

Drainage Strategy

And

Flood Risk Assessment

for

Proposed Development

Woodbine Street / Oldham Road

Rochdale OL16 5JB

Client Name: Arcon Housing Association
Our ref: LRD31163
Date: April 2021
Revision: 001

SUTCLIFFE

Drainage Strategy & Flood Risk Assessment

DOCUMENT VERIFICATION

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Revision History:

Rev	Date	Description	Prepared	Checked	Approved
01	April 2021	Issued for Planning	DS	MP	DS

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Contents

1.0	Introduction
2.0	Existing flood risk
3.0	Infiltration to ground
4.0	Discharge to suitable water course
5.0	Discharge to suitable surface water network
6.0	Discharge to suitable combined sewer network
7.0	Existing site surface water drainage
8.0	Site surface water drainage proposals
9.0	Site surface water runoff drainage design
10.0	Outstanding flood risk
11.0	Future surface water drainage management and maintenance

Appendix A	Existing Site Layout
	Proposed Site Layout
Appendix B	Existing United Utilities Sewer Records
Appendix C	Proposed Drainage Plan
	Proposed Flood Routing
Appendix D	Hydraulic Calculations

1.0 Introduction

The site is currently grassed with some trees located along the northern boundary and is located within a developed area of Rochdale.

The site is bound by Woodbine Street, to the south, Oldham Road, to the west, an existing building to the east and Rochdale Canal to the north. Between the north site boundary and canal is a strip of land whose ownership is unknown.

The proposed scheme consists of 22 flats with infrastructure.

The total site area is approximately 0.11 Ha and its location can be found by the following references;

Postcode OL16 5JB

Coordinates 390364, 412335

Grid reference SD 90364 12335

The site is currently undeveloped with a level difference of up to 0.5m from north east to south west.

The purpose of the strategy and flood risk assessment is to consider how the surface water runoff from the development site will be effectually drained and managed throughout the lifetime of the development.

The site must, in the first instance, consider the use of SUDS in accordance with the National Planning Policy Framework.

SUDS are the provision of a surface water drainage scheme that manages the surface water runoff at source.

The hierarchy of managing surface water at source is:

- Infiltration to ground
- Discharge to a suitable water course
- Discharge to a suitable surface water sewer network
- Discharge to a combined sewer network

The following statements are made in relation to the above stated hierarchy in relation to the proposed scheme.

2.0 Existing Flood Risk

An inspection of the Environment Agency flood maps was made on the internet and the following can be stated.

- That the site is located within a Zone 1 low risk flood area and the site is, therefore, considered not to be at risk of flooding from rivers or sea.

- That the site is not indicated as having surface water flooding. The site can, therefore, be assessed as having a very low risk of surface water flooding.
- That the site is not at risk from flooding from reservoirs or other man-made water features

Therefore, from the above observations we confirm that the site is at low risk of flooding from existing sources.

3.0 Infiltration to ground

Infiltration to ground is, in the main, provided by the provision of soakaways and permeable paving.

To provide infiltration via soakaways the ground conditions must be suitable to allow infiltration to occur and the ground water table must be at least 1.0m below the base of any soakaways provided.

To allow infiltration via permeable paving the ground conditions must be suitable to allow infiltration to occur.

Soakaways cannot be located within 5m of boundaries, highways or existing / proposed buildings.

The site layout will not allow for the provision of soakaways due to the limiting dimensions between houses and boundaries.

Permeable driveways may be possible if ground conditions are found to be suitable.

Intrusive ground investigations have not been carried out but a Phase 1 Preliminary Risk Assessment has been prepared and identifies the ground beneath the site as being Glaciofluvial deposits (clay) overlying mudstone, siltstone and sandstone.

A review of the British Geological Survey web site indicates that record boreholes to the northwest, southwest southeast and north east of the site indicate that there is a band of medium dense sand with occasional gravel present overlying clay. It may be that this band extends across the development site and can, therefore, potentially be used for permeable paving.

Therefore, infiltration via soakaways is not feasible for this development, but the potential use of permeable paving may be possible. This can be reassessed once a phase 2 intrusive ground investigation has been carried out.

However, surface infiltration will be achievable to allow the draining of paths and patios around the dwellings by ensuring surface water flows into gravel trenches and / or landscaped areas where surface infiltration will occur in to

the upper topsoil and also allow evaporation and plant uptake. By providing this the area of impermeable surfaces drained to a positive drainage network can be reduced.

Therefore, from the above it is not currently practical to provide soakaways or permeable paving for this development.

4.0 Discharge to suitable water course

An inspection of historic / current maps and the Environment Agency maps reveal that the Rochdale Canal is located 10m to the north of the site.

However, there are 2 aspects to consider before making a decision as to whether or not the canal is a viable option.

1. The level of the canal is only approximately 250mm above the canal water level. It would not be possible to drain from the development into the canal using a gravity drainage design.
2. There is third party land between the site and the Canal and it is not known if access to the canal can be reasonably gained. It is usual that a developer has to pay a commuted sum to the canal owner / operator and for a development of 22 flats the cost of a connection to the Canal, with the associated costs of a commuted sum, are likely to make the scheme unviable. This will need to be investigated by the Developer.

Therefore, discharge of surface water into a water course is not currently thought to be available for this site.

5.0 Discharge to a suitable surface water network

A review of the existing drainage network within the surroundings of the development site was made and of United Utility sewer records.

The review indicated that there are no surface water sewers located within or adjacent to the site.

Therefore, disposal of surface water drainage into a surface water sewer or highway drainage is not available for this site.

6.0 Discharge to a suitable combined sewer network

A review of the existing drainage network and of United Utility sewer records within the surroundings of the development site was made.

The review indicated that there are combined sewers in the following locations.

- a deep 600mm ø combined sewer is located to the north of the site at a depth of approximately 5.8m
- a 300mm ø combined sewer in Moss Mill Woodbine Street at a depth of approximately 3.0m

Therefore, discharge of surface water into a combined sewer is available for this site.

7.0 Existing Site Surface Water Drainage

A review of the existing drainage network and of United Utility sewer records within the surroundings of the development site was made.

This drainage strategy has established that there is a water course available for surface water runoff but requires a viability test and there is network of combined sewers that can service the site.

The site has been undeveloped since 2013 and is, therefore, classed as greenfield.

Greenfield run-off rates have been calculated using Micro Drainage software as being;

Q_{bar}	=	0.1 l/s
$Q_{1 \text{ year}}$	=	0.1 l/s
$Q_{2 \text{ year}}$	=	0.1 l/s
$Q_{30 \text{ year}}$	=	0.1 l/s
$Q_{100 \text{ year}}$	=	0.2 l/s

A copy of the existing drainage plan is included in Appendix B. Hydraulic calculations are included in Appendix D.

8.0 Site Surface Water Runoff Drainage Proposals

From the above discussions made the following surface water drainage strategy is proposed.

Infiltration via soakaways is not proposed due to the proposed site layout and constraints.

Permeable driveways may be possible but cannot be considered until ground conditions are known.

There is a watercourse within 10m of the northern site boundary but due to existing levels and potential access rights through third party land it not

possible, or may not be viable, to discharge to the watercourse. The Client will need to assess the viability of this.

There are no surface water sewers or highway drains available for the site drainage.

There are combined sewers adjacent to the site, which can be utilised.

United Utilities have been consulted but we have, at the time of writing this drainage strategy, not received a response back.

We expect that United Utilities will state that the site is classed as greenfield and will ask for the drainage hierarchy to be followed and if not able to deal with surface water using the hierarchy, then we will be allowed a discharge to a combined sewer adjacent to the site at a maximum discharge rate of 5 l/s

Therefore, it is proposed to drain surface water from the proposed development to an existing 300ø combined sewer in Woodbine Street with a maximum pass forward rate of 5 l/s.

9.0 Site Surface Water Runoff Drainage Design

The site is located in an area where SUDS cannot be utilised due to ground conditions and spatial reasons.

From the discussion in the previous section, it is proposed to provide a positive drainage using a piped network with additional offline cellular attenuation providing the necessary attenuation for rainfall events that exceed the maximum discharge rate of 5 l/s, for storm events up to and including the 100-year plus 40% climate change storm events.

From the above discussion, it is our proposal to provide the following surface water drainage proposal;

To provide a private drainage network to collect and discharge surface water to the adopted United Utilities sewer at a pass forward discharge rate of no more than 5.0 l/s. Attenuation will be provided within the private drainage network on site to attenuate all storm events exceeding a 5.0 l/s discharge off site up to and including the 100 year + 40% climate change storm events. All discharges connecting to the public sewer will be maintained at or below 5.0 l/s.

Hydraulic calculations undertaken for the proposed sewer network design using Micro Drainage provide evidence that the various storm events can be attenuated within the proposed drainage network and reduce future flood risk both on and off site.

Calculations for the following rainfall events were interrogated;

- 1 Year
- 2 Year
- 30 Year
- 100 year + 20% Climate Change
- 100 year + 30% Climate Change
- 100 year + 40% Climate Change

No flooding occurred for any of the storm events listed above and all discharges were maintained at or below 5.0 l/s for storm events of up to and including 100 year + 40% climate change.

Hydraulic calculations are included in Appendix D.

A preliminary drainage plan, 31163-SUT-ZZ-00-C-620-0001, has been prepared in accordance with the above proposals and is included in Appendix C.

In the event of an exceedance storm event (greater than 100 year + 40% climate change) or a drainage failure event, such as a blockage, then overland flooding could be expected. Overland flood routes have been indicated on the site plan and indicate where the water will flow. No dwellings, either on or off site are affected. The flood routing drawing, 31163-SUT-ZZ-00-C-621-0001, is included in Appendix C.

From the above we believe that the requirements of the Lead Local Flood Authority and United Utilities have been met in relation to maximum allowable surface water discharge and volume of surface water runoff from the site.

10.0 Outstanding Flood Risk

From the above drainage strategy and flood risk assessment we confirm that the site is at a low risk of flooding from on site and external sources.

The site also controls on-site and off-site flood risk as the surface water runoff generated, by the proposed development, is managed to discharge a maximum 5.0 l/s for all rainfall events up to and including the 100 year + 40% climate change.

In the event of exceedance rainfall events and / or blocked drains, flooding is likely to occur as the drainage system becomes overwhelmed. A flood exceedance flood route is indicated on drawing 31163-SUT-ZZ-00-C-621-0001, which shows the flows to pass around the proposed building and flow off site to an existing road gulley adjacent to the site.

Therefore, the proposed development has a low risk of flooding both on and off site and reduces flood risk from the previous development and has been designed to restrict surface water discharge off site for up to and including the 100 year + 40% climate change storm events.

11.0 Future Surface Water Drainage Management and Maintenance

At this point of the design process, we are not able to provide a full management and maintenance plan but the following summary can be provided to give a general strategy of future management and maintenance. As the development proceeds to full design and construction stage the management and maintenance strategy can be developed.

At this stage of design, it is anticipated that the drainage within the proposed development will remain privately owned and maintained by the Housing Association, who will be responsible for ongoing maintenance throughout the lifetime of the development.

The Housing Association will be responsible for the private drainage and offline cellular attenuation and costs for ongoing maintenance will be charged via a management fee that tenants contribute towards as part of their rent. The Housing Association will ensure that the private drainage is maintained to the point of discharge into the adopted sewers.

The maintenance schedule will be developed once planning is awarded and the drainage design is finalised.

Appendix A

Existing Site Layout

Proposed Site Layout

412380N
390320E

390340E

390360E

390380E

390400E

412380N
390420E



412360N

412360N

412340N

412340N

412320N

412320N

412300N

412300N

Station	Easting	Northing	Level
1	390391.908	412306.687	144.079
2	390359.782	412295.257	143.558

390320E
412280N

390340E

390360E

390380E

390400E

390420E
412280N

OLDHAM ROAD

WOODBINE STREET

UNMADE PATH

TP O

143.97
143.87
143.75

1

TP O

143.57
143.47
143.37

2

TP O

143.33
143.23
143.13

1

TP O

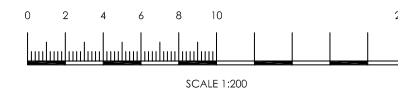
143.03
142.93
142.83

2

TP O

142.73
142.63
142.53

1



Abbreviations/Symbols (Measured Building Surveys):

- C: Window Cill Height
- H: Window Head Height
- BH: Beam Height
- DH: Door Height
- COL: Column
- SVP: Soil Vent Pipe
- FL: Floor Level
- TH: Threshold Level
- FCH: Floor to Ceiling Height
- V: Vaulted Ceiling

Line types

- Hedge Lines
- Drainage Runs
- Overhead Electricity Cables
- Overhead Telephone Cables

Symbols

- Tree/Bush
- Control Station
- Borehole
- Trial Hole
- Glass House
- Osbn

Abbreviations (Topographic Survey):

- AH: Arch Height
- AV: Air Valve
- BB: Belling Beacon
- BOX: Electricity Box, Cables Box, Etc.
- BOL: Bollard
- BS: Bus Stop
- BS/IC: Bus Stop / Lamp Post
- CAIV: CANV Inspection Chamber
- CCTV: Closed Circuit Television
- CL: Cellar Light
- C.PT: Catch Pit
- ER: Earth Road
- EC: Electricity Inspection Chamber
- EP: Electricity Pole
- FR: Fire Hydrant
- FP: Flag Pole
- GV: Gas Valve
- G: Gully
- IC: Inspection Chamber
- KO: Kerb Outlet
- LP: Lamp Post
- LB: Letter Box
- LC: Lighting Column
- MAR: Marker
- MH: Manhole
- MP: Mooring Post
- MS: Mile Stone
- NYNEX: Nynex Inspection Chamber
- O/H: Over Hang
- P: Post
- PO/IC: Post Office Inspection Chamber
- R/S: Road Sign
- RE: Retaining Wall
- RTW: Retaining Wall
- S/P: Sign Post
- SNP: Street Name Plate
- ST: Stop Tap
- SV: Stop Valve
- T: Telecom Inspection Chamber
- TCB: Telephone Call Box
- TH: Threshold Level
- TL: Traffic Light
- TP: Telegraph Pole
- TROUGH: Trough
- WO: Water Outlet
- WM: Water Meter

Fence Descriptions:

- B/W: Barbed Wire
- C/B: Close Boarded
- C/BARRIER: Crash Barrier
- C/L: Chain Link
- C/P: Chestnut Paling
- C/I: Corrugated Iron
- I/R: Iron Rolling
- MBC: Miscellaneous
- P/R: Post & Rail
- P/W: Post & Wire
- P/C: Post & Chain
- S/PAL: Steel Palisade
- W/M: Wire Mesh

Survey Notes:
Coordinates and Levels related to Ordnance Survey Datum - GPS OSGB36

Revision	Date	Description

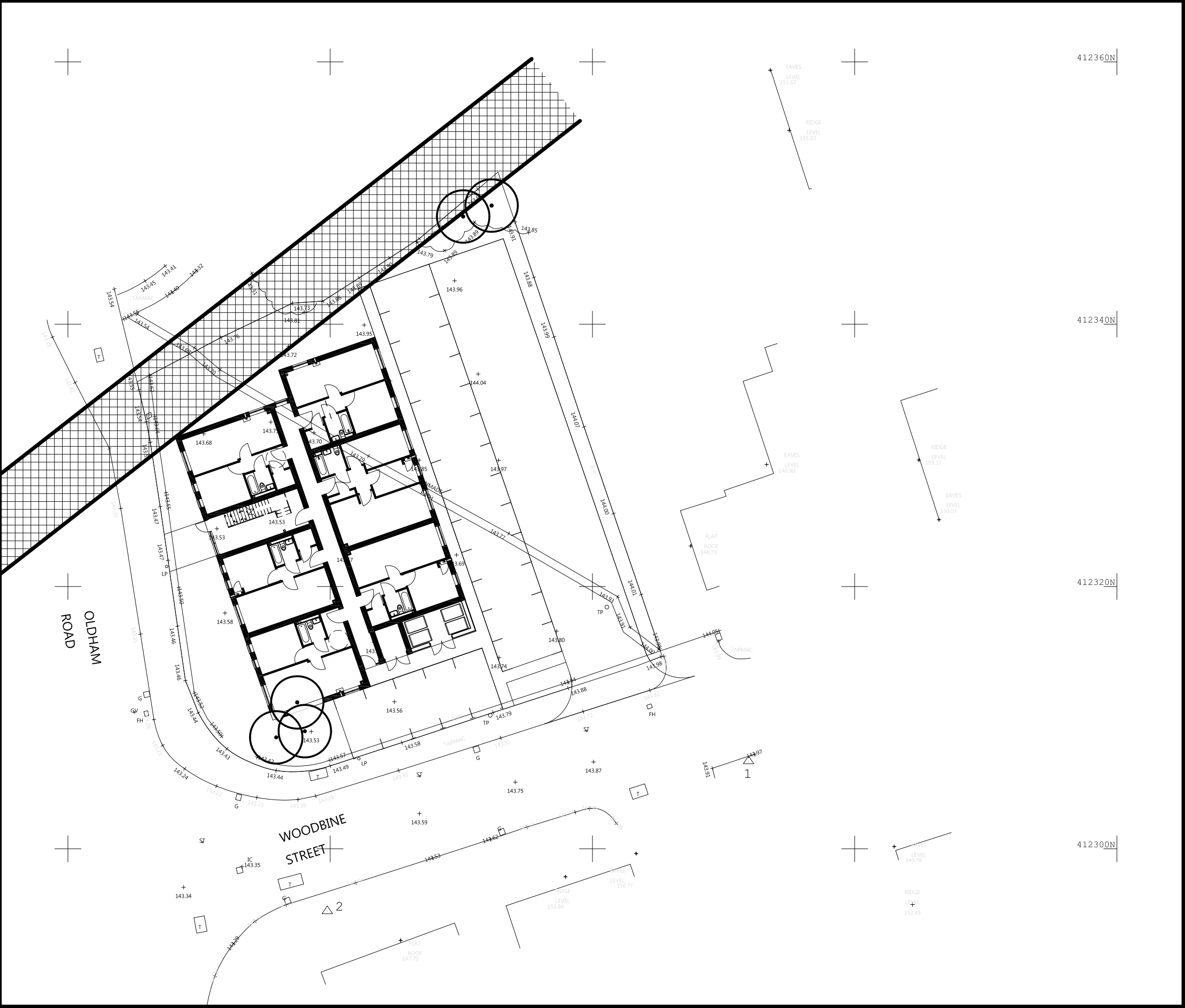


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M33 5PP
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Client
Bernard Taylor Partnership

Project
Woodbine Street, Rochdale
Site Survey

Scale	Surveyed By	Date
1:200	C G P	30.03.21
Drawing No.	Checked By	Date
300321/CP-01	CPLS	31.03.21
	Drawn By	Date
	J C	31.03.21

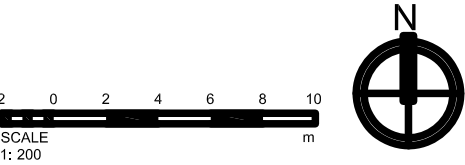


DO NOT SCALE FROM THIS DRAWING
ALL DIMENSIONS MUST BE CHECKED ON SITE BY CONTRACTOR
PRIOR TO CONSTRUCTION

Schedule of Accommodation

18no 1B2P Flats @ 50m²
4no 2B3P Flats @ 61m²
22no Total Houses

18 no car parking spaces
100% car parking



Layout subject to confirmation of red line boundary, all statutory approvals including highways, planning and building regulations, relevant surveys and reports such as topographical, ecology, trees, ground investigation and flood risk.

2	13.04.21	ED	Drawing revised following receipt of topographical survey and tree survey
1	28.07.20	ED	Drawing revised to amend accomodation schedule as per client comments
Rev	Date	Int	Description

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Arcon Housing

Woodbine Street, Rochdale

Proposed Site Plan Option 5

Feasibility

ED MA 30.04.20 1 : 200

3576 S0 110 2

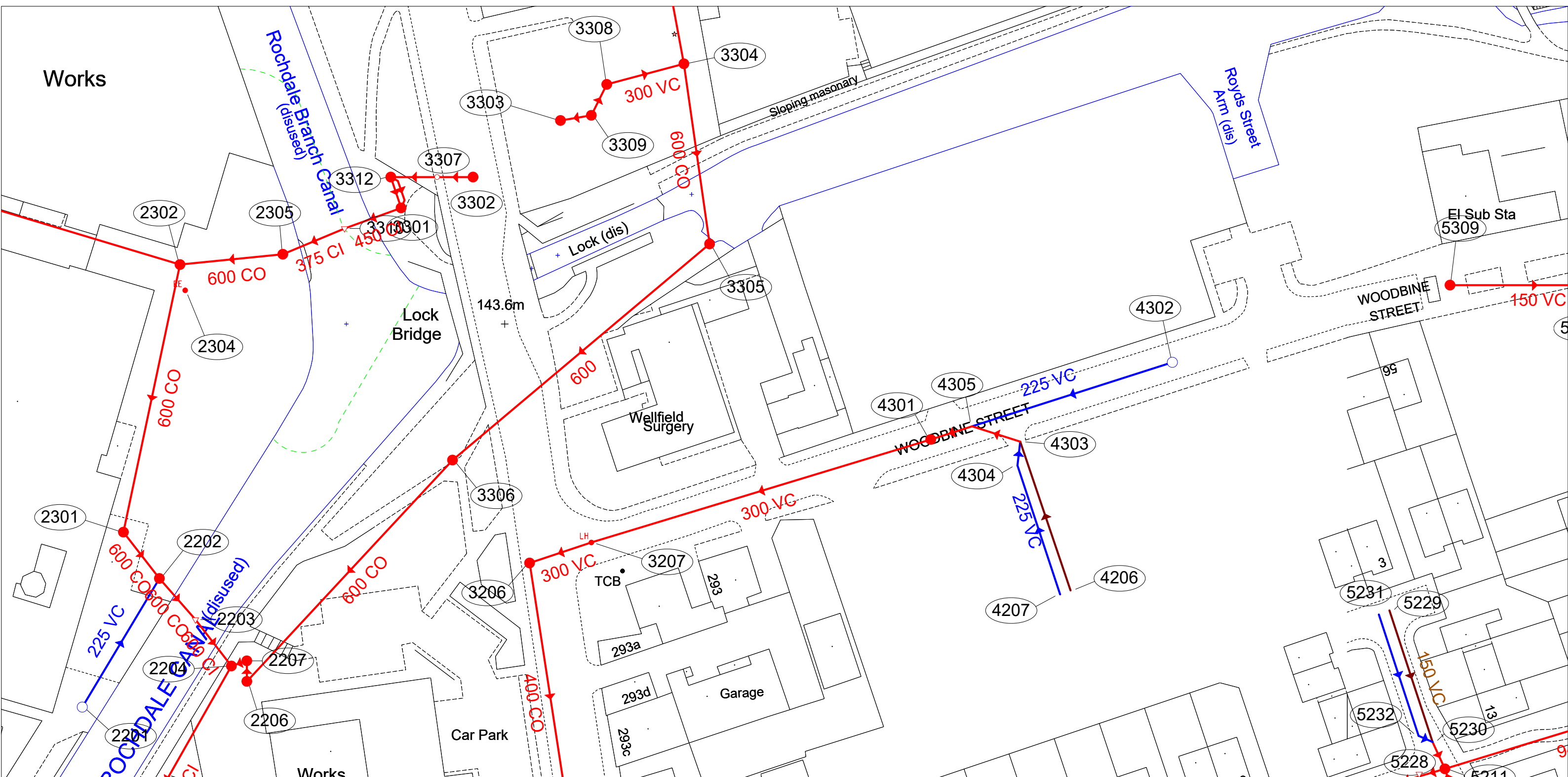
WS-BTP-00-SP-DR-A-3576_110.2

Elizabeth House 486 Didsbury Road Heaton Mersey Stockport SK4 3BS
0161 443 1221info@bernardtaylor.co.uk www.btparchitects.co.uk

00 Proposed Site Plan
1 : 200

Appendix B

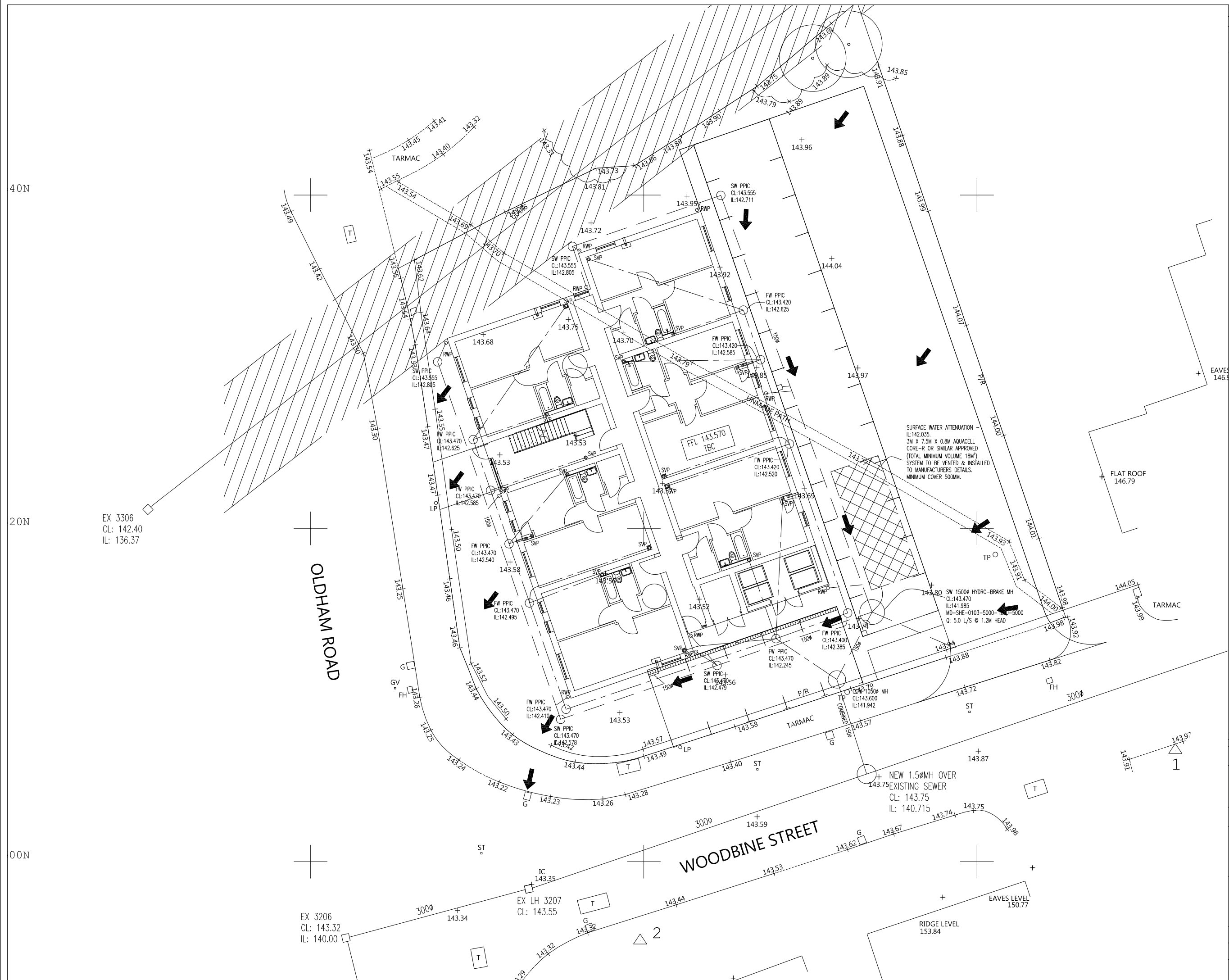
Existing United Utilities Sewer Records



Appendix C

Proposed Drainage Layout

Proposed Flood Routing



General Notes

DO NOT SCALE OFF THIS DRAWING

THIS DRAWING HAS BEEN PREPARED AS PART OF THE DRAINAGE STRATEGY REQUIRED AS PART OF THE PLANNING SUBMISSION.

KEY



INDICATES DIRECTION OF SURFACE FLOW OF
SURFACE WATER IN THE EVENT OF BLOCKED
DRAINAGE OR STORM EXCEEDENCE EVENT

P01	PRELIMINARY ISSUE	23.04.21	MJG	MDP
Rev	Description	Date	By	Chk
Drawing Status				

PRELIMINARY



Client

ARCON

Project
OLDHAM ROAD
ROCHDALE

Drawing Title

PROPOSED FLOOD ROUTING PLAN

Date APR 21	Drawn By MJG	Checked By DS
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Scale at A1 1:100	Project Number 31163
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Sheet Number	Revision
31163-SUT-ZZ-00-DR-C-621-0001	P01

Appendix D

Q_{bar} Hydraulic Calculations

Proposed Drainage Network Hydraulic Calculations

Sutcliffe		Page 1
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham	
Date 26/04/2021 10:43 File	Designed by DS Checked by	
Innovyze Source Control 2020.1.3		

ICP SUDS Mean Annual Flood

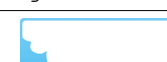
Input

Return Period (years)	2	Soil	0.150
Area (ha)	0.110	Urban	0.000
SAAR (mm)	1132	Region Number	Region 10

Results 1/s

QBAR Rural	0.1
QBAR Urban	0.1
Q2 years	0.1
Q1 year	0.1
Q30 years	0.1
Q100 years	0.2

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Sutcliffe		Page 1
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham SW Calculations	
Date 28/04/2021 16:48	Designed by MJG	
File 31163-SW CALCS-002.MDX	Checked by DS	
Innovyze	Network 2020.1.3	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.271	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	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	0.067	4-8	0.013

Total Area Contributing (ha) = 0.080

Total Pipe Volume (m³) = 1.467

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	22.686	0.227	99.9	0.015	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	9.931	0.695	14.3	0.006	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	9.393	0.094	100.0	0.005	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.000	9.417	0.118	79.8	0.006	5.00	0.0	0.600	o	100	Pipe/Conduit	
S2.001	26.595	0.898	29.6	0.049	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	4.251	0.043	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.004	5.954	0.060	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.38	142.805	0.015	0.0	0.0	0.0	1.01	17.8	2.0
S1.001	50.00	5.44	142.578	0.020	0.0	0.0	0.0	2.68	47.3	2.8
S1.002	50.00	5.59	141.883	0.026	0.0	0.0	0.0	1.00	17.8	3.5
S2.000	50.00	5.18	142.855	0.006	0.0	0.0	0.0	0.86	6.8	0.8
S2.001	50.00	5.42	142.687	0.054	0.0	0.0	0.0	1.86	32.8	7.3
S1.003	50.00	5.66	141.789	0.080	0.0	0.0	0.0	1.00	17.8	10.8
S1.004	50.00	5.76	141.746	0.080	0.0	0.0	0.0	1.00	17.8	10.8

Sutcliffe		Page 2
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham SW Calculations	
Date 28/04/2021 16:48 File 31163-SW CALCS-002.MDX	Designed by MJG Checked by DS	
Innovyze	Network 2020.1.3	

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.015	0.015	0.015
1.001	User	-	100	0.006	0.006	0.006
1.002	User	-	100	0.005	0.005	0.005
2.000	User	-	100	0.006	0.006	0.006
2.001	User	-	100	0.013	0.013	0.013
	User	-	100	0.035	0.035	0.049
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.080	0.080	0.080

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
---------------------	--------------	--------------	--------------	------------------	----------	--------

S1.004	S	143.750	141.686	0.000	0	0
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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 Coefficient	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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.271		

Sutcliffe		Page 3
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham SW Calculations	
Date 28/04/2021 16:48 File 31163-SW CALCS-002.MDX	Designed by MJG Checked by DS	
Innovyze	Network 2020.1.3	

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S4, DS/PN: S1.003, Volume (m³): 3.6

Unit Reference	MD-SHE-0103-5000-1200-5000
Design Head (m)	1.200
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	103
Invert Level (m)	141.789
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	5.0	Kick-Flo®	0.745	4.0
Flush-Flo™	0.354	5.0	Mean Flow over Head Range	-	4.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.4	0.800	4.1	2.000	6.3	4.000	8.8	7.000	11.5
0.200	4.7	1.000	4.6	2.200	6.6	4.500	9.3	7.500	11.8
0.300	5.0	1.200	5.0	2.400	6.9	5.000	9.8	8.000	12.2
0.400	5.0	1.400	5.4	2.600	7.2	5.500	10.2	8.500	12.6
0.500	4.9	1.600	5.7	3.000	7.7	6.000	10.7	9.000	12.9
0.600	4.7	1.800	6.0	3.500	8.3	6.500	11.1	9.500	13.3

Storage Structures for Storm

Cellular Storage Manhole: S4, DS/PN: S1.003

Invert Level (m) 141.850 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	22.5	24.5	0.800	22.5	41.3	0.801	0.0	41.3

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
S1.000	S1	0.212	0.401	0.000	0.613
S1.001	S2	0.252	0.175	0.000	0.428
S1.002	S3	0.449	0.166	0.000	0.615
S2.000	S6	0.198	0.074	0.000	0.272
S2.001	S5	0.245	0.470	0.000	0.715
S1.003	S4	2.971	0.075	17.107	20.153
S1.004	S5	3.276	0.105	0.000	3.382
Total		7.603	1.467	17.107	26.177

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
S1.000	S1	0.212	0.390	0.000	0.602
S1.001	S2	0.252	0.165	0.000	0.417
S1.002	S3	0.449	0.147	0.000	0.596
S2.000	S6	0.198	0.069	0.000	0.267
S2.001	S5	0.245	0.451	0.000	0.697
S1.003	S4	2.971	0.049	17.107	20.126
S1.004	S5	3.276	0.092	0.000	3.368
Total		7.603	1.364	17.107	26.074

Sutcliffe		Page 5
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham SW Calculations	
Date 28/04/2021 16:48 File 31163-SW CALCS-002.MDX	Designed by MJG Checked by DS	
Innovyze	Network 2020.1.3	

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 Coefficient 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 Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.269 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status OFF
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 2, 30, 100
 Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	1	+0%					142.837	-0.118	0.000
S1.001	S2	15 Winter	1	+0%					142.600	-0.128	0.000
S1.002	S3	30 Winter	1	+0%	30/15 Summer				141.933	-0.100	0.000
S2.000	S6	15 Winter	1	+0%					142.877	-0.078	0.000
S2.001	S5	15 Winter	1	+0%					142.729	-0.108	0.000
S1.003	S4	30 Winter	1	+0%	2/15 Summer				141.928	-0.011	0.000
S1.004	S5	30 Winter	1	+0%					141.798	-0.098	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain	Pipe	Status	Level Exceeded
				Time (mins)	Flow (l/s)		
S1.000	S1	0.10			1.7	OK	
S1.001	S2	0.05			2.2	OK	
S1.002	S3	0.15			2.4	OK	
S2.000	S6	0.10			0.7	OK	
S2.001	S5	0.17			5.4	OK	
S1.003	S4	0.30		11	3.8	OK	
S1.004	S5	0.26			3.8	OK	

Sutcliffe		Page 6
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham SW Calculations	
Date 28/04/2021 16:48 File 31163-SW CALCS-002.MDX	Designed by MJG Checked by DS	
Innovyze	Network 2020.1.3	

2 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 Offline Controls 0

Number of Time/Area Diagrams 0

Number of Online Controls 1

Number of Storage Structures 1

Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model

FSR M5-60 (mm) 19.000

Cv (Summer) 0.750

Region England and Wales

Ratio R 0.269

Cv (Winter) 0.840

Margin for Flood Risk Warning (mm)

300.0

Analysis Timestep 2.5 Second Increment (Extended)

DTS Status

OFF

DVD Status

ON

Inertia Status

ON

Profile(s)

Summer and Winter

Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440

Return Period(s) (years) 1, 2, 30, 100

Climate Change (%) 0, 0, 0, 0

PN	US/MH		Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water	Surcharged	Flooded
	Name	Storm							Level (m)	Depth (m)	Volume (m³)
S1.000	S1	15 Winter	2	+0%					142.841	-0.114	0.000
S1.001	S2	15 Winter	2	+0%					142.604	-0.124	0.000
S1.002	S3	30 Winter	2	+0%	30/15 Summer				141.975	-0.058	0.000
S2.000	S6	15 Winter	2	+0%					142.879	-0.076	0.000
S2.001	S5	15 Winter	2	+0%					142.735	-0.102	0.000
S1.003	S4	30 Winter	2	+0%	2/15 Summer				141.970	0.031	0.000
S1.004	S5	30 Winter	2	+0%					141.801	-0.095	0.000

PN	US/MH Name	Half Drain		Pipe Flow (l/s)	Time (mins)	Status	Level Exceeded
		Flow / Cap.	Overflow (l/s)				
S1.000	S1	0.13		2.2		OK	
S1.001	S2	0.07		2.9		OK	
S1.002	S3	0.19		3.0		OK	
S2.000	S6	0.13		0.8		OK	
S2.001	S5	0.22		7.0		OK	
S1.003	S4	0.34		13	4.3	SURCHARGED	
S1.004	S5	0.29		4.3		OK	

Sutcliffe		Page 7
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham SW Calculations	
Date 28/04/2021 16:48 File 31163-SW CALCS-002.MDX	Designed by MJG Checked by DS	
Innovyze	Network 2020.1.3	

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 Coefficient 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 Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.269 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status OFF
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 2, 30, 100
 Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	30	+0%					142.856	-0.099	0.000
S1.001	S2	15 Winter	30	+0%					142.615	-0.113	0.000
S1.002	S3	60 Winter	30	+0%	30/15 Summer				142.195	0.162	0.000
S2.000	S6	15 Winter	30	+0%					142.889	-0.066	0.000
S2.001	S5	15 Winter	30	+0%					142.764	-0.073	0.000
S1.003	S4	60 Winter	30	+0%	2/15 Summer				142.190	0.251	0.000
S1.004	S5	60 Winter	30	+0%					141.806	-0.090	0.000

				Half Drain	Pipe		
	US/MH	Flow /	Overflow	Time	Flow		Level
PN	Name	Cap.	(l/s)	(mins)	(l/s)	Status	Exceeded
S1.000	S1	0.24			4.1	OK	
S1.001	S2	0.14			5.8	OK	
S1.002	S3	0.26			4.1	SURCHARGED	
S2.000	S6	0.25			1.6	OK	
S2.001	S5	0.52			16.3	OK	
S1.003	S4	0.39		25	5.0	SURCHARGED	
S1.004	S5	0.34			5.0	OK	

Sutcliffe		Page 8
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham SW Calculations	
Date 28/04/2021 16:48 File 31163-SW CALCS-002.MDX	Designed by MJG Checked by DS	
Innovyze	Network 2020.1.3	

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 Coefficient 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 Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.269 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status OFF
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 2, 30, 100
 Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level	Surcharged Depth	Flooded Volume
									(m)	(m)	(m³)
S1.000	S1	15 Winter	100	+0%					142.863	-0.092	0.000
S1.001	S2	15 Winter	100	+0%					142.621	-0.107	0.000
S1.002	S3	60 Winter	100	+0%	30/15 Summer				142.390	0.357	0.000
S2.000	S6	15 Winter	100	+0%					142.895	-0.060	0.000
S2.001	S5	15 Winter	100	+0%					142.777	-0.060	0.000
S1.003	S4	60 Winter	100	+0%	2/15 Summer				142.384	0.445	0.000
S1.004	S5	120 Winter	100	+0%					141.806	-0.090	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level
							Exceeded
S1.000	S1	0.31			5.2	OK	
S1.001	S2	0.18			7.4	OK	
S1.002	S3	0.34			5.4	SURCHARGED	
S2.000	S6	0.33			2.1	OK	
S2.001	S5	0.67			21.0	OK	
S1.003	S4	0.39		34	5.0	SURCHARGED	
S1.004	S5	0.34			5.0	OK	

Sutcliffe		Page 1
18-20 Harrington Street Liverpool L2 9QA	Oldham Road / Woodbine Street Oldham SW Calculations	
Date 28/04/2021 16:50	Designed by MJG	
File 31163-SW CALCS-002.MDX	Checked by DS	
Innovyze	Network 2020.1.3	

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 Offline Controls	0
Number of Online Controls	1	Number of Storage Structures	1
		Number of Time/Area Diagrams	0
		Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR M5-60 (mm)	19.000	Cv (Summer)	0.750	
Region	England and Wales	Ratio R	0.269	Cv (Winter)	0.840
Margin for Flood Risk Warning (mm)					300.0
Analysis Timestep	2.5	Second Increment	(Extended)		
DTS Status					OFF
DVD Status					ON
Inertia Status					ON
Profile(s)					Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440				
Return Period(s) (years)					100
Climate Change (%)					40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level	Surcharged Depth	Flooded Volume
									(m)	(m)	(m³)
S1.000	S1 60	Winter	100	+40%	100/60	Winter			143.045	0.090	0.000
S1.001	S2 60	Winter	100	+40%	100/60	Winter			143.040	0.312	0.000
S1.002	S3 60	Winter	100	+40%	100/15	Summer			143.035	1.002	0.000
S2.000	S6 60	Winter	100	+40%	100/60	Winter			143.052	0.097	0.000
S2.001	S5 60	Winter	100	+40%	100/15	Summer			143.049	0.212	0.000
S1.003	S4 60	Winter	100	+40%	100/15	Summer			143.030	1.091	0.000
S1.004	S5 60	Winter	100	+40%					141.806	-0.090	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level
							Exceeded
S1.000	S1	0.27			4.5	SURCHARGED	
S1.001	S2	0.15			6.3	SURCHARGED	
S1.002	S3	0.47			7.4	SURCHARGED	
S2.000	S6	0.28			1.7	SURCHARGED	
S2.001	S5	0.54			16.8	SURCHARGED	
S1.003	S4	0.39		54	5.0	SURCHARGED	
S1.004	S5	0.34			5.0	OK	