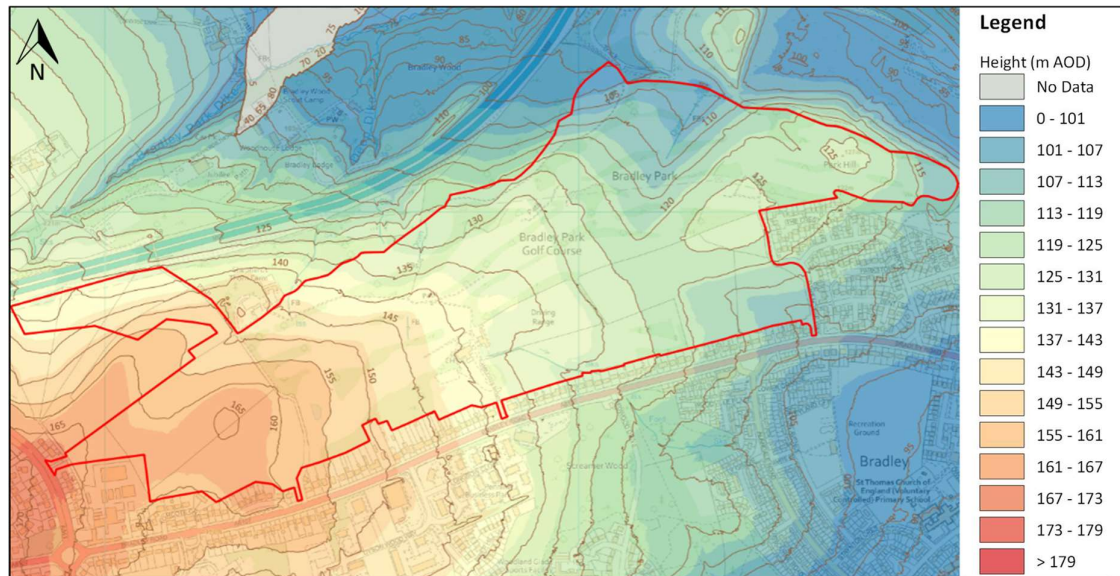


Figure 3: Digital Terrain Model from Topographic Survey

2.7 Flood Zone Designation

Flood zones refer to the probability of river and sea flooding. Table 1 of the NPPG defines flood zones as follows⁹:

- Flood zone 1: Low Probability. Land having a less than 1 in 1,000 annual probability of river or sea flooding
- Flood zone 2: Medium Probability. Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding
- Flood zone 3a: High Probability. Land having a 1 in 100 or greater annual probability of river flooding or a 1 in 200 or greater annual probability of sea flooding
- Flood zone 3b: Functional Floodplain. Land where water has to flow or be stored in times of flood.

The flood zones are shown on the Environment Agency Flood Map for Planning (Rivers and Sea)¹⁰.

The flood zones shown on the flood map are defined by the predicted extent of flooding during the present day 1 in 100 (non-tidal rivers), 1 in 200 (tidal rivers and sea) and 1 in 1,000 (rivers and sea) annual exceedance probability (AEP) events. The zones do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding.

Flood zone 3b (functional floodplain) is not separately distinguished on the Flood Map for Planning but is usually identified by local planning authorities in their SFRA. The boundary of flood zone 3b is normally defined as land that would flood during the present day 1 in 20 AEP event, although definitions may vary particularly in some districts and in urban areas.

⁹ <https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables>

¹⁰ <https://flood-map-for-planning.service.gov.uk/>

Where an area benefits from formal flood defences providing a minimum standard of protection, the defended area may be indicated as an area benefiting from flood defences. However, not all areas are shown as such, and unless specifically indicated, the Flood Map for Planning conservatively shows land at risk of flooding in the absence of flood defences.

The Flood Map for Planning (**Figure 4**) indicates the site to be located in flood zone 1. Map K of the SFRA reaffirms the sites flood zone 1 designation.

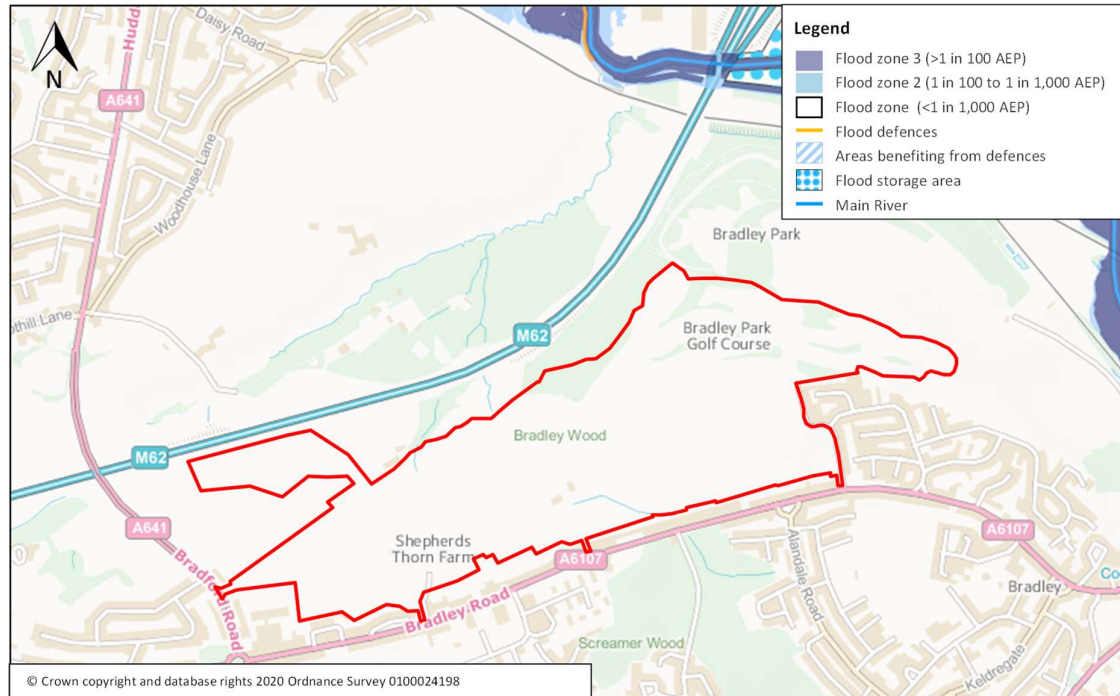


Figure 4: Flood Map for Planning

Source: gov.uk website; Accessed: October 2020

3 PLANNING POLICY AND GUIDANCE

3.1 National Requirements

3.1.1 Water Framework Directive

The Water Framework Directive (WFD) provides a legal framework for the protection, improvement and sustainable use of inland surface waters, groundwater, transitional waters, and coastal waters across England, and seeks to:

- Prevent deterioration in the status of aquatic ecosystems, protect them and improve the ecological condition of waters
- Achieve at least 'good' status for all waterbodies by 2015
- Promote the sustainable use of water as a natural resource
- Conserve habitats and species that depend directly on water
- Progressively reduce or phase out the release of individual pollutants or groups of pollutants that present a significant threat to the aquatic environment
- Progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants; and
- Contribute to mitigating the effects of floods and droughts.

The WFD applies to any proposed development which has the potential to impact on a waterbody. Where this is the case, the Environment Agency may require evidence demonstrating that the proposed development does not compromise the aims of the WFD.

3.1.2 National Planning Policy Framework

The NPPF sets out government's planning policies for England and how these are expected to be applied. The NPPF seeks to ensure that flood risk is taken into account at all stages in the planning process and is appropriately addressed.

Footnote 50 of the NPPF states that a site-specific flood risk assessment should be submitted for all development proposed in flood zone 2 and flood zone 3 whilst in flood zone 1, an assessment should accompany all proposals involving: sites of 1 ha or more; land identified as having critical drainage problems or 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.

NPPF paragraph 155 states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk but accepts that where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere. The policy of seeking to direct development away from areas at highest risk of flooding is implemented through the application of the sequential test (NPPF paragraph 158).

Paragraph 159 of the NPPF states that if it is not possible for a development to be located in zones with a lower risk of flooding, taking into account wider sustainable development objectives, the exception test may have to be applied.

The need for the exception test will depend on the flood zone of the site and the vulnerability of the development proposed (as set out in NPPG Table 2 and 3).

NPPF paragraph 160 states that application of the exception test for development proposals at the application stage should be informed by a site-specific flood risk assessment. For the test to be passed it should be demonstrated that: the development would provide wider sustainability benefits to the community that outweigh the flood risk; and the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

NPPF Paragraph 161 states that both elements of the exception test should be satisfied for development to be permitted.

NPPF paragraph 163 states that development should only be allowed in areas at risk of flooding if it incorporates sustainable drainage systems (SuDS) unless there is clear evidence that this would be inappropriate. NPPF paragraph 165 states that applications for major developments should incorporate sustainable drainage systems to appropriate operational standards and with maintenance arrangements in place unless there is clear evidence that this would be inappropriate.

3.1.3 National Guidance

Non-statutory technical standards for sustainable drainage published by DEFRA in March 2015 set out how surface water runoff generated during the present day 1 in 30 and 1 in 100 AEP rainfall events and for events exceeding the present day 1 in 100 AEP event should be managed, how peak runoff rates should be restricted and how runoff volumes should be controlled.

3.2 Local Planning Policy and Guidance

The Kirklees Local Plan was adopted on 27 February 2019. The following policies are relevant in respect of flood risk and drainage:

- Policy LP5: Masterplanning Sites Part M states, in part, that masterplans will be expected to provide appropriate measures to mitigate flood risk and ensure that the development is resilient to the potential impacts of climate change.
- Policy LP24: Design Part D vii states, in part, that proposals should promote good design by ensuring high levels of sustainability through designing buildings that are resilient and resistant to flood risk.
- Policy LP27: Flood Risk is summarised as follows:
 - *Proposals for development which require a Sequential Test will need to demonstrate that development has been directed to areas at the lowest probability of flooding, following a sequential risk-based approach*
 - *Proposals within flood zone 3ai will be assessed in accordance with national policies relating to flood zone 3a but with all of the following additional restrictions: No new highly vulnerable or more vulnerable uses will be permitted; Less vulnerable uses may only be permitted where the sequential test has been passed and where extensions are linked operationally to an existing business or where redevelopment of a site provides buildings with the same or a smaller footprint*
 - *All proposals will be expected to include flood mitigation measures which should be identified and considered through a site-specific flood risk assessment*
 - *Development will not be permitted within the functional floodplain*
- Policy LP28: Drainage is summarised as follows:
 - *SuDS will be used to assist in achieving the following:*
 - *Greenfield runoff rates should not be exceeded*
 - *Brownfield sites should have a minimum 30% reduction in runoff where previous positive surface water connections from the site can be proven. New connections will be subject to at least greenfield restrictions*
 - *No negative impact on local water quality*
 - *Consider whether proposed open spaces and green infrastructure within sites can contribute to sustainable drainage of the site*
 - *Local conditions may require a lower runoff rate to be agreed to reflect volume control, local surface water risks, watercourse capacity and flood risk further downstream*
 - *There will be a general presumption against pumping surface water. Also demonstrate that the surface water management solution is designed for the lifetime of the development including maintenance arrangements*
 - *Accommodate flow paths by ensuring paths are designed to avoid buildings and curtilages*
 - *Development will only be permitted if water supply and waste water infrastructure is available or can be co-ordinated to meet the demand from the new development.*

3.3 Land Drainage Consent

Land drainage consent may be required from the lead local flood authority or drainage board for work to an ordinary watercourse.

Undertaking activities controlled by local byelaws also requires the relevant consent.

4 REVIEW OF FLOOD RISK

4.1 Sequential Test and Exception Test

The site is located within flood zone 1. As such the proposals satisfy the requirements of the sequential test and the exception test need not be applied. Nevertheless, the proposals are still required to meet the requirements for site specific flood risk assessments.

4.2 Historical Records of Flooding

There are no records of historic flooding at the site in the SFRA or in the Environment Agency's Recorded Flood Outlines database¹¹.

4.3 Fluvial Flood Risk

The Flood Map for Planning only presents flood outlines for watercourses with a catchment area greater than 3.0 km²; land in the vicinity of watercourses with a smaller catchment area is shown to be in flood zone 1 by default. As such, the flood map may not represent flood risk from small watercourses.

The catchment area for Bradley Park Dike (including Deep Dike) is 1.64 km² i.e. below the 3.0 km² mapping threshold. UW1 and UW2 are not recognised on the FEH web service. In instances such as this, the Flood Risk from Surface Water map provides a useful proxy for fluvial flood risk.

The Flood Risk from Surface Water map (**Figure 5** and **Figure 6**) indicates that land adjacent to the on-site watercourses are at Low risk of flooding during extreme events, and therefore, there may be some propensity for localised flooding from the on-site watercourses with flood depths predominately less than 300 mm.

4.4 Flood Risk from Surface Water

The Flood Risk from Surface Water map (**Figure 5**) indicates that the site is predominantly at Very Low risk of flooding from surface water. A small number of surface water flow paths are indicated to be present on-site, however, most of the flow paths coincide with the on-site watercourses and as such, the risk of flooding is assumed to be associated with the watercourses. A surface water flow path is indicated to be present in the south-eastern corner of the site where the natural contours of the land forms a shallow swale feature where overland flow would be directed. The risk and extent of surface water flow paths, however, are reduced during less extreme events (**Figure 6**).

4.5 Flood Risk from Reservoirs, Canals and Other Artificial Sources

The site is a minimum of approximately 40 m above ground levels adjacent to the canal. Given the difference in elevation levels, the site is not considered to be at risk of flooding from this source. There are no other impounded waterbodies located within the immediate vicinity of the site. The Flood Risk from Reservoirs map indicates that the site is not at risk of flooding from such sources. The site is therefore not assessed to be at risk of flooding from reservoirs, canals or other artificial sources.

4.6 Flood Risk from Groundwater

The JBA Groundwater Flood Risk Indicator map (**Figure 7**) indicates that the site is at Negligible to Very Low risk of flooding from groundwater i.e. peak groundwater levels are at least 5.0 m below the ground surface during a 100 year return period event.

¹¹ <https://data.gov.uk/dataset/16e32c53-35a6-4d54-a111-ca09031eaaaf/recorded-flood-outlines>

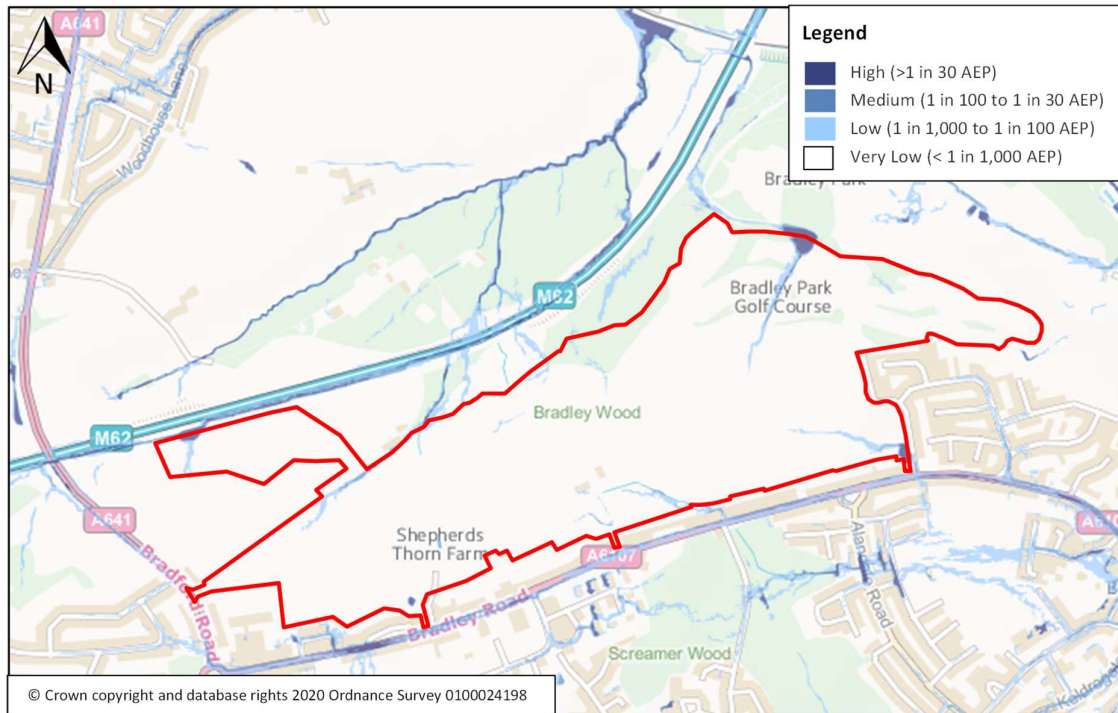


Figure 5: Flood Risk from Surface Water
Source: gov.uk website; Accessed: October 2020

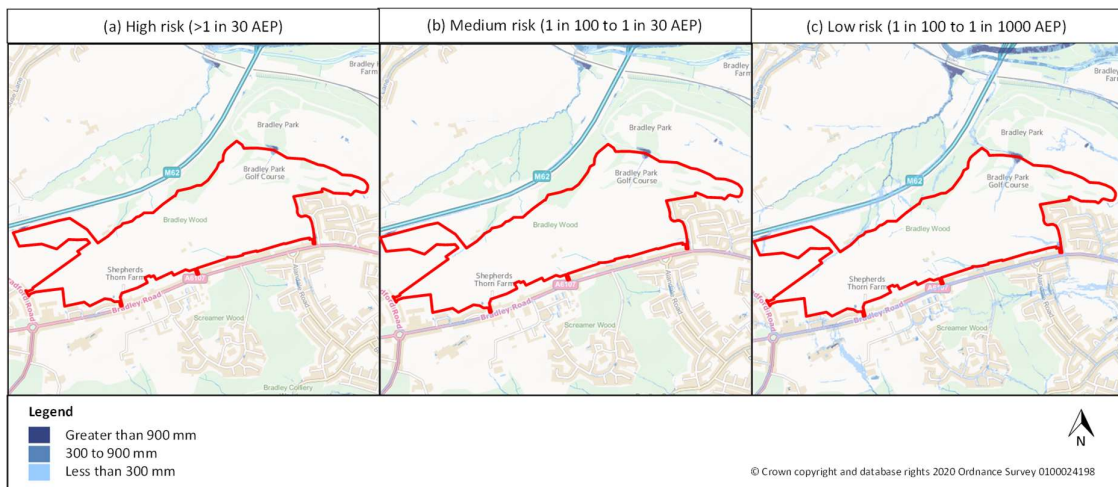


Figure 6: Flood Risk from Surface Water - Depth
Source: gov.uk website; Accessed: October 2020

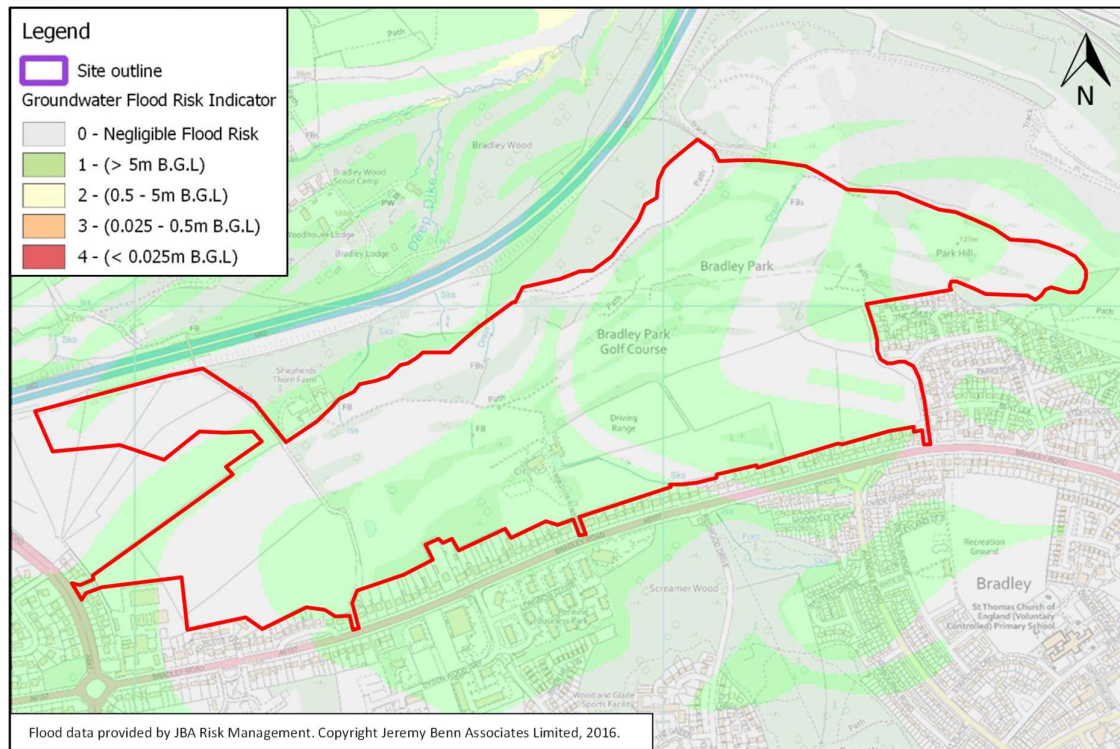


Figure 7: JBA Groundwater Flood Risk Indicator Map

Source: Blue Sky Maps; Accessed: September 2020

5 FLOOD RISK MITIGATION MEASURES

The risk of flooding to the proposed development from local watercourses and surface water will be mitigated through the implementation of the measures proposed within the following section of this report.

5.1 Finished Floor Levels

Finished floor levels should be set at a minimum of 0.15 m above adjacent ground levels following any reprofiling of the site.

This will, subject to the implementation of an appropriately designed surface water drainage scheme (**Section 6**), enable any potential overland flows to be conveyed safely across the site without affecting property in accordance with the approach promoted by government policy¹².

5.2 Bridge Design Principles

The conveyance capacity of any new culverts or bridges over Deep Dike and/or UW2 should maintain existing channel conveyance capacity so as not to increase flood risk; further details are to be provided at the detailed design stage.

5.3 Drain Maintenance

A maintenance regime should be implemented to minimise the risk of channel and/or culvert blockage.

¹² Making Space for Water, Taking forward a new Government strategy for flood and coastal erosion risk management in England, March 2005, Dept for Environment, Food and Rural Affairs

6 SURFACE WATER MANAGEMENT

6.1 Surface Water Drainage at the Existing Site

The site is undeveloped greenfield. As detailed in the RES report, the golf course has a complex drainage system, consisting of field drains and open drainage ditches; most of these ditches were reported to be dry during a site (March 2018) despite much of the ground being saturated with pooled water within localised low spots thus demonstrating poor drainage or saturated land.

Given site topography and ground conditions, surface water runoff would be expected to flow overland in a direction determined by local topography and slowly infiltrate where conditions allow.

The greenfield surface water runoff rates for the site, calculated using the ICP SUDS method within MicroDrainage are presented in **Table 1**. Details of the input parameters and the output results are provided in **Appendix B**.

Table 1: Greenfield Runoff Rate

AEP of Rainfall Event	Greenfield Runoff Rate (l/s/ha)
1 in 1	5.3
QBAR	6.3
1 in 30	11.1
1 in 100	13.2

6.2 Surface Water Drainage at the Developed Site

6.2.1 Disposal of Surface Water

In accordance with the NPPG¹³, surface water runoff should be disposed of according to the following hierarchy: Into the ground (infiltration); To a surface water body; To a surface water sewer, highway drain, or another drainage system; To a combined sewer.

As stated in **Section 2.4**, infiltration testing has been undertaken within Parcel R. The results show that soakaways are unlikely to provide a suitable drainage solution for the discharge of surface water runoff. Based on ground conditions for the remainder of the site, including Parcel A, the disposal of surface water via infiltration is unlikely to be feasible. In addition, the RES report indicates the topography of the site to have slopes greater than 1 in 10, and thus, the site is not considered suitable for infiltration due to the potential for re-emergence of flows lower down the slopes. Should areas of the site appear to be suitable for the use of soakaways, however, then infiltration tests may be undertaken at the detailed design stage in accordance with the guidelines in BRE365⁴.

It is proposed to direct all runoff from the developed site to existing watercourses and the culverted land drain (as illustrated in **Figure 8**).

6.2.2 Post Development Impermeable Area

To facilitate the development of an illustrative drainage scheme, the proposed development has been subdivided into eight drainage areas (in addition to Parcels R and A), as illustrated in **Figure 8**. The drainage areas are based on the Areas Plan (**Appendix A**) and site topography.

¹³ Paragraph 080, Reference ID: 7-080-20150323

The area of impermeable surfaces at the site are estimated to be as follows:

- Residential areas: 55%
- Primary school: 65%
- Local centre: 90%

A breakdown of each drainage area and the estimated impermeable surfaces within each area are presented in **Table 2**.

For Parcels R and A, the impermeable areas have been calculated to be 4.884 ha¹ and 2.020 ha² respectively.

It should be noted that land to the west of Parcel A (referred to as 'Phase 2' in the FRDA report²) has an estimated impermeable area of 2.135 ha; however, the Phase 2 area would need to be increased based on the current Areas Plan (as shown in **Figure 8**) and therefore the estimated impermeable area for Phase 2 would increase to 3.134 ha.

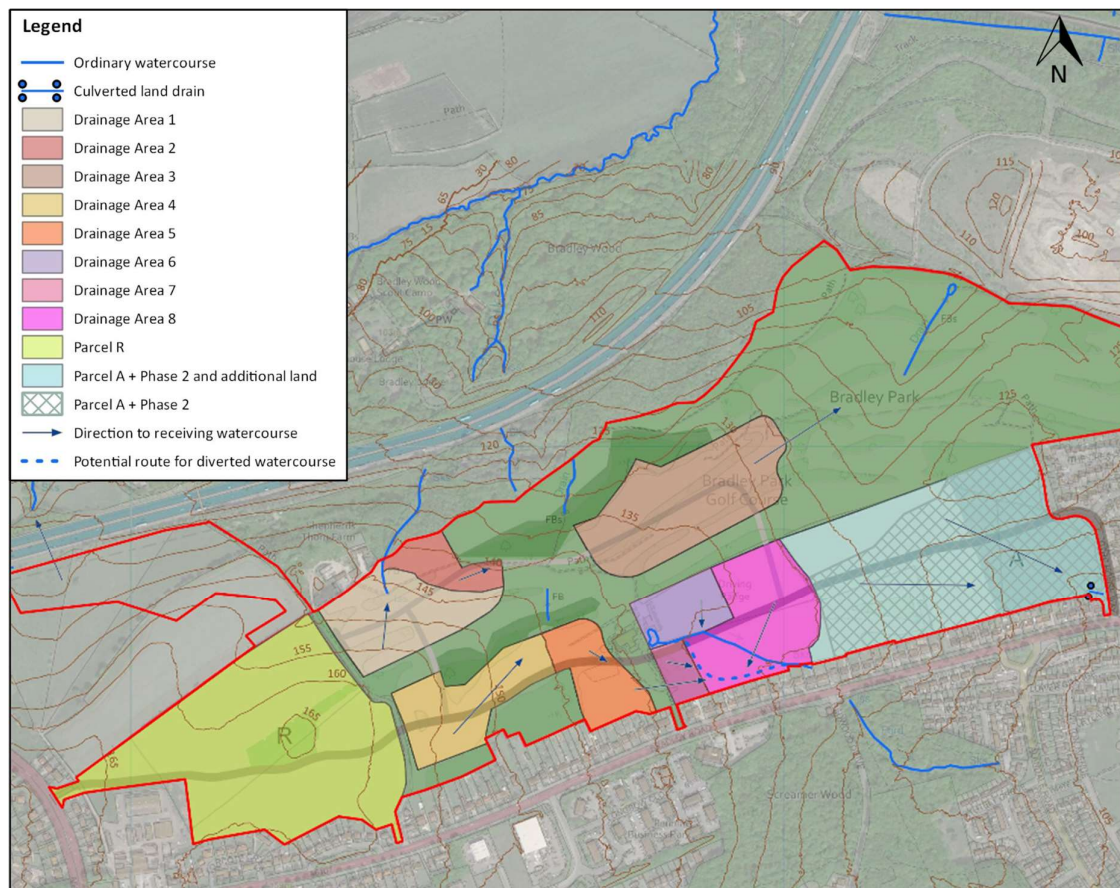


Figure 8: Indicative Drainage Areas

6.2.3 Peak Flow Control

It is proposed to restrict surface water runoff within each drainage area to the existing greenfield QBAR rate of 6.3 l/s/ha post development. The peak runoff rate for each drainage area is presented in **Table 2**.

For Parcel R, the existing greenfield surface water runoff rate has been calculated by ARP Associates using the IHT 124 Method as discussed in the Phase 1 FRDA¹. It is proposed to restrict surface water runoff to the existing 1 in 1 AEP event rate of 28.8 l/s.

For Parcel A, a discharge rate of 13.5 l/s has been agreed with Kirklees Council. Phase 2 is also accounted for within the agreed discharge rate.

6.2.4 Volume Control

Where reasonably practicable, for greenfield sites, the runoff volume from the proposed development to any highway drain, sewer or surface water body in the 1 in 100 AEP, 6 hour rainfall event should not exceed the greenfield runoff volume for the same event.

As outlined within the CIRIA SuDS Manual 2015 extra runoff volumes in extreme events may be managed by releasing all runoff (above the 1 in 1 AEP event) from the site at a maximum rate of 2 l/s/ha or QBAR, whichever is the higher value.

It is proposed to restrict peak discharge rates to the existing QBAR rate for drainage areas 1 – 8, the existing 1 in 1 AEP event for Parcel R and 13.5 l/s for Parcel A (including land to the west) in up to the 1 in 100 annual probability event including an allowance for climate change. Therefore, the runoff volume will not exceed the greenfield runoff volume during the 1 in 100 AEP, 6 hour rainfall event.

6.2.5 Attenuation Storage

Attenuation storage will be provided within each drainage area to store surface water runoff generated across roofs and hardstanding.

The attenuation storage facilities have been modelled using the Source Control module of MicroDrainage (**Appendix C**). The required storage volumes have been sized to store the 1 in 100 AEP rainfall event including a 30% increase in rainfall intensity to allow for climate change.

The storage volumes including the approximate land-takes required for each drainage area based on the peak runoff rates are provided in **Table 2**.

For residential areas (drainage areas 1-5 and 8) storage could be provided in above ground facilities such as attenuation basins filling to a depth of 1.0 m with a 0.3 m freeboard and a 1 in 3 side slope. For the primary school and local centre (drainage areas 6 and 7 respectively) storage could be provided in below ground facilities such as geo-cellular storage crates.

Table 2: Impermeable Areas, Indicative Peak Runoff Rates, Storage Volumes and Land Take

	Drainage Area (DA)							
	DA1	DA2	DA3	DA4	DA5	DA6	DA7	DA8
Development platform (ha)	2.541	0.926	4.186	2.258	1.460	1.139	0.489	3.071
Post development impermeable area (ha)	1.397	0.509	2.302	1.242	0.803	0.740	0.440	1.689
Proposed peak runoff rate (l/s)	8.8	3.2	14.5	7.8	5.1	4.7	2.8	10.6
Indicative attenuation storage volume (m³)	857	307	1426	760	487	450	274	1041
Land take of above ground storage (m²)	1126	473	1763	1012	691	-	-	1332

Additional SuDS features, such as rainwater harvesting, bioretention areas, filter strips, swales or filter drains may be incorporated into the surface water drainage strategy at the detailed design stage. As detailed in the RES report, it may be feasible to utilise the existing drainage on the golf course once fully mapped and its condition understood.

It should be noted that the calculations assume that all storage is provided within the attenuation storage facilities; with no storage being provided in the proposed pipe network. As such, the volumes of storage presented are likely to be an overestimate.

For Parcel R, it is proposed to store surface water runoff generated from roofs and hardstanding within an attenuation tank up to the 1 in 2 AEP event with an offline attenuation basin providing storage for all rainfall events greater than the 1 in 2 AEP event and up to the 1 in 100 plus 30% climate change AEP event. Assuming a peak discharge rate of 28.8 l/s, the attenuation tank will provide approximately 600 m³ of storage and the attenuation basin will provide approximately 1,740 m³ of storage (approximately 0.9 m depth and 1 in 3 side slope).

For Parcel A, the FRDA report proposes that both Phases 1 and 2 will have their own storage facility to store surface water runoff, with the Phase 2 storage system cascading into the Phase 1 storage system prior to discharging into the culverted land drain at a restricted rate of 13.5 l/s.

6.2.6 Exceedance Routes

Flows resulting from rainfall in excess of the 1 in 100 AEP plus climate change rainfall event will be managed in exceedance routes. It is assumed that as the development is constructed, exceedance flows would be directed towards carriageways and away from built development.

6.2.7 Pollution Control

Kirklees Council requires that two levels of treatment be provided for new residential developments to reduce the risk of pollution to receiving waterbodies. SuDS features such as permeable paving across proposed driveways, filter strips or swales for the drainage of the proposed highways before outfalling into an attenuation basin may be incorporated into the design of the drainage systems.

Attenuation basins can provide water quality benefits via the settlement of pollutants in still or slow-moving water, adsorption by the soil, and biological activity. The potential for additional SuDS features to be utilised at the site would be investigated further at the detailed design stage.

6.2.8 Adoption and Maintenance of SuDS

The pipe network, designed in accordance with the Design and Construction Guidance¹⁴, may be adopted by the sewerage undertaker.

SuDS elements within the curtilage of residential dwellings would be the responsibility of the owner of the property.

SuDS in open spaces may be maintained by a management company.

An indicative maintenance schedule is presented in **Table 3**.

Table 3: Maintenance Requirements

Schedule	Required action	Frequency
Attenuation Basin		
Regular maintenance	Remove litter and debris	Monthly
	Cut grass	Monthly during grow season Or as required)
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly

¹⁴ Design and Construction Guidance for foul and surface water sewers offered for adoption under the Code for adoption agreements for water and sewerage companies operating wholly or mainly in England ("the Code"), Approved Version 2.0, 10 March 2020

Schedule	Required action	Frequency
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies	Monthly for first year, then annually or as required
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets/outlets	Annually (or as required)
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every two years, or as required
	Remove sediments from inlets/outlets and main basin when required	
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	
	Repair/rehabilitation of inlets/outlets	
	Relevel uneven surface and reinstate design levels	
Geo-cellular Attenuation Storage Tank		
Regular maintenance	Inspect and identify any areas that are not operating correctly	Monthly for 3 months, then annually
	Remove debris from the catchment surface	Monthly
	Remove sediment from internal forebays	Annually, or as required
Remedial action	Repair inlet/outlet and vents	As required
Monitoring	Inspect catchpit manholes and note rate of sediment accumulation	Monthly in the first year and then annually
	Inspect inlet/outlet and vents to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years, or as required
Flow Control Unit		
Routine maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six Monthly
	Remove sediment, oil, grease and floatables	As necessary – Indicated by system inspections or immediately following significant spill
Remedial actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operation	Six Monthly
	Inspect filter media and establish appropriate replacement frequencies	Six Monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first year of operation, then every six months

7 SUMMARY AND RECOMMENDATIONS

This report has been prepared on behalf of Redrow Homes Yorkshire and relates to the proposed development of land at Bradley Villa Farm, Bradley, Huddersfield.

According to the Flood Map for Planning the proposed development is located outside the 1 in 1,000 AEP flood outline and is therefore defined by the NPPF as being situated within flood zone 1.

As the site is in flood zone 1, the sequential test is deemed to have been addressed and the exception test need not be addressed.

The site is assessed not to be at risk of flooding from the Calder and Hebble Navigation, groundwater and reservoirs.

The Flood Map for Planning does not present flood outlines for watercourses with a catchment area less than 3.0 km²; In instances such as this, the Flood Risk from Surface Water map provides a useful proxy for fluvial flood risk.

The Flood Risk from Surface Water map indicates that the site is predominantly at Very Low risk of flooding from surface water. A small number of surface water flow paths are indicated to be present on-site, however, most of the flow paths coincide with the on-site watercourses and as such, the risk of flooding is assumed to be associated with the watercourses. The mapping indicates that land adjacent to the on-site watercourses are at Low risk of flooding during extreme events, and therefore, there may be some propensity for localised flooding from the on-site watercourses with flood depths predominately less than 300 mm.

A surface water flow path is indicated to be present in the south-eastern corner of the site where the natural contours of the land forms a shallow swale feature where overland flow would be directed. The risk and extent of surface water flow paths, however, are reduced during less extreme events.

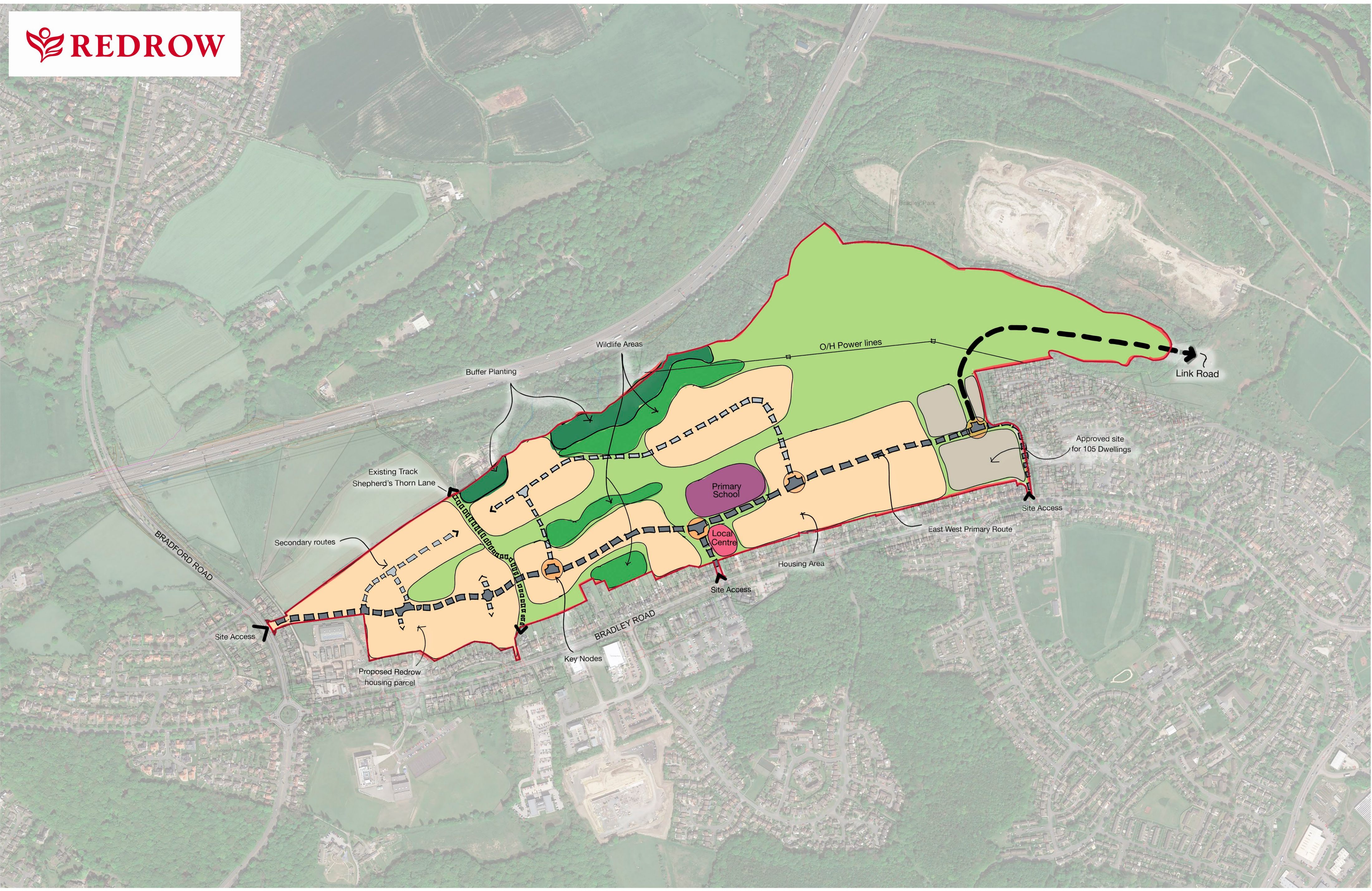
This report has demonstrated that the proposed development may be completed in accordance with the requirements of planning policy subject to the following:

- Finished floor levels to be set 150 mm above adjacent ground levels following any re-profiling at the site
- New culverts and/or bridges along the course of Deep Dike and/or any unnamed watercourses should maintain existing channel conveyance capacity
- A channel maintenance regime to be implemented
- A surface water drainage system that accords with the broad principles presented in this report.

Surface water runoff from the developed site can be sustainably managed in accordance with planning policy and is not expected to impact flood risk elsewhere.

APPENDIX A

Development Proposals



APPENDIX B

Greenfield Runoff Rate

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Joseph's Well Hanover Walk Leeds, LS3 1AB		
Date 11/08/2020 13:04 File	Designed by KeelyBonser Checked by	
XP Solutions Source Control 2020.1		

ICP SUDS Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 956 Urban 0.000
Area (ha) 1.000 Soil 0.450 Region Number Region 3

Results 1/s

QBAR Rural 6.3
QBAR Urban 6.3

Q100 years 13.2

Q1 year 5.4
Q30 years 11.1
Q100 years 13.2

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APPENDIX C

Surface Water Attenuation - Storage Volume Calculation

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Joseph's Well Hanover Walk Leeds, LS3 1AB					
Date 12/11/2020 10:41 File 2020-11-12 4937 DA1 100...		Designed by MichaelDarby Checked by			
XP Solutions		Source Control 2020.1			
<u>Summary of Results for 100 year Return Period (+30%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.382	0.382	8.8	292.7	0 K
30 min Summer	0.501	0.501	8.8	392.8	0 K
60 min Summer	0.623	0.623	8.8	499.8	0 K
120 min Summer	0.740	0.740	8.8	606.7	0 K
180 min Summer	0.798	0.798	8.8	661.3	0 K
240 min Summer	0.830	0.830	8.8	692.5	0 K
360 min Summer	0.866	0.866	8.8	727.0	0 K
480 min Summer	0.881	0.881	8.8	741.7	0 K
600 min Summer	0.884	0.884	8.8	745.0	0 K
720 min Summer	0.881	0.881	8.8	741.5	0 K
960 min Summer	0.870	0.870	8.8	731.1	0 K
1440 min Summer	0.841	0.841	8.8	702.9	0 K
2160 min Summer	0.791	0.791	8.8	654.5	0 K
2880 min Summer	0.737	0.737	8.8	603.9	0 K
4320 min Summer	0.614	0.614	8.8	491.6	0 K
5760 min Summer	0.498	0.498	8.8	390.2	0 K
7200 min Summer	0.401	0.401	8.8	308.3	0 K
8640 min Summer	0.323	0.323	8.8	244.5	0 K
10080 min Summer	0.263	0.263	8.8	196.7	0 K
15 min Winter	0.426	0.426	8.8	328.6	0 K
30 min Winter	0.557	0.557	8.8	441.4	0 K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	114.680	0.0	288.7	22	
30 min Summer	77.440	0.0	391.2	36	
60 min Summer	49.937	0.0	517.1	66	
120 min Summer	31.091	0.0	644.3	124	
180 min Summer	23.207	0.0	721.5	184	
240 min Summer	18.718	0.0	775.8	244	
360 min Summer	13.796	0.0	857.3	362	
480 min Summer	11.103	0.0	919.4	482	
600 min Summer	9.374	0.0	969.5	600	
720 min Summer	8.158	0.0	1011.5	684	
960 min Summer	6.546	0.0	1079.3	792	
1440 min Summer	4.790	0.0	1171.3	1044	
2160 min Summer	3.498	0.0	1314.8	1468	
2880 min Summer	2.794	0.0	1400.0	1876	
4320 min Summer	2.032	0.0	1525.5	2680	
5760 min Summer	1.619	0.0	1626.8	3400	
7200 min Summer	1.358	0.0	1704.3	4104	
8640 min Summer	1.177	0.0	1771.3	4760	
10080 min Summer	1.042	0.0	1828.1	5448	
15 min Winter	114.680	0.0	323.9	22	
30 min Winter	77.440	0.0	438.1	36	
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Joseph's Well Hanover Walk Leeds, LS3 1AB					
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XP Solutions		Source Control 2020.1			
<u>Summary of Results for 100 year Return Period (+30%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.692	0.692	8.8	562.7	0 K
120 min Winter	0.821	0.821	8.8	683.5	0 K
180 min Winter	0.886	0.886	8.8	746.7	0 K
240 min Winter	0.923	0.923	8.8	783.8	0 K
360 min Winter	0.966	0.966	8.8	826.9	0 K
480 min Winter	0.987	0.987	8.8	848.2	0 K
600 min Winter	0.996	0.996	8.8	856.6	0 K
720 min Winter	0.996	0.996	8.8	857.0	0 K
960 min Winter	0.983	0.983	8.8	843.5	0 K
1440 min Winter	0.945	0.945	8.8	805.6	0 K
2160 min Winter	0.876	0.876	8.8	737.1	0 K
2880 min Winter	0.799	0.799	8.8	662.2	0 K
4320 min Winter	0.614	0.614	8.8	491.3	0 K
5760 min Winter	0.435	0.435	8.8	336.8	0 K
7200 min Winter	0.300	0.300	8.8	225.9	0 K
8640 min Winter	0.211	0.211	8.6	156.3	0 K
10080 min Winter	0.161	0.161	8.2	117.7	0 K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	49.937	0.0	579.4	64	
120 min Winter	31.091	0.0	721.8	122	
180 min Winter	23.207	0.0	808.1	180	
240 min Winter	18.718	0.0	868.7	240	
360 min Winter	13.796	0.0	959.6	354	
480 min Winter	11.103	0.0	1028.7	468	
600 min Winter	9.374	0.0	1084.1	580	
720 min Winter	8.158	0.0	1130.2	690	
960 min Winter	6.546	0.0	1203.2	894	
1440 min Winter	4.790	0.0	1282.9	1112	
2160 min Winter	3.498	0.0	1472.7	1580	
2880 min Winter	2.794	0.0	1568.1	2044	
4320 min Winter	2.032	0.0	1709.0	2896	
5760 min Winter	1.619	0.0	1822.3	3576	
7200 min Winter	1.358	0.0	1909.2	4184	
8640 min Winter	1.177	0.0	1984.4	4760	
10080 min Winter	1.042	0.0	2048.7	5344	
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Joseph's Well Hanover Walk Leeds, LS3 1AB		
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XP Solutions		
Source Control 2020.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.341	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.397

Time (mins)	Area	Time (mins)	Area
From: To: (ha)		From: To: (ha)	
0 4 1.000		4 8 0.397	

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Joseph's Well Hanover Walk Leeds, LS3 1AB		
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Source Control 2020.1		

Model Details

Storage is Online Cover Level (m) 1.300

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	710.0	1.300	1126.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0137-8800-1000-8800
Design Head (m)	1.000
Design Flow (l/s)	8.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	137
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	8.8
Flush-Flo™	0.299	8.8
Kick-Flo®	0.664	7.3
Mean Flow over Head Range	-	7.6

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)
0.100	5.0	1.200	9.6	3.000	14.8	7.000	22.2
0.200	8.5	1.400	10.3	3.500	15.9	7.500	22.9
0.300	8.8	1.600	11.0	4.000	17.0	8.000	23.7
0.400	8.7	1.800	11.6	4.500	18.0	8.500	24.4
0.500	8.4	2.000	12.2	5.000	18.9	9.000	25.0
0.600	7.9	2.200	12.8	5.500	19.8	9.500	25.7
0.800	7.9	2.400	13.3	6.000	20.6		
1.000	8.8	2.600	13.8	6.500	21.4		

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Joseph's Well Hanover Walk Leeds, LS3 1AB					
Date 12/11/2020 10:48		Designed by MichaelDarby			
File 2020-11-12 4937 DA2 100...		Checked by			
XP Solutions		Source Control 2020.1			
Summary of Results for 100 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.420	0.420	3.2	107.0	O K
30 min Summer	0.540	0.540	3.2	143.3	O K
60 min Summer	0.659	0.659	3.2	182.1	O K
120 min Summer	0.768	0.768	3.2	219.8	O K
180 min Summer	0.821	0.821	3.2	239.0	O K
240 min Summer	0.850	0.850	3.2	249.7	O K
360 min Summer	0.880	0.880	3.2	261.1	O K
480 min Summer	0.892	0.892	3.2	265.5	O K
600 min Summer	0.892	0.892	3.2	265.8	O K
720 min Summer	0.887	0.887	3.2	263.8	O K
960 min Summer	0.874	0.874	3.2	258.7	O K
1440 min Summer	0.843	0.843	3.2	247.1	O K
2160 min Summer	0.794	0.794	3.2	229.1	O K
2880 min Summer	0.744	0.744	3.2	211.1	O K
4320 min Summer	0.635	0.635	3.2	174.0	O K
5760 min Summer	0.508	0.508	3.2	133.3	O K
7200 min Summer	0.405	0.405	3.2	102.5	O K
8640 min Summer	0.321	0.321	3.2	79.1	O K
10080 min Summer	0.257	0.257	3.2	61.8	O K
15 min Winter	0.464	0.464	3.2	120.1	O K
30 min Winter	0.596	0.596	3.2	161.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	114.680	0.0	107.8	19	
30 min Summer	77.440	0.0	145.7	34	
60 min Summer	49.937	0.0	189.8	64	
120 min Summer	31.091	0.0	236.4	122	
180 min Summer	23.207	0.0	264.7	182	
240 min Summer	18.718	0.0	284.7	242	
360 min Summer	13.796	0.0	314.7	362	
480 min Summer	11.103	0.0	337.6	480	
600 min Summer	9.374	0.0	356.1	600	
720 min Summer	8.158	0.0	371.7	684	
960 min Summer	6.546	0.0	397.2	790	
1440 min Summer	4.790	0.0	433.4	1042	
2160 min Summer	3.498	0.0	480.1	1468	
2880 min Summer	2.794	0.0	511.4	1876	
4320 min Summer	2.032	0.0	557.6	2720	
5760 min Summer	1.619	0.0	593.2	3408	
7200 min Summer	1.358	0.0	621.6	4104	
8640 min Summer	1.177	0.0	646.3	4760	
10080 min Summer	1.042	0.0	667.6	5448	
15 min Winter	114.680	0.0	120.8	19	
30 min Winter	77.440	0.0	163.1	33	
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Joseph's Well Hanover Walk Leeds, LS3 1AB					
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File 2020-11-12 4937 DA2 100...		Checked by			
XP Solutions		Source Control 2020.1			
<u>Summary of Results for 100 year Return Period (+30%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.726	0.726	3.2	204.8	O K
120 min Winter	0.845	0.845	3.2	248.0	O K
180 min Winter	0.904	0.904	3.2	270.4	O K
240 min Winter	0.938	0.938	3.2	283.4	O K
360 min Winter	0.975	0.975	3.2	298.2	O K
480 min Winter	0.992	0.992	3.2	305.2	O K
600 min Winter	0.998	0.998	3.2	307.5	O K
720 min Winter	0.997	0.997	3.2	307.0	O K
960 min Winter	0.982	0.982	3.2	300.9	O K
1440 min Winter	0.943	0.943	3.2	285.5	O K
2160 min Winter	0.876	0.876	3.2	259.8	O K
2880 min Winter	0.804	0.804	3.2	232.7	O K
4320 min Winter	0.641	0.641	3.2	175.9	O K
5760 min Winter	0.442	0.442	3.2	113.5	O K
7200 min Winter	0.298	0.298	3.2	72.9	O K
8640 min Winter	0.203	0.203	3.1	48.1	O K
10080 min Winter	0.146	0.146	2.9	33.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	49.937	0.0	212.6	62	
120 min Winter	31.091	0.0	264.8	122	
180 min Winter	23.207	0.0	296.5	180	
240 min Winter	18.718	0.0	318.8	238	
360 min Winter	13.796	0.0	352.3	354	
480 min Winter	11.103	0.0	377.9	468	
600 min Winter	9.374	0.0	398.5	578	
720 min Winter	8.158	0.0	415.8	688	
960 min Winter	6.546	0.0	443.7	894	
1440 min Winter	4.790	0.0	474.7	1112	
2160 min Winter	3.498	0.0	537.8	1580	
2880 min Winter	2.794	0.0	572.7	2044	
4320 min Winter	2.032	0.0	624.6	2940	
5760 min Winter	1.619	0.0	664.4	3576	
7200 min Winter	1.358	0.0	696.3	4184	
8640 min Winter	1.177	0.0	723.9	4840	
10080 min Winter	1.042	0.0	747.9	5440	
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Joseph's Well Hanover Walk Leeds, LS3 1AB		
Date 12/11/2020 10:48 File 2020-11-12 4937 DA2 100...	Designed by MichaelDarby Checked by	
XP Solutions Source Control 2020.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.341	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.509

Time (mins)		Area
From:	To:	(ha)
0	4	0.509

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Weetwood		Page 4																																																																																															
Joseph's Well Hanover Walk Leeds, LS3 1AB																																																																																																	
Date 12/11/2020 10:48 File 2020-11-12 4937 DA2 100...	Designed by MichaelDarby Checked by																																																																																																
XP Solutions																																																																																																	
Source Control 2020.1																																																																																																	
Model Details Storage is Online Cover Level (m) 1.300 Tank or Pond Structure Invert Level (m) 0.000 <table><thead><tr><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th></tr></thead><tbody><tr><td>0.000</td><td>220.0</td><td>1.300</td><td>472.8</td></tr></tbody></table> Hydro-Brake® Optimum Outflow Control Unit Reference MD-SHE-0085-3200-1000-3200 Design Head (m) 1.000 Design Flow (l/s) 3.2 Flush-Flo™ Calculated Objective Minimise upstream storage Application Surface Sump Available Yes Diameter (mm) 85 Invert Level (m) 0.000 Minimum Outlet Pipe Diameter (mm) 100 Suggested Manhole Diameter (mm) 1200 Control Points <table><thead><tr><th></th><th>Head (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>Design Point (Calculated)</td><td>1.000</td><td>3.2</td></tr><tr><td>Flush-Flo™</td><td>0.296</td><td>3.2</td></tr><tr><td>Kick-Flo®</td><td>0.624</td><td>2.6</td></tr><tr><td>Mean Flow over Head Range</td><td>-</td><td>2.8</td></tr></tbody></table> 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 <table><thead><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>0.100</td><td>2.6</td><td>1.200</td><td>3.5</td><td>3.000</td><td>5.3</td><td>7.000</td><td>7.9</td></tr><tr><td>0.200</td><td>3.1</td><td>1.400</td><td>3.7</td><td>3.500</td><td>5.7</td><td>7.500</td><td>8.2</td></tr><tr><td>0.300</td><td>3.2</td><td>1.600</td><td>4.0</td><td>4.000</td><td>6.1</td><td>8.000</td><td>8.5</td></tr><tr><td>0.400</td><td>3.1</td><td>1.800</td><td>4.2</td><td>4.500</td><td>6.4</td><td>8.500</td><td>8.7</td></tr><tr><td>0.500</td><td>3.0</td><td>2.000</td><td>4.4</td><td>5.000</td><td>6.8</td><td>9.000</td><td>8.9</td></tr><tr><td>0.600</td><td>2.7</td><td>2.200</td><td>4.6</td><td>5.500</td><td>7.1</td><td>9.500</td><td>9.2</td></tr><tr><td>0.800</td><td>2.9</td><td>2.400</td><td>4.8</td><td>6.000</td><td>7.4</td><td></td><td></td></tr><tr><td>1.000</td><td>3.2</td><td>2.600</td><td>5.0</td><td>6.500</td><td>7.7</td><td></td><td></td></tr></tbody></table>			Depth (m)	Area (m²)	Depth (m)	Area (m²)	0.000	220.0	1.300	472.8		Head (m)	Flow (l/s)	Design Point (Calculated)	1.000	3.2	Flush-Flo™	0.296	3.2	Kick-Flo®	0.624	2.6	Mean Flow over Head Range	-	2.8	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	2.6	1.200	3.5	3.000	5.3	7.000	7.9	0.200	3.1	1.400	3.7	3.500	5.7	7.500	8.2	0.300	3.2	1.600	4.0	4.000	6.1	8.000	8.5	0.400	3.1	1.800	4.2	4.500	6.4	8.500	8.7	0.500	3.0	2.000	4.4	5.000	6.8	9.000	8.9	0.600	2.7	2.200	4.6	5.500	7.1	9.500	9.2	0.800	2.9	2.400	4.8	6.000	7.4			1.000	3.2	2.600	5.0	6.500	7.7		
Depth (m)	Area (m²)	Depth (m)	Area (m²)																																																																																														
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Weetwood				Page 1	
Joseph's Well Hanover Walk Leeds, LS3 1AB					
Date 12/11/2020 11:00		Designed by MichaelDarby			
File 2020-11-12 4937 DA3 100...		Checked by			
XP Solutions		Source Control 2020.1			
Summary of Results for 100 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.370	0.370	14.4	480.9	O K
30 min Summer	0.489	0.489	14.4	646.5	O K
60 min Summer	0.611	0.611	14.4	823.6	O K
120 min Summer	0.730	0.730	14.4	1001.5	O K
180 min Summer	0.791	0.791	14.4	1093.9	O K
240 min Summer	0.825	0.825	14.4	1147.0	O K
360 min Summer	0.863	0.863	14.4	1207.0	O K
480 min Summer	0.881	0.881	14.4	1234.3	O K
600 min Summer	0.886	0.886	14.4	1242.1	O K
720 min Summer	0.883	0.883	14.4	1238.6	O K
960 min Summer	0.875	0.875	14.4	1225.0	O K
1440 min Summer	0.848	0.848	14.4	1183.3	O K
2160 min Summer	0.799	0.799	14.4	1105.9	O K
2880 min Summer	0.744	0.744	14.4	1022.1	O K
4320 min Summer	0.620	0.620	14.4	836.2	O K
5760 min Summer	0.509	0.509	14.4	675.4	O K
7200 min Summer	0.415	0.415	14.4	542.9	O K
8640 min Summer	0.339	0.339	14.4	438.9	O K
10080 min Summer	0.281	0.281	14.4	360.3	O K
15 min Winter	0.413	0.413	14.4	540.0	O K
30 min Winter	0.544	0.544	14.4	726.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	114.680	0.0	465.6	25	
30 min Summer	77.440	0.0	632.8	39	
60 min Summer	49.937	0.0	846.4	68	
120 min Summer	31.091	0.0	1055.3	126	
180 min Summer	23.207	0.0	1181.7	186	
240 min Summer	18.718	0.0	1270.7	246	
360 min Summer	13.796	0.0	1404.0	364	
480 min Summer	11.103	0.0	1505.3	482	
600 min Summer	9.374	0.0	1586.7	600	
720 min Summer	8.158	0.0	1654.8	684	
960 min Summer	6.546	0.0	1763.9	794	
1440 min Summer	4.790	0.0	1908.5	1046	
2160 min Summer	3.498	0.0	2162.1	1468	
2880 min Summer	2.794	0.0	2301.9	1876	
4320 min Summer	2.032	0.0	2506.6	2644	
5760 min Summer	1.619	0.0	2678.6	3400	
7200 min Summer	1.358	0.0	2805.8	4104	
8640 min Summer	1.177	0.0	2915.1	4760	
10080 min Summer	1.042	0.0	3006.4	5448	
15 min Winter	114.680	0.0	523.2	25	
30 min Winter	77.440	0.0	709.1	39	
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Joseph's Well Hanover Walk Leeds, LS3 1AB					
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XP Solutions		Source Control 2020.1			
Summary of Results for 100 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.681	0.681	14.4	926.8	O K
120 min Winter	0.813	0.813	14.4	1128.2	O K
180 min Winter	0.881	0.881	14.4	1234.0	O K
240 min Winter	0.920	0.920	14.4	1296.7	O K
360 min Winter	0.966	0.966	14.4	1370.4	O K
480 min Winter	0.989	0.989	14.4	1407.8	O K
600 min Winter	0.999	0.999	14.5	1423.7	O K
720 min Winter	1.000	1.000	14.5	1426.2	O K
960 min Winter	0.988	0.988	14.4	1407.2	O K
1440 min Winter	0.953	0.953	14.4	1349.9	O K
2160 min Winter	0.885	0.885	14.4	1240.6	O K
2880 min Winter	0.806	0.806	14.4	1117.7	O K
4320 min Winter	0.619	0.619	14.4	834.8	O K
5760 min Winter	0.448	0.448	14.4	590.0	O K
7200 min Winter	0.317	0.317	14.4	409.1	O K
8640 min Winter	0.230	0.230	14.2	293.4	O K
10080 min Winter	0.183	0.183	13.7	231.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	49.937	0.0	948.8	68	
120 min Winter	31.091	0.0	1182.3	124	
180 min Winter	23.207	0.0	1323.6	182	
240 min Winter	18.718	0.0	1422.9	240	
360 min Winter	13.796	0.0	1571.4	356	
480 min Winter	11.103	0.0	1683.8	470	
600 min Winter	9.374	0.0	1773.6	582	
720 min Winter	8.158	0.0	1848.1	690	
960 min Winter	6.546	0.0	1964.7	894	
1440 min Winter	4.790	0.0	2090.7	1114	
2160 min Winter	3.498	0.0	2422.0	1580	
2880 min Winter	2.794	0.0	2578.3	2044	
4320 min Winter	2.032	0.0	2808.4	2860	
5760 min Winter	1.619	0.0	3000.7	3576	
7200 min Winter	1.358	0.0	3143.5	4192	
8640 min Winter	1.177	0.0	3266.5	4768	
10080 min Winter	1.042	0.0	3370.3	5256	
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Joseph's Well Hanover Walk Leeds, LS3 1AB		
Date 12/11/2020 11:00	Designed by MichaelDarby	
File 2020-11-12 4937 DA3 100...	Checked by	
XP Solutions		Source Control 2020.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.341	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 2.302

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To: (ha)		From: To: (ha)		From: To: (ha)	
0 4 1.000		4 8 1.000		8 12 0.302	

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Joseph's Well Hanover Walk Leeds, LS3 1AB		
Date 12/11/2020 11:00 File 2020-11-12 4937 DA3 100...	Designed by MichaelDarby Checked by	
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Model Details

Storage is Online Cover Level (m) 1.300

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1230.0	1.300	1762.7

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0172-1450-1000-1450
Design Head (m)	1.000
Design Flow (l/s)	14.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	172
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	14.5
Flush-Flo™	0.320	14.4
Kick-Flo®	0.699	12.2
Mean Flow over Head Range	-	12.3

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)
0.100	6.1	1.200	15.8	3.000	24.5	7.000	36.8
0.200	13.9	1.400	17.0	3.500	26.3	7.500	38.0
0.300	14.4	1.600	18.1	4.000	28.1	8.000	39.2
0.400	14.3	1.800	19.2	4.500	29.7	8.500	40.4
0.500	14.0	2.000	20.1	5.000	31.3	9.000	41.5
0.600	13.5	2.200	21.1	5.500	32.7	9.500	42.6
0.800	13.0	2.400	22.0	6.000	34.1		
1.000	14.5	2.600	22.8	6.500	35.5		

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Joseph's Well Hanover Walk Leeds, LS3 1AB					
Date 12/11/2020 11:10 File 2020-11-12 4937 DA4 100...		Designed by MichaelDarby Checked by			
XP Solutions		Source Control 2020.1			
Summary of Results for 100 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.387	0.387	7.8	260.2	O K
30 min Summer	0.506	0.506	7.8	349.2	O K
60 min Summer	0.628	0.628	7.8	444.3	O K
120 min Summer	0.745	0.745	7.8	539.1	O K
180 min Summer	0.802	0.802	7.8	587.4	O K
240 min Summer	0.834	0.834	7.8	615.0	O K
360 min Summer	0.869	0.869	7.8	645.3	O K
480 min Summer	0.884	0.884	7.8	658.1	O K
600 min Summer	0.887	0.887	7.8	660.7	O K
720 min Summer	0.883	0.883	7.8	657.4	O K
960 min Summer	0.872	0.872	7.8	647.7	O K
1440 min Summer	0.843	0.843	7.8	622.1	O K
2160 min Summer	0.792	0.792	7.8	578.8	O K
2880 min Summer	0.738	0.738	7.8	533.8	O K
4320 min Summer	0.616	0.616	7.8	434.1	O K
5760 min Summer	0.499	0.499	7.8	343.6	O K
7200 min Summer	0.402	0.402	7.8	270.9	O K
8640 min Summer	0.323	0.323	7.8	214.3	O K
10080 min Summer	0.262	0.262	7.8	171.8	O K
15 min Winter	0.430	0.430	7.8	292.1	O K
30 min Winter	0.563	0.563	7.8	392.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	114.680	0.0	257.7	21	
30 min Summer	77.440	0.0	349.1	36	
60 min Summer	49.937	0.0	460.3	64	
120 min Summer	31.091	0.0	573.5	124	
180 min Summer	23.207	0.0	642.2	184	
240 min Summer	18.718	0.0	690.6	242	
360 min Summer	13.796	0.0	763.1	362	
480 min Summer	11.103	0.0	818.5	482	
600 min Summer	9.374	0.0	863.1	600	
720 min Summer	8.158	0.0	900.6	684	
960 min Summer	6.546	0.0	961.1	792	
1440 min Summer	4.790	0.0	1043.8	1044	
2160 min Summer	3.498	0.0	1169.4	1468	
2880 min Summer	2.794	0.0	1245.2	1876	
4320 min Summer	2.032	0.0	1357.0	2680	
5760 min Summer	1.619	0.0	1446.5	3400	
7200 min Summer	1.358	0.0	1515.5	4104	
8640 min Summer	1.177	0.0	1575.1	4760	
10080 min Summer	1.042	0.0	1625.9	5448	
15 min Winter	114.680	0.0	289.1	21	
30 min Winter	77.440	0.0	390.9	36	
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Joseph's Well Hanover Walk Leeds, LS3 1AB					
Date 12/11/2020 11:10 File 2020-11-12 4937 DA4 100...		Designed by MichaelDarby Checked by			
XP Solutions		Source Control 2020.1			
<u>Summary of Results for 100 year Return Period (+30%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.698	0.698	7.8	500.3	O K
120 min Winter	0.826	0.826	7.8	607.5	O K
180 min Winter	0.890	0.890	7.8	663.4	O K
240 min Winter	0.927	0.927	7.8	696.2	O K
360 min Winter	0.970	0.970	7.8	734.3	O K
480 min Winter	0.990	0.990	7.8	753.0	O K
600 min Winter	0.998	0.998	7.8	760.3	O K
720 min Winter	0.998	0.998	7.8	760.4	O K
960 min Winter	0.985	0.985	7.8	748.1	O K
1440 min Winter	0.947	0.947	7.8	713.8	O K
2160 min Winter	0.878	0.878	7.8	652.6	O K
2880 min Winter	0.800	0.800	7.8	585.9	O K
4320 min Winter	0.616	0.616	7.8	434.2	O K
5760 min Winter	0.436	0.436	7.8	296.5	O K
7200 min Winter	0.300	0.300	7.8	198.2	O K
8640 min Winter	0.211	0.211	7.6	136.5	O K
10080 min Winter	0.158	0.158	7.3	101.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	49.937	0.0	515.8	64	
120 min Winter	31.091	0.0	642.5	122	
180 min Winter	23.207	0.0	719.2	180	
240 min Winter	18.718	0.0	773.3	238	
360 min Winter	13.796	0.0	854.2	354	
480 min Winter	11.103	0.0	915.8	468	
600 min Winter	9.374	0.0	965.2	580	
720 min Winter	8.158	0.0	1006.4	688	
960 min Winter	6.546	0.0	1071.7	894	
1440 min Winter	4.790	0.0	1142.9	1112	
2160 min Winter	3.498	0.0	1309.8	1580	
2880 min Winter	2.794	0.0	1394.7	2044	
4320 min Winter	2.032	0.0	1520.2	2896	
5760 min Winter	1.619	0.0	1620.3	3576	
7200 min Winter	1.358	0.0	1697.7	4184	
8640 min Winter	1.177	0.0	1764.6	4832	
10080 min Winter	1.042	0.0	1822.0	5352	
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Weetwood		Page 3
Joseph's Well Hanover Walk Leeds, LS3 1AB		
Date 12/11/2020 11:10 File 2020-11-12 4937 DA4 100...	Designed by MichaelDarby Checked by	
XP Solutions Source Control 2020.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.341	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.242

Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)
0 4	1.000	4 8	0.242

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Joseph's Well Hanover Walk Leeds, LS3 1AB																																																																																																	
Date 12/11/2020 11:10 File 2020-11-12 4937 DA4 100...	Designed by MichaelDarby Checked by																																																																																																
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Model Details Storage is Online Cover Level (m) 1.300 Tank or Pond Structure Invert Level (m) 0.000 <table><thead><tr><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th></tr></thead><tbody><tr><td>0.000</td><td>620.0</td><td>1.300</td><td>1012.0</td></tr></tbody></table> Hydro-Brake® Optimum Outflow Control Unit Reference MD-SHE-0130-7800-1000-7800 Design Head (m) 1.000 Design Flow (l/s) 7.8 Flush-Flo™ Calculated Objective Minimise upstream storage Application Surface Sump Available Yes Diameter (mm) 130 Invert Level (m) 0.000 Minimum Outlet Pipe Diameter (mm) 150 Suggested Manhole Diameter (mm) 1200 Control Points <table><thead><tr><th></th><th>Head (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>Design Point (Calculated)</td><td>1.000</td><td>7.8</td></tr><tr><td>Flush-Flo™</td><td>0.302</td><td>7.8</td></tr><tr><td>Kick-Flo®</td><td>0.664</td><td>6.4</td></tr><tr><td>Mean Flow over Head Range</td><td>-</td><td>6.7</td></tr></tbody></table> 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 <table><thead><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>0.100</td><td>4.7</td><td>1.200</td><td>8.5</td><td>3.000</td><td>13.1</td><td>7.000</td><td>19.6</td></tr><tr><td>0.200</td><td>7.6</td><td>1.400</td><td>9.1</td><td>3.500</td><td>14.1</td><td>7.500</td><td>20.3</td></tr><tr><td>0.300</td><td>7.8</td><td>1.600</td><td>9.7</td><td>4.000</td><td>15.0</td><td>8.000</td><td>20.9</td></tr><tr><td>0.400</td><td>7.7</td><td>1.800</td><td>10.3</td><td>4.500</td><td>15.9</td><td>8.500</td><td>21.6</td></tr><tr><td>0.500</td><td>7.5</td><td>2.000</td><td>10.8</td><td>5.000</td><td>16.7</td><td>9.000</td><td>22.2</td></tr><tr><td>0.600</td><td>7.1</td><td>2.200</td><td>11.3</td><td>5.500</td><td>17.5</td><td>9.500</td><td>22.7</td></tr><tr><td>0.800</td><td>7.0</td><td>2.400</td><td>11.8</td><td>6.000</td><td>18.2</td><td></td><td></td></tr><tr><td>1.000</td><td>7.8</td><td>2.600</td><td>12.2</td><td>6.500</td><td>18.9</td><td></td><td></td></tr></tbody></table>			Depth (m)	Area (m²)	Depth (m)	Area (m²)	0.000	620.0	1.300	1012.0		Head (m)	Flow (l/s)	Design Point (Calculated)	1.000	7.8	Flush-Flo™	0.302	7.8	Kick-Flo®	0.664	6.4	Mean Flow over Head Range	-	6.7	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	4.7	1.200	8.5	3.000	13.1	7.000	19.6	0.200	7.6	1.400	9.1	3.500	14.1	7.500	20.3	0.300	7.8	1.600	9.7	4.000	15.0	8.000	20.9	0.400	7.7	1.800	10.3	4.500	15.9	8.500	21.6	0.500	7.5	2.000	10.8	5.000	16.7	9.000	22.2	0.600	7.1	2.200	11.3	5.500	17.5	9.500	22.7	0.800	7.0	2.400	11.8	6.000	18.2			1.000	7.8	2.600	12.2	6.500	18.9		
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XP Solutions			Designed by MichaelDarby Checked by			
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<u>Summary of Results for 100 year Return Period (+30%)</u>						
	Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
	15 min Summer	0.404	0.404	5.1	168.9	O K
	30 min Summer	0.524	0.524	5.1	226.2	O K
	60 min Summer	0.645	0.645	5.1	287.4	O K
	120 min Summer	0.758	0.758	5.1	347.5	O K
	180 min Summer	0.813	0.813	5.1	378.1	O K
	240 min Summer	0.844	0.844	5.1	395.3	O K
	360 min Summer	0.876	0.876	5.1	413.6	O K
	480 min Summer	0.888	0.888	5.1	420.9	O K
	600 min Summer	0.889	0.889	5.1	421.6	O K
	720 min Summer	0.885	0.885	5.1	418.8	O K
	960 min Summer	0.872	0.872	5.1	411.5	O K
	1440 min Summer	0.841	0.841	5.1	393.7	O K
	2160 min Summer	0.790	0.790	5.1	365.2	O K
	2880 min Summer	0.737	0.737	5.1	336.2	O K
	4320 min Summer	0.618	0.618	5.1	273.4	O K
	5760 min Summer	0.495	0.495	5.1	212.1	O K
	7200 min Summer	0.395	0.395	5.1	164.6	O K
	8640 min Summer	0.314	0.314	5.1	128.2	O K
	10080 min Summer	0.252	0.252	5.1	101.2	O K
	15 min Winter	0.448	0.448	5.1	189.5	O K
	30 min Winter	0.580	0.580	5.1	254.2	O K
	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
	15 min Summer	114.680	0.0	168.7	19	
	30 min Summer	77.440	0.0	228.2	34	
	60 min Summer	49.937	0.0	298.7	64	
	120 min Summer	31.091	0.0	372.1	122	
	180 min Summer	23.207	0.0	416.7	182	
	240 min Summer	18.718	0.0	448.1	242	
	360 min Summer	13.796	0.0	495.2	362	
	480 min Summer	11.103	0.0	531.2	480	
	600 min Summer	9.374	0.0	560.3	600	
	720 min Summer	8.158	0.0	584.8	672	
	960 min Summer	6.546	0.0	624.7	788	
	1440 min Summer	4.790	0.0	680.6	1040	
	2160 min Summer	3.498	0.0	756.9	1452	
	2880 min Summer	2.794	0.0	806.1	1876	
	4320 min Summer	2.032	0.0	878.8	2680	
	5760 min Summer	1.619	0.0	935.6	3400	
	7200 min Summer	1.358	0.0	980.3	4104	
	8640 min Summer	1.177	0.0	1019.1	4760	
	10080 min Summer	1.042	0.0	1052.4	5448	
	15 min Winter	114.680	0.0	189.1	19	
	30 min Winter	77.440	0.0	255.5	33	
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Summary of Results for 100 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.713	0.713	5.1	323.3	O K
120 min Winter	0.837	0.837	5.1	391.8	O K
180 min Winter	0.899	0.899	5.1	427.4	O K
240 min Winter	0.934	0.934	5.1	448.0	O K
360 min Winter	0.974	0.974	5.1	471.6	O K
480 min Winter	0.992	0.992	5.1	482.8	O K
600 min Winter	0.999	0.999	5.1	486.7	O K
720 min Winter	0.998	0.998	5.1	486.0	O K
960 min Winter	0.982	0.982	5.1	476.8	O K
1440 min Winter	0.943	0.943	5.1	453.3	O K
2160 min Winter	0.874	0.874	5.1	412.6	O K
2880 min Winter	0.797	0.797	5.1	369.2	O K
4320 min Winter	0.617	0.617	5.1	273.0	O K
5760 min Winter	0.428	0.428	5.1	180.2	O K
7200 min Winter	0.289	0.289	5.1	117.4	O K
8640 min Winter	0.199	0.199	5.0	78.8	O K
10080 min Winter	0.146	0.146	4.7	56.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	49.937	0.0	334.7	62	
120 min Winter	31.091	0.0	416.8	122	
180 min Winter	23.207	0.0	466.6	180	
240 min Winter	18.718	0.0	501.7	238	
360 min Winter	13.796	0.0	554.4	354	
480 min Winter	11.103	0.0	594.5	468	
600 min Winter	9.374	0.0	626.9	578	
720 min Winter	8.158	0.0	654.0	686	
960 min Winter	6.546	0.0	697.4	892	
1440 min Winter	4.790	0.0	748.4	1110	
2160 min Winter	3.498	0.0	847.8	1576	
2880 min Winter	2.794	0.0	902.8	2044	
4320 min Winter	2.032	0.0	984.4	2900	
5760 min Winter	1.619	0.0	1048.0	3576	
7200 min Winter	1.358	0.0	1098.1	4184	
8640 min Winter	1.177	0.0	1141.6	4760	
10080 min Winter	1.042	0.0	1179.1	5352	
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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.341	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.803

Time (mins)	Area
From:	To: (ha)
0	4 0.803

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Model Details

Storage is Online Cover Level (m) 1.300

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	375.0	1.300	690.5

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0107-5100-1000-5100
Design Head (m)	1.000
Design Flow (l/s)	5.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	107
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.1
Flush-Flo™	0.297	5.1
Kick-Flo®	0.640	4.2
Mean Flow over Head Range	-	4.4

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)
0.100	3.6	1.200	5.6	3.000	8.5	7.000	12.8
0.200	5.0	1.400	6.0	3.500	9.2	7.500	13.2
0.300	5.1	1.600	6.3	4.000	9.8	8.000	13.6
0.400	5.0	1.800	6.7	4.500	10.3	8.500	14.0
0.500	4.9	2.000	7.0	5.000	10.9	9.000	14.4
0.600	4.5	2.200	7.4	5.500	11.4	9.500	14.8
0.800	4.6	2.400	7.7	6.000	11.9		
1.000	5.1	2.600	8.0	6.500	12.3		

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<u>Summary of Results for 100 year Return Period (+30%)</u> Half Drain Time : 829 minutes. <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (1/s)</th><th>Max Control (1/s)</th><th>Max Outflow (1/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Summer</td><td>0.415</td><td>0.415</td><td>0.0</td><td>4.7</td><td>4.7</td><td>155.7</td><td>O K</td></tr><tr><td>30 min Summer</td><td>0.555</td><td>0.555</td><td>0.0</td><td>4.7</td><td>4.7</td><td>208.4</td><td>O K</td></tr><tr><td>60 min Summer</td><td>0.706</td><td>0.706</td><td>0.0</td><td>4.7</td><td>4.7</td><td>264.8</td><td>O K</td></tr><tr><td>120 min Summer</td><td>0.855</td><td>0.855</td><td>0.0</td><td>4.7</td><td>4.7</td><td>320.9</td><td>O K</td></tr><tr><td>180 min Summer</td><td>0.931</td><td>0.931</td><td>0.0</td><td>4.7</td><td>4.7</td><td>349.4</td><td>O K</td></tr><tr><td>240 min Summer</td><td>0.974</td><td>0.974</td><td>0.0</td><td>4.7</td><td>4.7</td><td>365.5</td><td>O K</td></tr><tr><td>360 min Summer</td><td>1.021</td><td>1.021</td><td>0.0</td><td>4.7</td><td>4.7</td><td>383.0</td><td>O K</td></tr><tr><td>480 min Summer</td><td>1.040</td><td>1.040</td><td>0.0</td><td>4.7</td><td>4.7</td><td>390.2</td><td>O K</td></tr><tr><td>600 min Summer</td><td>1.043</td><td>1.043</td><td>0.0</td><td>4.7</td><td>4.7</td><td>391.3</td><td>O K</td></tr><tr><td>720 min Summer</td><td>1.037</td><td>1.037</td><td>0.0</td><td>4.7</td><td>4.7</td><td>389.0</td><td>O K</td></tr><tr><td>960 min Summer</td><td>1.020</td><td>1.020</td><td>0.0</td><td>4.7</td><td>4.7</td><td>382.8</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>0.978</td><td>0.978</td><td>0.0</td><td>4.7</td><td>4.7</td><td>366.9</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>0.909</td><td>0.909</td><td>0.0</td><td>4.7</td><td>4.7</td><td>340.9</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>0.837</td><td>0.837</td><td>0.0</td><td>4.7</td><td>4.7</td><td>314.1</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>0.674</td><td>0.674</td><td>0.0</td><td>4.7</td><td>4.7</td><td>252.8</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>0.530</td><td>0.530</td><td>0.0</td><td>4.7</td><td>4.7</td><td>198.8</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>0.417</td><td>0.417</td><td>0.0</td><td>4.7</td><td>4.7</td><td>156.6</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>0.332</td><td>0.332</td><td>0.0</td><td>4.7</td><td>4.7</td><td>124.6</td><td>O K</td></tr><tr><td>10080 min Summer</td><td>0.268</td><td>0.268</td><td>0.0</td><td>4.6</td><td>4.6</td><td>100.5</td><td>O K</td></tr><tr><td>15 min Winter</td><td>0.466</td><td>0.466</td><td>0.0</td><td>4.7</td><td>4.7</td><td>174.7</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>114.680</td><td>0.0</td><td>155.0</td><td>19</td></tr><tr><td>30 min Summer</td><td>77.440</td><td>0.0</td><td>209.8</td><td>34</td></tr><tr><td>60 min Summer</td><td>49.937</td><td>0.0</td><td>275.1</td><td>64</td></tr><tr><td>120 min Summer</td><td>31.091</td><td>0.0</td><td>342.7</td><td>122</td></tr><tr><td>180 min Summer</td><td>23.207</td><td>0.0</td><td>383.7</td><td>182</td></tr><tr><td>240 min Summer</td><td>18.718</td><td>0.0</td><td>412.6</td><td>242</td></tr><tr><td>360 min Summer</td><td>13.796</td><td>0.0</td><td>456.0</td><td>362</td></tr><tr><td>480 min Summer</td><td>11.103</td><td>0.0</td><td>489.1</td><td>480</td></tr><tr><td>600 min Summer</td><td>9.374</td><td>0.0</td><td>515.9</td><td>600</td></tr><tr><td>720 min Summer</td><td>8.158</td><td>0.0</td><td>538.4</td><td>684</td></tr><tr><td>960 min Summer</td><td>6.546</td><td>0.0</td><td>574.9</td><td>790</td></tr><tr><td>1440 min Summer</td><td>4.790</td><td>0.0</td><td>625.5</td><td>1050</td></tr><tr><td>2160 min Summer</td><td>3.498</td><td>0.0</td><td>697.3</td><td>1468</td></tr><tr><td>2880 min Summer</td><td>2.794</td><td>0.0</td><td>742.6</td><td>1876</td></tr><tr><td>4320 min Summer</td><td>2.032</td><td>0.0</td><td>809.6</td><td>2680</td></tr><tr><td>5760 min Summer</td><td>1.619</td><td>0.0</td><td>862.1</td><td>3400</td></tr><tr><td>7200 min Summer</td><td>1.358</td><td>0.0</td><td>903.3</td><td>4104</td></tr><tr><td>8640 min Summer</td><td>1.177</td><td>0.0</td><td>939.0</td><td>4760</td></tr><tr><td>10080 min Summer</td><td>1.042</td><td>0.0</td><td>969.6</td><td>5448</td></tr><tr><td>15 min Winter</td><td>114.680</td><td>0.0</td><td>173.8</td><td>19</td></tr></table>								Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Outflow (1/s)	Max Volume (m³)	Status	15 min Summer	0.415	0.415	0.0	4.7	4.7	155.7	O K	30 min Summer	0.555	0.555	0.0	4.7	4.7	208.4	O K	60 min Summer	0.706	0.706	0.0	4.7	4.7	264.8	O K	120 min Summer	0.855	0.855	0.0	4.7	4.7	320.9	O K	180 min Summer	0.931	0.931	0.0	4.7	4.7	349.4	O K	240 min Summer	0.974	0.974	0.0	4.7	4.7	365.5	O K	360 min Summer	1.021	1.021	0.0	4.7	4.7	383.0	O K	480 min Summer	1.040	1.040	0.0	4.7	4.7	390.2	O K	600 min Summer	1.043	1.043	0.0	4.7	4.7	391.3	O K	720 min Summer	1.037	1.037	0.0	4.7	4.7	389.0	O K	960 min Summer	1.020	1.020	0.0	4.7	4.7	382.8	O K	1440 min Summer	0.978	0.978	0.0	4.7	4.7	366.9	O K	2160 min Summer	0.909	0.909	0.0	4.7	4.7	340.9	O K	2880 min Summer	0.837	0.837	0.0	4.7	4.7	314.1	O K	4320 min Summer	0.674	0.674	0.0	4.7	4.7	252.8	O K	5760 min Summer	0.530	0.530	0.0	4.7	4.7	198.8	O K	7200 min Summer	0.417	0.417	0.0	4.7	4.7	156.6	O K	8640 min Summer	0.332	0.332	0.0	4.7	4.7	124.6	O K	10080 min Summer	0.268	0.268	0.0	4.6	4.6	100.5	O K	15 min Winter	0.466	0.466	0.0	4.7	4.7	174.7	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	15 min Summer	114.680	0.0	155.0	19	30 min Summer	77.440	0.0	209.8	34	60 min Summer	49.937	0.0	275.1	64	120 min Summer	31.091	0.0	342.7	122	180 min Summer	23.207	0.0	383.7	182	240 min Summer	18.718	0.0	412.6	242	360 min Summer	13.796	0.0	456.0	362	480 min Summer	11.103	0.0	489.1	480	600 min Summer	9.374	0.0	515.9	600	720 min Summer	8.158	0.0	538.4	684	960 min Summer	6.546	0.0	574.9	790	1440 min Summer	4.790	0.0	625.5	1050	2160 min Summer	3.498	0.0	697.3	1468	2880 min Summer	2.794	0.0	742.6	1876	4320 min Summer	2.032	0.0	809.6	2680	5760 min Summer	1.619	0.0	862.1	3400	7200 min Summer	1.358	0.0	903.3	4104	8640 min Summer	1.177	0.0	939.0	4760	10080 min Summer	1.042	0.0	969.6	5448	15 min Winter	114.680	0.0	173.8	19
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Outflow (1/s)	Max Volume (m³)	Status																																																																																																																																																																																																																																																																																	
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180 min Summer	0.931	0.931	0.0	4.7	4.7	349.4	O K																																																																																																																																																																																																																																																																																	
240 min Summer	0.974	0.974	0.0	4.7	4.7	365.5	O K																																																																																																																																																																																																																																																																																	
360 min Summer	1.021	1.021	0.0	4.7	4.7	383.0	O K																																																																																																																																																																																																																																																																																	
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960 min Summer	1.020	1.020	0.0	4.7	4.7	382.8	O K																																																																																																																																																																																																																																																																																	
1440 min Summer	0.978	0.978	0.0	4.7	4.7	366.9	O K																																																																																																																																																																																																																																																																																	
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600 min Summer	9.374	0.0	515.9	600																																																																																																																																																																																																																																																																																				
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Micro Drainage

Joseph's Well
Hanover Walk
Leeds, LS3 1AB

Date 12/11/2020 12:05
File 2020-11-12 4937 DA6 100...

XP Solutions

Designed by MichaelDarby
Checked by

Source Control 2020.1

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	0.624	0.624	0.0	4.7	4.7	234.2	O K
60 min Winter	0.795	0.795	0.0	4.7	4.7	298.2	O K
120 min Winter	0.964	0.964	0.0	4.7	4.7	361.6	O K
180 min Winter	1.052	1.052	0.0	4.7	4.7	394.6	O K
240 min Winter	1.103	1.103	0.0	4.7	4.7	413.8	O K
360 min Winter	1.162	1.162	0.0	4.7	4.7	435.9	O K
480 min Winter	1.190	1.190	0.0	4.7	4.7	446.5	O K
600 min Winter	1.200	1.200	0.0	4.7	4.7	450.4	O K
720 min Winter	1.199	1.199	0.0	4.7	4.7	450.1	O K
960 min Winter	1.178	1.178	0.0	4.7	4.7	442.1	O K
1440 min Winter	1.123	1.123	0.0	4.7	4.7	421.4	O K
2160 min Winter	1.025	1.025	0.0	4.7	4.7	384.8	O K
2880 min Winter	0.920	0.920	0.0	4.7	4.7	345.3	O K
4320 min Winter	0.672	0.672	0.0	4.7	4.7	252.1	O K
5760 min Winter	0.456	0.456	0.0	4.7	4.7	171.2	O K
7200 min Winter	0.310	0.310	0.0	4.7	4.7	116.3	O K
8640 min Winter	0.218	0.218	0.0	4.5	4.5	81.8	O K
10080 min Winter	0.162	0.162	0.0	4.2	4.2	60.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	77.440	0.0	234.9	33
60 min Winter	49.937	0.0	308.2	62
120 min Winter	31.091	0.0	383.8	122
180 min Winter	23.207	0.0	429.7	180
240 min Winter	18.718	0.0	462.0	238
360 min Winter	13.796	0.0	510.5	354
480 min Winter	11.103	0.0	547.4	468
600 min Winter	9.374	0.0	577.1	578
720 min Winter	8.158	0.0	602.0	686
960 min Winter	6.546	0.0	641.6	892
1440 min Winter	4.790	0.0	685.6	1110
2160 min Winter	3.498	0.0	781.1	1580
2880 min Winter	2.794	0.0	831.8	2044
4320 min Winter	2.032	0.0	906.9	2892
5760 min Winter	1.619	0.0	965.7	3568
7200 min Winter	1.358	0.0	1011.8	4184
8640 min Winter	1.177	0.0	1051.9	4840
10080 min Winter	1.042	0.0	1086.4	5448

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Joseph's Well Hanover Walk Leeds, LS3 1AB		
Date 12/11/2020 12:05 File 2020-11-12 4937 DA6 100...	Designed by MichaelDarby Checked by	
XP Solutions Source Control 2020.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.341	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.740

Time (mins)		Area
From:	To:	(ha)
0	4	0.740

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Weetwood		Page 4
Joseph's Well Hanover Walk Leeds, LS3 1AB		
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Model Details

Storage is Online Cover Level (m) 1.950

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	395.0	0.0	1.201	1.0	0.0
1.200	395.0	0.0	1.950	1.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0099-4700-1200-4700
Design Head (m) 1.200
Design Flow (l/s) 4.7
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 99
Invert Level (m) 0.000
Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	4.7
Flush-Flo™	0.356	4.7
Kick-Flo®	0.746	3.8
Mean Flow over Head Range	-	4.1

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)
0.100	3.3	1.200	4.7	3.000	7.2	7.000	10.8
0.200	4.4	1.400	5.0	3.500	7.7	7.500	11.1
0.300	4.7	1.600	5.4	4.000	8.3	8.000	11.5
0.400	4.7	1.800	5.7	4.500	8.7	8.500	11.8
0.500	4.6	2.000	6.0	5.000	9.2	9.000	12.1
0.600	4.4	2.200	6.2	5.500	9.6	9.500	12.4
0.800	3.9	2.400	6.5	6.000	10.0		
1.000	4.3	2.600	6.7	6.500	10.4		

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Weetwood		Page 1																																																																																																																																																																																																																																																																																		
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Summary of Results for 100 year Return Period (+30%) Half Drain Time : 829 minutes. <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Control (l/s)</th><th>Max Outflow (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Summer</td><td>0.267</td><td>0.267</td><td>0.0</td><td>2.8</td><td>2.8</td><td>92.7</td><td>O K</td></tr><tr><td>30 min Summer</td><td>0.358</td><td>0.358</td><td>0.0</td><td>2.8</td><td>2.8</td><td>124.1</td><td>O K</td></tr><tr><td>60 min Summer</td><td>0.454</td><td>0.454</td><td>0.0</td><td>2.8</td><td>2.8</td><td>157.5</td><td>O K</td></tr><tr><td>120 min Summer</td><td>0.550</td><td>0.550</td><td>0.0</td><td>2.8</td><td>2.8</td><td>190.7</td><td>O K</td></tr><tr><td>180 min Summer</td><td>0.601</td><td>0.601</td><td>0.0</td><td>2.8</td><td>2.8</td><td>208.3</td><td>O K</td></tr><tr><td>240 min Summer</td><td>0.631</td><td>0.631</td><td>0.0</td><td>2.8</td><td>2.8</td><td>218.8</td><td>O K</td></tr><tr><td>360 min Summer</td><td>0.666</td><td>0.666</td><td>0.0</td><td>2.8</td><td>2.8</td><td>230.9</td><td>O K</td></tr><tr><td>480 min Summer</td><td>0.682</td><td>0.682</td><td>0.0</td><td>2.8</td><td>2.8</td><td>236.6</td><td>O K</td></tr><tr><td>600 min Summer</td><td>0.688</td><td>0.688</td><td>0.0</td><td>2.8</td><td>2.8</td><td>238.5</td><td>O K</td></tr><tr><td>720 min Summer</td><td>0.686</td><td>0.686</td><td>0.0</td><td>2.8</td><td>2.8</td><td>238.0</td><td>O K</td></tr><tr><td>960 min Summer</td><td>0.676</td><td>0.676</td><td>0.0</td><td>2.8</td><td>2.8</td><td>234.4</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>0.648</td><td>0.648</td><td>0.0</td><td>2.8</td><td>2.8</td><td>224.8</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>0.595</td><td>0.595</td><td>0.0</td><td>2.8</td><td>2.8</td><td>206.4</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>0.541</td><td>0.541</td><td>0.0</td><td>2.8</td><td>2.8</td><td>187.5</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>0.443</td><td>0.443</td><td>0.0</td><td>2.8</td><td>2.8</td><td>153.6</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>0.359</td><td>0.359</td><td>0.0</td><td>2.8</td><td>2.8</td><td>124.5</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>0.291</td><td>0.291</td><td>0.0</td><td>2.8</td><td>2.8</td><td>100.9</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>0.238</td><td>0.238</td><td>0.0</td><td>2.8</td><td>2.8</td><td>82.7</td><td>O K</td></tr><tr><td>10080 min Summer</td><td>0.198</td><td>0.198</td><td>0.0</td><td>2.7</td><td>2.7</td><td>68.6</td><td>O K</td></tr><tr><td>15 min Winter</td><td>0.300</td><td>0.300</td><td>0.0</td><td>2.8</td><td>2.8</td><td>104.0</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>114.680</td><td>0.0</td><td>90.8</td><td>19</td></tr><tr><td>30 min Summer</td><td>77.440</td><td>0.0</td><td>123.1</td><td>34</td></tr><tr><td>60 min Summer</td><td>49.937</td><td>0.0</td><td>162.9</td><td>64</td></tr><tr><td>120 min Summer</td><td>31.091</td><td>0.0</td><td>203.0</td><td>122</td></tr><tr><td>180 min Summer</td><td>23.207</td><td>0.0</td><td>227.3</td><td>182</td></tr><tr><td>240 min Summer</td><td>18.718</td><td>0.0</td><td>244.4</td><td>242</td></tr><tr><td>360 min Summer</td><td>13.796</td><td>0.0</td><td>270.0</td><td>362</td></tr><tr><td>480 min Summer</td><td>11.103</td><td>0.0</td><td>289.5</td><td>482</td></tr><tr><td>600 min Summer</td><td>9.374</td><td>0.0</td><td>305.2</td><td>600</td></tr><tr><td>720 min Summer</td><td>8.158</td><td>0.0</td><td>318.4</td><td>720</td></tr><tr><td>960 min Summer</td><td>6.546</td><td>0.0</td><td>339.6</td><td>830</td></tr><tr><td>1440 min Summer</td><td>4.790</td><td>0.0</td><td>367.9</td><td>1084</td></tr><tr><td>2160 min Summer</td><td>3.498</td><td>0.0</td><td>414.1</td><td>1472</td></tr><tr><td>2880 min Summer</td><td>2.794</td><td>0.0</td><td>441.0</td><td>1848</td></tr><tr><td>4320 min Summer</td><td>2.032</td><td>0.0</td><td>480.5</td><td>2636</td></tr><tr><td>5760 min Summer</td><td>1.619</td><td>0.0</td><td>512.4</td><td>3392</td></tr><tr><td>7200 min Summer</td><td>1.358</td><td>0.0</td><td>536.8</td><td>4104</td></tr><tr><td>8640 min Summer</td><td>1.177</td><td>0.0</td><td>557.9</td><td>4760</td></tr><tr><td>10080 min Summer</td><td>1.042</td><td>0.0</td><td>575.8</td><td>5448</td></tr><tr><td>15 min Winter</td><td>114.680</td><td>0.0</td><td>101.9</td><td>19</td></tr></table>				Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status	15 min Summer	0.267	0.267	0.0	2.8	2.8	92.7	O K	30 min Summer	0.358	0.358	0.0	2.8	2.8	124.1	O K	60 min Summer	0.454	0.454	0.0	2.8	2.8	157.5	O K	120 min Summer	0.550	0.550	0.0	2.8	2.8	190.7	O K	180 min Summer	0.601	0.601	0.0	2.8	2.8	208.3	O K	240 min Summer	0.631	0.631	0.0	2.8	2.8	218.8	O K	360 min Summer	0.666	0.666	0.0	2.8	2.8	230.9	O K	480 min Summer	0.682	0.682	0.0	2.8	2.8	236.6	O K	600 min Summer	0.688	0.688	0.0	2.8	2.8	238.5	O K	720 min Summer	0.686	0.686	0.0	2.8	2.8	238.0	O K	960 min Summer	0.676	0.676	0.0	2.8	2.8	234.4	O K	1440 min Summer	0.648	0.648	0.0	2.8	2.8	224.8	O K	2160 min Summer	0.595	0.595	0.0	2.8	2.8	206.4	O K	2880 min Summer	0.541	0.541	0.0	2.8	2.8	187.5	O K	4320 min Summer	0.443	0.443	0.0	2.8	2.8	153.6	O K	5760 min Summer	0.359	0.359	0.0	2.8	2.8	124.5	O K	7200 min Summer	0.291	0.291	0.0	2.8	2.8	100.9	O K	8640 min Summer	0.238	0.238	0.0	2.8	2.8	82.7	O K	10080 min Summer	0.198	0.198	0.0	2.7	2.7	68.6	O K	15 min Winter	0.300	0.300	0.0	2.8	2.8	104.0	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	15 min Summer	114.680	0.0	90.8	19	30 min Summer	77.440	0.0	123.1	34	60 min Summer	49.937	0.0	162.9	64	120 min Summer	31.091	0.0	203.0	122	180 min Summer	23.207	0.0	227.3	182	240 min Summer	18.718	0.0	244.4	242	360 min Summer	13.796	0.0	270.0	362	480 min Summer	11.103	0.0	289.5	482	600 min Summer	9.374	0.0	305.2	600	720 min Summer	8.158	0.0	318.4	720	960 min Summer	6.546	0.0	339.6	830	1440 min Summer	4.790	0.0	367.9	1084	2160 min Summer	3.498	0.0	414.1	1472	2880 min Summer	2.794	0.0	441.0	1848	4320 min Summer	2.032	0.0	480.5	2636	5760 min Summer	1.619	0.0	512.4	3392	7200 min Summer	1.358	0.0	536.8	4104	8640 min Summer	1.177	0.0	557.9	4760	10080 min Summer	1.042	0.0	575.8	5448	15 min Winter	114.680	0.0	101.9	19
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Date 12/11/2020 12:11 File 2020-11-12 4937 DA7 100...	Designed by MichaelDarby Checked by	
XP Solutions Source Control 2020.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.341	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.440

Time (mins)		Area
From:	To:	(ha)
0	4	0.440

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Date 12/11/2020 12:11 File 2020-11-12 4937 DA7 100...	Designed by MichaelDarby Checked by	
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Model Details

Storage is Online Cover Level (m) 1.550

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	365.0	0.0	0.801	1.0	0.0
0.800	365.0	0.0	1.550	1.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0080-2800-1000-2800
Design Head (m) 1.000
Design Flow (l/s) 2.8
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 80
Invert Level (m) 0.000
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.8
Flush-Flo™	0.299	2.8
Kick-Flo®	0.623	2.3
Mean Flow over Head Range	-	2.5

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)
0.100	2.3	1.200	3.0	3.000	4.7	7.000	6.9
0.200	2.7	1.400	3.3	3.500	5.0	7.500	7.2
0.300	2.8	1.600	3.5	4.000	5.3	8.000	7.4
0.400	2.8	1.800	3.7	4.500	5.6	8.500	7.6
0.500	2.6	2.000	3.9	5.000	5.9	9.000	7.8
0.600	2.4	2.200	4.0	5.500	6.2	9.500	8.0
0.800	2.5	2.400	4.2	6.000	6.4		
1.000	2.8	2.600	4.4	6.500	6.7		

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Weetwood				Page 1	
Joseph's Well Hanover Walk Leeds, LS3 1AB					
Date 12/11/2020 11:24		Designed by MichaelDarby			
File 2020-11-12 4937 DA8 100...		Checked by			
XP Solutions		Source Control 2020.1			
Summary of Results for 100 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.378	0.378	10.6	354.2	O K
30 min Summer	0.497	0.497	10.6	475.3	O K
60 min Summer	0.619	0.619	10.6	604.6	O K
120 min Summer	0.737	0.737	10.6	734.4	O K
180 min Summer	0.796	0.796	10.6	801.0	O K
240 min Summer	0.829	0.829	10.6	839.3	O K
360 min Summer	0.866	0.866	10.6	882.0	O K
480 min Summer	0.882	0.882	10.6	900.9	O K
600 min Summer	0.886	0.886	10.6	905.6	O K
720 min Summer	0.883	0.883	10.6	902.1	O K
960 min Summer	0.873	0.873	10.6	890.5	O K
1440 min Summer	0.845	0.845	10.6	857.6	O K
2160 min Summer	0.795	0.795	10.6	799.7	O K
2880 min Summer	0.741	0.741	10.6	738.3	O K
4320 min Summer	0.617	0.617	10.6	601.8	O K
5760 min Summer	0.504	0.504	10.6	481.8	O K
7200 min Summer	0.408	0.408	10.6	383.8	O K
8640 min Summer	0.331	0.331	10.6	306.8	O K
10080 min Summer	0.271	0.271	10.5	248.9	O K
15 min Winter	0.422	0.422	10.6	397.6	O K
30 min Winter	0.553	0.553	10.6	533.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	114.680	0.0	346.5	22	
30 min Summer	77.440	0.0	470.0	37	
60 min Summer	49.937	0.0	623.8	66	
120 min Summer	31.091	0.0	777.4	126	
180 min Summer	23.207	0.0	870.5	184	
240 min Summer	18.718	0.0	936.1	244	
360 min Summer	13.796	0.0	1034.3	362	
480 min Summer	11.103	0.0	1109.1	482	
600 min Summer	9.374	0.0	1169.4	600	
720 min Summer	8.158	0.0	1219.8	686	
960 min Summer	6.546	0.0	1301.0	794	
1440 min Summer	4.790	0.0	1410.0	1050	
2160 min Summer	3.498	0.0	1588.5	1468	
2880 min Summer	2.794	0.0	1691.4	1876	
4320 min Summer	2.032	0.0	1842.7	2676	
5760 min Summer	1.619	0.0	1966.3	3400	
7200 min Summer	1.358	0.0	2059.9	4104	
8640 min Summer	1.177	0.0	2140.6	4760	
10080 min Summer	1.042	0.0	2208.7	5448	
15 min Winter	114.680	0.0	389.0	22	
30 min Winter	77.440	0.0	526.4	36	
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Summary of Results for 100 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.689	0.689	10.6	680.7	O K
120 min Winter	0.819	0.819	10.6	827.3	O K
180 min Winter	0.885	0.885	10.6	904.2	O K
240 min Winter	0.923	0.923	10.6	949.5	O K
360 min Winter	0.968	0.968	10.6	1002.5	O K
480 min Winter	0.990	0.990	10.6	1029.0	O K
600 min Winter	0.999	0.999	10.6	1040.0	O K
720 min Winter	0.999	0.999	10.6	1041.1	O K
960 min Winter	0.987	0.987	10.6	1025.9	O K
1440 min Winter	0.950	0.950	10.6	981.4	O K
2160 min Winter	0.881	0.881	10.6	899.8	O K
2880 min Winter	0.803	0.803	10.6	809.4	O K
4320 min Winter	0.617	0.617	10.6	601.8	O K
5760 min Winter	0.443	0.443	10.6	419.0	O K
7200 min Winter	0.309	0.309	10.6	285.2	O K
8640 min Winter	0.220	0.220	10.4	200.2	O K
10080 min Winter	0.169	0.169	10.0	152.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	49.937	0.0	699.1	66	
120 min Winter	31.091	0.0	870.9	124	
180 min Winter	23.207	0.0	975.0	182	
240 min Winter	18.718	0.0	1048.2	240	
360 min Winter	13.796	0.0	1157.7	356	
480 min Winter	11.103	0.0	1240.8	470	
600 min Winter	9.374	0.0	1307.3	582	
720 min Winter	8.158	0.0	1362.7	690	
960 min Winter	6.546	0.0	1449.7	894	
1440 min Winter	4.790	0.0	1542.7	1114	
2160 min Winter	3.498	0.0	1779.4	1580	
2880 min Winter	2.794	0.0	1894.5	2044	
4320 min Winter	2.032	0.0	2064.3	2860	
5760 min Winter	1.619	0.0	2202.7	3576	
7200 min Winter	1.358	0.0	2307.7	4184	
8640 min Winter	1.177	0.0	2398.4	4832	
10080 min Winter	1.042	0.0	2475.6	5344	
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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.341	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.689

Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)
0 4	1.000	4 8	0.689

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Model Details

Storage is Online Cover Level (m) 1.300

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	875.0	1.300	1331.7

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0150-1060-1000-1060
Design Head (m)	1.000
Design Flow (l/s)	10.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	150
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	10.6
Flush-Flo™	0.309	10.6
Kick-Flo®	0.682	8.8
Mean Flow over Head Range	-	9.1

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)
0.100	5.4	1.200	11.5	3.000	17.8	7.000	26.7
0.200	10.2	1.400	12.4	3.500	19.2	7.500	27.6
0.300	10.6	1.600	13.2	4.000	20.4	8.000	28.5
0.400	10.5	1.800	14.0	4.500	21.6	8.500	29.4
0.500	10.2	2.000	14.7	5.000	22.7	9.000	30.2
0.600	9.8	2.200	15.4	5.500	23.8	9.500	31.0
0.800	9.5	2.400	16.0	6.000	24.8		
1.000	10.6	2.600	16.6	6.500	25.8		

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