

Stormwater Drainage Strategy for:
Proposed Dwelling at Former Penallta Colliery.

Steve Morgan Associates

Consulting Civil & Structural Engineers
9 Clytha Park Road
Newport
NP20 4PB

Tel: 01633 266244
e: engineers@smalimited.co.uk

**Former Penallta Colliery
Stormwater Drainage Strategy**

CLIENT: The Power Hall Limited
PROJECT: Former Penallta Colliery
TITLE: Stormwater Drainage Strategy
JOB NO: 1238452
DOCUMENT REF: 1238452 - SDS
Revision: 0

Revision	Purpose	Written	Approved	Date
0	Information	HG	SRM	11/11/25

Signed



S R Morgan B. Eng (Hons) C.Eng. M.I.C.E.

Doc ref: 1238452 - DS Rev 0



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1.0 INTRODUCTION

Steve Morgan Associates Limited (SMA) were appointed to prepare the stormwater drainage strategy for the proposed development at Former Penallta Colliery, Penallta.



Figure 1

Location Plan

The purpose of this report is to present the stormwater drainage strategy for the proposed development. The foul drainage will discharge to the existing drainage network.

2.0 DESCRIPTION OF EXISTING SITE

The site is located at:

Former Penallta Colliery, Penallta

The National Grid Reference for the site is ST 13978 95841.

The site is bounded to residential properties.

3.0 DESCRIPTION OF PROPOSED DEVELOPMENT

Subject to approval of planning permission(s), the site is to be occupied by a development of a number of flats and houses that amount to 172 individual residences, each with parking. The overall impermeable area has been assumed as 7600m², excluding roads and pathways. Parking bays will be permeable.

4.0 STORMWATER DRAINAGE STRATEGY

The drainage design will be undertaken in accordance with CIRIA C753. The proposed drainage scheme will follow the SuDS train with rainwater treated as near as possible to the source. Roof run-off will be discharged as follows:

BLOCK	ROOF AREA (m ²)	DISCHARGED INTO:	SIZE	DEPTH (min)
T1 Block 1	475	Soakaway 1	56500mm x 1000mm	800mm
T1 Block 2	285	Soakaway 2	33500mm x 1000mm	800mm
T1 Block 3	475	Soakaway 3	56500mm x 1000mm	800mm
T1 Block 4	475	Soakaway 4	56500mm x 1000mm	800mm
T1 Block 5	475	Soakaway 5	56500mm x 1000mm	800mm
T1 Block 6	380	Soakaway 6	45000mm x 1000mm	800mm
T4 Block 1	950	Perm. Pav. 1	270m ²	217mm
T4 Block 2	740	Perm. Pav. 2	300m ²	328mm
Block A	775			
Block B	400	Perm. Pav. 3	240m ²	79mm
Power Hall	2,175	Soakaway 7	25000mm x 12500mm	1200mm
		Soakaway 8	49000mm x 26500mm	1200mm

It is proposed that the impermeable roof area of Power Hall will discharge into two soakaways. Approximately 35% of roof run-off will be discharge into Soakaway 7 and 65% into Soakaway 8. The roof run-off will be discharged to soakaways 1-6 via filter chambers/SuDS planters to provide filtration. An outline proposed layout is appended to this report.



DRAINAGE STRATEGY (Cont...)

The permeability tests were undertaken in accordance with BRE-365. The results, attached as Appendix 1.0, have been utilised to carry out the design of the soakaways. All sizes and depths have been established based on the calculations in Appendix 2.0. All other road surfaces will be permeable but self-draining only and will require a minimum depth of 0mm.

The design has been based on a 100-year storm event plus 40% climate change. It should be considered that the use of a 1:100 years storm event with 40% climate change is relatively onerous and the Local Authority may consider a reduction in the criteria. An additional 10% has also been added for urban creep.

The drainage scheme will also make use of tree pits to provide amenity and biodiversity benefits to the site. Where the use of tree pits is not possible, SuDS planters will be utilised, mainly to rear gardens.

4.1 SURFACE WATER

Current guidance from SuDs Wales indicates the following surface water disposal options should be considered.

- 1 Disposal via on-site infiltration systems (Sustainable Urban Drainage).
- 2 Disposal to off-site watercourse.
- 3 Disposal to off-site sewer.

While current regulatory thinking/good practice encourages the use of sustainable drainage techniques, such as infiltration systems (soak-aways), these systems have a maintenance liability not normally associated with traditional, piped disposal systems and require sufficient and/or suitable competence of workings for their entire life span. Any soakaways or infiltration systems installed for the site must, therefore, be regularly maintained to ensure adequate sustainable drainage of effluent and to aid the prevention of flooding.



SURFACE WATER (Cont...)

The system proposed will require limited maintenance with visual inspection of the soakaways annually and cleaning of any porous surfaces such as parking bays bi-annually. All soakaways (dimensions stated above) will comprise Wavin or similar approved Aquacell tanks with 95% free volume (Appendix 3.0).

The proposal satisfies the requirements of the SAB by treating the rainwater close to the source and discharging to soakaways and pervious driveway.

To avoid discharge of water to the north plateau, the soakaways will be located minimum 5m from the boundary. This is to avoid the issue of pore water pressure build up behind the retaining wall. It is possible that the retaining wall will be replaced as part of this development. Should this be the case, any potential build up of water behind the wall will be considered in the final design to eliminate risk to the adjacent school.

The final design may be the subject of further BRE 365 testing once the site has been cut to the correct level.



APPENDIX 1.0

Permeability Test Results



Site	Penallta	Soakaway number	TP8			
Job Number	138452	Length	1.8			
Date of test		Width	1.7			
		Depth	0.25			
		Groundwater Level	Dry			
Method	BRE 365 1991					
	Test 3	Test 2	Test 1			
	Time (mins)	Depth to water (mm)	Time (mins)	Depth to water (mm)	Time (mins)	Depth to water (mm)
	0	0	0	0	0	0
	5	63	5	63	7	63
	10	110	10	100	10	90
	20	150	20	150	20	140
	25	188	25	188	30	188
	30	215	30	200	40	240
	40	230	40	220	50	245
50	245	50	240	60	250	
55	250	60	250			

Figures in red signify 25% depth and 75% depth with corresponding times, interpolated as necessary.

Effective storage depth (m)	0.25	0.25	0.25
75% effective storage depth	0.1875	0.1875	0.1875
Depth below ground level	0.3125	0.3125	0.3125
25% effective storage depth	0.0625	0.0625	0.0625
Depth below ground level	0.4375	0.4375	0.4375
Effective storage depth 75%-25%	0.125	0.125	0.125
Time to fall to 75% effective depth (mins)	25	25	30
Time to fall to 25% effective depth (mins)	5	5	7
V(75%-25%) m3	0.3825	0.3825	0.3825
a (50%)	3.935	3.935	3.935
t (75%-25%)	20	20	23
SOIL INFILTRATION RATE, f (m/s)	8.10038E-05	8.10038E-05	7.04381E-05
DESIGN INFILTRATION RATE (m/s)	7.04381E-05		

Site	Penallta	Soakaway number	TP9
Job Number	1238452	Length	1
Date of test		Width	1
		Depth	0.8
		Groundwater Level	Dry

Method	BRE 365 1991					
	Test 1		Test 2		Test 3	
	Time (mins)	Depth to water (mm)	Time (mins)	Depth to water (mm)	Time (mins)	Depth to water (mm)
	0	0	0	0	0	0
	10	35	10	65	10	95
	20	75	13	125	16	188
	30	105	20	215	20	280
	40	155	30	295	30	375
	50	190	40	375	40	470
	58	225	50	440	49	563
	60	255	53	500	50	570
	70	290			60	660
	77	300			65	750


Figures in red signify 25% depth and 75% depth with corresponding times, interpolated as necessary.

Effective storage depth (m)			
75% effective storage depth			
Depth below ground level			
25% effective storage depth			
Depth below ground level			
Effective storage depth 75%-25%			
Time to fall to 75% effective depth (mins)	58	40	49
Time to fall to 25% effective depth (mins)	20	13	16
V(75%-25%) m3	0.4	0.4	0.4
a (50%)	2.6	2.6	2.6
t (75%-25%)	38	27	33
SOIL INFILTRATION RATE, f (m/s)	6.74764E-05	9.49668E-05	7.77001E-05
DESIGN INFILTRATION RATE (m/s)	6.74764E-05		

APPENDIX 2.0

Soakaways and Permeable Paving Calculations



 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - T1 BLOCKS 1,3,4,5				Start page no./Revision 1	
	Calcs by HG	Calcs date 12/11/2025	Checked by	Checked date	Approved by	Approved date

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area	Cardiff
Impermeable area drained to the system	A = 474.6 m ²
Return period	Period = 100 yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = 0.300
5-year return period rainfall of 60 minutes duration	M5_60min = 20.0 mm
Increase of rainfall intensity due to global warming	p _{climate} = 50 %

Soakaway / infiltration trench details

Soakaway type	Rectangular
Minimum depth of pit (below incoming invert)	d = 800 mm
Width of pit	w = 1000 mm
Length of pit	l = 56500 mm
Percentage free volume	V _{free} = 95 %


Soil infiltration rate (BRE digest 365)

Length of trial pit	l _{trial} = 2300 mm
Width of trial pit	b _{trial} = 1900 mm
Depth of trial pit (below invert)	d _{trial} = 1000 mm
Free volume (if fill used)	V _{trial} = 100 %
75% depth of pit	d ₇₅ = (d _{trial} × 0.75) = 750.00 mm
50% depth of pit	d ₅₀ = (d _{trial} × 0.50) = 500.00 mm
25% depth of pit	d ₂₅ = (d _{trial} × 0.25) = 250.00 mm
Test 1 - time to fall from 75% depth to 25% depth	T1 = 435 min
Test 2 - time to fall from 75% depth to 25% depth	T2 = 480 min
Test 3 - time to fall from 75% depth to 25% depth	T3 = 500 min
Longest time to fall from 75% depth to 25% depth	t _{lg} = max(T1, T2, T3) = 500 min
Storage volume from 75% to 25% depth	V _{p75_25} = (l _{trial} × b _{trial} × (d ₇₅ - d ₂₅)) × V _{trial} = 2.19 m ³
Internal surface area to 50% depth	a _{p50} = ((l _{trial} × b _{trial}) + (l _{trial} + b _{trial}) × 2 × d ₅₀) = 8.57 m ²
Surface area of soakaway to 50% storage depth	A _{s50} = 2 × (l _{trial} + b _{trial}) × d _{trial} / 2 = 4.200 m ²
Soil infiltration rate	f = V _{p75_25} / (a _{p50} × t _{lg}) = 8.50×10⁻⁶ m/s
Wetted area of pit 50% full	a _{s50} = l × d + w × d = 46000000 mm ²

Table equations

Inflow	I = M100 × A
Outflow	O = a _{s50} × f × D
Storage	S = I - O

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m³)	Outflow (m³)	Storage required (m³)
5	0.34	10.2	1.91	19.5	9.26	0.12	9.14
10	0.49	14.7	1.99	29.2	13.85	0.23	13.62
15	0.59	17.7	2.01	35.6	16.90	0.35	16.55

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - T1 BLOCKS 1,3,4,5				Start page no./Revision 2	
	Calcs by HG	Calcs date 12/11/2025	Checked by	Checked date	Approved by	Approved date

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m³)	Outflow (m³)	Storage required (m³)
30	0.77	23.1	2.02	46.6	22.12	0.70	21.42
60	1.00	30.0	1.97	59.1	28.05	1.41	26.64
120	1.25	37.5	1.91	71.6	33.99	2.81	31.18
240	1.57	47.1	1.83	86.3	40.98	5.63	35.35
360	1.78	53.4	1.79	95.4	45.29	8.44	36.84
600	2.12	63.6	1.72	109.2	51.84	14.07	37.77
1440	2.84	85.2	1.60	136.3	64.67	33.78	30.89

Required storage volume

$$S_{\text{req}} = \mathbf{37.77 \text{ m}^3}$$

Soakaway storage volume


$$S_{\text{act}} = l \times d \times w \times V_{\text{free}} = \mathbf{42.94 \text{ m}^3}$$

PASS - Soakaway storage volume

Time for emptying soakaway to half volume

$$t_{s50} = S_{\text{req}} \times 0.5 / (a_{s50} \times f) = \mathbf{13\text{hr } 25\text{min } 6\text{s}}$$

PASS - Soakaway discharge time less than or equal to 24 hours

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - T1 BLOCK 2				Start page no./Revision 1	
	Calcs by HG	Calcs date 19/11/2025	Checked by	Checked date	Approved by	Approved date

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area	Cardiff
Impermeable area drained to the system	A = 285.0 m ²
Return period	Period = 100 yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = 0.300
5-year return period rainfall of 60 minutes duration	M5_60min = 20.0 mm
Increase of rainfall intensity due to global warming	p _{climate} = 50 %

Soakaway / infiltration trench details

Soakaway type	Rectangular
Minimum depth of pit (below incoming invert)	d = 800 mm
Width of pit	w = 1000 mm
Length of pit	l = 33500 mm
Percentage free volume	V _{free} = 95 %


Soil infiltration rate (BRE digest 365)

Length of trial pit	l _{trial} = 2300 mm
Width of trial pit	b _{trial} = 1900 mm
Depth of trial pit (below invert)	d _{trial} = 1000 mm
Free volume (if fill used)	V _{trial} = 100 %
75% depth of pit	d ₇₅ = (d _{trial} × 0.75) = 750.00 mm
50% depth of pit	d ₅₀ = (d _{trial} × 0.50) = 500.00 mm
25% depth of pit	d ₂₅ = (d _{trial} × 0.25) = 250.00 mm
Test 1 - time to fall from 75% depth to 25% depth	T1 = 435 min
Test 2 - time to fall from 75% depth to 25% depth	T2 = 480 min
Test 3 - time to fall from 75% depth to 25% depth	T3 = 500 min
Longest time to fall from 75% depth to 25% depth	t _{lg} = max(T1, T2, T3) = 500 min
Storage volume from 75% to 25% depth	V _{p75_25} = (l _{trial} × b _{trial} × (d ₇₅ - d ₂₅)) × V _{trial} = 2.19 m ³
Internal surface area to 50% depth	a _{p50} = ((l _{trial} × b _{trial}) + (l _{trial} + b _{trial}) × 2 × d ₅₀) = 8.57 m ²
Surface area of soakaway to 50% storage depth	A _{s50} = 2 × (l _{trial} + b _{trial}) × d _{trial} / 2 = 4.200 m ²
Soil infiltration rate	f = V _{p75_25} / (a _{p50} × t _{lg}) = 8.50×10⁻⁶ m/s
Wetted area of pit 50% full	a _{s50} = l × d + w × d = 27600000 mm ²

Table equations

Inflow	I = M100 × A
Outflow	O = a _{s50} × f × D
Storage	S = I - O

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m ³)	Outflow (m ³)	Storage required (m ³)
5	0.34	10.2	1.91	19.5	5.56	0.07	5.49
10	0.49	14.7	1.99	29.2	8.32	0.14	8.18
15	0.59	17.7	2.01	35.6	10.15	0.21	9.94

 Tedds STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project				Job no.	
	PENALLTA COLLIERY				1238452	
	Calcs for				Start page no./Revision	
	SOAKAWAY - T1 BLOCK 2				2	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	HG	19/11/2025				

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m³)	Outflow (m³)	Storage required (m³)
30	0.77	23.1	2.02	46.6	13.28	0.42	12.86
60	1.00	30.0	1.97	59.1	16.84	0.84	16.00
120	1.25	37.5	1.91	71.6	20.41	1.69	18.72
240	1.57	47.1	1.83	86.3	24.61	3.38	21.23
360	1.78	53.4	1.79	95.4	27.19	5.07	22.13
600	2.12	63.6	1.72	109.2	31.13	8.44	22.69
1440	2.84	85.2	1.60	136.3	38.83	20.27	18.57

Required storage volume

$$S_{\text{req}} = 22.69 \text{ m}^3$$

Soakaway storage volume


$$S_{\text{act}} = l \times d \times w \times V_{\text{free}} = 25.46 \text{ m}^3$$

PASS - Soakaway storage volume

Time for emptying soakaway to half volume

$$t_{s50} = S_{\text{req}} \times 0.5 / (a_{s50} \times f) = 13\text{hr } 26\text{min } 2\text{s}$$

PASS - Soakaway discharge time less than or equal to 24 hours

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - T1 BLOCK 6				Start page no./Revision 1	
	Calcs by HG	Calcs date 19/11/2025	Checked by	Checked date	Approved by	Approved date

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area	Cardiff
Impermeable area drained to the system	A = 380.0 m ²
Return period	Period = 100 yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = 0.300
5-year return period rainfall of 60 minutes duration	M5_60min = 20.0 mm
Increase of rainfall intensity due to global warming	p _{climate} = 50 %

Soakaway / infiltration trench details

Soakaway type	Rectangular
Minimum depth of pit (below incoming invert)	d = 800 mm
Width of pit	w = 1000 mm
Length of pit	l = 45000 mm
Percentage free volume	V _{free} = 95 %


Soil infiltration rate (BRE digest 365)

Length of trial pit	l _{trial} = 2300 mm
Width of trial pit	b _{trial} = 1900 mm
Depth of trial pit (below invert)	d _{trial} = 1000 mm
Free volume (if fill used)	V _{trial} = 100 %
75% depth of pit	d ₇₅ = (d _{trial} × 0.75) = 750.00 mm
50% depth of pit	d ₅₀ = (d _{trial} × 0.50) = 500.00 mm
25% depth of pit	d ₂₅ = (d _{trial} × 0.25) = 250.00 mm
Test 1 - time to fall from 75% depth to 25% depth	T1 = 435 min
Test 2 - time to fall from 75% depth to 25% depth	T2 = 480 min
Test 3 - time to fall from 75% depth to 25% depth	T3 = 500 min
Longest time to fall from 75% depth to 25% depth	t _{lg} = max(T1, T2, T3) = 500 min
Storage volume from 75% to 25% depth	V _{p75_25} = (l _{trial} × b _{trial} × (d ₇₅ - d ₂₅)) × V _{trial} = 2.19 m ³
Internal surface area to 50% depth	a _{p50} = ((l _{trial} × b _{trial}) + (l _{trial} + b _{trial}) × 2 × d ₅₀) = 8.57 m ²
Surface area of soakaway to 50% storage depth	A _{s50} = 2 × (l _{trial} + b _{trial}) × d _{trial} / 2 = 4.200 m ²
Soil infiltration rate	f = V _{p75_25} / (a _{p50} × t _{lg}) = 8.50×10⁻⁶ m/s
Wetted area of pit 50% full	a _{s50} = l × d + w × d = 36800000 mm ²

Table equations

Inflow	I = M100 × A
Outflow	O = a _{s50} × f × D
Storage	S = I - O

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m ³)	Outflow (m ³)	Storage required (m ³)
5	0.34	10.2	1.91	19.5	7.42	0.09	7.32
10	0.49	14.7	1.99	29.2	11.09	0.19	10.90
15	0.59	17.7	2.01	35.6	13.53	0.28	13.25

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - T1 BLOCK 6				Start page no./Revision 2	
	Calcs by HG	Calcs date 19/11/2025	Checked by	Checked date	Approved by	Approved date

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m³)	Outflow (m³)	Storage required (m³)
30	0.77	23.1	2.02	46.6	17.71	0.56	17.15
60	1.00	30.0	1.97	59.1	22.46	1.13	21.33
120	1.25	37.5	1.91	71.6	27.22	2.25	24.97
240	1.57	47.1	1.83	86.3	32.81	4.50	28.31
360	1.78	53.4	1.79	95.4	36.26	6.76	29.50
600	2.12	63.6	1.72	109.2	41.51	11.26	30.25
1440	2.84	85.2	1.60	136.3	51.78	27.02	24.75

Required storage volume

$$S_{\text{req}} = 30.25 \text{ m}^3$$

Soakaway storage volume


$$S_{\text{act}} = l \times d \times w \times V_{\text{free}} = 34.20 \text{ m}^3$$

PASS - Soakaway storage volume

Time for emptying soakaway to half volume

$$t_{s50} = S_{\text{req}} \times 0.5 / (a_{s50} \times f) = 13\text{hr } 26\text{min } 2\text{s}$$

PASS - Soakaway discharge time less than or equal to 24 hours

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - 35% POWER HALL				Start page no./Revision 1	
	Calcs by HG	Calcs date 14/11/2025	Checked by	Checked date	Approved by	Approved date

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area	Cardiff
Impermeable area drained to the system	A = 725.0 m ²
Return period	Period = 100 yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = 0.300
5-year return period rainfall of 60 minutes duration	M5_60min = 20.0 mm
Increase of rainfall intensity due to global warming	p _{climate} = 50 %

Soakaway / infiltration trench details

Soakaway type	Rectangular
Minimum depth of pit (below incoming invert)	d = 1200 mm
Width of pit	w = 12500 mm
Length of pit	l = 25000 mm
Percentage free volume	V _{free} = 95 %


Soil infiltration rate (BRE digest 365)

Length of trial pit	l _{trial} = 2300 mm
Width of trial pit	b _{trial} = 1900 mm
Depth of trial pit (below invert)	d _{trial} = 1000 mm
Free volume (if fill used)	V _{trial} = 100 %
75% depth of pit	d ₇₅ = (d _{trial} × 0.75) = 750.00 mm
50% depth of pit	d ₅₀ = (d _{trial} × 0.50) = 500.00 mm
25% depth of pit	d ₂₅ = (d _{trial} × 0.25) = 250.00 mm
Test 1 - time to fall from 75% depth to 25% depth	T1 = 435 min
Test 2 - time to fall from 75% depth to 25% depth	T2 = 480 min
Test 3 - time to fall from 75% depth to 25% depth	T3 = 500 min
Longest time to fall from 75% depth to 25% depth	t _{lg} = max(T1, T2, T3) = 500 min
Storage volume from 75% to 25% depth	V _{p75_25} = (l _{trial} × b _{trial} × (d ₇₅ - d ₂₅)) × V _{trial} = 2.19 m ³
Internal surface area to 50% depth	a _{p50} = ((l _{trial} × b _{trial}) + (l _{trial} + b _{trial}) × 2 × d ₅₀) = 8.57 m ²
Surface area of soakaway to 50% storage depth	A _{s50} = 2 × (l _{trial} + b _{trial}) × d _{trial} / 2 = 4.200 m ²
Soil infiltration rate	f = V _{p75_25} / (a _{p50} × t _{lg}) = 8.50×10⁻⁶ m/s
Wetted area of pit 50% full	a _{s50} = l × d + w × d = 45000000 mm ²

Table equations

Inflow	I = M100 × A
Outflow	O = a _{s50} × f × D
Storage	S = I - O

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m ³)	Outflow (m ³)	Storage required (m ³)
5	0.34	10.2	1.91	19.5	14.15	0.11	14.03
10	0.49	14.7	1.99	29.2	21.16	0.23	20.93
15	0.59	17.7	2.01	35.6	25.81	0.34	25.47

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - 35% POWER HALL				Start page no./Revision 2	
	Calcs by HG	Calcs date 14/11/2025	Checked by	Checked date	Approved by	Approved date

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m³)	Outflow (m³)	Storage required (m³)
30	0.77	23.1	2.02	46.6	33.79	0.69	33.10
60	1.00	30.0	1.97	59.1	42.85	1.38	41.47
120	1.25	37.5	1.91	71.6	51.93	2.75	49.17
240	1.57	47.1	1.83	86.3	62.60	5.51	57.09
360	1.78	53.4	1.79	95.4	69.18	8.26	60.92
600	2.12	63.6	1.72	109.2	79.19	13.77	65.43
1440	2.84	85.2	1.60	136.3	98.78	33.04	65.74

Required storage volume

$$S_{\text{req}} = \mathbf{65.74 \text{ m}^3}$$

Soakaway storage volume


$$S_{\text{act}} = l \times d \times w \times V_{\text{free}} = \mathbf{356.25 \text{ m}^3}$$

PASS - Soakaway storage volume

Time for emptying soakaway to half volume

$$t_{s50} = S_{\text{req}} \times 0.5 / (a_{s50} \times f) = \mathbf{23\text{hr } 52\text{min } 29\text{s}}$$

PASS - Soakaway discharge time less than or equal to 24 hours

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - 65% POWER HALL				Start page no./Revision 1	
	Calcs by HG	Calcs date 14/11/2025	Checked by	Checked date	Approved by	Approved date

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area **Cardiff**
 Impermeable area drained to the system **A = 1450.0 m²**
 Return period **Period = 100 yr**
 Ratio 60 min to 2 day rainfall of 5 yr return period **r = 0.300**
 5-year return period rainfall of 60 minutes duration **M5_60min = 20.0 mm**
 Increase of rainfall intensity due to global warming **p_{climate} = 50 %**

Soakaway / infiltration trench details

Soakaway type **Rectangular**
 Minimum depth of pit (below incoming invert) **d = 1200 mm**
 Width of pit **w = 26500 mm**
 Length of pit **l = 49000 mm**
 Percentage free volume **V_{free} = 95 %**


Soil infiltration rate (BRE digest 365)

Length of trial pit **l_{trial} = 2300 mm**
 Width of trial pit **b_{trial} = 1900 mm**
 Depth of trial pit (below invert) **d_{trial} = 1000 mm**
 Free volume (if fill used) **V_{trial} = 100 %**
 75% depth of pit **d₇₅ = (d_{trial} × 0.75) = 750.00 mm**
 50% depth of pit **d₅₀ = (d_{trial} × 0.50) = 500.00 mm**
 25% depth of pit **d₂₅ = (d_{trial} × 0.25) = 250.00 mm**
 Test 1 - time to fall from 75% depth to 25% depth **T1 = 435 min**
 Test 2 - time to fall from 75% depth to 25% depth **T2 = 480 min**
 Test 3 - time to fall from 75% depth to 25% depth **T3 = 500 min**
 Longest time to fall from 75% depth to 25% depth **t_{lg} = max(T1, T2, T3) = 500 min**
 Storage volume from 75% to 25% depth **V_{p75_25} = (l_{trial} × b_{trial} × (d₇₅ - d₂₅)) × V_{trial} = 2.19 m³**
 Internal surface area to 50% depth **a_{p50} = ((l_{trial} × b_{trial}) + (l_{trial} + b_{trial}) × 2 × d₅₀) = 8.57 m²**
 Surface area of soakaway to 50% storage depth **A_{s50} = 2 × (l_{trial} + b_{trial}) × d_{trial} / 2 = 4.200 m²**
 Soil infiltration rate **f = V_{p75_25} / (a_{p50} × t_{lg}) = 8.50×10⁻⁶ m/s**
 Wetted area of pit 50% full **a_{s50} = l × d + w × d = 90600000 mm²**

Table equations

Inflow **I = M100 × A**
 Outflow **O = a_{s50} × f × D**
 Storage **S = I - O**

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m ³)	Outflow (m ³)	Storage required (m ³)
5	0.34	10.2	1.91	19.5	28.30	0.23	28.07
10	0.49	14.7	1.99	29.2	42.31	0.46	41.85
15	0.59	17.7	2.01	35.6	51.63	0.69	50.93

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SOAKAWAY - 65% POWER HALL				Start page no./Revision 2	
	Calcs by HG	Calcs date 14/11/2025	Checked by	Checked date	Approved by	Approved date

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m³)	Outflow (m³)	Storage required (m³)
30	0.77	23.1	2.02	46.6	67.58	1.39	66.19
60	1.00	30.0	1.97	59.1	85.70	2.77	82.92
120	1.25	37.5	1.91	71.6	103.86	5.54	98.31
240	1.57	47.1	1.83	86.3	125.20	11.09	114.11
360	1.78	53.4	1.79	95.4	138.36	16.63	121.73
600	2.12	63.6	1.72	109.2	158.39	27.72	130.67
1440	2.84	85.2	1.60	136.3	197.57	66.53	131.04

Required storage volume

$$S_{\text{req}} = 131.04 \text{ m}^3$$

Soakaway storage volume


$$S_{\text{act}} = l \times d \times w \times V_{\text{free}} = 1480.29 \text{ m}^3$$

PASS - Soakaway storage volume

Time for emptying soakaway to half volume

$$t_{s50} = S_{\text{req}} \times 0.5 / (a_{s50} \times f) = 23\text{hr } 38\text{min } 13\text{s}$$

PASS - Soakaway discharge time less than or equal to 24 hours

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project				Job no.	
	PENALLTA COLLIERY				1238452	
	Calcs for				Start page no./Revision	
	PAVING TO T4 BLOCK 1				1	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	HG	12/11/2025				

PLANE INFILTRATION SYSTEM DESIGN

In accordance with CIRIA C697 SUDS

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area Cardiff
 Impermeable area drained to the system $A = 1220.0 \text{ m}^2$
 Return period Period = 100 yr
 Ratio 60 min to 2 day rainfall of 5 yr return period $r = 0.300$
 5-year return period rainfall of 60 minutes duration $M5_{60\text{min}} = 20.0 \text{ mm}$
 Increase of rainfall intensity due to global warming $p_{\text{climate}} = 50 \%$

Infiltration blanket details

Base area of blanket $A_b = 270.0 \text{ m}^2$
 Porosity $n = 0.45$
 Drainage ratio $R = A / A_b = 4.5$


Soil infiltration rate (BRE digest 365)

Length of trial pit $l_{\text{trial}} = 1800 \text{ mm}$
 Width of trial pit $b_{\text{trial}} = 1700 \text{ mm}$
 Depth of trial pit (below invert) $d_{\text{trial}} = 250 \text{ mm}$
 Free volume (if fill used) $V_{\text{trial}} = 100 \%$
 75% depth of pit $d_{75} = (d_{\text{trial}} \times 0.75) = 187.50 \text{ mm}$
 50% depth of pit $d_{50} = (d_{\text{trial}} \times 0.50) = 125.00 \text{ mm}$
 25% depth of pit $d_{25} = (d_{\text{trial}} \times 0.25) = 62.50 \text{ mm}$
 Test 1 - time to fall from 75% depth to 25% depth $T1 = 20 \text{ min}$
 Test 2 - time to fall from 75% depth to 25% depth $T2 = 20 \text{ min}$
 Test 3 - time to fall from 75% depth to 25% depth $T3 = 23 \text{ min}$
 Longest time to fall from 75% depth to 25% depth $t_g = \max(T1, T2, T3) = 23 \text{ min}$
 Storage volume from 75% to 25% depth $V_{p75_{25}} = (l_{\text{trial}} \times b_{\text{trial}} \times (d_{75} - d_{25})) \times V_{\text{trial}} = 0.38 \text{ m}^3$
 Internal surface area to 50% depth $a_{p50} = ((l_{\text{trial}} \times b_{\text{trial}}) + (l_{\text{trial}} + b_{\text{trial}}) \times 2 \times d_{50}) = 3.94 \text{ m}^2$
 Surface area of soakaway to 50% storage depth $A_{s50} = 2 \times (l_{\text{trial}} + b_{\text{trial}}) \times d_{\text{trial}} / 2 = 0.875 \text{ m}^2$
 Soil infiltration rate $f = V_{p75_{25}} / (a_{p50} \times t_g) = 70.4 \times 10^{-6} \text{ m/s}$

Table equations

Rainfall intensity $i = M100 / D$
 Minimum depth required $H = D / n \times (R \times i - f)$

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Intensity, i (mm/hr)	Depth (mm)
5	0.34	10.2	1.91	19.5	234.18	149
10	0.49	14.7	1.99	29.2	175.09	199
15	0.59	17.7	2.01	35.6	142.42	217
30	0.77	23.1	2.02	46.6	93.21	186
60	1.00	30.0	1.97	59.1	59.10	30
120	1.25	37.5	1.91	71.6	35.81	0
240	1.57	47.1	1.83	86.3	21.59	0
360	1.78	53.4	1.79	95.4	15.90	0


 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for PAVING TO T4 BLOCK 1				Start page no./Revision 2	
	Calcs by HG	Calcs date 12/11/2025	Checked by	Checked date	Approved by	Approved date

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Intensity, i (mm/hr)	Depth (mm)
600	2.12	63.6	1.72	109.2	10.92	0
1440	2.84	85.2	1.60	136.3	5.68	0

Min depth of blanket req'd $H_{\max} = 217 \text{ mm}$

Time for emptying blanket to half volume $t_{s50} = n \times H_{\max} / (2 \times f) = 11 \text{ min } 32 \text{ s}$

PASS - Infiltration system discharge time less than or equal to 24 hours

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project				Job no.	
	PENALLTA COLLIERY				1238452	
	Calcs for PAVING TO T4 BLOCK 2 AND BLOCK A				Start page no./Revision 1	
	Calcs by HG	Calcs date 12/11/2025	Checked by	Checked date	Approved by	Approved date

PLANE INFILTRATION SYSTEM DESIGN

In accordance with CIRIA C697 SUDS

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area Cardiff
 Impermeable area drained to the system $A = 1765.0 \text{ m}^2$
 Return period Period = 100 yr
 Ratio 60 min to 2 day rainfall of 5 yr return period $r = 0.300$
 5-year return period rainfall of 60 minutes duration $M5_{60\text{min}} = 20.0 \text{ mm}$
 Increase of rainfall intensity due to global warming $p_{\text{climate}} = 50 \%$

Infiltration blanket details

Base area of blanket $A_b = 300.0 \text{ m}^2$
 Porosity $n = 0.45$
 Drainage ratio $R = A / A_b = 5.9$


Soil infiltration rate (BRE digest 365)

Length of trial pit $l_{\text{trial}} = 1800 \text{ mm}$
 Width of trial pit $b_{\text{trial}} = 1700 \text{ mm}$
 Depth of trial pit (below invert) $d_{\text{trial}} = 250 \text{ mm}$
 Free volume (if fill used) $V_{\text{trial}} = 100 \%$
 75% depth of pit $d_{75} = (d_{\text{trial}} \times 0.75) = 187.50 \text{ mm}$
 50% depth of pit $d_{50} = (d_{\text{trial}} \times 0.50) = 125.00 \text{ mm}$
 25% depth of pit $d_{25} = (d_{\text{trial}} \times 0.25) = 62.50 \text{ mm}$
 Test 1 - time to fall from 75% depth to 25% depth $T1 = 20 \text{ min}$
 Test 2 - time to fall from 75% depth to 25% depth $T2 = 20 \text{ min}$
 Test 3 - time to fall from 75% depth to 25% depth $T3 = 23 \text{ min}$
 Longest time to fall from 75% depth to 25% depth $t_g = \max(T1, T2, T3) = 23 \text{ min}$
 Storage volume from 75% to 25% depth $V_{p75_{25}} = (l_{\text{trial}} \times b_{\text{trial}} \times (d_{75} - d_{25})) \times V_{\text{trial}} = 0.38 \text{ m}^3$
 Internal surface area to 50% depth $a_{p50} = ((l_{\text{trial}} \times b_{\text{trial}}) + (l_{\text{trial}} + b_{\text{trial}}) \times 2 \times d_{50}) = 3.94 \text{ m}^2$
 Surface area of soakaway to 50% storage depth $A_{s50} = 2 \times (l_{\text{trial}} + b_{\text{trial}}) \times d_{\text{trial}} / 2 = 0.875 \text{ m}^2$
 Soil infiltration rate $f = V_{p75_{25}} / (a_{p50} \times t_g) = 70.4 \times 10^{-6} \text{ m/s}$

Table equations

Rainfall intensity $i = M100 / D$
 Minimum depth required $H = D / n \times (R \times i - f)$

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Intensity, i (mm/hr)	Depth (mm)
5	0.34	10.2	1.91	19.5	234.18	208
10	0.49	14.7	1.99	29.2	175.09	288
15	0.59	17.7	2.01	35.6	142.42	325
30	0.77	23.1	2.02	46.6	93.21	328
60	1.00	30.0	1.97	59.1	59.10	209
120	1.25	37.5	1.91	71.6	35.81	0
240	1.57	47.1	1.83	86.3	21.59	0
360	1.78	53.4	1.79	95.4	15.90	0


 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project				Job no.	
	PENALLTA COLLIERY				1238452	
	Calcs for				Start page no./Revision	
	PAVING TO T4 BLOCK 2 AND BLOCK A				2	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	HG	12/11/2025				

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Intensity, i (mm/hr)	Depth (mm)
600	2.12	63.6	1.72	109.2	10.92	0
1440	2.84	85.2	1.60	136.3	5.68	0

Min depth of blanket req'd $H_{\max} = 328 \text{ mm}$

Time for emptying blanket to half volume $t_{s50} = n \times H_{\max} / (2 \times f) = 17 \text{ min } 26 \text{ s}$

PASS - Infiltration system discharge time less than or equal to 24 hours

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project				Job no.	
	PENALLTA COLLIERY				1238452	
	Calcs for				Start page no./Revision	
	PAVING TO BLOCK B				1	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	HG	12/11/2025				

PLANE INFILTRATION SYSTEM DESIGN

In accordance with CIRIA C697 SUDS

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area Cardiff
 Impermeable area drained to the system $A = 640.0 \text{ m}^2$
 Return period Period = 100 yr
 Ratio 60 min to 2 day rainfall of 5 yr return period $r = 0.300$
 5-year return period rainfall of 60 minutes duration $M5_{60\text{min}} = 20.0 \text{ mm}$
 Increase of rainfall intensity due to global warming $p_{\text{climate}} = 50 \%$

Infiltration blanket details

Base area of blanket $A_b = 240.0 \text{ m}^2$
 Porosity $n = 0.45$
 Drainage ratio $R = A / A_b = 2.7$


Soil infiltration rate (BRE digest 365)

Length of trial pit $l_{\text{trial}} = 1800 \text{ mm}$
 Width of trial pit $b_{\text{trial}} = 1700 \text{ mm}$
 Depth of trial pit (below invert) $d_{\text{trial}} = 250 \text{ mm}$
 Free volume (if fill used) $V_{\text{trial}} = 100 \%$
 75% depth of pit $d_{75} = (d_{\text{trial}} \times 0.75) = 187.50 \text{ mm}$
 50% depth of pit $d_{50} = (d_{\text{trial}} \times 0.50) = 125.00 \text{ mm}$
 25% depth of pit $d_{25} = (d_{\text{trial}} \times 0.25) = 62.50 \text{ mm}$
 Test 1 - time to fall from 75% depth to 25% depth $T1 = 20 \text{ min}$
 Test 2 - time to fall from 75% depth to 25% depth $T2 = 20 \text{ min}$
 Test 3 - time to fall from 75% depth to 25% depth $T3 = 23 \text{ min}$
 Longest time to fall from 75% depth to 25% depth $t_g = \max(T1, T2, T3) = 23 \text{ min}$
 Storage volume from 75% to 25% depth $V_{p75_{25}} = (l_{\text{trial}} \times b_{\text{trial}} \times (d_{75} - d_{25})) \times V_{\text{trial}} = 0.38 \text{ m}^3$
 Internal surface area to 50% depth $a_{p50} = ((l_{\text{trial}} \times b_{\text{trial}}) + (l_{\text{trial}} + b_{\text{trial}}) \times 2 \times d_{50}) = 3.94 \text{ m}^2$
 Surface area of soakaway to 50% storage depth $A_{s50} = 2 \times (l_{\text{trial}} + b_{\text{trial}}) \times d_{\text{trial}} / 2 = 0.875 \text{ m}^2$
 Soil infiltration rate $f = V_{p75_{25}} / (a_{p50} \times t_g) = 70.4 \times 10^{-6} \text{ m/s}$

Table equations

Rainfall intensity $i = M100 / D$
 Minimum depth required $H = D / n \times (R \times i - f)$

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Intensity, i (mm/hr)	Depth (mm)
5	0.34	10.2	1.91	19.5	234.18	69
10	0.49	14.7	1.99	29.2	175.09	79
15	0.59	17.7	2.01	35.6	142.42	70
30	0.77	23.1	2.02	46.6	93.21	0
60	1.00	30.0	1.97	59.1	59.10	0
120	1.25	37.5	1.91	71.6	35.81	0
240	1.57	47.1	1.83	86.3	21.59	0
360	1.78	53.4	1.79	95.4	15.90	0

 Tedds STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project				Job no.	
	PENALLTA COLLIERY				1238452	
	Calcs for				Start page no./Revision	
	PAVING TO BLOCK B				2	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	HG	12/11/2025				

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Intensity, i (mm/hr)	Depth (mm)
600	2.12	63.6	1.72	109.2	10.92	0
1440	2.84	85.2	1.60	136.3	5.68	0


Min depth of blanket req'd

$$H_{\max} = 79 \text{ mm}$$

Time for emptying blanket to half volume

$$t_{s50} = n \times H_{\max} / (2 \times f) = 4 \text{ min } 12 \text{ s}$$

PASS - Infiltration system discharge time less than or equal to 24 hours

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project				Job no.	
	PENALLTA COLLIERY				1238452	
	Calcs for				Start page no./Revision	
	SELF-PERMEABLE PAVING				1	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	HG	12/11/2025				

PLANE INFILTRATION SYSTEM DESIGN

In accordance with CIRIA C697 SUDS

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area Cardiff
 Impermeable area drained to the system $A = 250.0 \text{ m}^2$
 Return period Period = 100 yr
 Ratio 60 min to 2 day rainfall of 5 yr return period $r = 0.300$
 5-year return period rainfall of 60 minutes duration $M5_{60\text{min}} = 20.0 \text{ mm}$
 Increase of rainfall intensity due to global warming $p_{\text{climate}} = 50 \%$

Infiltration pavement details

Base area of pavement $A_b = 250.0 \text{ m}^2$
 Porosity $n = 0.45$
 Drainage ratio $R = A / A_b = 1.0$


Soil infiltration rate (BRE digest 365)

Length of trial pit $l_{\text{trial}} = 1800 \text{ mm}$
 Width of trial pit $b_{\text{trial}} = 1700 \text{ mm}$
 Depth of trial pit (below invert) $d_{\text{trial}} = 250 \text{ mm}$
 Free volume (if fill used) $V_{\text{trial}} = 100 \%$
 75% depth of pit $d_{75} = (d_{\text{trial}} \times 0.75) = 187.50 \text{ mm}$
 50% depth of pit $d_{50} = (d_{\text{trial}} \times 0.50) = 125.00 \text{ mm}$
 25% depth of pit $d_{25} = (d_{\text{trial}} \times 0.25) = 62.50 \text{ mm}$
 Test 1 - time to fall from 75% depth to 25% depth $T1 = 20 \text{ min}$
 Test 2 - time to fall from 75% depth to 25% depth $T2 = 20 \text{ min}$
 Test 3 - time to fall from 75% depth to 25% depth $T3 = 23 \text{ min}$
 Longest time to fall from 75% depth to 25% depth $t_g = \max(T1, T2, T3) = 23 \text{ min}$
 Storage volume from 75% to 25% depth $V_{p75_{25}} = (l_{\text{trial}} \times b_{\text{trial}} \times (d_{75} - d_{25})) \times V_{\text{trial}} = 0.38 \text{ m}^3$
 Internal surface area to 50% depth $a_{p50} = ((l_{\text{trial}} \times b_{\text{trial}}) + (l_{\text{trial}} + b_{\text{trial}}) \times 2 \times d_{50}) = 3.94 \text{ m}^2$
 Surface area of soakaway to 50% storage depth $A_{s50} = 2 \times (l_{\text{trial}} + b_{\text{trial}}) \times d_{\text{trial}} / 2 = 0.875 \text{ m}^2$
 Soil infiltration rate $f = V_{p75_{25}} / (a_{p50} \times t_g) = 70.4 \times 10^{-6} \text{ m/s}$

Table equations

Rainfall intensity $i = M100 / D$
 Minimum depth required $H = D / n \times (R \times i - f)$

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Intensity, i (mm/hr)	Depth (mm)
5	0.34	10.2	1.91	19.5	234.18	0
10	0.49	14.7	1.99	29.2	175.09	0
15	0.59	17.7	2.01	35.6	142.42	0
30	0.77	23.1	2.02	46.6	93.21	0
60	1.00	30.0	1.97	59.1	59.10	0
120	1.25	37.5	1.91	71.6	35.81	0
240	1.57	47.1	1.83	86.3	21.59	0
360	1.78	53.4	1.79	95.4	15.90	0

 STEVE MORGAN ASSOCIATES 9 CLYTHA PARK ROAD NEWPORT NP20 4PB	Project PENALLTA COLLIERY				Job no. 1238452	
	Calcs for SELF-PERMEABLE PAVING				Start page no./Revision 2	
	Calcs by HG	Calcs date 12/11/2025	Checked by	Checked date	Approved by	Approved date

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Intensity, i (mm/hr)	Depth (mm)
600	2.12	63.6	1.72	109.2	10.92	0
1440	2.84	85.2	1.60	136.3	5.68	0

Min depth of pavement req'd

$$H_{\max} = 0 \text{ mm}$$

Time for emptying blanket to half volume

$$t_{s50} = n \times H_{\max} / (2 \times f) = 0s$$

PASS - Infiltration system discharge time less than or equal to 24 hours

APPENDIX 3.0

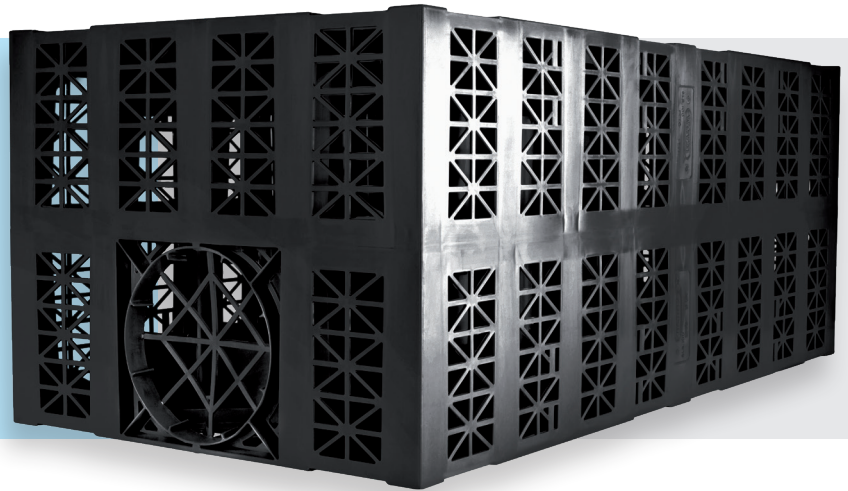
Wavin AquaCell Datasheet



AquaCell Core-R

Product description

AquaCell Core-R has been designed for use in deep applications, subject to regular and heavy traffic loadings, e.g. cars and HGV's. AquaCell Core-R can also be used in both landscaped and deep soakaway applications.



Technical specification

Cat code	6LB150	Void ratio	95%
Colour	Black	Material	Recycled PP
Dimensions	1m x 0.5m x 0.4m	Vertical loading	66.9 tonnes/m ² (669 kN/m ²)
Weight	11.5kg	Lateral loading	12.3 tonnes/m ² (123 kN/m ²)
Storage volume	190 litres	BBA approval	Certificate 03/4018

Maximum installation depths

Typical soil type	Maximum depth of installation – to base of units (m) ¹				
	Soil weight kN/m ³	Angle of internal friction ϕ (degrees) ^{2,3}	Landscaped areas	Vehicle mass <9 tonnes ^{4,5}	Vehicle mass <44 tonnes
Over consolidated stiff clay	20	24	3.85	3.61	3.36
Silty sandy clay	19	26	4.35	4.09	3.83
Loose sand and gravel	18	30	5.34	5.06	4.78
Medium dense sand and gravel	19	34	5.94	5.68	5.41
Dense sand and gravel	20	38	6.68	6.43	6.18

Minimum cover depths

	Landscaped areas	Car parks with vehicle mass <3 tonnes ⁵	Car parks with vehicle mass <9 tonnes	Car parks with vehicle mass <12 tonnes	Low speed roads with vehicle mass <60 tonnes
Minimum cover depth (m)	0.30	0.50	0.60	0.70	1.11

- Without groundwater present below base of units – AquaCell Core-R may be used where groundwater is present, contact Wavin for technical advice.
- Loosening of dense sand or softening of clay by water can occur during installation. The designer should allow for any such likely effects when choosing an appropriate value of ϕ .
- The design is very sensitive to small changes in the assumed value of ϕ , therefore, it should be confirmed by a chartered geotechnical engineer. In clay soils, it may be possible to utilise cohesion in some cases.
- Applicable for car parks or other areas trafficked only by cars or occasional refuse collection trucks or similar vehicles (typically one per week).
- This category should be used when considering landscaped areas that may be trafficked by ride on mowers.

Assumptions made:

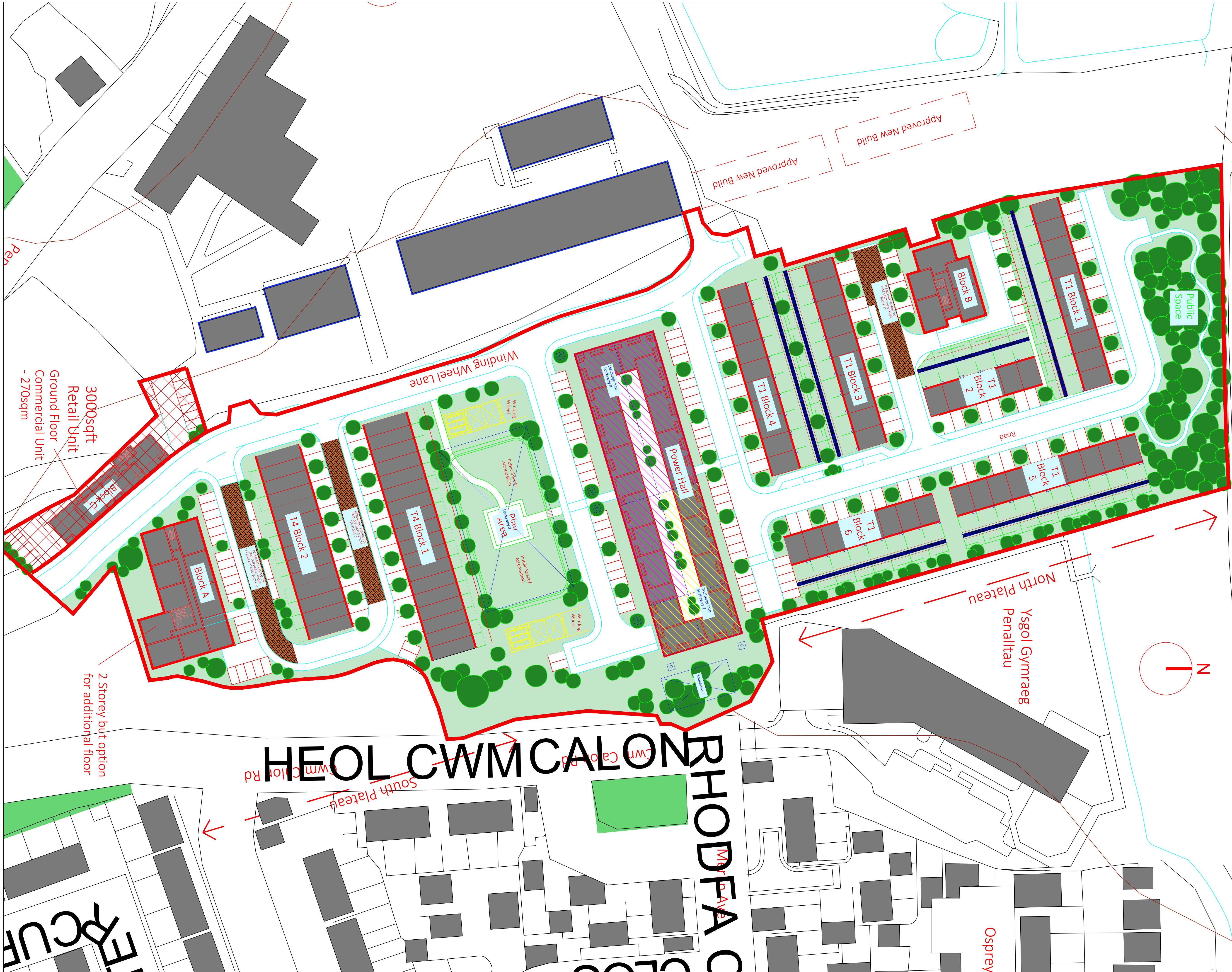
- Ground surface is horizontal
- Shear planes or other weaknesses are not present within the structure of the soil

Source: BBA

APPENDIX 4.0

Proposed SuDS Layout





- General Notes :
- 1.) Do not scale from this drawing except for planning purposes.
 - 2.) All dimensions are in millimetres.
 - 3.) All levels are in metres relative to datum.
 - 4.) All dimensions stated are to be confirmed on site prior to commencement of any works and any discrepancies found are to be reported to Steve Morgan Associates Limited immediately.

SOAKAWAY

PERMEABLE PAVING TO TAKE ROOF DISCHARGE

ROOF AREA

TREE PIT

SUDS PLANTER

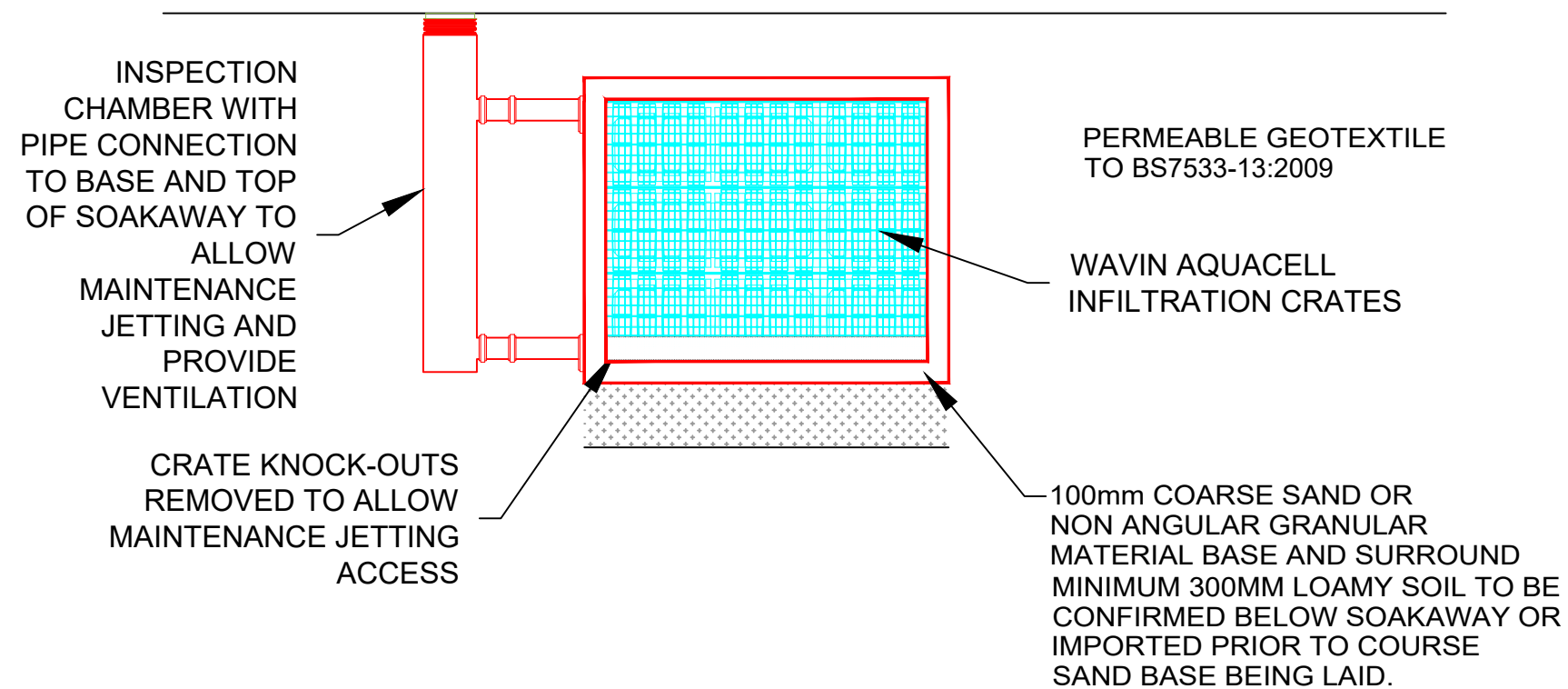
PERMEABLE ROAD SURFACE TO DRAIN OWN AREA

A	HG	02/12/25	INITIAL ISSUE
REV.	By	Date	Description
Client THE POWER HALL LIMITED			
Project Description FORMER PENALLTA COLLIERY			
Drawing Title SUDS DRAINAGE PLAN			
Drawn	HG	Date	02/12/25
Checked	SM	Date	02/12/25
Scales 1:500 @ A1			
 STEVE MORGAN ASSOCIATES CONSULTING ENGINEERS 9 Clytha Park Road Newport NP20 4PB tel: 01633 266244 fax: 01633 266275 e-mail: engineers@smalimited.co.uk Web: smalimited.co.uk			
Project Number		1238452	
Drawing Number		DR-700	Rev A

APPENDIX 5.0


Typical Soakaway Construction





TYPICAL SOAKAWAY SECTION
NOT TO SCALE

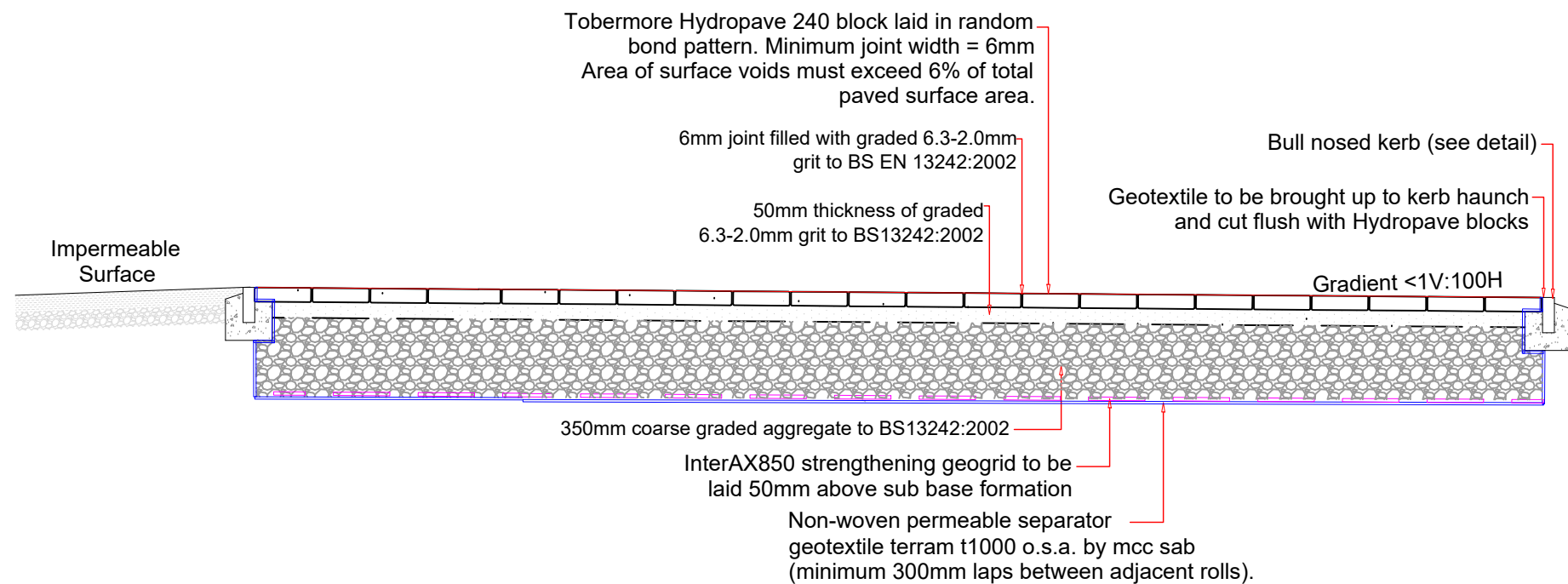
REV. By Date Description

 STEVE MORGAN ASSOCIATES CONSULTING ENGINEERS	9 Clytha Park Road Newport NP20 4PB tel: 01633 266244 fax: 01633 266275 e-mail: engineers@smalimited.co.uk Web: smalimited.co.uk	Client	Project Description PENALLTA COLLIERY SOAKAWAY DETAIL	Drawn HG	Date 02/12/25	Scales NOT TO SCALE	Project Number 1238452
				Checked SM	Date 02/12/25	Drawing Number DR-703	Rev.

APPENDIX 6.0

Typical Permeable Paving Makeup





TYPICAL PERMEABLE
PAVING CONSTRUCTION
NOT TO SCALE

SUBGRADE GEOTEXTILE SPECIFICATION

FOR SYSTEM A PAVEMENTS (FULL INFILTRATION INTO THE SUBGRADE) A GEOTEXTILE SHALL BE INSTALLED BETWEEN THE SUB-BASE AND SUBGRADE. THE GEOTEXTILE CAN BE EITHER A MONO FILAMENT WOVEN, NON WOVEN BONDED OR NEEDLE PUNCHED NON-WOVEN FABRIC. THE GEOTEXTILE SHALL BE MANUFACTURED FROM A SUITABLE POLYETHYLENE OR POLYPROPYLENE FILAMENT ABLE TO WITHSTAND NATURALLY OCCURRING CHEMICAL AND MICROBIAL EFFECTS.

THE PRODUCTION OF THE GEOTEXTILE SHALL BE IN ACCORDANCE WITH BS EN ISO 9001: 2008. THE TENSILE PROPERTIES OF THE MATERIAL SHALL BE VERIFIED IN ACCORDANCE WITH BS EN ISO 10319: 1996. THE PHYSICAL PROPERTIES SHALL COMPLY WITH TABLE 1. THE GEOTEXTILE SHALL BE PROTECTED FROM ULTRAVIOLET LIGHT WHILST STORED. THE GEOTEXTILE SHALL BE LAID WITH A MINIMUM OVERLAP OF 200MM.

CHARACTERISTICS STANDARD WOVEN FILTER NON WOVEN FILTER
WEIGHT BS EN 965: 1995 ≥ 200 G/M2 ≥ 300 G/M2
ULTIMATE TENSILE BS EN ISO 10319:
STRENGTH 1996
LONGITUDINAL ≥ 30 KN/M ≥ 15 KN/M
TRANSVERSE ≥ 30 KN/M ≥ 15 KN/M
STRAIN AT NOMINAL BS EN ISO 10319:
TENSILE STRENGTH 1996
LONGITUDINAL $\leq 25\% \leq 70\%$
TRANSVERSE $\leq 25\% \leq 70\%$
CBR PUNCTURE BS EN ISO 12236: ≥ 3 KN ≥ 3 KN
2006
OPENING SIZE BS EN ISO 12956: ≥ 0.2 MM ≥ 0.1 MM
1999
WATER PERMEABILITY BS EN ISO 11058: $\geq 20 \times 10^{-3}$ M/S $\geq 40 \times 10^{-3}$ M/S
1999

USE TERRAM 1000 OR SIMILAR APPROVED BY MCC SAB.

SUBGRADE SPECIFICATION


THE SUB-BASE MAY BE COMPRISED OF THE COARSE GRADED AGGREGATE (CGA) ONLY OR CGA OVERLAID WITH HYDRAULICALLY BOUND COARSE GRADED AGGREGATE (HBCGA).

(PERMCALC WILL AUTOMATICALLY DETERMINE THE MAKEUP AND THICKNESSES OF THE PAVEMENT LAYERS.)

THE SUB-BASE AGGREGATE SHALL COMPLY WITH THE REQUIREMENTS OF BS 7533 -13:2009 *PAVEMENTS CONSTRUCTED WITH CLAY, NATURAL STONE OR CONCRETE PAVERS - GUIDE FOR THE DESIGN OF PERMEABLE PAVEMENTS CONSTRUCTED WITH CONCRETE PAVING BLOCKS AND FLAGS, NATURAL STONE SLABS AND SETTS AND CLAY PAVERS*, AS FOLLOWS:-

- THE AGGREGATE SHALL BE A CRUSHED TYPE 4/20 (4 MM MINIMUM AND 20 MM MAXIMUM PARTICLE SIZE)
- THE VOIDS RATIO OF THE SUB-BASE AGGREGATE SHALL BE AT LEAST 30%.
- AGGREGATE PARTICLE SHAPE: PREFERABLY A HARD CRUSHED ROCK. THE AGGREGATE MUST HAVE SUFFICIENT INTERNAL STABILITY TO PERFORM BOTH DURING INSTALLATION AND IN THE LONG TERM.
- PHYSICAL PROPERTIES SHALL COMPLY WITH BS EN 13242: 2002 - AGGREGATES FOR UNBOUND AND HYDRAULICALLY BOUND MATERIALS FOR USE IN CIVIL ENGINEERING WORK AND ROAD CONSTRUCTION.

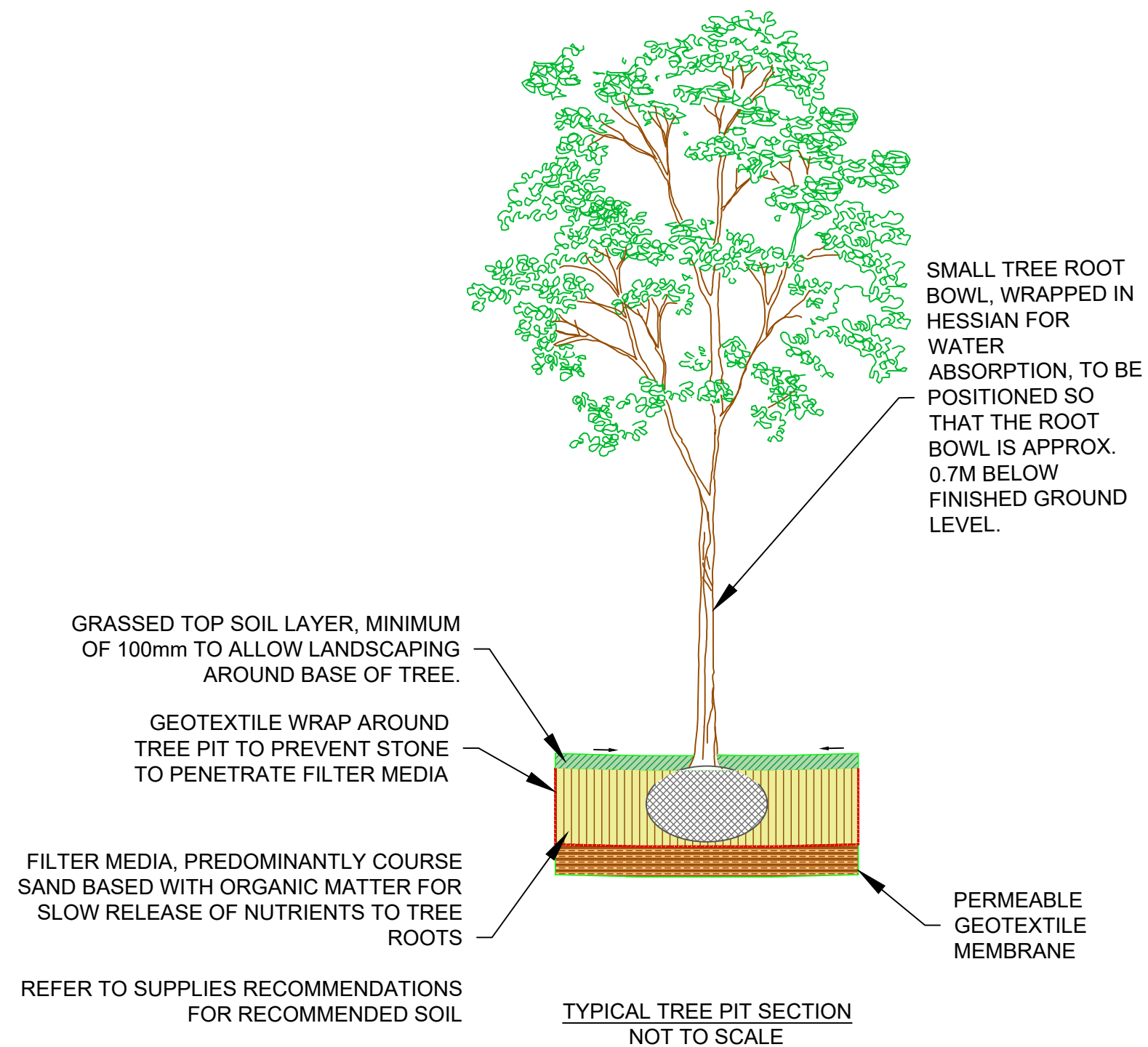
REV. By Date Description

 STEVE MORGAN ASSOCIATES CONSULTING ENGINEERS	9 Clytha Park Road Newport NP20 4PB tel: 01633 266244 fax: 01633 266275 e-mail: engineers@smalimited.co.uk Web: smalimited.co.uk	Client	Project Description PENALLTA COLLIERY PERMEABLE PAVING DETAIL	Drawn HG	Date 02/12/25	Scales NOT TO SCALE	Project Number 1238452
				Checked SM	Date 02/12/25	Drawing Number DR-701	Rev.


APPENDIX 7.0

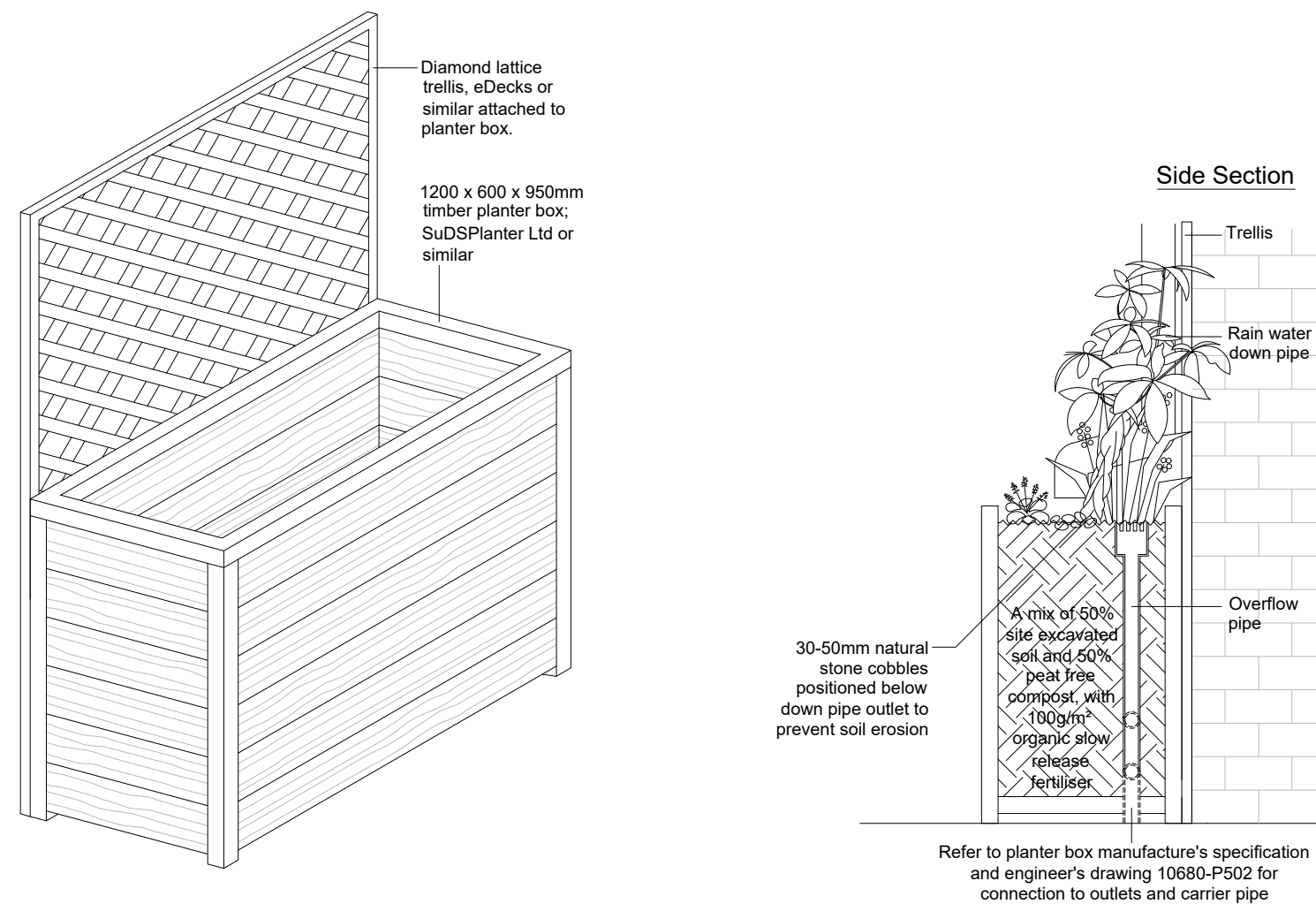
Tree Pit and SuDS Planter Details






REV. By Date Description

 STEVE MORGAN ASSOCIATES CONSULTING ENGINEERS	9 Clytha Park Road Newport NP20 4PB tel: 01633 266244 fax: 01633 266275 e-mail: engineers@smalimited.co.uk Web: smalimited.co.uk	Client	Project Description PENALLTA COLLIERY TREE PIT DETAILS	Drawn HG	Date 02/12/25	Scales NOT TO SCALE	Project Number 1238452
				Checked SM	Date 02/12/25	Drawing Number DR-702	Rev.



TYPICAL SUDS PLANTER CONSTRUCTION NOT TO SCALE

REV. By Date Description

 <p>STEVE MORGAN ASSOCIATES CONSULTING ENGINEERS</p> <p>9 Clytha Park Road Newport NP20 4PB tel: 01633 266244 fax: 01633 266275 e-mail: engineers@smalimited.co.uk Web: smalimited.co.uk</p>	Client	Project Description PENALLTA COLLIERY SUDS PLANTER DETAIL	Drawn HG	Date 02/12/25	Scales NOT TO SCALE	Project Number 1238452
			Checked SM	Date 02/12/25	Drawing Number DR-704	Rev.