

LAND AT HENTHORN ROAD, CLITHEROE

DRAINAGE ASSESSMENT Final Report v1.1

October 2017

**Weetwood Services Ltd
Park House
Broncoed Business Park
Ffordd Byrnwr Gwair
Mold
CH7 1FQ**

t: 01352 700045
e: info@weetwood.net
w: www.weetwood.net

Report Title: **Land at Henthorn Road, Clitheroe**
Drainage Assessment
Final Report v1.1

Client: The Strategic Land Group Ltd

Date of Issue: 4 October 2017

Prepared by: Jamie Eden BEng (Hons)
Technical Engineer

Checked by: Geoff Waite BSc CEng C.WEM MICE MCIWEM
Consultant

Approved by: Rebecca Murphy BSc (Hons)
Associate Director

This document has been prepared solely as a Drainage Assessment for The Strategic Land Group Ltd. This report is confidential to The Strategic Land Group Ltd and Weetwood Services Ltd accepts no responsibility or liability for any use that is made of this document other than by The Strategic Land Group Ltd for the purposes for which it was originally commissioned and prepared.

Contents

	Page
Signature Sheet	i
Contents	ii
List of Tables, Figures & Appendices	iii
1 INTRODUCTION	1
1.1 Purpose of Report	1
1.2 Structure of the Report.....	1
2 PLANNING POLICY AND GUIDANCE	2
2.1 National Planning Policy	2
2.2 Local Planning Policy and Guidance	3
3 SITE DETAILS AND PROPOSED DEVELOPMENT	4
3.1 Site Location	4
3.2 Existing and Proposed Development.....	4
3.3 Waterbodies in the Vicinity of the Site	4
3.4 Ground Conditions	5
3.5 Site Levels	5
4 SURFACE WATER MANAGEMENT	6
4.1 Disposal of Surface Water	6
4.2 Peak Flow Control	6
4.3 Volume Control.....	7
4.4 Managing Surface Water within the Development	7
4.5 Adoption and Maintenance of SuDS.....	8
5 SUMMARY	9
6 RECOMMENDATIONS.....	10

List of Tables

Table 3: Greenfield Runoff Rate 6

List of Figures

Figure 1: Site Location 4
Figure 2: Illustrative Surface Water Drainage Layout..... 8

List of Appendices

Appendix A: Illustrative Development Proposals
Appendix B: Topographic Survey
Appendix C: Greenfield Runoff Calculations
Appendix D: Surface Water Attenuation - Storage Volume Calculation
Appendix E: Surface Water Attenuation - Sensitivity

1 INTRODUCTION

1.1 PURPOSE OF REPORT

Weetwood Services Ltd ('Weetwood') has been instructed by The Strategic Land Group Ltd to undertake a Drainage Assessment for the proposed development of land at Henthorn Road, Clitheroe.

1.2 STRUCTURE OF THE REPORT

The report is structured as follows:

- Section 1** Introduction and report structure
- Section 2** Presents national and local drainage planning policy
- Section 3** Provides background information relating to the development site
- Section 4** Addresses the effect of the proposed development on surface water runoff and presents an illustrative surface water drainage scheme to ensure that surface water runoff is sustainably managed and flood risk is not increased elsewhere.
- Section 5** Presents a summary of key findings
- Section 6** Presents the recommendations

2 PLANNING POLICY AND GUIDANCE

2.1 NATIONAL PLANNING POLICY

2.1.1 National Planning Policy Framework

The aim of the National Planning Policy Framework (NPPF) is to ensure that flood risk is taken into account at all stages in the planning process and is appropriately addressed.

2.1.2 House of Commons Written Statement (HCWS161), December 2014

Planning applications for major developments¹ are required² to provide Sustainable Drainage Systems (SuDS) for the management of surface water runoff, unless demonstrated to be inappropriate³ or disproportionately expensive.

SuDS aim to mimic natural drainage and can achieve multiple objectives such as removing pollutants from urban runoff at source, controlling surface water runoff from developments, and ensuring that flood risk is not increased downstream. Combining water management with green space can provide amenity and biodiversity enhancement.

2.1.2.1 DEFRA Technical Standards for Sustainable Drainage Systems, March 2015

In considering a development that includes a sustainable drainage system, the local planning authority will need to be satisfied that the proposed minimum standards of operation are appropriate and that there are clear arrangements in place for ongoing maintenance.

According to Technical Standards⁴ published by DEFRA, surface water drainage systems must be designed so that:

- Flooding does not occur on any part of the site for a 1 in 30 annual probability rainfall event, unless an area is designed to hold and/or convey water as part of the design;
- Flooding does not occur in any part of a building during a 1 in 100 annual probability event; and
- Flows resulting from rainfall in excess of a 1 in 100 annual probability rainfall event are managed in exceedance routes that minimise the risks to people and property, so far as is reasonably practicable.
- For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

¹ Developments of 10 dwellings or more; or equivalent non-residential or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010)

² Written Statement (HCWS161) made by the Secretary of State for Communities and Local Government (Mr Eric Pickles) on 18 December 2014

³ Paragraph 082 (Reference ID: 7-082-20150323) of the Planning Practice Guidance outlines how a sustainable drainage system might be judged to be inappropriate

⁴ Non-Statutory Technical Standards for Sustainable Drainage Systems, DEFRA, March 2015

- Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event
- Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

2.2 LOCAL PLANNING POLICY AND GUIDANCE

Policy DME6: Water Management of the Ribble Valley Borough Council Core Strategy 2008-2028 (adopted December 2014) states:

'Development will not be permitted where the proposal would be at an unacceptable risk of flooding or exacerbate flooding elsewhere.'

Applications for development should include appropriate measures for the conservation, protection and management of water such that development contributes to:

- 1. Preventing pollution of surface and/ or groundwater*
- 2. Reducing water consumption*
- 3. Reducing the risk of surface water flooding (for example the use of [SuDS])*

As a part of the consideration of water management issues, and in parallel with flood management objectives, the authority will also seek the protection of the boroughs watercourses for their biodiversity value.'

3 SITE DETAILS AND PROPOSED DEVELOPMENT

3.1 SITE LOCATION

The site is located north of Pendleton Brook, at Ordnance Survey National Grid Reference SD 733 406 as shown in **Figure 1** and has a total area of 1.41 ha.

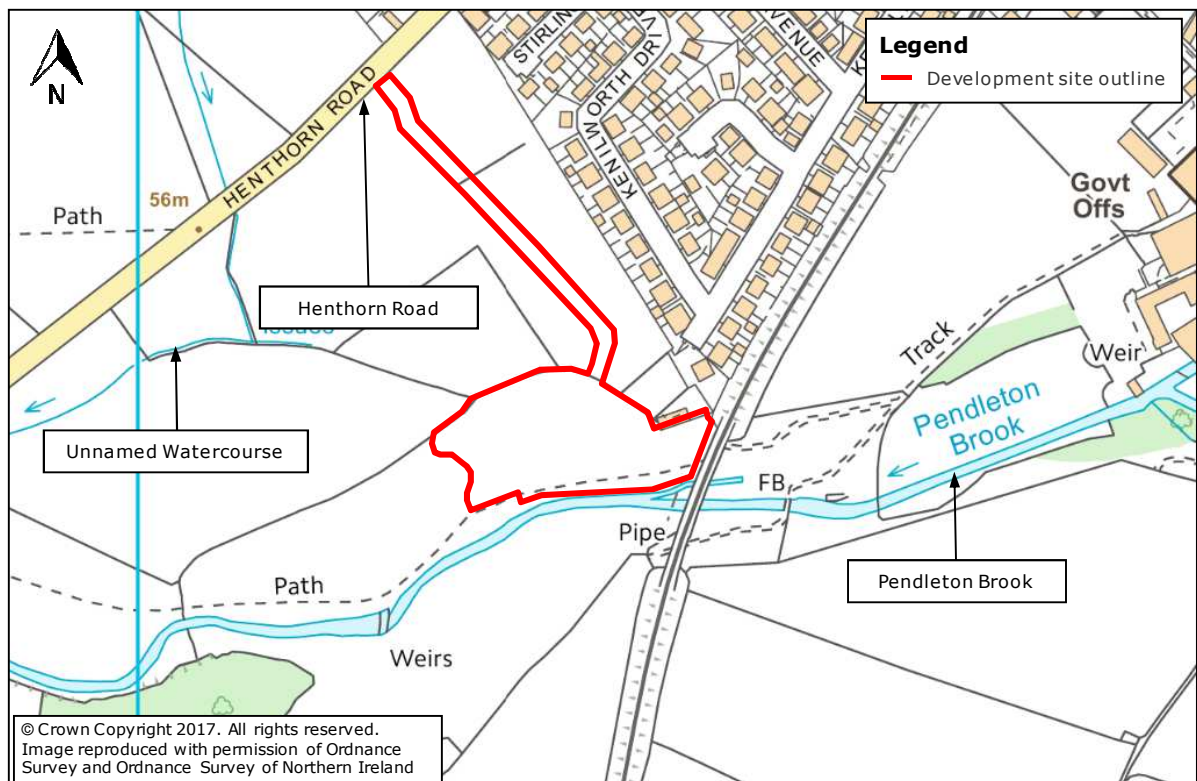


Figure 1: Site Location

3.2 EXISTING AND PROPOSED DEVELOPMENT

The existing site consists of greenfield land.

The outline planning proposals are for the construction of a residential development consisting of up to 25 dwellings with associated infrastructure. Illustrative plans can be seen in **Appendix A**.

It should be noted that the estate road connecting the site to Henthorn Road is part of a consented scheme and while located within the development outline is not a part of the development proposals.

3.3 WATERBODIES IN THE VICINITY OF THE SITE

Pendleton Brook borders the southern boundary of the site and flows in a westerly direction.

An unnamed watercourse is located approximately 120 m north-west of the site and flows in a south-westerly direction, which ultimately discharges into Pendleton Brook approximately 450 m west of the site.

Pendleton Brook is classified as a 'main river'. The unnamed watercourse is classified as an 'ordinary watercourse'.

3.4 GROUND CONDITIONS

According to British Geological Survey (BGS) the bedrock geology is '*Clitheroe Limestone and Hodder Mudstone Formation*', whilst the superficial deposits are likely to be '*Till, Devensian – Diamicton*'.

According to the Soilscales maps produced by the National Soils Research Institute⁵, soil conditions at the site and within the surrounding area are described as '*slowly permeable seasonally wet loamy and clayey soils*'.

3.5 SITE LEVELS

A topographic survey of the main development platform of the site has been undertaken by Powers & Tiltman Ltd Land Surveyors and is provided in **Appendix B**.

Site levels are shown to be in the region of 55.0 to 63.0 metres Above Ordnance Datum (m AOD) with a general fall from north to south.

LiDAR data has been utilised to give an indication of levels for the section of the site which will form the new access road. Levels are shown to be in the region of 60.0 to 63.1 m AOD.

⁵ Soilscales www.landis.org.uk/soilscales/

4 SURFACE WATER MANAGEMENT

4.1 DISPOSAL OF SURFACE WATER

In accordance with the NPPF Planning Practice Guidance⁶, surface water runoff should be disposed of according to the following hierarchy:

1. Into the ground (infiltration)
2. To a surface water body
3. To a surface water sewer, highway drain, or another drainage system
4. To a combined sewer

As detailed previously, according to the Soilscape maps the site is underlain by soils with impeded drainage. Additionally infiltration testing was carried out by REC⁷ for a site bordering the western boundary of the development. This concluded that the ground was not suitable for soakaway design.

Considering the above, disposal of surface water via infiltration is unlikely to be feasible. Given this, it is proposed to direct all runoff from the developed site to Pendleton Brook.

4.2 PEAK FLOW CONTROL

For greenfield sites, the peak runoff rate from the proposed development to any highway drain, sewer or surface water body for the 1 in 1 annual probability rainfall event and the 1 in 100 annual probability rainfall event should not exceed the peak greenfield runoff rate for the same event.

The site has a total area of 1.41 ha. An area of 0.09 ha of proposed green spaces located along the southern boundary of the site would continue to runoff independently of the proposed drainage system and into Pendleton Brook. Additionally the access road with an area of 0.22 ha connecting the site to Henthorn Road north is served by an existing drainage network and would continue to drain to this.

A proposed development platform of 1.1 ha has therefore been assumed in the following calculations.

The greenfield surface water runoff rate has been calculated using the ICP SUDS method within MicroDrainage (**Appendix C** and **Table 1**).

Table 1: Greenfield Runoff Rate

Annual probability of rainfall event	Greenfield Runoff Rate for 1.1 ha Site (l/s)
1 in 1	7.5
1 in 30	14.6
1 in 100	17.9

⁶ Paragraph 080, Reference ID: 7-080-20150323

⁷ Phase II Geo-Environmental Site Investigation. REC Report: 45328p1r2

4.3 VOLUME CONTROL

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

It is proposed to restrict discharge rates to equivalent greenfield rates which should have a negligible impact on the volume of surface water discharged from the site.

4.4 MANAGING SURFACE WATER WITHIN THE DEVELOPMENT

The proposed impermeable areas within the development have been estimated to be 0.58 ha, based upon the proposed layout provided in **Appendix A**.

The surface water storage facilities have been modelled using the Detailed Design module of MicroDrainage Source Control (**Appendix D**). The required storage volume has been sized to store the 1 in 100 annual probability rainfall event including a 20% increase in rainfall intensity in order to allow for climate change in accordance with EA guidance⁸.

Assuming peak discharge rates in accordance with those presented in **Table 1** and a design depth of 1.4 m, a total storage volume of 233 m³ would be required. A complex flow control device has been used to ensure that the post-development discharge rate is no higher than the existing 1 in 1 and 1 in 100 annual probability event greenfield runoff rates.

Additionally, a freeboard should be provided to accommodate for the 1 in 100 annual probability event including a 40% increase in rainfall intensity (**Appendix E**).

The overall storage volume could be accommodated within a detention basin with a plan area at ground level of 306.5 m², a depth of 1.6 m and with 1 in 3 side slopes. The detention basin would fill to a depth of 1.40 m during the 20% climate change event and 1.57 m during the 40% climate change event. This would provide a freeboard of 0.20 m and 0.03 m respectively.

Given the difference in elevations between and the invert level of the proposed detention basin there should be sufficient fall for a gravity connection for the entire site.

Figure 2 provides an indicative surface water drainage layout for the site. Additional SuDS features, such as rainwater harvesting and permeable paving may be incorporated into the surface water drainage strategy at the detailed design stage.

The storage facilities have been sized to accommodate the entire storage requirements for the site. This is likely to be an overestimate as the storage capacity within the surface water conveyance system and other SuDS features has not been taken into account.

⁸ Flood Risk Assessments: climate change allowances (<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>)

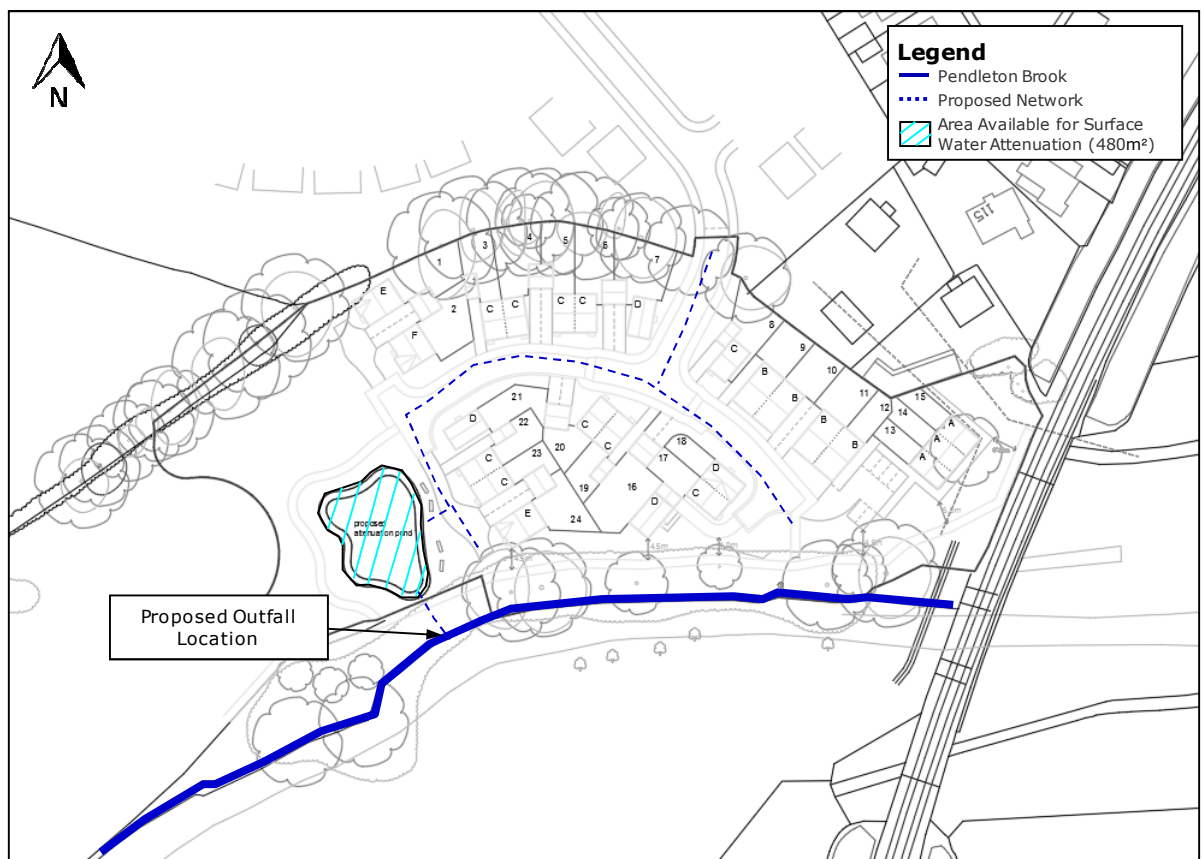


Figure 2: Illustrative Surface Water Drainage Layout

4.5 ADOPTION AND MAINTENANCE OF SUDS

The pipe network, designed to Sewers for Adoption (7th edition) standard, may be adopted by United Utilities.

United Utilities and Lancashire County Council have confirmed that they do not currently adopt detention basins. As such this would need to be maintained by a private maintenance company.

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

5 SUMMARY

This Drainage Assessment has been prepared on behalf of Strategic Land Group Ltd and relates to the proposed development of land at Henthorn Road, Clitheroe.

Due to existing ground conditions, disposal of surface water via infiltration is unlikely to be feasible. Given this, it is proposed to direct all runoff from the developed site to Pendleton Brook.

The illustrative surface water drainage scheme presented by this report provides SuDS elements to reduce the rate and volume of runoff from the developed site and to provide quality treatment via a SuDS treatment train.

Surface water runoff from the developed site may therefore be sustainably managed in accordance with the NPPF and local policy.

The storage calculations may be refined at the detailed design stage and a final decision made on the types of storage to be provided.

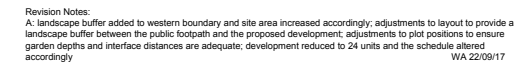
6 RECOMMENDATIONS

This Drainage Assessment has demonstrated that the proposed development may be completed without conflicting with the requirements of the NPPF subject to the following:

- The detailed drainage design, developed in accordance with the principles set down in this Drainage Assessment, should be submitted to and approved by the local planning authority prior to the commencement of development

APPENDIX A:

Development Proposals



APPENDIX B:

Topographic Survey

APPENDIX C:

Greenfield Runoff Calculations

Weetwood		Page 1
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold		
Date 04/09/2017 15:11 File	Designed by JamieEden Checked by	
Micro Drainage Source Control 2017.1.2		
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 1 Soil 0.450 Area (ha) 1.000 Urban 0.000 SAAR (mm) 1150 Region Number Region 10 Results l/s QBAR Rural 7.9 QBAR Urban 7.9 Q1 year 6.8 Q1 year 6.8 Q30 years 13.3 Q100 years 16.3		
©1982-2017 XP Solutions		

APPENDIX D:

Surface Water Attenuation - Storage Volume Calculation

Weetwood					Page 1
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold					
Date 04/10/2017 11:09 File 2017-10-04 3886 Q0100cc...			Designed by JamieEden Checked by		
Micro Drainage			Source Control 2017.1.2		
<u>Summary of Results for 100 year Return Period (+20%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.827	0.827	9.5	105.0	O K
30 min Summer	1.014	1.014	15.0	141.2	O K
60 min Summer	1.162	1.162	16.5	173.6	O K
120 min Summer	1.259	1.259	16.6	196.5	O K
180 min Summer	1.283	1.283	16.6	202.6	O K
240 min Summer	1.289	1.289	16.6	204.1	O K
360 min Summer	1.274	1.274	16.6	200.4	O K
480 min Summer	1.246	1.246	16.6	193.4	O K
600 min Summer	1.214	1.214	16.6	185.7	O K
720 min Summer	1.182	1.182	16.6	178.1	O K
960 min Summer	1.119	1.119	16.4	163.7	O K
1440 min Summer	1.025	1.025	15.5	143.5	O K
2160 min Summer	0.948	0.948	11.1	127.7	O K
2880 min Summer	0.823	0.823	9.4	104.4	O K
4320 min Summer	0.596	0.596	8.1	67.2	O K
5760 min Summer	0.397	0.397	7.5	40.2	O K
7200 min Summer	0.185	0.185	7.4	16.7	O K
8640 min Summer	0.135	0.135	6.9	11.8	O K
10080 min Summer	0.122	0.122	6.2	10.6	O K
15 min Winter	0.898	0.898	9.8	118.2	O K
30 min Winter	1.096	1.096	16.3	158.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	103.090	0.0	112.0	18	
30 min Summer	72.607	0.0	157.8	32	
60 min Summer	48.861	0.0	212.5	60	
120 min Summer	31.513	0.0	274.1	100	
180 min Summer	23.844	0.0	311.1	134	
240 min Summer	19.547	0.0	340.0	168	
360 min Summer	14.720	0.0	384.1	238	
480 min Summer	12.010	0.0	417.9	306	
600 min Summer	10.243	0.0	445.5	372	
720 min Summer	8.987	0.0	469.0	436	
960 min Summer	7.300	0.0	508.0	566	
1440 min Summer	5.429	0.0	566.7	808	
2160 min Summer	4.024	0.0	630.1	1216	
2880 min Summer	3.255	0.0	679.6	1616	
4320 min Summer	2.418	0.0	757.1	2336	
5760 min Summer	1.960	0.0	818.3	3120	
7200 min Summer	1.667	0.0	870.2	3680	
8640 min Summer	1.463	0.0	916.1	4392	
10080 min Summer	1.311	0.0	957.8	5120	
15 min Winter	103.090	0.0	125.4	18	
30 min Winter	72.607	0.0	176.7	32	
©1982-2017 XP Solutions					

Weetwood				Page 2	
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold					
Date 04/10/2017 11:09 File 2017-10-04 3886 Q0100cc...		Designed by JamieEden Checked by			
Micro Drainage		Source Control 2017.1.2			
<u>Summary of Results for 100 year Return Period (+20%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	1.269	1.269	16.6	199.1	O K
120 min Winter	1.375	1.375	17.4	226.5	O K
180 min Winter	1.397	1.397	17.6	232.1	O K
240 min Winter	1.400	1.400	17.6	233.0	O K
360 min Winter	1.373	1.373	17.4	225.8	O K
480 min Winter	1.329	1.329	17.0	214.2	O K
600 min Winter	1.278	1.278	16.6	201.5	O K
720 min Winter	1.224	1.224	16.6	188.2	O K
960 min Winter	1.127	1.127	16.4	165.5	O K
1440 min Winter	1.009	1.009	14.7	140.2	O K
2160 min Winter	0.894	0.894	9.8	117.4	O K
2880 min Winter	0.704	0.704	8.8	84.1	O K
4320 min Winter	0.291	0.291	7.5	27.9	O K
5760 min Winter	0.130	0.130	6.7	11.4	O K
7200 min Winter	0.113	0.113	5.7	9.8	O K
8640 min Winter	0.103	0.103	5.0	8.8	O K
10080 min Winter	0.095	0.095	4.5	8.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	48.861	0.0	238.0	60	
120 min Winter	31.513	0.0	307.0	114	
180 min Winter	23.844	0.0	348.4	142	
240 min Winter	19.547	0.0	380.9	180	
360 min Winter	14.720	0.0	430.2	256	
480 min Winter	12.010	0.0	468.0	330	
600 min Winter	10.243	0.0	498.9	402	
720 min Winter	8.987	0.0	525.3	468	
960 min Winter	7.300	0.0	568.9	596	
1440 min Winter	5.429	0.0	634.7	838	
2160 min Winter	4.024	0.0	705.7	1300	
2880 min Winter	3.255	0.0	761.2	1676	
4320 min Winter	2.418	0.0	847.9	2420	
5760 min Winter	1.960	0.0	916.5	2936	
7200 min Winter	1.667	0.0	974.6	3664	
8640 min Winter	1.463	0.0	1026.0	4328	
10080 min Winter	1.311	0.0	1072.7	5024	
©1982-2017 XP Solutions					

Weetwood		Page 4
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold		
Date 04/10/2017 11:09 File 2017-10-04 3886 Q0100cc...	Designed by JamieEden Checked by	
Micro Drainage Source Control 2017.1.2		

Model Details

Storage is Online Cover Level (m) 1.600

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	81.0	1.400	270.4	1.600	306.5

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0134-7480-0500-7480
Design Head (m)	0.500
Design Flow (l/s)	7.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	134
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	7.5
Flush-Flo™	0.205	7.5
Kick-Flo®	0.384	6.6
Mean Flow over Head Range	-	6.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.8	1.200	11.3	3.000	17.5	7.000	26.3
0.200	7.5	1.400	12.1	3.500	18.8	7.500	27.2
0.300	7.2	1.600	12.9	4.000	20.0	8.000	28.1
0.400	6.7	1.800	13.7	4.500	21.2	8.500	29.0
0.500	7.5	2.000	14.4	5.000	22.3	9.000	29.8
0.600	8.1	2.200	15.0	5.500	23.3	9.500	30.6
0.800	9.3	2.400	15.7	6.000	24.3		
1.000	10.4	2.600	16.3	6.500	25.3		

©1982-2017 XP Solutions

Weetwood		Page 5
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold		
Date 04/10/2017 11:09 File 2017-10-04 3886 Q0100cc...	Designed by JamieEden Checked by	
Micro Drainage		

Source Control 2017.1.2

Hydro-Brake® Optimum

Unit Reference MD-SHE-0117-5500-0495-5500
Design Head (m) 0.495
Design Flow (l/s) 5.5
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 117
Invert Level (m) 0.905
Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.495	5.5
Flush-Flo™	0.184	5.5
Kick-Flo®	0.372	4.8
Mean Flow over Head Range	-	4.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.1	1.200	8.3	3.000	12.8	7.000	19.3
0.200	5.5	1.400	8.9	3.500	13.8	7.500	20.0
0.300	5.3	1.600	9.5	4.000	14.7	8.000	20.7
0.400	5.0	1.800	10.1	4.500	15.6	8.500	21.3
0.500	5.5	2.000	10.6	5.000	16.3	9.000	21.9
0.600	6.0	2.200	11.1	5.500	17.1	9.500	22.5
0.800	6.9	2.400	11.5	6.000	17.9		
1.000	7.6	2.600	12.0	6.500	18.6		

APPENDIX E:

Surface Water Attenuation - Sensitivity

Weetwood					Page 1	
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold						
Date 04/10/2017 11:10 File 2017-10-04 3886 Q0100cc...			Designed by JamieEden Checked by			
Micro Drainage			Source Control 2017.1.2			
<u>Summary of Results for 100 year Return Period (+40%)</u>						
	Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
	15 min Summer	0.924	0.924	10.2	123.2	O K
	30 min Summer	1.123	1.123	16.4	164.7	O K
	60 min Summer	1.300	1.300	16.7	207.0	O K
	120 min Summer	1.410	1.410	17.7	235.7	O K
	180 min Summer	1.438	1.438	18.0	243.6	O K
	240 min Summer	1.449	1.449	18.1	246.6	O K
	360 min Summer	1.441	1.441	18.0	244.4	O K
	480 min Summer	1.417	1.417	17.8	237.6	O K
	600 min Summer	1.387	1.387	17.5	229.7	O K
	720 min Summer	1.356	1.356	17.2	221.4	O K
	960 min Summer	1.292	1.292	16.6	205.0	O K
	1440 min Summer	1.161	1.161	16.5	173.3	O K
	2160 min Summer	1.029	1.029	15.7	144.2	O K
	2880 min Summer	0.971	0.971	12.4	132.4	O K
	4320 min Summer	0.783	0.783	9.2	97.4	O K
	5760 min Summer	0.598	0.598	8.1	67.6	O K
	7200 min Summer	0.436	0.436	7.5	45.2	O K
	8640 min Summer	0.213	0.213	7.5	19.5	O K
	10080 min Summer	0.141	0.141	7.2	12.4	O K
	15 min Winter	0.998	0.998	14.1	137.9	O K
	30 min Winter	1.218	1.218	16.6	186.6	O K
	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
	15 min Summer	120.271	0.0	130.7	18	
	30 min Summer	84.708	0.0	184.1	32	
	60 min Summer	57.005	0.0	247.9	62	
	120 min Summer	36.765	0.0	319.8	104	
	180 min Summer	27.818	0.0	362.9	136	
	240 min Summer	22.804	0.0	396.7	170	
	360 min Summer	17.174	0.0	448.2	240	
	480 min Summer	14.011	0.0	487.5	308	
	600 min Summer	11.950	0.0	519.7	378	
	720 min Summer	10.484	0.0	547.2	446	
	960 min Summer	8.516	0.0	592.6	578	
	1440 min Summer	6.334	0.0	661.1	824	
	2160 min Summer	4.694	0.0	735.1	1172	
	2880 min Summer	3.798	0.0	792.9	1584	
	4320 min Summer	2.820	0.0	883.3	2376	
	5760 min Summer	2.286	0.0	954.7	3112	
	7200 min Summer	1.945	0.0	1015.2	3888	
	8640 min Summer	1.706	0.0	1068.8	4416	
	10080 min Summer	1.529	0.0	1117.4	5128	
	15 min Winter	120.271	0.0	146.3	18	
	30 min Winter	84.708	0.0	206.2	32	
©1982-2017 XP Solutions						

Weetwood				Page 2	
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold					
Date 04/10/2017 11:10 File 2017-10-04 3886 Q0100cc...					
Designed by JamieEden Checked by					
Micro Drainage			Source Control 2017.1.2		
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	1.411	1.411	17.7	236.1	O K
120 min Winter	1.535	1.535	18.8	271.1	O K
180 min Winter	1.560	1.560	19.0	278.5	O K
240 min Winter	1.569	1.569	19.1	281.3	O K
360 min Winter	1.550	1.550	19.0	275.6	O K
480 min Winter	1.509	1.509	18.6	263.5	O K
600 min Winter	1.461	1.461	18.2	249.8	O K
720 min Winter	1.412	1.412	17.7	236.3	O K
960 min Winter	1.314	1.314	16.8	210.5	O K
1440 min Winter	1.122	1.122	16.4	164.4	O K
2160 min Winter	0.994	0.994	13.8	137.0	O K
2880 min Winter	0.912	0.912	9.9	120.9	O K
4320 min Winter	0.604	0.604	8.2	68.5	O K
5760 min Winter	0.206	0.206	7.5	18.8	O K
7200 min Winter	0.130	0.130	6.7	11.3	O K
8640 min Winter	0.115	0.115	5.8	10.0	O K
10080 min Winter	0.106	0.106	5.3	9.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	57.005	0.0	277.7	60	
120 min Winter	36.765	0.0	358.2	114	
180 min Winter	27.818	0.0	406.5	144	
240 min Winter	22.804	0.0	444.3	182	
360 min Winter	17.174	0.0	501.9	260	
480 min Winter	14.011	0.0	546.0	334	
600 min Winter	11.950	0.0	582.1	406	
720 min Winter	10.484	0.0	612.9	478	
960 min Winter	8.516	0.0	663.8	616	
1440 min Winter	6.334	0.0	740.5	852	
2160 min Winter	4.694	0.0	823.3	1212	
2880 min Winter	3.798	0.0	888.0	1700	
4320 min Winter	2.820	0.0	989.3	2460	
5760 min Winter	2.286	0.0	1069.3	3056	
7200 min Winter	1.945	0.0	1137.1	3664	
8640 min Winter	1.706	0.0	1197.0	4336	
10080 min Winter	1.529	0.0	1251.5	5120	
©1982-2017 XP Solutions					

Weetwood		Page 4
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold		
Date 04/10/2017 11:10 File 2017-10-04 3886 Q0100cc...	Designed by JamieEden Checked by	
Micro Drainage Source Control 2017.1.2		

Model Details

Storage is Online Cover Level (m) 1.600

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	81.0	1.400	270.4	1.600	306.5

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0134-7480-0500-7480
Design Head (m)	0.500
Design Flow (l/s)	7.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	134
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	7.5
Flush-Flo™	0.205	7.5
Kick-Flo®	0.384	6.6
Mean Flow over Head Range	-	6.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.8	1.200	11.3	3.000	17.5	7.000	26.3
0.200	7.5	1.400	12.1	3.500	18.8	7.500	27.2
0.300	7.2	1.600	12.9	4.000	20.0	8.000	28.1
0.400	6.7	1.800	13.7	4.500	21.2	8.500	29.0
0.500	7.5	2.000	14.4	5.000	22.3	9.000	29.8
0.600	8.1	2.200	15.0	5.500	23.3	9.500	30.6
0.800	9.3	2.400	15.7	6.000	24.3		
1.000	10.4	2.600	16.3	6.500	25.3		

©1982-2017 XP Solutions

Weetwood		Page 5																																																																																							
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold																																																																																									
Date 04/10/2017 11:10 File 2017-10-04 3886 Q0100cc...	Designed by JamieEden Checked by																																																																																								
Micro Drainage Source Control 2017.1.2																																																																																									
<u>Hydro-Brake® Optimum</u> Unit Reference MD-SHE-0117-5500-0495-5500 Design Head (m) 0.495 Design Flow (l/s) 5.5 Flush-Flo™ Calculated Objective Minimise upstream storage Application Surface Sump Available Yes Diameter (mm) 117 Invert Level (m) 0.905 Minimum Outlet Pipe Diameter (mm) 150 Suggested Manhole Diameter (mm) 1200 <table border="0"> <thead> <tr> <th>Control Points</th> <th>Head (m)</th> <th>Flow (l/s)</th> </tr> </thead> <tbody> <tr> <td>Design Point (Calculated)</td> <td>0.495</td> <td>5.5</td> </tr> <tr> <td>Flush-Flo™</td> <td>0.184</td> <td>5.5</td> </tr> <tr> <td>Kick-Flo®</td> <td>0.372</td> <td>4.8</td> </tr> <tr> <td>Mean Flow over Head Range</td> <td>-</td> <td>4.5</td> </tr> </tbody> </table> The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated <table border="1"> <thead> <tr> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> </tr> </thead> <tbody> <tr><td>0.100</td><td>4.1</td><td>1.200</td><td>8.3</td><td>3.000</td><td>12.8</td><td>7.000</td><td>19.3</td></tr> <tr><td>0.200</td><td>5.5</td><td>1.400</td><td>8.9</td><td>3.500</td><td>13.8</td><td>7.500</td><td>20.0</td></tr> <tr><td>0.300</td><td>5.3</td><td>1.600</td><td>9.5</td><td>4.000</td><td>14.7</td><td>8.000</td><td>20.7</td></tr> <tr><td>0.400</td><td>5.0</td><td>1.800</td><td>10.1</td><td>4.500</td><td>15.6</td><td>8.500</td><td>21.3</td></tr> <tr><td>0.500</td><td>5.5</td><td>2.000</td><td>10.6</td><td>5.000</td><td>16.3</td><td>9.000</td><td>21.9</td></tr> <tr><td>0.600</td><td>6.0</td><td>2.200</td><td>11.1</td><td>5.500</td><td>17.1</td><td>9.500</td><td>22.5</td></tr> <tr><td>0.800</td><td>6.9</td><td>2.400</td><td>11.5</td><td>6.000</td><td>17.9</td><td></td><td></td></tr> <tr><td>1.000</td><td>7.6</td><td>2.600</td><td>12.0</td><td>6.500</td><td>18.6</td><td></td><td></td></tr> </tbody> </table>			Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	0.495	5.5	Flush-Flo™	0.184	5.5	Kick-Flo®	0.372	4.8	Mean Flow over Head Range	-	4.5	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	4.1	1.200	8.3	3.000	12.8	7.000	19.3	0.200	5.5	1.400	8.9	3.500	13.8	7.500	20.0	0.300	5.3	1.600	9.5	4.000	14.7	8.000	20.7	0.400	5.0	1.800	10.1	4.500	15.6	8.500	21.3	0.500	5.5	2.000	10.6	5.000	16.3	9.000	21.9	0.600	6.0	2.200	11.1	5.500	17.1	9.500	22.5	0.800	6.9	2.400	11.5	6.000	17.9			1.000	7.6	2.600	12.0	6.500	18.6		
Control Points	Head (m)	Flow (l/s)																																																																																							
Design Point (Calculated)	0.495	5.5																																																																																							
Flush-Flo™	0.184	5.5																																																																																							
Kick-Flo®	0.372	4.8																																																																																							
Mean Flow over Head Range	-	4.5																																																																																							
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)																																																																																		
0.100	4.1	1.200	8.3	3.000	12.8	7.000	19.3																																																																																		
0.200	5.5	1.400	8.9	3.500	13.8	7.500	20.0																																																																																		
0.300	5.3	1.600	9.5	4.000	14.7	8.000	20.7																																																																																		
0.400	5.0	1.800	10.1	4.500	15.6	8.500	21.3																																																																																		
0.500	5.5	2.000	10.6	5.000	16.3	9.000	21.9																																																																																		
0.600	6.0	2.200	11.1	5.500	17.1	9.500	22.5																																																																																		
0.800	6.9	2.400	11.5	6.000	17.9																																																																																				
1.000	7.6	2.600	12.0	6.500	18.6																																																																																				
©1982-2017 XP Solutions																																																																																									



Development • Planning • Environment

Delivering client focussed services

Flood Risk Assessments
Flood Consequences Assessments
Surface Water Drainage
Foul Water Drainage
Environmental Impact Assessments
River Realignment and Restoration
Water Framework Directive Assessments
Flood Defence Consent Applications
Sequential, Justification and Exception Tests
Utility Assessments
Expert Witness and Planning Appeals
Discharge of Planning Conditions

www.weetwood.net