Drainage Assessment

Former Hickleton Colliery Site
Thurnscoe Business Park
Thurnscoe

December 2016

Issue 01









FAIRHURST

CONTROL SHEET

CLIENT: **Balmoral Group LTD.**

PROJECT TITLE: **Former Hickleton Colliery Site**

REPORT TITLE: **Drainage Assessment**

PROJECT REFERENCE: **116641**

DOCUMENT NUMBER: **116641 – DA01**

Issue & Approval Schedule	ISSUE 1 DRAFT	Name	Signature	Date
	Prepared by	A. Gray		20/12/2016
	Checked by	K. Thomson		20/12/2016
	Approved by	A. Scott-Kidde		20/12/2016

Revision Record	Rev.	Date	Status	Description	Signature	
	1				By	
					Checked	
					Approved	
	2				By	
					Checked	
					Approved	

This document has been prepared in accordance with procedure OP/P02 of the *Fairhurst Quality and Environmental Management System*

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Drainage Assessment

The Development Proposal

The client; Balmoral Group, proposes to develop a new office/workshop building, with associated yard and car parking.

The 2.81 Ha site is located on Barrowfield Road at OS Ref: SE 46361 05244, and is bounded to the north by Barrowfield Road and to the east, west and south by existing greenfield land.

For details of the Drainage Layout and Site Location Plan, refer to Appendix A – Drawing Nos. 116641/2001 & 9500.

Existing Drainage

There are existing foul sewers within Barrowfield Road, to the North of the site.

There is an existing watercourse to the south of the site flowing to the West.

Any existing private drainage with the site is to be removed/abandoned as required.

Foul Drainage

Foul discharge from the office building will drain to new gravity drains, which will discharge into the existing foul sewer via a disconnection chamber

Trade effluent from the workshop will drain to new gravity drains alongside the building. The new drains will discharge to a full retention separator. The separator will discharge into the new foul drains to the sewer.

For details of the drainage layout, refer to Appendix A – Drawing No. 116641/2001.

Surface Water Drainage

Referring to The SUDS Manual (CIRIA C753), the surface water run-off will be dealt with as follows:-

Building

Surface water run-off from the building roof area will drain via downpipes to the new gravity drains, which in turn drain into the stone filled trenches along the perimeter of the yard, providing one level of treatment.

The stone filled trenches will discharge into the attenuation tank.

Yard

Surface water run-off from the yard area will shed to the stone filled trenches along the perimeter of the yard, providing one level of surface water treatment. The stone filled trenches will discharge into the attenuation tank.

Car Parking Area

Surface water run-off from the car parking area will shed to porous paving, which will discharge to the stone filled trench beneath, providing two levels of treatment. The stone filled trench will discharge into the attenuation tank.

Surface water run-off from the site access will shed to a drainage channel and gullies, which will discharge via new gravity drains into the stone filled trench, providing one level of treatment.

The cellular storage attenuation tank & basin sit at the same invert level, and are connected by a 300mm Ø pipe. Flows will pass through the basin, providing a further level of treatment. The cellular storage will act as additional attenuation volume.

For details of the drainage layout, refer to Appendix A – Drawing No. 116641/2001.

Hydraulic Control

The rate and volume of surface water run-off from the post development situation will not exceed the surface water run-off from the existing greenfield site. As such, surface water discharge from the site will be restricted to 9.9 l/second during the critical 10 year rainfall event.

Attenuation volume will be provided within the linked cellular storage tank & basin. The basin and cellular storage are set at the same invert level to provide the required storage volume.

The attenuation measures will contain the run-off volume generated by the critical 200 year return period rainfall event.

As part of the detailed drainage design for each of the development areas, sensitivity tests to assess flood risk from the drainage system will be carried out for rainfall events up to and including the 200 year, plus climate change, rainfall return event. Site levels will be set in order to prevent water entering buildings or restricting access for emergency vehicles.

Maintenance

- All drainage within the site will be owned and maintained by the site factor in accordance with the maintenance regime.

Construction Phase SUDS

A method statement, detailing how surface water arising during construction will be dealt with, will be prepared by the contractor for approval prior to commencement of works on site.

During the development of the site a surface water management strategy will be prepared for each individual construction phase. This strategy will be submitted to the Planning Authority for their approval prior to the commencement of works.

The surface water management strategy will be based on the Contractor's Method Statement and will incorporate the following measures to prevent the surface water run-off from the construction works discharging direct to the watercourses.

- Localised interception of surface water run-off. Temporary ditches or channels around the area of works would provide this. Check dams or silt traps can be provided to encourage the settlement of silt.
- Surface water settlement and filtration. Temporary settlement ponds will be formed and water intercepted at the construction area will be directed to these where it will be retained to allow silt suspended in the run-off to settle. A high level outlet will be formed from the settlement pond to allow treated run-off to discharge to the watercourse. Additional protection could be provided by placing straw bales in the high level outlet so that all flows pass through these before entering the watercourse.
- Protection of permanent drainage system. Surface water run-off from construction areas will, where practicable, not be drained to the permanent drainage system. This will prevent silt and other construction debris from building up in the system. Where the use of the permanent system cannot be avoided then the system will need to be thoroughly cleaned on the completion of the construction phase.

Appendix A - Drawings

- 116641/2001 Drainage Layout
- 116641/9500 Site Location Plan

Do not scale from this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARD/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING RISKS AND INFORMATION.

RISKS LISTED HERE ARE NOT EXHAUSTIVE. REFER TO DESIGN ASSESSMENT FORM NO.

CONSTRUCTION

WORKS TO BE CARRIED OUT ADJACENT TO EXISTING MINESHAFT & WATERCOURSE.

WORKS TO BE CARRIED OUT IN BARROWFIELD ROAD.

FOR INFORMATION RELATING TO USE, CLEANING AND MAINTENANCE SEE THE HEALTH AND SAFETY FILE

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.

N

BARROWFIELD ROAD

THE WINDINGS

Power Station

EX FOUL SEWER

SURFACE WATER DISCHARGE RATE TO BE RESTRICTED TO 9.9 l/sec DURING THE CRITICAL 10 YEAR RAINFALL EVENT BY A HYROBRAKE WITHIN THE OUTLET CONTROL MANHOLE

CELLULAR STORAGE ATTENUATION TANK 655m³ x 0.4 m DEEP

FFL: 50.00

REQUIREMENT FOR COMMERCIAL FOUL DRAINAGE TO BE CONFIRMED BY CLIENT

EX. MINESHAFT

OUTLET IL: 46.8 Drain

Phoenix Park

LEGEND

- FOUL DRAIN
- SURFACE WATER DRAIN
- INSPECTION CHAMBER (450/600 ø)
- MANHOLE (1200 ø)
- EX. FOUL SEWER
- GULLEY
- DRAINAGE CHANNEL
- PROPOSED POROUS PAVING
- PROPOSED FILTER TRENCH WITH PERFORATED PIPE AT INVERT
- PROPOSED CELLULAR STORAGE TANK

Rev.	Date	Description	Drawn	Checked	Approved

Notes:

1. 150mm diameter sewer connections to be:–

   PVC Structured Wall Gravity Sewer Pipes with manufacturer's flexible joints and comply with the relevant provisions of BS EN 1401–1 (Stiffness Classification SN8) and WIS 4–35–01. or
   Vitrified Clay pipes with manufacturer's flexible joints and comply with the relevant requirements of BS EN 295.

2. All other pipes to be PVC Plain Wall with manufacturer's flexible joints and comply with the relevant provisions of BS EN 1401–1 (Stiffness Classification SN4).

3. All access points and chambers to be in accordance with the relevant provisions of BS EN 752:2008. Disconnection and inspection chambers to have lockable covers.

4. Precast concrete chambers to be in accordance with Table NA.22 of BS EN 752:2008.

   INSPECTION CHAMBER COVER NOTES
   ALL INSPECTION CHAMBERS LOCATED WITHIN TRAFFICABLE AREAS ARE TO BE FITTED WITH A HEAVY DUTY CHAMBER COVER.

   ALL MANHOLE OR INSPECTION CHAMBER COVERS ARE TO BE ORIENTATED PERPENDICULAR TO THE KERB LINES OR BUILDING LINES. WHERE COVERS ARE LOCATED WITHIN AREAS OF HARD, SQUARE OR RECTANGULAR COVERS ARE TO BE USED, ROUND COVERS ARE TO ONLY BE INSTALLED WITHIN AREAS OF SOFT LANDSCAPING

INVERT LEVEL OF WATER COURSE TIE IN & EXISTING FOUL SEWER TO BE CONFIRMED AS PART OF DETAILED DESIGN.

Client: BALMORAL www.balmoral-group.com

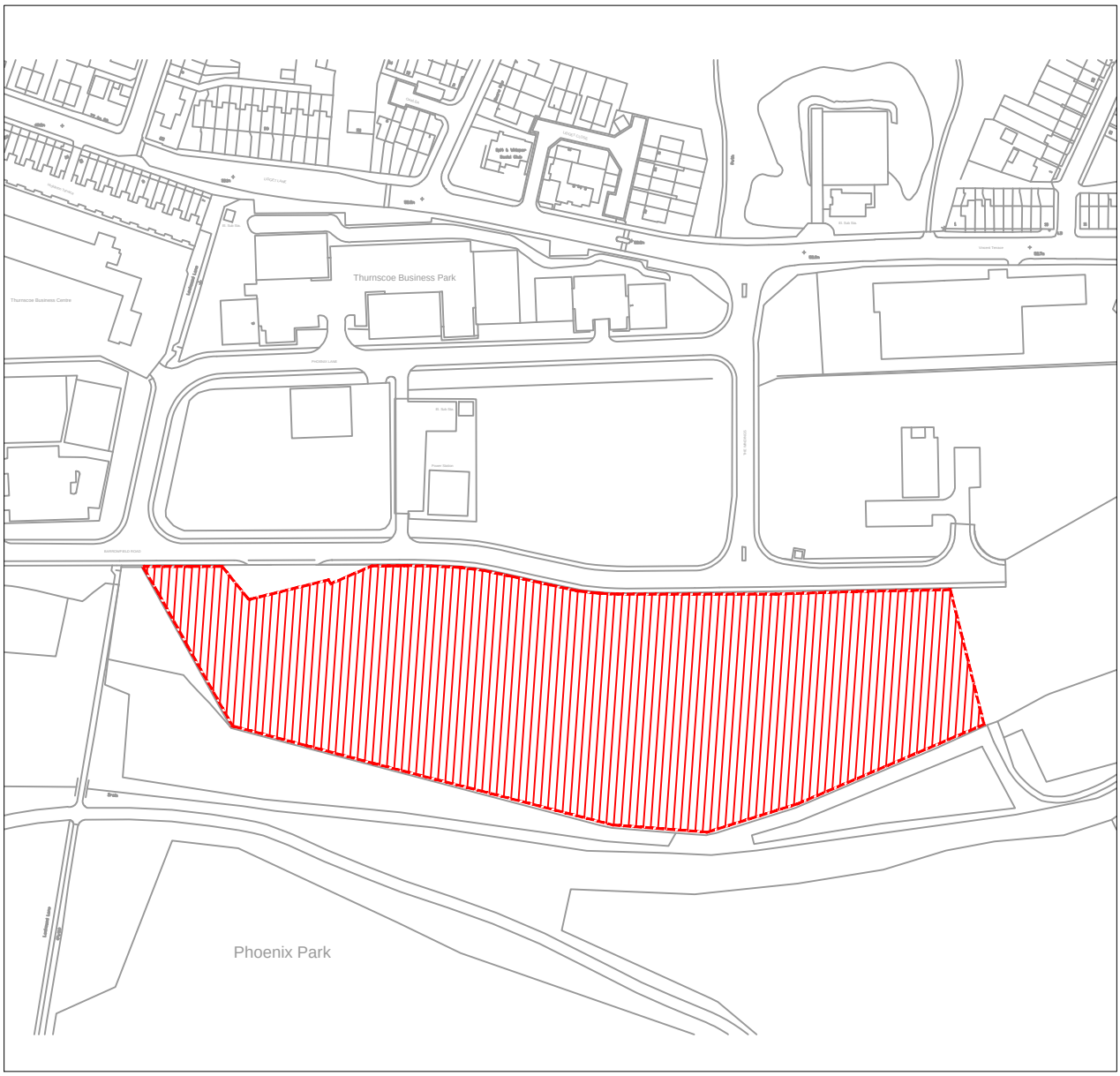
Project Title: HICKLETON COLLIERY SITE, THURNSCOE, BARNSLEY, SOUTH YORKSHIRE

Drawing Title: DRAINAGE LAYOUT

FAIRHURST
88 Queens Rood,
ABERDEEN, AB15 4YQ
Tel: 01224 321 222 Fax: 01224 323 201

Scale at A1:	Status:	
1:500	For Approval	
Drawn: AG	Checked: AM	Approved: ASK
Date: 15/12/16	Date: 15/12/16	Date: 15/12/16
Drawing No.: 116641/2001		Revision: –

Do not scale from this drawing.



OS GRID REFERENCE - SE 46361 05244

Rev.	Date	Description	Drawn	Checked	Approved

Project Title:
HICKLETON COLLIERY SITE,
THURNSCOE, BARNSLEY,
SOUTH YORKSHIRE

Drawing Title:
LOCATION PLAN

FAIRHURST
88 Queens Road,
ABERDEEN, AB15 4YQ
Tel: 01224 321 222 Fax: 01224 323 201

Scale at A4:	Status:		
NTS	For Information		
Drawn:	Checked:	Approved:	
AG			
Date:	Date:	Date:	
20/12/16			
Drawing No.:			Revision:
116641/9500			–

Appendix B - Calculations

- Greenfield Run-off Calculation
- Basin/Cellular Storage 10 Yr
- Basin/Cellular Storage 30 Yr
- Basin/Cellular Storage 200 Yr

FAIRHURST

CALCULATION SHEET

CONSULTING STRUCTURAL AND CIVIL ENGINEERS	**PROJECT**	**JOB No.**	116641	**Calculated by**	A. Gray
Former hickleton Colliery Site **Thurnscoe Business Park** **Thurnscoe**		**SHEET No.**	1	**Checked by**	K. Thomson
Pre-development Run-off per Hectare Calculation		**DATE**	12/12/16		

To establish Winter Rain Acceptance Potential (WRAP) for site from site investigation results

From FSR Clause 4

A Drainage group: *Commonly waterlogged. Assume Class 2.*

B Depth to impermeable layers: *Maximum 800mm. Assume Class 2.*

C Permeability group: *Assume medium permeability. Class 2.*

D Slope: *Majority flatter than 1 in 7. Assume Class 2.*

From Table 4.5 of FSR a WRAP of **4** is obtained.

Establish Pre-development Peak Surface Water Run-off for 50 hectares

The following formula is used to calculate the peak flow in m^3/s ;-

$Q_{BARrural(50ha)} = 0.00108 \times Area^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

where, AREA is the Gross Area in km^2 = 50.000 ha / 100 = 0.50000 km2
SAAR for Aberdeen = 650
SOIL is factor for WRAP value. For WRAP of 4 , SOIL is 0.45

$Q_{BARrural(50ha)} = 0.00108 \times 0.50000^{0.89} \times 650^{1.17} \times 0.45^{2.17}$

$= 0.00108 \times 0.53961 \times 1954.83 \times 0.17680$

$= 0.20142\ m^3/s$

$= \mathbf{201.42\ l/s}$

Gross Site Area = 1.000 ha

Peak flow from gross site area = 201.42 l/s / 50 ha x 1.000 ha = **4.03 l/s**

Apply Regional Growth Factors from Table 1(2.39) of FSSR 14

Site is in Region 1 (Fig. 2.4), therefore Factors are:

10 year event is 1.45, therefore 10 year pre-development Run-off	=	4.03	x	1.45	**=**	**5.84 l/s**
30 year event is 1.90, therefore 30 year pre-development Run-off	=	4.03	x	1.90	**=**	**7.66 l/s**
100 year event is 2.60, therefore 100 year pre-development Run-off	=	4.03	x	2.60	**=**	**10.48 l/s**
200 year event is 2.81, therefore 200 year pre-development Run-off	=	4.03	x	2.81	**=**	**11.32 l/s**

Summary of Results for 10 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	48.116	0.266	9.9	0.0	9.9	228.4	O K
30 min Winter	48.189	0.339	9.9	0.0	9.9	294.1	O K
60 min Winter	48.259	0.409	9.9	0.0	9.9	358.7	O K
120 min Winter	48.327	0.477	9.9	0.0	9.9	415.9	O K
180 min Winter	48.359	0.509	9.9	0.0	9.9	440.8	O K
240 min Winter	48.374	0.524	9.9	0.0	9.9	452.0	O K
360 min Winter	48.379	0.529	9.9	0.0	9.9	455.5	O K
480 min Winter	48.368	0.518	9.9	0.0	9.9	447.6	O K
600 min Winter	48.353	0.503	9.9	0.0	9.9	436.9	O K
720 min Winter	48.340	0.490	9.9	0.0	9.9	426.5	O K
960 min Winter	48.310	0.460	9.9	0.0	9.9	402.7	O K
1440 min Winter	48.251	0.401	9.9	0.0	9.9	351.0	O K
2160 min Winter	48.154	0.304	9.9	0.0	9.9	262.7	O K
2880 min Winter	48.067	0.217	9.9	0.0	9.9	185.3	O K
4320 min Winter	47.944	0.094	9.8	0.0	9.8	78.9	O K
5760 min Winter	47.897	0.047	8.9	0.0	8.9	39.1	O K
7200 min Winter	47.878	0.028	7.7	0.0	7.7	23.5	O K
8640 min Winter	47.866	0.016	6.8	0.0	6.8	13.4	O K
10080 min Winter	47.858	0.008	6.0	0.0	6.0	6.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	66.641	0.0	237.4	0.0	22
30 min Winter	43.554	0.0	310.6	0.0	37
60 min Winter	27.350	0.0	389.8	0.0	66
120 min Winter	16.756	0.0	477.9	0.0	124
180 min Winter	12.482	0.0	534.1	0.0	182
240 min Winter	10.100	0.0	576.4	0.0	238
360 min Winter	7.474	0.0	639.9	0.0	348
480 min Winter	6.034	0.0	688.6	0.0	452
600 min Winter	5.108	0.0	728.9	0.0	486
720 min Winter	4.457	0.0	763.6	0.0	562
960 min Winter	3.592	0.0	820.6	0.0	718
1440 min Winter	2.649	0.0	907.8	0.0	1028
2160 min Winter	1.952	0.0	1003.4	0.0	1436
2880 min Winter	1.571	0.0	1076.6	0.0	1816
4320 min Winter	1.157	0.0	1188.8	0.0	2468
5760 min Winter	0.930	0.0	1274.9	0.0	3056
7200 min Winter	0.786	0.0	1345.7	0.0	3752
8640 min Winter	0.684	0.0	1406.1	0.0	4488
10080 min Winter	0.609	0.0	1459.6	0.0	5144

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.372	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.700

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	1.700

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Model Details

Storage is Online Cover Level (m) 49.050

Tank or Pond Structure

Invert Level (m) 47.850

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	828.0	2.400	0.0	4.800	0.0	7.200	0.0	9.600	0.0
0.400	923.0	2.800	0.0	5.200	0.0	7.600	0.0	10.000	0.0
0.800	376.0	3.200	0.0	5.600	0.0	8.000	0.0		
1.200	508.0	3.600	0.0	6.000	0.0	8.400	0.0		
1.600	0.0	4.000	0.0	6.400	0.0	8.800	0.0		
2.000	0.0	4.400	0.0	6.800	0.0	9.200	0.0		

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0150-9900-0630-9900
Design Head (m)	0.630
Design Flow (l/s)	9.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	150
Invert Level (m)	47.750
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.630	9.9	Kick-Flo®	0.471	8.6
Flush-Flo™	0.236	9.9	Mean Flow over Head Range	-	8.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.800	11.1	2.000	17.1	4.000	23.8	7.000	31.1
0.200	9.8	1.000	12.3	2.200	17.9	4.500	25.2	7.500	32.2
0.300	9.8	1.200	13.4	2.400	18.6	5.000	26.5	8.000	33.3
0.400	9.4	1.400	14.4	2.600	19.4	5.500	27.8	8.500	34.3
0.500	8.9	1.600	15.4	3.000	20.7	6.000	29.0	9.000	35.3
0.600	9.7	1.800	16.3	3.500	22.3	6.500	29.9	9.500	36.3

Pipe Overflow Control

Diameter (m)	0.225	Roughness k (mm)	0.600	Upstream Invert Level (m)	48.620
Slope (1:X)	200.0	Entry Loss Coefficient	0.500		
Length (m)	2.000	Coefficient of Contraction	0.600		

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Summary of Results for 30 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	48.186	0.336	9.9	0.0	9.9	291.5	O K
30 min Winter	48.283	0.433	9.9	0.0	9.9	379.9	O K
60 min Winter	48.396	0.546	10.0	0.0	10.0	467.5	O K
120 min Winter	48.528	0.678	10.9	0.0	10.9	547.3	O K
180 min Winter	48.604	0.754	11.4	0.0	11.4	583.1	O K
240 min Winter	48.645	0.795	11.7	0.5	12.2	599.8	O K
360 min Winter	48.663	0.813	11.8	1.3	13.1	606.5	O K
480 min Winter	48.649	0.799	11.7	0.7	12.3	601.3	O K
600 min Winter	48.624	0.774	11.5	0.0	11.5	591.4	O K
720 min Winter	48.600	0.750	11.4	0.0	11.4	581.4	O K
960 min Winter	48.548	0.698	11.1	0.0	11.1	557.8	O K
1440 min Winter	48.453	0.603	10.4	0.0	10.4	505.0	O K
2160 min Winter	48.339	0.489	9.9	0.0	9.9	426.1	O K
2880 min Winter	48.245	0.395	9.9	0.0	9.9	345.6	O K
4320 min Winter	48.061	0.211	9.9	0.0	9.9	180.2	O K
5760 min Winter	47.947	0.097	9.8	0.0	9.8	81.1	O K
7200 min Winter	47.901	0.051	9.2	0.0	9.2	42.2	O K
8640 min Winter	47.883	0.033	8.0	0.0	8.0	27.8	O K
10080 min Winter	47.872	0.022	7.2	0.0	7.2	17.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	84.323	0.0	300.7	0.0	23
30 min Winter	55.582	0.0	396.4	0.0	37
60 min Winter	35.085	0.0	500.1	0.0	66
120 min Winter	21.510	0.0	613.7	0.0	124
180 min Winter	15.985	0.0	684.0	0.0	182
240 min Winter	12.891	0.0	736.1	0.6	238
360 min Winter	9.482	0.0	812.2	3.6	348
480 min Winter	7.625	0.0	870.9	2.8	452
600 min Winter	6.435	0.0	918.4	0.0	500
720 min Winter	5.599	0.0	959.1	0.0	570
960 min Winter	4.493	0.0	1026.4	0.0	726
1440 min Winter	3.291	0.0	1127.7	0.0	1042
2160 min Winter	2.408	0.0	1237.2	0.0	1496
2880 min Winter	1.927	0.0	1320.6	0.0	1936
4320 min Winter	1.407	0.0	1445.8	0.0	2640
5760 min Winter	1.124	0.0	1541.0	0.0	3232
7200 min Winter	0.945	0.0	1618.6	0.0	3752
8640 min Winter	0.819	0.0	1684.0	0.0	4496
10080 min Winter	0.726	0.0	1741.3	0.0	5152

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.372	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.700

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	1.700

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Model Details

Storage is Online Cover Level (m) 49.050

Tank or Pond Structure

Invert Level (m) 47.850

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	828.0	2.400	0.0	4.800	0.0	7.200	0.0	9.600	0.0
0.400	923.0	2.800	0.0	5.200	0.0	7.600	0.0	10.000	0.0
0.800	376.0	3.200	0.0	5.600	0.0	8.000	0.0		
1.200	508.0	3.600	0.0	6.000	0.0	8.400	0.0		
1.600	0.0	4.000	0.0	6.400	0.0	8.800	0.0		
2.000	0.0	4.400	0.0	6.800	0.0	9.200	0.0		

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0150-9900-0630-9900
Design Head (m)	0.630
Design Flow (l/s)	9.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	150
Invert Level (m)	47.750
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.630	9.9	Kick-Flo®	0.471	8.6
Flush-Flo™	0.236	9.9	Mean Flow over Head Range	-	8.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.800	11.1	2.000	17.1	4.000	23.8	7.000	31.1
0.200	9.8	1.000	12.3	2.200	17.9	4.500	25.2	7.500	32.2
0.300	9.8	1.200	13.4	2.400	18.6	5.000	26.5	8.000	33.3
0.400	9.4	1.400	14.4	2.600	19.4	5.500	27.8	8.500	34.3
0.500	8.9	1.600	15.4	3.000	20.7	6.000	29.0	9.000	35.3
0.600	9.7	1.800	16.3	3.500	22.3	6.500	29.9	9.500	36.3

Pipe Overflow Control

Diameter (m)	0.225	Roughness k (mm)	0.600	Upstream Invert Level (m)	48.620
Slope (1:X)	200.0	Entry Loss Coefficient	0.500		
Length (m)	2.000	Coefficient of Contraction	0.600		

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Summary of Results for 200 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	48.361	0.511	9.9	0.0	9.9	442.2	O K
30 min Winter	48.610	0.760	11.5	0.0	11.5	586.0	O K
60 min Winter	48.905	1.055	13.2	35.5	48.6	708.1	O K
120 min Winter	49.002	1.152	13.7	54.7	68.4	753.8	O K
180 min Winter	49.037	1.187	13.9	58.3	72.1	771.2	O K
240 min Winter	49.038	1.188	13.9	58.4	72.3	772.1	O K
360 min Winter	49.012	1.162	13.7	55.8	69.6	758.8	O K
480 min Winter	48.983	1.133	13.6	51.5	65.1	744.6	O K
600 min Winter	48.956	1.106	13.4	46.6	60.1	731.7	O K
720 min Winter	48.933	1.083	13.3	42.0	55.3	720.9	O K
960 min Winter	48.899	1.049	13.1	33.8	46.9	705.0	O K
1440 min Winter	48.860	1.010	12.9	21.0	34.0	687.5	O K
2160 min Winter	48.780	0.930	12.5	10.2	22.7	653.3	O K
2880 min Winter	48.708	0.858	12.0	4.8	16.8	624.2	O K
4320 min Winter	48.464	0.614	10.5	0.0	10.5	511.7	O K
5760 min Winter	48.268	0.418	9.9	0.0	9.9	366.7	O K
7200 min Winter	48.082	0.232	9.9	0.0	9.9	198.8	O K
8640 min Winter	47.966	0.116	9.9	0.0	9.9	98.0	O K
10080 min Winter	47.909	0.059	9.6	0.0	9.6	49.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	126.602	0.0	451.7	0.0	23
30 min Winter	84.689	0.0	604.3	0.0	37
60 min Winter	53.940	0.0	769.7	71.0	64
120 min Winter	33.111	0.0	945.4	199.7	100
180 min Winter	24.504	0.0	1049.3	269.5	136
240 min Winter	19.645	0.0	1121.6	309.9	174
360 min Winter	14.301	0.0	1225.2	346.3	244
480 min Winter	11.423	0.0	1304.6	363.4	314
600 min Winter	9.587	0.0	1368.9	367.2	382
720 min Winter	8.304	0.0	1422.4	360.9	450
960 min Winter	6.613	0.0	1510.3	330.1	584
1440 min Winter	4.788	0.0	1640.7	252.9	872
2160 min Winter	3.458	0.0	1777.4	153.1	1344
2880 min Winter	2.742	0.0	1879.3	61.3	1820
4320 min Winter	1.973	0.0	2028.3	0.0	2812
5760 min Winter	1.560	0.0	2137.7	0.0	3688
7200 min Winter	1.299	0.0	2225.7	0.0	4256
8640 min Winter	1.118	0.0	2299.0	0.0	4840
10080 min Winter	0.985	0.0	2362.0	0.0	5248

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.372	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.700

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	1.700

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Model Details

Storage is Online Cover Level (m) 49.050

Tank or Pond Structure

Invert Level (m) 47.850

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	828.0	2.400	0.0	4.800	0.0	7.200	0.0	9.600	0.0
0.400	923.0	2.800	0.0	5.200	0.0	7.600	0.0	10.000	0.0
0.800	376.0	3.200	0.0	5.600	0.0	8.000	0.0		
1.200	508.0	3.600	0.0	6.000	0.0	8.400	0.0		
1.600	0.0	4.000	0.0	6.400	0.0	8.800	0.0		
2.000	0.0	4.400	0.0	6.800	0.0	9.200	0.0		

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0150-9900-0630-9900
Design Head (m)	0.630
Design Flow (l/s)	9.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	150
Invert Level (m)	47.750
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.630	9.9	Kick-Flo®	0.471	8.6
Flush-Flo™	0.236	9.9	Mean Flow over Head Range	-	8.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
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