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Flood Risk Assessment

&

Surface Water Drainage

Assessment

Waterfold Mill

Waterfold Lane

Heywood

July 2022

On behalf of

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1. Introduction

Earth Environmental and Geotechnical Ltd, has prepared a Flood Risk Assessment (FRA) and supporting surface water drainage strategy for proposed residential development off Waterfold Lane, Heywood, Bury, Greater Manchester BL9 7JY.

The Environment Agency (EA) and Rochdale Metropolitan Borough Council need to be satisfied that the granting of planning permission will address any risk of flooding to the development, and that the proposals will not in turn increase the risk of flooding to neighbouring land and property.

This Flood Risk Assessment (FRA) has been prepared to the national guidance and requirements set out in the National Planning Policy Framework, 2021 (NPPF) and National Planning Practice Guidance (NPPG), which present guidance for preparation of site specific FRA's.

The FRA has also been prepared to the local guidance and requirements set out in Rochdale Borough Council's Core Strategy (Adopted 2016), Rochdale Borough's Strategy for Flood Risk Management 2014-2024 and Bury, Rochdale & Oldham Councils' 2009 Strategic Flood Risk Assessment.

This FRA identifies and evaluates the various possible sources of flood risk to the application site and identifies any mitigation or protection measures deemed necessary or feasible to manage the risk of flooding to the development and surrounding land.

2. Site Setting and Description

2.1. Site Location

The address of the application site is Waterfold Lane, Heywood, Bury, Greater Manchester, BL9 7JY, and the co-ordinates of the centre of the site are: Easting: 38210, Northing: 41034.

The application site is located immediately west of the village of Heap Bridge, approximately 2km east of Bury town centre and approximately 3km west of Heywood town centre, Greater Manchester. The River Roch forms the site's northern and eastern boundary, with the M66 Motorway and agricultural land bounding the site to the west and south respectively. A site location plan is included as Appendix A.

2.2. Existing Site

The application site is the location of a former woollen mill; historic maps presented within the Phase 1 GeoEnvironmental Desk Study indicate the mill buildings were demolished by the 1960s. The site currently comprises vacant land with remnants of former development, as indicated in Figure 1. The southern part of the application site extends across Waterfold Lane.

Figure 1 – Current Site Layout (extract from Pulman Associates, May 2021, Pre-Application Document)

The application site is bound to the west by an embankment to the M66 Motorway and Junction 2 slip road, to the north and east by the River Roch and to the south agricultural land.

2.3. Proposed Development

The proposed development is shown on the development layout plan in Appendix B, with a full description of the development being stated by the Architect.

In brief, and in relation to this FRA, the proposal comprises the erection of 6no. three-storey residential buildings providing 12no. one-bedroom apartments and 24no. two-bedroom apartments, with associated car parking and landscaping.

NPPG Paragraph 066, Table 2 confirms that residential development is classified as 'more vulnerable' in flood risk

terms.

2.4. Topography

Ordnance Survey mapping indicates that the local topography falls to the north, towards the River Roch, with ground levels within the application site of approximately 79mAOD.

A topographic site survey was undertaken in October 2021 and a copy is included as Appendix C. The survey is reported to a local datum elevation (not mAOD), but confirms that the application site is relatively level, with a slight topographic fall, of approximately 2.5m, across the site from north to south, away from the River Roch. The current site levels are influenced by remnants of hard standing and a perimeter bund adjacent to the highway.

Figure 2 presents the LIDAR 2020 1m Digital Terrain Model for the application site, with a number of spot heights (mAOD) indicated across the site.

Figure 2 – LIDAR Topographic Survey (extract from Environment Agency 2020 1m DTM)

The LIDAR topographic survey confirms that the application site has a slight topographic fall to the south-west away from the River Roch, with site levels in the range 77mAOD to 79mAOD. The central part of the site, where remnants of hardstanding are present, is slightly elevated above the surrounding land. The LIDAR data also confirms that the application site is elevated approximately 1.5m above the opposite bank of the River Roch.

2.5. Coast / Rivers / Canals / Artificial Waterbodies

The River Roch (classified as a main river) forms the north-eastern boundary of the application site and flows in a north-westerly direction past the site but meanders in an overall south-westerly direction to its confluence with the River Irwell near Blackford Bridge approximately 3.5km south-west of the site.

Figure 3 is a photograph of the River Roch from the application site; this confirms that the application site is elevated compared to the opposite riverbank, as indicated by the LIDAR topographic data.

Figure 3 – River Roch Adjacent to the Application Site (view east)

Figure 4 presents the local hydrological setting.

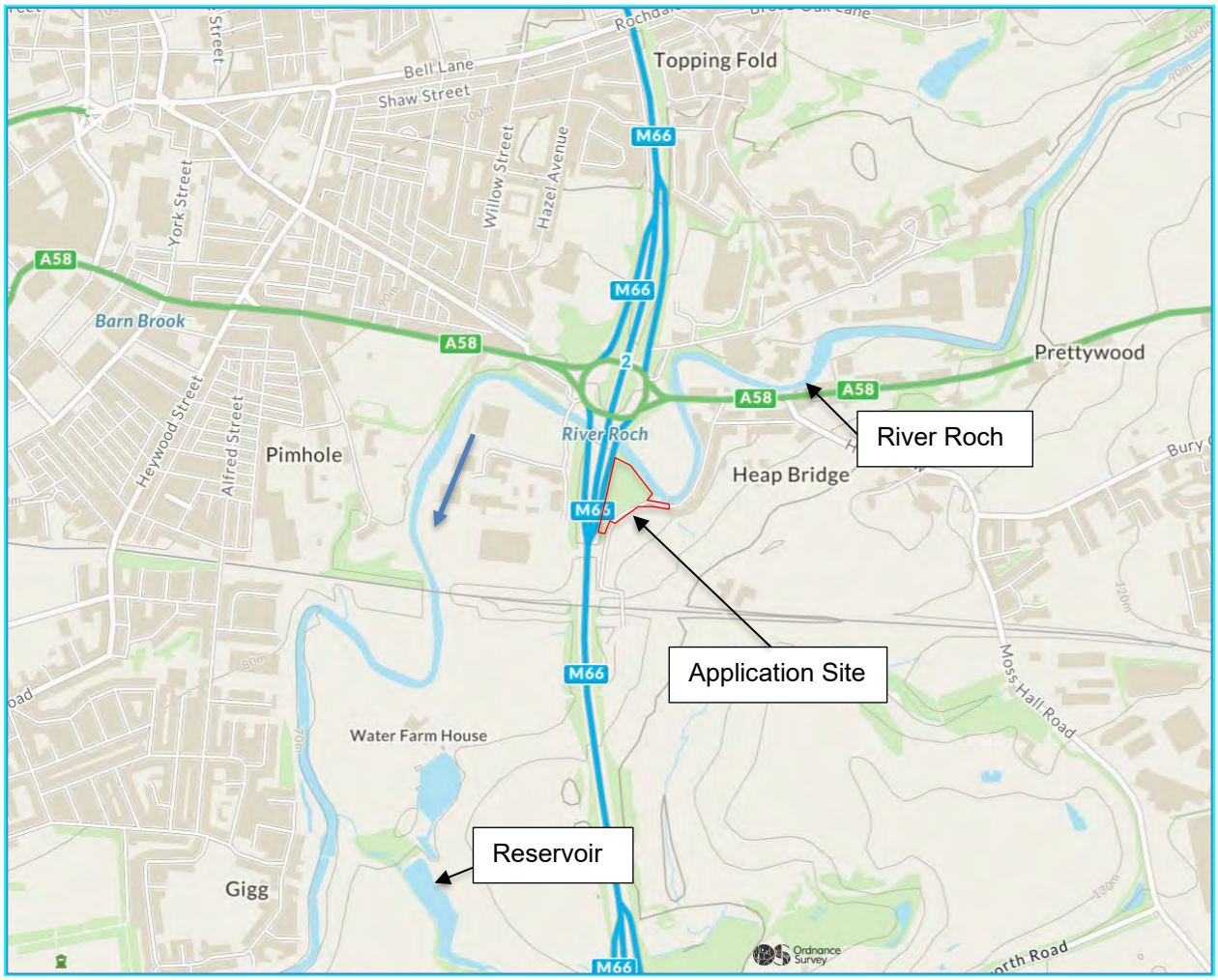

Figure 4 – Hydrological Site Setting

2.6. Drains and Sewers

The exact location of any water main or drains within the application site are to be confirmed. However, due to the historic, pre-developed nature of the application site and wider site setting, it is assumed that public drains and water mains are located in the immediate vicinity.

2.7. Ground Conditions

The ground conditions for the site can be determined via the British Geological Survey (BGS) website, where it indicates the site is underlain by superficial River Terrace Deposits (sand and gravel) and Alluvium (clay, silt, sand, and gravel) associated with the River Roch overlying the Pennine Middle Coal Measures Formation (interbedded sandstone, siltstone, and mudstone with coal seams).

A published geological log is available from a borehole installed to a depth of 200 feet (60.96m) in 1917 on the north-western boundary of the application site. This confirms the presence of interbedded shale and mudstone, with occasional sandstone (Pennine Middle Coal Measures Formation), from 6 feet (1.82m) below ground level. There are no details provided on the geological log regarding shallow groundwater or groundwater strikes. Due to the site's proximity to the River Roch, it is likely that shallow (potentially perched) groundwater is in hydraulic continuity with the river.

Review of Cranfield University's online Soilscapes Map indicates that the soils beneath the application site are classified as Soilscape 17: slowly permeable, seasonally wet, acid loamy and clayey soils with impeded drainage.

3. National & Local Flood Risk Policy

3.1. National Planning Policy Framework (NPPF) and National Planning Practice Guidance (NPPG)

NPPF 2021 sets out the Government's national policy on development and flood risk and seeks to provide clarity on what is required at regional and local levels, to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk.

NPPF Paragraphs 153 to 154 provide guidance for developments for the plans to take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk.

NPPF Paragraphs 159 to 169 provides guidance for planning and flood risk, where are plans should apply a sequential, risk-based approach to the location of development taking into account current and future impacts of climate change; to ensure that flood risk is not increased elsewhere due to the development; and to incorporate sustainable drainage systems.

NPPG, Paragraph 030, outlines that the objectives of this FRA are to establish whether a proposed development is likely to be affected by current or future flooding from any source; whether it will increase flood risk elsewhere; whether the measures proposed to deal with these effects and risks are appropriate; whether the evidence for the local planning authority to apply (if necessary) the Sequential Test; and whether the development will be safe and pass the Exception Test, if applicable.

3.2. Strategic Flood Risk Assessment

Bury, Rochdale & Oldham Borough Council's 2009 Strategic Flood Risk Assessment (SFRA) reviews the risk of flooding from all sources and provides guidance for developers on site-specific FRA requirements.

3.3. Rochdale Borough Council's Local Plan

Rochdale Borough Council's Core Strategy (Adopted October 2016) presents local planning policies for the period up to 2028.

Policy G1 – Tackling and Adapting to Climate Change, includes the following statements:

New developments will be expected to:

d. Address the impacts of climate change by incorporating comprehensive adaptation measures, including:

- *i. suitable measures, such as urban greening, for tackling the 'urban heat island' effect;*
- *ii. where possible, the opening up of covered and culverted sections of waterways and provision of new water features, to help cooling and provide biodiversity, landscape, and flood prevention benefits;*
- *iii. the incorporation of appropriate water conservation and management measures, such as Sustainable Drainage Systems (SuDS), including ensuring that the rate of run-off on 'greenfield' sites is not increased and on 'brownfield' sites is significantly reduced, and avoiding the use of impermeable surfaces;*

Policy G8 – Managing Water Resources and Flood Risk, includes the following statements:

We will ensure that new development (including flood risk mitigation measures) does not lead to any form of increased flooding locally or further downstream, does not impede natural water and flood risk management, is not detrimental to existing or potential flood storage areas, contributes where possible to alleviating existing flood risk, is itself well protected from flood risk and ensures prudent use of water resources. We will require:

a. Compliance with a 'sequential' approach to new development and flood risk, directing development away from areas of high risk, in accordance with the National Planning Policy Framework;

b. Full regard to and compliance with the advice of the Environment Agency (or equivalent agency) and the objectives and priorities for flood risk management set out in the Local Flood Risk Management Strategy, including any mitigation measures recommended for particular sites;
c. Full regard to the published evidence of local flood risk and its significance as included in Strategic Flood Risk Assessments, Surface Water Management Plans and other recognised sources of flood risk data and the production of additional Flood Risk Assessments (FRAs) as appropriate;
d. Incorporation of appropriate measures for the management of surface and flood water, including flood storage areas, Sustainable Urban Drainage Systems (SUDS) and the protection of 'overland flow paths';
e. Compliance with any Surface Water Management Plan or drainage strategies produced, such as for the identified critical drainage areas of Littleborough and Heywood;
f. The avoidance of culverting, and support the opening up of existing culverts wherever possible;
g. The incorporation of measures for the conservation of water to minimise potable water consumption, including rainwater collection measures, which should be integral to the design of buildings and spaces;
h. Development that does not directly or indirectly lead to pollution of existing water resources such as watercourses and groundwater or the derogation of the quantity of groundwater;
i. The incorporation of measures to improve water quality; and
j. The taking of opportunities to improve the habitat value of watercourses and water bodies.

In addition, we will identify additional flood storage areas which will be protected from development.

4. Sources of Flooding

In accordance with the NPPF, flood risk must be assessed for all sources of flooding and development of the site should be carried out in such a way as to mitigate any potential flood risk to both the site and third parties and their property. This section identifies all possible sources of flooding.

4.1. Fluvial Flooding

Fluvial flooding results from watercourses / rivers surcharging and flooding the surrounding areas.

4.2. Coastal Flooding

Coastal flooding results from high tides from the sea.

4.3. Pluvial Flooding

‘Pluvial' (surface water) flooding is that which results from rainfall generated overland flow before the run-off enters any watercourse, drain or sewer. It is more often linked to high intensity rainfall events (typically in excess of 30mm per hour). However, it can also result from lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or has low permeability. This results in overland flow and ponding in depressions in the topography. In urban areas 'pluvial' flows are likely to follow the routes of highways and other surface connectivity to low spots where flooding can occur. In some cases, it can deviate from this route into adjacent developments via dropped kerbs (either for access to driveways or disability access).

4.4. Groundwater Flooding

Groundwater flooding is caused by the emergence of water from sub-surface permeable strata. Fluctuations in the groundwater table can cause flooding should the table rise above the existing ground level. Groundwater flooding events tend to have long durations, lasting days, or weeks.

4.5. Flooding from Drains and Sewers

Flooding from drains and sewers is caused when the capacity of the drains and sewers is exceeded and will result in flooding from the manholes.

4.6. Canals, Reservoirs and Other Artificial Sources

Flooding from canals, reservoirs and artificial sources is caused when the capacity of the sources is exceeded, or if there is, an infrastructure failure.

5. Sourced Data

Data from the Environment Agency, local Strategic Flood Risk Assessment and other referenced sources have been studied to establish which potential sources of flooding are at the site.

5.1. Environment Agency Flood Maps for Planning

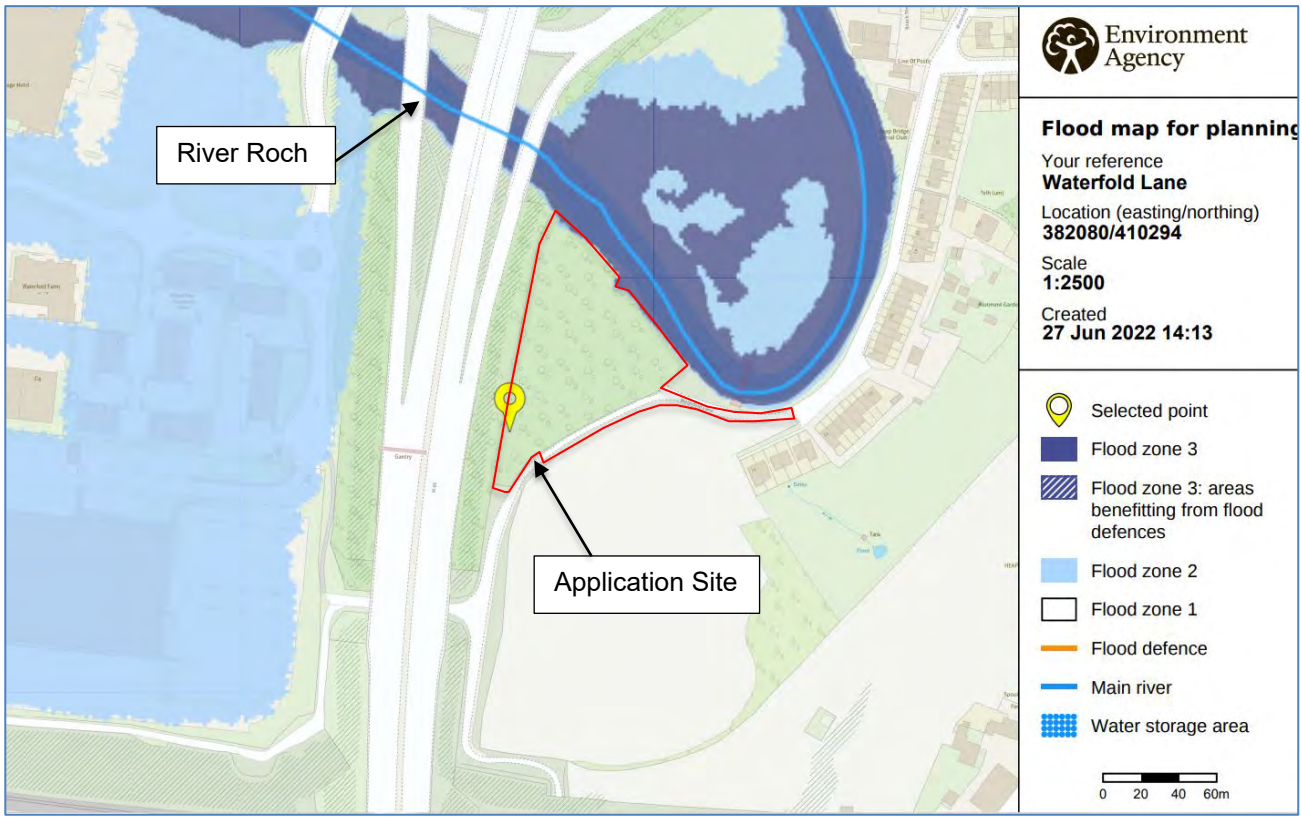

Figure 5 – EA Flood Zone Map

The EA flood zone map shown in Figure 5, indicates that the application site lies within Flood Zone 1, defined as land with a low probability of fluvial flooding (<0.1% annual probability). However, the north-eastern boundary of the site, adjacent to the River Roch, potentially extends into Flood Zone 3. Flood Zone 3 is land defined as having a high probability of flooding (>1.0% annual probability of flooding). The flood zone map does not take into account the presence of local flood defences.

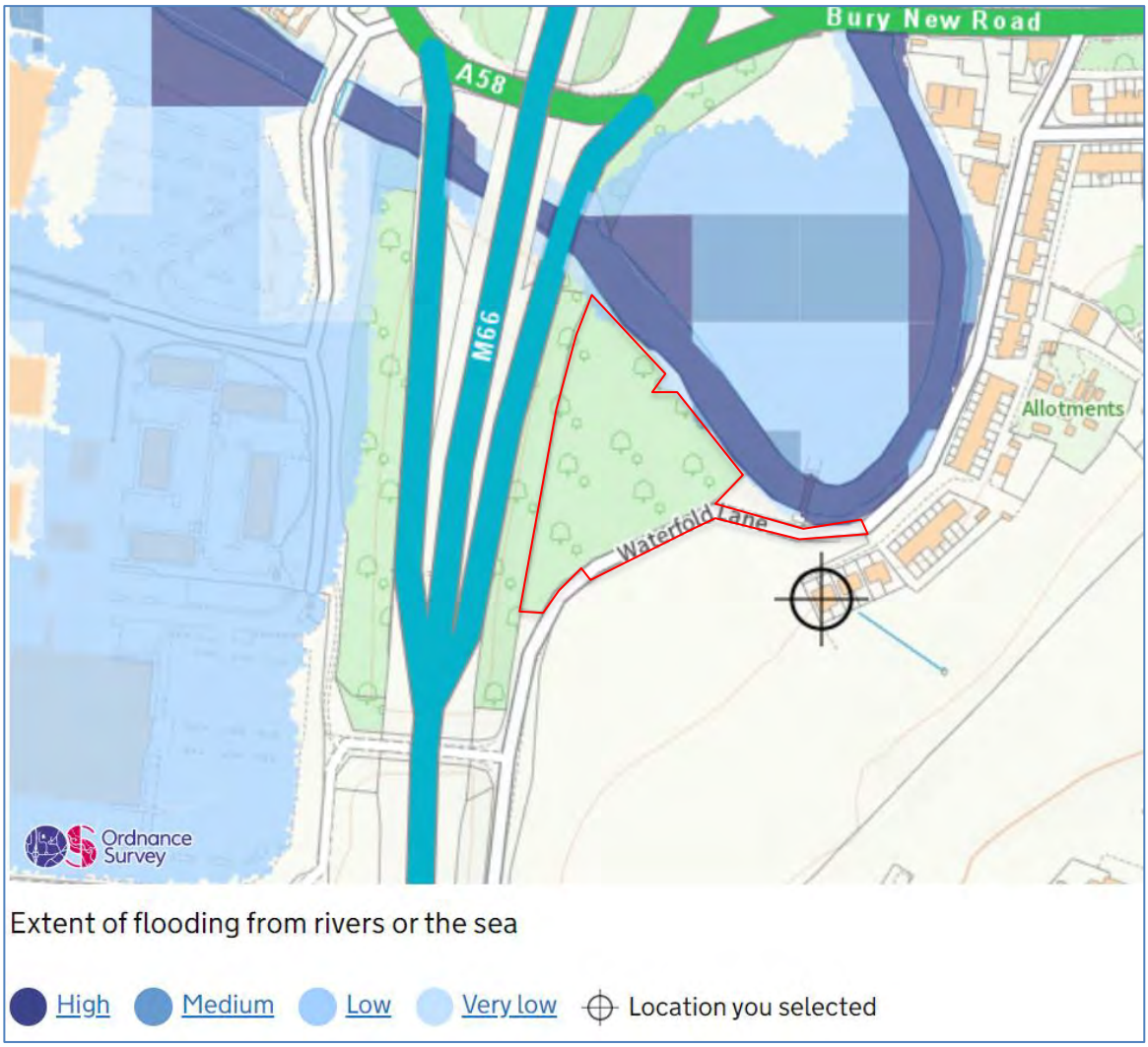

Figure 6 – EA Fluvial Flood Map

The EA fluvial flood map shown in Figure 6, confirms that virtually the entire application site has a negligible risk (<0.1% annual probability) of flooding from rivers. The north-eastern boundary, adjacent to the River Roch, is shown to have a low risk (0.1% to 1.0% annual probability) or a medium risk (1.0% to 3.3% annual probability) of flooding from rivers. This takes into account the presence of any local flood defences.

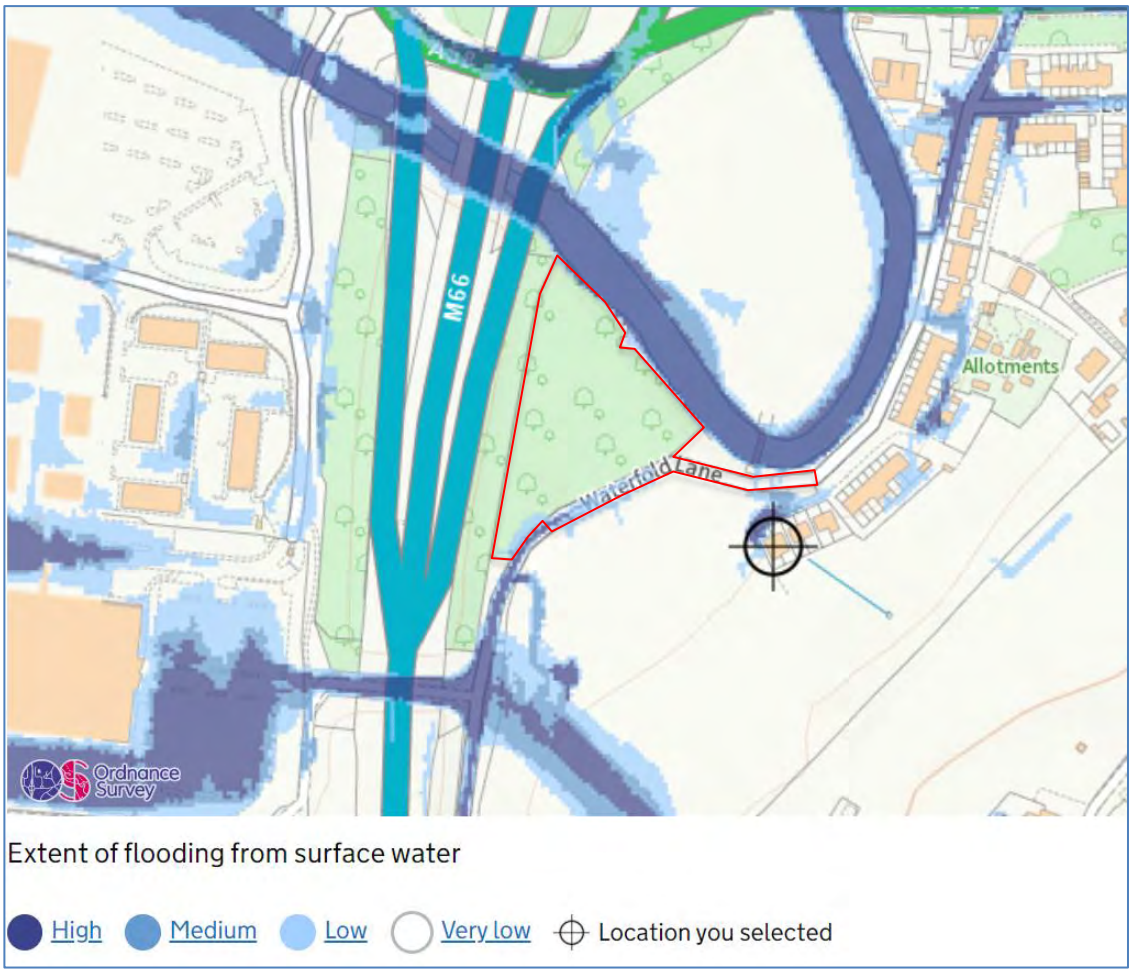

Figure 7 – EA Surface Water Flood Map

The EA surface water flood map shown in Figure 7, indicates that virtually the entire application site has a very low probability of surface water flooding (<0.1% annual probability). Isolated areas adjacent to the River Roch, an area in the south of the site and Waterfold Lane are shown to have a low risk (0.1% to 1.0% annual probability) of surface water flooding. The risk of surface water flooding along Waterfold Lane increases to the south, rising to a high risk of surface water flooding (>3.3% annual probability).

Predicted flood water depths for the worse-case, low risk scenario is presented on Figure 8 and remain below 300mm in all areas.

Review of the proposed development plan (Appendix B) confirms that no built development is proposed within the areas identified as being at risk of surface water flooding. The site access is provided off Waterfold Lane at the northern end of the site, where the risk of surface water flooding is very low.

Figure 8 – Predicted Surface Water Flood Depth, Low Risk Scenario

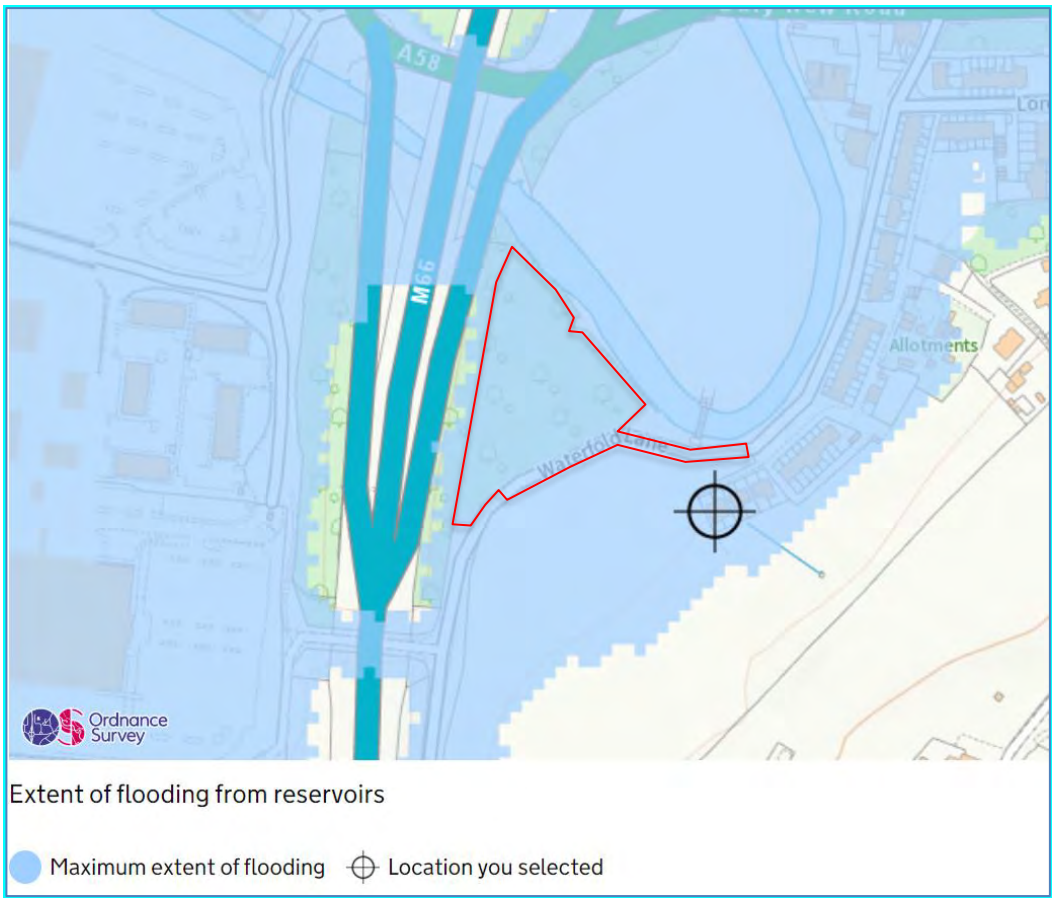

Figure 9 – EA Reservoir Flood Map

The EA reservoir flood map shown in Figure 9, indicates that the application site lies within the predicted maximum extent of flooding in the unlikely event of the failure of local reservoir(s). It is recognised that the likelihood of reservoir failure is extremely low, with reservoirs capable of holding 25,000m^3 or more of water regulated under the Reservoirs Act 1975, as amended by the Flood and Water Management Act, 2010.

Review of the Environment Agency's online historic flood map indicates there are no records of historic flooding within the application site, although land to the immediate north of the River Roch is shown to have flooded in the past.

The application site is not located within an Environment Agency flood warning area but is within the extensive flood alert area for the Upper River Irwell catchment with Oldham, Bolton, Rochdale, Haslingden, Ramsbottom and Rawtenstall.

5.2. Environment Agency Climate Change Allowances

Environment Agency guidance on climate change allowances (February 2016, last updated May 2022) presents predictions of anticipated changes for peak river flows and rainfall intensities by river basin district. The application site is located within the Irwell Management Catchment. The proposed development is classified as 'More Vulnerable' in flood risk terms and the EA guidance recommends applying the central climate change allowance for such developments in Flood Zones 2 and 3a. For the Irwell Management Catchment, the recommended climate change allowance for the 2080s is 35% (central allowance).

The EA's guidance also presents predicted climate change allowances for peak rainfall intensity and confirms the following predicted peak rainfall climate change allowances for the 2070s (2061-2025) for the Irwell Management Catchment:

- 3.3% annual exceedance rainfall event: 30% (central allowance) to 40% (upper end allowance)

- 1.0% annual exceedance rainfall event: 30% (central allowance) to 45% (upper end allowance)

The guidance advises that drainage systems should be designed to make sure there is no increase in the rate of runoff discharged from the site for the upper end allowances.

These climate change allowances are incorporated within the assessment of the design flood water level (Section 5.3) and within the proposed flood risk mitigation measures (Section 8) and surface water drainage strategy (Section 9).

5.3. Environment Agency Product 4 Data & Design Flood Water Level

The Environment Agency has been consulted to obtain site-specific predicted flood water level data (Product 4 data); their response is included as Appendix D. The EA's response confirms they have no record of historic flooding at the application site; however, land to the immediate north of the River Roch is shown to have flooded in December 2015. There are no raised flood defences for the River Roch adjacent to the application site.

The EA has provided site-specific predicted flood water levels from the Lower Roch 2017 Study, for a range of flood events including the defended and undefended scenarios. The model node closest to the application site is ROCH02_00964 on the north-eastern site boundary (grid reference: 382155 410372). Predicted flood water levels at this location are presented below:

Lower Roch 2017 Study – Predicted Flood Water Levels (mAOD)		
Model Scenario	**Predicted Flood Water Level Defended Scenario**	**Predicted Flood Water Level Undefended Scenario**
	Node ROCH02_00964	Node ROCH02_00964
1% Annual Probability	75.69	75.40
1% Annual Probability + 30% climate change	76.20	75.90
1% Annual Probability + 35% climate change	76.30	75.99
1% Annual Probability + 70% climate change	76.88	76.48
0.1% Annual Probability	76.63	76.27

Section 5.2 above, confirms that a 35% climate change allowance is appropriate for the proposed development. The modelled flood water level data presented above and within Appendix D indicates that the highest (worse case) water levels are observed during the defended scenario. Therefore, the design flood water level, based on the defended model scenario, for the 1% annual probability flood event + 35% climate change is: **76.30mAOD.**

Review of the site topography (Section 2.4) confirms that a minimum site level of approximately 77.0mAOD. The LIDAR data confirm that current site levels are elevated above the design flood water level of 76.3mAOD; therefore, the site would remain safe and dry during the design flood event.

However, the design flood water level of 76.30mAOD has informed the recommended flood risk mitigation measures outlined in Section 8.

5.4. Strategic Flood Risk Assessment (SFRA) and Local Flood Risk Management Strategy (LFRMS)

The Rochdale Borough Council's 2009 SFRA and 2014-2024 Strategy for Flood Risk Management have been reviewed (LFRMS) to assess flood risk from local watercourses, surface water runoff, sewers, and groundwater; a summary of each of these potential sources is as follows:

Fluvial Flooding

An extract of the fluvial flood risk map from the 2009 SFRA is reproduced as Figure 10 below. This indicates that the majority of the application site lies within Flood Zone 1, but that the northern part of the site extends into Flood Zone 2 and Flood Zone 3b (functional floodplain) of the River Roch.

It is acknowledged that the SFRA dates from 2009; the Environment Agency's site-specific flood data from the 2017 Lower Roch study presented above in Section 5.3 represents the most up-to-date flood model and predicted flood water levels for the site.

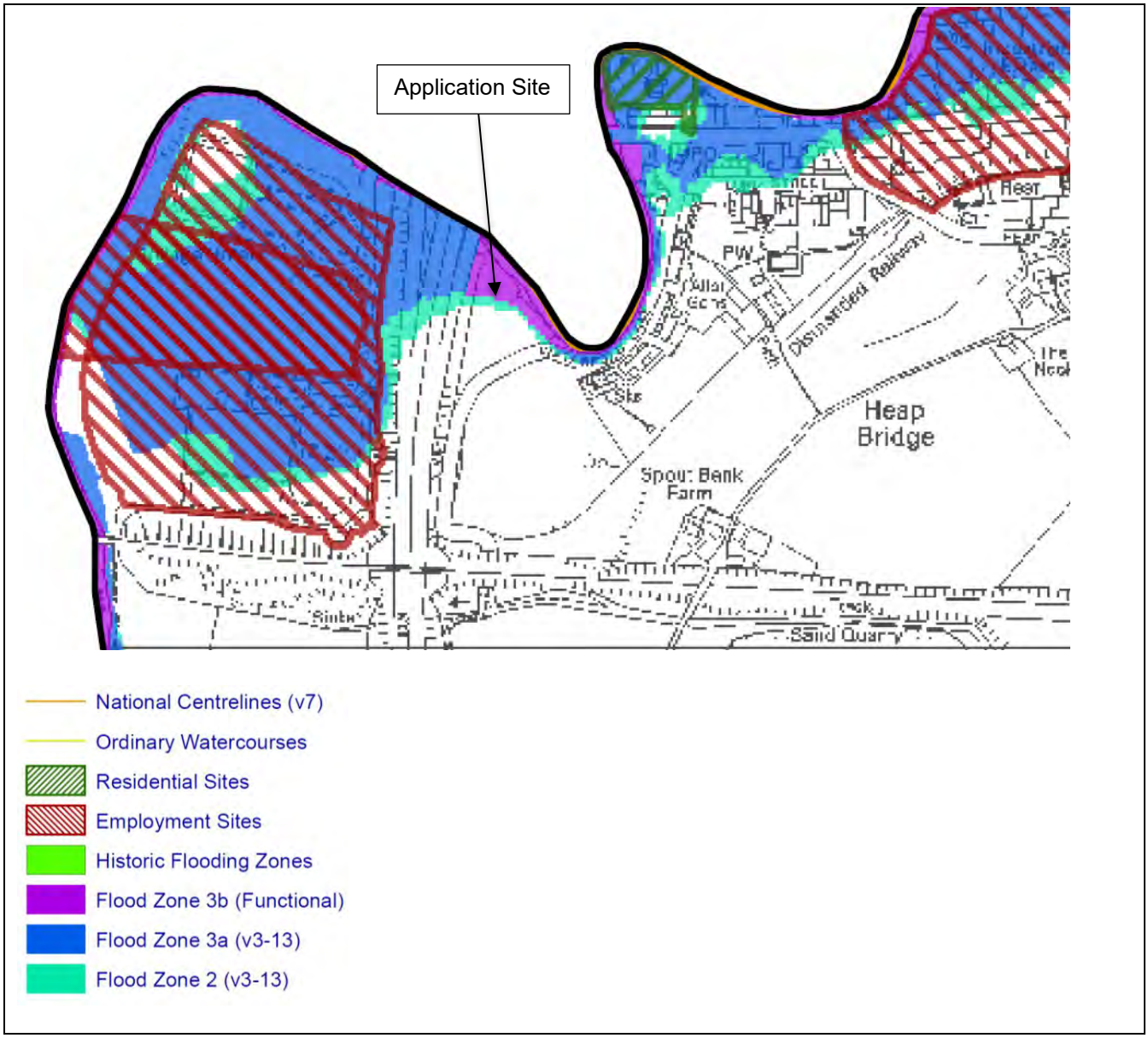

Figure 10 – Extract of 2009 Bury, Rochdale & Oldham SFRA Flood Zone Map 1.2J

Surface Water Flooding

Figure 11 presents an extract of Map 1.4J of the 2009 SFRA which indicates that the north-eastern and southern areas of the application site are at risk of surface water flooding during a 1 in 200-year rainfall event. As for fluvial flood risk, it is recognised that the SFRA dates from 2009 and the Environment Agency's current flood risk mapping (Figure 7) presents an up-to-date assessment of surface water flood risk to the application site.

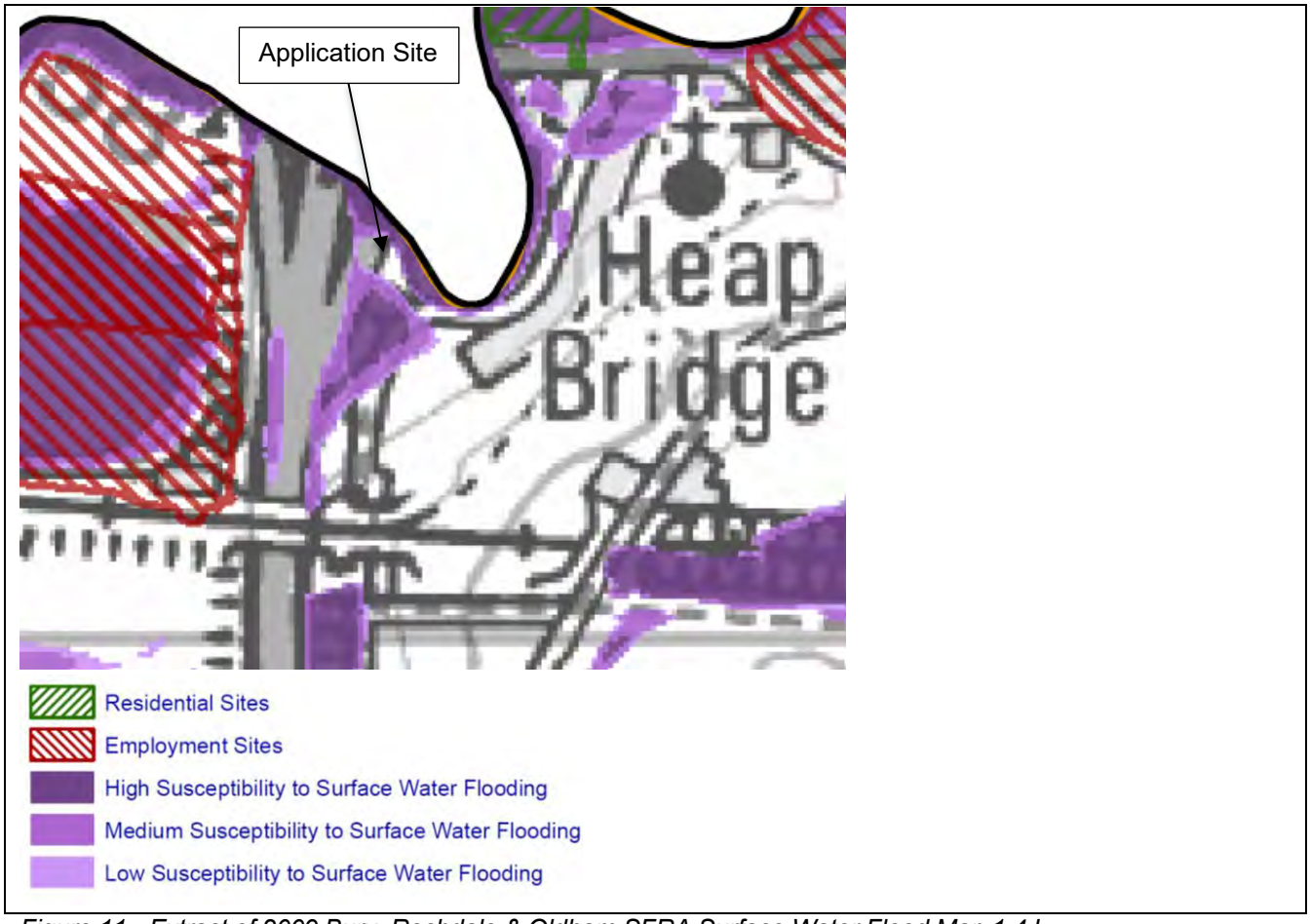

Figure 11 - Extract of 2009 Bury, Rochdale & Oldham SFRA Surface Water Flood Map 1.4J

Map 1.7A of the SFRA confirms that the application site does not lie within the Heywood Critical Drainage Area.

Canals and Reservoirs

The 2009 Level 2 SFRA includes an assessment of flood risk from Rochdale Canal, in the event of a breach or overtopping. However, the application site is located approximately 6km from the canal, beyond the area considered within the SFRA.

Therefore, the application site is not located within an area identified to be at greatest risk of flooding from canal overtopping/failure.

Sewers

The Level 1 SFRA does not include a detailed assessment of the risk of flooding from sewers but does confirm that the application site is not within a Critical Drainage Area. The SFRA does confirm that Rochdale had a relatively low number of flood incidents from sewers, within the Greater Manchester area. The application site is relatively rural and not therefore considered to be within an area at significant risk of flooding from sewers.

Groundwater Flooding

Section 5.14 of the LFRMS states that groundwater flooding within the Borough is uncommon, although limited, smaller scale flooding, often of cellars and basements, has occurred.

Review of Figure 6 of the LFRMS indicates that the application site lies within an area of moderate groundwater flood risk, (50% to 75% of the 1km grid square has geological and hydrogeological conditions that indicate groundwater might emerge).

The SFRA confirms that the risk posed by groundwater flooding across the region is likely to remain remote, with relatively few reported incidents.

Historic Flooding

Table 2-4 of the SFRA provides details of historic flood events within the Borough up until 2008, predominantly relating to surface water and fluvial flooding. No flood incidents are identified in the vicinity of the application site.

SFRA Flood Zone Map 1.2J, reproduced as Figure 10 above, includes historic fluvial flooding zones and confirms that the application site is not within an area that has recorded flooding. The SFRA pre-dates the 2015 flood event outline provided by the Environment Agency (Appendix D).

6. Probability of Flooding

Now that the extents of the sources of flooding are known from the above data, an assessment is to be made of the probability of flooding from each of the sources.

6.1. Fluvial Flooding - *Probability: Very Low*

The potential source of fluvial flood risk is the River Roch, which flows in a north-westerly direction along the north-eastern boundary of the application site. The Environment Agency flood maps indicate that the application site lies within low probability Flood Zone 1 (<0.1% annual probability of flooding), with the north-eastern boundary adjacent to the river potentially extending into Flood Zone 3, defined as land with a high probability of flooding (>1.0% annual probability).

Site-specific flood risk data (Product 4 data) has been provided by the EA from the 2017 Lower Roch Study, and the design flood water level for the application site, equivalent to the 1.0% annual probability event plus 35% climate change is **76.30mAOD.**

Topographic LIDAR data confirms that ground levels across the entire application site are elevated above this design flood water level.

There is no record of historic flooding within the application site; land to the immediate north, on the opposite bank of the River Roch has reported flooding in the past but is located at a significantly lower elevation than the application site.

Therefore, the risk of fluvial flooding within the site is concluded to be very low.

6.2. Surface Water Flooding - *Probability: Very Low*

The EA flood mapping indicates that virtually the entire application site has a very low risk of surface water flooding, defined as <0.1% annual probability of flooding. Limited peripheral areas of the site, including Waterfold Lane are indicated to have a low risk of surface water flooding (0.1% to 1.0% annual probability), rising to a high risk (>3.3% annual probability) at the southern end of Waterfold Lane, with predicted flood water depths of <300mm. No built development is proposed within these areas of proposed landscaping, parking, or gardens. Site access is proposed via the northern end of Waterfold Lane, where the risk of surface water flooding is very low and the risk remains very low along Waterfold Lane towards the north, allowing safe access and egress.

The application site will benefit from a surface water drainage strategy (refer to Section 9). Therefore, the risk of surface water flooding to the development is concluded to be very low.

6.3. Groundwater Flooding - *Probability: Low*

Published reports indicate that the site is within an area with moderate risk of groundwater flooding, based on the geological and hydrogeological ground conditions. However, across the region groundwater flood incidents are limited, and often of cellars or basements.

No below ground (basement) development is proposed therefore, it is concluded that the probability of groundwater flooding to the development is low.

6.4. Flooding from Drains and Sewers - *Probability: Low*

The application site is not located within a critical drainage area, as defined within the SFRA and is within a semi-rural setting isolated from local major development by the M66 Motorway.

Therefore, the probability of flooding from drains and sewers is deemed to be low.

6.5. Canals, Reservoirs and Other Artificial Sources - *Probability: Very Low*

The EA flood map indicates that the application site is within the predicted flood extent of local reservoir(s). However, in England, reservoirs that are capable of holding 25,000m^3 or more of water are regulated under the Reservoirs Act 1975, as amended by the Flood and Water Management Act, 2010. These reservoirs are registered with the Environment Agency and subject to inspection and supervision by reservoir engineers. Therefore, due to the tight regulations on periodic inspections and maintenance of the reservoir(s) and water level monitoring, the probability of reservoir failure is very low and therefore the risk of flooding is considered very low.

7. Flood Risk and Vulnerability

The NPPG Paragraphs 065 to 067 sets out the flood risk for a site by assessing the flood zones, flood risk vulnerability classification, and flood risk vulnerability and flood zone 'compatibility'.

7.1. Flood Zones

There are four classifications for flood zones, as defined in Table 1 of the NPPF and NPPG document.

Table 1 – Flood Zones	
Flood Zone	**Definition**
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water should flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

The application site is entirely within low probability Flood Zone 1.

7.2. Flood Risk Vulnerability Classification

NPPG Paragraph 066, Table 2 stated the flood risk vulnerability classifications as:

Table 2 - Flood Risk Vulnerability Classification
Essential Infrastructure Essential transport infrastructure (including mass evacuation routes) which should cross the area at risk; Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood; Wind turbines.
Highly Vulnerable Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding; Emergency dispersal points; Basement dwellings; Caravans, mobile homes and park homes intended for permanent residential use; Installations requiring hazardous substances consent.
More Vulnerable Hospitals; Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels; Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels; Non–residential uses for health services, nurseries and educational establishments; Landfill* and sites used for waste management facilities for hazardous waste; Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable Police, ambulance and fire stations which are not required to be operational during flooding; Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'More Vulnerable' class; and assembly and leisure; Land and buildings used for agriculture and forestry; Waste treatment (except landfill* and hazardous waste facilities); Minerals working and processing (except for sand and gravel working); Water treatment works which do not need to remain operational during times of flood.
Water-Compatible Development Flood control infrastructure; Water transmission infrastructure and pumping stations; Sewage transmission infrastructure and pumping stations; Sand and gravel working; Docks, marinas, and wharves; Navigation facilities.

The proposed development of residential properties is classed as 'More Vulnerable' in flood risk terms.

7.3. Flood Risk Vulnerability and Flood Zone 'Compatibility'

NPPG Paragraph 067 Table 3, gives guidance on flood risk vulnerability compared with flood zone, to determine the compatibility.

NPPF – Table 3 - Flood Risk Vulnerability and Flood Zone 'Compatibility'					
Flood Zones	**Flood Risk Vulnerability Classification**				
	Essential Infrastructure	Highly Vulnerable	**More Vulnerable**	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	† Exception Test required	✗	Exception Test required	✓	✓
Zone 3b*	* Exception Test required	✗	✗	✗	✓*

In accordance with Table 3 of the NPPF, 'More Vulnerable' development is acceptable within Flood Zone 1.

8. The Sequential Test and Flood Risk Mitigation

8.1. Applicability of the Sequential and Exception Test

The Sequential Test aims to steer new development to areas with the lowest risk of flooding (i.e., Flood Zone 1); Section 6 above confirms that the application site is entirely within Flood Zone 1 and the risk of flooding from all potential sources is low or very low. Therefore, the Sequential Test is passed.

Table 3 above confirms that all development types are acceptable within Flood Zone 1. However, it is recognised that the development must be safe for its lifetime, without increasing flood risk elsewhere; therefore, a number of flood risk mitigation measures are proposed for the development.

8.2. Safe Development

For the development to be safe for its lifetime taking account of the vulnerability of its users, there are several design principles for the development, which include:

- Analysis of the finished floor level against predicted flood water levels;
- Safe and access and egress from the development;
- Consideration of surface water drainage to ensure there is no increased flood risk elsewhere.

Each of the design principles to be applied for the development are detailed below.

The Environment Agency's flood risk standing advice for vulnerable development has also been referenced.

8.3. Finished Floor Level Analysis

With regards to the finished floor level of the building, the NPPF and EA's flood risk standing advice state that to reduce the probability of flooding, the finished floor level should be a minimum of whichever is higher of:

- 300mm above the general ground level of the site;
- 600mm above the estimated 1% annual probability river flood level.

The design flood water level (1% annual probability + 35% climate change) is 76.30mAOD and the ground level is variable across the site but at least 77.0mAOD within the area of proposed development. Therefore, it is recommended that finished floor levels are set a minimum of 300mm above external site level, equivalent to a minimum of 77.3mAOD.

8.4. Safe Access and Egress

Review of the fluvial flood mapping (Figure 5) confirms that safe access within low probability Flood Zone 1 is available via Waterfold Lane and the A58. Therefore, safe access and egress would be available to the application site during the design flood event.

8.5. Surface Water Management

It is recognised that new development can increase the rate of surface water runoff compared to pre-development conditions, due to the introduction of impermeable surfaces. Therefore, an appropriate, sustainable surface water drainage strategy is proposed to manage the risk of surface water flooding to the development and to ensure no increase in flood risk to others. Further details regarding the proposed surface water drainage strategy are presented in Section 9.

8.6. Development Near a Main River

Review of the proposed development plans confirms that no built development (structure) is proposed within the 8m easement from the top of bank of the River Roch. Therefore, long term access will be maintained to the river corridor for future monitoring and maintenance. The requirement for Environment Agency consent (via a Flood Risk Activity Permit) should be determined if a new outfall to the River Roch is required for the surface water drainage strategy.

9. Surface Water Management

9.1. Introduction and Design Principles

This section of the FRA presents an outline sustainable drainage strategy (SuDS) for the proposed development, based on the development proposals, local planning policy and guidance and current UK SuDS guidance. A detailed surface water drainage strategy shall be developed from these outline principles, post-planning.

Planning Policy and Design Rainfall Event

Policies G1 and G8 of Rochdale Borough Council's Core Strategy state that new developments will be expected to incorporate SuDS, including ensuring that the rate of run-off on 'greenfield' sites is not increased and on 'brownfield' sites is significantly reduced.

The application site comprises previously developed land, being the location of a former woollen mill. However, in accordance with current best practice guidance, the surface water drainage strategy has been designed to attenuate post-development runoff to the pre-development Greenfield rate.

The following surface water drainage strategy has been designed with a dual outflow control, to attenuate surface water runoff during the 1 in 1 year return period rainfall event to the 1 in 1 year greenfield rate and to attenuate surface water runoff during the 1 in 100 year event plus 45% climate change allowance to the 1 in 100 year greenfield rate.

Discharge Hierarchy

The proposed method of surface water discharge has been chosen based on the following hierarchy of drainage options:

1. Infiltration to ground
2. Discharge to a surface water body
3. Discharge to a surface water sewer or highway drain
4. Discharge to a combined sewer

Section 2.7 of this report summarises the ground conditions beneath the site as relatively low permeability Alluvium and shale/mudstone with probable shallow groundwater. Therefore, it is inferred that discharge of surface water runoff via infiltration to ground would not be feasible.

Therefore, based on the relatively low permeability ground conditions and proximity of the adjacent River Roch, it is assumed that surface water runoff would discharge to the River Roch, in accordance with the discharge hierarchy.

9.2. Greenfield Surface Water Runoff Rates

The pre-development Greenfield surface water runoff rates have been calculated using HR Wallingford's online drainage design tools (www.uksuds.com). The Greenfield runoff rate has been calculated for the area of the application site that would contribute runoff to the site's drainage system, (i.e., the footprint of proposed development only); this equates to an area of 0.351 hectares (ha).

The Greenfield runoff calculations are included within Appendix E and summarised below:

1 in 1 year: 2.4l/s
1 in 30 year: 4.7l/s
1 in 100 year: 5.75l/s

9.3. Surface Water Drainage Strategy

The surface water drainage strategy has been designed to attenuate runoff for all rainfall events, up to and including

the 1 in 100 year event with 45% allowance for climate change, to the pre-development Greenfield rate, with controlled discharge to the adjacent River Roch. The proposed drainage strategy and supporting calculations are included within Appendix E.

Surface water attenuation is proposed on-site, via the introduction of permeable paving with 350mm sub-base storage beneath the parking areas, and below ground geocellular storage. Type B (partial infiltration) permeable paving is proposed with appropriate overflow into the wider drainage system. Roof drainage shall discharge into the geocellular storage units. An appropriate dual flow control device (hydro-brake or similar) would restrict off-site discharge to the River Roch to the relevant pre-development Greenfield rate for the 1:1 year rainfall event and the 1:100 year + 45% climate change rainfall event. The drainage strategy has also been analysed for the 1:30 year + 40% climate change rainfall event, to confirm discharge would be restricted to the 1:30 year greenfield rate (calculations are included within Appendix E). Any infiltration to ground, via Type B the permeable paving system, would further reduce the final off-site discharge rates.

Appropriate management of surface water quality would be provided by the permeable paving filter media, catchpits, and a final separator, prior to discharge to the River Roch, as indicated on the Drainage Strategy plan within Appendix E.

The requirement for Environment Agency consent (via a Flood Risk Activity Permit) should be determined if a new outfall to the River Roch is required for the surface water drainage strategy

9.4. Maintenance Schedule

To ensure the drainage system continues to operate as designed, maintenance tasks need to be carried out at appropriate intervals. General requirements:

- Collect litter/debris at least monthly.
- Retain site drainage plans and protect all below ground drainage infrastructure during any future site works.

All components of the surface water drainage strategy should be maintained in accordance with the manufacturer's recommendations; the following maintenance schedules are typical (after CIRIA, 2016, UK SuDS Manual).

Operation and maintenance requirements for pervious pavements

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Operation and maintenance requirements for attenuation storage tanks

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows 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

An example of operation and maintenance requirements for a proprietary treatment system

Maintenance schedule	Required action	Typical frequency
Routine maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six monthly
	Change the filter media	As recommended by manufacturer
	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 half year of operation, then every six months

10. Residual Risk

It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible, however, there are practicable ways to minimise the risk such as by allowing a freeboard (safety margin) and by using suitable construction and management techniques.

This flood risk assessment has been prepared in accordance with the NPPF, NPPG, Local Planning Policy and Environment Agency Flood Risk Standing Advice.

Earth Environmental and Geotechnical Ltd do not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

It will be the owner's /occupier's responsibility to maintain the drainage network on site throughout the lifetime of the development to ensure that flood risk on and off site is managed effectively.

Appendix A - Site Location Plan

Appendix B - Proposed Development Plans

Appendix C - Site Topographic Survey

Appendix D - Environment Agency Product 4

Appendix E - Surface Water Drainage Strategy & Calculations

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Rev	Description	Date
02	Red line update	Mar 2022
01	Boundary added, road improvements	Mar 2022

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Bridge House 18A Bridge Street Milnrow Lancashire OL16 3ND

Planning

Project: **Waterfold Mill**

Client: David Gibbons

Site: Waterfold Mill
Waterfold Lane
Rochdale

Drawing: **Location plan**

Drg No: **M21-13-LP** Rev: **02**

Scale: **1:1250** Paper: **A3** Date: **Mar 2022**

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North

Rev	Description	Date
02	Road modified, parking updated, footpaths and crossing updated.	Apr 2022
01	Boundary added, road improvements	Feb 2022

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Bridge House 18A Bridge Street Milnrow Lancashire OL16 3ND

Planning

Project: **Waterfold Mill**
Client: David Gibbons
Site: Waterfold Mill
Waterfold Lane
Heywood

Drawing: **Site Layout Plan**
Drg No: **M21-13-08** Rev: **02**
Scale: **1:500** Paper: **A1** Date: **Mar 2022**

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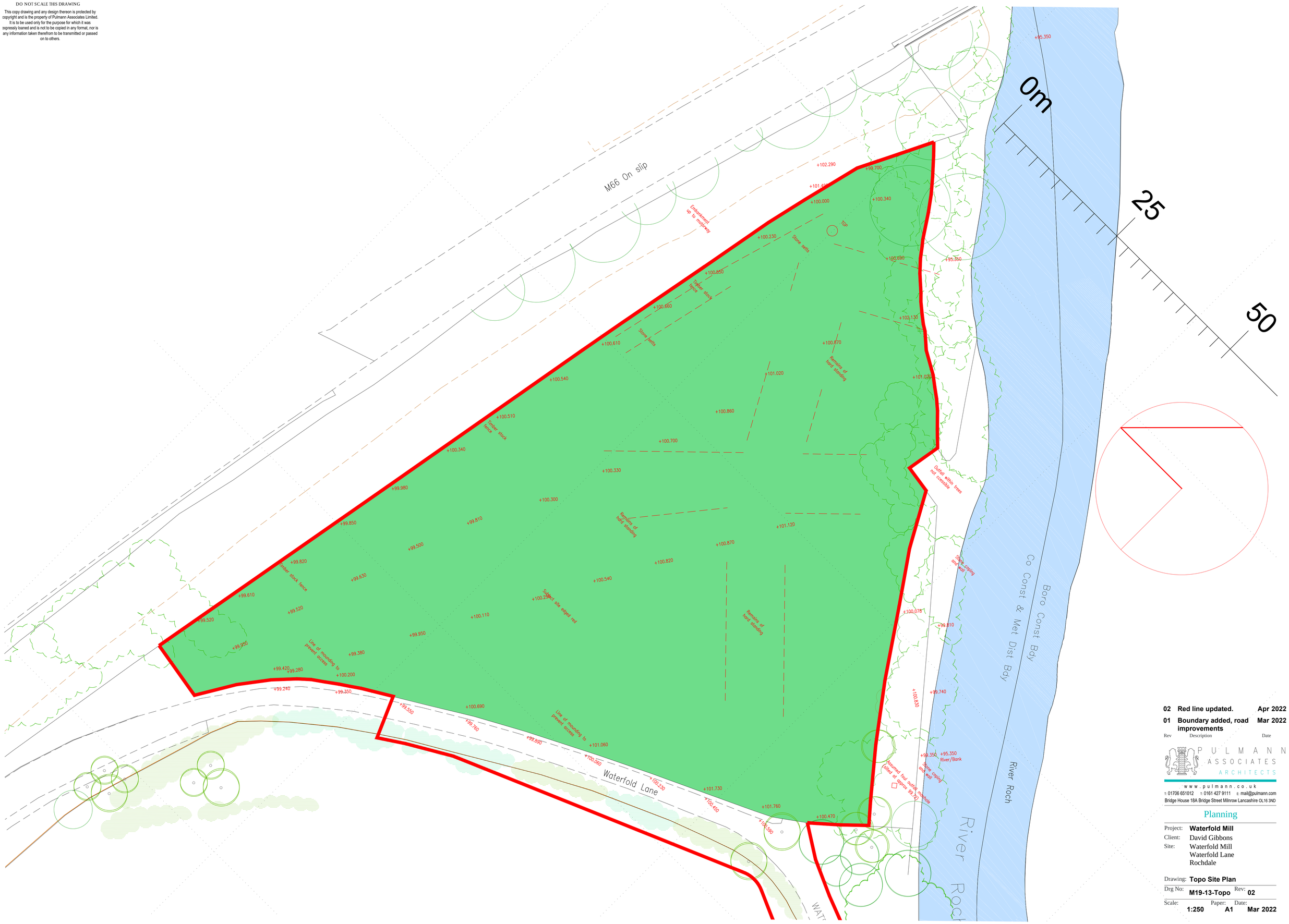

Rev	Description	Date
02	Red line updated.	Apr 2022
01	Boundary added, road improvements	Mar 2022

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t: 01706 651012 f: 0161 427 9111 e: mail@pulmann.com
Bridge House 18A Bridge Street Milnrow Lancashire OL16 3ND

Planning

Project: **Waterfold Mill**
Client: David Gibbons
Site: Waterfold Mill
Waterfold Lane
Rochdale

Drawing: **Topo Site Plan**
Drg No: **M19-13-Topo** Rev: **02**
Scale: **1:250** Paper: **A1** Date: **Mar 2022**

nicola@nsugg.co.uk

From: GMMC Info Requests <InfoRequests.GMMC@environment-agency.gov.uk>
Sent: 21 October 2021 12:12
To: nicola@nsugg.co.uk
Subject: GMMC237603AB Response attached from the Environment Agency

Dear Nicola,

Re: Flood Risk Information Request (Product 4) - Waterfold Lane, Heywood, Bury, Greater Manchester

Thank you for your enquiry which was received on 18/10/21.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

I enclose the data requested.

There are no flood defences in the vicinity of the site.

There are no 2D levels available for this site

There is no flood hazard mapping available for this site.

Please be aware you can check your risk of flooding on our external website https://flood-warning-information.service.gov.uk/long-term-flood-risk/

Here are some useful links below:

https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

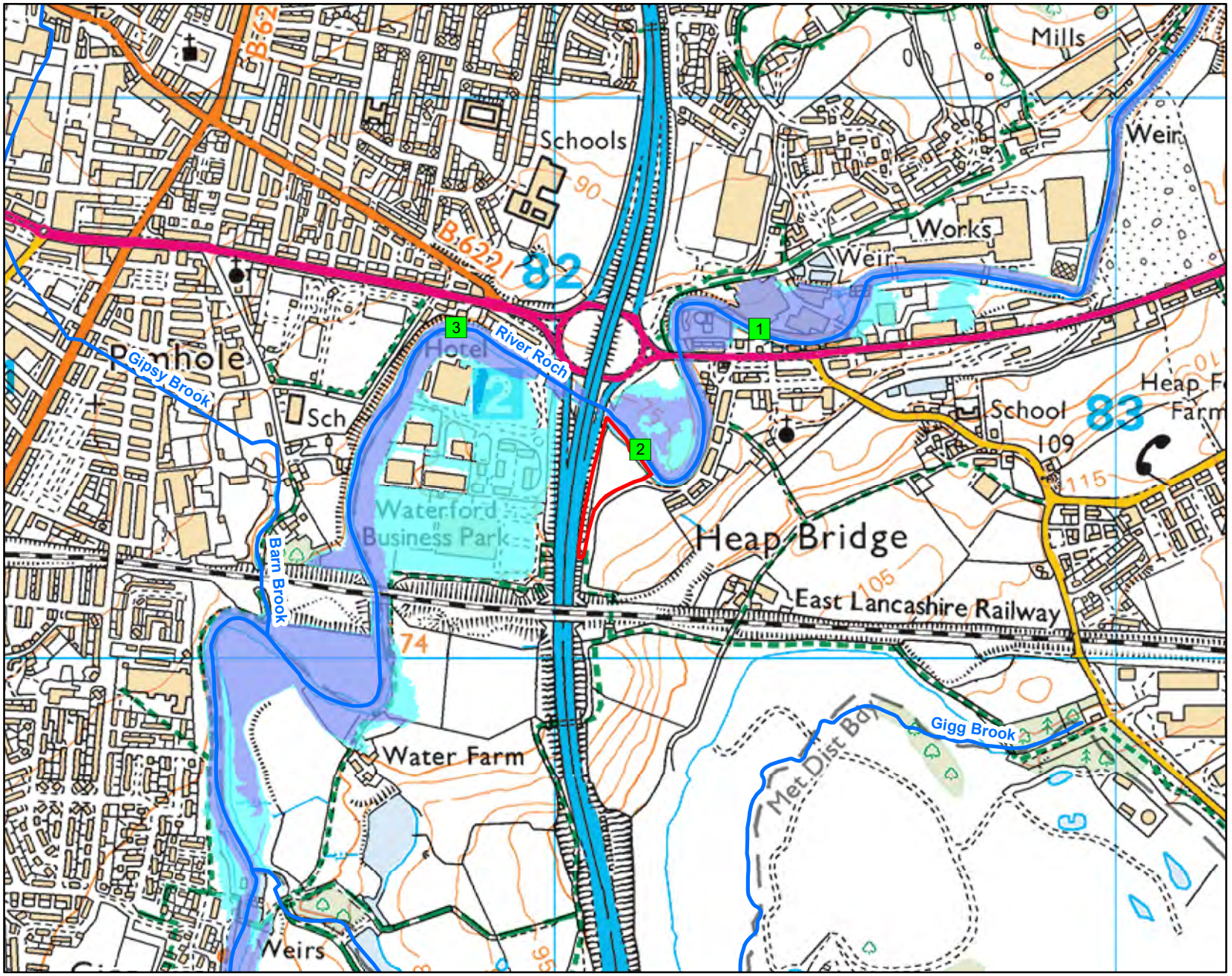
Please refer to the Open Government Licence which explains the permitted use of this information.

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

Kind regards,

Anne Ball
Customer and Engagement Officer
Greater Manchester, Merseyside and Cheshire
Email: Inforequests.gmmc@environment-agency.gov.uk

Detailed Flood Map centred on Waterfold Lane, Heywood, Bury, Greater Manchester BL9 7JY.
Created on 19/10/2021 [GMMC237603AB]



Environment Agency

1:10,001

N

Legend

- Site Location
- Model Measurements
- Main River
- Flood Zone 3
- Flood Zone 2

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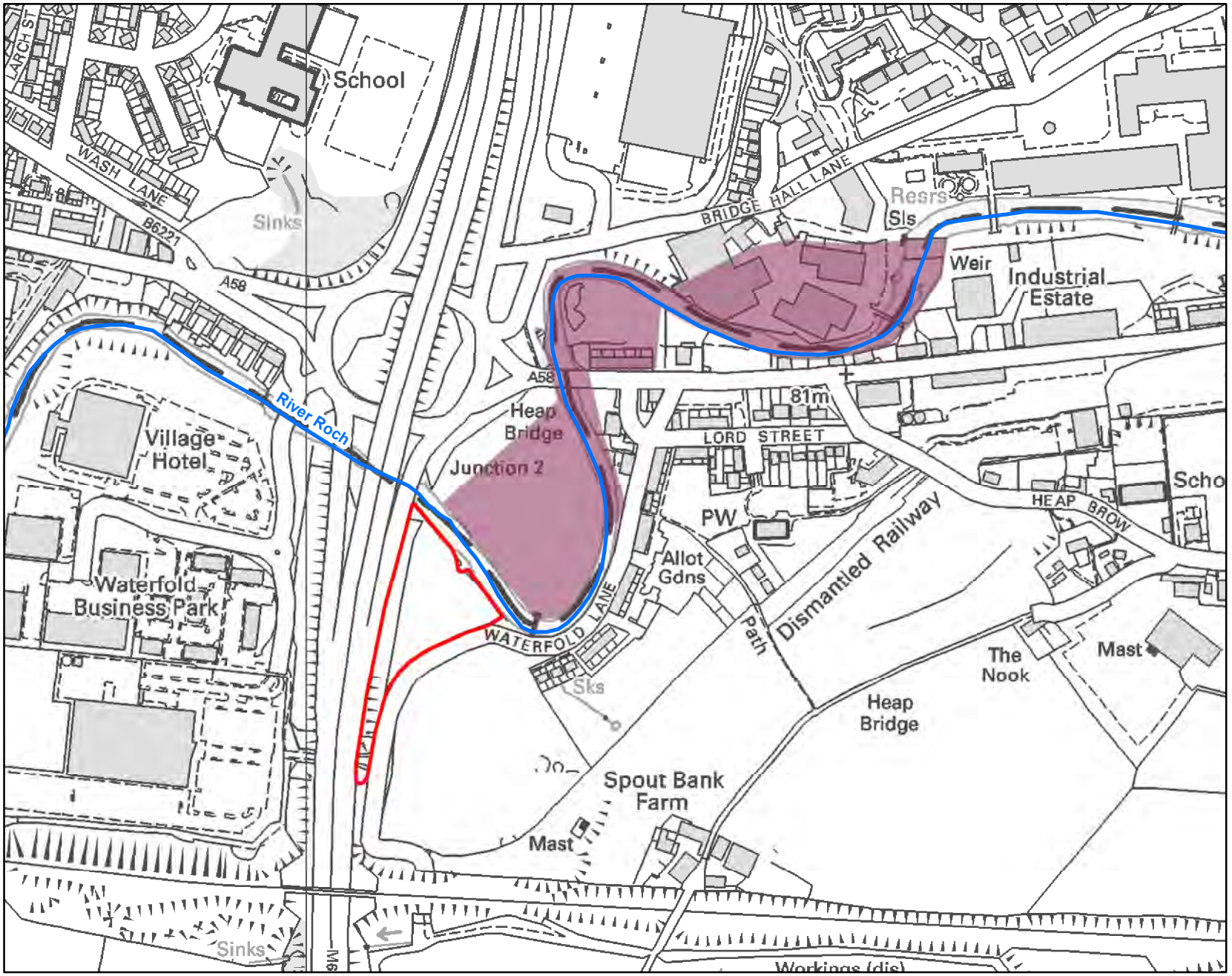
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Recorded Flood Outline Map centred on Waterfold Lane, Heywood, Bury, Greater Manchester BL9 7JY.
Created on 19/10/2021 [GMMC237603AB]



Environment Agency

1:5,000

N

Legend

Site Location

Main River

Recorded Flood Outlines

Start Date

26/12/2015

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					Undefended															Defended																	
Map Reference	Model Node Reference	Easting	Northing	Data	50 % AEP (1 in 2 year)	20 % AEP (1 in 5 year)	10 % AEP (1 in 10 year)	5 % AEP (1 in 20 year)	4 % AEP (1 in 25 year)	2 % AEP (1 in 50 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 30% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)	0.1 % AEP (1 in 1000 year) + 30% increase in flow	50 % AEP (1 in 2 year)	20 % AEP (1 in 5 year)	10 % AEP (1 in 10 year)	5 % AEP (1 in 20 year)	4 % AEP (1 in 25 year)	2 % AEP (1 in 50 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 30% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)	0.1 % AEP (1 in 1000 year) + 30% increase in flow
1	ROCH02_01547	382367	415587	Modelled Water Level (m ausNZ)	76.16	76.48	76.70	76.82	76.89	77.22	77.53	77.61	77.74	77.81	78.20	77.03	78.01	78.54	74.44	76.76	76.97	77.18	77.24	77.43	77.63	77.80	77.91	77.98	78.41	77.71	78.21	78.78
				Modelled Flow (cumecs)	57.94	73.96	85.96	98.58	102.69	114.75	120.99	125.05	132.04	137.34	146.24	140.16	173.41	210.89	57.94	73.96	85.96	98.58	102.85	116.63	124.17	130.07	134.59	138.29	156.30	176.59	144.50	170.73	192.40
2	ROCH02_00964	382155	415372	Modelled Water Level (m ausNZ)	74.25	74.53	74.72	74.92	74.98	75.19	75.31	75.40	75.90	75.96	76.49	75.51	76.27	76.82	74.35	74.83	75.02	75.20	75.26	75.46	75.58	75.69	76.20	76.30	76.88	75.96	76.63	77.29
				Modelled Flow (cumecs)	57.94	73.96	85.95	98.55	102.62	117.67	126.75	133.47	174.03	182.22	230.37	196.48	268.27	275.40	57.94	73.96	85.95	98.56	102.63	117.71	126.75	134.51	150.79	151.38	153.05	146.29	152.56	153.31
3	ROCH02_00992	381926	415590	Modelled Water Level (m ausNZ)	73.24	73.54	73.74	73.93	73.98	74.16	74.25	74.32	74.71	74.77	75.14	74.25	74.98	75.38	73.53	73.81	74.00	74.18	74.24	74.42	74.52	74.61	74.99	75.06	75.41	74.83	75.27	75.68
				Modelled Flow (cumecs)	57.92	73.93	85.92	98.52	102.60	117.65	126.73	133.45	173.40	181.28	219.77	196.40	204.35	238.74	57.92	73.94	85.93	98.53	102.60	117.65	126.90	134.94	173.40	180.42	220.15	198.40	204.48	237.02

Model data taken from Live or Reich 2017 Study

AEP - Annual Exceedence Probability

m ausNz - metres above ordnance datum New lyn

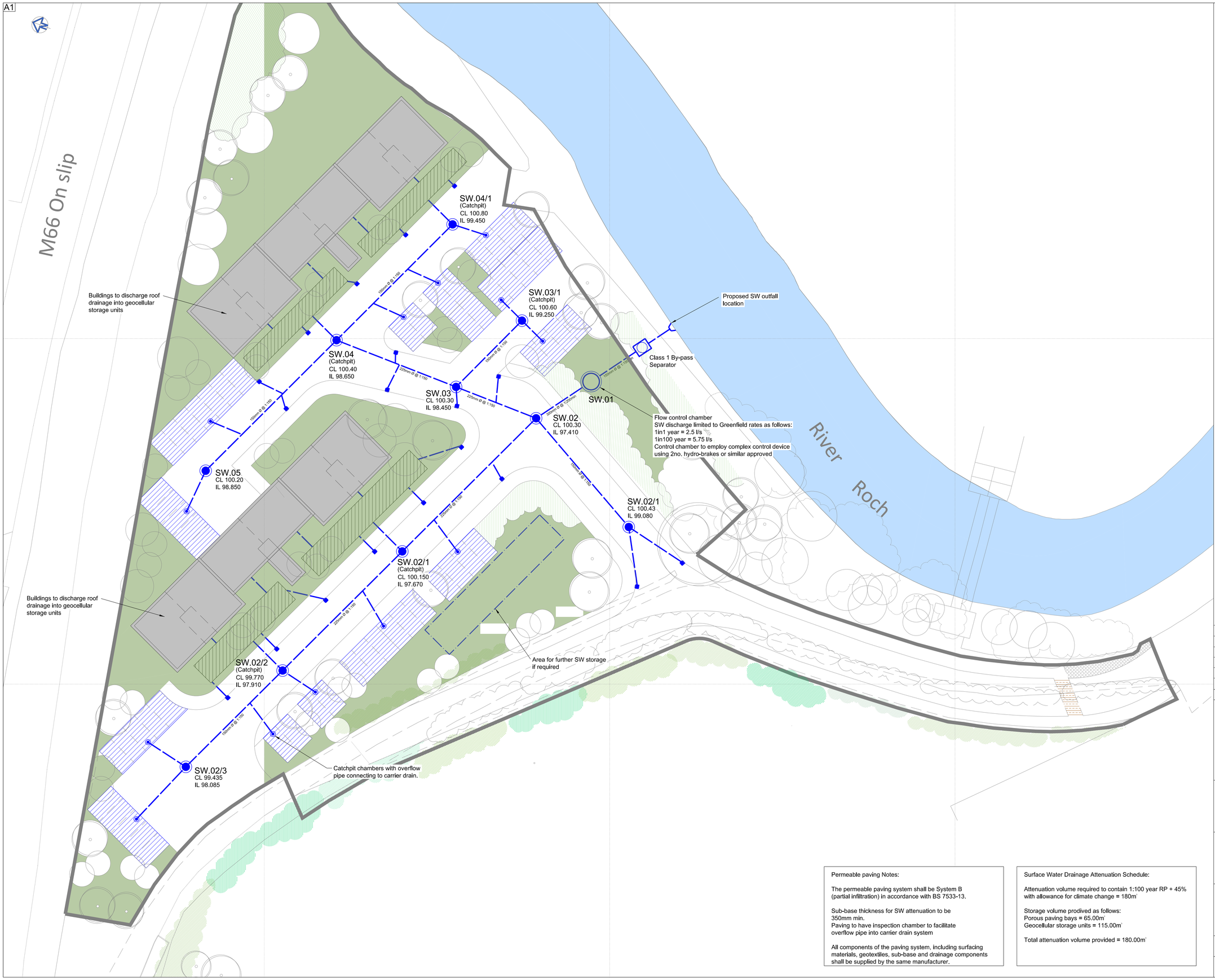
cumecs - cubic metres per second

Notes: Climate Change Scenario - 30%, 35% and 70% increases in flow calculated for the 2080's (2070 - 2115). Please see https://w w w .gov.uk/guidance/flood-risk-assessments-climate-change-allow ances for more information regarding the new climate change guidance. The location of the site and the type (vulnerability) of development determine the climate change allow ances to consider in any flood risk assessment.

Recorded Flood Outlines

Flood Event Code	Name	Start Date	End Date	Source of Flooding	Cause of Flooding
4079983	Heap Bridge	26/12/2015	26/12/2015	Main River	channel capacity exceeded (no raised defences)

A1



Legend

- Proposed SW drainage
- Proposed SW tank sewer
- Proposed road gulley
- Proposed parking bay catchpit
- Permeable paving
- Geocellular Storage Units

Drainage Strategy Notes:

1. This drawing has been produced for planning approval only, not to be used for construction.

2. The existing site drainage has not been surveyed, therefore it is not possible to reuse the existing drainage connection to the Public Sewer Network.

3. Proposed discharge rates to be agreed with Local Planning Authority and Environment Agency.

5. Surface water attenuation sized to contain 1:100 year rainfall events with 45% allowance for climate change.

6. Requirements for permits and consents for SW outfall into River Roch to be confirmed with Environment Agency

7. Development levels to be confirmed (by others)

Permeable paving Notes:

The permeable paving system shall be System B (partial infiltration) in accordance with BS 7533-13.

Sub-base thickness for SW attenuation to be 350mm min.
Paving to have inspection chamber to facilitate overflow pipe into carrier drain system

All components of the paving system, including surfacing materials, geotextiles, sub-base and drainage components shall be supplied by the same manufacturer.

Surface Water Drainage Attenuation Schedule:

Attenuation volume required to contain 1:100 year RP + 45% with allowance for climate change = 180m³

Storage volume prodived as follows:
Porous paving bays = 65.00m³
Geocellular storage units = 115.00m³

Total attenuation volume provided = 180.00m³

Rev	Date	Name	Check	
02	11/07/22	RLC	RLC	
Updated to suit revised Layout, Issued for Planning Approval				
01	07/01/22	RLC	RLC	
Issued for Planning Approval				

RLC
Consulting Ltd
10 Hillburn Rd
St. George
Bristol
BS5 7PW
tel: 07723 757015
email: richc73@blueyonder.co.uk

Client

EARTH ENVIRONMENTAL & GEOTECHNICAL

Project

Waterfold Mill, Heywood

Drawing

Surface Water Drainage Strategy

Scale	Drawing Status	
1:250	**Planning**	
Job No	Drawing No	Revision
030	**D001**	**02**

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Richard Clapp
Site name:	Waterfold Mill
Site location:	Bury

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

Site Details

Latitude:	53.58935° N
Longitude:	2.27185° W
Reference:	3573896063
Date:	Jul 08 2022 13:46

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.351

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics	Default	Edited
SAAR (mm):	1063	1063
Hydrological region:	10	10
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	1.7	1.7
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

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

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

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	2.76	2.76
1 in 1 year (l/s):	2.4	2.4
1 in 30 years (l/s):	4.7	4.7
1 in 100 year (l/s):	5.75	5.75
1 in 200 years (l/s):	6.55	6.55

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

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	Waterfold Mill, Heywood SW drainage Calculations 1:1 year	
Date 08/07/2022 File Storage Vol_1year.SRCX	Designed by RLC Checked by RLC	
XP Solutions	Source Control 2020.1.3	

Summary of Results for 1 year Return Period

Half Drain Time : 165 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.600	0.100	0.0	1.7	1.7	16.6	O K
30 min Summer	98.628	0.128	0.0	1.8	1.8	21.3	O K
60 min Summer	98.657	0.157	0.0	1.9	1.9	26.1	O K
120 min Summer	98.680	0.180	0.0	2.0	2.0	29.9	O K
180 min Summer	98.690	0.190	0.0	2.0	2.0	31.6	O K
240 min Summer	98.696	0.196	0.0	2.0	2.0	32.6	O K
360 min Summer	98.701	0.201	0.0	2.0	2.0	33.3	O K
480 min Summer	98.699	0.199	0.0	2.0	2.0	33.0	O K
600 min Summer	98.695	0.195	0.0	2.0	2.0	32.4	O K
720 min Summer	98.690	0.190	0.0	2.0	2.0	31.5	O K
960 min Summer	98.678	0.178	0.0	2.0	2.0	29.6	O K
1440 min Summer	98.654	0.154	0.0	1.9	1.9	25.7	O K
2160 min Summer	98.626	0.126	0.0	1.8	1.8	21.0	O K
2880 min Summer	98.605	0.105	0.0	1.7	1.7	17.5	O K
4320 min Summer	98.583	0.083	0.0	1.5	1.5	13.8	O K
5760 min Summer	98.571	0.071	0.0	1.3	1.3	11.7	O K
7200 min Summer	98.563	0.063	0.0	1.2	1.2	10.5	O K
8640 min Summer	98.558	0.058	0.0	1.1	1.1	9.6	O K
10080 min Summer	98.554	0.054	0.0	1.0	1.0	8.9	O K
15 min Winter	98.612	0.112	0.0	1.8	1.8	18.6	O K
30 min Winter	98.645	0.145	0.0	1.9	1.9	24.0	O K
60 min Winter	98.677	0.177	0.0	2.0	2.0	29.5	O K
120 min Winter	98.705	0.205	0.0	2.0	2.0	34.1	O K
180 min Winter	98.715	0.215	0.0	2.0	2.0	35.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	27.111	0.0	17.1	24
30 min Summer	17.900	0.0	22.8	37
60 min Summer	11.517	0.0	30.0	64
120 min Summer	7.285	0.0	38.0	114
180 min Summer	5.550	0.0	43.5	146
240 min Summer	4.572	0.0	47.8	180
360 min Summer	3.471	0.0	54.4	248
480 min Summer	2.839	0.0	59.4	318
600 min Summer	2.428	0.0	63.5	386
720 min Summer	2.137	0.0	67.1	454
960 min Summer	1.748	0.0	73.1	586
1440 min Summer	1.318	0.0	82.6	842
2160 min Summer	0.994	0.0	94.0	1200
2880 min Summer	0.813	0.0	102.4	1560
4320 min Summer	0.612	0.0	115.5	2256
5760 min Summer	0.501	0.0	126.6	2992
7200 min Summer	0.429	0.0	135.5	3680
8640 min Summer	0.379	0.0	143.2	4408
10080 min Summer	0.340	0.0	150.0	5144
15 min Winter	27.111	0.0	19.3	24
30 min Winter	17.900	0.0	25.6	38
60 min Winter	11.517	0.0	33.6	64
120 min Winter	7.285	0.0	42.6	118
180 min Winter	5.550	0.0	48.7	164

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	Waterfold Mill, Heywood SW drainage Calculations 1:1 year
Date 08/07/2022 File Storage Vol_1year.SRCX	Designed by RLC Checked by RLC
XP Solutions	Source Control 2020.1.3

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	98.721	0.221	0.0	2.0	2.0	36.7	O K
360 min Winter	98.723	0.223	0.0	2.0	2.0	37.1	O K
480 min Winter	98.717	0.217	0.0	2.0	2.0	36.1	O K
600 min Winter	98.709	0.209	0.0	2.0	2.0	34.8	O K
720 min Winter	98.700	0.200	0.0	2.0	2.0	33.2	O K
960 min Winter	98.680	0.180	0.0	2.0	2.0	29.9	O K
1440 min Winter	98.644	0.144	0.0	1.9	1.9	23.9	O K
2160 min Winter	98.605	0.105	0.0	1.7	1.7	17.5	O K
2880 min Winter	98.585	0.085	0.0	1.6	1.6	14.2	O K
4320 min Winter	98.566	0.066	0.0	1.2	1.2	11.0	O K
5760 min Winter	98.557	0.057	0.0	1.0	1.0	9.4	O K
7200 min Winter	98.551	0.051	0.0	0.9	0.9	8.4	O K
8640 min Winter	98.547	0.047	0.0	0.8	0.8	7.8	O K
10080 min Winter	98.544	0.044	0.0	0.7	0.7	7.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	4.572	0.0	53.5	192
360 min Winter	3.471	0.0	61.0	270
480 min Winter	2.839	0.0	66.5	346
600 min Winter	2.428	0.0	71.2	418
720 min Winter	2.137	0.0	75.2	490
960 min Winter	1.748	0.0	82.0	626
1440 min Winter	1.318	0.0	92.6	884
2160 min Winter	0.994	0.0	105.3	1236
2880 min Winter	0.813	0.0	114.7	1564
4320 min Winter	0.612	0.0	129.5	2260
5760 min Winter	0.501	0.0	141.8	2992
7200 min Winter	0.429	0.0	151.8	3680
8640 min Winter	0.379	0.0	160.5	4416
10080 min Winter	0.340	0.0	168.1	5144

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	Waterfold Mill, Heywood SW drainage Calculations 1:1 year	
Date 08/07/2022 File Storage Vol_1year.SRCX	Designed by RLC Checked by RLC	
XP Solutions	Source Control 2020.1.3	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.200	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.351

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.117	4	8	0.117	8	12	0.117

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	Waterfold Mill, Heywood SW drainage Calculations 1:1 year	
Date 08/07/2022 File Storage Vol_1year.SRCX	Designed by RLC Checked by RLC	
XP Solutions	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	175.0	175.0	1.000	175.0	230.0	1.100	0.0	230.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0068-2500-1500-2500
Design Head (m)	1.500
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	68
Invert Level (m)	98.500
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	2.5	Kick-Flo®	0.609	1.7
Flush-Flo™	0.300	2.0	Mean Flow over Head Range	-	2.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.7	0.800	1.9	2.000	2.9	4.000	3.9	7.000	5.1
0.200	2.0	1.000	2.1	2.200	3.0	4.500	4.2	7.500	5.3
0.300	2.0	1.200	2.3	2.400	3.1	5.000	4.4	8.000	5.4
0.400	2.0	1.400	2.4	2.600	3.2	5.500	4.6	8.500	5.6
0.500	1.9	1.600	2.6	3.000	3.4	6.000	4.8	9.000	5.8
0.600	1.7	1.800	2.7	3.500	3.7	6.500	4.9	9.500	5.9

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	Waterfold Mill, Heywood SW Calculations 1:300year + 40% CC
Date 08/07/2022 File Storage Vol_30year plus 40%.SRCX	Designed by RLC Checked by RLC
XP Solutions	Source Control 2020.1.3

Summary of Results for 30 year Return Period (+40%)

Half Drain Time : 233 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.833	0.333	0.0	4.5	4.5	56.9	O K
30 min Summer	98.934	0.434	0.0	4.5	4.5	74.2	O K
60 min Summer	99.031	0.531	0.0	4.5	4.5	90.7	O K
120 min Summer	99.106	0.606	0.0	4.5	4.5	103.7	O K
180 min Summer	99.129	0.629	0.0	4.5	4.5	107.5	O K
240 min Summer	99.132	0.632	0.0	4.5	4.5	108.0	O K
360 min Summer	99.122	0.622	0.0	4.5	4.5	106.4	O K
480 min Summer	99.106	0.606	0.0	4.5	4.5	103.6	O K
600 min Summer	99.085	0.585	0.0	4.5	4.5	100.1	O K
720 min Summer	99.063	0.563	0.0	4.5	4.5	96.3	O K
960 min Summer	99.018	0.518	0.0	4.5	4.5	88.6	O K
1440 min Summer	98.932	0.432	0.0	4.5	4.5	73.9	O K
2160 min Summer	98.826	0.326	0.0	4.5	4.5	55.8	O K
2880 min Summer	98.750	0.250	0.0	4.3	4.3	42.8	O K
4320 min Summer	98.660	0.160	0.0	3.9	3.9	27.3	O K
5760 min Summer	98.618	0.118	0.0	3.5	3.5	20.1	O K
7200 min Summer	98.600	0.100	0.0	3.1	3.1	17.2	O K
8640 min Summer	98.589	0.089	0.0	2.7	2.7	15.2	O K
10080 min Summer	98.581	0.081	0.0	2.4	2.4	13.8	O K
15 min Winter	98.875	0.375	0.0	4.5	4.5	64.1	O K
30 min Winter	98.990	0.490	0.0	4.5	4.5	83.8	O K
60 min Winter	99.102	0.602	0.0	4.5	4.5	102.9	O K
120 min Winter	99.195	0.695	0.0	4.5	4.5	118.8	O K
180 min Winter	99.229	0.729	0.0	4.5	4.5	124.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.869	0.0	60.4	25
30 min Summer	61.593	0.0	80.3	39
60 min Summer	39.159	0.0	102.8	66
120 min Summer	24.199	0.0	127.1	124
180 min Summer	18.072	0.0	142.4	180
240 min Summer	14.625	0.0	153.6	210
360 min Summer	10.795	0.0	170.1	272
480 min Summer	8.703	0.0	182.9	338
600 min Summer	7.359	0.0	193.3	408
720 min Summer	6.414	0.0	202.2	474
960 min Summer	5.160	0.0	216.9	610
1440 min Summer	3.793	0.0	239.1	870
2160 min Summer	2.784	0.0	263.6	1236
2880 min Summer	2.234	0.0	282.0	1588
4320 min Summer	1.636	0.0	309.6	2292
5760 min Summer	1.311	0.0	331.2	2944
7200 min Summer	1.103	0.0	348.3	3680
8640 min Summer	0.958	0.0	362.9	4408
10080 min Summer	0.850	0.0	375.5	5136
15 min Winter	92.869	0.0	67.8	25
30 min Winter	61.593	0.0	90.0	39
60 min Winter	39.159	0.0	115.1	66
120 min Winter	24.199	0.0	142.3	122
180 min Winter	18.072	0.0	159.5	178

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	Waterfold Mill, Heywood SW Calculations 1:300year + 40% CC
Date 08/07/2022 File Storage Vol_30year plus 40%.SRCX	Designed by RLC Checked by RLC
XP Solutions	Source Control 2020.1.3

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.236	0.736	0.0	4.5	4.5	125.9	O K
360 min Winter	99.217	0.717	0.0	4.5	4.5	122.7	O K
480 min Winter	99.193	0.693	0.0	4.5	4.5	118.5	O K
600 min Winter	99.162	0.662	0.0	4.5	4.5	113.1	O K
720 min Winter	99.127	0.627	0.0	4.5	4.5	107.2	O K
960 min Winter	99.054	0.554	0.0	4.5	4.5	94.8	O K
1440 min Winter	98.920	0.420	0.0	4.5	4.5	71.8	O K
2160 min Winter	98.772	0.272	0.0	4.4	4.4	46.5	O K
2880 min Winter	98.683	0.183	0.0	4.0	4.0	31.2	O K
4320 min Winter	98.609	0.109	0.0	3.3	3.3	18.7	O K
5760 min Winter	98.588	0.088	0.0	2.7	2.7	15.1	O K
7200 min Winter	98.577	0.077	0.0	2.3	2.3	13.2	O K
8640 min Winter	98.570	0.070	0.0	2.0	2.0	11.9	O K
10080 min Winter	98.565	0.065	0.0	1.8	1.8	11.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	14.625	0.0	172.1	234
360 min Winter	10.795	0.0	190.6	296
480 min Winter	8.703	0.0	204.9	370
600 min Winter	7.359	0.0	216.5	446
720 min Winter	6.414	0.0	226.5	520
960 min Winter	5.160	0.0	242.9	662
1440 min Winter	3.793	0.0	267.8	926
2160 min Winter	2.784	0.0	295.3	1284
2880 min Winter	2.234	0.0	315.9	1620
4320 min Winter	1.636	0.0	346.8	2252
5760 min Winter	1.311	0.0	370.9	2952
7200 min Winter	1.103	0.0	390.2	3680
8640 min Winter	0.958	0.0	406.5	4408
10080 min Winter	0.850	0.0	420.6	5128

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	Waterfold Mill, Heywood SW Calculations 1:300year + 40% CC
Date 08/07/2022 File Storage Vol_30year plus 40%.SRCX	Designed by RLC Checked by RLC
XP Solutions	Source Control 2020.1.3

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.200	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.351

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.117	4	8	0.117	8	12	0.117

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	Waterfold Mill, Heywood SW Calculations 1:300year + 40% CC	
Date 08/07/2022 File Storage Vol_30year plus 40%.SRCX	Designed by RLC Checked by RLC	
XP Solutions	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	180.0	180.0	1.000	180.0	236.0	1.100	0.0	236.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0095-4700-1500-4700
Design Head (m)	1.500
Design Flow (l/s)	4.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	95
Invert Level (m)	98.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	4.7	Kick-Flo®	0.848	3.6
Flush-Flo™	0.418	4.5	Mean Flow over Head Range	-	4.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	0.800	3.9	2.000	5.4	4.000	7.4	7.000	9.7
0.200	4.1	1.000	3.9	2.200	5.6	4.500	7.9	7.500	10.0
0.300	4.4	1.200	4.2	2.400	5.8	5.000	8.3	8.000	10.3
0.400	4.5	1.400	4.5	2.600	6.1	5.500	8.6	8.500	10.6
0.500	4.5	1.600	4.8	3.000	6.5	6.000	9.0	9.000	10.9
0.600	4.4	1.800	5.1	3.500	7.0	6.500	9.4	9.500	11.2

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	Waterfold Mill, Heywood SW Calculations 1:100year + 40% CC
Date 08/07/2022 File Storage Vol_100year plus	Designed by RLC Checked by RLC
XP Solutions	Source Control 2020.1.3

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

Half Drain Time : 260 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.945	0.445	0.0	5.8	5.8	76.0	O K
30 min Summer	99.087	0.587	0.0	5.8	5.8	100.4	O K
60 min Summer	99.224	0.724	0.0	5.8	5.8	123.8	O K
120 min Summer	99.334	0.834	0.0	5.8	5.8	142.7	O K
180 min Summer	99.370	0.870	0.0	5.8	5.8	148.8	O K
240 min Summer	99.372	0.872	0.0	5.8	5.8	149.1	O K
360 min Summer	99.346	0.846	0.0	5.8	5.8	144.7	O K
480 min Summer	99.316	0.816	0.0	5.8	5.8	139.5	O K
600 min Summer	99.283	0.783	0.0	5.8	5.8	133.9	O K
720 min Summer	99.249	0.749	0.0	5.8	5.8	128.0	O K
960 min Summer	99.181	0.681	0.0	5.8	5.8	116.5	O K
1440 min Summer	99.057	0.557	0.0	5.8	5.8	95.2	O K
2160 min Summer	98.906	0.406	0.0	5.8	5.8	69.4	O K
2880 min Summer	98.801	0.301	0.0	5.6	5.6	51.4	O K
4320 min Summer	98.681	0.181	0.0	5.1	5.1	31.0	O K
5760 min Summer	98.629	0.129	0.0	4.6	4.6	22.1	O K
7200 min Summer	98.609	0.109	0.0	3.9	3.9	18.6	O K
8640 min Summer	98.596	0.096	0.0	3.4	3.4	16.4	O K
10080 min Summer	98.587	0.087	0.0	3.0	3.0	14.9	O K
15 min Winter	99.001	0.501	0.0	5.8	5.8	85.7	O K
30 min Winter	99.163	0.663	0.0	5.8	5.8	113.4	O K
60 min Winter	99.322	0.822	0.0	5.8	5.8	140.6	O K
120 min Winter	99.461	0.961	0.0	5.8	5.8	164.3	O K
180 min Winter	99.512	1.012	0.0	5.8	5.8	172.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	124.228	0.0	81.1	25
30 min Summer	83.202	0.0	108.8	39
60 min Summer	53.243	0.0	139.8	68
120 min Summer	32.966	0.0	173.2	124
180 min Summer	24.572	0.0	193.7	182
240 min Summer	19.824	0.0	208.4	236
360 min Summer	14.532	0.0	229.2	288
480 min Summer	11.665	0.0	245.3	348
600 min Summer	9.829	0.0	258.4	414
720 min Summer	8.541	0.0	269.4	482
960 min Summer	6.837	0.0	287.6	614
1440 min Summer	4.988	0.0	314.6	872
2160 min Summer	3.632	0.0	344.0	1236
2880 min Summer	2.896	0.0	365.6	1588
4320 min Summer	2.101	0.0	397.7	2260
5760 min Summer	1.671	0.0	422.3	2944
7200 min Summer	1.399	0.0	441.6	3672
8640 min Summer	1.209	0.0	457.9	4408
10080 min Summer	1.068	0.0	471.9	5136
15 min Winter	124.228	0.0	90.9	25
30 min Winter	83.202	0.0	121.9	39
60 min Winter	53.243	0.0	156.7	66
120 min Winter	32.966	0.0	194.1	124
180 min Winter	24.572	0.0	217.0	180

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	Waterfold Mill, Heywood SW Calculations 1:100year + 40% CC
Date 08/07/2022 File Storage Vol_100year plus	Designed by RLC Checked by RLC
XP Solutions	Source Control 2020.1.3

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.530	1.030	0.0	5.8	5.8	174.7	O K
360 min Winter	99.494	0.994	0.0	5.8	5.8	170.0	O K
480 min Winter	99.452	0.952	0.0	5.8	5.8	162.8	O K
600 min Winter	99.402	0.902	0.0	5.8	5.8	154.3	O K
720 min Winter	99.347	0.847	0.0	5.8	5.8	144.8	O K
960 min Winter	99.237	0.737	0.0	5.8	5.8	126.1	O K
1440 min Winter	99.042	0.542	0.0	5.8	5.8	92.7	O K
2160 min Winter	98.832	0.332	0.0	5.7	5.7	56.7	O K
2880 min Winter	98.712	0.212	0.0	5.3	5.3	36.2	O K
4320 min Winter	98.620	0.120	0.0	4.3	4.3	20.5	O K
5760 min Winter	98.596	0.096	0.0	3.4	3.4	16.5	O K
7200 min Winter	98.584	0.084	0.0	2.9	2.9	14.3	O K
8640 min Winter	98.576	0.076	0.0	2.5	2.5	12.9	O K
10080 min Winter	98.570	0.070	0.0	2.2	2.2	12.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	19.824	0.0	233.4	236
360 min Winter	14.532	0.0	256.7	340
480 min Winter	11.665	0.0	274.7	388
600 min Winter	9.829	0.0	289.4	460
720 min Winter	8.541	0.0	301.8	532
960 min Winter	6.837	0.0	322.1	670
1440 min Winter	4.988	0.0	352.4	930
2160 min Winter	3.632	0.0	385.3	1280
2880 min Winter	2.896	0.0	409.6	1616
4320 min Winter	2.101	0.0	445.5	2248
5760 min Winter	1.671	0.0	473.0	2944
7200 min Winter	1.399	0.0	494.7	3632
8640 min Winter	1.209	0.0	512.9	4320
10080 min Winter	1.068	0.0	528.6	5144

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	Waterfold Mill, Heywood SW Calculations 1:100year + 40% CC	
Date 08/07/2022 File Storage Vol_100year plus	Designed by RLC Checked by RLC	
XP Solutions	Source Control 2020.1.3	

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)	18.200	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.351

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.117	4	8	0.117	8	12	0.117

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	Waterfold Mill, Heywood SW Calculations 1:100year + 40% CC	
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Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	180.0	180.0	1.000	180.0	236.0	1.100	0.0	236.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0106-5800-1500-5800
Design Head (m)	1.500
Design Flow (l/s)	5.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	106
Invert Level (m)	98.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.8	Kick-Flo®	0.926	4.6
Flush-Flo™	0.453	5.8	Mean Flow over Head Range	-	5.1

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)	Depth (m)	Flow (l/s)
0.100	3.6	0.800	5.3	2.000	6.6	4.000	9.2	7.000	12.0
0.200	5.2	1.000	4.8	2.200	6.9	4.500	9.7	7.500	12.4
0.300	5.6	1.200	5.2	2.400	7.2	5.000	10.2	8.000	12.8
0.400	5.8	1.400	5.6	2.600	7.5	5.500	10.7	8.500	13.1
0.500	5.8	1.600	6.0	3.000	8.0	6.000	11.1	9.000	13.5
0.600	5.7	1.800	6.3	3.500	8.6	6.500	11.6	9.500	13.9

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