Proposed Residential Development

School Road, Tarrington

Flood Risk Assessment

Final Report for

Stoke Edith Estate

January 2017

Hydrock Ref: C-05818-C
BIM Ref: TAR-HYD-XX-XX-RP-D-5001

DOCUMENT CONTROL SHEET

Issued by: Hydrock Consultants Limited
Over Court Barns
Over Lane
Almondsbury
Bristol
BS32 4DF

Tel: 01454 619533
Fax: 01454 614125
www.hydrock.com

Client: **Stoke Edith Estate**

Project: **Proposed Residential Development – School Road, Tarrington**

Title: **Flood Risk Assessment**

Status: Final

Date: January 2017

Document Production Record

Issue Number:	**P1.2-S0**	**Name**	**Signature**
Prepared		Jon Cracknell BSc, MSc *Senior Flood Risk Consultant*	[redacted]
Checked		David Lloyd BSc, PhD *Technical Director – Flood Risk*	[redacted]
Approved		David Lloyd BSc, PhD *Technical Director – Flood Risk*	[redacted]

Document Revision Record

Issue number	**Date**	**Revision Details**
P1.1-S0	24th January 2017	Draft
P1.2-S0	31st January 2017	Final

CONTENTS

APPENDICES

1.0 INTRODUCTION

This report has been prepared by Hydrock on behalf of Stoke Edith Estate in support of a planning application to be submitted to Herefordshire Council for the proposed residential development of land off School Road, Tarrington.

This Flood Risk Assessment report has been prepared to address the requirements of the *National Planning Policy Framework* (*NPPF*), through:

- Assessing whether the site is likely to be affected by flooding.
- Assessing whether the proposed development is appropriate in the suggested location.
- Presenting any flood risk mitigation measures necessary to ensure that the proposed development and occupants will be safe, whilst ensuring flood risk is not increased elsewhere.

The report considers the requirements for undertaking a Flood Risk Assessment as detailed in the *NPPF*.

2.0 SITE INFORMATION

2.1 Location

Table. 1: Site Referencing Information

Site Address	Land off School Road, Tarrington, HR1 4EX
Grid Reference	SO 61664 40615

The site is located within the centre of Tarrington, a village located approximately 10.5km to the east of Hereford. A site location plan is included in Appendix A.

2.2 Existing Site

The site currently comprises a grassed field utilised for pasture use.

The site is bounded by agricultural land to the northwest; residential properties and garden areas to the northeast, east and west; and, School Road to the south, with a residential property and garden area beyond.

2.3 Topography

The high point of the site, and local area, is located in the southwestern corner of the site at approximately 90.5m AOD, from which point ground levels fall toward the northern, eastern and southern site boundaries, at 83.0m AOD, 82.0m AOD and 85.0 respectively.

A topographical survey of the site is included in Appendix A.

2.4 Proposed Development

The scheme proposes the residential development of the site, along with associated infrastructure and landscaping. Access is to be provided off School Road.

A proposed site layout plan is included in Appendix A.

3.0 ASSESSMENT OF FLOOD RISK

3.1 Fluvial and Tidal Flooding

3.1.1 Flood Zone Mapping

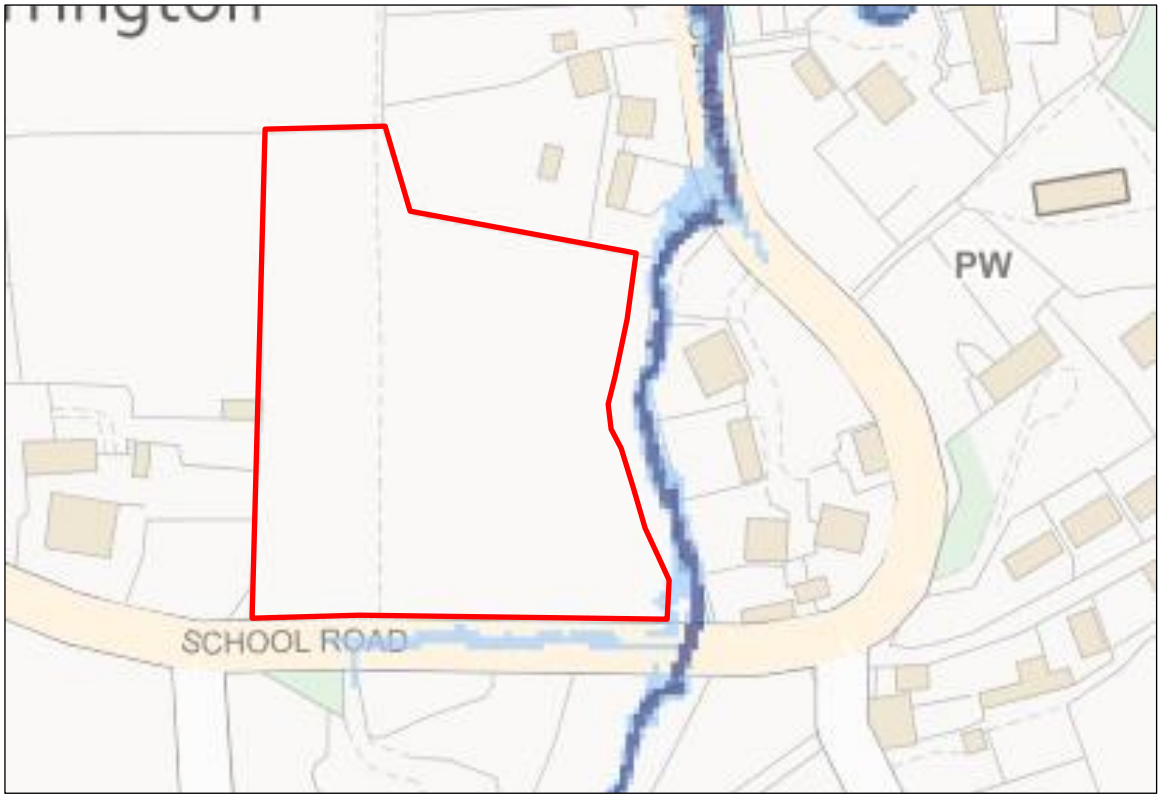
The entirety of the site and surrounding area is shown to be within Flood Zone 1, i.e. land at low risk of fluvial and tidal flooding.

3.1.2 Tarrington Brook

A small Brook flows northwards parallel to the eastern site boundary, known for the purposes of this report as the Tarrington Brook. The Brook flows in culvert beneath School Road up- and down-stream of the site, and in open channel adjacent to the site.

The EA's Surface Water Flood Risk mapping, as shown in Figure 1 below, indicates that the majority of flows are contained within the channel of the Brook, with the exception of some minor out of bank flooding within the very southeastern corner of the site.

Figure 1: EA Surface Water Flood Risk Mapping



The topographical survey and a site walkover survey indicate that the Brook is relatively incised, with ground levels rising across the site from the eastern site boundary / the Tarrington Brook. Such topography will contain any out of bank flows from the Brook within the immediate vicinity of the channel, as evidenced by the EA's Surface Water Flood Risk mapping, as shown above.

Based on this, the site is considered to be at low risk of fluvial flooding / flooding from the Tarrington Brook.

3.1.3 Tidal

Noting the elevation and location of the area, the site is concluded to be at negligible risk of tidal flooding.

3.2 Surface Water Flooding

Given that the site occupies a locally elevated position, any surface water run-off is unlikely to be directed onto the site, but rather be directed around the site (including along a ditch running parallel with the southern site boundary / School Road) and towards surrounding lower lying areas and/or the Tarrington Brook.

As such, the site is considered to be at low risk of surface water flooding, as evidenced by the EA's Surface Water Flood Risk mapping (shown in Figure 1).

3.3 Groundwater Flooding

British Geological Survey mapping shows the site to be underlain by the Raglan Mudstone Formation comprising Siltstone and Mudstone. The higher portion of the site is shown to be underlain by Sandstone of the Raglan Mudstone Formation.

To the south of the site, where ground levels rise towards Seager Hill, there are shown to be a series of geologies, with the lowest layer (i.e. that immediately overlying the Raglan Mudstone Formation) comprising Sandstone and Siltstone of the Downton Castle Sandstone Formation.

Given the presence of permeable geologies overlying lower permeability geology, there is the potential for groundwater emergence at these geological boundaries. If any groundwater emergence were to occur within or adjacent to the site, any such water will run-off and be directed downslope off-site and/or towards the Tarrington Brook. As such, the flood risk posed by the Brook is considered a suitable indication of the potential worst-case groundwater flooding scenario.

Consequently, whilst there is the potential for groundwater emergence and resulting shallow overland groundwater flows through the site, there is considered to be a low risk of groundwater flooding / 'ponding' within the site.

3.4 Infrastructure Failure Flooding

Similarly to the assessment of surface water flooding, any surcharged sewer flows generated within the vicinity of the site are unlikely to be directed onto the site, but rather be directed around the site and towards surrounding lower lying areas and/or the Tarrington Brook.

No other potential sources of infrastructure failure flooding, such as reservoirs or canals, were identified within the immediate vicinity, or upstream, of the site, and as such, the site is considered to be at low risk of infrastructure failure flooding.

4.0 *NPPF* REQUIREMENTS

4.1 Sequential Test

This assessment has demonstrated that the site is on land designated as Flood Zone 1 by the EA's Flood Zone Mapping.

The *NPPF* considers residential development as 'more vulnerable development' in respect of flood risk.

The *NPPF* Flood Risk Vulnerability and Flood Zone Compatibility matrix (Table 3) indicates that 'more vulnerable' development is appropriate in Flood Zone 1 and accordingly the proposed development is concluded to meet the requirements of the Sequential Test.

4.2 Exception Test

Whilst an Exception Test is not explicitly required under the *NPPF*, due to the site being demonstrated to pass the Sequential Test, the following section details any measures necessary to mitigate any residual flood risks, to ensure that the proposed development and occupants will be safe and that flood risk will not be increased elsewhere, akin to the requirements of the second section of the Exception Test.

4.2.1 Resistance and Resilience of Proposed Buildings

In order to afford the site some protection from potential groundwater emergence overland flows through the site, and any other residual risks, finished floor levels will be set a minimum 300mm above adjacent infrastructure thoroughfare levels. The proposed highway and building layout has also been designed to create preferential overland flow routes through the site and towards the Tarrington Brook, i.e. any overland flows will be preferentially directed along the proposed access roads, away from dwellings, and towards the Tarrington Brook.

4.2.2 Safe Access and Egress

Access to the site will be via a new access off School Road. Westwards from this point, a short section of School Road is indicated by the EA's Surface Water Flood Risk mapping to be at 'low risk' of surface water flooding to a depth <300mm.

However, based on the 'low risk' designation combined with the minimal potential depth of flooding, safe access and egress is still considered feasible to and from the site, westwards along School Road.

4.2.3 Flood Risk within Catchment

The proposed development of the site will not result in a loss of floodplain storage, given that no ground raising works or new structures are proposed within areas potentially at risk of flooding from the Tarrington Brook.

A minimum 5.0m easement will be provided from any proposed buildings to the top of bank of the adjacent Tarrington Brook.

5.0 SURFACE WATER MANAGEMENT

5.1 Pre-development

The site is entirely 'greenfield' and it has been assumed, based on existing site use, that there are no existing engineered public surface drainage systems within the site boundary.

Sewer record plans have been obtained from Welsh Water and these confirm that there are no public surface water sewers within the site boundary. However, it should be noted that there may be private drains present which are not recorded.

As such, currently rainfall will either infiltrate into the ground or, if run-off is generated, be directed to the perimeter of the site and existing watercourses (specifically the Tarrington Brook).

5.2 Post-development

5.2.1 Proposed Strategy

The proposed development will create impermeable areas within the site and as such, without management, could increase both the volume and rate of surface water run-off.

A Site Investigation is not currently available. However, reference to the Cranfield University 'Soilscapes' website indicates that the underlying soils are 'slightly acid loamy and clayey soils with impeded drainage'. A walkover of the site identified areas of soft boggy ground which also indicates a non-permeable nature. On this basis it is assumed that infiltration to ground will not be a viable method of surface water disposal.

As the existing 'natural' drainage from the site is directed towards the Tarrington Brook, it is proposed to retain this drainage regime and discharge the post-development surface water run-off from the site to the Brook. The maximum discharge rate will be limited to the equivalent un-developed 'greenfield' run-off rate and the excess volume of water stored on site.

The existing 'greenfield' run-off rate has been calculated using the industry standard software *MicroDrainage*. The current QBAR 'greenfield' run-off rate has been calculated as 3.4l/s/ha. A copy of the calculations is included in Appendix B.

The proposed surface water drainage system will include attenuation storage for up to the 1 in 100 year + 40% storm event.

The proposed impermeable area has been measured from the proposed Masterplan and an allowance of +10% for 'urban creep' factored into the calculation in accordance with the recommendations of clause 24.7.2 of the *CIRIA SUDS Manual*. However, the proposed discharge rate calculations have been based on the measured area only.

The total proposed post-development impermeable area is 0.326ha, excluding the 'urban creep', meaning a proposed discharge rate of 1.1l/s. However, the minimum practical flow rate for a control is 2l/s, as smaller rates are prone to blockage. As such, the minimum proposed discharge rate has been set at 2l/s for the purposes of this design.

It is proposed to provide an attenuation basin in the southeast corner of the site prior to the controlled discharge to the Brook. Due to the restricted area available, the basin volume will be supplemented by the provision of additional 1.5m x 1.5m box culverts under proposed highway areas.

The proposed surface water drainage strategy plan is included in Appendix B, along with copies of relevant *MicroDrainage* calculations.

5.2.2 Water Quality

Surface water run-off from the proposed development will, by its nature, contain certain contaminants. In order to reduce the impact of these on the receiving watercourse, a number of measures are proposed, as follows:

- Trapped gulleys to all highways.
- Provision of permeable paving with a 'clean stone' sub-base to all private hardstanding areas.
- An attenuation basin near the outfall point.

The above measures should ensure that there are no elevated concentrations of contaminants being discharged from the site.

6.0 FOUL WATER MANAGEMENT

6.1 Pre-development

The site is entirely 'greenfield' and it has been assumed, based on existing site use, that there are no existing engineered public foul drainage systems within the site boundary.

Sewer record plans have been obtained from Welsh Water and these confirm that there are no public foul water sewers within the site boundary. However, it should be noted that there may be private drains present which are not recorded.

The nearest foul sewer is located within the rear gardens of the houses to the east of the site. There is also a foul sewer manhole located in School Road near the southeastern corner of the site.

6.2 Post-development

The proposed development will be drained via a separate foul sewer which will be offered for adoption to Welsh Water.

It is proposed to connect to the existing public foul manhole, reference SO61407501, in School Road to the southeast of the site. The invert level of this manhole is not recorded. However, from an inspection of the site survey, it is considered unlikely that it will be possible to connect to this sewer by gravity. It is therefore proposed to provide a foul pumping station which will then discharge via a rising main to the public sewer.

The proposed foul water drainage strategy plan is included in Appendix B.

Based on *Sewers for Adoption 7th Edition*, the peak flow rate from the proposed 15 unit development is anticipated to be 0.7l/s.

It will also be necessary to provide a storage volume at the proposed foul pumping station for emergency storage in case of pump failure. The standard requirement is to provide 160l/dwelling, equating to approximately 2.4m^3 in this instance. This volume can be accommodated in a separate tank located immediately adjacent to the station or by oversizing the wet well.

The proposal to discharge foul water from the site to the existing public foul water sewer will be subject to Welsh Water approval / capacity.

7.0 CONCLUSIONS

This report has considered the flood risk posed to the proposal site from a variety of sources of flooding.

The entirety of the site is confirmed to be within Flood Zone 1, and at low risk of flooding from all other potential flood sources considered. There was however identified the potential for groundwater emergence and resulting shallow overland groundwater flows through the site, though there is considered to be a low risk of any groundwater flooding / 'ponding' within the site.

The application is concluded to meet the requirements of the Sequential and Exception Tests.

Finished floor levels will be set a minimum 300mm above adjacent infrastructure thoroughfare levels, and the proposed highway and building layout has also been designed to create preferential overland flow routes through the site and towards the Tarrington Brook. Such measures are intended to afford the site some protection from potential groundwater emergence overland flows through the site, and any other residual risks.

Safe access and egress has also been demonstrated to and from the site, as well as the fact that the proposed scheme will not result in a loss of floodplain storage and provide an appropriate easement to the adjacent Tarrington Brook.

Surface and foul water drainage strategies have also been proposed, involving at attenuated discharge to the adjacent Tarrington Brook, and a pumped discharge to Welsh Water's existing public foul water sewer network respectively.

This report therefore demonstrates that the proposed scheme:

- Is suitable in the location proposed.
- Will be adequately flood resistant and resilient.
- Will not place additional persons at risk of flooding, and will offer a safe means of access and egress.
- Will not increase flood risk elsewhere as a result of the proposed development through the loss of floodplain storage or impedance of flood flows.
- Will put in place measures to ensure surface and foul water is appropriately managed.

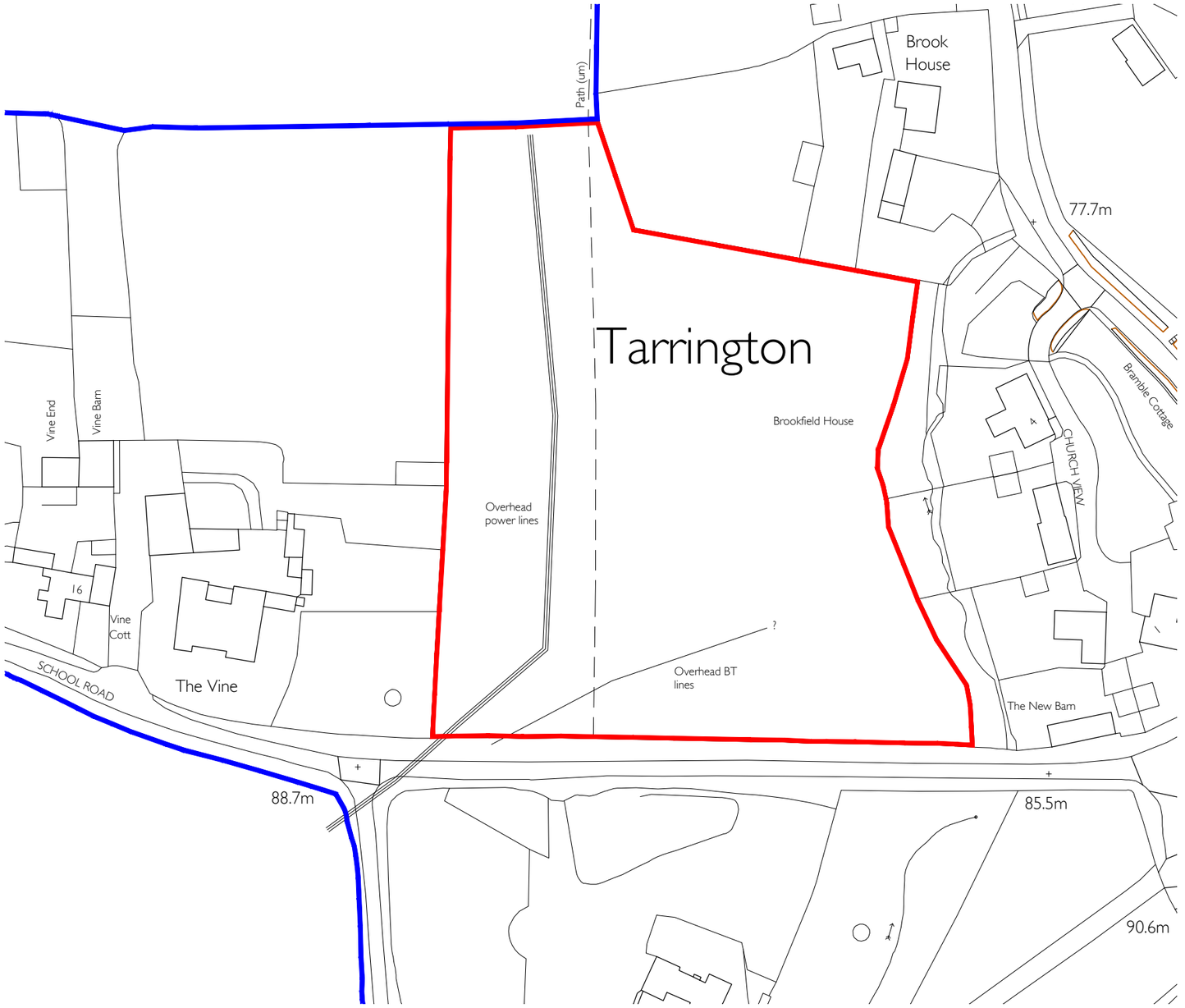
As such, the application is concluded to meet the flood risk requirements of the *NPPF*.

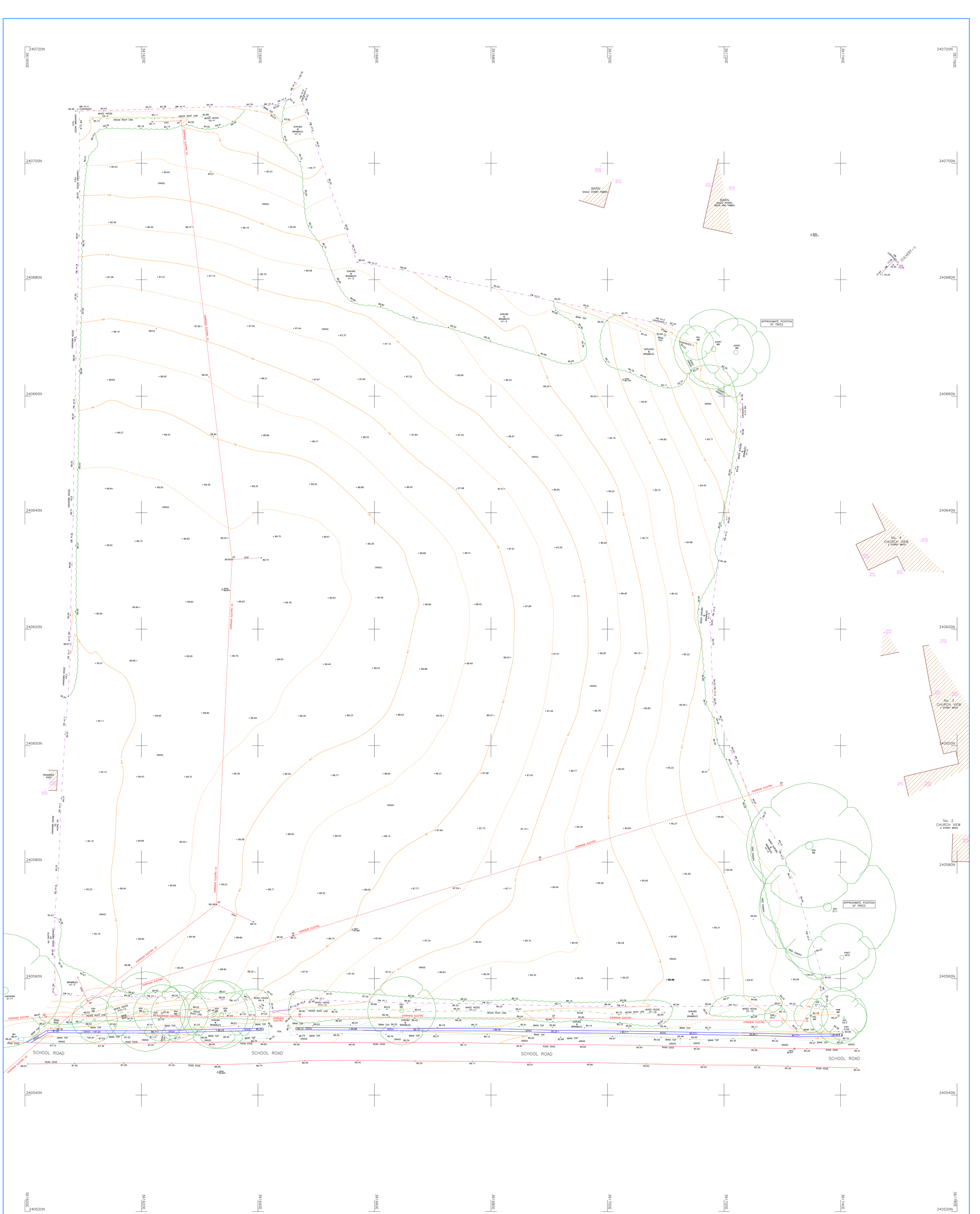
Hydrock Consultants Limited

APPENDIX A SITE DRAWINGS

Drawing No.	Title
-	Location Plan
4961-20JAN17-01	Topographical Survey
-	Proposed Site Plan

SITE AREA = 1.5 HA / 3.85 AC





Notes

- Datum : Ordnance Survey Level datum via OS Active GPS Network
- Survey Grid : Ordnance Survey National Grid Co-ordinates derived via OS Active GPS Network.
- Survey contents correct as of date of survey and survey undertaken to agreed specification
- All critical dimensions to be checked prior to site works
- All kerb levels shown are channel levels
- Drainage and Service covers :
  Covers buried or obscured at the time of the survey are not shown. Manholes have not been entered for safety reasons and all pipe diameters are estimated from the surface. Drainage pipe diameters are in millimetres, eg. D100 means a 100mm diameter pipe. The flow type stated is based on visual evidence seen from the surface at the time of the survey. All internal manhole details should be confirmed by the contractor on site prior to site works.
- Trees :
  For concentric spread trees the spread plotted is an average value drawn to scale to the nearest metre. The minimum individual diameter surveyed is 0.15m at 1m up the trunk from the ground. Trunk diameters are not plotted to size. General species are only stated where noted. A qualified arboriculturalist should be consulted for species type and condition. Heights (when requested) are approximate to the nearest metre.

Legend of Abbreviations

AV	Air Valve	FLP	Floodlight Post	SCK	Stop Cock
BEDS	Flower Beds	FP	Footpath	SOF	Soffit Level
BK/W	Brick Wall	G	Gully	ST/W	Stone Wall
BLK/W	Block Wall	GV	Gas Valve	SV	Sluice Valve
BOL	Bollard	HW	Head Wall	SVP	Soil Vent Pipe
BS	Brick Setts	IC	Inspection Cover	TEL	Call Box (telephone)
BT	British Telecom	IL	Invert Level	TH	Threshold Level
BW	Barbed Wire Fence	IR	Iron Railing	TL	Traffic Light
CB	Close Board Fence	LL	Larch-lap Fence	TP	Telegraph Pole
CCTV	Closed Circuit Television Camera	LP	Lamp Post	TV	Cable Television
CELL	Cellar Cover	MB	Multibole Tree	UTL	Unable to Lift (Cover)
CGI	Corrugated Iron Fence	MH	Manhole	V	Valve (Unknown Type)
CL	Cover Level	MP	Marker Post	VP	Vent Pipe
C/L	Chain Link Fence	MP-E	Marker Post - Electric	W-HT	Top of Wall Level
CONC	Concrete Surface	MP-G	Marker Post - Gas	WL	Water Level
CONC/P	Concrete Panel Fence	MP-T	Marker Post - Telephone	WM	Water Meter
CP	Chestnut Paling Fence	MP-W	Marker Post - Water	W/M	Wire Mesh Fence
CRB	Crash Barrier	NAME	Road Nameplate	WO	Washout Valve
D	Diameter (trees in metres / drainage pipes in millimetres)	PAL	Palisade Fence	WV	Water Valve
DK	Drop Kerb	POK	Top of Kerb Level		
E	Electricity Cover	PR	Post and Rail Fence		
EP	Electricity Pole	PW	Post and Wire Fence		
ER	Earth Rod	RE	Rodding Eye		
FFL	Finished Floor Level	RET	Retaining		
FH	Fire Hydrant	RS	Road Sign		
FLAG	Flag Pole	RWP	Rainwater Pipe		

Tree Abbreviations

ALD	Alder
BCH	Beech
CED	Cedar
CHE	Cherry
CYP	Cypress
EUC	Eucalyptus
FAC	False Acacia
FRT	Fruit
HAW	Hawthorn
HOL	Holly
HOAK	Holm Oak
HORN	Hornbeam
HCH	Horse Chestnut
LAR	Larch
LAU	Laurel
MAP	Maple
PLN	London Plane
POP	Poplar
RHO	Rhododendron
ROW	Rowan
SAL	Sallow
SB	Silver Birch
SPR	Spruce
SCH	Sweet Chestnut
WBM	Whitebeam
WIL	Willow

Survey Stations

Station	Easting	Northing	Level
S001	361656.222	240568.377	87.987
S002	361633.099	240543.927	86.944
S003	361732.091	240547.937	85.417
S004	361702.702	240662.827	85.144
S005	361633.914	240626.796	89.874
S04A	361734.963	240687.694	78.511

A D Horner Limited

Land and Measured Building Surveyors

51 Bridge Street
Pershore
Worcestershire
WR10 1AL

Telephone: 01386-555486

1 Folly House
Venton
Plymouth, Devon
PL7 5DS

Telephone: 01752-837382

Website: www.adhorner.co.uk
E-mail: enquiries@adhorner.co.uk

Title	Field north side of School Road, Tarrington, Herefordshire HR1 4EX
Client	Rural Solutions
Date	January 2017
Drawing No.	4961-20JAN17-01
Plot scale	1 : 200 on A0 Sheet
Digital scale	1 CAD unit : 1 metre
Revision	
Surveyed	LM
Checked	JKW

0 metres 10

N
Ordnance Survey Grid North

PROPOSED SITE PLAN - 1:1000 @ A3

Overhead power lines

Neighbouring field

Grass verges and public open green space

Existing roadside hedgerow and trees

Existing landscape buffer

Turning head

Buff-coloured, resin-bound gravel

New footpath

Pumping station

Pond

Proposed site entrance

N

Scale 1:1000 Meters
0 10 20 30 40 50

APPENDIX B SURFACE & FOUL WATER MANAGEMENT CALCULATIONS & DRAWINGS

Drawing No.	Title
-	*MicroDrainage* – ICP SUDS Mean Annual Flood Calculations
TAR-HYD-XX-XX-DR-C-2200-P1	Proposed Surface & Foul Water Drainage Strategy
-	*MicroDrainage* – Network Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	1.000	Urban	0.000
SAAR (mm)	700	Region Number	Region 9

Results l/s

QBAR Rural	3.4
QBAR Urban	3.4
Q100 years	7.4
Q1 year	3.0
Q30 years	6.0
Q100 years	7.4

OS NORTH

Existing Watercourse

Existing Public Foul Sewer

Proposed Foul Sewer

Proposed Foul Sewer Rising Main

Proposed Surface Water Sewer

Proposed Surface Water Storage Pond
(serving up to 1 in 100 year + 40% storm events)

Ø 225mm (1.000) Proposed Surface Water Sewer Pipe Diameter and MicroDrainage Calculations Pipe Reference

Proposed Permeable Paving to Private Hardstanding Areas

Existing MH F SO61407601

Existing MH F SO61407602

Existing MH F SO61408611

Existing MH F SO61407603

Existing MH F SO61407502

MH SW
CL 87.650
IL 86.150

MH F
CL 87.650
IL 86.300

MH SW
CL 87.150
IL 83.915

MH SW
CL 85.500
IL 84.000

MH F
CL 87.150
IL 85.800

MH F
CL 85.500
IL 84.150

MH F
CL 87.750
IL 85.553

MH SW
CL 87.750
IL 83.813

MH F
CL 88.050
IL 85.000

MH F
CL 86.950
IL 85.157

MH SW
CL 86.950
IL 82.827

MH F
CL 85.750
IL 84.400

MH SW
CL 88.050
IL 82.927

MH F
CL 85.650
IL 84.300

MH SW
CL 85.750
IL 82.751

MH SW
CL 85.650
IL 82.691

MH SW
CL 86.700
IL 82.638

Box culvert 1500mm x 1500mm

Ø 225mm

Ø 300mm

Pumping Station Compound

Attenuation Pond

Proposed Surface Water Storage Pond
(serving up to 1 in 100 year + 40% storm events)
Area 153m²
Volume 92m³
Effective depth 1.4m

Control MH SW
CL 84.100
IL 82.600
Discharge @ 2l/s

Proposed Surface Water Outfall to Watercourse

Proposed Foul Discharge to existing MH F SO61407501
CL 85.5
IL TBC

Overhead power lines

Overhead BT lines (To be relocated)

Brookfield House

Bramble Cottage

The New Barn

CHURCH VIEW

SCHOOL ROAD

Rev	Date	Description	By	Ckd
P1	27/01/17	First Issue.	EAG	RJH

Hydrock

Over Court Barns, Over Lane, Almondsbury, Bristol, BS32 4DF.
TEL: 01454 619 533 FAX: 01454 614 125 or visit
www.hydrock.com

Client:

STOKE EDITH ESTATE

Project:

SCHOOL ROAD
TARRINGTON

Hydrock Project No: C-05818-C

Drawing Title:

PROPOSED SURFACE & FOUL WATER DRAINAGE STRATEGY

Status: S0 Purpose of Issue: FOR APPROVAL

Drawn:	Checked:	Scale @ A1:	Drawn Date:	First Issue:
EAG	RJH	1:500	27/01/2017	27/01/2017

Drawing No. TAR-HYD-XX-XX-DR-C-2200 Revision P1

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Time Area Diagram for Existing

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.281	4-8	0.073

Total Area Contributing (ha) = 0.353

Total Pipe Volume (m^3) = 152.717

Existing Network Details for Existing

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
E1.000	17.026	0.085	200.0	0.040	5.00	0.0	0.600	o	225
E2.000	8.818	3.044	2.9	0.038	5.00	0.0	0.600	o	225
E1.001	20.328	0.102	200.0	0.024	0.00	0.0	0.600	o	300
E1.002	32.040	0.986	32.5	0.077	0.00	0.0	0.600	o	300
E3.000	20.197	0.101	200.0	0.055	5.00	0.0	0.600	[]	-29
E1.003	15.238	0.076	200.5	0.042	0.00	0.0	0.600	[]	-29
E1.004	11.958	0.060	199.3	0.040	0.00	0.0	0.600	[]	-29
E1.005	10.729	0.053	202.4	0.018	0.00	0.0	0.600	[]	-29
E1.006	7.611	0.038	200.3	0.019	0.00	0.0	0.600	[]	-29
E1.007	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
E1.000	84.000	0.040	0.0	0.92	36.6
E2.000	86.150	0.038	0.0	7.74	307.9
E1.001	83.915	0.102	0.0	1.11	78.3
E1.002	83.813	0.179	0.0	2.77	195.6
E3.000	82.928	0.055	0.0	3.03	6817.2
E1.003	82.827	0.276	0.0	3.03	6808.2
E1.004	82.751	0.316	0.0	3.03	6828.7
E1.005	82.691	0.334	0.0	3.01	6775.4
E1.006	82.638	0.353	0.0	3.03	6811.8
E1.007	82.600	0.353	0.0	0.71	12.5

Conduit Sections for Existing

NOTE: Diameters less than 66 refer to section numbers of hydraulic conduits. These conduits are marked by the symbols:- [] box culvert, \/ open channel, oo dual pipe, ooo triple pipe, O egg.

Section numbers < 0 are taken from user conduit table

Section Number	Conduit Type	Major Dimn. (mm)	Minor Dimn. (mm)	Side Slope (Deg)	Corner Splay (mm)	4*Hyd Radius (m)	XSect Area (m²)
-29	[]	1500	1500	90.0		1.500	2.250

Manhole Schedules for Existing

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
E1	85.500	1.500	Open Manhole	1200	E1.000	84.000	225				
E2	87.650	1.500	Open Manhole	1200	E2.000	86.150	225				
E2	87.150	4.044	Open Manhole	1200	E1.001	83.915	300	E1.000	83.915	225	
								E2.000	83.106	225	
E3	87.750	3.937	Open Manhole	1200	E1.002	83.813	300	E1.001	83.813	300	
E4	88.050	5.122	Open Manhole	2400	E3.000	82.928	-29				
E4	86.950	4.123	Open Manhole	2400	E1.003	82.827	-29	E1.002	82.827	300	
								E3.000	82.827	-29	
E5	85.750	2.999	Open Manhole	2400	E1.004	82.751	-29	E1.003	82.751	-29	
E6	85.650	2.959	Open Manhole	2400	E1.005	82.691	-29	E1.004	82.691	-29	
E7	86.700	4.062	Open Manhole	2400	E1.006	82.638	-29	E1.005	82.638	-29	
E10	84.100	1.500	Open Manhole	1200	E1.007	82.600	150	E1.006	82.600	-29	
E	84.000	1.425	Open Manhole	0		OUTFALL		E1.007	82.575	150	

Area Summary for Existing

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.040	0.040	0.040
2.000	-	-	100	0.038	0.038	0.038
1.001	-	-	100	0.024	0.024	0.024
1.002	-	-	100	0.077	0.077	0.077
3.000	-	-	100	0.055	0.055	0.055
1.003	-	-	100	0.042	0.042	0.042
1.004	-	-	100	0.040	0.040	0.040
1.005	-	-	100	0.018	0.018	0.018
1.006	User	-	100	0.019	0.019	0.019
1.007	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.353	0.353	0.353

Free Flowing Outfall Details for Existing

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
E1.007	E	84.000	82.575	82.575	0	0

Simulation Criteria for Existing

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
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	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.800	Storm Duration (mins)	30
Ratio R	0.400		

Online Controls for Existing

Hydro-Brake Optimum® Manhole: E10, DS/PN: E1.007, Volume (m³): 14.8

Unit Reference	MD-SHE-0062-2000-1400-2000
Design Head (m)	1.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	62
Invert Level (m)	82.600
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.400	2.0
Flush-Flo™	0.272	1.6
Kick-Flo®	0.553	1.3
Mean Flow over Head Range	-	1.6

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	1.4	1.200	1.9	3.000	2.8	7.000	4.2
0.200	1.6	1.400	2.0	3.500	3.0	7.500	4.4
0.300	1.6	1.600	2.1	4.000	3.2	8.000	4.5
0.400	1.6	1.800	2.2	4.500	3.4	8.500	4.6
0.500	1.5	2.000	2.4	5.000	3.6	9.000	4.7
0.600	1.4	2.200	2.5	5.500	3.8	9.500	4.9
0.800	1.6	2.400	2.6	6.000	3.9		
1.000	1.7	2.600	2.7	6.500	4.1		

Storage Structures for Existing

Tank or Pond Manhole: E10, DS/PN: E1.007

Invert Level (m) 82.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2.6	1.400	153.5	2.800	0.0	4.200	0.0
0.200	12.5	1.600	0.0	3.000	0.0	4.400	0.0
0.400	29.6	1.800	0.0	3.200	0.0	4.600	0.0
0.600	49.5	2.000	0.0	3.400	0.0	4.800	0.0
0.800	71.9	2.200	0.0	3.600	0.0	5.000	0.0
1.000	96.8	2.400	0.0	3.800	0.0		
1.200	123.9	2.600	0.0	4.000	0.0		

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
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	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.800	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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
E1.000	15 Winter	1	0%					
E2.000	15 Winter	1	0%					
E1.001	15 Winter	1	0%					
E1.002	15 Winter	1	0%					
E3.000	180 Winter	1	0%					
E1.003	180 Winter	1	0%					
E1.004	180 Winter	1	0%					
E1.005	180 Winter	1	0%					
E1.006	180 Winter	1	0%					
E1.007	180 Winter	1	0%	1/15 Summer				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.000	E1	84.062	-0.163	0.000	0.17	0.0	5.4	OK
E2.000	E2	86.173	-0.202	0.000	0.02	0.0	5.2	OK
E1.001	E2	84.006	-0.209	0.000	0.20	0.0	13.4	OK
E1.002	E3	83.884	-0.229	0.000	0.13	0.0	22.3	OK
E3.000	E4	83.127	-1.301	0.000	0.00	0.0	1.7	OK
E1.003	E4	83.127	-1.200	0.000	0.00	0.0	7.4	OK

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

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.004	E5	83.127	-1.124	0.000	0.00	0.0	7.2	OK
E1.005	E6	83.128	-1.063	0.000	0.00	0.0	6.1	OK
E1.006	E7	83.128	-1.010	0.000	0.00	0.0	5.1	OK
E1.007	E10	83.128	0.378	0.000	0.16	0.0	1.6	SURCHARGED

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
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	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.800	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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
E1.000	15 Winter	30	0%					
E2.000	15 Winter	30	0%					
E1.001	15 Winter	30	0%					
E1.002	15 Winter	30	0%					
E3.000	600 Winter	30	0%					
E1.003	600 Winter	30	0%					
E1.004	600 Winter	30	0%					
E1.005	600 Winter	30	0%					
E1.006	600 Winter	30	0%					
E1.007	600 Winter	30	0%	1/15 Summer				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.000	E1	84.107	-0.118	0.000	0.41	0.0	13.3	OK
E2.000	E2	86.183	-0.192	0.000	0.05	0.0	12.9	OK
E1.001	E2	84.068	-0.147	0.000	0.50	0.0	34.2	OK
E1.002	E3	83.935	-0.178	0.000	0.34	0.0	60.7	OK
E3.000	E4	83.576	-0.852	0.000	0.00	0.0	1.5	OK
E1.003	E4	83.576	-0.751	0.000	0.00	0.0	7.2	OK

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

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.004	E5	83.570	-0.681	0.000	0.00	0.0	11.4	OK
E1.005	E6	83.567	-0.624	0.000	0.00	0.0	5.6	OK
E1.006	E7	83.576	-0.562	0.000	0.00	0.0	5.3	OK
E1.007	E10	83.573	0.823	0.000	0.17	0.0	1.7	SURCHARGED

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
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	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.800	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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
E1.000	15 Winter	100	+40%					
E2.000	15 Winter	100	+40%					
E1.001	15 Winter	100	+40%					
E1.002	600 Winter	100	+40%					
E3.000	600 Winter	100	+40%					
E1.003	600 Winter	100	+40%					
E1.004	600 Winter	100	+40%					
E1.005	600 Winter	100	+40%					
E1.006	600 Winter	100	+40%					
E1.007	600 Winter	100	+40%	1/15 Summer				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.000	E1	84.193	-0.032	0.000	0.74	0.0	24.1	OK
E2.000	E2	86.197	-0.178	0.000	0.10	0.0	23.4	OK
E1.001	E2	84.144	-0.071	0.000	0.90	0.0	61.8	OK
E1.002	E3	84.049	-0.064	0.000	0.06	0.0	10.1	OK
E3.000	E4	84.049	-0.379	0.000	0.00	0.0	2.7	OK
E1.003	E4	84.049	-0.278	0.000	0.00	0.0	12.2	OK

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

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.004	E5	84.049	-0.202	0.000	0.00	0.0	12.3	OK
E1.005	E6	84.049	-0.142	0.000	0.00	0.0	11.7	OK
E1.006	E7	84.049	-0.089	0.000	0.00	0.0	11.2	OK
E1.007	E10	84.050	1.300	0.000	0.20	0.0	2.0	FLOOD RISK