Peace Wood Quarry, Huddersfield

Drainage Strategy

December 2022

Waterco

Assessment | Modelling | Design

Project Information	
Project:	Peace Wood Quarry, Huddersfield
Report Title:	Drainage Strategy
Client:	The Mineral Planning Group Ltd
Instruction:	The instruction to undertake this Drainage Strategy was received from Sheena Peat of The Mineral Planning Group Ltd.
File Ref:	14760-Drainage Strategy-02

Approval Record	
Author:	Megan Williams BSc (Hons)
Checker:	Jordan Jones BSc (Hons) MCIWEM
Approver:	Alun Roberts BEng (Hons) CEng MICE

Document History		
Revision	**Date**	**Comment**
01	30/06/2022	First issue
02	21/12/2022	Second issue – Updated with new development proposals

This report will remain valid for a period of twelve months (from the date of last issue) after which the source data should be reviewed in order to reassess the findings and conclusions on the basis of latest available information.

Contents

Appendices

Introduction

Waterco has been commissioned to undertake a Drainage Strategy in relation to a proposed clay quarry extension at Peace Wood Quarry, Huddersfield, HD8 8LH.

The aim of this Drainage Strategy is to identify water management measures to ensure the quarry void remains operational (flood free) during the 1 in 30 year plus 25% Climate Change storm event whilst ensuring flood risk elsewhere is not increased.

Existing Conditions

The site covers an area of approximately 2.31 hectares (ha) and is located at National Grid Reference (NGR): 421674, 411233. A location plan and an aerial image are included in Appendix A.

Online mapping (including Google Maps / Google Streetview imagery, accessed December 2022) shows that the site comprises agricultural land intersected by an existing access road to Peace Wood Quarry. The site is bordered by Peace Wood Quarry to the north, agricultural land and residential properties to the east, Huddersfield Road to the south and agricultural land to the west. Access to the site is provided from Huddersfield Road (B6116) to the south.

Local Topography

Topographic levels to metres Above Ordnance Datum (m AOD) have been derived from a 1m resolution Environment Agency (EA) composite 'Light Detecting and Ranging' (LiDAR) Digital Terrain Model (DTM). A review of LiDAR data shows that the site slopes from approximately 202m AOD in the north-west to approximately 191m AOD in the east. A LiDAR extract is included in Appendix B.

Ground Conditions

Published Geology

The British Geological Survey (BGS) online mapping (1:50,000 scale) indicates that the site is underlain by the Penistone Flags geological unit which forms part of the Pennine Lower Coal Measures Formation consisting of mudstone, siltstone and sandstone.

The geological mapping is available at a scale of 1:50,000 and as such may not be accurate on a site-specific basis.

Hydrogeology

According to the EA's Aquifer Designation data, obtained from MAGIC's online mapping [accessed December 2022], the Pennine Lower Coal Measures Formation is classified as a Secondary A Aquifer.

Secondary A Aquifers are 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers'.

The EA's 'Source Protection Zones' data, obtained from MAGIC's online mapping [accessed December 2022], indicates that the site is not located within a Groundwater Source Protection Zone.

The Cranfield University 'Soilscapes' map [accessed December 2022] indicates that the site is underlain by '*Freely draining slightly acid loamy soils'*

Site Investigations

A Phase 2 Ground Investigation Report has been produced by Wardell Armstrong in November 2018 (reference: ST15986/RPT-002/Final). Site investigations comprised 3no. rotary cored boreholes (BH4-6) advanced to a maximum depth of 15.3m.bgl and 1no. groundwater monitoring standpipe. The ground conditions identified were generally consistent across all boreholes and comprised clay, sandstone and mudstone. Siltstone was also identified within BH5 at approximately 8m.bgl.

Groundwater was recorded in the upper sandstone layer within BH5. A borehole location plan is included in Appendix C for reference.

Development Proposals

The proposed development is for a clay quarry extension. Site operations will be consistent with the existing quarry, which includes clay extraction followed by infilling with engineering material prior to restoration to agricultural pasture.

The quarry is divided into 2no. development phases. The Phase 1 extraction area covers 4,194m^2 and Phase 2 extraction area covers 6,066m^2.

Information from the Client suggests that proposed quarry excavations will reach a maximum depth of 15m.bgl.

Proposed development plans are included Appendix D.

Planning Policy

The Kirklees Council Local Plan (adopted February 2019) contains the following policies relating to drainage:

'Policy LP28 - Drainage

The presumption is that Sustainable Drainage Systems (SuDS) will be used to assist in achieving the following on each site:

a. for proposals on greenfield sites, typical greenfield run-off rates should not be exceeded;

b. for proposals on brownfield sites there should be a minimum 30% reduction in surface water run-off where previous positive surface water connections from the site can be proven. New connections will be subject to

at least greenfield restrictions;

c. No negative impact on local water quality and improvements in water quality where practicable;

d. Consider whether proposed open spaces and green infrastructure within sites can contribute to the sustainable drainage of the site'.

Consultation

A consultation request was submitted to the Lead Local Flood Authority in June 2022. A response is awaited.

Surface Water Management

The proposed development is for a quarry extension. Proposals include clay extraction and infilling with engineering material prior to restoration.

Surface water runoff from the existing Peace Wood Quarry, north of the site, is served by a drainage ditch which conveys flows to a series of ponds including attenuation and sediment settlement ponds. Outfall from the ponds is made to Baildon Dike north of Peace Wood Quarry. A surface water drainage plan of the existing quarry is included in Appendix E.

The proposed drainage scheme will emulate the existing drainage system and will comprise:

- Ditch(es) to collect runoff.
- A pumped system will collect runoff from the ditches and direct it to an attenuation pond, which will be sized to accommodate the 1 in 30 year plus 25% CC storm event. A new attenuation pond will be provided, or alternatively, where possible, the existing attenuation pond serving Peace Wood Quarry will be utilised and modified to serve the development.
- Storm events in excess of the 1 in 30 year plus 25% CC storm event (i.e 1 in 100 year) will be permitted to produce temporary shallow depth flooding within the quarry void.
- The attenuation pond will discharge at a limited greenfield rate (via a flow control device) to a settlement pond. A new settlement pond will be provided, or alternatively, where possible, the existing settlement pond serving Peace Wood Quarry will be utilised and modified to serve the development.
- The settlement pond will discharge to Baildon Dike.

This Drainage Strategy sets out the size of each element of the surface water management system.

Runoff Rates

In order to inform the limited discharge rate and sizes of the proposed ditch(es), greenfield runoff rates have been estimated using the ICP SUDS method within MicroDrainage. A summary of the greenfield runoff rates for a range of events is provided as Appendix F.

Phase 1

The 1 in 1 year greenfield runoff rate for the extraction area is 0.9 l/s. The 1 in 30 year greenfield runoff rate is 1.8 l/s. The 1 in 100 year greenfield runoff rate is 2.2 l/s.

Phase 1 & 2

The 1 in 1 year greenfield runoff rate for the extraction area is 2.2 l/s. The 1 in 30 year greenfield runoff rate is 4.3 l/s. Th 1 in 100 year greenfield runoff rate is 5.3 l/s.

Sizing of the ditches

Drainage ditches will be placed at the perimeter of the quarry void to convey runoff to a sump point which will pump runoff to an attenuation pond outside of the quarry void. The drainage ditches will be sized to accommodate peak flows during the 1 in 30 year plus 25% climate change event.

The size of the drainage ditches has been estimated using the Chezy-Manning formula. The ditch sizing calculations are provided as Appendix G. The ditch(es) should be sized to accommodate 2.25 l/s during Phase 1 and 5.38 l/s during Phase 1 & 2.

Phase 1

The 1 in 30 year greenfield runoff rate is 1.8 l/s. With 25% climate change (CC) applied, the runoff rate is estimated at 2.25 l/s.

The ditch(es) will be excavated as open trapezoidal channels. A 0.3m deep ditch with a minimum base width of 0.1m, a top width of 0.7m and 1:1 side-slopes will accommodate up to 143.4 l/s. A manning's coefficient of 0.029 has been used to represent a clean, straight, full stage natural channel with no pooling. A minimum ditch gradient of 1 in 52.86 has been utilised in the calculations, based on proposed site levels and gradients.

Phase 1 & 2

The 1 in 30 year greenfield runoff rate is 4.3 l/s. With 25% climate change (CC) applied, the runoff rate is estimated at 5.38 l/s.

The ditch(es) will be excavated as open trapezoidal channels. A 0.3m deep ditch with a minimum base width of 0.1m, a top width of 0.7m and 1:1 side-slopes will accommodate up to 181.5 l/s. A manning's coefficient of 0.029 has been used to represent a clean, straight, full stage natural channel with no pooling. A minimum ditch gradient of 1 in 33 has been utilised in the calculations, based on proposed site levels and gradients.

Sizing of the attenuation pond

The attenuation pond has been sized using MicroDrainage. MicroDrainage storage estimates for the 1 in 30 year plus 25% CC storm event and 1 in 100 year plus 25% CC storm event are included in Appendix H.

A coefficient value of 0.75 has been utilised within the attenuation storage estimate and represents 75% of all rainfall falling within the quarry void entering the ditches and subsequently the attenuation pond. The remaining 25% of rainfall will be lost through limited infiltration and evaporation.

Phase 1

The Phase 1 extraction area covers 4,194m^2.

The 1 in 1 year greenfield runoff rate was estimated at 0.9 l/s which is insufficient to ensure a self-cleansing drainage system. As such, the QBAR rate has been utilised.

Based on a limited discharge rate of 1 l/s (equivalent to QBAR rate), an estimated storage volume of 268.4m^3 will be required to accommodate the 1 in 30 year plus 25% CC event. An estimated storage volume of 369.2m^3 will be required to accommodate the 1 in 100 year plus 25% CC event.

Attenuation is sized to accommodate the 1 in 30 year plus 25% CC storm event. Storm events in excess of the 1 in 30 year plus 25% CC storm event will be permitted to produce temporary shallow depth flooding within the quarry void. During the 1 in 100 year plus 25% CC storm event, 100.8m^3 of flood storage is required within the quarry void.

Phase 1 & 2

The Phase 1 & 2 extraction area covers 10,260m^2.

Based on a limited discharge rate of 2.2 l/s (equivalent to the 1 in 1 year greenfield runoff rate), an estimated storage volume of 677.3m^3 will be required to accommodate the 1 in 30 year plus 25% CC event. An estimated storage volume of 928.9m^3 will be required to accommodate the 1 in 100 year plus 25% CC event.

Attenuation is sized to accommodate the 1 in 30 year plus 25% CC storm event. Storm events in excess of the 1 in 30 year plus 25% CC storm event will be permitted to produce temporary shallow depth flooding within the quarry void. During the 1 in 100 year plus 25% CC storm event, 251.6m^3 of flood storage is required within the quarry void.

Sizing of the sediment pond

A sediment pond is proposed to reduce the sediment load of the water discharged from the site to Baildon Dike and therefore reduce the risk of potential pollution by suspended solids.

The guidance contained within the 'Sizing of surface water management systems at landfill sites' has been used to estimate the size of the sediment pond:

$$A = Q/u_s$$

Where:

A is the calculated area of the settlement pond (m^2)

Q is the flow rate through the settlement pond (m^3/s)

u_s is the settlement velocity of a particle (m/s)

The u_s value is taken from the guidance contained within the 'Sizing of surface water management systems at landfill sites' as 1 x 10^{-5} m/s. The guidance also suggests a minimum pond depth of 1m in order to provide sufficient depth to minimise erosion of the base of the pond and resuspension of settled sediment.

Phase 1

Based on a proposed incoming flow rate of 1 l/s (0.001 m^3/s), equivalent to the QBAR rate, and a settlement velocity of 1 x 10^{-5} m/s, an estimated sediment pond surface area of 100m^2 will be required.

Phase 1 & 2

Based on a proposed incoming flow rate of 2.2 l/s (0.0022 m^3/s), and a settlement velocity of 1 x 10^{-5} m/s, an estimated sediment pond surface area of 220m^2 will be required.

Maintenance

Maintenance of the drainage features will be the responsibility of the site owner. The proposed design should ensure safe and easy access for maintenance and repair over the lifetime of the surface water management system. Maintenance should include regular inspection and arrangements for periodic removal of silt from the sediment pond. All ditches should be regularly inspected to ensure that they are free from obstructions to maintain the designed efficiency and capacity.

Other Considerations

Flows from the quarry void will be pumped to an attenuation pond. In order to reduce the risk of flooding in the event of plant or power failure, the quarry void should be excavated as to direct flood flows to a designated low point (sump).

Provision of standby pumps, an automated pump exercise regime and a pump failure alarm system would limit the risk of pump failure.

Conclusions

The proposed development is for a clay quarry extension at Peace Wood Quarry. Site operations will be consistent with the existing quarry, which includes clay extraction to depths of up to 15m.bgl followed by infilling with engineering material prior to restoration to agricultural pasture.

The development will be divided into Phase 1, which covers an area of approximately 4,194m^2, and Phase 1 & 2 which covers an area of approximately 10,260m^2.

Runoff from the quarry void will be discharged to Baildon Dike at the northern boundary of the existing Peace Wood Quarry at the limited discharge rate of 1 l/s for Phase 1 (equivalent to QBAR rate) and 2.2 l/s for Phase 1 & 2 (equivalent to the 1 in 1 year greenfield runoff).

The proposed drainage system will compromise:

- Drainage ditch(es) on the perimeter of the quarry void to collect runoff. The ditch(es) will be excavated as open trapezoidal channels and will be no less than 0.3m deep with a base width 0.1m, a top width 0.7m and 1:1 side-slopes. This will ensure the ditch(es) can accommodate flows during a 1 in 30 year plus 25% CC event.

- Flows from the ditch(es) will be directed to a sump point and pumped to an attenuation pond. The attenuation pond will be sized to accommodate storm events up to and including the 1 in 30 year plus 25% climate change event. An estimated attenuation volume of 268.4m^3 is required for Phase 1 and an attenuation volume of 677.3m^3 is required for Phase 1 & 2.

- Storm events in excess of the 1 in 30 year plus 25% CC storm events (i.e 1 in 100 year) will be permitted to produce temporary shallow depth flooding within the quarry void.

- A sediment pond will be placed downstream of the attenuation pond to reduce the sediment load of the water discharged from the site to Baildon Dike. An estimated sediment pond area of 100m^2 is required for Phase 1 and 220m^2 is required for Phase 2. The sediment pond depth should be a minimum of 1m.

- Discharge to Baildon Dike will be made at a limited rate of 1 l/s during Phase 1 and 2.2 l/s during Phase 1 & 2.

The drainage system will provide surface water runoff reduction and sediment control, both in the short term i.e during extraction works and also the long term following completion of the restoration works.

A Concept Designer's Risk Assessment (cDRA) has been prepared to inform future designers of any identified hazards associated with the scheme. The cDRA has been included in Appendix I.

Recommendations

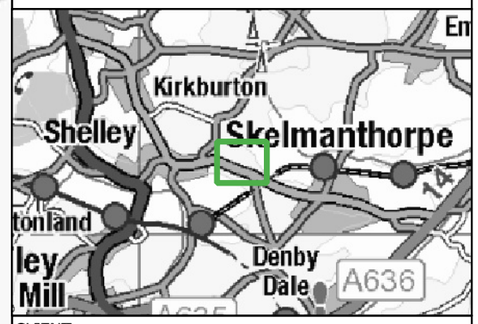
1. Submit this Drainage Strategy to the Planning Authority in support of the Planning Application.

Appendix A Location Plan and Aerial Image

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Watercourses
- Waterbodies



CLIENT:
The Mineral Planning Group Ltd

waterco
www.waterco.co.uk

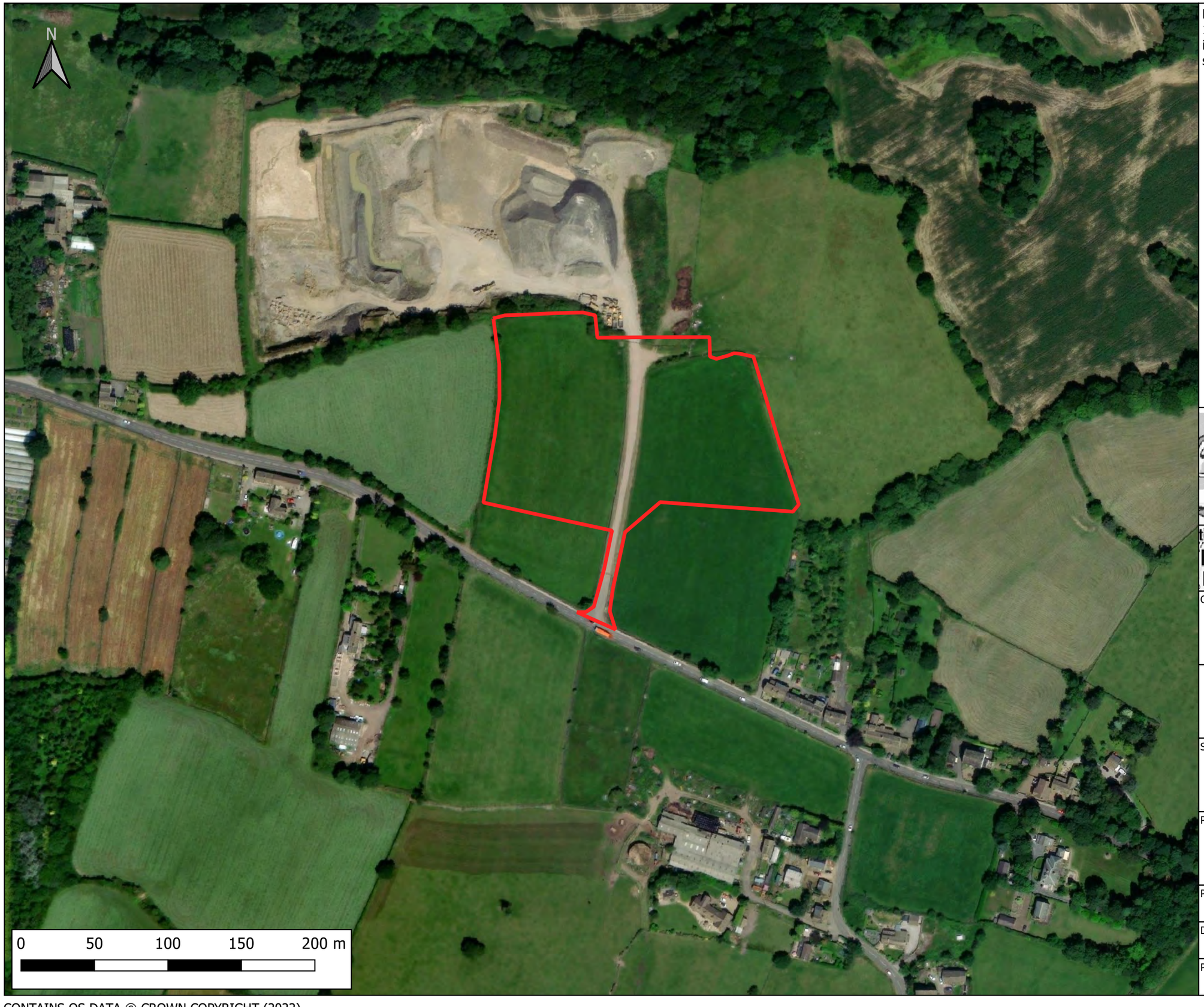
SCHEME:
Peace Wood Quarry, Huddersfield

PLOT TITLE:
Location Plan

PLOT STATUS:	DATE:
FINAL	21-12-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AM	JJ	APR	1:2500

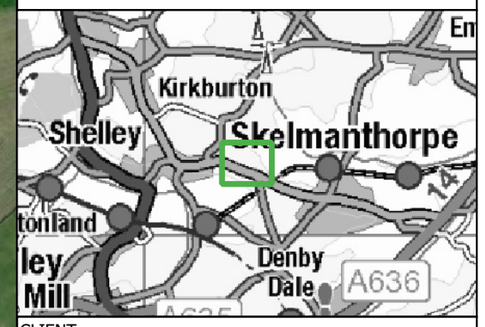
PLOT NAME:	REVISION:
14760_Location_Plan	-



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

Site Boundary



CLIENT:
The Mineral Planning Group Ltd

waterco
www.waterco.co.uk

SCHEME:
Peace Wood Quarry, Huddersfield

PLOT TITLE:
Aerial Plan

PLOT STATUS:	DATE:			
FINAL	21-12-2022			
DRAWN: AM	CHECKED: JJ	APPROVED: APR	PLOT SCALE AT A3: 1:2500	
PLOT NAME: 14760_Aerial_Plan				REVISION: -

Appendix B LiDAR extract

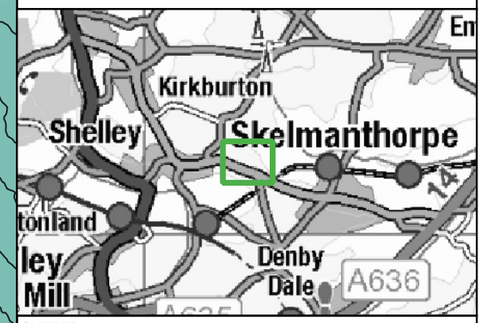
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Site Levels (m AOD)

Ground Elevations (m AOD)

- <= 185
- 185 - 190
- 190 - 195
- 195 - 200
- 200 - 205
- > 205



CLIENT:
The Mineral Planning Group Ltd

www.waterco.co.uk

SCHEME:
Peace Wood Quarry, Huddersfield

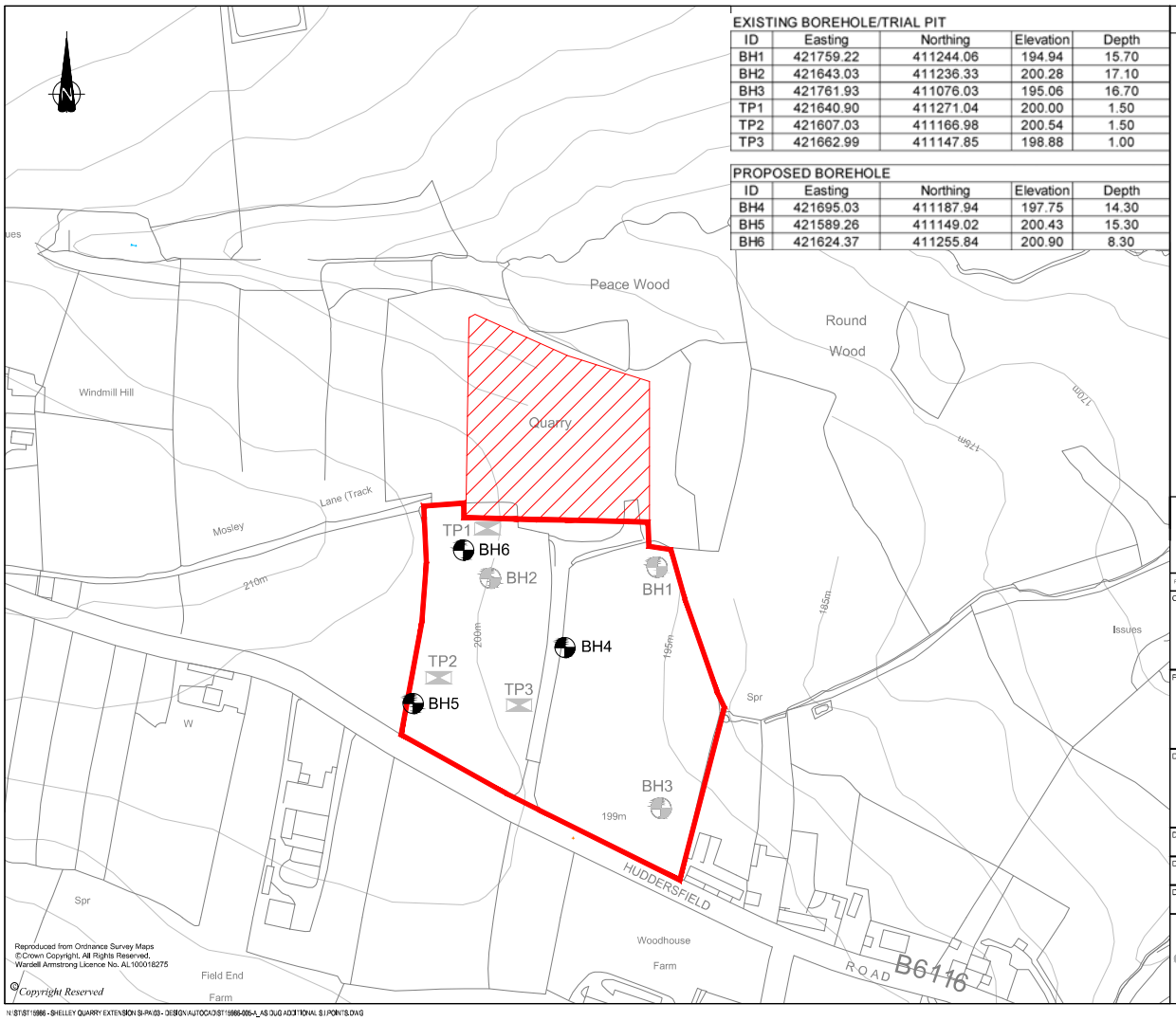
PLOT TITLE:
LiDAR Plan
1m Resolution
Data from Environment Agency

PLOT STATUS:	DATE:
FINAL	21-12-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AM	JJ	APR	1:2500

PLOT NAME:	REVISION:
14760_LiDAR_Plan	-

Appendix C Borehole Location Plan



EXISTING BOREHOLE/TRIAL PIT

ID	Easting	Northing	Elevation	Depth
BH1	421759.22	411244.06	194.94	15.70
BH2	421643.03	411236.33	200.28	17.10
BH3	421761.93	411076.03	195.06	16.70
TP1	421640.90	411271.04	200.00	1.50
TP2	421607.03	411166.98	200.54	1.50
TP3	421662.99	411147.85	198.88	1.00

PROPOSED BOREHOLE

ID	Easting	Northing	Elevation	Depth
BH4	421695.03	411187.94	197.75	14.30
BH5	421589.26	411149.02	200.43	15.30
BH6	421624.37	411255.84	200.90	8.30

DO NOT SCALE FROM THIS DRAWING

KEY

- SITE BOUNDARY
- SHELLEY QUARRY
- TRIAL PIT 2017
- BOREHOLE 2017
- BOREHOLE 2018

REVISION	DETAILS	DATE	DRN	CHKD	APPD
A	First Issue	06-Jul-17	DR	NL	AS

CLIENT: Naylor Industries PLC

PROJECT: Shelley Quarry Extension

DRAWING TITLE: As Dug
Additional S.I. Points

DRG No.	REV
ST15986-005	A

DRG SIZE	SCALE	DATE
A3	1:2500 @ A3	22/08/17

DRAWN BY	CHECKED BY	APPROVED BY
DR	NL	AS

wardell armstrong
STOKE ON TRENT | TEL: 01782 276700 | WWW.WARDELL-ARMSTRONG.COM
BIRMINGHAM | BOLTON | CARDIFF | CARLISLE | EDINBURGH | GLASGOW | LONDON | MANCHESTER | NEWCASTLE | SHEFFIELD

N:\ST\ST15986 - SHELLEY QUARRY EXTENSION SI-PA\03 - DESIGN\AUTOCAD\ST15986-005-A_AS DUG ADDITIONAL S.I.POINTS.DWG

Appendix D Development Plan

REVISIONS

	Date	Description	By
//	//	//	//
//	//	//	//
//	//	//	//
//	//	//	//

Legend:

- Land Under Control of Applicant
- Planning Application Area
- Top of Banking
- Bottom of Banking
- Kerb - Top
- Kerb - Channel
- Fence - Post & Wire
- Fence - Secure
- Gate
- Track / Footpath
- Wall
- Edge of Waterline
- Hedgeline
- Overhead Cable
- 60.0 2m Contour Intervals
- OS Backcloth
- Building/Structure
- Verge Line
- Foliage Line
- Top of Rock Face
- MH Manhole
- IC Inspection Cover
- BT British Telecom Cover
- G Gully
- LP Lamp Post
- TP Telegraph Pole
- EP Electric Pole
- ST Stop Tap
- GV Gas Valve
- WL Water Level
- IL Invert Level
- CL Cover Level
- EL Eave Level
- RL Ridge Level
- BH Borehole / Trial Pit
- 133.92 Spot Level
- Trees
- Survey Control Station

Datum: Levels relative to Ordnance Survey by connection to OS Active Network by GPS

N

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WF15 6DG

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Client

THE MINERAL PLANNING GROUP LIMITED

Job Title

SHELLEY QUARRY
SHELLEY
HUDDERSFIELD
HD8 8NE

Scale	Date	Drawn by	Surveyed
1:1250@A2	NOV 2022	SW	SW

Dwg. title

Phase 1 Extraction Design

DWG No. SQ/0922/PA-03 Rev.

PLOT SIZE: A2. PLOT SCALE: 1:TYPE SCALE HERE

REVISIONS

	Date	Description	By
//	//	//	//
//	//	//	//
//	//	//	//
//	//	//	//

Legend:

- Land Under Control of Applicant
- Planning Application Area

Top of Banking	MH	Manhole
Bottom of Banking	IC	Inspection Cover
Kerb - Top	BT	British Telecom Cover
Kerb - Channel	G	Gully
Fence - Post & Wire	LP	Lamp Post
Fence - Secure	TP	Telegraph Pole
Gate	EP	Electric Pole
Track / Footpath	ST	Stop Tap
Wall	GV	Gas Valve
Edge of Waterline	WL	Water Level
Hedgeline	IL	Invert Level
Overhead Cable	CL	Cover Level
60.0 2m Contour Intervals	EL	Eave Level
OS Backcloth	RL	Ridge Level
Building/Structure	BH	Borehole / Trial Pit
Verge Line	133.92	Spot Level
Foliage Line		Trees
Top of Rock Face		Survey Control Station

Datum: Levels relative to Ordnance Survey by connection to OS Active Network by GPS

N

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Client

THE MINERAL PLANNING GROUP LIMITED

Job Title

SHELLEY QUARRY
SHELLEY
HUDDERSFIELD
HD8 8NE

Scale	Date	Drawn by	Surveyed
1:1250@A2	NOV 2022	SW	SW

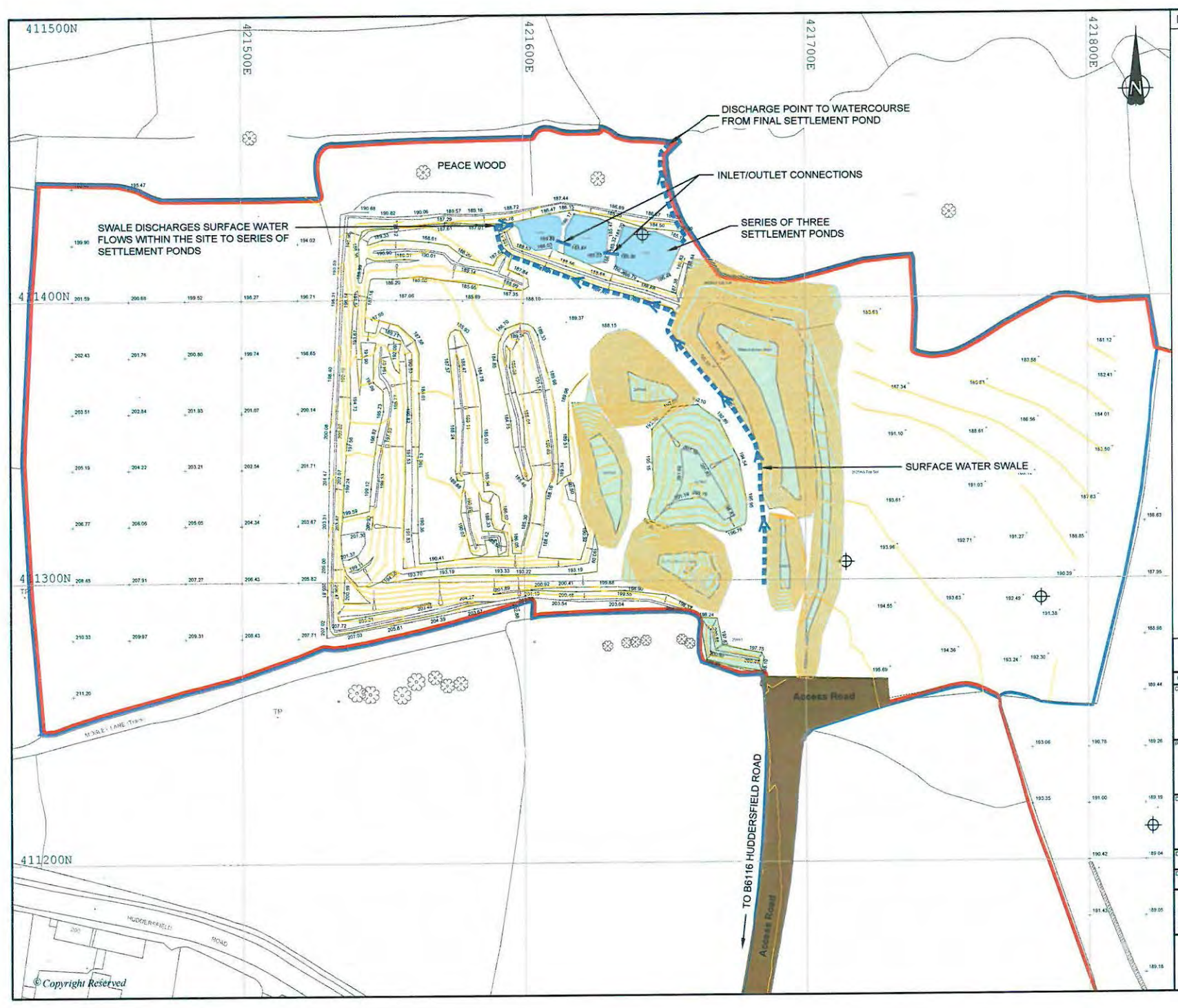
Dwg. title

Phase 2 Extraction Design

DWG No. SQ/0922/PA-04 Rev.

PLOT SIZE: A2. PLOT SCALE: 1:TYPE SCALE HERE

Appendix E Existing Surface Water Drainage Plan


411500N
421500E
421600E
421700E
421800E
411400N
411300N
411200N
DISCHARGE POINT TO WATERCOURSE FROM FINAL SETTLEMENT POND
INLET/OUTLET CONNECTIONS
SERIES OF THREE SETTLEMENT PONDS
SWALE DISCHARGES SURFACE WATER FLOWS WITHIN THE SITE TO SERIES OF SETTLEMENT PONDS
PEACE WOOD
SURFACE WATER SWALE
Access Road
TO B6116 HUDDERSFIELD ROAD
HUDDERSFIELD ROAD
MOSLEY LANE
TP
© Copyright Reserved

Appendix F Runoff Rates

ICP SUDS Mean Annual Flood

Input

Return Period (years)	30	Soil	0.300
Area (ha)	0.419	Urban	0.000
SAAR (mm)	911	Region Number	Region 10

Results l/s

QBAR Rural	1.0
QBAR Urban	1.0
Q30 years	1.8
Q1 year	0.9
Q30 years	1.8
Q100 years	2.2

ICP SUDS Mean Annual Flood

Input

Return Period (years)	30	Soil	0.300
Area (ha)	1.026	Urban	0.000
SAAR (mm)	911	Region Number	Region 10

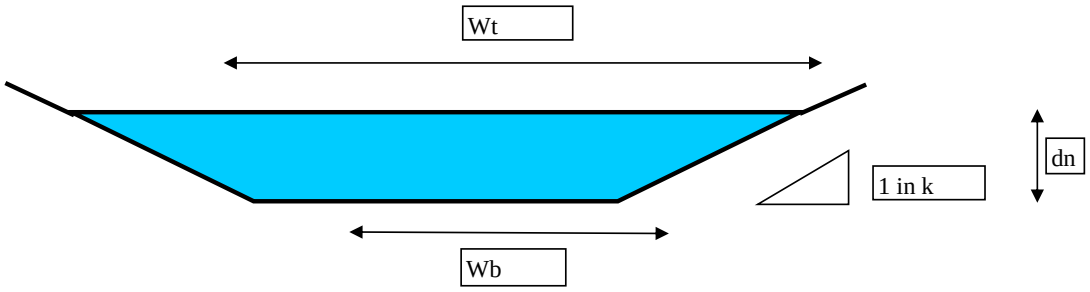
Results l/s

QBAR Rural	2.5
QBAR Urban	2.5
Q30 years	4.3
Q1 year	2.2
Q30 years	4.3
Q100 years	5.3

Appendix G Ditch Sizing Calculations

waterco consultants	*Eden Court, Lon Parcwr, Ruthin, 01824 702220*	Calculations	ref	**Phase 1**
Scheme:	14760 - Peace Wood Quarry		Prefix Page no.	A
Section:	Drainage Strategy		Date:	19/12/2022

Trapezoidal Channel Flow
Output Discharge

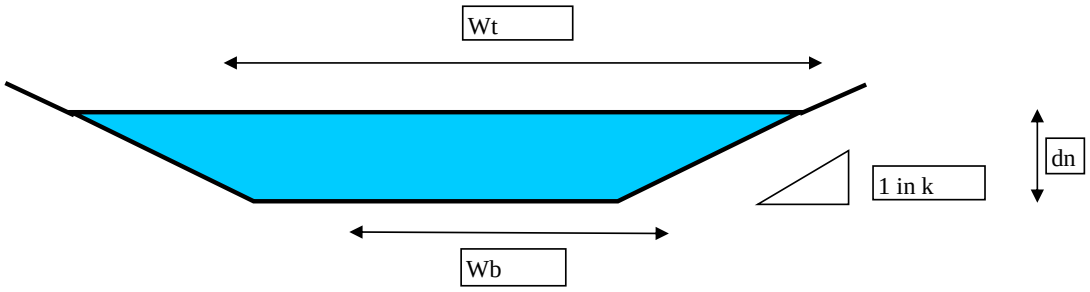


Manning Formula **V=(1/n)*R^(2/3)*S^(1/2)** **Q=A*V**

Bottom width Wb (m)	0.100	
Side slope (1 in k)	1.000	
Bed slope(1 in x)	52.86	
Manning "n"	0.029	
Depth dn (m)	0.300	
Bed slope s (m/m)	0.018918	1 / x
Top width Wt (m)	0.700	Wb + 2*k*dn
Area A (m2)	0.120	(Wb + Wt)/2)*dn
Perim P (m)	0.949	Wb + 2*dn*SQRT(1+k^2)
Hyd Rad R (m)	0.127	A / R
Velocity V (m/s)	**1.195**	1/n*R^(2/3)*S^(1/2)
Discharge Q (m3/s)	**0.1434**	A*V

waterco consultants	*Eden Court, Lon Parcwr, Ruthin, 01824 702220*	Calculations	ref	**Phase 1&2**
Scheme:	14760 - Peace Wood Quarry		Prefix Page no.	A
Section:	Drainage Strategy		Date:	19/12/2022

Trapezoidal Channel Flow
Output Discharge



Manning Formula **V=(1/n)*R^(2/3)*S^(1/2)** **Q=A*V**

Bottom width Wb (m)	0.100	
Side slope (1 in k)	1.000	
Bed slope(1 in x)	33.00	
Manning "n"	0.029	
Depth dn (m)	0.300	
Bed slope s (m/m)	0.030303	1 / x
Top width Wt (m)	0.700	Wb + 2*k*dn
Area A (m2)	0.120	(Wb + Wt)/2)*dn
Perim P (m)	0.949	Wb + 2*dn*SQRT(1+k^2)
Hyd Rad R (m)	0.127	A / R
Velocity V (m/s)	**1.513**	1/n*R^(2/3)*S^(1/2)
Discharge Q (m3/s)	**0.1815**	A*V

Appendix H MicroDrainage Calculations

Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.545	0.545	0.6	73.6	O K
30 min Summer	8.729	0.729	0.6	98.4	O K
60 min Summer	8.929	0.929	0.7	125.4	O K
120 min Summer	9.105	1.105	0.8	149.2	O K
180 min Summer	9.216	1.216	0.8	164.2	O K
240 min Summer	9.299	1.299	0.8	175.4	O K
360 min Summer	9.423	1.423	0.9	192.1	O K
480 min Summer	9.515	1.515	0.9	204.5	O K
600 min Summer	9.588	1.588	0.9	214.3	O K
720 min Summer	9.647	1.647	0.9	222.3	O K
960 min Summer	9.738	1.738	0.9	234.7	Flood Risk
1440 min Summer	9.855	1.855	1.0	250.4	Flood Risk
2160 min Summer	9.931	1.931	1.0	260.7	Flood Risk
2880 min Summer	9.967	1.967	1.0	265.5	Flood Risk
4320 min Summer	9.985	1.985	1.0	267.9	Flood Risk
5760 min Summer	9.959	1.959	1.0	264.5	Flood Risk
7200 min Summer	9.913	1.913	1.0	258.3	Flood Risk
8640 min Summer	9.860	1.860	1.0	251.2	Flood Risk
10080 min Summer	9.805	1.805	1.0	243.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	94.213	0.0	45.0	16
30 min Summer	63.227	0.0	48.5	31
60 min Summer	40.534	0.0	99.8	62
120 min Summer	24.414	0.0	106.8	122
180 min Summer	18.118	0.0	113.1	182
240 min Summer	14.670	0.0	117.5	242
360 min Summer	10.924	0.0	123.8	362
480 min Summer	8.888	0.0	128.1	482
600 min Summer	7.586	0.0	131.3	602
720 min Summer	6.673	0.0	133.6	722
960 min Summer	5.461	0.0	136.7	960
1440 min Summer	4.136	0.0	138.7	1440
2160 min Summer	3.133	0.0	266.9	2008
2880 min Summer	2.568	0.0	271.6	2336
4320 min Summer	1.935	0.0	267.0	3112
5760 min Summer	1.575	0.0	472.7	3928
7200 min Summer	1.337	0.0	473.6	4824
8640 min Summer	1.166	0.0	468.4	5616
10080 min Summer	1.037	0.0	457.1	6456

Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	8.545	0.545	0.6	73.6	O K
30 min Winter	8.729	0.729	0.6	98.4	O K
60 min Winter	8.929	0.929	0.7	125.4	O K
120 min Winter	9.106	1.106	0.8	149.3	O K
180 min Winter	9.218	1.218	0.8	164.4	O K
240 min Winter	9.301	1.301	0.8	175.6	O K
360 min Winter	9.426	1.426	0.9	192.5	O K
480 min Winter	9.519	1.519	0.9	205.0	O K
600 min Winter	9.592	1.592	0.9	215.0	O K
720 min Winter	9.653	1.653	0.9	223.2	O K
960 min Winter	9.747	1.747	0.9	235.9	Flood Risk
1440 min Winter	9.870	1.870	1.0	252.5	Flood Risk
2160 min Winter	9.956	1.956	1.0	264.1	Flood Risk
2880 min Winter	9.979	1.979	1.0	267.2	Flood Risk
4320 min Winter	9.988	1.988	1.0	268.4	Flood Risk
5760 min Winter	9.943	1.943	1.0	262.4	Flood Risk
7200 min Winter	9.872	1.872	1.0	252.7	Flood Risk
8640 min Winter	9.793	1.793	1.0	242.1	Flood Risk
10080 min Winter	9.713	1.713	0.9	231.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	94.213	0.0	45.0	16
30 min Winter	63.227	0.0	48.5	31
60 min Winter	40.534	0.0	99.8	62
120 min Winter	24.414	0.0	106.8	120
180 min Winter	18.118	0.0	113.0	180
240 min Winter	14.670	0.0	117.4	240
360 min Winter	10.924	0.0	123.6	358
480 min Winter	8.888	0.0	127.9	474
600 min Winter	7.586	0.0	131.0	590
720 min Winter	6.673	0.0	133.3	708
960 min Winter	5.461	0.0	136.3	940
1440 min Winter	4.136	0.0	138.1	1396
2160 min Winter	3.133	0.0	266.3	2052
2880 min Winter	2.568	0.0	270.7	2568
4320 min Winter	1.935	0.0	265.7	3284
5760 min Winter	1.575	0.0	472.4	4208
7200 min Winter	1.337	0.0	473.1	5120
8640 min Winter	1.166	0.0	468.2	6048
10080 min Winter	1.037	0.0	457.0	6952

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 421667 411178 SE 21667 11178
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.750
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+25

Time Area Diagram

Total Area (ha) 0.419

Time (mins) From:	To:	Area (ha)
0	1	0.419

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	135.0	2.000	135.0

Hydro-Brake® Optimum Outflow Control

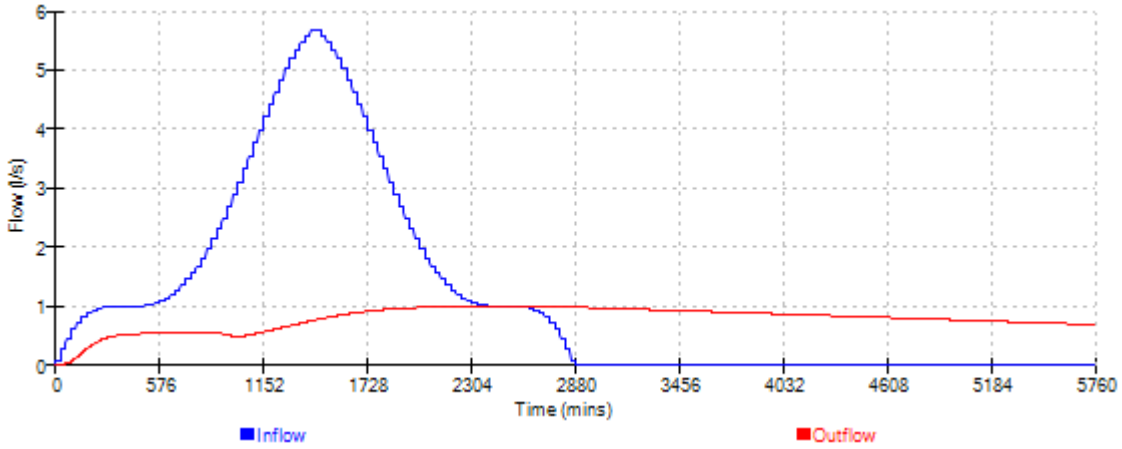
Unit Reference	MD-SHE-0040-1000-2000-1000
Design Head (m)	2.000
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	40
Invert Level (m)	7.995
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

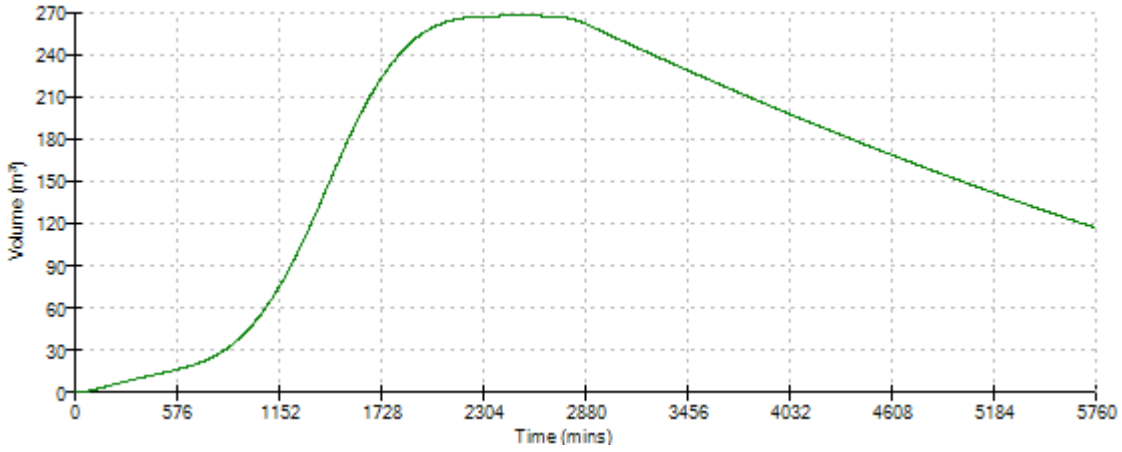
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	1.0
Flush-Flo™	0.173	0.6
Kick-Flo®	0.355	0.5
Mean Flow over Head Range	-	0.7

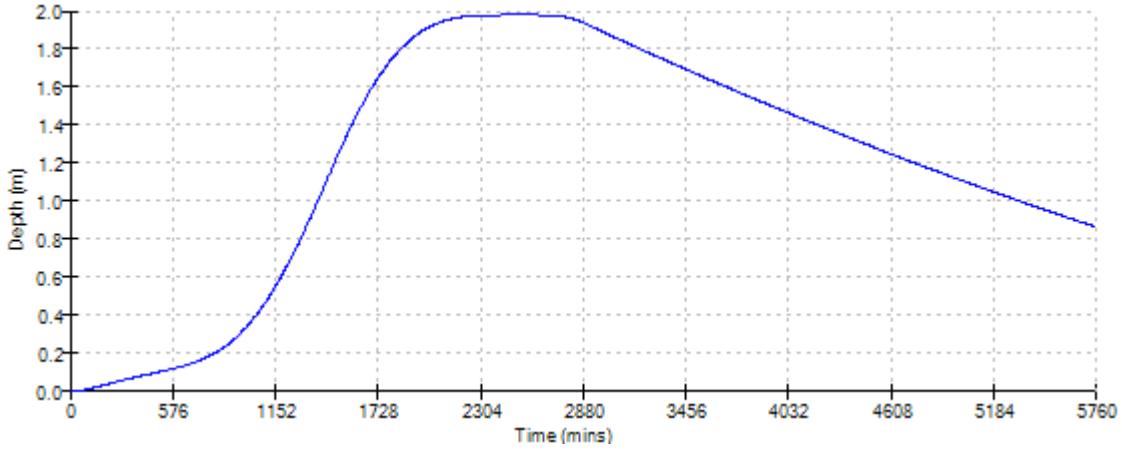
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.5	1.600	0.9	5.000	1.5
0.200	0.6	1.800	1.0	5.500	1.6
0.300	0.5	2.000	1.0	6.000	1.6
0.400	0.5	2.200	1.0	6.500	1.7
0.500	0.5	2.400	1.1	7.000	1.8
0.600	0.6	2.600	1.1	7.500	1.8
0.800	0.7	3.000	1.2	8.000	1.9
1.000	0.7	3.500	1.3	8.500	1.9
1.200	0.8	4.000	1.4	9.000	2.0
1.400	0.9	4.500	1.4	9.500	2.0

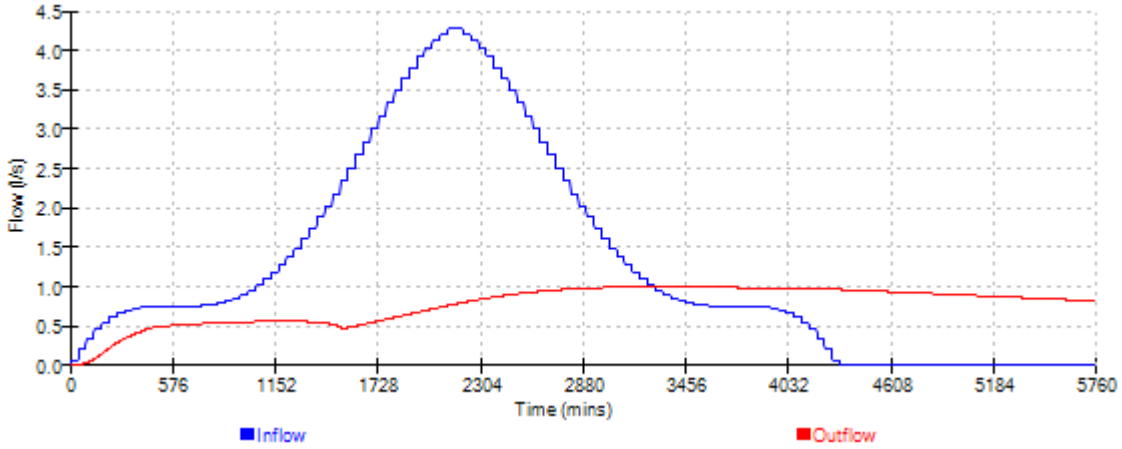
Event: 2880 min Winter

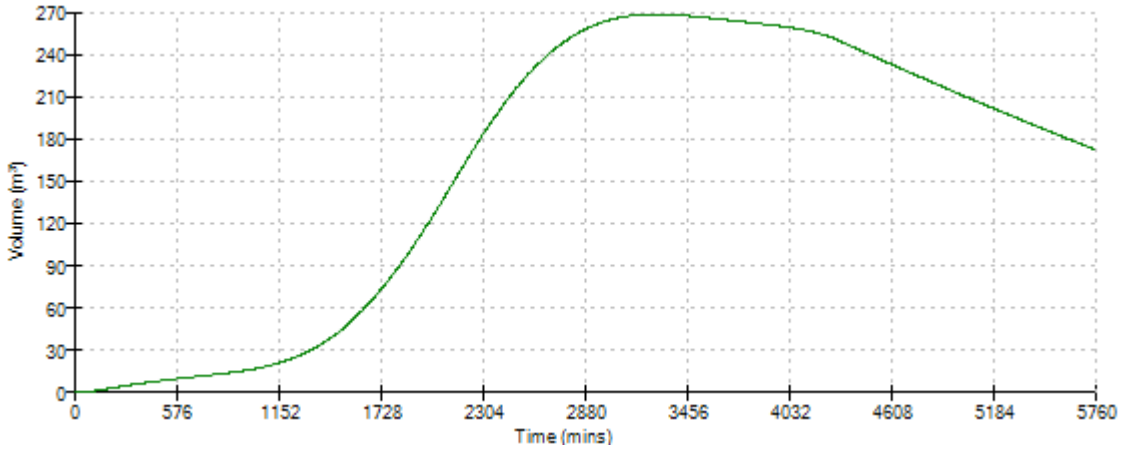


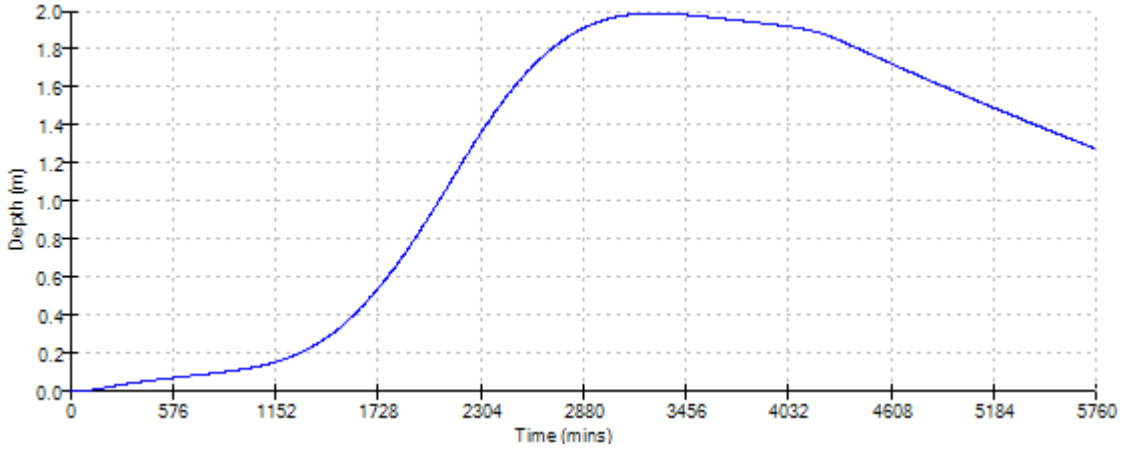




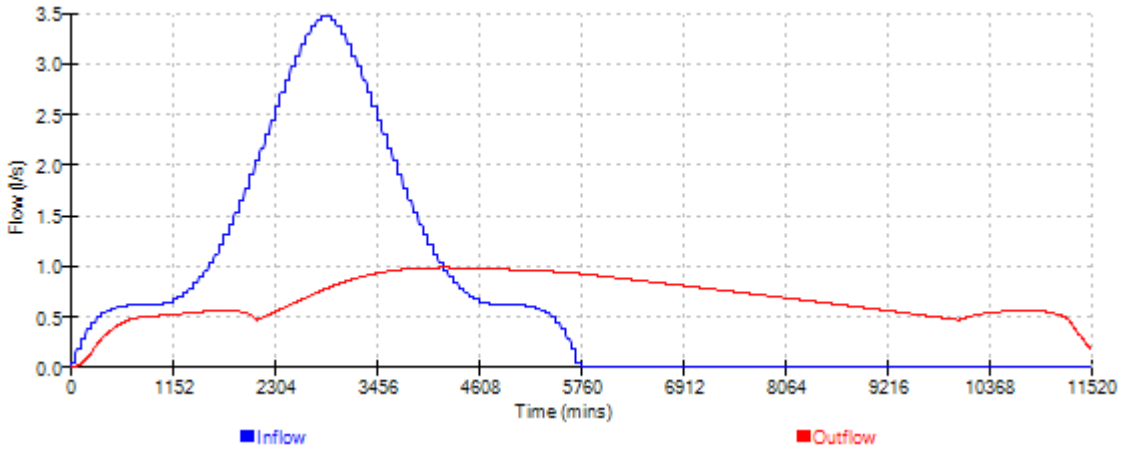
Event: 4320 min Winter

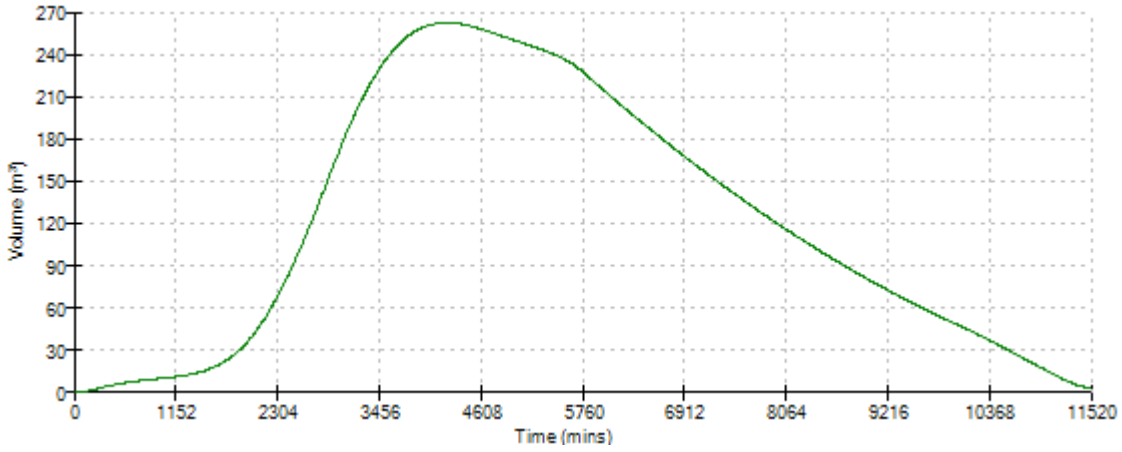


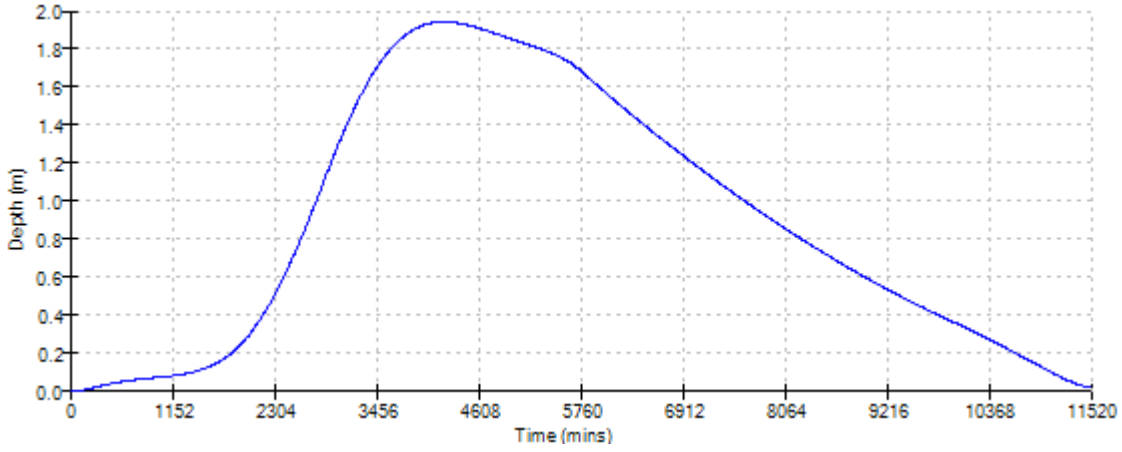




Event: 5760 min Winter







Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.529	0.529	0.6	97.9	O K
30 min Summer	8.714	0.714	0.6	132.0	O K
60 min Summer	8.918	0.918	0.7	169.8	O K
120 min Summer	9.077	1.077	0.8	199.3	O K
180 min Summer	9.184	1.184	0.8	219.0	O K
240 min Summer	9.266	1.266	0.8	234.1	O K
360 min Summer	9.391	1.391	0.8	257.3	O K
480 min Summer	9.485	1.485	0.9	274.8	O K
600 min Summer	9.561	1.561	0.9	288.7	O K
720 min Summer	9.623	1.623	0.9	300.3	O K
960 min Summer	9.719	1.719	0.9	318.1	Flood Risk
1440 min Summer	9.850	1.850	1.0	342.2	Flood Risk
2160 min Summer	9.942	1.942	1.0	359.2	Flood Risk
2880 min Summer	9.970	1.970	1.0	364.4	Flood Risk
4320 min Summer	9.982	1.982	1.0	366.6	Flood Risk
5760 min Summer	9.956	1.956	1.0	361.9	Flood Risk
7200 min Summer	9.910	1.910	1.0	353.3	Flood Risk
8640 min Summer	9.856	1.856	1.0	343.3	Flood Risk
10080 min Summer	9.800	1.800	1.0	333.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	125.189	0.0	44.1	16
30 min Summer	84.618	0.0	49.8	31
60 min Summer	54.670	0.0	102.8	62
120 min Summer	32.383	0.0	112.1	122
180 min Summer	23.919	0.0	117.8	182
240 min Summer	19.333	0.0	121.9	242
360 min Summer	14.374	0.0	127.8	362
480 min Summer	11.676	0.0	131.7	482
600 min Summer	9.948	0.0	134.5	602
720 min Summer	8.733	0.0	136.6	722
960 min Summer	7.115	0.0	139.0	962
1440 min Summer	5.349	0.0	140.0	1440
2160 min Summer	4.006	0.0	278.2	2160
2880 min Summer	3.253	0.0	279.8	2736
4320 min Summer	2.419	0.0	271.3	3416
5760 min Summer	1.950	0.0	507.9	4160
7200 min Summer	1.642	0.0	506.7	4976
8640 min Summer	1.423	0.0	497.0	5872
10080 min Summer	1.259	0.0	480.3	6656

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	8.529	0.529	0.6	97.9	O K
30 min Winter	8.714	0.714	0.6	132.0	O K
60 min Winter	8.918	0.918	0.7	169.8	O K
120 min Winter	9.078	1.078	0.8	199.4	O K
180 min Winter	9.185	1.185	0.8	219.1	O K
240 min Winter	9.267	1.267	0.8	234.3	O K
360 min Winter	9.392	1.392	0.9	257.6	O K
480 min Winter	9.488	1.488	0.9	275.2	O K
600 min Winter	9.564	1.564	0.9	289.3	O K
720 min Winter	9.627	1.627	0.9	301.0	O K
960 min Winter	9.725	1.725	0.9	319.2	Flood Risk
1440 min Winter	9.860	1.860	1.0	344.0	Flood Risk
2160 min Winter	9.960	1.960	1.0	362.5	Flood Risk
2880 min Winter	9.995	1.995	1.0	369.2	Flood Risk
4320 min Winter	9.993	1.993	1.0	368.7	Flood Risk
5760 min Winter	9.961	1.961	1.0	362.8	Flood Risk
7200 min Winter	9.901	1.901	1.0	351.7	Flood Risk
8640 min Winter	9.829	1.829	1.0	338.4	Flood Risk
10080 min Winter	9.755	1.755	0.9	324.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	125.189	0.0	44.1	16
30 min Winter	84.618	0.0	49.8	31
60 min Winter	54.670	0.0	102.8	62
120 min Winter	32.383	0.0	112.0	122
180 min Winter	23.919	0.0	117.7	180
240 min Winter	19.333	0.0	121.8	240
360 min Winter	14.374	0.0	127.6	358
480 min Winter	11.676	0.0	131.5	476
600 min Winter	9.948	0.0	134.2	594
720 min Winter	8.733	0.0	136.2	712
960 min Winter	7.115	0.0	138.5	942
1440 min Winter	5.349	0.0	139.3	1410
2160 min Winter	4.006	0.0	277.4	2076
2880 min Winter	3.253	0.0	278.7	2736
4320 min Winter	2.419	0.0	269.7	3460
5760 min Winter	1.950	0.0	506.8	4384
7200 min Winter	1.642	0.0	505.5	5328
8640 min Winter	1.423	0.0	495.9	6224
10080 min Winter	1.259	0.0	479.5	7160

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 421667 411178 SE 21667 11178
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.750
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+25

Time Area Diagram

Total Area (ha) 0.419

Time (mins) From:	To:	Area (ha)
0	1	0.419

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	185.0	2.000	185.0

Hydro-Brake® Optimum Outflow Control

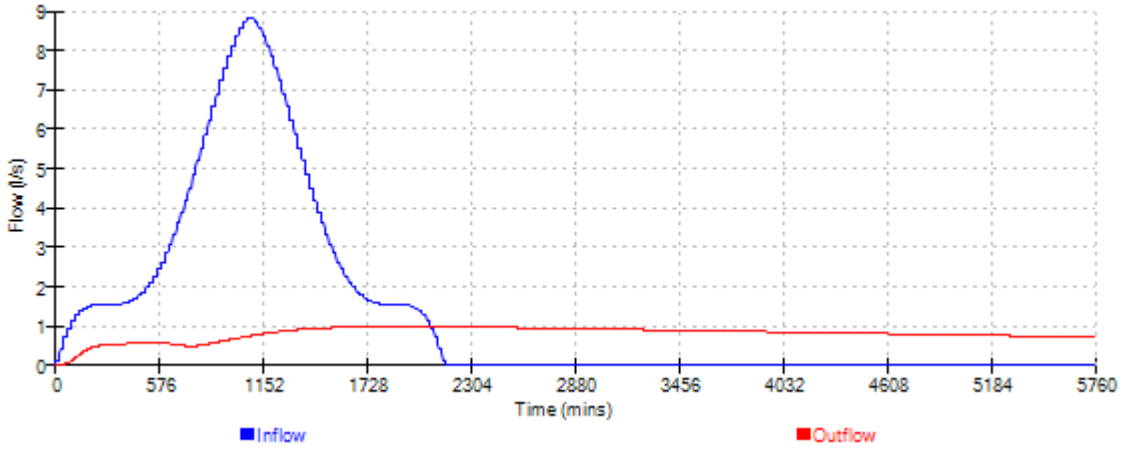
Unit Reference	MD-SHE-0040-1000-2000-1000
Design Head (m)	2.000
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	40
Invert Level (m)	7.995
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

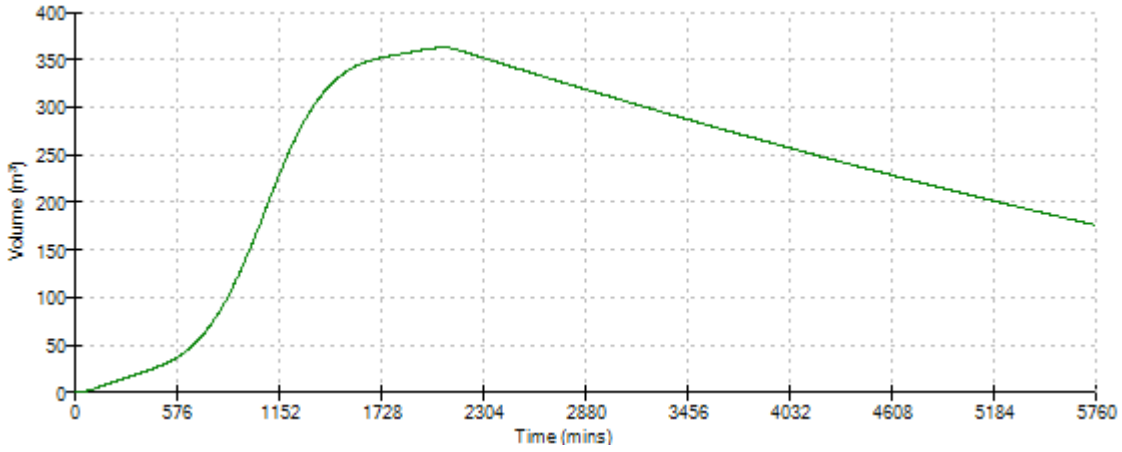
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	1.0
Flush-Flo™	0.173	0.6
Kick-Flo®	0.355	0.5
Mean Flow over Head Range	-	0.7

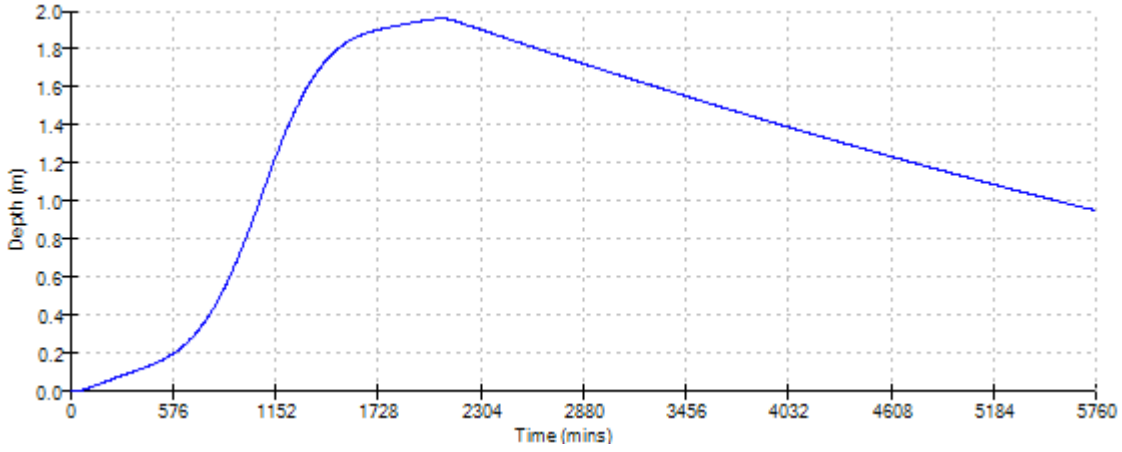
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.5	1.600	0.9	5.000	1.5
0.200	0.6	1.800	1.0	5.500	1.6
0.300	0.5	2.000	1.0	6.000	1.6
0.400	0.5	2.200	1.0	6.500	1.7
0.500	0.5	2.400	1.1	7.000	1.8
0.600	0.6	2.600	1.1	7.500	1.8
0.800	0.7	3.000	1.2	8.000	1.9
1.000	0.7	3.500	1.3	8.500	1.9
1.200	0.8	4.000	1.4	9.000	2.0
1.400	0.9	4.500	1.4	9.500	2.0

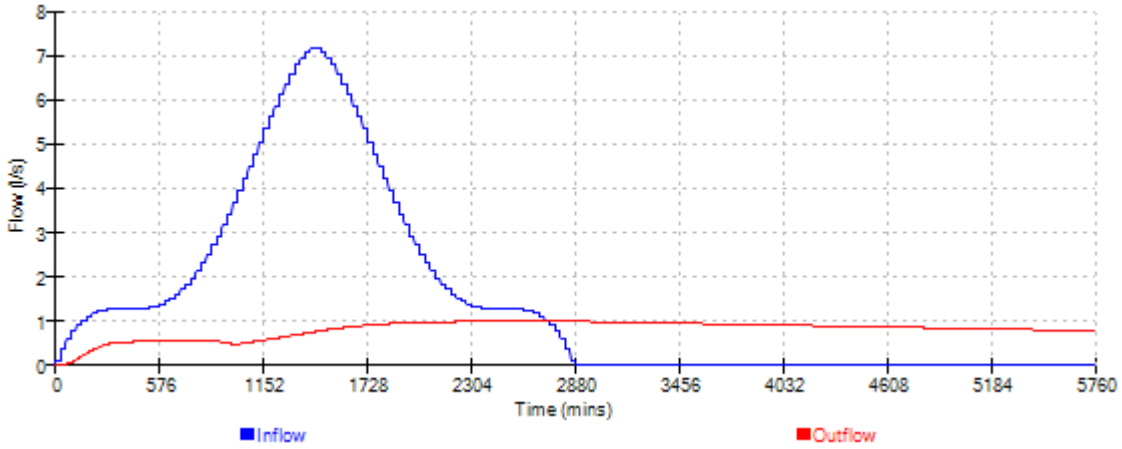
Event: 2160 min Winter

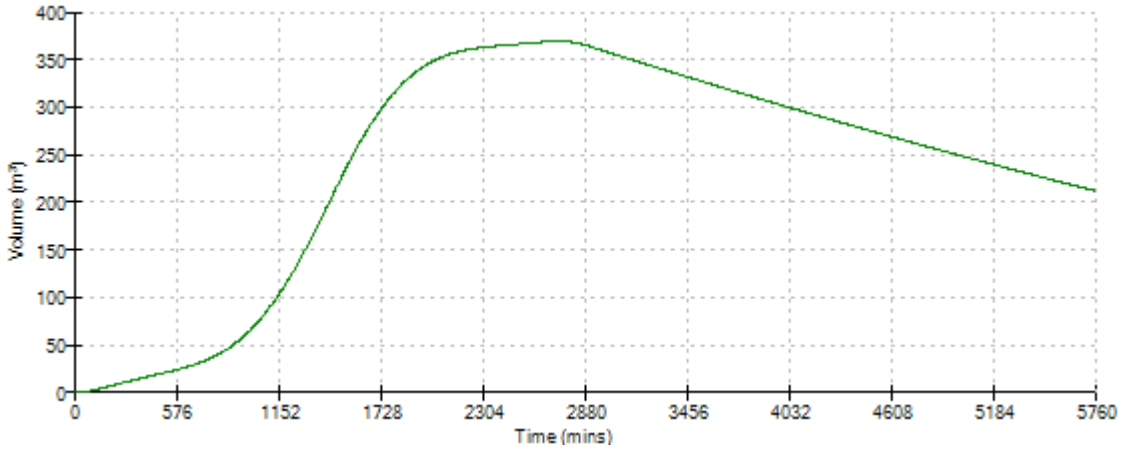


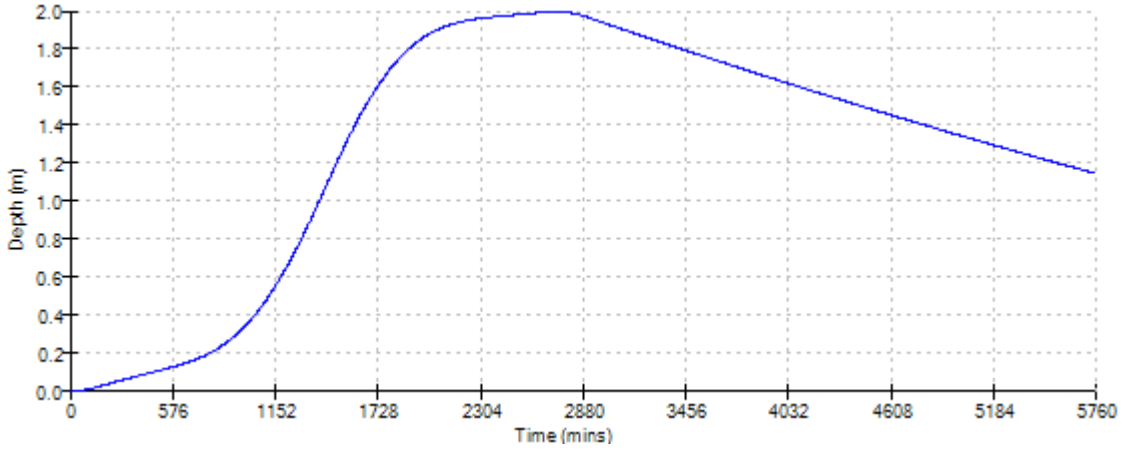




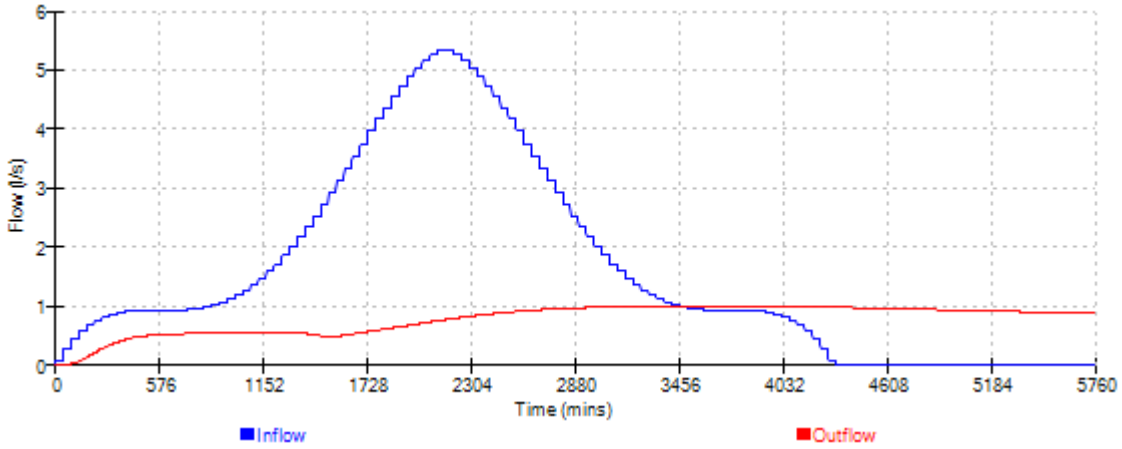
Event: 2880 min Winter

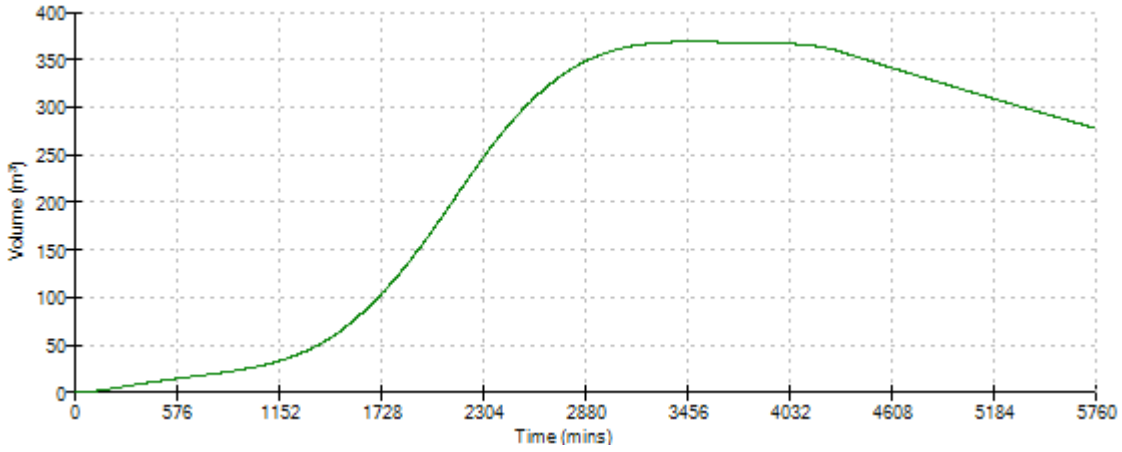


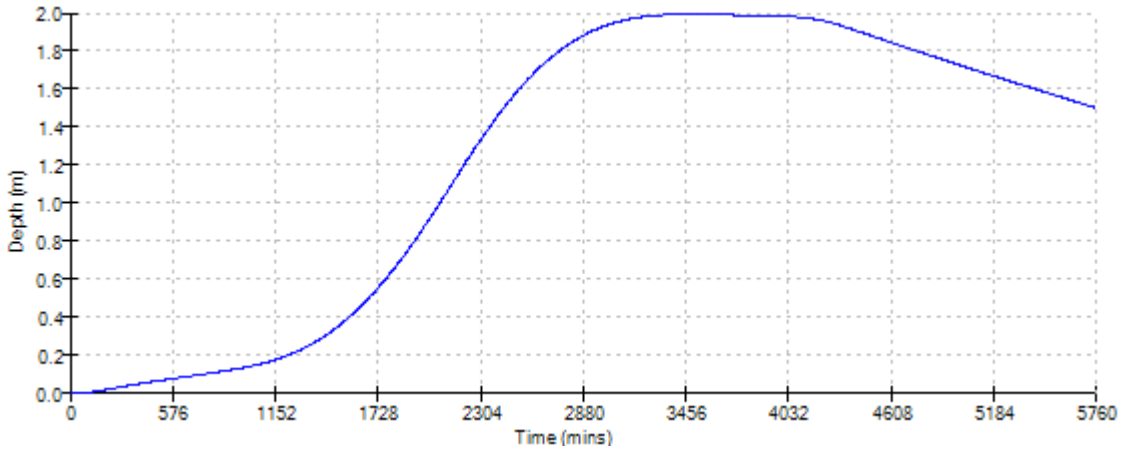




Event: 4320 min Winter







Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.516	0.516	1.5	239.8	O K
30 min Summer	8.696	0.696	1.5	323.5	O K
60 min Summer	8.895	0.895	1.5	416.2	O K
120 min Summer	9.051	1.051	1.6	488.9	O K
180 min Summer	9.156	1.156	1.7	537.5	O K
240 min Summer	9.237	1.237	1.8	575.1	O K
360 min Summer	9.360	1.360	1.8	632.6	O K
480 min Summer	9.455	1.455	1.9	676.4	O K
600 min Summer	9.530	1.530	1.9	711.5	O K
720 min Summer	9.593	1.593	2.0	740.7	O K
960 min Summer	9.691	1.691	2.0	786.3	O K
1440 min Summer	9.826	1.826	2.1	849.3	Flood Risk
2160 min Summer	9.928	1.928	2.2	896.7	Flood Risk
2880 min Summer	9.966	1.966	2.2	914.0	Flood Risk
4320 min Summer	9.978	1.978	2.2	919.6	Flood Risk
5760 min Summer	9.956	1.956	2.2	909.4	Flood Risk
7200 min Summer	9.915	1.915	2.2	890.3	Flood Risk
8640 min Summer	9.866	1.866	2.1	867.7	Flood Risk
10080 min Summer	9.815	1.815	2.1	843.8	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	125.189	0.0	122.1	16
30 min Summer	84.618	0.0	111.2	31
60 min Summer	54.670	0.0	235.0	62
120 min Summer	32.383	0.0	246.8	122
180 min Summer	23.919	0.0	259.4	182
240 min Summer	19.333	0.0	268.6	242
360 min Summer	14.374	0.0	281.7	362
480 min Summer	11.676	0.0	290.7	482
600 min Summer	9.948	0.0	297.2	602
720 min Summer	8.733	0.0	302.0	722
960 min Summer	7.115	0.0	308.0	962
1440 min Summer	5.349	0.0	311.8	1440
2160 min Summer	4.006	0.0	623.7	2160
2880 min Summer	3.253	0.0	628.3	2880
4320 min Summer	2.419	0.0	612.5	3588
5760 min Summer	1.950	0.0	1163.7	4328
7200 min Summer	1.642	0.0	1158.7	5120
8640 min Summer	1.423	0.0	1135.8	5968
10080 min Summer	1.259	0.0	1098.3	6768

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	8.516	0.516	1.5	239.8	O K
30 min Winter	8.696	0.696	1.5	323.5	O K
60 min Winter	8.895	0.895	1.5	416.2	O K
120 min Winter	9.052	1.052	1.6	489.0	O K
180 min Winter	9.157	1.157	1.7	537.8	O K
240 min Winter	9.238	1.238	1.8	575.5	O K
360 min Winter	9.362	1.362	1.8	633.3	O K
480 min Winter	9.457	1.457	1.9	677.5	O K
600 min Winter	9.533	1.533	1.9	713.0	O K
720 min Winter	9.597	1.597	2.0	742.5	O K
960 min Winter	9.696	1.696	2.0	788.8	O K
1440 min Winter	9.836	1.836	2.1	853.6	Flood Risk
2160 min Winter	9.945	1.945	2.2	904.3	Flood Risk
2880 min Winter	9.991	1.991	2.2	925.6	Flood Risk
4320 min Winter	9.998	1.998	2.2	928.9	Flood Risk
5760 min Winter	9.968	1.968	2.2	915.3	Flood Risk
7200 min Winter	9.917	1.917	2.2	891.4	Flood Risk
8640 min Winter	9.853	1.853	2.1	861.8	Flood Risk
10080 min Winter	9.786	1.786	2.1	830.4	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	125.189	0.0	122.2	16
30 min Winter	84.618	0.0	111.2	31
60 min Winter	54.670	0.0	235.0	62
120 min Winter	32.383	0.0	246.7	122
180 min Winter	23.919	0.0	259.3	180
240 min Winter	19.333	0.0	268.4	240
360 min Winter	14.374	0.0	281.3	358
480 min Winter	11.676	0.0	290.1	476
600 min Winter	9.948	0.0	296.4	594
720 min Winter	8.733	0.0	301.1	712
960 min Winter	7.115	0.0	306.8	944
1440 min Winter	5.349	0.0	309.7	1412
2160 min Winter	4.006	0.0	621.2	2096
2880 min Winter	3.253	0.0	624.9	2764
4320 min Winter	2.419	0.0	607.5	3976
5760 min Winter	1.950	0.0	1160.1	4496
7200 min Winter	1.642	0.0	1154.8	5408
8640 min Winter	1.423	0.0	1132.2	6320
10080 min Winter	1.259	0.0	1095.4	7264

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 421667 411178 SE 21667 11178
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.750
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+25

Time Area Diagram

Total Area (ha) 1.026

Time (mins) From:	To:	Area (ha)
0	1	1.026

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	465.0	2.000	465.0

Hydro-Brake® Optimum Outflow Control

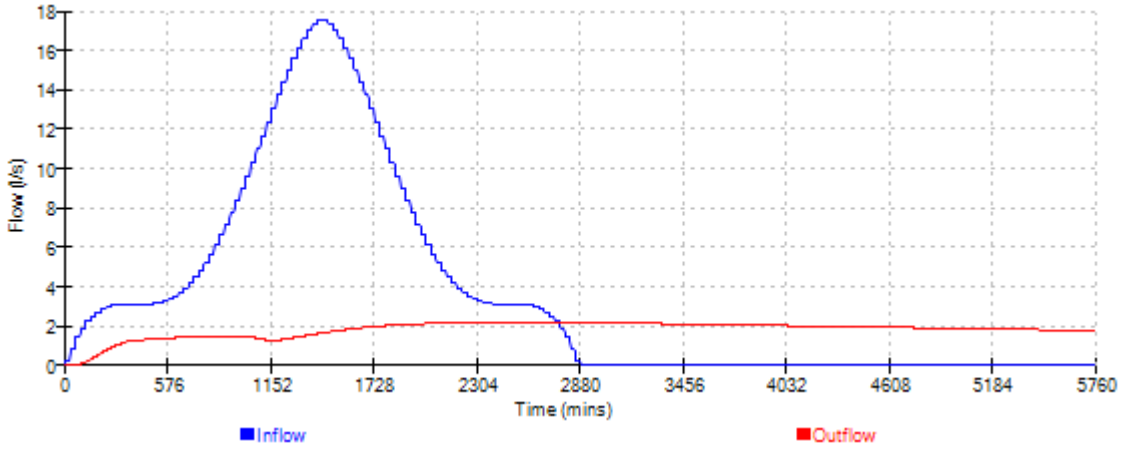
Unit Reference	MD-SHE-0060-2200-2000-2200
Design Head (m)	2.000
Design Flow (l/s)	2.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	60
Invert Level (m)	7.995
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

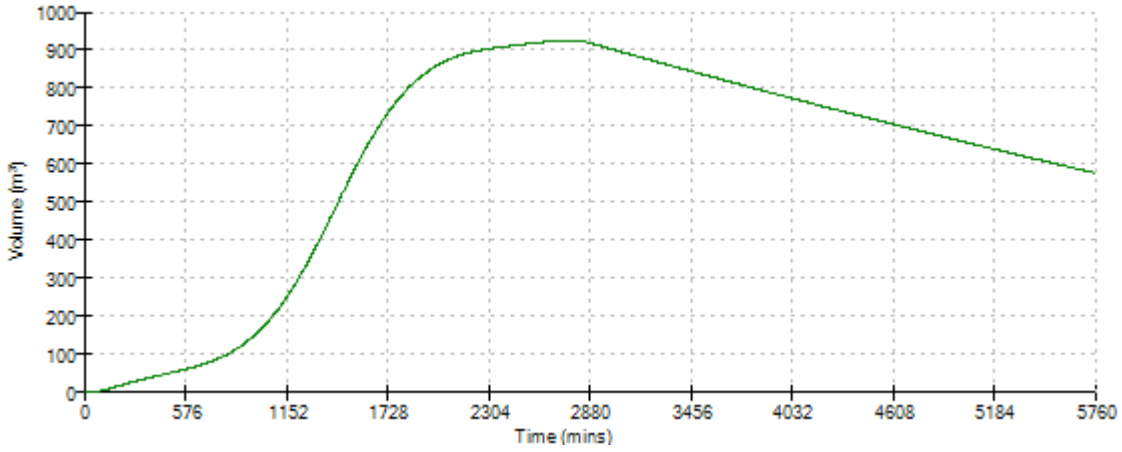
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	2.2
Flush-Flo™	0.262	1.5
Kick-Flo®	0.534	1.2
Mean Flow over Head Range	-	1.6

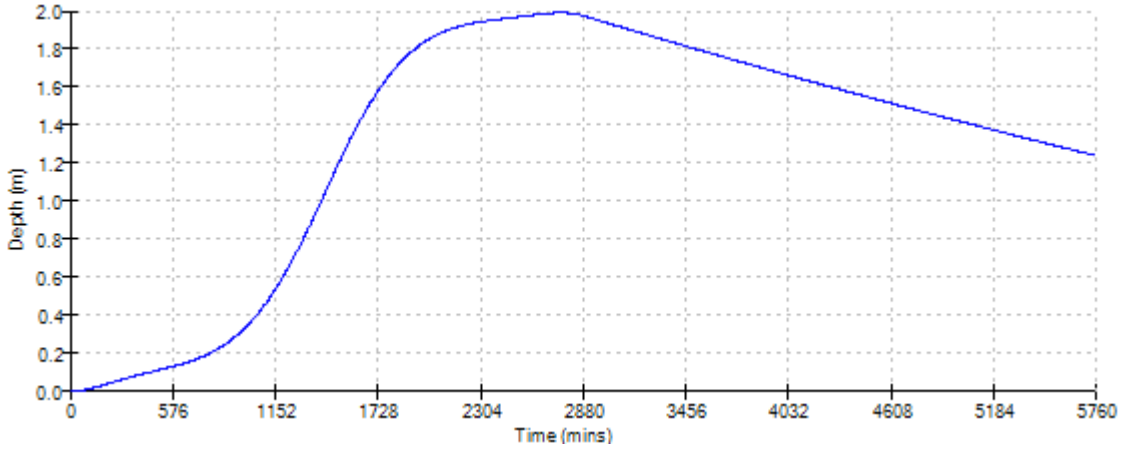
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	1.600	2.0	5.000	3.4
0.200	1.5	1.800	2.1	5.500	3.5
0.300	1.5	2.000	2.2	6.000	3.7
0.400	1.4	2.200	2.3	6.500	3.8
0.500	1.3	2.400	2.4	7.000	3.9
0.600	1.3	2.600	2.5	7.500	4.1
0.800	1.4	3.000	2.6	8.000	4.2
1.000	1.6	3.500	2.8	8.500	4.3
1.200	1.7	4.000	3.0	9.000	4.4
1.400	1.9	4.500	3.2	9.500	4.5

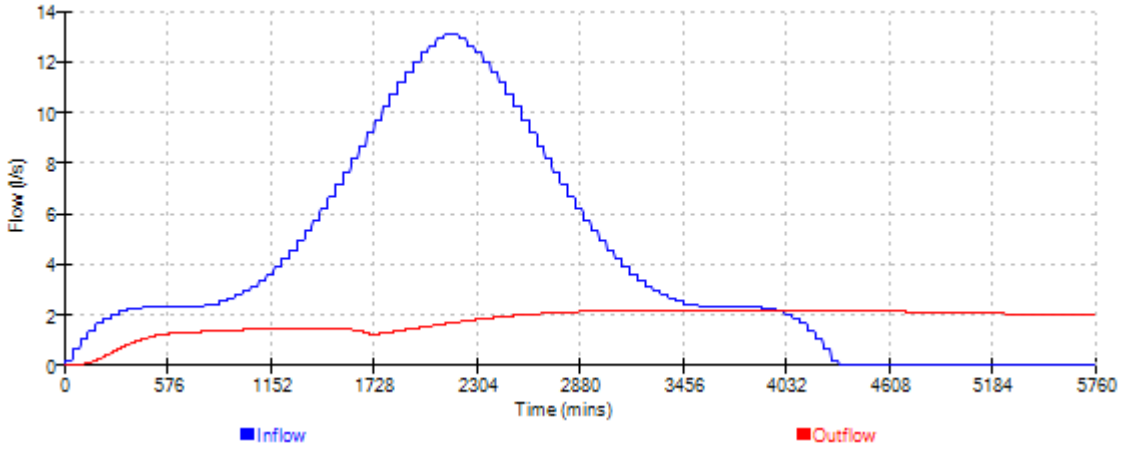
Event: 2880 min Winter

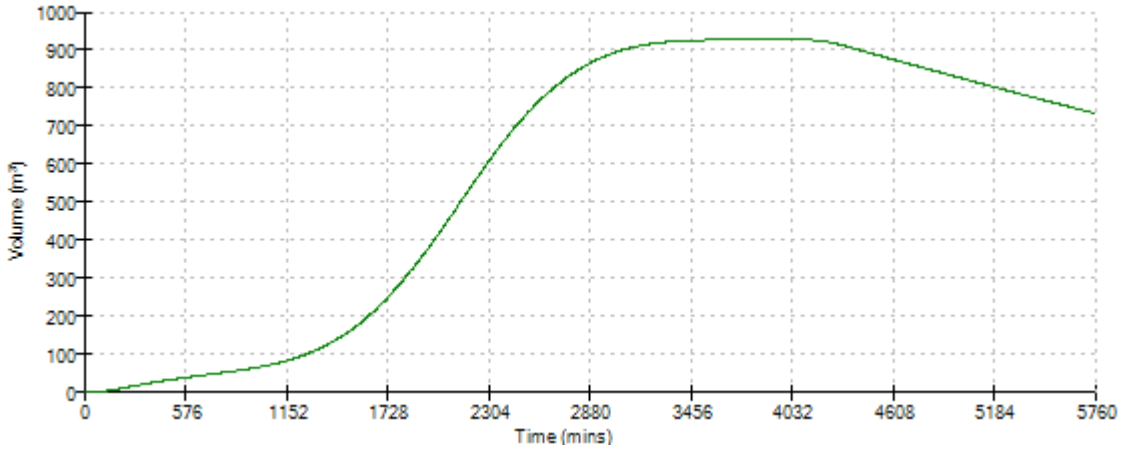


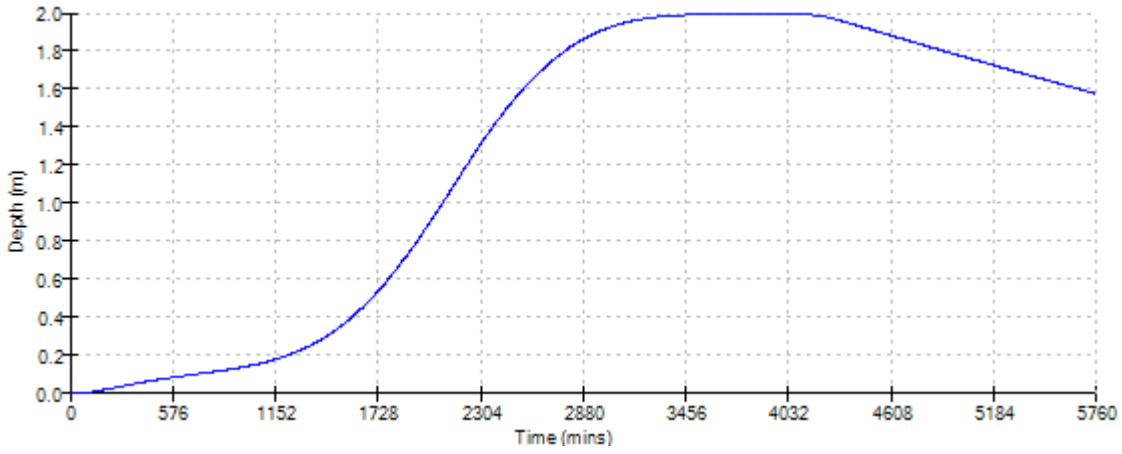




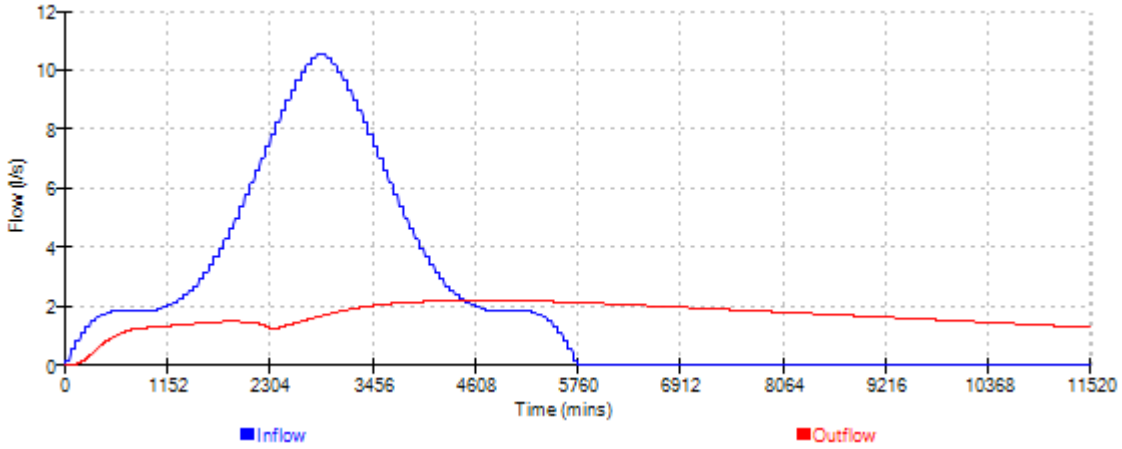
Event: 4320 min Winter

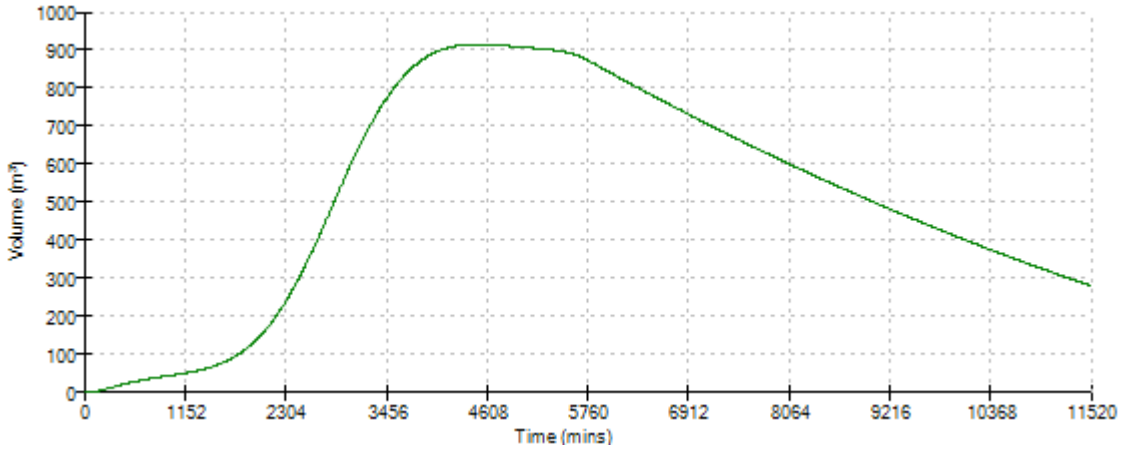


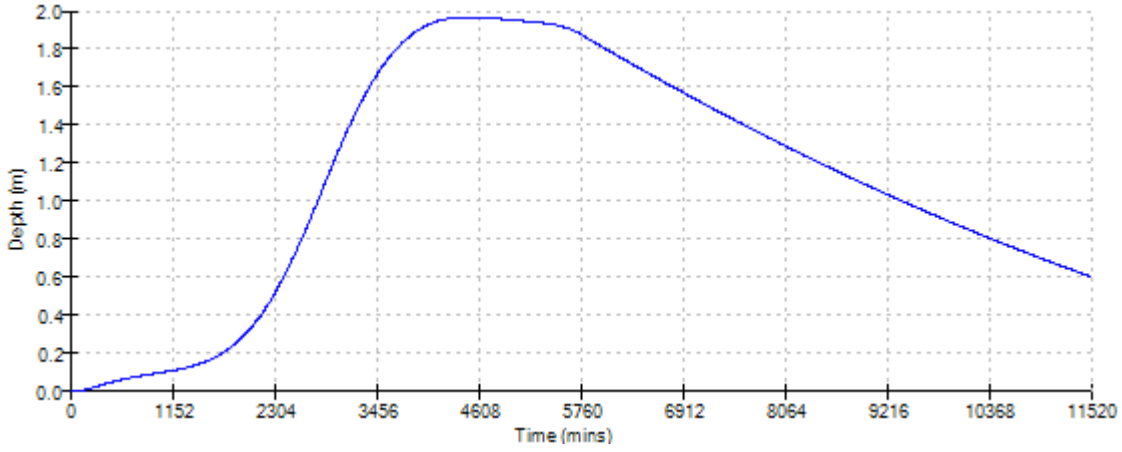




Event: 5760 min Winter







Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.532	0.532	1.5	180.2	O K
30 min Summer	8.711	0.711	1.5	241.2	O K
60 min Summer	8.907	0.907	1.5	307.4	O K
120 min Summer	9.080	1.080	1.7	366.2	O K
180 min Summer	9.190	1.190	1.7	403.4	O K
240 min Summer	9.272	1.272	1.8	431.3	O K
360 min Summer	9.395	1.395	1.9	473.0	O K
480 min Summer	9.488	1.488	1.9	504.4	O K
600 min Summer	9.561	1.561	2.0	529.3	O K
720 min Summer	9.622	1.622	2.0	549.8	O K
960 min Summer	9.717	1.717	2.0	581.9	Flood Risk
1440 min Summer	9.842	1.842	2.1	624.3	Flood Risk
2160 min Summer	9.929	1.929	2.2	653.9	Flood Risk
2880 min Summer	9.964	1.964	2.2	665.8	Flood Risk
4320 min Summer	9.986	1.986	2.2	673.2	Flood Risk
5760 min Summer	9.968	1.968	2.2	667.1	Flood Risk
7200 min Summer	9.929	1.929	2.2	653.8	Flood Risk
8640 min Summer	9.881	1.881	2.1	637.7	Flood Risk
10080 min Summer	9.831	1.831	2.1	620.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	94.213	0.0	122.4	16
30 min Summer	63.227	0.0	113.8	31
60 min Summer	40.534	0.0	240.2	62
120 min Summer	24.414	0.0	244.5	122
180 min Summer	18.118	0.0	251.7	182
240 min Summer	14.670	0.0	260.8	242
360 min Summer	10.924	0.0	274.7	362
480 min Summer	8.888	0.0	284.4	482
600 min Summer	7.586	0.0	291.6	602
720 min Summer	6.673	0.0	297.1	722
960 min Summer	5.461	0.0	304.4	960
1440 min Summer	4.136	0.0	310.1	1440
2160 min Summer	3.133	0.0	603.6	2144
2880 min Summer	2.568	0.0	614.2	2476
4320 min Summer	1.935	0.0	605.2	3244
5760 min Summer	1.575	0.0	1116.4	4040
7200 min Summer	1.337	0.0	1099.3	4896
8640 min Summer	1.166	0.0	1082.5	5712
10080 min Summer	1.037	0.0	1053.7	6552

Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	8.532	0.532	1.5	180.2	O K
30 min Winter	8.711	0.711	1.5	241.2	O K
60 min Winter	8.907	0.907	1.5	307.4	O K
120 min Winter	9.081	1.081	1.7	366.3	O K
180 min Winter	9.191	1.191	1.7	403.7	O K
240 min Winter	9.274	1.274	1.8	431.8	O K
360 min Winter	9.398	1.398	1.9	473.8	O K
480 min Winter	9.491	1.491	1.9	505.5	O K
600 min Winter	9.566	1.566	2.0	530.8	O K
720 min Winter	9.628	1.628	2.0	551.8	O K
960 min Winter	9.725	1.725	2.1	584.8	Flood Risk
1440 min Winter	9.856	1.856	2.1	629.2	Flood Risk
2160 min Winter	9.955	1.955	2.2	662.7	Flood Risk
2880 min Winter	9.989	1.989	2.2	674.2	Flood Risk
4320 min Winter	9.998	1.998	2.2	677.3	Flood Risk
5760 min Winter	9.965	1.965	2.2	666.1	Flood Risk
7200 min Winter	9.904	1.904	2.1	645.4	Flood Risk
8640 min Winter	9.834	1.834	2.1	621.6	Flood Risk
10080 min Winter	9.760	1.760	2.1	596.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	94.213	0.0	122.4	16
30 min Winter	63.227	0.0	113.8	31
60 min Winter	40.534	0.0	240.2	62
120 min Winter	24.414	0.0	244.4	122
180 min Winter	18.118	0.0	251.5	180
240 min Winter	14.670	0.0	260.5	240
360 min Winter	10.924	0.0	274.3	358
480 min Winter	8.888	0.0	283.9	476
600 min Winter	7.586	0.0	290.9	594
720 min Winter	6.673	0.0	296.2	708
960 min Winter	5.461	0.0	303.2	942
1440 min Winter	4.136	0.0	308.2	1398
2160 min Winter	3.133	0.0	601.5	2056
2880 min Winter	2.568	0.0	611.4	2680
4320 min Winter	1.935	0.0	601.3	3368
5760 min Winter	1.575	0.0	1113.5	4320
7200 min Winter	1.337	0.0	1097.2	5256
8640 min Winter	1.166	0.0	1081.3	6136
10080 min Winter	1.037	0.0	1053.4	7056

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 421667 411178 SE 21667 11178
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.750
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+25

Time Area Diagram

Total Area (ha) 1.026

Time (mins) From:	To:	Area (ha)
0	1	1.026

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	339.0	2.000	339.0

Hydro-Brake® Optimum Outflow Control

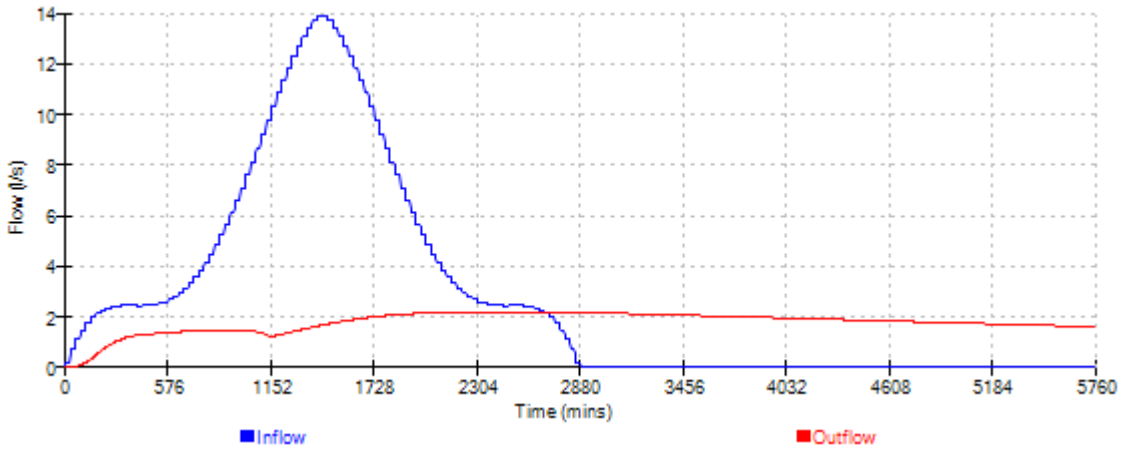
Unit Reference	MD-SHE-0060-2200-2000-2200
Design Head (m)	2.000
Design Flow (l/s)	2.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	60
Invert Level (m)	7.995
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

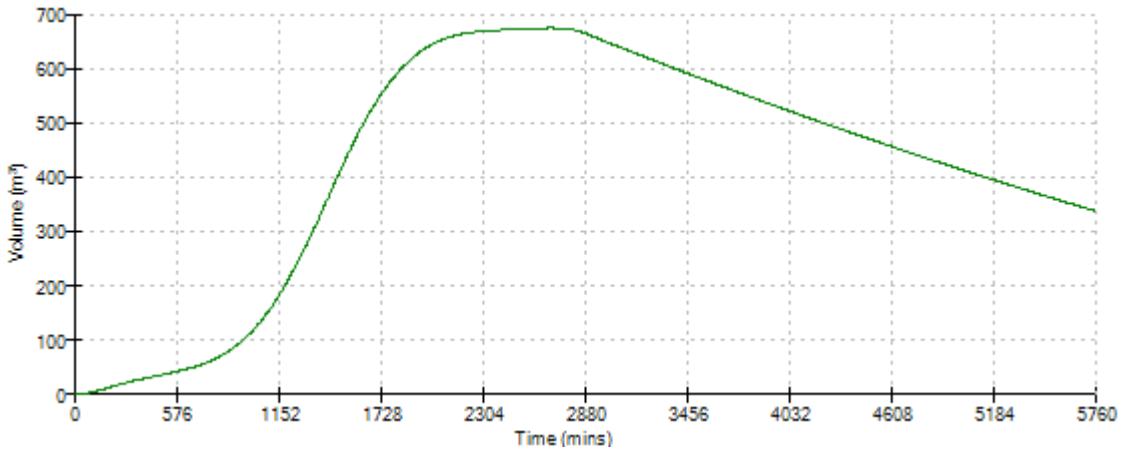
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	2.2
Flush-Flo™	0.262	1.5
Kick-Flo®	0.534	1.2
Mean Flow over Head Range	-	1.6

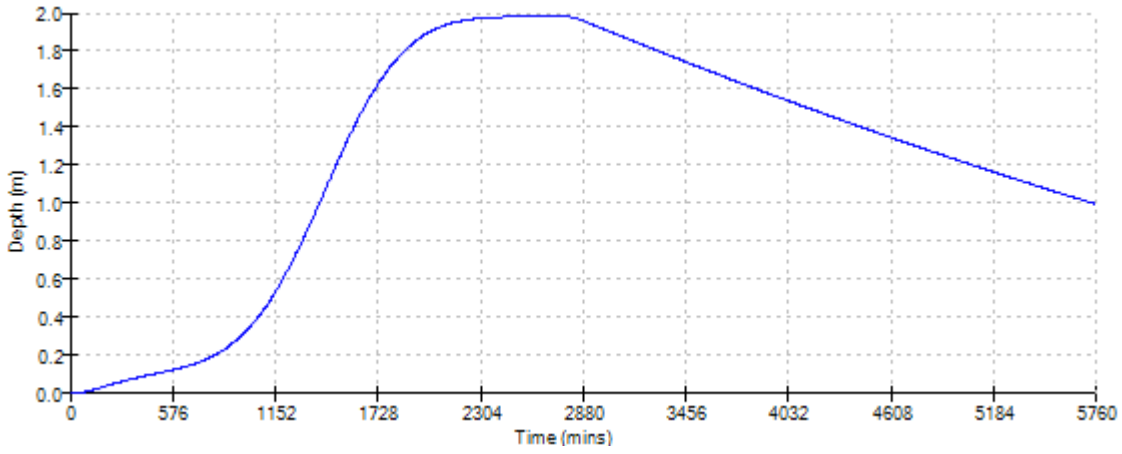
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	1.600	2.0	5.000	3.4
0.200	1.5	1.800	2.1	5.500	3.5
0.300	1.5	2.000	2.2	6.000	3.7
0.400	1.4	2.200	2.3	6.500	3.8
0.500	1.3	2.400	2.4	7.000	3.9
0.600	1.3	2.600	2.5	7.500	4.1
0.800	1.4	3.000	2.6	8.000	4.2
1.000	1.6	3.500	2.8	8.500	4.3
1.200	1.7	4.000	3.0	9.000	4.4
1.400	1.9	4.500	3.2	9.500	4.5

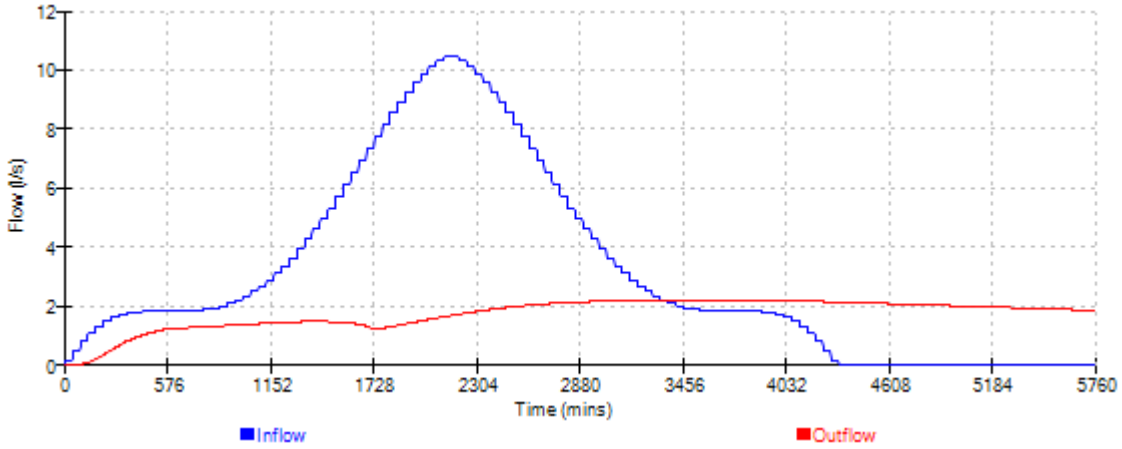
Event: 2880 min Winter

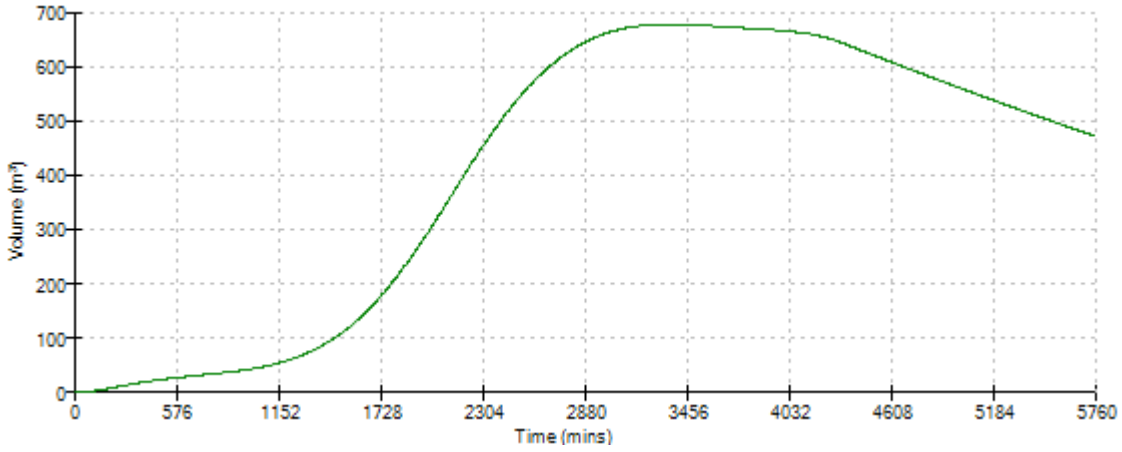


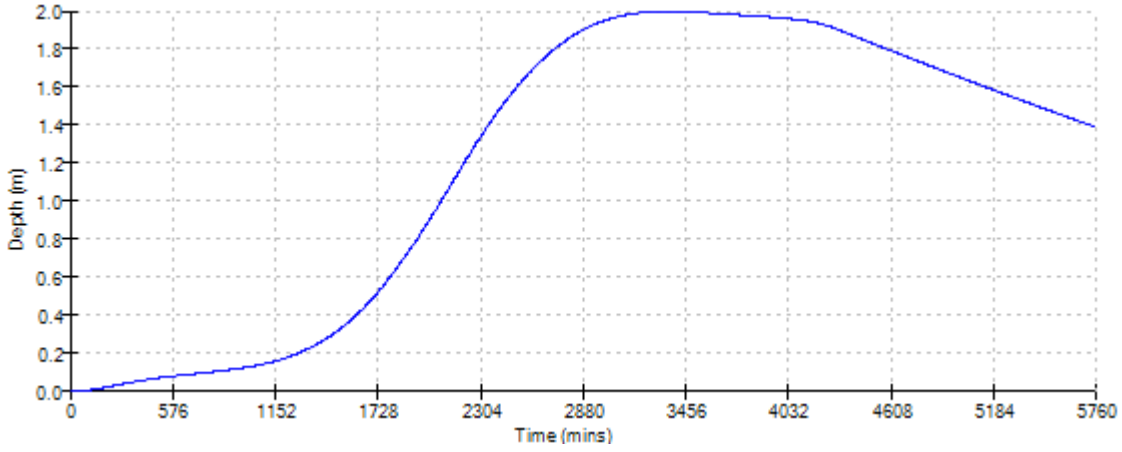




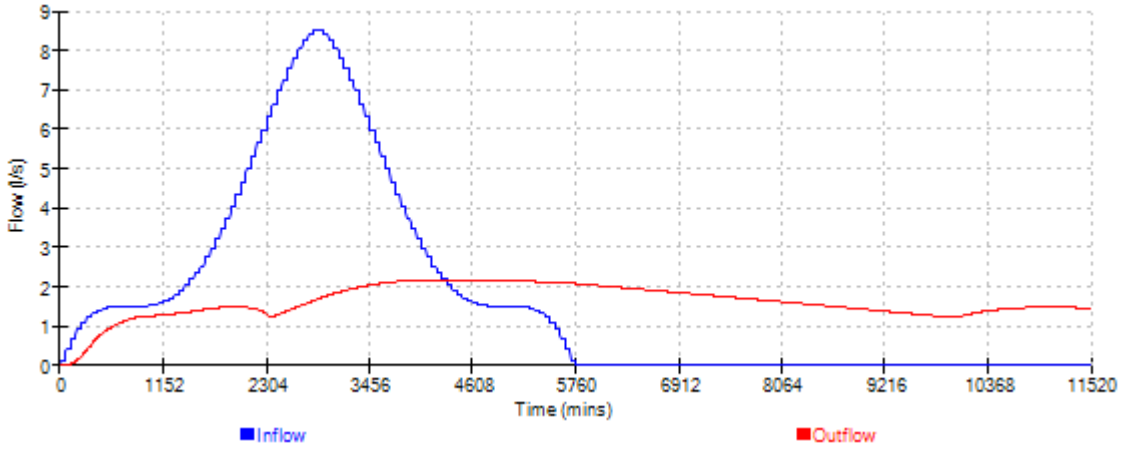
Event: 4320 min Winter

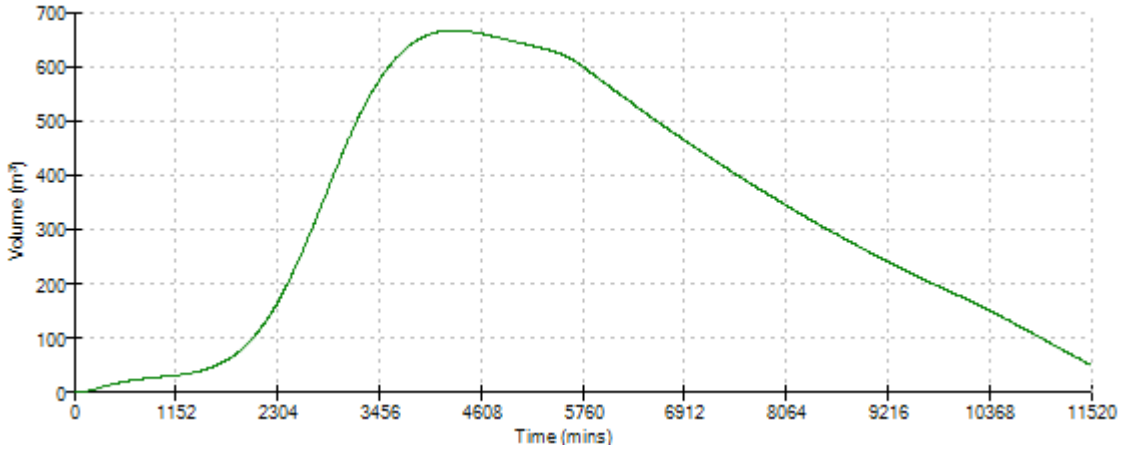


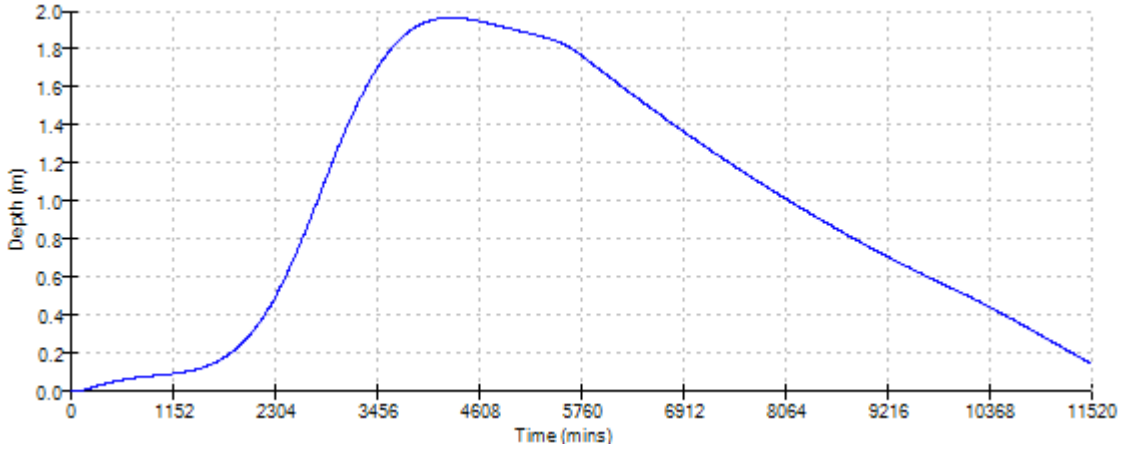




Event: 5760 min Winter







Appendix I Concept Designer's Risk Assessment

CONCEPT DESIGNER'S RISK ASSESSMENT

Project:	Peace Wood Quarry, Huddersfield	**Project No:**	14760
Client:	The Mineral Planning Group Ltd		
Report Reference:	14760-Drainage Strategy-02		

Prepared by:	Megan Williams	**Date:**	16/12/2022
Checked by:	Jordan Jones	**Date:**	19/12/2022
Reviewed by:	Alun Roberts	**Date:**	20/12/2022

Requirement:

The Construction (Design and Management) Regulations 2015 (CDM 2015) place an obligation on the Designer to take all reasonable steps to provide, with the design, sufficient information about the design, construction or maintenance of the structure, to adequately assist the client, other designers and contractors to comply with their duties under CDM. The Designer has undertaken this assessment to identify any extra-ordinary risks, or those that would not be expected on this particular project by an experienced and competent Contractor. The aim is to avoid needless paperwork and bureaucracy and ensure the assessment is project specific, relevant and proportionate to the risk.

DRA Summary

Each of the following risk areas has been considered using the question below. Is a risk present which is considered to be **extra-ordinary or unexpected** in this instance?

If **YES** - A detailed risk assessment is required at design stage
If **UNKNOWN** - Insufficient information has been provided at concept design stage and the risks are unknown. Further consideration must be given at design stage(s)
If **NO** - No further action is required.

Hazard Ref.	Risk Areas	YES, UNKNOWN or NO	Comments
1	Ground Conditions	Unknown	To be confirmed at detail design stage
2	Hazardous Environment	Unknown	To be confirmed at detail design stage
3	Existing Working Environment	Yes	Existing quarry north of the site
4	Existing Services	Unknown	To be confirmed at detail design stage
5	Proximity to Other Structure(s)	Yes	Existing quarry north of the site
6	Near Waterbody / flood risk	Yes	Nicholas Spring east of the site & Baildon Dike north of existing quarry
7	Proximity to Other Activities	Yes	Existing quarry north of the site
8	Sequence of Construction	Unknown	To be confirmed at detail design stage
9	Access	Unknown	To be confirmed at detail design stage
10	Interfaces	Unknown	To be confirmed at detail design stage
11	Confined Space Working	Unknown	To be confirmed at detail design stage
12	Maintenance Considerations	Unknown	To be confirmed at detail design stage
13	Working at Height	Unknown	To be confirmed at detail design stage
14	Steep Slopes	Unknown	To be confirmed at detail design stage
15	Demolition / Refurbishment / Repair	Unknown	To be confirmed at detail design stage
16	Welfare	Unknown	To be confirmed at detail design stage
17	Occupational Health	Unknown	To be confirmed at detail design stage
18	Environmental Issues	Unknown	To be confirmed at detail design stage
19	Other Significant Hazards not Identified Above	Unknown	To be confirmed at detail design stage
20	Residual Risk to Future Users	Unknown	To be confirmed at detail design stage