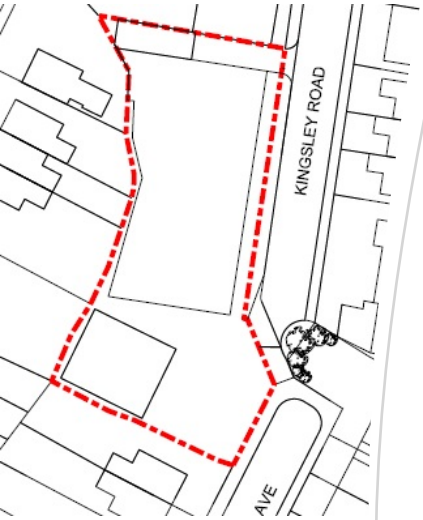

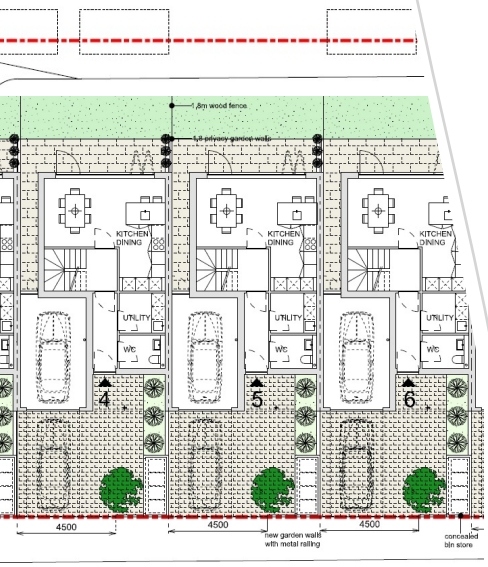

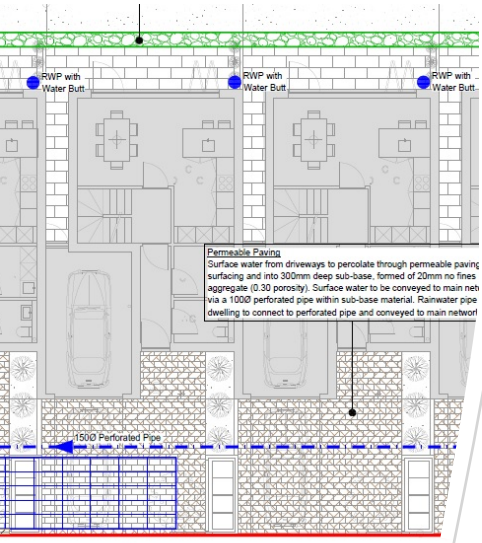

Earth Environmental
& Geotechnical

Residential Development
Kingsley Road
Northenden, Manchester

Surface Management Report

Revision A
May 2021

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Appendix I	Surface Water Management Calculations

Report Title:	Residential Development at Kingsley Road, Northenden, Manchester, M22 4NL
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1. Introduction

Earth Environmental and Geotechnical Ltd have produced this surface water management report to discharge Planning Condition 7 for a residential development at Kingsley Road, Northenden, Manchester, which states:

'No development shall take place until a surface water drainage scheme, designed in accordance with Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015) or any subsequent replacement national standards, have been submitted to and approved in writing by the Local Planning Authority. The submitted scheme shall include:

- *Results of ground investigation carried out under Building Research Establishment Digest 365. Site investigations should be undertaken in locations and at proposed depths of the proposed infiltration devices.*
- *Details of surface water attenuation that offers a reduction in surface water runoff rate in line with the Manchester Trafford and Salford Strategic Flood Risk Assessment, i.e. at least a 50% reduction in runoff rate compared to the existing rates, as the site is located within Critical Drainage Area;*
- *Runoff volume in the 1 in 100-year, 6 hours rainfall shall be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but never to exceed the runoff volume from the development site prior to redevelopment;*
- *Evidence that the drainage system has been designed so that flooding does not occur during a 1 in 100-year rainfall event with allowance for climate change in any part of a building;*
- *Assessment of overland flow routes for extreme events that is diverted away from buildings (including basements);*
- *Hydraulic calculation of the existing and proposed drainage system and construction details of flow control and SuDS elements'.*

This report describes and demonstrates how the surface water run-off from the post development area will be managed to adhere to national and local planning policy, regulations, and relevant design guidance, which include:

- National Planning Policy Framework (NPPF) 2019 Paragraphs 149-150 and 155-165;
- National Planning Practice Guidance (NPPG);
- Principles of Sustainable drainage systems (SuDS) set out by DEFRA (2011);
- Ciria SuDS Manual C753 (2015);
- Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015);
- Manchester City, Salford City and Trafford Councils Level 1 SFRA (May 2010);
- Manchester City, Salford City and Trafford Councils Level 2 SFRA (March 2011);
- Manchester City Council – Local Flood Risk Management Strategy (March 2014);
- Manchester Local Development Framework – Core Strategy Development Plan (July 2012).

Manchester City Council (acting as Lead Local Flood Authority - LLFA) need to be satisfied that the design and drainage principles of the proposed development will address the surface water management and risk of flooding within the site; will ensure that the drainage is managed and maintained for its lifetime to prevent flooding; and will ensure that the development will not increase the risk of flooding to neighbouring land and property.

2. National Policies and Water Management Guidance

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

The NPPF 2019 sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development can be produced. This document is used to form this surface water management report, with particular attention to Paragraphs 149 to 154 Planning for Climate Change, and Paragraphs 155 to 165 Planning for Flood Risk.

NPPG, Paragraph 051 states that sustainable drainage systems (SuDS) are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible, where they provide opportunities to reduce the causes and impacts of flooding; remove pollutants from urban run-off at source; and to combine water management with green space with benefits for amenity, recreation, and wildlife.

Further to this NPPG, Paragraph 080 states that the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable which (in order) are into the ground (infiltration); to a surface water body; to a surface water sewer, highway drain, or another drainage system; to a combined sewer.

2.2. Flood and Water Management Act

The Flood and Water Management Act takes forward some of the proposals from three previous strategy documents published by the UK Government - Future Water (2008), Making Space for Water (2008) and the UK Government's response to the Sir Michael Pitt's Review of the summer 2007 floods. In doing so it gives the EA a strategic overview role for flood risk, and gives local authorities responsibility for preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses in their areas.

2.3. Manchester Local Development Framework – Core Strategy Development Plan

Relevant Policy EN 08 states:

'All new development will be expected to be adaptable to climate change in terms of the design, layout, siting, and function of both buildings and associated external spaces. In achieving developments which are adaptable to climate change developers should minimise flood risk by appropriate siting, drainage, and treatment of surface areas to ensure rainwater permeability, and will be permitted to use green infrastructure elements such as green roofs'.

Relevant Policy EN 14 states:

'All new development should minimise surface water run-off, including through Sustainable Drainage Systems (SUDS) and the appropriate use of Green Infrastructure. Developers should have regard to the surface water run-off rates in the SFRA User Guide. In CDAs, evidence to justify the surface water run-off approach / rates will be required'.

Relevant Policy EN 17 states:

'Development should avoid any adverse impact on water quality, including during the construction phase, and wherever possible should seek to enhance water quality, both chemical and ecological; Development should minimise surface water run-off from development and associated roads, and maximise the use of appropriate sustainable drainage systems, to minimise groundwater contamination, and to avoid pollutants reaching watercourses; Development close to a watercourse should also ensure that waste or litter cannot enter the watercourse from the site; Development should, where feasible and appropriate, seek to open up any culverted or hidden watercourse beneath the site to improve the ecological status of that watercourse'.

3. Site Setting and Description

3.1. Site Location

The development site located in a residential area of Northenden, is approximately 1kmm north west of Gatley train station, approximately 1 km west East Didsbury train station, and as shown in Appendix A, is bound by a dwelling at No.16 Kingsley Road to the north; Kingsley Road to the east; residential dwellings leading onto Beach Avenue to the south; and residential dwellings leading onto Chapel Road to the west.

The full site address of the site is 18 and 18a Kingsley Road, Northenden, Manchester, with the nearest postcode being M22 4NL, and the co-ordinates of the centre of the site being: Easting: 382900, Northing: 389949.

3.2. Existing Site

As detailed in Appendix B, the existing site currently consists of a large commercial building which covers most of the northern and central site areas; a car park / service yard to the south east of the site; and a smaller commercial building to the south west of the site. All of the existing site is impermeable / developed and therefore is classed as a brownfield site.

In term of topography the site is relatively flat, with a slight fall in a south west to north east direction (towards Kingsley Road), and an approximate average level of 32.00m AOD.

3.3. Proposed Development

The full description of the development site is to be stated by the Architect, with a detailed plan shown in Appendix C. In brief, and as stated on the planning decision notice, the development is the:

'Erection of 8no dwelling house comprising of 2no. two storey semi-detached and 6no. three storey terraced townhouses together with associated car parking, landscaping and boundary treatment'.

The commercial buildings will be demolished, and the new residential units will be built through the centre of the site, with the driveways and access routes being to the front of the units / east of the site (adjacent to Kingsley Road and Beech Avenue), and patio with garden areas being to the rear of the units / west of the site.

3.4. Ground Conditions

A ground investigation and infiltration tests are yet to take place at the development site. However, data for the ground conditions can be sourced from the British Geological Survey (BGS) website, where it identifies the development site to have superficial deposits of Devensian (sand and gravel), over bedrock consisting of Tarporley Siltstone Formation (siltstone, mudstone, and sandstone).

The BGS website also shows borehole log data from areas within 150m of the site and within the same superficial deposit / strata (see Figure 1 for location and Appendix D for details), which identify the strata of the ground to predominantly consist of clay. The data between the boreholes is consistent, and therefore it is assumed that the ground at the development site predominantly consist of clay.

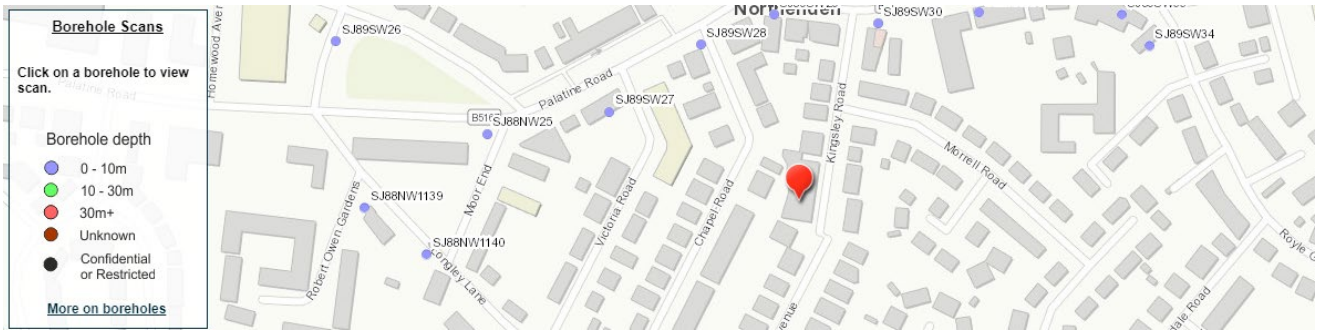


Figure 1 – BGS Borehole Location

3.5. Waterbodies

There are no known waterbodies, rivers, canals, or reservoirs directly adjacent to the development site, with the nearest main waterbody being the River Mersey approximately 500m to the north west.

3.6. Public Sewers and On-Site Drainage

As detailed on the United Utilities asset plans in Appendix E, there is a 225mm diameter combined water sewer within Kingsley Road (east of site), that flows in a northerly direction.

An on-site drainage survey is yet to take place. However, as all of the pre-development site consists of buildings and external hard-standing areas, it is believed that the surface water run-off discharge to a below ground drainage network, prior to connection / discharge to the combined sewer within Kingsley Road.

3.7. Development Areas

The development site boundary area equates to approximately 1,560m² / **0.156 ha**.

The pre-development site consists of the existing commercial buildings and external hard-standing areas, with all the site deemed to be impermeable.

The surface water run-off from the existing building and hard standing areas is believed to discharge to an existing surface water network (and subsequently to the combined water sewer), and therefore for the purpose of the surface water management calculations, the urban factor is deemed to be 1.00 (0.75 and 0.50 maximum factors for run-off rate and volume calculations, respectively) and a pre-development run-off area equating to **0.156 ha**.

The post development site consists of the new dwellings, driveways, footpaths, and patio areas, which equate to approximately 1,100m² / 0.110 ha, and the garden area to the rear, which is deemed to be permeable, which equates to approximately 460m² / 0.046 ha.

The surface water run-off from the new dwellings, driveways, footpaths, and patio areas will discharge to a new below ground drainage network, with the surface water run-off from the garden areas discharging off the site at a natural / greenfield rate.

Therefore, for the purpose of the surface water management calculations, the post development surface water run-off management area will equate to **0.110 ha**.

4. Surface Water Management Principles

4.1. Run-Off Destination

Surface water run-off is to discharge to one or more of the following in the order of priority shown: Discharge into the ground (infiltration); Discharge to a surface water body; Discharge to a surface water sewer, highway drain or other drain; Discharge to combined sewer.

4.2. The Management Train

A concept fundamental to implementing a successful SuDS scheme is the management train. This is a sequence of SuDS components that serve to reduce run-off rates and volumes and reduce pollution. The hierarchy of techniques that are to be used for the surface water management of the development are: Prevention - Prevention of run-off by good site design and reduction of impermeable areas; Source Control - Dealing with water where and when it falls (e.g. infiltration techniques); Site Control - Management of water in the local area (e.g. swales, detention basins); Regional Control - Management of run-off from sites (e.g. balancing ponds, wetlands).

4.3. Design Principles

The design principles for the surface water management of the development will be to: Ensure that people, property and critical infrastructure are protected from flooding; Ensure that the development does not increase flood risk off site; Ensure that SuDS can be economically maintained for the development.

4.4. Peak Surface Water Flow

The peak surface water flow from the post development site is to adhere to the NPPF guidance, Manchester City, Salford City and Trafford Councils SFRA, and as stated in Condition 7 of the planning consent, where:

'The surface water run-off rate to be at least a 50% reduction in run-off rate compared to the existing rates.'

4.5. Surface Water Run-Off Volume

The surface water run-off volume is to adhere to Condition 7 of the planning consent notice, which states:

Run-off *volume in the 1 in 100-year, 6 hours rainfall shall be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but never to exceed the run-off volume from the development site prior to redevelopment.*

4.6. Flood Risk

The prevention of flood risk is to adhere to Condition 7 of the planning consent notice, which states:

'Evidence that the drainage system has been designed so that flooding does not occur during a 1 in 100-year rainfall event with allowance for climate change in any part of a building';

4.7. Pollution

The SuDS design for the development site will ensure that the quality of any receiving water body is not adversely affected and preferably enhanced in accordance with Ciria SuDS Manual C753, Chapter 4.

4.8. Designing for Exceedance

The development site design will be such that when SuDS features fail or are exceeded, exceedance flows do not cause flooding of properties on or off site. This is achieved by completely containing the surface water within the drainage system (including areas designed to hold or convey water) for all events up to a 1 in 30-year event. The design of the site ensures that flows from rainfall more than a 1 in 100-year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site.

5. Surface Water Run-Off Destination

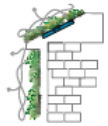
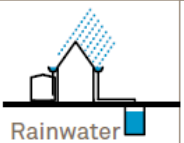
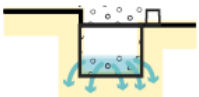
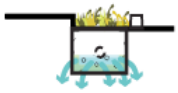
The destination of the surface water run-off from the post development site has been assessed against the prioritisation set by the Approved Document H (2010). The feasibility of the surface water run-off to the priority receptors are as follows:

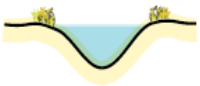
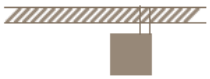
Run-Off Destination	Feasible	Description
Discharge to Ground	No	BGS data identifies the development site to have superficial deposits of Devensian (sand and gravel), over bedrock consisting of Tarporley Siltstone Formation (siltstone, mudstone, and sandstone). The BGS borehole log data within the same strata also identifies the strata of the ground to predominantly consist of clay. As the boreholes are consistent, it is assumed therefore that the ground at the development site predominantly consist of clay (exceptionally low infiltration value), and therefore discharging the surface water to ground will not be feasible.
Discharge to Surface Water Body	No	There are no known waterbodies near to the development site, and therefore discharge of the surface water to a waterbody is not feasible.
Discharge to Surface Water Sewer	No	There are no known surface water sewers near to the development site, and therefore discharge of the surface water to a surface water sewer is not feasible.
Discharge to Highway Drain or Other	No	There are no known highway drains or other drains near the development site, and therefore discharge to a highway or other drain is not a feasible destination.
Discharge to Combined Water Sewer	**Yes**	As the ground is not suitable for infiltration, and there are no known waterbodies, surface water sewers, or highway drains near the site, the alternative is to discharge the surface water to the 225mm combined water sewer in Kingsley Road. This surface water runoff destination is believed to replicate the pre-development run-off destination.

6. SuDS Feasibility

To reduce the surface water run-off to the greenfield rate, SuDS methods are to be introduced to the post development design.

SuDS methods as per the Sustainable Drainage System (SuDS) hierarchy, and the Non-Statutory Technical Standards for Sustainable Drainage Systems – March 2015, that can be used are detailed below:

	Description	Setting	Required area
 Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation.	Building	Building integrated.
 Rainwater harvesting	Rainwater is collected from the roof of a building or from other paved surfaces and stored in an overground or underground tank for treatment and reuse locally. Water could be used for toilet flushing and irrigation.	Building	Water storage (underground or above ground).
 Soakaway	A soakaway is designed to allow water to quickly soak into permeable layers of soil. Constructed like a dry well, an underground pit is dug filled with gravel or rubble. Water can be piped to a soakaway where it will be stored and allowed to gradually seep into the ground.	Open space	Dependant on runoff volumes and soils.
Filter Strip	Filter strips are grassed or planted areas that runoff is allowed to run across to promote infiltration and cleansing.	Open space	Minimum length 5 metres.
Permeable paving	Paving which allows water to soak through. Can be in the form of paving blocks with gaps between solid blocks or porous paving where water filters through the block itself. Water can be stored in the sub-base beneath or allowed to infiltrate into ground below.	Street/open space	Can typically drain double its area.
 Bioretention area	A vegetated area with gravel and sand layers below designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to a perforated pipe and be conveyed elsewhere. Bioretention systems can be integrated with tree-pits or gardens.	Street/open space	Typically surface area is 5-10% of drained area with storage below.

	Description	Setting	Required area
Swale	Swales are vegetated shallow depressions designed to convey and filter water. These can be 'wet' where water gathers above the surface, or 'dry' where water gathers in a gravel layer beneath. Can be lined or unlined to allow infiltration.	Street/open space	Account for width to allow safe maintenancce typically 2-3 metres wide.
Hardscape storage	Hardscape water features can be used to store run-off above ground within a constructed container. Storage features can be integrated into public realm areas with a more urban character.	Open space	Could be above or below ground and sized to storage need.
 Pond / Basin	Ponds can be used to store and treat water. 'Wet' ponds have a constant body of water and run-off is additional, while 'dry' ponds are empty during periods without rainfall. Ponds can be designed to allow infiltration into the ground or to store water for a period of time before discharge.	Open space	Dependant on runoff volumes and soils.
Wetland	Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated with a natural or hardscape environment.	Open space	Typically 5-15% of drainage area to provide good treatment.
 Underground storage	Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation.	Open space	Dependant on runoff volumes and soils.

The feasibility of the above SuDS methods for the post developed site are summarised in the table below:

SuDS Method	Feasible Use	Description
Green Roofs	No	The new dwellings are to have pitched roofs, and therefore green roofs would not be advantageous, and therefore are not a feasible SuDS method.
Rainwater Harvesting	**Yes**	Rainwater harvesting for water re-use has not been considered for the development due to the cost of a dual pipe network. However, a water butt could be installed for at least one rainwater pipe for each dwelling (locations to be confirmed), so that the water can be used for irrigating the garden areas.
Soakaway	No	As stated previously, BGS data identifies the development site to have superficial deposits of Devensian (sand and gravel), over bedrock consisting of Tarporley Siltstone Formation (siltstone, mudstone, and sandstone). The BGS borehole log data within the same strata also identifies the strata of the ground to predominantly consist of clay. As the boreholes are consistent, it is assumed

		therefore that the ground at the development site predominantly consist of clay (exceptionally low infiltration value), and the use of soakways is not feasible
Filter Strips	**Yes**	There is potential to install filter drains within the gardens of the dwelling, which will take the surface water run-off from the patio, footpath, and dwelling roof areas. Due to the ground conditions the filter drains will not infiltrate the surface water to ground, but will convey the surface water to the main drainage network and act as a pollutant control at source.
Permeable Paving / Surfacing	**Yes**	There is potential to install permeable paving / surfacing within the driveway and footpath areas of each of the dwellings. Due to the ground conditions the permeable paving / surfacing systems will not infiltrate the surface water to ground, but will convey the surface water to the main drainage network, and act as a pollutant control at source.
Swales / Shallow Pond	No	Most of small soft landscaping areas within the development site are to be used as a private garden or for planting. Therefore, due to the insufficient areas and development levels areas the use of these SuDS methods are not feasible.
Hardscape Storage	No	The external hard standing areas of the site are to be used for driveways and patio areas only. Therefore, there is limited areas for hardscape storage, and is not a feasible SuDs method.
Underground Storage	**Yes**	The surface water management strategy will be to discharge the surface water run-off from the post development site at the greenfield rate, where practical. The controlled rate will be at a lower rate than the surface water run-off rate, therefore there will be a requirement to have underground storage. This will prevent flooding for storm events up to the 1 in 30-year; and to suitable sized so that the volume of water during the 1 in 100-year storm event is kept a minimum at surface level, where it can be contained on site.

7. Development Greenfield Run-Off Rate and Volumes

To minimise the surface water run-off from the new development areas of the site, it is preferred that the post development surface water run-off be restricted to the equivalent greenfield run-off rate and volumes, where possible.

7.1. Greenfield Run-Off Rate

The Flood Estimation Handbook (FEH) is often used for the calculation of the greenfield run-off rate, however, relevant documents state that to calculate the greenfield run-off rates on small catchments less than 25km², the IH 124 QBAR equation (and the equation for the instantaneous time to peak for the unit hydrograph approach) is to be used. The IH method is based on the Flood Studies Report (FSR) approach and is developed for use on catchments less than 25km². It yields the Mean Annual Maximum Flood (QBAR). This reference also recommends the use Ciria C753 Table 24.2 to generate Growth Factors. These are used to convert QBAR to different return periods for different regions in the UK.

The input variables to establish QBAR are:

Return Period (years)	Results based on a range of return periods and the specified RP;
Area	Catchment Area (ha) which is adjusted to km2 for use in the equation;
SAAR	Average annual rainfall in mm (1941-1970) from FSR figure II.3.1;
Soil	Procedure Volume 3. Soil classes 1 to 5 have Soil Index values of 0.15, 0.3, 0.4, 0.45 and 0.5 respectively;
Urban	Proportion of area urbanised expressed as a decimal;
Region Number	Region number of the catchment based on FSR Figure I.2.4.

QBAR(l/s)

The output variables to establish QBAR are calculated using the following formula (equation yields m³/s):

$$\textbf{QBAR} = \textbf{0.00108 x AREA}^{0.89} \textbf{ x SAAR}^{1.17} \textbf{ x SOIL}^{2.17}$$

The IH 124 Variables (taken from FSR) that are specific to this site are as follows:

Area	=	50.00 ha (required area for calculation)
SAAR	=	868
Soil	=	0.450
Urban Factor	=	0.75 (actual 1.00, but 0.75 maximum for equation)
Region Number	=	10

The calculations in Appendix F, show the rate for 50.00ha is 705.6 l/s, but is to be reduced to reflect the surface water catchment area (0.110 ha) of the development site. Therefore, the QBAR (greenfield run-off) for development area has been calculated to be:

QBAR = **<u>1.55 l/s (14.11 l/s/ha)</u>**

Ciria C753 Table 24.2 identifies the growth factors for each of the storm events, based on the known QBAR figure. The growth factors from the table vary depending on the site location. In this case hydrometric area (Region Number) is 10.

Based on the figures shown in the table, the growth factors, and the existing greenfield run-off rates for each of the storm events for the development areas of the site are as follows:

Storm Event	QBAR	Growth Factor (C753 Table 24.2)	Greenfield Run-off Rate
Q_1	1.55 l/s	0.87	**1.4 l/s**
Q_{30}	1.55 l/s	1.70	**2.6 l/s**
Q_{100}	1.55 l/s	2.08	**3.2 l/s**

7.2. Greenfield Run-Off Volume

The greenfield run-off volume for the 100-year, 6-hour storm event has also been calculated in the MicroDrainage software using the data from the Flood Estimation Handbook (FEH), with the results shown in Appendix F.

The FEH data and variables used to calculate the greenfield run-off volume at the development site locations are as follows:

Site Location = GB 383250 390300 SJ 83250 90300

C (1km) = -0.025

D1 (1km) = 0.308

D2(1km) = 0.344

D3 (1km) = 0.337

E (1km) = 0.303

F (1km) = 2.443

Areal Reduction Factor = 1.000

Area = 60,590.250 ha

SAAR = 1153

CWI = 123.707

SPR Host = 38.840

URBTEXT = 0.50 (actual 1.00, but 0.50 maximum for calculation)

Based on these variables, and the calculation results provided by the MicroDrainage computer software (Appendix F), the greenfield run-off volume for the overall catchment area of 60,590.250 ha, at the site location, is:

$Q_{100\ (6\text{-Hour})}$ = 20,335,121.842m³

This figure is to be reduced to reflect the surface water catchment area of the development site which is 0.110 ha. Therefore, the greenfield run-off volume for the development site area has been calculated to be:

$Q_{100\ (6\text{-Hour})}$ = **36.92m³ (335.62m³/ha)**

8. Pre-Development Surface Water Run-Off Rates and Volume

The pre-development surface water run-off rate from the commercial buildings and hard-standing areas are to be calculated, so that the post development rates are at least a 50% betterment.

The calculations to determine the pre-development surface water run-off rates are based on the pre-development surface water run-off area of 0.156 ha, and the data given by the Flood Estimation Handbook (FEH).

The pre-development surface water run-off rates and volume have also been simulated in the MicroDrainage WinDes software (Appendix G), where the variables used (FEH data) to calculate the surface water run-off rates and volumes are as follows:

Pre-Development Area	=	0.156 ha
Site Location	=	GB 383250 390300 SJ 83250 90300
C (1km)	=	-0.025
D1 (1km)	=	0.308
D2(1km)	=	0.344
D3 (1km)	=	0.337
E (1km)	=	0.303
F (1km)	=	2.443

Based on the above variables and computer software results, the pre-development surface water run-off rates will be as follows:

Q_1	=	19.8 l/s (15-minute storm duration*)
Q_{30}	=	65.2 l/s (15-minute storm duration*)
Q_{100}	=	97.4 l/s (15-minute storm duration*)

**The critical storm duration for each of the return period is 15 minutes.*

Based on the above variables for the surface water run-off from the pre-development impermeable area, it has been calculated that the pre-development surface water discharge volume for the pre-development site (at 6-hour storm events) are as follows:

Q_{100}	=	76.68m³ (360-minute storm duration)

9. Below Ground Drainage Networks and Surface Water Management Calculations

9.1. Climate Change

The NPPF makes it a planning requirement to account for climate change in the proposed design. The recommended allowances are taken from the Environment Agency guidance (Table 2) summarised in Table 4 below.

Applies across all of England	Total change anticipated for the 2020's	Total change anticipated for the 2050's	Total change anticipated for the 2080's
Upper End	10%	20%	**40%**
Central	5%	10%	20%

The baseline year is 1961 to 1990. It is anticipated the life span of the new dwellings will be approximately 80 years, and therefore will fall at least into the 2080's and will have rainfall intensity increase of 40%.

This increase in rainfall is to be taken into consideration for the surface water management of the proposed development site (100-year event), to ensure that the probability of flooding remains low.

9.2. Surface Water Network Calculations

The FEH data and variables used to calculate the required below ground attenuation network and attenuation volumes at the development site are as follows:

SW Catchment Area = 0.110 ha

Site Location = GB 383250 390300 SJ 83250 90300

C (1km) = -0.025

D1 (1km) = 0.308

D2(1km) = 0.344

D3 (1km) = 0.337

E (1km) = 0.303

F (1km) = 2.443

Time of Entry = 5 minutes

9.3. Surface Water Drainage Networks

As shown on the below ground drainage layout drawing in Appendix H, the main surface water drainage network will consist of 450mm diameter inspection chambers; 150mm a diameters pipes; 150mm perforated pipes; permeable paving systems; filter drains; rainwater harvesting butts; a flow control chamber; and a below ground attenuation tank in the form of cellular units.

The surface water run-off from the dwelling roof areas will discharge to the network via water butts, trapped gullies, permeable paving, and filter drain systems (directly to perforated pipe); the surface water run-off from the driveways will discharge to the network via permeable paving; and the surface water run-off from the patio and footpath areas will discharge to the network vial filter drains.

The surface water within the network will pass through the flow control chamber, prior to discharge to the 225mm diameter United Utilities surface water sewer with Kingsley Road (east of development). The restricted surface water will surcharge the network, and will be attenuated within the attenuation tanks, and permeable paving sub-base.

9.4. Surface Water Run-Off Rate

For the surface water run-off from the post development site to be at the greenfield run-off rate, they are to be restricted to 1.4 l/s for the 1 in 1-year storm event; 2.6 l/s for the 1 in 30-year storm event, and 3.2 l/s for the 1 in 100-year storm event including 40% rainfall intensity increase (climate change).

For the surface water run-off to be at least a 50% betterment of the pre-development rates, the surface water runoff from the post development site are to be restricted to 9.9 l/s for the 1 in 1-year storm event (50% of 19.8 l/s); 32.6 l/s for the 1 in 30-year storm event (50% of 65.2 l/s); and 49.7 l/s for the 1 in 100-year storm event including 40% climate change (50% of 97.4 l/s).

The practicality of reducing surface water run-off rates will depend on the flow control size / diameter. If the flow control opening / diameter is too small, there will be an increased risk of blockage and subsequent flooding.

Therefore, the flow control is to be sized appropriately to reduce the risk of blockage, but to reduce the surface water run-off rates from the post development site to as low as possible, to at least a 50% betterment of the rates and a betterment of the surface water discharge volume.

This is to adhere to Ciria document C753 – The SuDS Manual which states that: *'the flow controls / orifice design should be designed so that it has simplicity on operation, and has resistance to clogging, blocking or mechanical failure'.* Based on this guideline, the flow control (hydro-brake) diameter is to be the lowest practical size of 78mm.

As shown in the output calculation from the MicroDrainage computer software in Appendix G, if the hydro-brake opening is set at 78mm, with a design head of 1.50m (level between control invert and top of permeable paving sub-base / attenuation level limit), and a design flow of 3.20 l/s (equivalent greenfield run-off rate), the maximum surface water run-off rates for each storm event will be as follows:

Strom	**-**	**Rate**	**-**	**Critical Storm Event**
Q_1	**-**	**2.5 l/s**	-	60-minute winter storm duration
Q_{30}	**-**	**2.8 l/s**	-	60-minute winter storm duration
Q_{100}	**-**	**3.2 l/s**	-	120-minute winter storm duration

A summary of the post development surface water run-off rates compared to the greenfield and pre-development rates are as follows:

Greenfield Rate to Post Development Rate

Strom	**-**	**Greenfield**	**-**	**Post Dev**	**-**	**Difference**
Q_1	-	1.4 l/s	-	2.5 l/s	-	1.80 x Greenfield
Q_{30}	-	2.6 l/s	-	2.8 l/s	-	1.08 x Greenfield
Q_{100}	-	3.2 l/s	-	3.2 l/s	-	**Equivalent Greenfield**

Pre-Development Rate to Post Development Rate

Strom	-	Pre-Dev	-	Post Dev	-	Difference
Q_1	-	19.8 l/s	-	2.5 l/s	-	0.13 x Pre-Dev (87% Betterment)
Q_{30}	-	65.2 l/s	-	2.8 l/s	-	0.05 x Pre-Dev (95% Betterment)
Q_{100}	-	97.4 l/s	-	3.2 l/s	-	0.03 x Pre-Dev (97% Betterment)

The surface water run-off rates are greater than the 1-year and 30-year greenfield rates but is the equivalent of the 100-year greenfield rate, and between an 87% and 97% betterment of the pre-development surface water run-off rates. Therefore, the surface water run-off from the post development site adheres to the Manchester City, Salford City and Trafford Councils SFRA, and subsequent Planning Condition 7 requirements, which is deemed to be acceptable.

9.5. Surface Water Run-Off Volume

The surface water run-off volumes for the post development site have also been calculated for 1 in 100-Year the 6-hour duration (Inc. 40% RII), based on the peak 100-year + 40% climate change surface water run-off rate:

Q_{100}	-	3.2 l/s x 60 x 60 x 6	-	69,120 litres	-	**69.12m³**

A summary of the post development surface water run-off volume compared to the greenfield and pre-development volumes are as follows:

Greenfield Volume to Post Development Volume

Strom	-	Greenfield	-	Post Dev	-	Difference
Q_{100}	-	36.92m³	-	69.12m³	-	1.87 x Greenfield

Pre-Development Volume to Post Development Volume

Strom	-	Pre-Dev	-	Post Dev	-	Difference
Q_{100}	-	76.68m³	-	69.12m³	-	0.90 x Greenfield (10% betterment

The surface water run-off volume for the 100-year, 6-hour storm event is exceeding the greenfield run-off volume, but is a 10% betterment of the pre-development run-off volume. Therefore, the surface water run-off volume from the post development site adheres to the Planning Condition 7 requirements, which is deemed to be acceptable.

9.6. Surface Water Attenuation Calculations

As the positively drained areas of the post development site are being restricted, there will be a requirement for below ground attenuation to prevent flooding.

Ciria SuDS Manual 2015, Paragraph 10.2.4 where it states that: *'Exceedance flows (i.e., flows more than those for which the system is designed) should be managed safely in above-ground space such that risks to people and property are acceptable'.*

The surface water attenuation for the development site will be within the attenuation tank (comprising of cellular units), and sub-base of permeable paving system. As detailed in the MicroDrainage calculations (Appendix I) and surface water management layout (Appendix H) the attenuation volumes for each of the SuDS methods re as follows:

Attenuation Tank - Cellular Units

Length	-	15.00m
Width	-	2.50m
Area	-	37.50m²
Depth	-	1.20m
Porosity	-	0.95
Volume	-	**42.75m³**

Permeable Paving

Paving Area	-	350.00m²
Sub-Base Depth	-	0.30m
Porosity	-	0.30
Gradient	-	1 in 60
Volume	-	**15.00m³**

The total tank and permeable paving attenuation volume equates to **57.75m³**.

The MicroDrainage calculations (Appendix I) show that with these SuDs methods and volumes, no flooding will occur for all storms up to and including the 1 in 100-year event + 40% climate change. Therefore, the proposed attenuation within the post development site adheres to the Planning Condition 7 requirements, which is deemed to be acceptable.

10. Management and Maintenance Requirements

Details of the maintenance required, and the parties to carry out the maintenance of all drainage aspects, to ensure that the SuDS methods are working affectively, and subsequently reducing the risk of flooding on or near the site.

The management and maintenance of the surface water drainage networks and SuDS features will be by contractors appointed by the owners / residents of the dwellings, where payments of the works will form part of the property deeds and / or rental agreements, and will be carried out as follows:

10.1. Surface Water Drainage Network

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from manholes (where may cause risk performance)	Monthly
Where rainfall into network from above, check surface or filter for blockage or silt, algae, or other matter by jetting	As required, but at least twice a year
Remove sediment from pipework by jetting.	Annually or as required
Repair/check all inlets, outlets, and overflow pipes	As required
Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating as designed	Annually and after large storms

10.2. Flow Control and Cellular Units

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from flow control chamber and attenuation tank (where may cause risk performance)	Monthly
Where rainfall into flow control chamber and attenuation tank from above, check surface or filter for blockage or silt, algae, or other matter by jetting	As required, but at least twice a year
Remove sediment from upstream surface water network by jetting.	Annually or as required
Repair/check all inlets, outlets, and overflow pipes	As required
Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating as designed	Annually and after large storms

10.3. Permeable Paving and Filter Drain

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from catchment surface of paving and areas near filter drain (where may cause risk performance)	Monthly
Where rainfall infiltration into paving and filter drain, check surface for blockage or silt, algae, or other matter by jetting	As required, but at least twice a year

10.4. Linked and Further Maintenance and Maintenance Activities

The maintenance of the drainage network and SuDS features are to be linked with the wider site maintenance for the new residential landscaped / garden areas.

A log of all maintenance activities is to be kept and made available to the local planning authority (LPA) and / or the Lead Local Flood Authority (LLFA) on request.

11. Water Quality / Pollution Control

The level of water treatment is to be assessed against the details set out in Ciria SuDS Manual C753. Chapter 26 sets out the Pollution Hazard Indices for different land classifications, and how to calculate that against the SuDS mitigation indices to show suitable levels of treatment.

Dwelling Roof, Patio, and Footpath Area Pollutant Hazard

C753 Table 26.2 Pollution Hazard Level = Very Low

C753 Table 26.2 Pollution Hazard Index:

- Total Suspended Solid (TSS) = 0.2
- Metals = 0.2
- Hydrocarbons = 0.05

Pollution Hazard Index = **0.45**

Dwelling Roof Patio, and Footpath Area Pollutant Mitigation

Mitigation Measures:

- Filter Drain

Filter Drain Pollutant Mitigation Indices

- Total Suspended Solid (TSS) = 0.4
- Metals = 0.4

- Hydrocarbons = 0.5

SuDS Mitigation Indices = **1.30**

The mitigation indices is greater than the pollution hazard index, and therefore suitable water quality is achieved.

Driveway Area Pollutant Hazard

C753 Table 26.2 Pollution Hazard Level = Low

C753 Table 26.2 Pollution Hazard Index:

- Total Suspended Solid (TSS) = 0.5
- Metals = 0.4
- Hydrocarbons = 0.4

Pollution Hazard Index = **1.30**

Driveway Area Pollutant Mitigation

Mitigation Measures:

- Permeable Paving

Permeable Paving Pollutant Mitigation Indices

Total Suspended Solid (TSS) = 0.7

Metals = 0.6

Hydrocarbons = 0.7

SuDS Mitigation Indices = **2.00**

The mitigation indices is greater than the pollution hazard index, and therefore suitable water quality is achieved.

12. Surface Water Design Exceedance

In the unlikely event of an extreme storm greater than 100-year + 40% climate change, or poor maintenance of the SuDS features and / or pipework, potential flooding of the drainage network could occur. Surface water flow paths to follow existing and proposed ground topography, where water will flow to the east of the site and into Kingsley Road.

Surface water will flow away from the proposed dwellings, will not flow towards any existing properties / dwellings, and will be contained within Kingsley Road due to the road's gradients (allowing water to flow and not pond) and upstand kerbs (barrier for flood water within road).

The volume of water discharging off the site will be no greater than the pre-development volume, due to there now being large attenuation structures in the ground, and therefore, as these structures will hold water in any storm event, the risk of flooding at surface and subsequently the risk of flooding to any properties will not increase.

Therefore, the flood risk to land or properties within or outside the development would not increase even in an extreme (greater than 1% AEP + 40% cc) storm event.

13. Conclusion / Summary

The details in this report and associated appendices have demonstrated that the surface water management adheres to Condition 7 of the planning consent, and therefore the condition is to be approved. A summary of the information provide when compared to the requirements in the planning condition are as follow:

13.1. SuDS Principles and SW Discharge Destination

'Results of ground investigation carried out under Building Research Establishment Digest 365. Site investigations should be undertaken in locations and at proposed depths of the proposed infiltration devices'.

BGS data identifies the development site to have superficial deposits of Devensian (sand and gravel), over bedrock consisting of Tarporley Siltstone Formation (siltstone, mudstone, and sandstone).

The BGS borehole log data within the same strata also identifies the strata of the ground to predominantly consist of clay. As the boreholes are consistent, it is assumed therefore that the ground at the development site predominantly consist of clay (exceptionally low infiltration value), and therefore discharge of surface water to ground is not feasible. As the ground is not suitable for infiltration, and there are no known waterbodies, surface water sewers, or highway drains near the site, the alternative is to discharge the surface water to the 225mm combined water sewer in Kingsley Road.

This surface water runoff destination is believed to replicate the pre-development run-off destination.

13.2. Peak Flow Control

'Details of surface water attenuation that offers a reduction in surface water runoff rate in line with the Manchester Trafford and Salford Strategic Flood Risk Assessment, i.e. at least a 50% reduction in runoff rate compared to the existing rates, as the site is located within Critical Drainage Area'

The surface water run-off rates are greater than the 1-year and 30-year greenfield rates but is the equivalent of the 100-year greenfield rate, and between an 87% and 97% betterment of the pre-development surface water run-off rates. Therefore, the surface water run-off from the post development site adheres to the Manchester City, Salford City and Trafford Councils SFRA, and subsequent Planning Condition 7 requirements, which is deemed to be acceptable.

The surface water run-off rates are greater than the 1-year greenfield rates but the equivalent of the 30-year and 100-year greenfield rates. Therefore, as the surface water run-off rates discharging to the existing sewer is equivalent to greenfield run-off rates during the extreme storm events (30-year and 100-year), the surface water management meets the requirements of Policy EN17 of the Core Strategy, and will ensure that the development will not increase the risk of flooding to neighbouring land and/or property.

13.3. Volume Control

'Run-off volume in the 1 in 100-year, 6 hours rainfall shall be constrained to a value as close as is reasonably practicable to the greenfield run-off volume for the same event, but never to exceed the run-off volume from the development site prior to redevelopment.'

The surface water run-off volume for the 100-year, 6-hour storm event is exceeds the greenfield run-off volume, but is a 10% betterment of the pre-development run-off volume. Therefore, the surface water run-off volume from the post development site adheres to the Planning Condition 7 requirements, which is deemed to be acceptable.

13.4. Flood Risk within the Development

'Evidence that the drainage system has been designed so that flooding does not occur during a 1 in 100-year rainfall event with allowance for climate change in any part of a building;'

The MicroDrainage calculations (Appendix I) show that with these SuDs methods and volumes, no flooding will occur for all storms up to and including the 1 in 100-year event + 40% climate change. Therefore, the proposed attenuation within the post development site adheres to the Planning Condition 7 requirements, which is deemed to be acceptable.

13.5. Management and Maintenance

The management and maintenance of the surface water drainage networks and SuDS features will be by contractors appointed by the owners / residents of the dwellings, where payments of the works will form part of the property deeds and / or rental agreements.

13.6. Exceedance Events

'Assessment of overland flow routes for extreme events that is diverted away from buildings'

In the unlikely event of an extreme storm greater than 100-year + 40% climate change, or poor maintenance of the SuDS features and / or pipework, potential flooding of the drainage network could occur. Surface water flow paths to follow existing and proposed ground topography, where water will flow to the east of the site and into Kingsley Road.

Surface water will flow away from the proposed dwellings, will not flow towards any existing properties / dwellings, and will be contained within Kingsley Road due to the road's gradients (allowing water to flow and not pond) and upstand kerbs (barrier for flood water within road).

The volume of water discharging off the site will be no greater than the pre-development volume, due to there now being large attenuation structures in the ground, and therefore, as these structures will hold water in any storm event, the risk of flooding at surface and subsequently the risk of flooding to any properties will not increase. Therefore, the flood risk to land or properties within or outside the development would not increase even in an extreme (greater than 1% AEP + 40% cc) storm event.

13.7. Water Quality

The level of water treatment has been assessed against the details set out in Ciria SuDS Manual C753. Chapter 26, which sets out the Pollution Hazard Indices for different land classifications, and how to calculate that against the SuDS mitigation indices to show suitable levels of treatment.

The mitigation indices is greater than the pollution hazard index, and therefore suitable water quality is achieved.

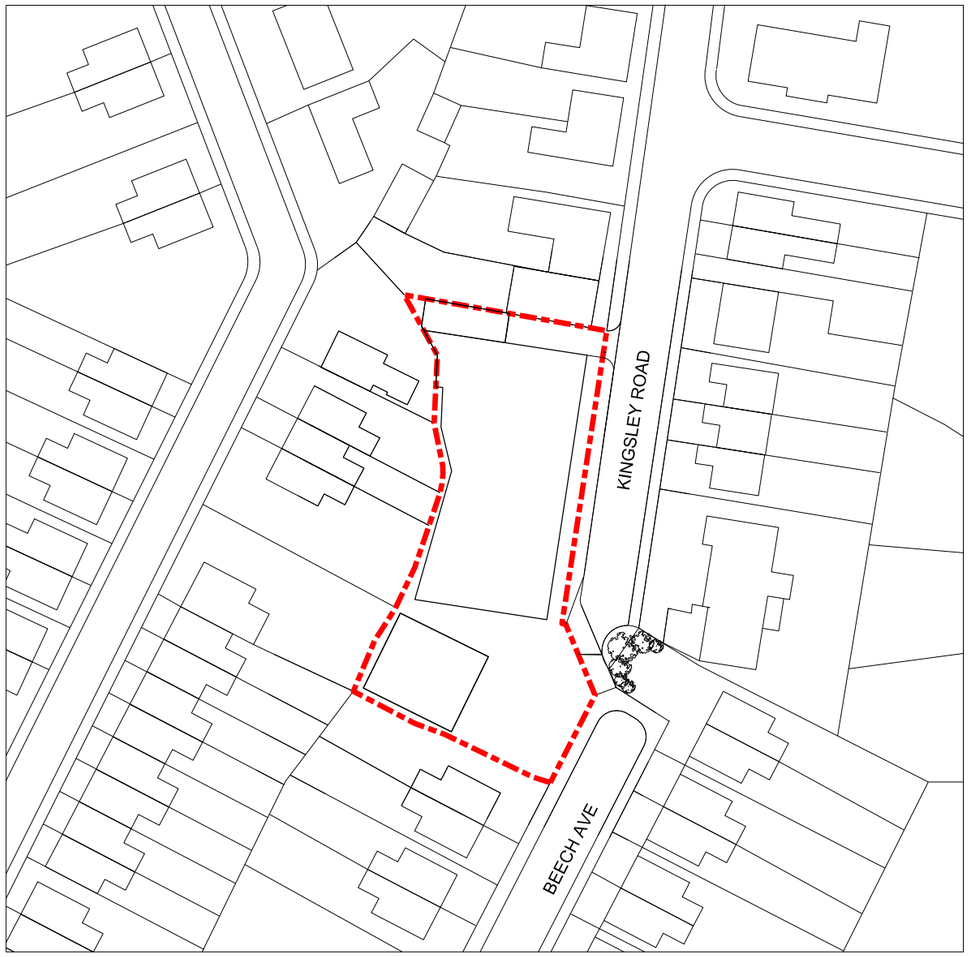
13.8. Calculation and Drainage Details

'Hydraulic calculation of the existing and proposed drainage system and construction details of flow control and SuDS elements'

The hydraulic calculations are detailed in Appendix I and the drainage system with construction details of the flow control and SuDS elements are de*tailed in Appendix H.*

Appendix A

Site Location Plan



NOTES:
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GENERAL NOTES:

1. Do not scale. Use figured dimensions only.

2. Confirm all dimensions and levels on site.

3. All works to be carried out in accordance with the Building regulations, British Standards, Codes of practice and any printed directions issued by manufacturers of proprietary materials and components used (specified or not).

4. The contractor shall be responsible for the stability of the existing structure during construction and shall provide all temporary supports necessary for this purpose. He shall also prevent overloading of any completed or partially completed elements.

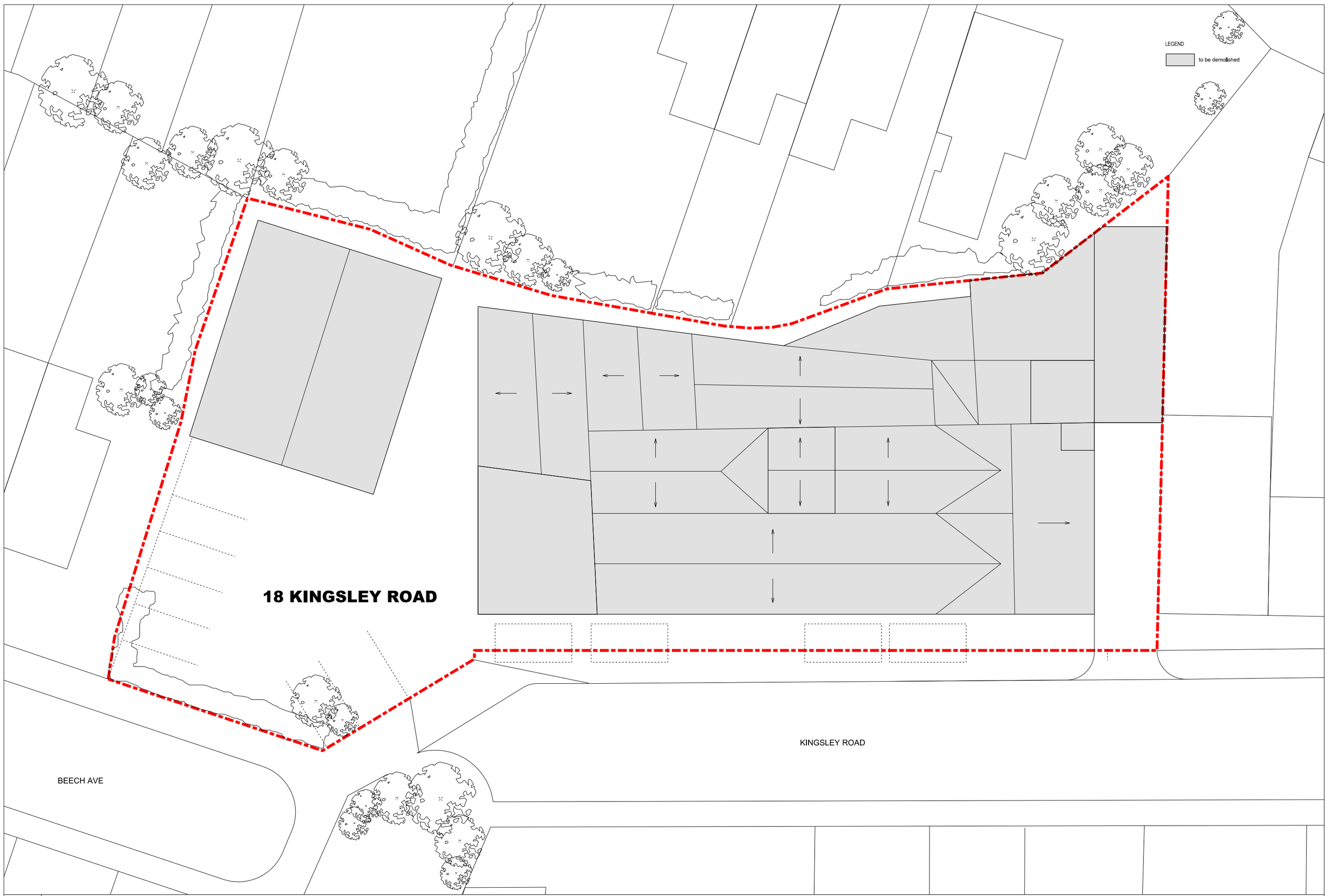
5. The building owner is responsible for the service of any notice required under the Part Wall Act 1996 and for ensuring that all parties with an interest in the building are given due notice of the works prior to commencement.

6. This specification is to be read in conjunction with the drawings and any other consultants drawings for structural or mechanical engineering calculations.

NORTH	DRAWING TITLE	PROJECT	DATE	SCALE	SIZE	STATUS	DRAWING NUMBER	REVISION	DETAILS
	LOCATION PLAN	KINGSLEY ROAD, MANCHESTER	15.09.2018	1:1250	A4	PLANNING	PL000	P3	KINGSLEY ROAD LTD

Appendix B

Existing Site Plans



NOTES:
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GENERAL NOTES:

1. Do not scale. Use figured dimensions only.
2. Confirm all dimensions and levels on site.
3. All works to be carried out in accordance with the Building regulations, British Standards, Codes of practice and any printed directions issued by manufacturers of proprietary materials and components used (specified or not).
4. The contractor shall be responsible for the stability of the existing structure during construction and shall provide all temporary supports necessary for this purpose. We shall also prevent overloading of any completed or partially completed elements.
5. The building owner is responsible for the service of any notices required under the Fire Hall Act 1968 and for ensuring that all parties with an interest in the building are given due Notice of the works prior to commencement.
6. This specification is to be read in conjunction with the drawings and any other consultants drawings for structural or mechanical engineering calculations.

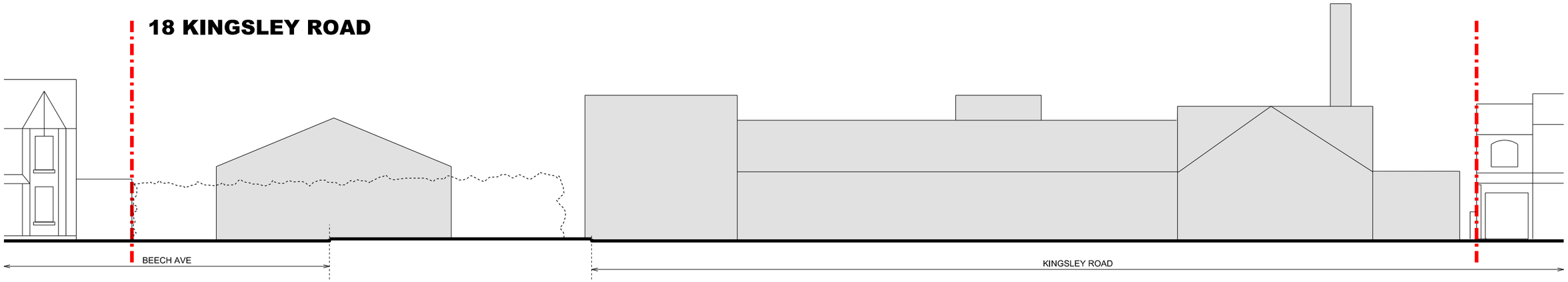
0 2 10

NORTH

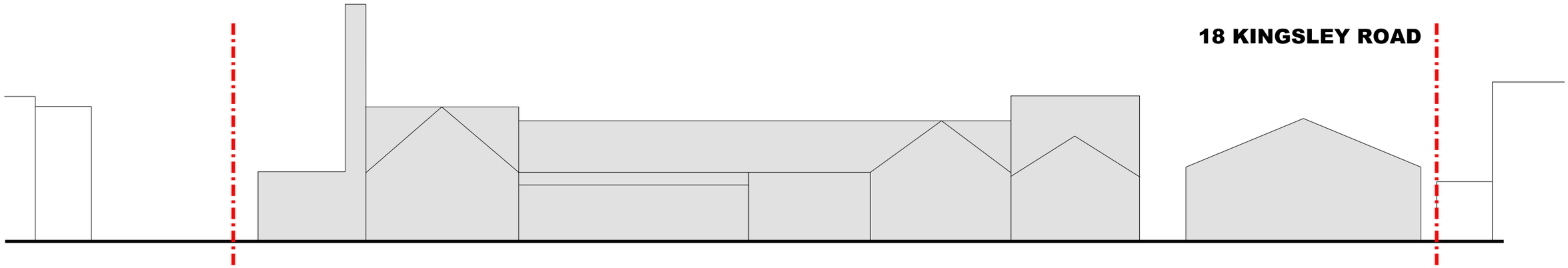
DRAWING TITLE	PROJECT	DATE	SCALE	SIZE	STATUS	DRAWING NUMBER	REVISION	DETAILS
EXISTING SITE PLAN	KINGSLEY ROAD, MANCHESTER	15.09.2018	1:200	A3	PLANNING	PL001	P3	KINGSLEY ROAD LTD

LEGEND

to be demolished



EXISTING EAST ELEVATION



EXISTING WEST ELEVATION

NOTES:

GENERAL NOTES:

1. Do not scale. Use figured dimensions only.
2. Confirm all dimensions and levels on site.
3. All works to be carried out in accordance with the Building regulations, British Standards, Codes of practice and any printed directions issued by manufacturers of proprietary materials and components used (specified or not).
4. The contractor shall be responsible for the stability of the existing structure during construction and shall provide all temporary supports necessary for this purpose. He shall also prevent overloading of any completed or partially completed elements.
5. The building owner is responsible for the service of any notices required under the Plan Act 1966 and for ensuring that all parties who are in connection with the building are given due Notice of the works prior to commencement.
6. This specification is to be read in conjunction with the drawings and any other consultants drawings for structural or mechanical engineering calculations.

0 2 10

NORTH

DRAWING TITLE	PROJECT	DATE	SCALE	SIZE	STATUS	DRAWING NUMBER	REVISION	DETAILS
EXISTING ELEVATIONS	KINGSLEY ROAD, MANCHESTER	15.09.2018	1:200	A3	PLANNING	PL002	P3	KINGSLEY ROAD LTD

Appendix C

Proposed Site Plans

NOTES:
xxxxxxx

GENERAL NOTES:

1. Do not scale. Use figured dimensions only.
2. Confirm all dimensions and levels on site.
3. All works to be carried out in accordance with the Building regulations, British Standards, Codes of practice and any printed directions issued by manufacturers of proprietary materials and components used (specified or not).
4. The contractor shall be responsible for the stability of the existing structure during construction and shall provide all temporary supports necessary for this purpose, he shall also prevent overloading of any completed or partially completed elements.
5. The building owner is responsible for the service of any notices required under the Fire Safety Act 1998 and for ensuring that all parties with an interest in the building are given due notice of the works prior to commencement.
6. This specification is to be read in conjunction with the drawings and any other consultants drawings for structural or mechanical engineering calculations.

0 2 10

NORTH

DRAWING TITLE	PROJECT	DATE	SCALE	SIZE	STATUS	DRAWING NUMBER	REVISION	DETAILS
PROPOSED GROUND FLOOR PLAN	KINGSLEY ROAD, MANCHESTER	15.09.2018	1:200	A3	PLANNING	PL003	P4	KINGSLEY ROAD LTD

Appendix D

BGS Data

Folio _____ County Lamp. 34 Manholes (cont'd)

6 in. Map 111SW E

Description.		Thickness. Feet.	Thickness. Inches.	Depth. Feet.	Depth. Inches.	
No. 5. 101 ft. O.D.				-	6	
39 29	Soil	-	6	-	6	0.15
	Gravel	5	6	6	-	1.83
	Sand	6	6	12	6	3.81
No. 5A. 103 ft. O.D.						
40 30	Soil	-	6	-	6	0.15
	Gravel	8	6	9	-	2.74
	Sand	1	6	10	6	3.20
	Clay	3	6	14	-	4.27
No. 6 103 ft. O.D.						
41 31	Soil	-	9	-	9	0.23
	Filling	2	9	3	6	1.07
	Gravel	6	6	10	-	3.05
	Clay	3	6	13	6	4.11
No 6A. 102 ft. 6 in. O.D.						
42 32	Soil	-	9	-	9	0.23
	Gravel	2	9	3	6	4.11
	Sand	6	-	9	6	2.90
	Clay	3	6	13	-	
No. 6B. 105 ft. O.D.						
43 33	Soil	1	-	1	-	0.30
Water level 7 ft. 9 ins.	Gravel	2	6	3	6	3.96
	Clay	3	6	7	-	2.13
	Sand	5	6	12	6	3.81
	Marly clay	3	6	16	-	4.88
No. 7. 108 ft. O.D.						
44 34	Soil	1	-	1	-	0.30
	Gravel	3	-	4	-	1.22
	Clay	3	-	7	-	2.13
	Sand	9	-	16	-	4.88
	Marly clay	2	-	18	-	5.49

SJ89SW/27-28

Name and Number of Shaft or Bore

For Messrs.

Town or Village

County Six-inch quarter sheet

Exact site

6-inch Map Registered No.

Attach a tracing from a map, or a sketch-map, if possible.

Purpose for which made

Level at which shaft/bore commenced relative to O.D. State if shaft/bore is up, down, horizontal or inclined; in latter cases give angle of inclination and direction

Made by

Information from Date of Sinking

Specimens

Additional Notes in Space Overleaf

(For Survey use only) Geological Classification	Nature of Strata	Thickness		Depth	
	No. 4 106 ft. O.D				
3727	Soil	1 -		0·30	1 -
	Gravel	6 -		2·13	7 -
	Clay	5 -		3·66	12 -
	Loamy clay	5 -		5·18	17 -
	No. 4A. 104 ft. O.D.				
3828	Soil	-	3	0·08	- 3
	Gravel	2	9	0·91	3 -
	Loamy sand	1	6	1·37	4 6
	Clay	9 -		4·11	13 6
	Loamy clay	1	6	4·57	15 -

(B12268) Wt. 13119—0014 5000 9/27 Gp. 160 O.A.

Continued Overleaf

Geological Survey and Museum,	Date received	Correspondence File No.	1″ N.S. Map No.	1″ O.S. Map No.	Site marked (use symbol) on 1″ Map	on 6″ Map

SJ89 SW 493

SUB SOIL SURVEYS LTD.
MANCHESTER.

BOREHOLE No. 5
8228 9001

EXPLORATORY BORING RECORD

British Geological Survey

SITE Princess Parkway, Manchester Ref.:- 65/34

Boring Method Shell and Chisel Ground Level 109.72 33.44m O.D.

DATE	DIA. OF CASING & DEPTH BELOW G.L.	WATER LEVEL MORNING & EVENING	DEPTH OF STRATA BELOW G.L.	STRATA (APPROX. SCALE 10 FT. TO ONE INCH)	NO. OF SAMP.	TYPE OF SAMP	PENETRATION OF SAMPLER OR CORE BARREL FROM	TO	NO. OF BLOWS	CORE RECOVERY
				Top Soil and roots	1	x	4'0	5'0	15	
					2	U	5'6	7'0	32	
			4'0"	Compact mottled brown very clayey sand and gravel	3	o	7'0			
					4	B	8'0			
			6'6"	Medium dry sand and gravel Some Clay	5	x	10'0	11'0	15	
					6	B	13'0			
			10'9"	Stiff brown silty and sandy clay with laminations of silt	7	U	13'0	14'6	22	
					8	o	14'6			
					9	x	17'6	18'6	17	
			17'0"	Compact brown silty sand with small bands of stiff brown stoney clay	10	B	19'0			
10.Jun	20'0"	14'0"			11	B	22'0			
11.Jun		16'0"	21'6"	Stiff brown clay with stone inclusions and laminations of silt	12	U	23'0	24'6	27	
					13	o	24'6			
			23'0"	Compact brown silty sand	14	B	26'0			
					15	x	25'6	26'6	35	
					16	x	26'6	27'6	67	
			26'6"	Very stiff to hard red/brown marly clay with stone inclusions and sand pockets	17	B	27'6			
					18	U	27'6	28'6	150	
11.Jun	27'0"	Nil	32'0"		19	o	28'6			
12.Jun		14'0"		Hard red brown sandy marly clay with sand pockets	20	x	32'0	32'9	70	
					21	W	33'0			
					22	x	5'0	36'9	88	
					23	x	41'0	42'0	105	
1 Jun	27'0"	15'0"			24	x	45'0	46'0	104	
12.Jun		14'0"	approx 45'0"		25	x	49'0	49'6	73	
				Hard red silty marl						
13.Jun	27'0"	12'0"	50'0" 15.24m							

Samples shown thus: Disturbed O. Undisturbed U. Standard Pen. Test X. Water W. Bulk B.

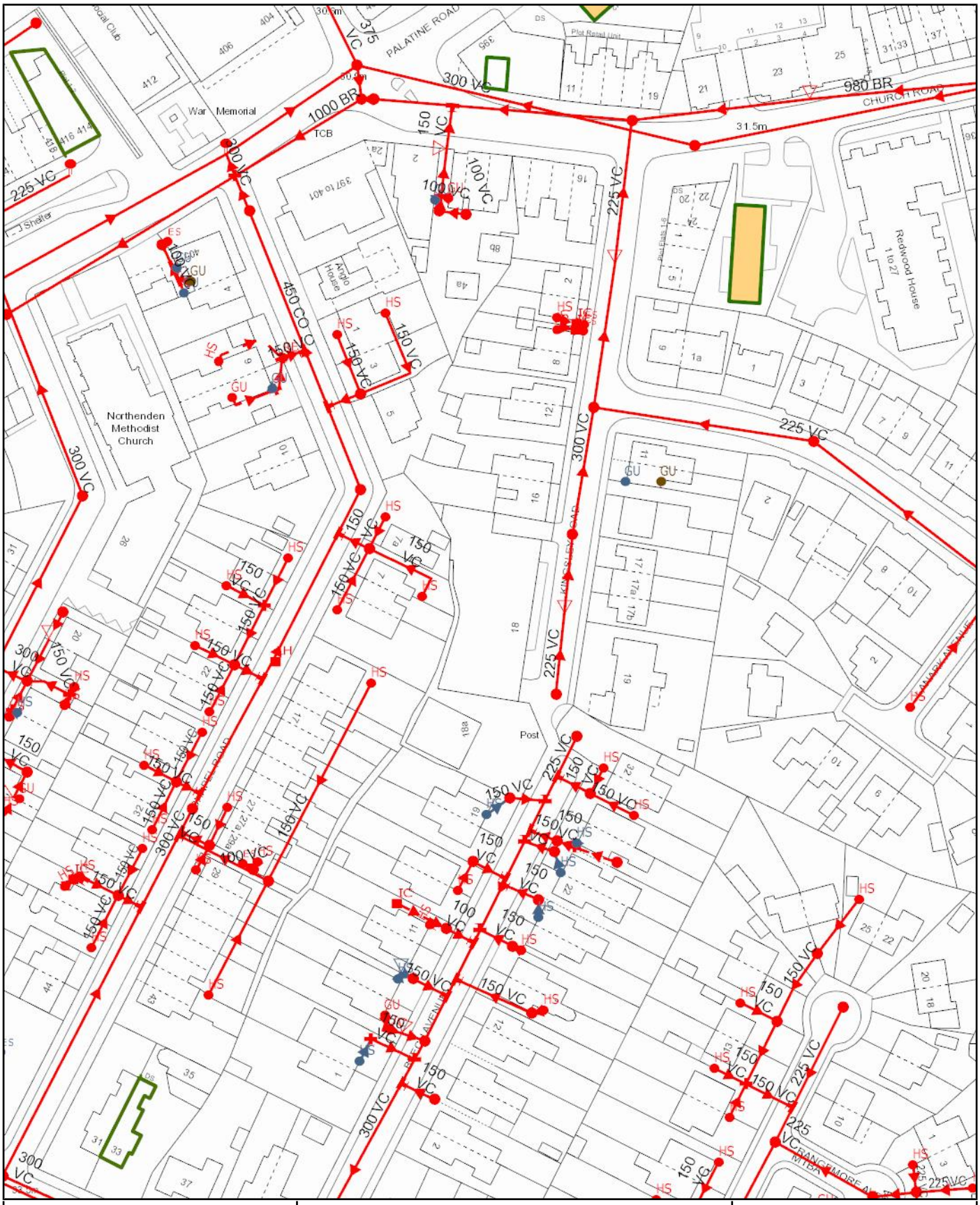
WATER STRUCK AT THE FOLLOWING DEPTHS	DEPTH OF CASING WHEN SEALED (N.S.—NOT SEALED)	ESTIMATED SEEPAGE	WATER ADDED AT FOLLOWING DEPTHS TO ASSIST BORING	WATER LEVEL IN CASED/UNCASED BOREHOLE ON COMPLETION: DATE	WATER LEVEL	DEPTH OF CASING
1. 9'6	N.S.	Slow		13.6.65	14'	27'0
2. 17'0	N.S.	Medium				
3. 23'0	27'0	Medium				
4.						
5.						
6.						

REMARKS:

i) Penetrometer not driven on initial 6" for sample Nos. 20, 22, 23, 24 and 25.

Appendix E

United Utilities Asset Plan



Scale: 1:1250 **Date:** 26/05/2021	**SEWER RECORDS**	United Utilities Water for the North West
Address or Site Reference:	EASY SMART CONSULTING 18 KINGSLEY ROAD, MANCHESTER, M22 4NL	
Printed by:	Property Searches	

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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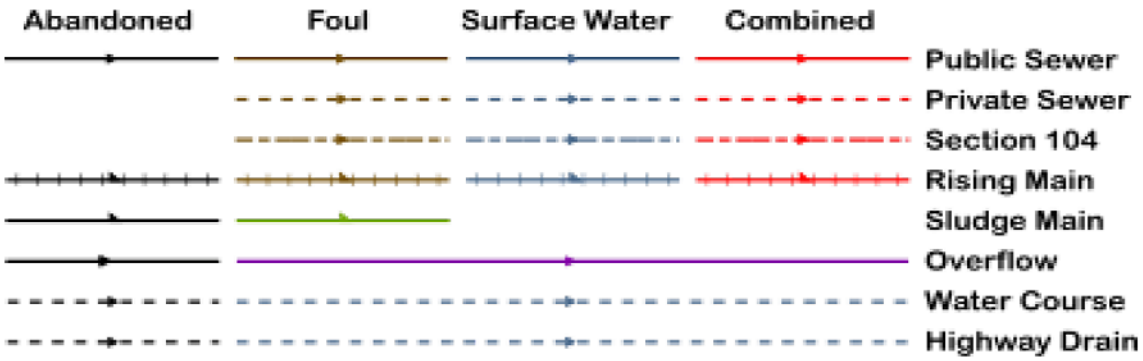
United Utilities
Water for the North West

Wastewater Symbology



All point assets follow the standard colour convention: red – combined, brown - foul, blue – surface water, purple - overflow

- Manhole
- HS Head of System
- ES Extent of Survey
- RE Rodding Eye
- IN Inlet
- DP Discharge Point
- HY Vortex
- PE Penstock
- WO Washout Chamber
- VA Valve
- AV Air Valve
- NRV Non Return Valve
- SO Soakaway
- GU Gully
- CA Cascade
- FM Flow Meter
- HA Hatch Box
- OI Oil Interceptor
- SM Summit
- DS Drop Shaft
- OP Orifice Plate
- Side Entry Manhole
- Outfall
- Screen Chamber
- IC Inspection Chamber
- Bifurcation Chamber
- LH Lamp Hole
- T Junction / Saddle
- Catchpit
- Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- T Network Storage Tank
- V Sewer Overflow
- WwTW Ww Treatment Works
- Ww Pumping Station
- Septic Tank
- Control Kiosk
- Change of Characteristic

Appendix F

Greenfield Run-Off Rates and Volume Calculations

IH 124 Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (ha)	50.000	Urban	0.750
SAAR (mm)	868	Region Number	Region 10

Results	**l/s**
QBAR Rural	282.5
QBAR Urban	705.6
Q1 year	613.9
Q1 year	613.9
Q2 years	720.8
Q5 years	865.1
Q10 years	932.2
Q20 years	993.5
Q25 years	1009.3
Q30 years	1021.8
Q50 years	1054.3
Q100 years	1110.4
Q200 years	1188.3
Q250 years	1211.6
Q1000 years	1357.1

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Greenfield Runoff Volume

FEH Data

Return Period (years)	100
Storm Duration (mins)	360
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Areal Reduction Factor	1.00
Area (ha)	60590.250
SAAR (mm)	1153
CWI	123.707
SPR Host	38.840
URBEXT (USER)	0.5000

Results

Percentage Runoff (%)	51.21
Greenfield Runoff Volume (m^3)	20335121.842

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Appendix G

Pre-Development Run-Off Rates and Volume Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.129	4-8	0.027

Total Area Contributing (ha) = 0.156

Total Pipe Volume (m³) = 0.795

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

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Simulation Criteria for Storm

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	1	+0%	30/15 Summer				30.086
1.001	2	15 Winter	1	+0%	30/15 Summer				30.008

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.139	0.000	0.31			13.4	OK	
1.001	2	-0.117	0.000	0.46			19.8	OK	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	30	+0%	30/15 Summer				30.351
1.001	2	15 Winter	30	+0%	30/15 Summer				30.256

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.126	0.000	0.97			42.0	SURCHARGED	
1.001	2	0.131	0.000	1.50			65.2	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	100	+0%	30/15 Summer				30.753
1.001	2	15 Winter	100	+0%	30/15 Summer				30.544

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.528	0.000	1.45			62.9	SURCHARGED	
1.001	2	0.419	0.000	2.25			97.4	SURCHARGED	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.129	4-8	0.027

Total Area Contributing (ha) = 0.156

Total Pipe Volume (m³) = 0.795

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

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Simulation Criteria for Storm

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	360
Return Period(s) (years)	100
Climate Change (%)	0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	1	360 minute 100 year Summer I+0%	32.000	30.068	-0.157	0.000	0.20
1.001	2	360 minute 100 year Summer I+0%	32.000	29.986	-0.139	0.000	0.31

PN	US/MH Name	Overflow (l/s)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1		49.166	8.6	OK
1.001	2		76.675	13.4	OK

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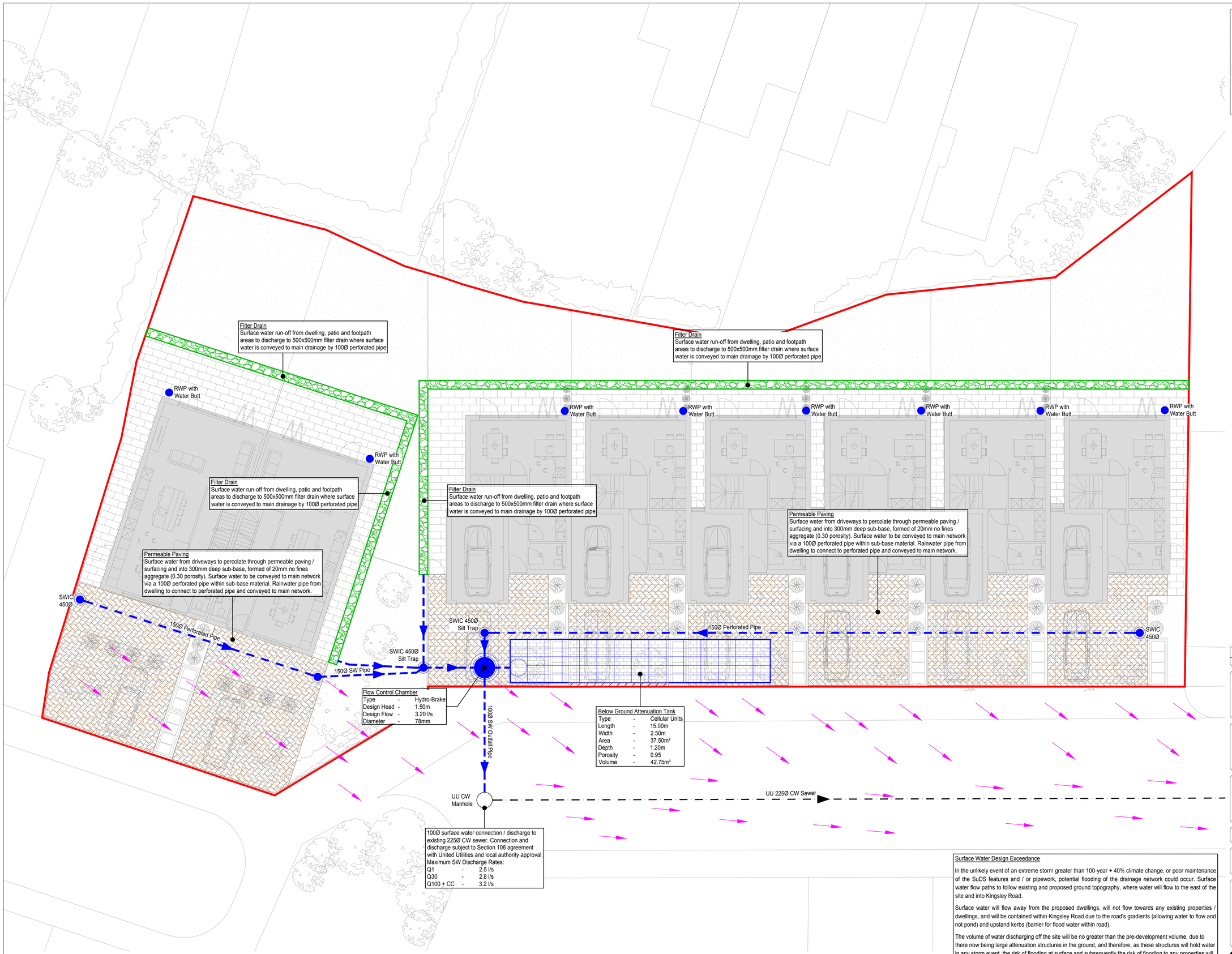
Appendix H

Surface Water Management Layout and Details



Surface Water Design Exceedance

In the unlikely event of an extreme storm greater than 100-year + 40% climate change, or poor maintenance of the SuDS features and / or pipework, potential flooding of the drainage network could occur. Surface water flow paths to follow existing and proposed ground topography, where water will flow to the east of the site and into Kingsley Road.

Surface water will flow away from the proposed dwellings, will not flow towards any existing properties / dwellings, and will be contained within Kingsley Road due to the road's gradients (allowing water to flow and not pond) and upstand kerbs (barrier for flood water within road).

The volume of water discharging off the site will be no greater than the pre-development volume, due to there now being large attenuation structures in the ground, and therefore, as these structures will hold water in any storm event, the risk of flooding at surface and subsequently the risk of flooding to any properties will not increase. Therefore, the flood risk to land or properties within or outside the development would not increase even in an extreme (greater than 1% AEP + 40% cc) storm event.

Rev	Description	Drn	Chk	Date
P1	Issued for Planning	MDS	AC	27.05.21

Client
-

Project
Kingsley Road, Northenden
Manchester, M22 4NL

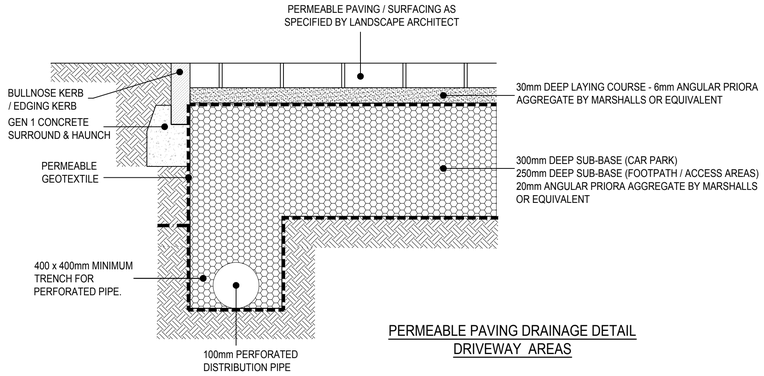
Drawing
Surface Water
Management Layout

Scale	Date	Drawn by	Checked
1:100@A1	May '21	MDS	AC

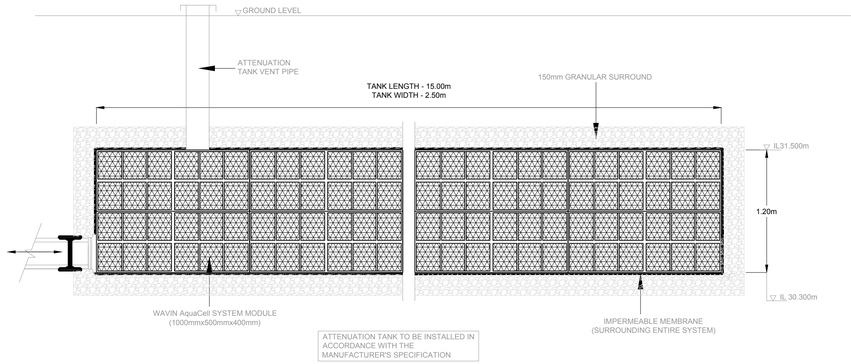
Status
Planning

Earth Environmental & Geotechnical

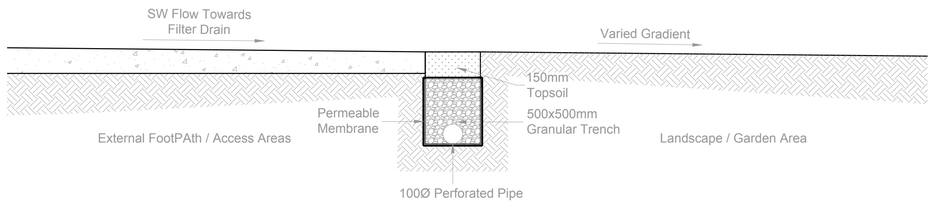
Job No.	Drg. No.	Rev
716	DR-100	P1



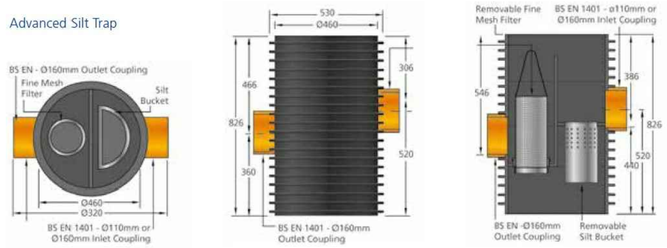
PERMEABLE PAVING DRAINAGE DETAIL
DRIVEWAY AREAS

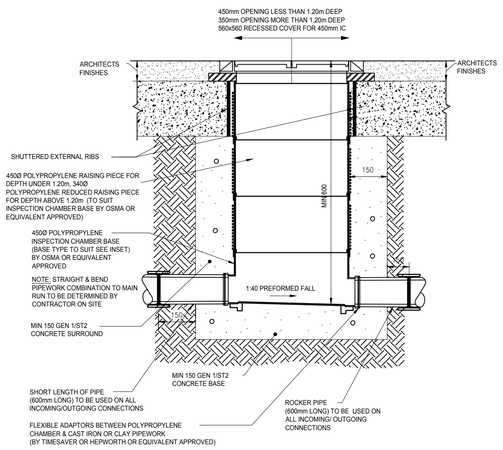


ATTENUATION TANK DETAIL



Filter Drain Detail

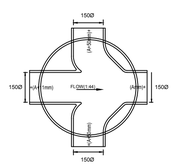




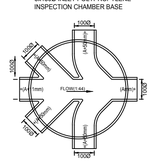
NOTES:
1. THIS CHAMBER IS NOT TO BE USED UNDER HEAVY VEHICULAR AREAS.
2. MAXIMUM INCOMING/OUTGOING PIPE DIAMETER SHALL BE 100 OR 150Ø.

PPIC
POLYPROPYLENE INSPECTION CHAMBER

NOTE:
COVERS TO BE ORIENTATED BY CONTRACTOR ON SITE TO SUIT PAVEMENT FINISHES.
COVERS SHOULD NOT STRADDLE TWO PAVEMENT FINISHES.

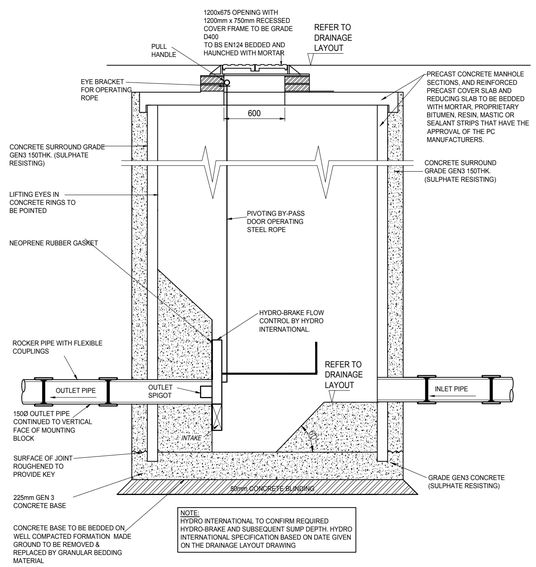


3x150Ø INLET POLYPROPYLENE INSPECTION CHAMBER BASE



5x100Ø INLET POLYPROPYLENE INSPECTION CHAMBER BASE

I.C. TYPE 2 BASE TYPES



FLOW CONTROL MANHOLE DETAIL

CONTROL MANHOLE NOTES

ALL DIMENSION ARE IN MILLIMETRES

PRECAST CONCRETE UNITS TO BE BS5911 PART . 200 AND TO BE CONSTRUCTED WITH A MINIMUM CLASS 3 SULPHATE RESISTING CEMENT.

ALL INSITU CONCRETE TO BE CLASS STANDARD MIX ST4 (GRADE C20) IN ACCORDANCE WITH SECTION 4 OF BS5328 PART 2.

MATERIALS FOR JOINTING MANHOLE RINGS TO BE A RUBBER BITUMEN COMPOUND OF APPROVED MANUFACTURER 'TOKSTRIP' OR SIMILAR.

ALL BRICKWORK TO BE CLASS B ENGINEERING -2 COURSES MIN.4 COURSES MAX; 225mm THICK - BS5628 PART 3.

20mm THICK GRANOLITHIC CONCRETE BENCHING TO BE BROUGHT UP TO A DENSE SMOOTH FACE NEATLY SHAPED AND FINISHED TO ALL BRANCH CONNECTIONS. WHERE BENCHING IS LESS THAN 450mm WIDE, SLOPE TO BE 1:10, MORE THAN 450mm, 1:30

PIPES ENTERING MANHOLES TO HAVE A FLEXIBLE JOINT AS CLOSE AS FEASIBLE TO OUTSIDE FACE OF ANY STRUCTURE INTO WHICH THE PIPE IS BUILT IN ORDER TO FACILITATE MOVEMENT OF THE JOINT.

THE LENGTH OF THE NEXT PIPE (ROCKER PIPELINES. BEDDING, LAYING AND JOINTING OF PIPES AND BACKFILLING OF TRENCHES SHALL BE IN ACCORDANCE WITH THE W.S.A.SPEC 'SEWERS FOR ADOPTION' - 6TH EDITION TOGETHER WITH ANY LOCAL AUTHORITY REQUIREMENTS.

Rev	Description	Drn	Chk	Date
P1	Issued for Planning	MDS	AC	27.05.21

Client
-

Project
Kingsley Road, Northenden
Manchester, M22 4NL

Drawing
Surface Water
Management Details

Scale	Date	Drawn by	Checked
N.T.S	May '21	MDS	AC

Status
Planning

Earth Environmental & Geotechnical

Job No.	Drg. No.	Rev
716	DR-101	P1

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.500	3.200
Flush-Flo™	0.343	2.794
Kick-Flo®	0.697	2.253
Mean Flow		2.597

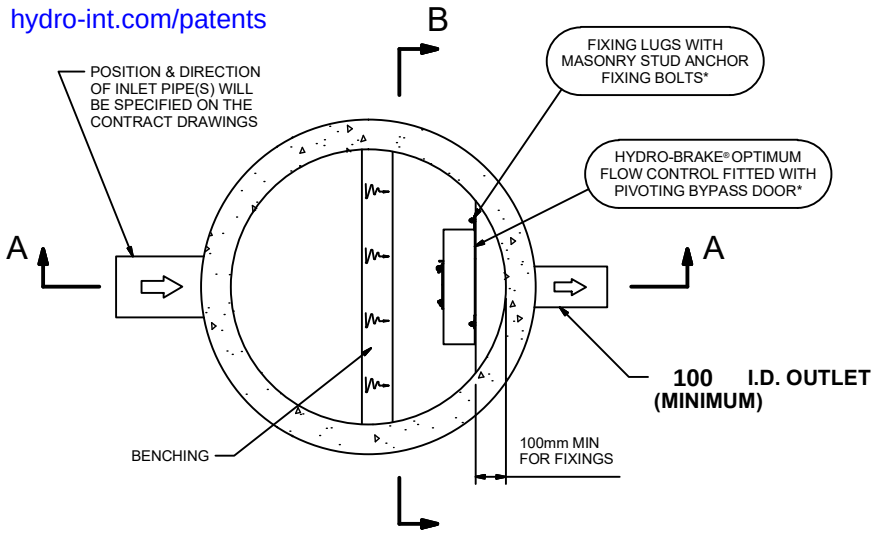
Hydro-Brake® Optimum Flow Control including:

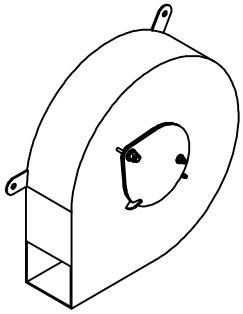
- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting by-pass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Beed blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Rubber gasket to seal outlet

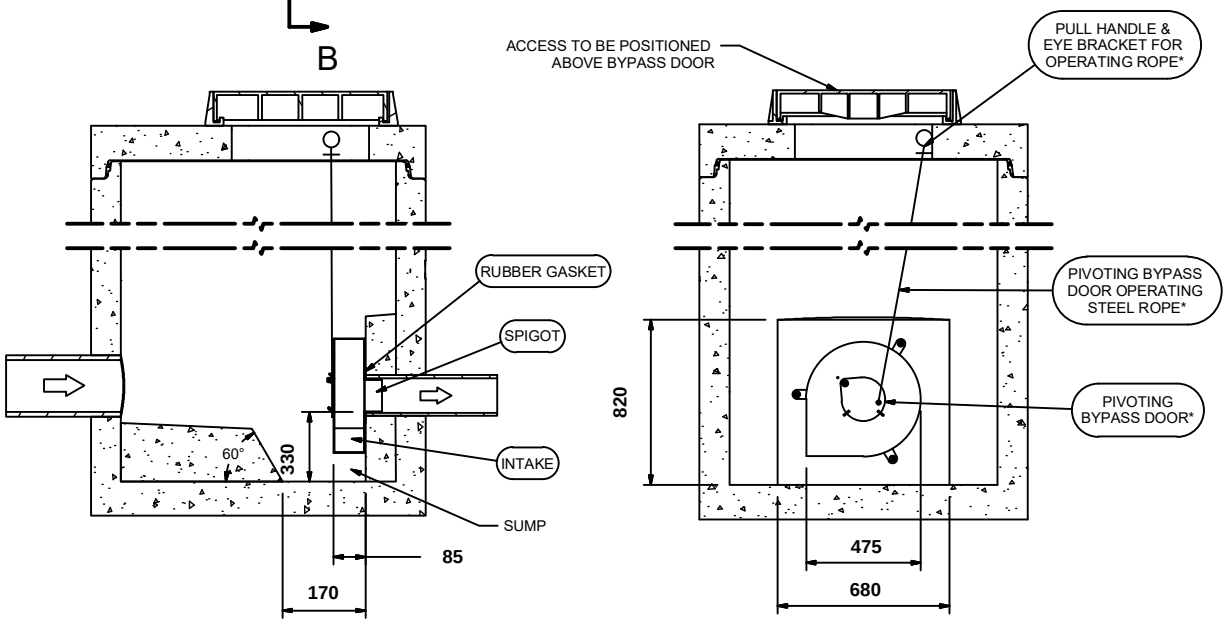
BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE 08/4596

WRc Approved
PT/329/0412

hydro-int.com/patents







SECTION A-A

SECTION B-B

IMPORTANT: ⬭ LIMIT OF HYDRO INTERNATIONAL SUPPLY
THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED
HYDRO-BRAKE® FLOW CONTROL & HYDRO-BRAKE® OPTIMUM FLOW CONTROL ARE REGISTERED TRADEMARKS FOR FLOW CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.

DESIGN ADVICE !

The head/flow characteristics of this SHE-0078-3200-1500-3200 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro International®

DATE	5/27/2021 11:26 AM
SITE	Kingsley Road
DESIGNER	Mark Symonds
REF	716

SHE-0078-3200-1500-3200
Hydro-Brake® Optimum

© 2021 Hydro International Ltd, Shearwater House, Clevedon Hall Estate, Victoria Road, Clevedon, BS21 7RD. Tel; 01275 878371 Fax; 01275 874979 Web; www.hydro-int.com Email; enquiries@hydro-int.com

markdavidsymonds@gmail.com

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.500	3.200
Flush-Flo	0.343	2.794
Kick-Flo®	0.697	2.253
Mean Flow		2.597

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4596

WRc APPROVED
PT/329/0412

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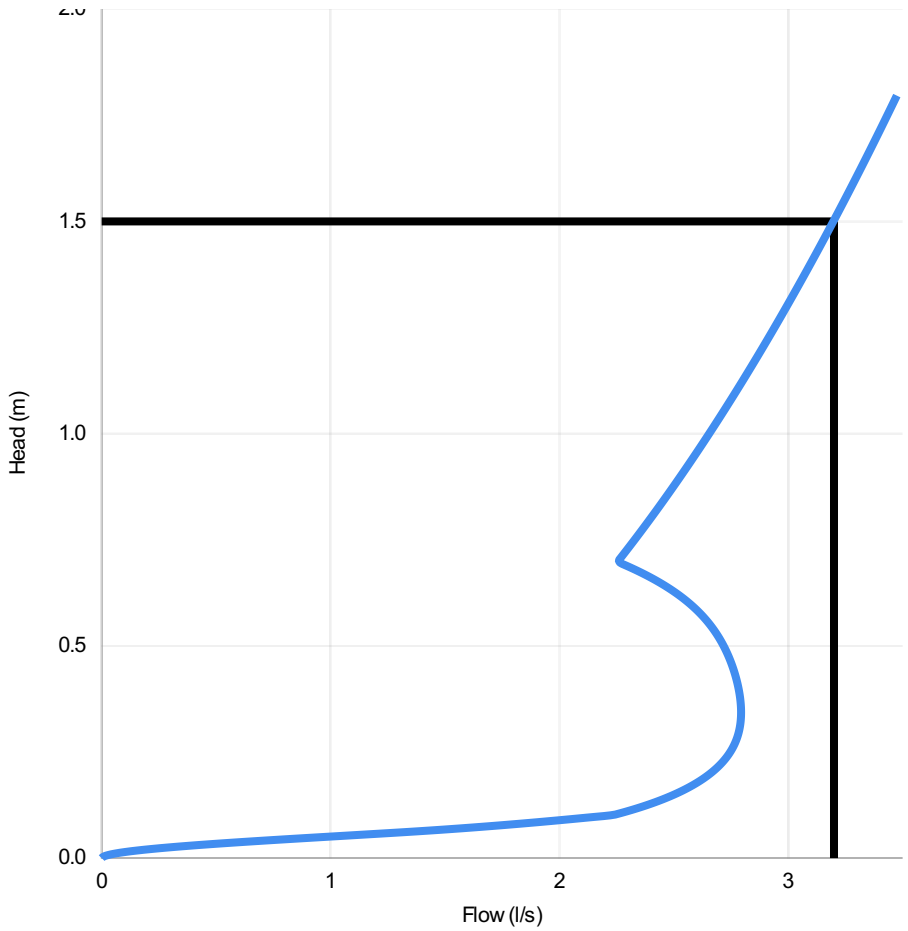

Head (m)	Flow (l/s)
0.000	0.000
0.052	1.030
0.103	2.250
0.155	2.523
0.207	2.676
0.259	2.756
0.310	2.789
0.362	2.793
0.414	2.777
0.466	2.747
0.517	2.700
0.569	2.628
0.621	2.520
0.672	2.358
0.724	2.292
0.776	2.365
0.828	2.435
0.879	2.503
0.931	2.569
0.983	2.634
1.034	2.696
1.086	2.757
1.138	2.816
1.190	2.874
1.241	2.931
1.293	2.986
1.345	3.040
1.397	3.094
1.448	3.146
1.500	3.197

DESIGN ADVICE

The head/flow characteristics of this SHE-0078-3200-1500-3200 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

!

The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro International®

DATE	27/05/2021 11:26
Site	Kingsley Road
DESIGNER	Mark Symonds
Ref	716

SHE-0078-3200-1500-3200

Hydro-Brake Optimum®

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Appendix I

Surface Water Management Calculations

Summary of Results for 1 year Return Period

Half Drain Time : 26 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	30.392	0.092	0.0	2.0	2.0	3.3	O K
30 min Summer	30.411	0.111	0.0	2.3	2.3	4.0	O K
60 min Summer	30.423	0.123	0.0	2.4	2.4	4.4	O K
120 min Summer	30.428	0.128	0.0	2.4	2.4	4.6	O K
180 min Summer	30.422	0.122	0.0	2.4	2.4	4.3	O K
240 min Summer	30.413	0.113	0.0	2.3	2.3	4.0	O K
360 min Summer	30.398	0.098	0.0	2.2	2.2	3.5	O K
480 min Summer	30.386	0.086	0.0	1.9	1.9	3.1	O K
600 min Summer	30.378	0.078	0.0	1.8	1.8	2.8	O K
720 min Summer	30.372	0.072	0.0	1.6	1.6	2.6	O K
960 min Summer	30.364	0.064	0.0	1.4	1.4	2.3	O K
1440 min Summer	30.354	0.054	0.0	1.1	1.1	1.9	O K
2160 min Summer	30.347	0.047	0.0	0.9	0.9	1.7	O K
2880 min Summer	30.342	0.042	0.0	0.7	0.7	1.5	O K
4320 min Summer	30.336	0.036	0.0	0.6	0.6	1.3	O K
5760 min Summer	30.332	0.032	0.0	0.5	0.5	1.1	O K
7200 min Summer	30.330	0.030	0.0	0.4	0.4	1.1	O K
8640 min Summer	30.328	0.028	0.0	0.3	0.3	1.0	O K
10080 min Summer	30.326	0.026	0.0	0.3	0.3	0.9	O K
15 min Winter	30.406	0.106	0.0	2.3	2.3	3.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	30.034	0.0	4.4	24
30 min Summer	18.591	0.0	5.9	33
60 min Summer	11.508	0.0	7.7	50
120 min Summer	7.123	0.0	9.9	82
180 min Summer	5.380	0.0	11.4	112
240 min Summer	4.409	0.0	12.6	144
360 min Summer	3.330	0.0	14.4	202
480 min Summer	2.729	0.0	15.9	262
600 min Summer	2.339	0.0	17.1	322
720 min Summer	2.062	0.0	18.1	382
960 min Summer	1.707	0.0	20.1	502
1440 min Summer	1.308	0.0	23.1	742
2160 min Summer	1.003	0.0	26.4	1104
2880 min Summer	0.830	0.0	29.0	1472
4320 min Summer	0.635	0.0	32.8	2200
5760 min Summer	0.524	0.0	35.6	2936
7200 min Summer	0.452	0.0	37.8	3640
8640 min Summer	0.401	0.0	39.5	4296
10080 min Summer	0.362	0.0	41.0	5056
15 min Winter	30.034	0.0	5.1	24

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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
30 min Winter	30.429	0.129	0.0	2.4	2.4	4.6	O K
60 min Winter	30.440	0.140	0.0	2.5	2.5	5.0	O K
120 min Winter	30.434	0.134	0.0	2.4	2.4	4.8	O K
180 min Winter	30.419	0.119	0.0	2.3	2.3	4.2	O K
240 min Winter	30.404	0.104	0.0	2.3	2.3	3.7	O K
360 min Winter	30.385	0.085	0.0	1.9	1.9	3.0	O K
480 min Winter	30.373	0.073	0.0	1.6	1.6	2.6	O K
600 min Winter	30.365	0.065	0.0	1.4	1.4	2.3	O K
720 min Winter	30.360	0.060	0.0	1.3	1.3	2.1	O K
960 min Winter	30.353	0.053	0.0	1.1	1.1	1.9	O K
1440 min Winter	30.345	0.045	0.0	0.8	0.8	1.6	O K
2160 min Winter	30.339	0.039	0.0	0.6	0.6	1.4	O K
2880 min Winter	30.335	0.035	0.0	0.5	0.5	1.2	O K
4320 min Winter	30.330	0.030	0.0	0.4	0.4	1.1	O K
5760 min Winter	30.327	0.027	0.0	0.3	0.3	1.0	O K
7200 min Winter	30.325	0.025	0.0	0.3	0.3	0.9	O K
8640 min Winter	30.323	0.023	0.0	0.3	0.3	0.8	O K
10080 min Winter	30.322	0.022	0.0	0.2	0.2	0.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	18.591	0.0	6.8	34
60 min Winter	11.508	0.0	8.8	52
120 min Winter	7.123	0.0	11.3	86
180 min Winter	5.380	0.0	13.0	118
240 min Winter	4.409	0.0	14.3	148
360 min Winter	3.330	0.0	16.4	206
480 min Winter	2.729	0.0	18.1	266
600 min Winter	2.339	0.0	19.4	326
720 min Winter	2.062	0.0	20.6	382
960 min Winter	1.707	0.0	22.8	502
1440 min Winter	1.308	0.0	26.2	744
2160 min Winter	1.003	0.0	30.0	1108
2880 min Winter	0.830	0.0	33.0	1472
4320 min Winter	0.635	0.0	37.3	2208
5760 min Winter	0.524	0.0	40.6	2944
7200 min Winter	0.452	0.0	43.2	3648
8640 min Winter	0.401	0.0	45.4	4280
10080 min Winter	0.362	0.0	47.2	5152

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.110

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.030	4	8	0.030	8	12	0.030	12	16	0.020

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Model Details

Storage is Online Cover Level (m) 32.000

Complex Structure

Cellular Storage

Invert Level (m) 30.300 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)
0.000	37.5	0.0	2.600	0.0	0.0
0.200	37.5	0.0	2.800	0.0	0.0
0.400	37.5	0.0	3.000	0.0	0.0
0.600	37.5	0.0	3.200	0.0	0.0
0.800	37.5	0.0	3.400	0.0	0.0
1.000	37.5	0.0	3.600	0.0	0.0
1.200	37.5	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	70.0
Max Percolation (l/s)	97.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.500	Cap Volume Depth (m)	0.300

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0078-3200-1500-3200
Design Head (m)	1.500
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	78
Invert Level (m)	30.300
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

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Hydro-Brake® Optimum Outflow Control

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	3.2
Flush-Flo™	0.343	2.8
Kick-Flo®	0.697	2.3
Mean Flow over Head Range	-	2.6

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	2.2	1.200	2.9	3.000	4.4	7.000	6.6
0.200	2.7	1.400	3.1	3.500	4.7	7.500	6.8
0.300	2.8	1.600	3.3	4.000	5.0	8.000	7.0
0.400	2.8	1.800	3.5	4.500	5.3	8.500	7.2
0.500	2.7	2.000	3.7	5.000	5.6	9.000	7.4
0.600	2.6	2.200	3.8	5.500	5.9	9.500	7.6
0.800	2.4	2.400	4.0	6.000	6.1		
1.000	2.7	2.600	4.1	6.500	6.3		

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Summary of Results for 30 year Return Period

Half Drain Time : 67 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	30.716	0.416	0.0	2.8	2.8	14.8	O K
30 min Summer	30.774	0.474	0.0	2.8	2.8	16.9	O K
60 min Summer	30.805	0.505	0.0	2.8	2.8	18.0	O K
120 min Summer	30.792	0.492	0.0	2.8	2.8	17.5	O K
180 min Summer	30.763	0.463	0.0	2.8	2.8	16.5	O K
240 min Summer	30.729	0.429	0.0	2.8	2.8	15.3	O K
360 min Summer	30.662	0.362	0.0	2.8	2.8	12.9	O K
480 min Summer	30.603	0.303	0.0	2.8	2.8	10.8	O K
600 min Summer	30.554	0.254	0.0	2.8	2.8	9.1	O K
720 min Summer	30.515	0.215	0.0	2.7	2.7	7.7	O K
960 min Summer	30.462	0.162	0.0	2.6	2.6	5.8	O K
1440 min Summer	30.406	0.106	0.0	2.3	2.3	3.8	O K
2160 min Summer	30.379	0.079	0.0	1.8	1.8	2.8	O K
2880 min Summer	30.366	0.066	0.0	1.5	1.5	2.4	O K
4320 min Summer	30.354	0.054	0.0	1.1	1.1	1.9	O K
5760 min Summer	30.347	0.047	0.0	0.9	0.9	1.7	O K
7200 min Summer	30.343	0.043	0.0	0.8	0.8	1.5	O K
8640 min Summer	30.339	0.039	0.0	0.7	0.7	1.4	O K
10080 min Summer	30.337	0.037	0.0	0.6	0.6	1.3	O K
15 min Winter	30.778	0.478	0.0	2.8	2.8	17.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	94.165	0.0	17.6	26
30 min Summer	54.968	0.0	20.9	37
60 min Summer	32.087	0.0	24.7	60
120 min Summer	18.730	0.0	29.0	94
180 min Summer	13.671	0.0	31.9	128
240 min Summer	10.934	0.0	34.1	160
360 min Summer	7.980	0.0	37.5	226
480 min Summer	6.382	0.0	40.0	288
600 min Summer	5.367	0.0	42.1	348
720 min Summer	4.658	0.0	43.8	406
960 min Summer	3.764	0.0	47.2	522
1440 min Summer	2.788	0.0	52.4	750
2160 min Summer	2.065	0.0	58.0	1108
2880 min Summer	1.669	0.0	62.2	1472
4320 min Summer	1.232	0.0	68.3	2200
5760 min Summer	0.994	0.0	72.7	2936
7200 min Summer	0.841	0.0	76.2	3656
8640 min Summer	0.734	0.0	79.1	4336
10080 min Summer	0.654	0.0	81.5	5040
15 min Winter	94.165	0.0	20.0	26

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Summary of Results for 30 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
30 min Winter	30.846	0.546	0.0	2.8	2.8	19.5	O K
60 min Winter	30.887	0.587	0.0	2.8	2.8	20.9	O K
120 min Winter	30.865	0.565	0.0	2.8	2.8	20.1	O K
180 min Winter	30.819	0.519	0.0	2.8	2.8	18.5	O K
240 min Winter	30.765	0.465	0.0	2.8	2.8	16.6	O K
360 min Winter	30.661	0.361	0.0	2.8	2.8	12.8	O K
480 min Winter	30.574	0.274	0.0	2.8	2.8	9.8	O K
600 min Winter	30.509	0.209	0.0	2.7	2.7	7.5	O K
720 min Winter	30.463	0.163	0.0	2.6	2.6	5.8	O K
960 min Winter	30.410	0.110	0.0	2.3	2.3	3.9	O K
1440 min Winter	30.379	0.079	0.0	1.8	1.8	2.8	O K
2160 min Winter	30.361	0.061	0.0	1.3	1.3	2.2	O K
2880 min Winter	30.353	0.053	0.0	1.1	1.1	1.9	O K
4320 min Winter	30.344	0.044	0.0	0.8	0.8	1.6	O K
5760 min Winter	30.339	0.039	0.0	0.6	0.6	1.4	O K
7200 min Winter	30.335	0.035	0.0	0.5	0.5	1.2	O K
8640 min Winter	30.333	0.033	0.0	0.5	0.5	1.2	O K
10080 min Winter	30.331	0.031	0.0	0.4	0.4	1.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	54.968	0.0	23.6	38
60 min Winter	32.087	0.0	27.8	62
120 min Winter	18.730	0.0	32.7	102
180 min Winter	13.671	0.0	36.0	138
240 min Winter	10.934	0.0	38.5	174
360 min Winter	7.980	0.0	42.2	240
480 min Winter	6.382	0.0	45.1	302
600 min Winter	5.367	0.0	47.4	360
720 min Winter	4.658	0.0	49.4	416
960 min Winter	3.764	0.0	53.2	522
1440 min Winter	2.788	0.0	59.0	748
2160 min Winter	2.065	0.0	65.3	1104
2880 min Winter	1.669	0.0	70.1	1460
4320 min Winter	1.232	0.0	77.1	2200
5760 min Winter	0.994	0.0	82.2	2856
7200 min Winter	0.841	0.0	86.3	3640
8640 min Winter	0.734	0.0	89.6	4392
10080 min Winter	0.654	0.0	92.5	5152

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.110

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.030	4	8	0.030	8	12	0.030	12	16	0.020

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Model Details

Storage is Online Cover Level (m) 32.000

Complex Structure

Cellular Storage

Invert Level (m) 30.300 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)
0.000	37.5	0.0	2.600	0.0	0.0
0.200	37.5	0.0	2.800	0.0	0.0
0.400	37.5	0.0	3.000	0.0	0.0
0.600	37.5	0.0	3.200	0.0	0.0
0.800	37.5	0.0	3.400	0.0	0.0
1.000	37.5	0.0	3.600	0.0	0.0
1.200	37.5	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	70.0
Max Percolation (l/s)	97.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.500	Cap Volume Depth (m)	0.300

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0078-3200-1500-3200
Design Head (m)	1.500
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	78
Invert Level (m)	30.300
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

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Hydro-Brake® Optimum Outflow Control

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	3.2
Flush-Flo™	0.343	2.8
Kick-Flo®	0.697	2.3
Mean Flow over Head Range	-	2.6

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	2.2	1.200	2.9	3.000	4.4	7.000	6.6
0.200	2.7	1.400	3.1	3.500	4.7	7.500	6.8
0.300	2.8	1.600	3.3	4.000	5.0	8.000	7.0
0.400	2.8	1.800	3.5	4.500	5.3	8.500	7.2
0.500	2.7	2.000	3.7	5.000	5.6	9.000	7.4
0.600	2.6	2.200	3.8	5.500	5.9	9.500	7.6
0.800	2.4	2.400	4.0	6.000	6.1		
1.000	2.7	2.600	4.1	6.500	6.3		

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Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 154 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	31.309	1.009	0.0	2.8	2.8	35.9	O K
30 min Summer	31.431	1.131	0.0	2.8	2.8	40.3	O K
60 min Summer	31.519	1.219	0.0	2.9	2.9	43.4	O K
120 min Summer	31.525	1.225	0.0	2.9	2.9	43.6	O K
180 min Summer	31.477	1.177	0.0	2.9	2.9	41.9	O K
240 min Summer	31.431	1.131	0.0	2.8	2.8	40.3	O K
360 min Summer	31.343	1.043	0.0	2.8	2.8	37.1	O K
480 min Summer	31.260	0.960	0.0	2.8	2.8	34.2	O K
600 min Summer	31.182	0.882	0.0	2.8	2.8	31.4	O K
720 min Summer	31.106	0.806	0.0	2.8	2.8	28.7	O K
960 min Summer	30.953	0.653	0.0	2.8	2.8	23.3	O K
1440 min Summer	30.709	0.409	0.0	2.8	2.8	14.6	O K
2160 min Summer	30.520	0.220	0.0	2.7	2.7	7.8	O K
2880 min Summer	30.437	0.137	0.0	2.4	2.4	4.9	O K
4320 min Summer	30.386	0.086	0.0	1.9	1.9	3.1	O K
5760 min Summer	30.370	0.070	0.0	1.6	1.6	2.5	O K
7200 min Summer	30.361	0.061	0.0	1.3	1.3	2.2	O K
8640 min Summer	30.355	0.055	0.0	1.1	1.1	2.0	O K
10080 min Summer	30.351	0.051	0.0	1.0	1.0	1.8	O K
15 min Winter	31.443	1.143	0.0	2.8	2.8	40.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	198.753	0.0	39.2	28
30 min Summer	113.601	0.0	45.0	40
60 min Summer	64.930	0.0	51.8	66
120 min Summer	37.112	0.0	59.4	120
180 min Summer	26.755	0.0	64.3	150
240 min Summer	21.212	0.0	68.1	182
360 min Summer	15.292	0.0	73.7	252
480 min Summer	12.124	0.0	77.9	320
600 min Summer	10.126	0.0	81.3	390
720 min Summer	8.741	0.0	84.2	458
960 min Summer	7.002	0.0	89.9	588
1440 min Summer	5.122	0.0	98.6	814
2160 min Summer	3.747	0.0	107.9	1152
2880 min Summer	3.002	0.0	115.0	1496
4320 min Summer	2.190	0.0	125.1	2204
5760 min Summer	1.750	0.0	132.7	2904
7200 min Summer	1.471	0.0	138.7	3664
8640 min Summer	1.277	0.0	143.6	4336
10080 min Summer	1.133	0.0	147.9	5128
15 min Winter	198.753	0.0	44.1	28

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Summary of Results for 100 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
30 min Winter	31.622	1.322	0.0	3.0	3.0	45.7	O K
60 min Winter	31.807	1.507	0.0	3.2	3.2	49.4	Flood Risk
120 min Winter	31.834	1.534	0.0	3.2	3.2	50.1	Flood Risk
180 min Winter	31.763	1.463	0.0	3.2	3.2	48.2	Flood Risk
240 min Winter	31.666	1.366	0.0	3.1	3.1	46.3	O K
360 min Winter	31.483	1.183	0.0	2.9	2.9	42.2	O K
480 min Winter	31.364	1.064	0.0	2.8	2.8	37.9	O K
600 min Winter	31.248	0.948	0.0	2.8	2.8	33.8	O K
720 min Winter	31.135	0.835	0.0	2.8	2.8	29.7	O K
960 min Winter	30.884	0.584	0.0	2.8	2.8	20.8	O K
1440 min Winter	30.574	0.274	0.0	2.8	2.8	9.8	O K
2160 min Winter	30.418	0.118	0.0	2.3	2.3	4.2	O K
2880 min Winter	30.386	0.086	0.0	1.9	1.9	3.1	O K
4320 min Winter	30.364	0.064	0.0	1.4	1.4	2.3	O K
5760 min Winter	30.355	0.055	0.0	1.1	1.1	1.9	O K
7200 min Winter	30.349	0.049	0.0	1.0	1.0	1.7	O K
8640 min Winter	30.345	0.045	0.0	0.8	0.8	1.6	O K
10080 min Winter	30.342	0.042	0.0	0.7	0.7	1.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	113.601	0.0	50.7	40
60 min Winter	64.930	0.0	58.2	66
120 min Winter	37.112	0.0	66.7	120
180 min Winter	26.755	0.0	72.3	156
240 min Winter	21.212	0.0	76.5	192
360 min Winter	15.292	0.0	82.8	270
480 min Winter	12.124	0.0	87.5	346
600 min Winter	10.126	0.0	91.4	420
720 min Winter	8.741	0.0	94.6	496
960 min Winter	7.002	0.0	101.0	620
1440 min Winter	5.122	0.0	110.8	828
2160 min Winter	3.747	0.0	121.3	1140
2880 min Winter	3.002	0.0	129.3	1472
4320 min Winter	2.190	0.0	140.7	2196
5760 min Winter	1.750	0.0	149.3	2856
7200 min Winter	1.471	0.0	156.1	3624
8640 min Winter	1.277	0.0	161.8	4368
10080 min Winter	1.133	0.0	166.7	4952

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 383250 390300 SJ 83250 90300
C (1km)	-0.025
D1 (1km)	0.308
D2 (1km)	0.344
D3 (1km)	0.337
E (1km)	0.303
F (1km)	2.443
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.110

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.030	4	8	0.030	8	12	0.030	12	16	0.020

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Model Details

Storage is Online Cover Level (m) 32.000

Complex Structure

Cellular Storage

Invert Level (m) 30.300 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)
0.000	37.5	0.0	2.600	0.0	0.0
0.200	37.5	0.0	2.800	0.0	0.0
0.400	37.5	0.0	3.000	0.0	0.0
0.600	37.5	0.0	3.200	0.0	0.0
0.800	37.5	0.0	3.400	0.0	0.0
1.000	37.5	0.0	3.600	0.0	0.0
1.200	37.5	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	70.0
Max Percolation (l/s)	97.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.500	Cap Volume Depth (m)	0.300

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0078-3200-1500-3200
Design Head (m)	1.500
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	78
Invert Level (m)	30.300
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

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Hydro-Brake® Optimum Outflow Control

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	3.2
Flush-Flo™	0.343	2.8
Kick-Flo®	0.697	2.3
Mean Flow over Head Range	-	2.6

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	2.2	1.200	2.9	3.000	4.4	7.000	6.6
0.200	2.7	1.400	3.1	3.500	4.7	7.500	6.8
0.300	2.8	1.600	3.3	4.000	5.0	8.000	7.0
0.400	2.8	1.800	3.5	4.500	5.3	8.500	7.2
0.500	2.7	2.000	3.7	5.000	5.6	9.000	7.4
0.600	2.6	2.200	3.8	5.500	5.9	9.500	7.6
0.800	2.4	2.400	4.0	6.000	6.1		
1.000	2.7	2.600	4.1	6.500	6.3		

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