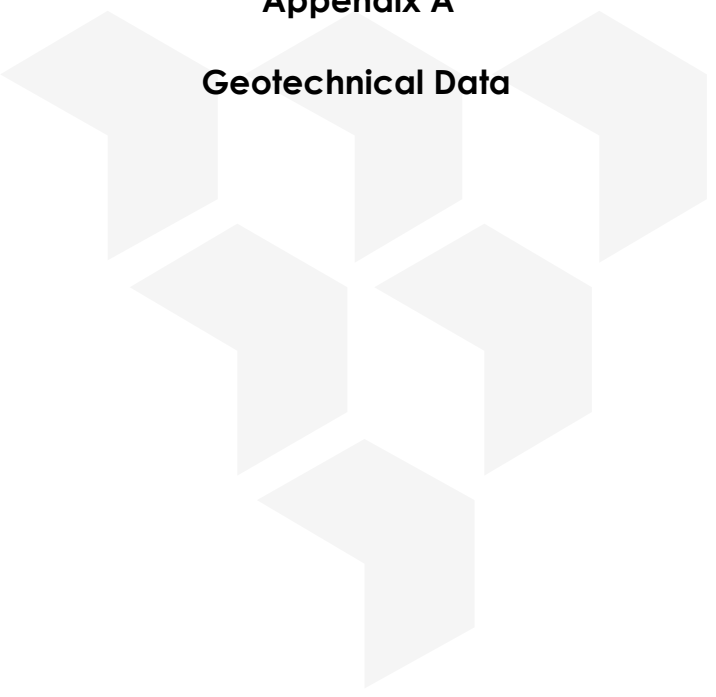


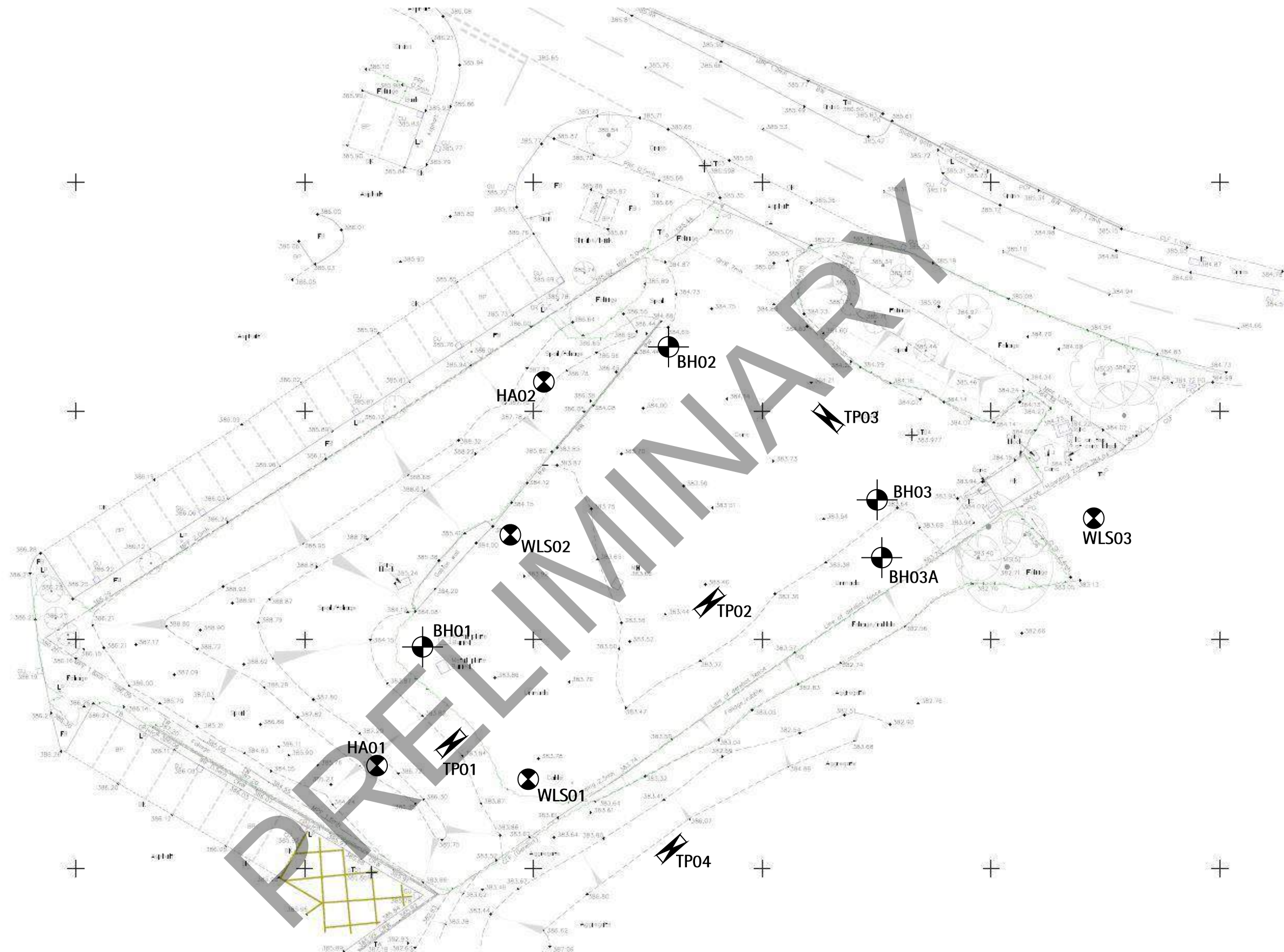
Appendices





Appendix A

Geotechnical Data



NB: Positions of Boreholes and/or Trial Pits are only indicative unless dimensioned

Site: Penygarnddu Industrial Estate, Merthyr Tydfil, CF48 2TA

STL: J15809

Fig No: 3

Date: 18th March 2025

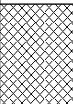
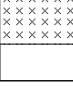
Site plan showing approximate exploratory hole locations.

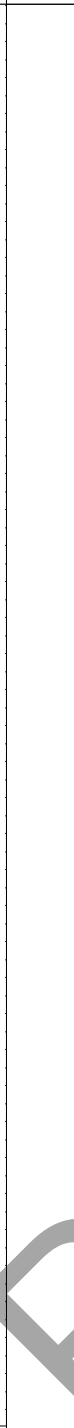


Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN



				Start - End Date:		Project ID:		Hole Type:		BH01		
				21/03/2025 - 25/03/2025		J15809		CP+RC		Sheet 1 of 3		
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:		
						E 307911 - N 208439		383.93		SM		
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA				
Well	Water Strikes	Samples and Insitu Testing			Coring			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type/Fl	Results	TCR	SCR	RQD					
		0.00	B						(0.40)		Reddish brown to greyish brown, sandy, medium to coarse, sub-angular limestone GRAVEL (sub-base).	
		0.40						383.53			Greyish brown to grey, gravelly, CLAY. Gravel comprises fragments of brick, siltstone and mudstone. MADE GROUND	
		1.00	B SPT	N=10 (2,4/4,2,2,2)								1
		2.00	B SPT	N=6 (1,1/1,2,1,2)								2
		3.00	B SPT	N=9 (2,2/1,2,3,3)					(5.60)			3
		4.00	B SPT	N=8 (1,2/1,2,3,2)								4
		5.00	B SPT	N=9 (2,2/2,3,2,2)								5
		6.00	B					6.00	377.93		Dark grey, gravelly, sandy, CLAY. Gravel comprises fine to coarse, sub-angular mudstone and siltstone. REWORKED GROUND	6
		6.50	SPT	N=12 (1,2/3,3,3,3)					(1.20)			7
		7.00	B					7.20	376.73		Soft, dark grey, silty, sandy, shaley, CLAY. REWORKED GROUND	8
		8.00	B SPT	N=18 (2,3/6,6,3,3)					(1.80)			9
		9.00	B					9.00	374.93		Dark grey to orange brown, silty, gravelly, CLAY. Gravel comprises fine to coarse, sub-angular, siltstone, mudstone and coal. REWORKED GROUND	10
		9.50	SPT	N=8 (2,1/1,2,3,2)								
		10.00	B						(2.00)			
Remarks:												
Status:		DRAFT		Log Print Date and Time:		16/04/2025 08:44		Log Approved By:				

				Start - End Date:		Project ID:		Hole Type:		BH01		
				21/03/2025 - 25/03/2025		J15809		CP+RC		Sheet 2 of 3		
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:		
						E 307911 - N 208439		383.93		SM		
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA				
Well	Water Strikes	Samples and Insitu Testing			Coring			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type/FI	Results	TCR	SCR	RQD					
		11.00	B SPT	N=29 (4,6/6,8,7,8)				11.00	372.93		Dark grey to orange brown, silty, gravelly, CLAY. Gravel comprises fine to coarse, sub-angular, siltstone, mudstone and coal. REWORKED GROUND	11
		12.00	B					(1.30)		Firm, dark grey, silty, gravelly, CLAY. Gravel comprises fine to coarse, sub-angular, siltstone and mudstone.		12
		12.50	SPT	N=49				12.30	371.63		Strong to very strong, thinly laminated, black, SILTSTONE.	
		12.70	C	(4,5/11,12,13,13)				(2.00)				13
		13.50 - 15.00			▼ 1			14.30	369.63 (0.25)		Black, non-intact, vitrain, COAL.	
					93	15	15	14.55	369.38 (0.25)		Moderately strong, dark grey, SILTSTONE.	
								14.80	369.13		Moderately strong to strong, pale grey, SILTSTONE, with iron strained surfaces. [15.0m (bgl) - fossil plant fragment.]	15
		15.00 - 16.50			▼ 2		1					16
					87	40	25	(2.45)				
					▼ 3		2					17
		16.50 - 18.00						17.25	366.68		Moderately strong to strong, thinly laminated, pale grey to grey, SILTSTONE, with frequent thin laminations of coal.	
					▼ 4		3				[17.8-18.0m (bgl) - Sub-vertical fracture with iron stained surfaces.]	18
								(2.25)		[18.2-18.35m (bgl) - Sub-vertical fracture with iron stained surfaces.]		19
		18.60	C									
		18.00 - 19.50			▼ 5		4					20
					60	55	28					
		19.50 - 21.00						19.50	364.43		Moderately strong to strong, very fractured, dark grey to grey, SILTSTONE.	
					91	69	11	(1.20)		[20.4-20.55m (bgl) - Sub-vertical fracture.]		
Remarks:												
Status:		DRAFT		Log Print Date and Time:		16/04/2025 08:44		Log Approved By:				

				Start - End Date:		Project ID:	Hole Type:	BH01					
				21/03/2025 - 25/03/2025		J15809	CP+RC	Sheet 3 of 3					
Client:		Glanville Consultants Ltd.				Co-ordinates:	Level (m AOD)	Logger:					
						E 307911 - N 208439	383.93	SM					
Project Name:		Penygarnddu Industrial Estate				Location:	Merthyr Tydfil, CF48 2TA						
Well	Water Strikes	Samples and Insitu Testing			Coring			Depth (m)	Level (m AOD)	Legend	Stratum Description		
		Depth (m)	Type/FI	Results	TCR	SCR	RQD						
								20.70	363.23	xxxxxx	Moderately strong to strong, very fractured, dark grey to grey, SILTSTONE.	21	
								20.75	(0.05)	xxxxxx			Black, non-intact, vitrain, COAL.
		21.10	C		6		5	21.10	363.18	xxxxxx	Moderately strong, dark grey, SILTSTONE.		
									(0.35)	xxxxxx	Moderately strong to strong, thinly laminated, pale grey to grey, SILTSTONE, with frequent thin laminations of coal.		
									362.83	xxxxxx			
									(1.05)	xxxxxx			
		21.00 - 22.50			100	94	82						
		21.80	C										
									22.15	361.78	xxxxxx	Strong to very strong, thinly laminated, pale grey, SANDSTONE.	22
		22.80	C		7		6						
												[22.7-22.8m (bgl) - Sub-vertical fracture.]	
												[23.0-23.2m (bgl) - Sub-vertical fracture.]	23
		22.50 - 24.00			97	88	39						
									(3.35)				
		24.00 - 25.50			47	32	17						24
		25.50	C		9		8	25.50	358.43	xxxxxx	Moderately strong, thinly laminated, dark grey to grey, SILTSTONE.	26	
									(0.60)	xxxxxx			
		25.50 - 27.00			97	85	39	26.10	357.83	xxxxxx	Moderately strong to strong, thinly laminated, dark grey to black, SILTSTONE.	27	
							(0.90)	xxxxxx					
											28		
27.00 - 28.50			90	77	46	27.00	356.93	xxxxxx	Moderately strong to strong, dark grey, SILTSTONE, with occasional quartz veins.				
28.00	C					27.30	356.63	xxxxxx	Moderately strong to strong, grey to dark grey, SILTSTONE.	29			
							(1.10)	xxxxxx	[27.5-27.65m (bgl) - Sub-vertical fracture with iron stained surfaces.]				
									[27.65-27.75m (bgl) - Sub-vertical fracture with iron stained surfaces.]				
28.50	C		11		10	28.40	355.53	xxxxxx	Strong to very strong, thinly laminated, pale grey to grey, SANDSTONE.	30			
							(0.90)						
28.50 - 30.00			95	70	69	29.30	354.63		Strong to very strong, grey, SANDSTONE.	31			
29.35	C						(0.70)						
						30.00	353.93		End of Borehole at 30.00m				
Remarks:													
Status:		DRAFT			Log Print Date and Time:			16/04/2025 08:44		Log Approved By:			

	Start - End Date:	Project ID:	Hole Type:	BH01
	21/03/2025 - 25/03/2025	J15809	CP+RC	Sheet 1 of 1

Depth Related Hole Information									
Top Depth (m)	Base Depth (m)	Hole Type	Start Date	End Date	Crew	Plant Used	Barrel Type	Logged By	Remarks
0.00 13.50	13.50 30.00	CP RC	20/03/2025 24/03/2025	24/03/2025 25/03/2025				SM SM	

Hole Diameter			Casing Diameter		
Hole Diameter (mm)	Depth to Base (m)	Remarks	Casing Diameter (mm)	Depth to Base (m)	Remarks
200	13.50		200	8.80	

Project Specific Time Related Remarks				Drilling Progress by Time				
Date Time Start	Date Time End	Duration	Remarks	Date Time	Depth (m)	Casing Depth (m)	Water Depth (m)	Remarks
				25/03/2025 08:30:00	21.00	13.50	19.5	

Core Drill Run Information								
Run No.	Top Depth (m)	Base Depth (m)	Duration	Hole Diameter (mm)	TCR (%)	SCR (%)	RQD (%)	Remarks
1	13.50	15.00		75	93	15	15	
2	15.00	16.50		75	87	40	25	
3	16.50	18.00		75	83	39	32	
4	18.00	19.50		75	60	55	28	
5	19.50	21.00		75	91	69	11	
6	21.00	22.50		75	100	94	82	
7	22.50	24.00		75	97	88	39	
8	24.00	25.50		75	47	32	17	
9	25.50	27.00		75	97	85	39	
10	27.00	28.50		75	90	77	46	
11	28.50	30.00		75	95	70	69	

Status:	DRAFT	Log Print Date and Time:	16/04/2025 08:44	Log Approved By:	
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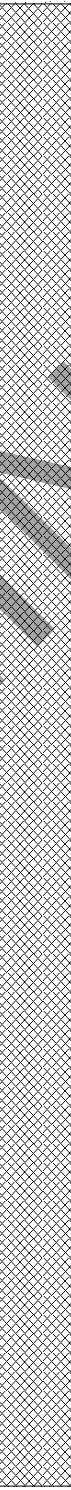
SPT								
Top Depth (m)	Test Type	Casing Depth (m)	Water Depth (m)	Self Weight Penetration (mm)	Reported Result (N Value)	Hammer Serial No.	Energy Ratio %	Remarks
1.00	C	1.00			N=10 (2,4/4,2,2,2)			
2.00	C	1.30			N=6 (1,1/1,2,1,2)			
3.00	C	2.80			N=9 (2,2/1,2,3,3)			
4.00	C	3.80			N=8 (1,2/1,2,3,2)			
5.00	C	4.30			N=9 (2,2/2,3,2,2)			
6.50	C	4.30			N=12 (1,2/3,3,3,3)			
8.00	C	7.80			N=18 (2,3/6,6,3,3)			
9.50	C	8.80			N=8 (2,1/1,2,3,2)			
11.00	C	8.80			N=29 (4,6/6,8,7,8)			
12.50	C	8.80			N=49 (4,5/11,12,13,13)			

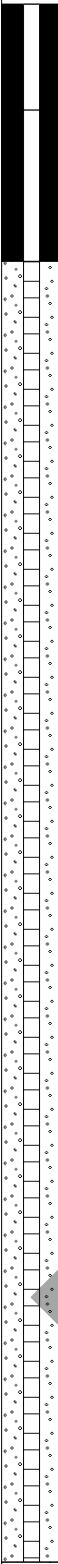
Water Strikes and Details							
Depth Strike	Date Time	Depth Casing (mm)	Depth Sealed (m)	Remarks	Time Elapsed (mins)	Water Depth (m)	Remarks

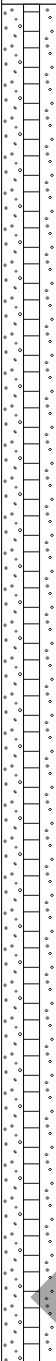
Backfill Details			
Top of Section (m)	Base of Section (m)	Material	Remarks
0.00	14.00	Bentonite	
14.00	30.00	Gravel Backfill	

Installation Details						Pipe Construction				
Distance	Point Ref.	Type	Top of Response Zone (m)	Base of Response Zone (m)	Pipe Ref.	Pipe Ref.	Pipe Top (m)	Pipe Base (m)	Pipe Dia. (mm)	Type of Pipe
0.00	1	SP	14.00	30.00	1	1	0.00	14.00	50	PLAIN
						1	14.00	30.00	50	SLOTTED

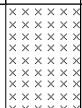
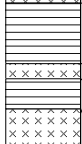
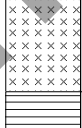
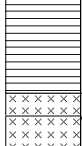
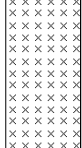
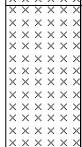
Drilling Flush Details						
From Depth (m)	To Depth (m)	Flush Type	Flush Return Min Percentage	Flush Return Max Percentage	Flush Colour	Remarks

Southern Testing ST Consult						Start - End Date: 20/03/2025 - 24/03/2025		Project ID: J15809		Hole Type: CFA+RC		BH02 Sheet 1 of 3	
Client:		Glanville Consultants Ltd.					Co-ordinates: E 307934 - N 208466		Level (m AOD) 384.67		Logger: SM		
Project Name: Penygarnddu Industrial Estate						Location:		Merthyr Tydfil, CF48 2TA					
Well	Water Strikes	Samples and Insitu Testing			Progress	Depth (m)	Level (m)	Legend	Stratum Description				
		Depth (m)	Type/Fl	Results	Window Run								
						0.50	(0.50) 384.17		Concrete/Sub-base (DRILLERS DESCRIPTION)		1		
							Sandy Till/Reworked Ground (DRILLERS DESCRIPTION)						
							(10.00)				2		
											3		
											4		
											5		
											6		
											7		
											8		
											9		
											10		
Remarks:													
Status:		DRAFT		Log Print Date and Time:		16/04/2025 08:44		Log Approved by:					

				Start - End Date:		Project ID:		Hole Type:		BH02		
				20/03/2025 - 24/03/2025		J15809		CFA+RC		Sheet 2 of 3		
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:		
						E 307934 - N 208466		384.67		SM		
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA				
Well	Water Strikes	Samples and Insitu Testing			Progress			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type/Fl	Results	Window Run							
								10.50	374.17		Sandy Till/Reworked Ground (DRILLERS DESCRIPTION)	
											Weak to moderately strong, thinly laminated, dark grey, MUDSTONE, with orange brown ironstained surfaces.	
		11.00 - 12.00			90	39	10		(1.85)			11
					▼ 2		1					
								12.35	372.32		[12.0 - 12.35m (bgl) - Quartz veins.] Moderately strong, thinly laminated to thinly bedded, black, SILTSTONE.	12
		12.00 - 13.50			89	69	15		(0.95)			13
											[13.05 - 13.10m (bgl) - Black, non-intact, vitrain, coal.] Black, non-intact, vitrain, COAL.	
		14.05 13.50 - 15.00	C		▼ 3		2	13.30 13.50	371.37 371.17		Weak to moderately strong, dark grey, thinly laminated, MUDSTONE/SILTSTONE, with occasional plant fossils.	14
		15.35	C		▼ 4		3		(2.95)			15
		15.00 - 16.50										16
		16.50	C		▼ 5		4	16.45	368.22		Moderately strong to strong, pale grey to grey, SILTSTONE.	17
		16.50 - 18.00										
					▼ 6		5		(3.45)			18
		18.00 - 19.50										19
					▼ 7		6					
		19.50 - 21.00 20.45	C		100	77	44	19.90 20.30	364.77 364.37		Moderately strong to strong, thinly laminated, dark grey to black, SILTSTONE.	20
									(0.60)		Moderately strong to strong, thinly laminated, dark grey, SILTSTONE.	
Remarks:												
Status:		DRAFT		Log Print Date and Time:			16/04/2025 08:44		Log Approved by:			

				Start - End Date:		Project ID:	Hole Type:	BH02				
				20/03/2025 - 24/03/2025		J15809	CFA+RC	Sheet 3 of 3				
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)	Logger:			
						E 307934 - N 208466		384.67	SM			
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA				
		Samples and Insitu Testing			Coring			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type/FI	Results	TCR	SCR	RQD					
		21.00 - 22.00	C		8	68	7	20.90	363.77		Moderately strong to strong, thinly laminated, dark grey, SILTSTONE.	21
		21.80			84	68	60		(0.90)		Moderately strong to strong, thinly laminated, pale grey, SILTSTONE.	
		22.00 - 23.00			9	42	8	21.80	362.87		Strong, pale grey to grey, SANDSTONE, with occasional quartz veining.	22
					97	42	11		(1.60)			
		23.00 - 24.50	C		10	61	9	23.40	361.27		Moderately strong to strong, thinly laminated, dark grey, SILTSTONE, with frequent black laminations.	24
					80	61	18		(1.75)			
		24.50 - 26.00			11	45	8	25.15	359.52		Weak to moderately strong, thinly laminated, dark grey, MUDSTONE.	25
					70	45	8		(0.85)			
		26.00 - 27.50	C		12	63	11	26.00	358.67		Moderately strong to strong, thinly laminated, dark grey to black, SILTSTONE.	26
					95	63	34	26.55	358.12		Moderately strong to strong, thinly laminated, dark grey, SILTSTONE.	27
		27.30			13		12		(1.60)			
		28.15			100	87	65	28.15	356.52		Strong to very strong, dark grey to grey, SANDSTONE.	28
		27.50 - 29.00							(1.45)			
29.00 - 29.60			14	27	0	29.60	355.07			29		
					14				End of Borehole at 29.60m	30		
Remarks:												
Status:		DRAFT		Log Print Date and Time:		16/04/2025 08:44		Log Approved By:				

Southern Testing ST Consult						Start - End Date: 18/03/2025 - 20/03/2025			Project ID: J15809		Hole Type: CFA+RC		BH03 Sheet 1 of 4	
Client:		Glanville Consultants Ltd.						Co-ordinates: E 307952 - N 208451		Level (m AOD) 383.69		Logger: SM		
Project Name:		Penygarnddu Industrial Estate						Location:		Merthyr Tydfil, CF48 2TA				
Well	Water Strikes	Samples and Insitu Testing			Progress			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type/Fl	Results	Window Run									
								0.10	(0.10) 383.59		CONCRETE.		1	
							0.50	(0.40) 383.19	Reddish brown to greyish brown, sandy, medium to coarse, sub-angular limestone GRAVEL (sub-base).					
											MADE GROUND (DRILLERS DESCRIPTION).		2	
												SANDY TILL (DRILLERS DESCRIPTION).		3
														4
													5	
													6	
													7	
													8	
													9	
													10	
Remarks:														
Status:		DRAFT		Log Print Date and Time:		16/04/2025 08:44		Log Approved by:						

				Start - End Date:		Project ID:		Hole Type:		BH03												
				18/03/2025 - 20/03/2025		J15809		CFA+RC		Sheet 2 of 4												
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:												
						E 307952 - N 208451		383.69		SM												
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA														
Well	Water Strikes	Samples and Insitu Testing			Coring			Depth (m)	Level (m AOD)	Legend	Stratum Description											
		Depth (m)	Type/FI	Results	TCR	SCR	RQD															
		11.10 10.50 - 12.00	D		▼ 2		▲ 1	11.00	372.69 (0.40)		Very weak to weak, dark grey, MUDSTONE, with frequent patches of clay.	11										
		12.00 - 13.50	D		▼ 3		▲ 2	11.40	372.29 (0.10)		Moderately strong, dark grey, SILTSTONE.	12										
								11.50	372.19 (0.20)		Very weak to weak, dark grey, MUDSTONE, with frequent patches of clay.											
								11.70	371.99 (0.60)		Moderately strong, dark grey, SILTSTONE.											
								12.30	371.39 (0.40)		Very weak to weak, dark grey, MUDSTONE, with frequent patches of clay.											
								12.70	370.99 (0.10)		Moderately strong, dark grey, SILTSTONE.											
								12.80	370.89 (0.10)		Very weak to weak, dark grey, MUDSTONE, with frequent patches of clay.											
								12.90	370.79 (0.60)		Moderately strong, dark grey, SILTSTONE.											
								13.50	370.19 (0.80)		Weak to moderately strong, thinly laminated, dark grey to black, SILTSTONE, with occasional bands of coal.											
								14.30	369.39 (0.25)		Black, non-intact, vitrain, COAL.											
								14.55	369.14 (0.05)		Dark grey, silty, CLAY.											
								14.60	369.09 (0.90)		Moderately strong to strong, dark grey, SILTSTONE, with frequent fossil plant fragments.											
		15.50 15.00 - 16.50	D		▼ 5		▲ 4	15.50	368.19 (0.85)		Weak to moderately strong, thinly laminated, dark grey, shaley, MUDSTONE.	16										
								16.35	367.34 (0.15)		Weak to moderately strong, dark grey to grey, SILTSTONE.											
								16.50	367.19 (1.20)		Weak to moderately strong, thinly laminated, dark grey, shaley, MUDSTONE/ SILTSTONE.											
								17.70	365.99 (1.50)		Moderately strong to strong, dark grey, SILTSTONE.											
		18.00 - 19.50	C HP	UCS(kPa)=350	▼ 7		▲ 6	18.00	364.49 (0.30)		Firm, thinly laminated, grey to dark grey, CLAY.	19										
								19.20	364.19 (0.35)		Moderately strong, thinly laminated, dark grey to black, SILTSTONE.											
								19.80	363.84 (0.55)		Moderately strong to strong, thinly laminated, dark grey to pale grey, SILTSTONE.											
								19.50 - 21.00	20.40		363.29		Strong to very strong, pale grey to grey, SANDSTONE.									
		20.60	C					19.20	364.49 (0.30)		Firm, thinly laminated, grey to dark grey, CLAY.											
								19.50	364.19 (0.35)		Moderately strong, thinly laminated, dark grey to black, SILTSTONE.											
								19.85	363.84 (0.55)		Moderately strong to strong, thinly laminated, dark grey to pale grey, SILTSTONE.	20										
								20.40	363.29		Strong to very strong, pale grey to grey, SANDSTONE.											
								Remarks:														
		Status:		DRAFT		Log Print Date and Time:		16/04/2025 08:44		Log Approved By:												

				Start - End Date:		Project ID:		Hole Type:		BH03		
				18/03/2025 - 20/03/2025		J15809		CFA+RC		Sheet 3 of 4		
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:		
						E 307952 - N 208451		383.69		SM		
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA				
Well	Water Strikes	Samples and Insitu Testing			Coring			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type/FI	Results	TCR	SCR	RQD					
		21.00 - 22.00			▼ 9		8 ▲	(2.80)			Strong to very strong, pale grey to grey, SANDSTONE.	21
					90	73	28					
		22.65 22.00 - 23.50	C		▼ 10		9 ▲					22
					95	77	63					
		23.20	C					23.20	360.49	xxxxxx	Moderately strong, thinly laminated, dark grey, SILTSTONE.	23
		23.50 - 25.00			▼ 11		10 ▲	(1.90)		xxxxxx	[24.6-24.7m (bgl) - Sub-vertical fracture.]	24
					88	75	34					
		25.60 25.00 - 26.50	C		▼ 12		11 ▲	25.10	358.59	xxxxxx	Moderately strong, thinly laminated, dark grey to black, SILTSTONE.	25
					97	71	33					
		26.00	C					26.00	357.69	xxxxxx	Weak to moderately strong, thinly laminated, dark grey, SILTSTONE.	26
		26.50 - 28.00 27.45	C		▼ 13		12 ▲	26.90	356.79	xxxxxx	Moderately strong, pale grey to grey, SANDSTONE, with black laminations.	27
		28.00 - 28.90			▼ 14		13 ▲		(2.10)		[27.8-28.4m (bgl) - Sub-vertical fracture with calcite stained surfaces.]	28
					108	44	0					
		29.40 28.90 - 29.90	C		▼ 15		14 ▲	29.00	354.69 (0.20)	xxxxxx	Moderately strong, dark grey, SANDSTONE.	29
					102	91	58					
						29.90	353.79	xxxxxx	VOID.	30		
			▼ 16			30.60	353.09	xxxxxx	Moderately strong to strong, thinly laminated, dark grey, SILTSTONE. [30.6 - 33.6m (bgl) - Intermittent cavities noted.]			
Remarks:												
Status:		DRAFT			Log Print Date and Time:		16/04/2025 08:44		Log Approved By:			

Log Approved By:

						Start - End Date:		Project ID:		Hole Type:		BH03A	
						18/03/2025		J15809		HA		Sheet 1 of 1	
Client:		Glanville Consultants Ltd.					Co-ordinates:		Level (m AOD)		Logger:		
							E 307950 - N 208447		383.61		SM		
Project Name:		Penygarnddu Industrial Estate					Location:		Merthyr Tydfil, CF48 2TA				
Well	Water Strikes	Samples and Insitu Testing			Progress		Depth (m)	Level (m AOD)	Legend	Stratum Description			
		Depth (m)	Type/Fl	Results	Window Run								
							(0.20)		Reddish brown to greyish brown, sandy, medium to coarse, sub-angular limestone GRAVEL (sub-base).		1		
		0.20				383.41 (0.10)	CONCRETE.						
		0.30				383.31	Void.						
							(2.10)				2		
						2.40	381.21		End of Borehole at 2.40m		3		
Remarks:													
1. Borehole terminated, due to presence of void.													
2. Borehole position moved, see BH03 log.													
3. Standing water level at 0.65m (bgl).													
Status:		DRAFT			Log Print Date and Time:		16/04/2025 09:04		Log Approved By:				

						Start - End Date:		Project ID:		Hole Type:		HA01	
19/03/2025						J15809		HA		Sheet 1 of 1			
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:			
						E 307922 - N 208464		387.00		SM			
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA					
Well	Water Strikes	Samples and Insitu Testing			Progress		Depth (m)	Level (m AOD)	Legend	Stratum Description			
		Depth (m)	Type/Fl	Results	Window Run								
		0.10				0.10	(0.10) 386.90		Dark grey to black, silty, SAND, with frequent roots and rootlets. MADE GROUND	1			
							(0.50)		Dark grey, sandy, gravelly, CLAY. Gravel comprises fragments of limestone, siltstone and mudstone. MADE GROUND				
							0.60		386.40		Greyish brown to grey, gravelly, CLAY. Gravel comprises fragments of brick, sandstone, mudstone, siltstone and limestone, with occasional limestone cobbles. MADE GROUND		
								(0.90)					
		0.70	ES										
		1.50	ES			1.50	385.50		End of Borehole at 1.50m	2			
Remarks:													
1. Hand auger unable to process past 1.5m (bgl). 2. Borehole dry upon completion of excavation.													
Status:		DRAFT		Log Print Date and Time:		16/04/2025 09:06		Log Approved By:					

					Start - End Date:		Project ID:		Hole Type:		HA02	
					19/03/2025		J15809		HA		Sheet 1 of 1	
Client:		Glanville Consultants Ltd.					Co-ordinates:		Level (m AOD)		Logger:	
							E 307910 - N 208426		386.48		SM	
Project Name:		Penygarnddu Industrial Estate					Location:		Merthyr Tydfil, CF48 2TA			
Well	Water Strikes	Samples and Insitu Testing			Progress		Depth (m)	Level (m AOD)	Legend	Stratum Description		
		Depth (m)	Type/Fl	Results	Window Run							
		0.30	ES							Dark grey, sandy, gravelly, CALY. Gravel comprises fine to coarse, sub-angular, concrete, limestone, siltstone and mudstone, with occasional limestone cobbles. MADE GROUND		
		1.00	ES									1
		1.50	ES			1.50	384.98			End of Borehole at 1.50m		2
Remarks:												
1. Hand auger unable to process past 1.5m (bgl). 2. Borehole dry upon completion of excavation.												
Status:		DRAFT			Log Print Date and Time:		16/04/2025 09:06		Log Approved By:			

Status:	DRAFT	Log Print Date and Time:	16/04/2025 09:22	Log Approved By:	
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	Start - End Date:	Project ID:	Hole Type:	WLS01
	19/03/2025	J15809	WLS	Sheet 1 of 1

Depth Related Hole Information									
Top Depth (m)	Base Depth (m)	Hole Type	Start Date	End Date	Crew	Plant Used	Contractor	Logged By	Remarks
0.00	5.00	WLS	19/03/2025	19/03/2025	DT & JS	Prem 110	STL	SM	

Hole Diameter			Casing Diameter		
Hole Diameter (mm)	Depth to Base (m)	Remarks	Casing Diameter (mm)	Depth to Base (m)	Remarks

Dynamic Sample Drill Run Information						
Run No.	Top Depth (m)	Base Depth (m)	Duration	Hole Diameter (mm)	Sample Recovery (%)	Remarks

Project Specific Time Related Remarks				Drilling Progress by Time				
Date Time Start	Date Time End	Duration	Remarks	Date Time	Depth (m)	Casing Depth (m)	Water Depth (m)	Remarks

SPT								
Top Depth (m)	Test Type	Casing Depth (m)	Water Depth (m)	Self Weight Penetration (mm)	Reported Result (N Value)	Hammer Serial No.	Energy Ratio %	Remarks
1.00	S				N=12 (1,2/3,3,3)			
2.00	S				N=7 (1,1/2,2,1,2)			
3.00	S				N=3 (3,1/1,1,1,0)			
4.00	S				N=9 (3,4/3,2,2,2)			
5.00	S				N=6 (1,1/2,1,2,1)			

Water Strikes and Details							
Depth Strike (m)	Date Time	Depth Casing (m)	Depth Sealed (m)	Remarks	Time Elapsed (mins)	Water Depth (m)	Remarks

Installation Details						Pipe Construction				
Distance	Point Ref.	Type	Top of Response Zone (m)	Base of Response Zone (m)	Pipe Ref.	Pipe Reference	Depth Top (m)	Depth Base (m)	Diameter (mm)	Pipe Type
0.00	1	SP	1.00	5.00	1	1	0.00	1.00	50	PLAIN
						1	1.00	5.00	50	SLOTTED

Backfill Details			
Depth Top	Depth Base	Material	Remarks
0.00	1.00	Bentonite	
1.00	5.00	Gravel Backfill	

Status:	DRAFT	Log Print Date and Time:	16/04/2025 09:22	Log Approved By:	
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				Start - End Date:		Project ID:		Hole Type:		WLS02	
				19/03/2025		J15809		WLS		Sheet 1 of 1	
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:	
						E 307917 - N 208447		383.95		SM	
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA			
Well	Water Strikes	Samples and Insitu Testing			Progress	Depth (m)	Level (m AOD)	Legend	Stratum Description		
		Depth (m)	Type/Fl	Results	Runs						
		0.30	ES			0.20	383.75		Reddish brown, sandy, medium to coarse, sub-angular, limestone GRAVEL (Sub-base).		
			0.70	ES			0.50	383.45			Dark grey, gravelly, CLAY. Gravel comprises fragments of limestone, ash and concrete. MADE GROUND
			1.00	SPT	N=8 (1,1/2,2,2,2)						Dark grey to black, gravelly, SAND. Gravel comprises fragments of siltstone, mudstone and limestone. MADE GROUND
			1.50	ES			1.30	382.65			Firm, pale grey to grey, gravelly, shaley, CLAY. Gravel comprises fine to medium, sub-angular, mudstone, siltstone and limestone. REWORKED GROUND
			2.00	D HP SPT	UCS(kPa)=200 N=6 (1,1/2,1,1,2)						
			2.50	D HP	UCS(kPa)=90			(2.50)			
			3.00	D HP SPT	UCS(kPa)=140 N=20 (1,1/3,6,5,6)						
		3.50	D								
		4.00	D SPT	N=8 (1,1/2,1,3,2)		3.80	380.15		Firm, orange brown mottled bluish grey, silty, sandy, CLAY. REWORKED GROUND		
						4.00	379.95		End of Borehole at 4.00m		
Remarks:											
1. Borehole dry upon completion of drilling.											
Status:		DRAFT		Log Print Date and Time:		16/04/2025 09:22		Log Approved By:			

	Start - End Date:	Project ID:	Hole Type:	WLS02
	19/03/2025	J15809	WLS	Sheet 1 of 1

Depth Related Hole Information									
Top Depth (m)	Base Depth (m)	Hole Type	Start Date	End Date	Crew	Plant Used	Contractor	Logged By	Remarks
0.00	4.00	WLS	19/03/2025	19/03/2025	DT & JS	Prem 110	STL	SM	

Hole Diameter			Casing Diameter		
Hole Diameter (mm)	Depth to Base (m)	Remarks	Casing Diameter (mm)	Depth to Base (m)	Remarks

Dynamic Sample Drill Run Information						
Run No.	Top Depth (m)	Base Depth (m)	Duration	Hole Diameter (mm)	Sample Recovery (%)	Remarks

Project Specific Time Related Remarks				Drilling Progress by Time				
Date Time Start	Date Time End	Duration	Remarks	Date Time	Depth (m)	Casing Depth (m)	Water Depth (m)	Remarks

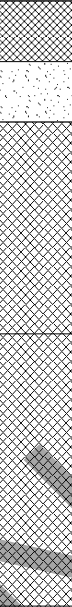
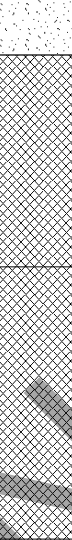
SPT								
Top Depth (m)	Test Type	Casing Depth (m)	Water Depth (m)	Self Weight Penetration (mm)	Reported Result (N Value)	Hammer Serial No.	Energy Ratio %	Remarks
1.00 2.00 3.00 4.00	S S S S				N=8 (1,1/2,2,2,2) N=6 (1,1/2,1,1,2) N=20 (1,1/3,6,5,6) N=8 (1,1/2,1,3,2)			

Water Strikes and Details							
Depth Strike (m)	Date Time	Depth Casing (m)	Depth Sealed (m)	Remarks	Time Elapsed (mins)	Water Depth (m)	Remarks

Installation Details						Pipe Construction				
Distance	Point Ref.	Type	Top of Response Zone (m)	Base of Response Zone (m)	Pipe Ref.	Pipe Reference	Depth Top (m)	Depth Base (m)	Diameter (mm)	Pipe Type
0.00	1	SP	1.00	4.00	1	1	0.00 1.00	1.00 4.00	50 50	PLAIN SLOTTED

Backfill Details			
Depth Top	Depth Base	Material	Remarks
0.00 1.00	1.00 4.00	Bentonite Gravel Backfill	

Status:	DRAFT	Log Print Date and Time:	16/04/2025 09:22	Log Approved By:	
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				Start - End Date:		Project ID:		Hole Type:		WLS03				
				20/03/2025		J15809		WLS		Sheet 1 of 1				
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:				
						E 307975 - N 208452		383.51		SM				
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA						
Well	Water Strikes	Samples and Insitu Testing			Progress	Depth (m)	Level (m AOD)	Legend	Stratum Description					
		Depth (m)	Type/Fl	Results	Runs									
		0.60	ES			0.20	383.31		BLACKTOP.	1				
									(0.20)		CONCRETE.			
									0.40		383.11		Dark grey to black, sandy, gravelly, CLAY. Gravel comprises fragments of ash, clinker, limestone and siltstone. MADE GROUND	
														(0.70)
														(0.90)
1.10	382.41		Pale grey mottled orange brown, silty, CLAY, with occasional medium to coarse, sub-angular limestone, siltstone and mudstone gravel. REWORKED GROUND											
1.50	ES				2.00	381.51		End of Borehole at 2.00m	2					
2.00	D SPT		N=51 (3,2/51 for 260mm)							3				
										4				
										5				
Remarks:														
1. Borehole refused at 2.0m (bgl).														
2. Borehole dry upon completion of drilling.														
Status:		DRAFT		Log Print Date and Time:		16/04/2025 09:22		Log Approved By:						

				Start - End Date:		Project ID:		Hole Type:		WLS03	
				20/03/2025		J15809		WLS		Sheet 1 of 1	

Depth Related Hole Information									
Top Depth (m)	Base Depth (m)	Hole Type	Start Date	End Date	Crew	Plant Used	Contractor	Logged By	Remarks
0.00	2.00	WLS	20/03/2025	20/03/2025	DT & JS	Prem 110	STL	SM	

Hole Diameter			Casing Diameter		
Hole Diameter (mm)	Depth to Base (m)	Remarks	Casing Diameter (mm)	Depth to Base (m)	Remarks

Dynamic Sample Drill Run Information						
Run No.	Top Depth (m)	Base Depth (m)	Duration	Hole Diameter (mm)	Sample Recovery (%)	Remarks

Project Specific Time Related Remarks				Drilling Progress by Time				
Date Time Start	Date Time End	Duration	Remarks	Date Time	Depth (m)	Casing Depth (m)	Water Depth (m)	Remarks

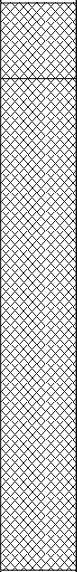
SPT								
Top Depth (m)	Test Type	Casing Depth (m)	Water Depth (m)	Self Weight Penetration (mm)	Reported Result (N Value)	Hammer Serial No.	Energy Ratio %	Remarks
1.00 2.00	S S				N=6 (3,2/1,1,2,2) N=51 (3,2/51 for 260mm)			

Water Strikes and Details							
Depth Strike (m)	Date Time	Depth Casing (m)	Depth Sealed (m)	Remarks	Time Elapsed (mins)	Water Depth (m)	Remarks

Installation Details						Pipe Construction				
Distance	Point Ref.	Type	Top of Response Zone (m)	Base of Response Zone (m)	Pipe Ref.	Pipe Reference	Depth Top (m)	Depth Base (m)	Diameter (mm)	Pipe Type

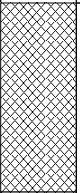
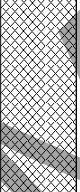
Backfill Details			
Depth Top	Depth Base	Material	Remarks
0.00	2.00	Arisings	

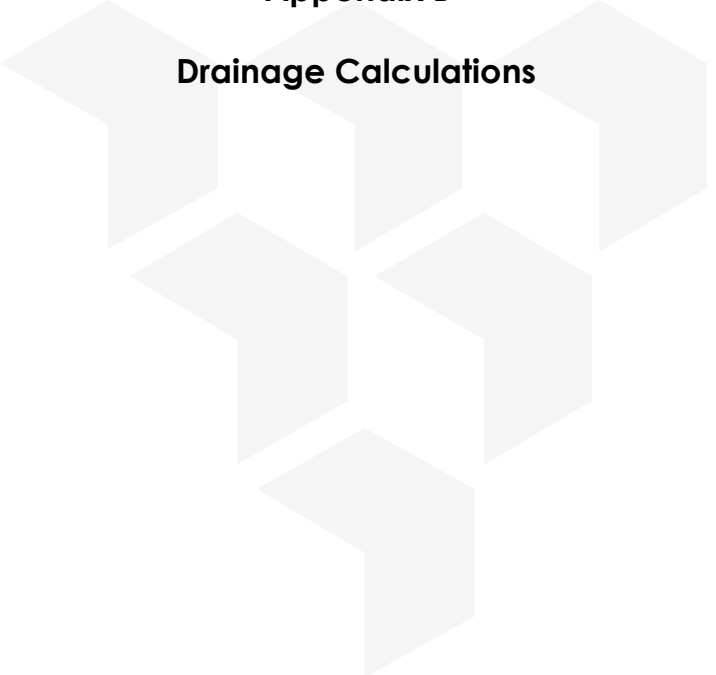
Status:	DRAFT	Log Print Date and Time:	16/04/2025 09:22	Log Approved By:	
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				Start - End Date:		Project ID:		Hole Type:		TP01	
				21/03/2025		J15809		TP		Sheet 1 of 1	
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:	
						E 307912 - N 208430		384.72		SM	
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA			
Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description				
Depth (m bgl)	Type	Results									
0.10	ES		384.52	(0.20)		0.20	Dark grey to black, silty, sandy, CLAY, with frequent roots and rootlets. MADE GROUND				
1.00	ES			(1.30)			Dark grey to grey, gravelly, CLAY. Gravel comprises fragments of brick, wood, plastic, siltstone and mudstone. MADE GROUND				
			383.22			1.50	Pit terminated at 1.50m				
Pit Dimension (m)		Pit Stability:		1. Trial pit sides stable upon completion of excavation.			Water Strikes				
		Weather:					Depth (m)	Date/Time	Remarks		
Width:	0.60	Remarks: 1. Trial pit through bund. 2. Trial pit dry upon completion of excavation.									
Length:	1.60										
Depth:	1.50										
Status:		DRAFT		Log Print Date and Time:		16/04/2025 09:13		Log Approved By:			

				Start - End Date:		Project ID:		Hole Type:		TP02		
				21/03/2025		J15809		TP		Sheet 1 of 1		
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:		
						E 307936 - N 208448		383.44		SM		
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA				
Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description					
Depth (m bgl)	Type	Results										
0.40	ES		383.34	(0.10)		0.10	CONCRETE with 5mm steel mesh reinforcement.					
				(0.50)		0.60	Dark grey to greyish brown, gravelly, SAND. Gravel comprises fragments of brick, concrete, tile, limestone, siltstone, mudstone. MADE GROUND					
1.00	ES		382.84				Firm, grey mottled yellowish brown, silty, gravelly, CLAY. Gravel comprises fine to medium, sub-angular, mudstone and siltstone, with occasional fragments of coal. REWORKED GROUND					
								[1.0m (bgl) - Water pipe & Cable.]				
2.00	D HP	UCS(kPa)=100		(2.40)								
3.00	D			380.44			3.00	Pit terminated at 3.00m				
Pit Dimension (m)		Pit Stability:		1. Trial pit sides stable upon completion of excavation.			Water Strikes					
		Weather:					Depth (m)	Date/Time	Remarks			
Width:	0.60	Remarks: 1. Trial pit dry upon completion of excavation.										
Length:	2.60											
Depth:	3.00											
Status:		DRAFT		Log Print Date and Time:		16/04/2025 09:13		Log Approved By:				

				Start - End Date:		Project ID:		Hole Type:		TP03			
				21/03/2025		J15809		TP		Sheet 1 of 1			
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:			
						E 307947 - N 208459		383.98		SM			
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA					
Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description						
Depth (m bgl)	Type	Results											
0.30	ES		383.88	(0.10)		0.10	CONCRETE with 5mm steel mesh reinforcement.						
	0.50		ES	383.58		(0.30)	0.40	Dark grey to greyish brown, gravelly, SAND. Gravel comprises fragments of brick, concrete, limestone, siltstone and mudstone. MADE GROUND					
1.50		ES PPT	N=16(450)	382.78	(0.80)		1.20	Orange brown to dark grey and black, silty, CLAY, with an organic odour and occasional fragments of brick, concrete and limestone. MADE GROUND					
	2.00	D HP					UCS(kPa)=200	(1.80)			Firm, yellowish brown to dark grey and black, silty, sandy, gravelly, CLAY. Gravel comprises medium to coarse, sub-angular limestone, siltstone and mudstone, with occasional limestone cobbles and boulders. REWORKED GROUND		
3.00		D HP	UCS(kPa)=300	380.98									Pit terminated at 3.00m
Pit Dimension (m)		Pit Stability:		1. Trial pit sides stable upon completion of excavation.				Water Strikes					
		Weather:						Depth (m)		Date/Time		Remarks	
Width:	0.70	Remarks:											
Length:	2.10	1. Trial pit dry upon completion of excavation.											
Depth:	3.00												
Status:		DRAFT		Log Print Date and Time:		16/04/2025 09:13		Log Approved By:					

				Start - End Date:		Project ID:		Hole Type:		TP04	
				21/03/2025		J15809		TP		Sheet 1 of 1	
Client:		Glanville Consultants Ltd.				Co-ordinates:		Level (m AOD)		Logger:	
						E 307928 - N 208424		382.72		SM	
Project Name:		Penygarnddu Industrial Estate				Location:		Merthyr Tydfil, CF48 2TA			
Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description				
Depth (m bgl)	Type	Results									
0.70	D		382.22	(0.50)		0.50	Dark grey to black, silty, gravelly, SAND. Gravel comprises fine to coarse, sub-angular limestone. MADE GROUND				
				(0.70)		1.20	Greyish brown to dark grey, gravelly, SAND. Gravel comprises fragments of brick, concrete, limestone, mudstone and siltstone. MADE GROUND				
1.50	D HP	UCS(kPa)=250	381.52				Dark grey to yellowish brown, gravelly, CLAY. Gravel comprises medium to coarse, sub-angular, limestone, siltstone and mudstone, with occasional limestone cobbles and boulders. REWORKED GROUND				
1.70	PPT	N=17(450)									
2.50	D HP	UCS(kPa)=160		(1.80)							
			379.72			3.00	Pit terminated at 3.00m				
Pit Dimension (m)		Pit Stability:		1. Trial pit sides stable upon completion of excavation.			Water Strikes				
		Weather:					Depth (m)	Date/Time	Remarks		
Width:	0.70	Remarks: 1. Trial pit dry upon completion of excavation.									
Length:	2.50										
Depth:	3.00										
Status:	DRAFT		Log Print Date and Time:		16/04/2025 09:13		Log Approved By:				



Appendix B

Drainage Calculations

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	0	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	0.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Simulation Settings

Rainfall Methodology	FEH-22	Starting Level (m)	
Rainfall Events	Singular	Check Discharge Rate(s)	✓
Summer CV	0.750	1 year (l/s)	5.5
Winter CV	0.840	2 year (l/s)	5.8
Analysis Speed	Normal	30 year (l/s)	11.3
Skip Steady State	x	100 year (l/s)	13.7
Drain Down Time (mins)	240	Check Discharge Volume	x
Additional Storage (m³/ha)	20.0		

Storm Durations

15	60	180	360	600	960
30	120	240	480	720	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.80
Greenfield Method	FEH	Growth Factor 100 year	2.18
Positively Drained Area (ha)	0.298	Betterment (%)	0
SAAR (mm)	1479	QMed	5.9
Host	1	QBar	6.3
BFIHost	0.301	Q 1 year (l/s)	5.5
Region	9	Q 2 year (l/s)	5.8
QBar/QMed conversion factor	1.075	Q 30 year (l/s)	11.3
Growth Factor 1 year	0.88	Q 100 year (l/s)	13.7
Growth Factor 2 year	0.93		



Design Settings

Rainfall Methodology	FEH-22	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	0.000
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	x
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	0.750	Connection Type	Level Soffits		
Time of Entry (mins)	6.00	Minimum Backdrop Height (m)	0.200		

Simulation Settings

Rainfall Methodology	FEH-22	Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Rate(s)	x
Rainfall Events	Singular	Analysis Speed	Normal	Additional Storage (m ³ /ha)	20.0	Check Discharge Volume	x
Summer CV	0.750	Skip Steady State	x	Starting Level (m)			

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0	100	40	0	0
30	0	0	0				

Node SW FC Online Hydro-Brake® Control

Flap Valve	x	Design Flow (l/s)	5.5	Min Outlet Diameter (m)	0.150
Replaces Downstream Link	x	Objective	(HE) Minimise upstream storage	Min Node Diameter (mm)	1200
Invert Level (m)	381.900	Sump Available	✓		
Design Depth (m)	1.000	Product Number	CTL-SHE-0110-5500-1000-5500		

Node Bio-Retention Strip Outlet Bioretention Area Storage Structure

Underdrain Link Type	Circular	Underdrain DS Node	Bio-Retention Strip D1	Invert Level (m)	383.919
Underdrain Diameter (mm)	150	Filter Conductivity (m/hr)	0.31500	Time to half empty (mins)	105
Underdrain Velocity	Colebrook-White	Filter Depth (m)	0.300	Main Channel Length (m)	63.000
Underdrain ks (mm) / n	0.600	Base Inf Coefficient (m/hr)	0.00001	Main Channel Slope (1:X)	170.0
Underdrain Length (m)	63.000	Side Inf Coefficient (m/hr)	0.00000	Main Channel n	0.600
Underdrain Slope (1:X)	170.0	Safety Factor	2.0		
Underdrain Height above base (m)	0.075	Porosity	0.30		

Inlet Node	Connects To
Bio-Retention Strip Inlet	Underdrain

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	38.0	0.400	38.0

Node Bio-Retention Area Outlet Rain Garden Storage Structure

Filter Conductivity (m/hr)	0.31500	Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	382.825
Filter Depth (m)	0.400	Safety Factor	2.0	Time to half empty (mins)	40
Base Inf Coefficient (m/hr)	0.00001	Porosity	0.30	Analyse flow through structure	x

Inlets
Bio-Retention Area Inlet

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	66.4	0.600	162.5

Node Bio-Retention Area Outlet Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	382.025
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	
Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	25.0	25.0	0.400	25.0	32.1
			0.401	0.0	32.1

Node Tank 02 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	381.900
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	
Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	135.0	135.0	1.000	135.0	176.2
			1.001	0.0	176.2

Node Permeable Parking 01 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	10.000	Depth (m)	0.350
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	383.960	Length (m)	10.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	0	Slope (1:X)	300.0		

Node Permeable Paving 02 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	10.000	Depth (m)
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	384.580	Length (m)	3.700	Inf Depth (m)
Safety Factor	2.0	Time to half empty (mins)		Slope (1:X)	300.0	

Node Permeable Paving 03 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	8.000	Depth (m)
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	383.540	Length (m)	10.000	Inf Depth (m)
Safety Factor	2.0	Time to half empty (mins)	0	Slope (1:X)	300.0	



Results for 1 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SW 05	12	383.076	0.119	9.2	0.1341	0.0000	OK
360 minute summer	Bio-Retention Strip Inlet	200	384.353	0.063	1.4	0.0000	0.0000	OK
15 minute summer	Bio-Retention Strip D1	1	383.694	0.000	0.0	0.0000	0.0000	OK
15 minute winter	Bio-Retention Strip Outlet	11	383.462	0.022	2.4	1.1041	0.0000	OK
360 minute summer	Bio-Retention Strip Outlet Filter Layer	216	383.707	0.088	0.7	1.0454	0.0000	OK
15 minute winter	Bio-Retention Area Inlet	11	382.827	0.002	2.4	0.0000	0.0000	OK
480 minute summer	Bio-Retention Area Outlet	280	382.086	0.061	1.9	1.5110	0.0000	OK
15 minute summer	Bio-Retention Area Outlet Filter Layer	1	382.425	0.000	0.0	0.0000	0.0000	OK
480 minute summer	SW FC	280	382.086	0.186	6.7	0.2102	0.0000	SURCHARGED
15 minute winter	SW 01	11	383.378	0.028	1.4	0.0435	0.0000	OK
15 minute winter	SW 02	11	383.255	0.043	3.3	0.0655	0.0000	OK
15 minute winter	SPEL	12	383.048	0.095	10.3	0.1292	0.0000	OK
15 minute winter	Permeable Parking 01	12	383.981	0.021	1.9	0.2182	0.0000	OK
15 minute winter	SW 03	11	384.042	0.042	2.7	0.0437	0.0000	OK
15 minute winter	SW 04	11	383.937	0.032	4.4	0.0090	0.0000	OK
480 minute summer	Tank 02	288	382.086	0.185	4.8	23.6638	0.0000	OK
480 minute summer	SW PUMP	288	381.929	0.053	4.8	0.0000	0.0000	OK
15 minute winter	Permeable Paving 02	11	384.032	0.032	1.7	0.0183	0.0000	OK
15 minute winter	Permeable Paving 03	12	383.567	0.027	3.4	0.3201	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SW 05	1.002	SPEL	9.1	0.761	0.510	0.0313	
360 minute summer	Bio-Retention Strip Inlet	Bioretention Area	Bio-Retention Strip Outlet	0.6	0.017	0.030		
15 minute winter	Bio-Retention Strip Outlet	7.000	Bio-Retention Area Inlet	2.4	1.254	0.018	0.0091	
15 minute winter	Bio-Retention Strip Outlet	Filtration		0.0				
15 minute winter	Bio-Retention Strip Outlet	Underdrain		0.0	0.195	0.003	0.0137	0.3
360 minute summer	Bio-Retention Strip Outlet Filter Layer	Infiltration		0.0				
480 minute summer	Bio-Retention Area Outlet	5.000	Tank 02	1.9	0.187	0.046	0.4214	
480 minute summer	Bio-Retention Area Outlet	Filtration		0.0				
15 minute summer	Bio-Retention Area Outlet Filter Layer	Infiltration		0.0				
480 minute summer	SW FC	1.004	SW PUMP	4.8	0.788	0.270	0.0146	63.3
15 minute winter	SW 01	1.000	SW 02	1.4	0.433	0.079	0.0454	
15 minute winter	SW 02	1.001	SW 05	3.3	0.430	0.184	0.1865	
15 minute winter	SPEL	1.003	SW FC	10.3	0.948	0.579	0.0263	
15 minute winter	Permeable Parking 01	4.000	SW 05	1.6	0.227	0.041	0.1617	
15 minute winter	SW 03	2.000	SW 04	2.7	0.805	0.152	0.0321	
15 minute winter	SW 04	2.001	SW 05	4.4	0.746	0.099	0.1345	
480 minute summer	Tank 02	5.001	SW FC	-3.0	-0.194	-0.670	0.3970	
15 minute winter	Permeable Paving 02	3.000	SW 04	1.7	0.624	0.093	0.0247	
15 minute winter	Permeable Paving 03	6.000	SW FC	3.1	1.457	0.068	0.0198	



Results for 30 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SW 05	12	383.451	0.494	32.1	0.5589	0.0000	SURCHARGED
60 minute winter	Bio-Retention Strip Inlet	44	384.440	0.150	6.7	0.0000	0.0000	OK
15 minute summer	Bio-Retention Strip D1	1	383.694	0.000	0.2	0.0000	0.0000	OK
15 minute winter	Bio-Retention Strip Outlet	11	383.484	0.044	9.4	3.9666	0.0000	OK
120 minute winter	Bio-Retention Strip Outlet Filter Layer	84	383.714	0.095	1.5	1.1641	0.0000	OK
15 minute winter	Bio-Retention Area Inlet	11	382.831	0.006	9.4	0.0000	0.0000	OK
360 minute winter	Bio-Retention Area Outlet	272	382.434	0.409	4.2	9.6731	0.0000	SURCHARGED
15 minute summer	Bio-Retention Area Outlet Filter Layer	1	382.425	0.000	0.0	0.0000	0.0000	OK
360 minute winter	SW FC	272	382.434	0.534	13.1	0.6037	0.0000	SURCHARGED
15 minute winter	SW 01	13	383.557	0.206	5.4	0.3161	0.0000	SURCHARGED
15 minute winter	SW 02	13	383.545	0.334	11.4	0.5027	0.0000	SURCHARGED
15 minute winter	SPEL	12	383.283	0.330	35.8	0.4463	0.0000	SURCHARGED
15 minute winter	Permeable Parking 01	12	384.001	0.041	7.3	0.7719	0.0000	OK
15 minute winter	SW 03	11	384.089	0.089	10.4	0.0927	0.0000	OK
15 minute winter	SW 04	11	383.970	0.065	16.9	0.0183	0.0000	OK
360 minute winter	Tank 02	272	382.434	0.533	9.8	68.3009	0.0000	SURCHARGED
60 minute winter	SW PUMP	48	381.933	0.057	5.5	0.0000	0.0000	OK
15 minute winter	Permeable Paving 02	11	384.066	0.066	6.5	0.0379	0.0000	OK
15 minute winter	Permeable Paving 03	12	383.597	0.057	13.2	1.0689	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SW 05	1.002	SPEL	31.3	1.779	1.764	0.0463	
60 minute winter	Bio-Retention Strip Inlet	Bioretention Area	Bio-Retention Strip Outlet	2.0	0.026	0.109		
15 minute winter	Bio-Retention Strip Outlet	7.000	Bio-Retention Area Inlet	9.4	1.832	0.070	0.0247	
15 minute winter	Bio-Retention Strip Outlet	Filtration		0.0				
15 minute winter	Bio-Retention Strip Outlet	Underdrain		0.3	0.330	0.024	0.0633	1.5
120 minute winter	Bio-Retention Strip Outlet Filter Layer	Infiltration		0.0				
360 minute winter	Bio-Retention Area Outlet	5.000	Tank 02	2.4	0.336	0.057	0.7686	
360 minute winter	Bio-Retention Area Outlet	Filtration		0.0				
15 minute summer	Bio-Retention Area Outlet Filter Layer	Infiltration		0.0				
360 minute winter	SW FC	1.004	SW PUMP	5.5	0.816	0.310	0.0162	140.1
15 minute winter	SW 01	1.000	SW 02	5.3	0.582	0.300	0.2443	
15 minute winter	SW 02	1.001	SW 05	10.7	0.608	0.603	0.4078	
15 minute winter	SPEL	1.003	SW FC	35.5	2.018	2.001	0.0424	
15 minute winter	Permeable Parking 01	4.000	SW 05	6.5	0.613	0.162	0.2119	
15 minute winter	SW 03	2.000	SW 04	10.4	1.150	0.587	0.0861	
15 minute winter	SW 04	2.001	SW 05	16.8	1.161	0.377	0.1903	
360 minute winter	Tank 02	5.001	SW FC	-7.5	-0.290	-1.653	0.4510	
15 minute winter	Permeable Paving 02	3.000	SW 04	6.5	0.886	0.357	0.0664	
15 minute winter	Permeable Paving 03	6.000	SW FC	12.5	2.123	0.272	0.0546	



Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	SW 05	21	383.968	1.011	48.5	1.1436	0.0000	SURCHARGED
60 minute winter	Bio-Retention Strip Inlet	43	384.540	0.250	11.8	0.0000	0.0000	OK
15 minute summer	Bio-Retention Strip D1	1	383.694	0.000	0.5	0.0000	0.0000	OK
30 minute summer	Bio-Retention Strip Outlet	18	383.500	0.060	16.8	7.6709	0.0000	OK
60 minute winter	Bio-Retention Strip Outlet Filter Layer	51	383.721	0.102	2.6	1.2716	0.0000	OK
480 minute winter	Bio-Retention Area Inlet	376	383.017	0.192	4.9	0.0000	0.0000	OK
480 minute winter	Bio-Retention Area Outlet	376	383.013	0.988	6.1	25.2418	0.0000	SURCHARGED
240 minute winter	Bio-Retention Area Outlet Filter Layer	240	382.825	0.400	2.0	7.9580	0.0000	OK
480 minute winter	SW FC	376	383.012	1.112	18.0	1.2578	0.0000	SURCHARGED
30 minute summer	SW 01	21	384.228	0.878	9.4	1.3443	0.0000	FLOOD RISK
30 minute summer	SW 02	21	384.200	0.989	18.0	1.4901	0.0000	SURCHARGED
30 minute summer	SPEL	20	383.570	0.617	54.9	0.8349	0.0000	SURCHARGED
30 minute summer	Permeable Parking 01	21	384.022	0.062	12.5	1.4214	0.0000	OK
30 minute summer	SW 03	20	384.380	0.380	17.9	0.3971	0.0000	SURCHARGED
30 minute summer	SW 04	20	384.290	0.385	27.2	0.1089	0.0000	SURCHARGED
480 minute winter	Tank 02	376	383.012	1.111	18.8	128.1306	0.0000	SURCHARGED
480 minute winter	SW PUMP	376	381.934	0.058	5.6	0.0000	0.0000	OK
30 minute summer	Permeable Paving 02	20	384.322	0.322	11.2	0.1853	0.0000	SURCHARGED
30 minute summer	Permeable Paving 03	19	383.620	0.080	22.8	1.6580	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	SW 05	1.002	SPEL	48.3	2.743	2.720	0.0463	
60 minute winter	Bio-Retention Strip Inlet	Bioretention Area	Bio-Retention Strip Outlet	4.1	0.032	0.224		
30 minute summer	Bio-Retention Strip Outlet	7.000	Bio-Retention Area Inlet	16.7	2.121	0.125	0.0381	
30 minute summer	Bio-Retention Strip Outlet	Filtration		0.0				
30 minute summer	Bio-Retention Strip Outlet	Underdrain		0.9	0.440	0.066	0.1291	3.2
60 minute winter	Bio-Retention Strip Outlet Filter Layer	Infiltration		0.0				
480 minute winter	Bio-Retention Area Outlet	5.000	Tank 02	5.9	0.352	0.143	0.7686	
480 minute winter	Bio-Retention Area Outlet	Filtration		2.7				
240 minute winter	Bio-Retention Area Outlet Filter Layer	Infiltration		0.0				
480 minute winter	SW FC	1.004	SW PUMP	5.6	0.820	0.316	0.0164	191.8
30 minute summer	SW 01	1.000	SW 02	7.3	0.588	0.414	0.2443	
30 minute summer	SW 02	1.001	SW 05	16.3	0.928	0.920	0.4078	
30 minute summer	SPEL	1.003	SW FC	54.5	3.099	3.073	0.0424	
30 minute summer	Permeable Parking 01	4.000	SW 05	10.9	0.792	0.270	0.2412	
30 minute summer	SW 03	2.000	SW 04	16.6	1.189	0.934	0.1677	
30 minute summer	SW 04	2.001	SW 05	25.5	1.478	0.572	0.2697	
480 minute winter	Tank 02	5.001	SW FC	-12.9	-0.329	-2.849	0.4510	
30 minute summer	Permeable Paving 02	3.000	SW 04	10.7	0.919	0.587	0.1593	
30 minute summer	Permeable Paving 03	6.000	SW FC	21.9	2.424	0.476	0.0837	

Design Settings

Rainfall Methodology	FEH-22	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	0.000
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	x
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	0.750	Connection Type	Level Soffits		
Time of Entry (mins)	6.00	Minimum Backdrop Height (m)	0.200		

Simulation Settings

Rainfall Methodology	FEH-22	Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Rate(s)	x
Rainfall Events	Singular	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0	Check Discharge Volume	x
Summer CV	0.750	Skip Steady State	x	Starting Level (m)			

Storm Durations

15 | 30 | 60 | 120 | 180 | 240

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	40	0	0



Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 98.46%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	SW 05	21	383.968	1.011	48.5	1.1436	0.0000	SURCHARGED
60 minute winter	Bio-Retention Strip Inlet	43	384.540	0.250	11.8	0.0000	0.0000	OK
15 minute summer	Bio-Retention Strip D1	1	383.694	0.000	0.5	0.0000	0.0000	OK
30 minute summer	Bio-Retention Strip Outlet	18	383.500	0.060	16.8	7.6711	0.0000	OK
60 minute winter	Bio-Retention Strip Outlet Filter Layer	51	383.721	0.102	2.6	1.2717	0.0000	OK
240 minute winter	Bio-Retention Area Inlet	480	383.382	0.556	12.9	0.0000	0.0000	OK
240 minute winter	Bio-Retention Area Outlet	480	383.381	1.356	21.3	71.6105	0.0000	FLOOD RISK
120 minute summer	Bio-Retention Area Outlet Filter Layer	244	382.825	0.400	1.1	7.9580	0.0000	OK
240 minute winter	SW FC	456	383.381	1.481	28.0	1.6754	0.0000	SURCHARGED
30 minute summer	SW 01	21	384.228	0.878	9.4	1.3444	0.0000	FLOOD RISK
30 minute summer	SW 02	21	384.200	0.989	18.0	1.4902	0.0000	SURCHARGED
30 minute summer	SPEL	20	383.570	0.617	54.9	0.8350	0.0000	SURCHARGED
30 minute summer	Permeable Parking 01	21	384.022	0.062	12.5	1.4215	0.0000	OK
30 minute summer	SW 03	20	384.380	0.380	17.9	0.3972	0.0000	SURCHARGED
30 minute summer	SW 04	20	384.290	0.385	27.2	0.1089	0.0000	SURCHARGED
240 minute winter	Tank 02	452	383.381	1.480	35.8	128.1336	0.0000	SURCHARGED
240 minute winter	SW PUMP	480	383.382	1.506	0.5	1.7027	0.0000	OK
30 minute summer	Permeable Paving 02	20	384.322	0.322	11.2	0.1853	0.0000	SURCHARGED
30 minute summer	Permeable Paving 03	19	383.620	0.080	22.8	1.6580	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	SW 05	1.002	SPEL	48.3	2.743	2.720	0.0463	
60 minute winter	Bio-Retention Strip Inlet	Bioretention Area	Bio-Retention Strip Outlet	4.1	0.032	0.224		
30 minute summer	Bio-Retention Strip Outlet	7.000	Bio-Retention Area Inlet	16.7	2.121	0.125	0.0381	
30 minute summer	Bio-Retention Strip Outlet	Filtration		0.0				
30 minute summer	Bio-Retention Strip Outlet	Underdrain		0.9	0.440	0.066	0.1291	3.2
60 minute winter	Bio-Retention Strip Outlet Filter Layer	Infiltration		0.0				
240 minute winter	Bio-Retention Area Outlet	5.000	Tank 02	-19.9	-0.500	-0.478	0.7686	
240 minute winter	Bio-Retention Area Outlet	Filtration		5.2				
120 minute summer	Bio-Retention Area Outlet Filter Layer	Infiltration		0.0				
240 minute winter	SW FC	1.004	SW PUMP	0.5	0.257	0.029	0.0423	
30 minute summer	SW 01	1.000	SW 02	7.4	0.588	0.414	0.2443	
30 minute summer	SW 02	1.001	SW 05	16.3	0.928	0.920	0.4078	
30 minute summer	SPEL	1.003	SW FC	54.5	3.099	3.073	0.0424	
30 minute summer	Permeable Parking 01	4.000	SW 05	10.9	0.792	0.270	0.2412	
30 minute summer	SW 03	2.000	SW 04	16.6	1.188	0.934	0.1677	
30 minute summer	SW 04	2.001	SW 05	25.5	1.478	0.572	0.2697	
240 minute winter	Tank 02	5.001	SW FC	-27.1	-0.682	-5.984	0.4510	
240 minute winter	SW PUMP	Pump	SW FC	0.0				0.0
30 minute summer	Permeable Paving 02	3.000	SW 04	10.7	0.919	0.587	0.1593	
30 minute summer	Permeable Paving 03	6.000	SW FC	21.9	2.424	0.476	0.0837	

Design Settings

Rainfall Methodology	FEH-22	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	0.000
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	x
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	0.750	Connection Type	Level Soffits		
Time of Entry (mins)	6.00	Minimum Backdrop Height (m)	0.200		

Simulation Settings

Rainfall Methodology	FEH-22	Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Rate(s)	x
Rainfall Events	Singular	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0	Check Discharge Volume	x
Summer CV	0.750	Skip Steady State	x	Starting Level (m)			

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1000	0	0	0



Results for 1000 year Critical Storm Duration. Lowest mass balance: 99.91%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	SW 05	21	383.976	1.019	48.7	1.1529	0.0000	SURCHARGED
60 minute winter	Bio-Retention Strip Inlet	43	384.546	0.256	12.1	0.0000	0.0000	OK
15 minute summer	Bio-Retention Strip D1	1	383.694	0.000	0.5	0.0000	0.0000	OK
30 minute summer	Bio-Retention Strip Outlet	18	383.501	0.061	16.9	7.7530	0.0000	OK
60 minute winter	Bio-Retention Strip Outlet Filter Layer	50	383.721	0.102	2.6	1.2784	0.0000	OK
480 minute winter	Bio-Retention Area Inlet	352	383.009	0.184	4.9	0.0000	0.0000	OK
480 minute winter	Bio-Retention Area Outlet	352	383.004	0.979	6.0	24.4353	0.0000	SURCHARGED
240 minute winter	Bio-Retention Area Outlet Filter Layer	272	382.825	0.400	1.6	7.9580	0.0000	OK
480 minute winter	SW FC	352	383.004	1.104	18.0	1.2482	0.0000	SURCHARGED
30 minute summer	SW 01	21	384.241	0.891	9.5	1.3648	0.0000	FLOOD RISK
30 minute summer	SW 02	21	384.213	1.002	18.2	1.5098	0.0000	SURCHARGED
30 minute summer	SPEL	20	383.575	0.622	55.2	0.8424	0.0000	SURCHARGED
30 minute summer	Permeable Parking 01	21	384.024	0.064	12.6	1.4731	0.0000	OK
30 minute summer	SW 03	20	384.397	0.397	18.1	0.4144	0.0000	SURCHARGED
30 minute summer	SW 04	20	384.305	0.400	27.5	0.1132	0.0000	SURCHARGED
480 minute winter	Tank 02	352	383.004	1.103	18.8	128.1306	0.0000	SURCHARGED
480 minute winter	SW PUMP	352	381.934	0.058	5.6	0.0000	0.0000	OK
30 minute summer	Permeable Paving 02	20	384.338	0.338	11.3	0.1944	0.0000	SURCHARGED
30 minute summer	Permeable Paving 03	19	383.620	0.080	23.0	1.6700	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	SW 05	1.002	SPEL	48.5	2.754	2.730	0.0463	
60 minute winter	Bio-Retention Strip Inlet	Bioretention Area	Bio-Retention Strip Outlet	4.3	0.032	0.232		
30 minute summer	Bio-Retention Strip Outlet	7.000	Bio-Retention Area Inlet	16.8	2.126	0.126	0.0384	
30 minute summer	Bio-Retention Strip Outlet	Filtration		0.0				
30 minute summer	Bio-Retention Strip Outlet	Underdrain		0.9	0.441	0.067	0.1301	3.2
60 minute winter	Bio-Retention Strip Outlet Filter Layer	Infiltration		0.0				
480 minute winter	Bio-Retention Area Outlet	5.000	Tank 02	5.9	0.356	0.142	0.7686	
480 minute winter	Bio-Retention Area Outlet	Filtration		2.6				
240 minute winter	Bio-Retention Area Outlet Filter Layer	Infiltration		0.0				
480 minute winter	SW FC	1.004	SW PUMP	5.6	0.820	0.315	0.0164	191.5
30 minute summer	SW 01	1.000	SW 02	7.3	0.580	0.413	0.2443	
30 minute summer	SW 02	1.001	SW 05	16.5	0.937	0.929	0.4078	
30 minute summer	SPEL	1.003	SW FC	54.8	3.116	3.090	0.0424	
30 minute summer	Permeable Parking 01	4.000	SW 05	10.9	0.796	0.271	0.2437	
30 minute summer	SW 03	2.000	SW 04	16.7	1.191	0.942	0.1677	
30 minute summer	SW 04	2.001	SW 05	25.7	1.482	0.576	0.2697	
480 minute winter	Tank 02	5.001	SW FC	-12.9	-0.326	-2.852	0.4510	
30 minute summer	Permeable Paving 02	3.000	SW 04	10.8	0.922	0.593	0.1593	
30 minute summer	Permeable Paving 03	6.000	SW FC	22.1	2.429	0.480	0.0843	



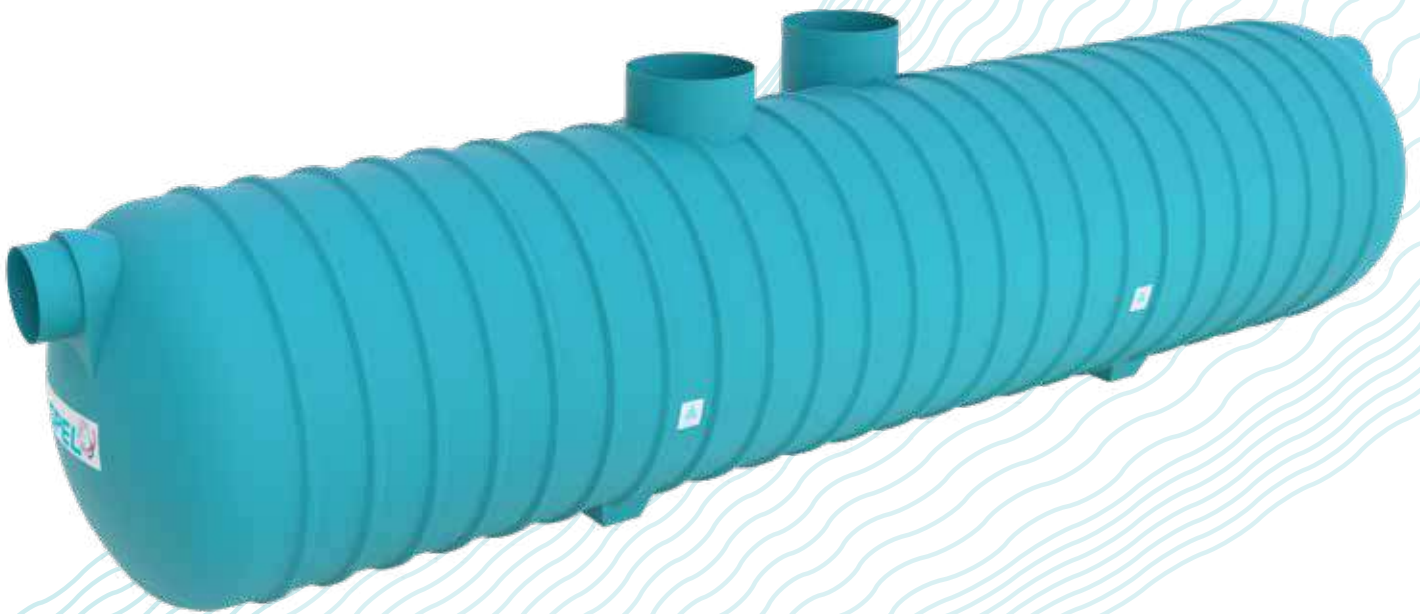
Appendix C

Product Details



Quality solutions protecting our global environment

The **safest answer** for **pollution control** and our **environment**



SPEL Stormceptor

ESR (Enhanced Silt Retention)

SuDS Compliant ESR Range

spelproducts.co.uk

SPEL Stormceptor ESR Range

By-Pass System

The **total** treatment solution for SuDS

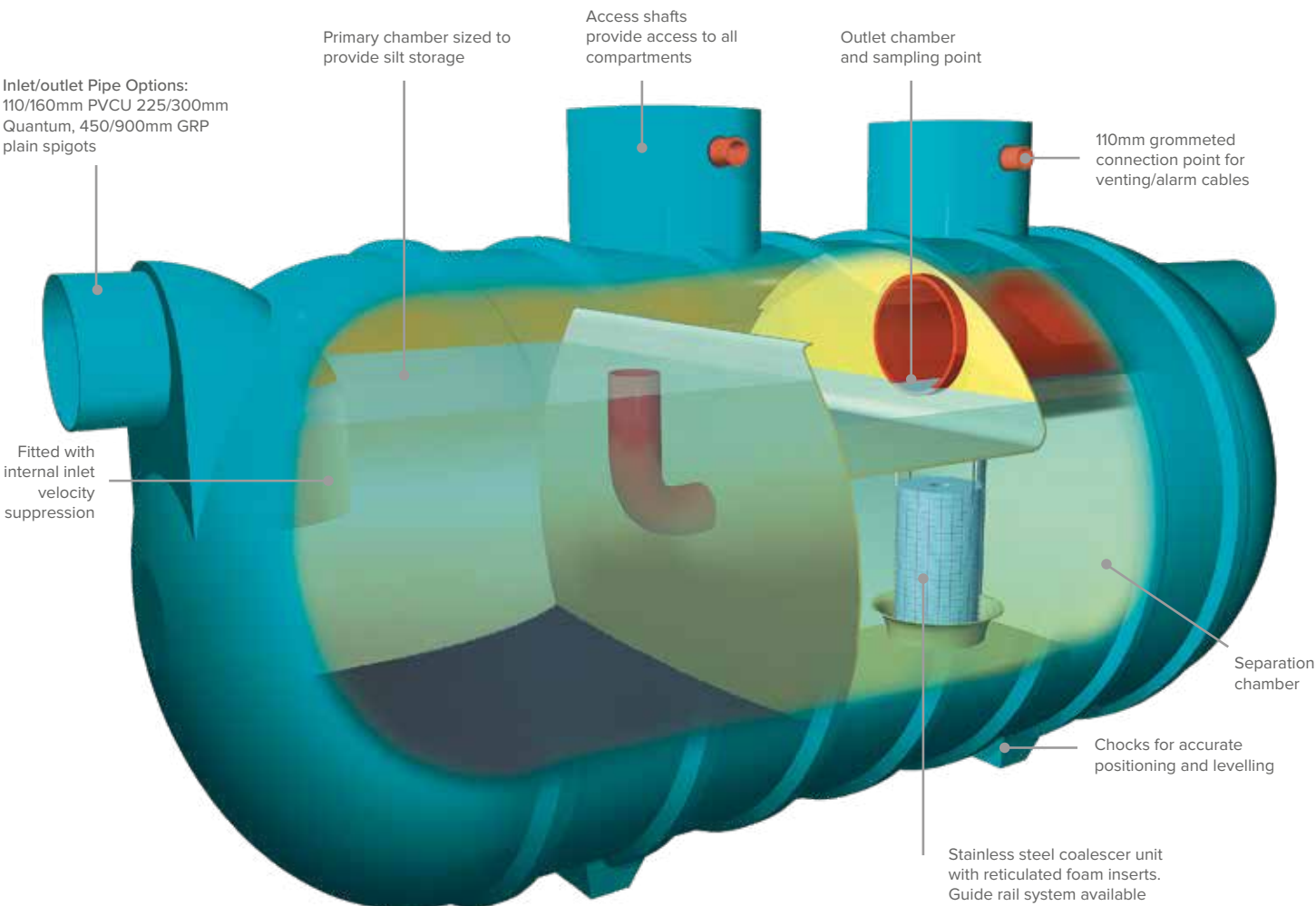
The new SPEL ESR System is fully certified to meet the CIRIA SuDS Mitigation Index. It has been tested by WRc (for TSS and Metals) to the British Water Code of Practice for Manufactured Treatment Devices. This unit is also compliant to the British and European Standard BS EN 858.

SPEL's ESR range is a total treatment system removing Hydrocarbons, Total Suspended Solids (TSS) and Metals (particulate). It's a highly efficient, single unit, water quality SuDS component.

SPEL ESR Stormceptor Certified Mitigation Index

TSS	0.8
Metals	0.6
Hydrocarbons	0.9*

**H R Wallingford test results to BS EN 858*



SPEL Stormceptor ESR Range

By-Pass System



Surface Water Treatment Device Performance Declaration

Testing carried out according to British Water Code of Practice

Product Details	Description
Manufacturer	SPEL Products
Treatment Device Name/Model	Stormceptor Type 210 C1/SC
General description	Class 1 By-pass Separator with Silt Capacity
Envisaged application	Treatment of Surface Water Run-off
Pollutant(s) captured	Suspended Solids

Test	Value	Unit
Treatment device capacity	3200	litres
Sediment Storage capacity	1000	litres
Treatment Flow rate	10	l/s
Connected Area	1,333	m ²
Pollution retention flow rate	10	l/s

Parameter	Value	Unit
Maximum capacity flow rate	100	l/s
Device head loss (at treatment flowrate)	0.15	m
Device head loss (at maximum capacity treatment flowrate)	-	m
TSS capture and retention efficiency (Milisil W4 test sediment)	82	%
Zinc capture efficiency (if tested)	Not tested for dissolved metals	%
Zinc retention efficiency (if tested)	Not tested for dissolved metals	%
Copper capture efficiency (if tested)	Not tested for dissolved metals	%
Copper retention efficiency (if tested)	Not tested for dissolved metals	%
Dissolved Metals reduction	0.0	%
Particulate metals reduction*	61.5*	%
Total Metals reduction*	61.5*	%
Total Metals Mitigation Index	0.615*	-

* Extrapolated value in accordance with British Water How to Guide: Applying the CIRIA The SuDS Manual (C753) Simple Index Approach to Proprietary / Manufactured Stormwater Treatment Devices. Version 7, Section 4.3, (2021- under pre-publication review).

Certificates of compliance from WRc and HR Wallingford for the SPEL Stormceptor ESR Range

CERTIFICATE

LIGHT LIQUID SEPARATOR TEST PERFORMANCE CERTIFICATE
Compliance with Clause 8.3.3 of BS EN 858

Separator make and model number: SPEL STORMCEPTOR 330C1/SC NSB30
As detailed in SPEL Drawing SSP 9076

The separator tested complied with the drawing provided by the manufacturer and no additional features were noticed

Test date: 12 October 2006

Designated/nominal flow rate, Qw (litres/second): 30 litres/s
Net capacity of separator (excluding any allowance for silt storage), V_k (litres): 5050 litres

Total duration of test (minutes): 20 min
Running-in period (≥ 15 minutes): 15 min
Sampling period (minutes): 5 minutes common to all tests

Oil flow rate (based on 0.5% of water flowrate, litres/second): 0.15 litres/s

Temperature of oil (°C): 16.2
Temperature of water (°C): 15.6
Temperature of air (°C): 16.8

Analysis of samples by IR spectroscopy carried out by: Intertek Caleb Brett Testing Services*
Date of results: 16 October 2006

Sample	Oil concentration (mg/l)**	Name	Date
1	0.1		
2	0.5		
3	<0.1		
4	0.6		
5	0.2		
Resulting average:	0.3mg/l		

* NEMAS accredited laboratory
** Value of baseline concentration deducted

For and on behalf of HR Wallingford Ltd.



SPEL's Head of Technical Development alongside the WRc testing officer.

Research and Development

Research and development is at the heart of what we do at SPEL, our passion as Zero Pollution Ambassadors is to be at the cutting edge of clean surface water technology.

Months of rigorous testing has resulted in the new SPEL Stormceptor ESR Range.

Protecting our Environment for Over 45 Years

The SuDS Manual is leading good practise in drainage design, SPEL are endorsing this with the release of the new SPEL Stormceptor ESR range.

Total Suspended Solids (TSS)	Metals	Hydrocarbons
0.8	0.6	0.9*

*H R Wallingford test results to BS EN 858

Added to these class-leading Mitigation Indices, the ESR range benefits from:

- British/European Standard BS EN 858-1 2002 certification.
- The SPEL 25 year shell Warranty.
- 50 year+ life expectancy.
- ISO9001 quality assurance.
- ISO14001 committed to environmental improvement

26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²

26.3 Indicative SuDS mitigation indices for discharges to surface waters

Type of SuDS component	Mitigation Indices		
	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4 ²	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond ⁴	0.7 ³	0.7	0.5
Wetland	0.8 ³	0.8	0.8
Proprietary treatment systems ^{5,6}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Tables from The SuDS Manual (C753), p568-569

For reference notes, please see the full manual: https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

SPEL Stormceptor ESR Range By-Pass System

ESR Specification Chart

Model	Series	Treated Flow Rate - l/s	Maximum Flow	Catchment area (m ²)*	Oil storage (litres)	Silt capacity (litres)	Overall length* (mm) L	Overall diameter (mm)	Inlet Invert (mm) A	Base to Inlet (mm) B	Base to outlet (mm) C	Max in/ out pipe diameter** (mm)	Number of access shafts (dia. mm)			
													600	750	900	1200
210C1/ESR	200	10	100	1,333	150	1,000	2,920	1,225	560	1,350	1,300	300	-	1	-	-
212C1/ESR	200	12	120	1,600	180	1200	3,570	1,225	560	1,350	1,300	300	-	1	-	-
215C1/ESR	200	15	150	2,000	225	1,500	4,237	1,225	560	1,350	1,300	300	-	1	-	-
320C1/ESR	300	20	200	2,665	300	2,000	3,200	1,875	700	1,450	1,350	450	2	-	-	-
325C1/ESR	300	25	250	3,333	375	2,500	3,540	1,875	700	1,450	1,350	450	2	-	-	-
330C1/ESR	300	30	300	4,000	450	3,000	4,420	1,875	700	1,450	1,350	450	-	1	1	-
340C1/ESR	300	40	400	5,333	600	4,000	5,760	1,875	740	1,410	1,310	450	1	1	-	-
345C1/ESR	300	45	450	6,000	675	4,500	6,570	1,875	740	1,410	1,310	450	1	1	-	-
350/C1/ESR	300	50	500	6,665	750	5,000	7,060	1,875	740	1,410	1,310	450	1	1	-	-
460C1/ESR	400	60	600	8,000	900	6,000	4,400	2,700	950	2,100	2,000	600	1	-	1	-
470C1/ESR	400	70	700	9,333	1,050	7,000	5,250	2,700	950	2,100	2,000	600	1	-	1	-
480C1/ESR	400	80	800	10,665	1,200	8,000	6,170	2,700	950	2,100	2,000	600	1	-	1	-
4100C1/ESR	400	100	1000	13,333	1,500	10,000	7,400	2,700	1,100	1,950	1,850	750	1	-	1	-
4125C1/ESR	400	125	1250	16,665	1,875	12,500	9,050	2,700	1,100	1,950	1,850	750	1	-	1	-
4150C1/ESR	400	150	1500	20,000	2,250	15,000	9,950	2,700	1,100	1,950	1,850	750	-	-	2	-
4160C1/ESR	400	160	1600	21,333	2,400	16,000	11,830	2,700	1,250	1,800	1,700	750	1	1	1	-
5180C1/ESR	500	180	1800	24,000	2,700	18,000	7,470	3,650	1,185	2,690	2,550	900	Access shafts dependent on orientation of pipework (see page 7 for orientation options).			
5200C1/ESR	500	200	2000	26,665	3,000	20,000	8,530	3,650	1,185	2,690	2,355	1,200				
5250C1/ESR	500	250	2500	33,333	3,750	25,000	10,040	3,650	1,185	2,690	2,355	1,200				
6300C1/ESR	600	300	3000	40,000	4,500	30,000	10,310	4,150	1,325	2,850	2,675	1,200				
6350C1/ESR	600	350	3500	46,665	5,250	35,000	11,470	4,150	1,325	2,850	2,675	1,200				
6400C1/ESR	600	400	4000	53,333	6,000	40,000	12,690	4,150	1,325	2,850	2,675	1,200				
6500C1/ESR	600	500	5000	66,665	7,500	50,000	15,870	4,150	1,325	2,850	2,675	1,200				
6600C1/ESR	600	600	6000	80,000	9,000	60,000	18,260	4,150	1,325	2,850	2,675	1,200				
6700C1/ESR	600	700	7000	93,333	10,500	70,000	22,250	4,150	2,850	2,850	2,675	1,200				

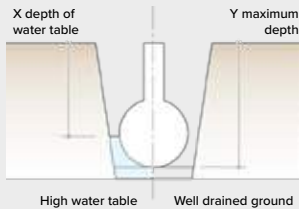
*These catchment areas are based on the SuDS Manual requirement for By-Pass devices to treat the 1 in 1 year storm event (27mm).
**This dimension is for A-C inlet/outlet options, larger pipe sizes are available for D-I inlet/outlet options.

Tank Shell Specifications

The 'standard' specification is normally adequate for most installations but Heavy, Extra Heavy and Special specifications are available depending upon the burial depth and water table level, in winter. The concern is when the system is emptied completely and remains empty for a period of time.

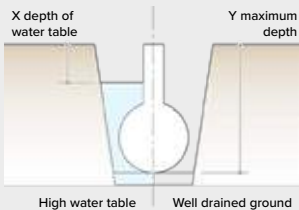
Standard tanks

Series	WT (m)	D (m)
200	1.0	4.0
300	0.9	4.0
400	1.3	5.0
500	1.9	5.7
600	2.4	6.2



Heavy tanks

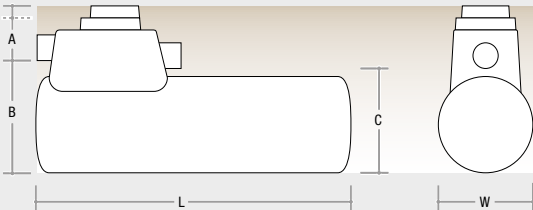
Series	WT (m)	D (m)
200	2.0	6.0
300	2.8	5.6
400	3.5	6.0
500	4.5	7.25
600	4.7	7.3



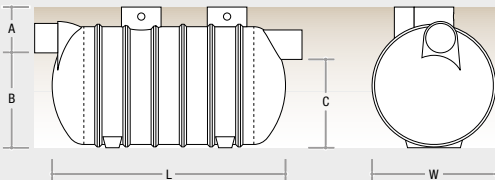
Based on installation in concrete with concrete surround.
For pea gravel surround, see SPEL Data Manual p13.5

- 200 Series ESR** – Inside diameter 1200mm, outside diameter 1225mm.
- 300 series ESR** – Inside diameter 1800mm, outside diameter 1875mm.
- 400 series ESR** – Inside diameter 2600mm, outside diameter 2700mm.
- 500 series ESR** – Inside diameter 3500mm, outside diameter 3650mm.
- 600 series ESR** – Inside diameter 4000mm, outside diameter 4150mm.

200 series



300/400/500 & 600 series



Commissioning, Installation & Maintenance

Installation

SPEL Separators can be installed with a concrete or pea gravel surround, dependent upon ground conditions and water table level. Detailed installation instructions are provided with each unit, see Installation TSII or SPEL Data Manual Section 13.

Site access and conditions

It is the responsibility of the contractor to ensure suitable access to good hard ground that is safe and suitable for off-loading.

Off-loading/handling

The contractor is responsible for off-loading. The tank must be handled with care to prevent accidental damage from impact or contact with sharp objects.

Tanks should be lifted using slings, not chains or wire ropes. Do not drag tanks along the ground for any distance and avoid jarring or bumps. Do not lift with water in the tank.

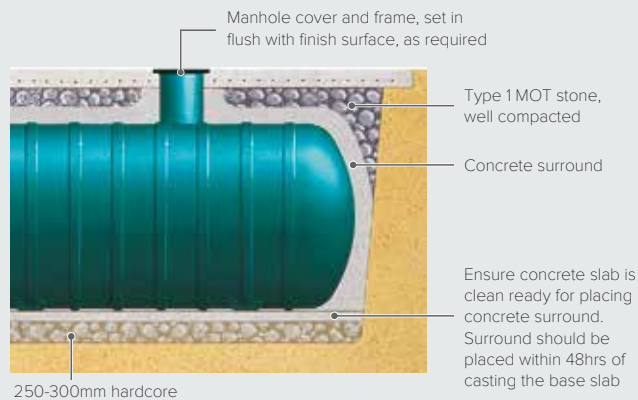
Health and safety

Installation should be carried out by a competent contractor in accordance with Health & Safety at Work legislation and good building practice.

A warning notice should be visible at the top of each access shaft – 'danger, harmful fumes' and 'respirators must be worn in this tank'. Before entering persons must be qualified in accordance with 'confined space' requirements.

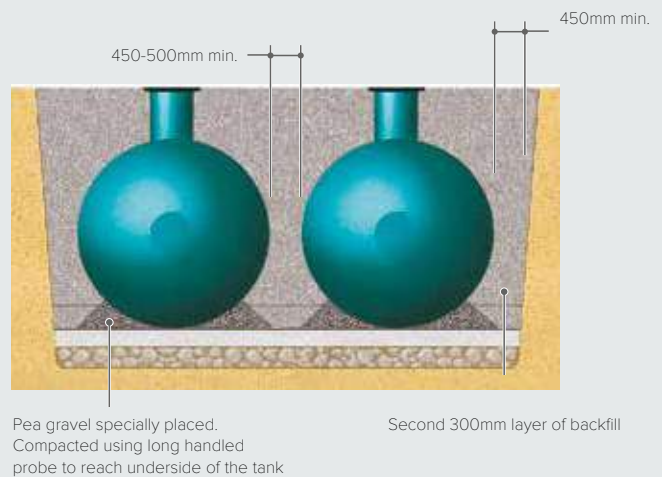
Installation – Concrete

Installation of SPEL Separator tank with chocks and a load bearing cover slab.



Installation – Pea gravel

Installation of SPEL Separator tank where ground over installation is not required to be vehicle load bearing.



Tanks surrounded with pea gravel or similar

Where it is economical to do so, SPEL Separator tanks can be surrounded in pea gravel or with similar free flowing clean rounded aggregate. Details of the installation procedure, approved backfill materials and the need for mechanical anchoring in specific circumstances are contained in the SPEL Data Manual and SPEL Separator Installation Instructions.

Maintenance Requirements

We recommend the SPEL Separator is checked at 3, 6 or 12 monthly intervals to determine the depth of silt in the primary chamber.

The SPEL automatic alarm/monitoring system will automatically warn you when the SPEL Separator requires emptying of light liquids. See ref. 3.10 – 3.19. However, silt will accumulate and require removing at intervals depending on the site conditions.

SPELGuard contracts available.

For more information contact us:

info@spelproducts.co.uk | 01743 445 200



SPELGuard Commissioning & Maintenance

Optional extras

SPEL coalescer unit guide rail systems

To facilitate easy insertion of coalescer units, the SPEL guide rail system manufactured in stainless steel can be incorporated into SPEL Puraceptors and class 1 Stormceptors.

Brackets fixed to the top and bottom of the coalescer unit simply engage the stainless steel guide rail fixed to the top of the stub access shaft. The coalescer unit is then lowered in the normal way, being guided at the correct angle into the conical base.

Lifting chains are available for the larger coalescer units and where extension shafts are fitted.

Extension guide rails can be incorporated into SPEL extension shafts to suit.

SPEL coalescer unit lifting, locating and locking system

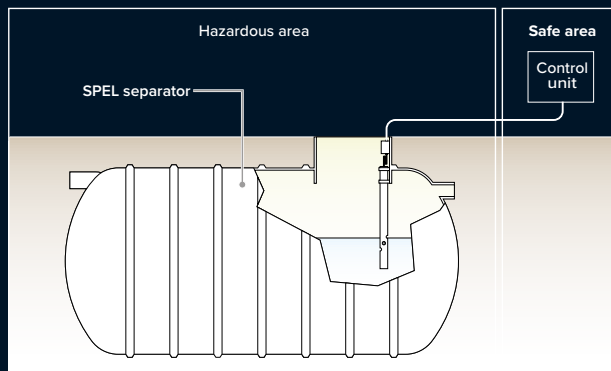
The SPEL lifting, locating and locking system is manufactured in stainless steel and replaces the standard coalescer unit handle.

The locating/locking handle ensures the coalescer unit is seated and locked in its correct position after maintenance.



Above left:
Lifting, locating and locking system with guide rail system.

Above right:
The SPEL coalescer unit with lifting chain.



SPEL offer a range of alarms, for full details refer to the *SPEL Data Manual Section 3*. Kiosks with beacons and provision for BMS and remote information via browser user interface.

SPEL Model Alarm-DY14400

Oil alarm only – not BMS compatible

SPEL Model IdOil-20

Oil, silt and/or high level alarm with volt free terminal for beacon and BMS capability

SPEL Model IdOil-30

For oil, silt and/or high level as required. This alarm provides a range of options for BMS and remote information to on or off-site monitoring facilities.

SPEL Model IdOil Solar Oil Separator Alarm

for remote off-grid areas.

SPEL extension access shafts

Extension access shafts are available for deep invert applications.



Socket joint stub access shaft with extension shaft.

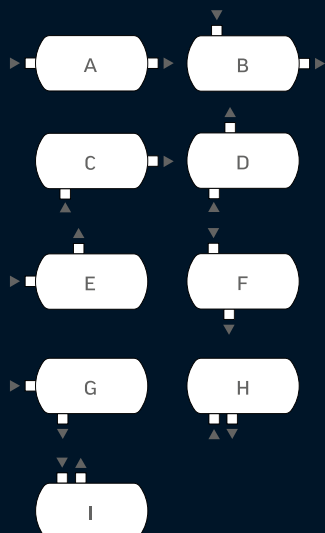
600mm, 750mm, 900mm and 1200mm diameter.

See tripod drawing below for other extension adjustments

Double seal if required

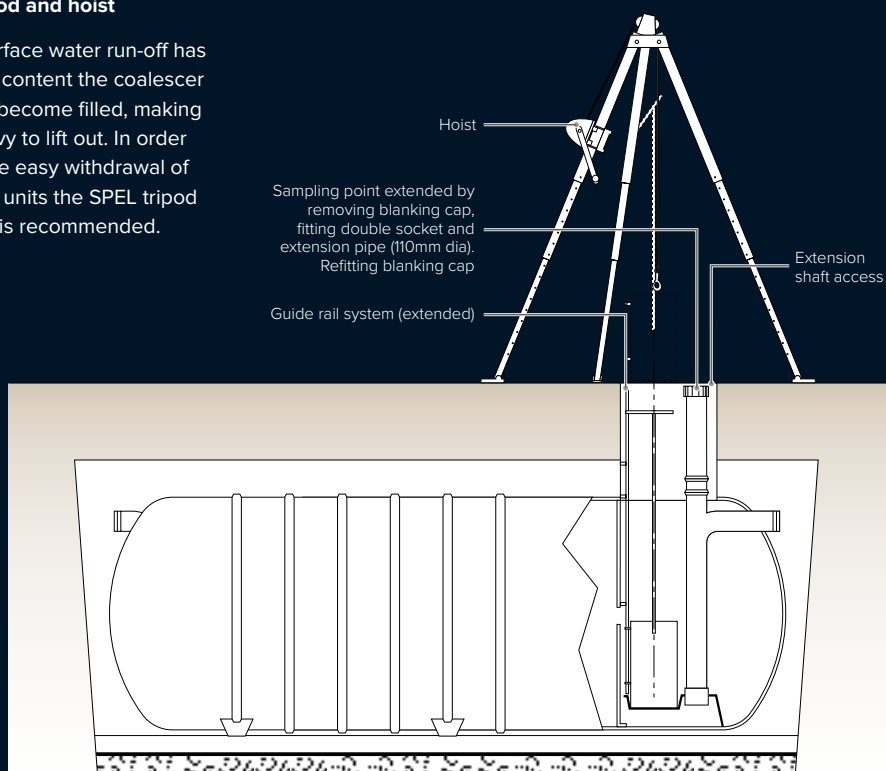
SPEL ESR Range – Inlet/outlet orientation

Dependent upon model and diameter of connections, these nine different orientations are available. However on the larger models it is important to check with our technical department.



SPEL tripod and hoist

Where surface water run-off has a high silt content the coalescer units can become filled, making them heavy to lift out. In order to facilitate easy withdrawal of coalescer units the SPEL tripod and hoist is recommended.



Stormceptor ESR

Enhanced Silt Retention

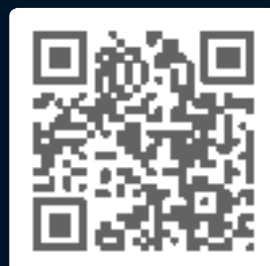
SPEL's ESR range is a total treatment system removing Hydrocarbons, Total Suspended Solids (TSS) and Metals (particulate). It's a highly efficient, single unit, water quality SuDS component.



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spelproducts.co.uk

08/22

Hydro-Brake® Optimum

Control surface water, foul and combined flows with customisable performance

Product Summary

The Hydro-Brake® Optimum is our **most popular and best performing** vortex flow control, capable of controlling storm, foul or combined flows from very low up to 550 l/s. Independently verified by the BBA and WRC it is trusted to provide reliable control of flows, and prevent flooding and has a proven track record with over 14,000 units installed worldwide

With a wide range of configurations and the ability for engineers to customise the performance by tailoring the all-important head / discharge curve, Hydro-Brake® Optimum is an industry leader.

Applications

- » Surface water management systems and Sustainable Drainage Systems (SuDS).
- » Combined drainage systems and Combined Sewer Overflows (CSOs).
- » Watercourse flood prevention.
- » Sewer network optimisation.
- » Wastewater treatment plants.

Benefits

Online design tool

Engineers can explore the customisable options on their own Hydro-Brake® Optimum designs with a free-to-use online design tool, and output unit data, head/discharge curves and data for use in other modelling software.

Built-in future proof adjustability

Standard, Hydraulic Efficient, Hydro-Brake® Optimum units are supplied with an adjustable inlet, allowing post-installation flow adjustments without the need to replace the whole device.

Cut costs with better performance

The customisable curve of the Hydro-Brake® Optimum allows engineers to optimise drainage system designs to reduce the amount of storage required.

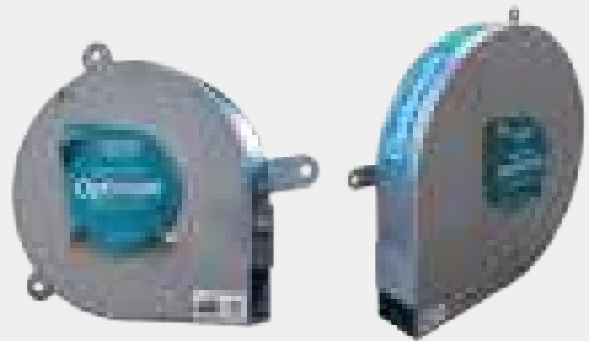
Save time and cost on site

The Hydro-Brake® Optimum has a wide range of fitting and installation options designed to save contractors time, cut costs and meet project deadlines.

Hydro-Brake® Optimum configurations

Standard

For control of low, moderate and high **surface water flows**. To help you be prepared for the effects of urban creep, changes in regulations or changing climate, this model now incorporates **an adjustable inlet as standard**. This future-proof feature allows **flow adjustments post installation** without the need to replace the whole device. This unit can also be used for regulating the outflow from balancing tanks and detention ponds. This unit requires a sump.



Conical

With a large inlet to reduce the risk of blockage, the conical unit is ideal for control of **foul or combined sewer flows**. It can also be used for surface water systems with **high flow rates where space is restricted** or where a **sump is not possible**.



Find out more about how the Hydro-Brake® Optimum can help you design optimised drainage systems:

→ hydro-int.com/hboptimum

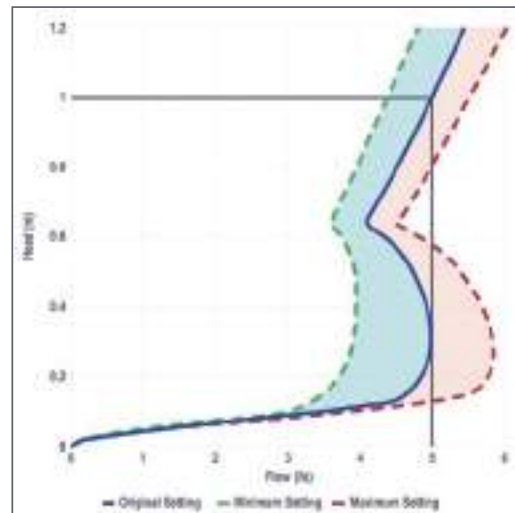
Hydro-Brake® Optimum performance customisation options

Reduce onsite storage - Hydraulic Efficiency design

Matching the Flush-Flo™ point equal to the design point means that the device will pass forward as much flow as possible during the earlier stages of a storm, reducing the amount of water that needs to be stored upstream.

To help engineers **be prepared** for the effects of urban creep, changes in regulations or a changing climate, **Hydraulic Efficient** S-type units are now supplied with **an adjustable inlet as standard**. This future-proof feature allows **flow adjustments post installation without the need to replace the whole device**. A **unique triple flow head/discharge curve** is generated by the Online Design Tool (hydro-int.design) for these units.

The adjustable inlet can be added to Conical Hydro-Brake® Optimum units as an optional extra by selecting the 'Future proof' option in the Online Design Tool.



Limit flow control size

Reducing the Flush-Flo™ point reduces the size of the device, so if the exact available space is known then the Flush-Flo™ point may be tuned to give the most hydraulically efficient performance within the space available.

Design complex systems

Custom Flush-Flo™ points can be specified, enabling the design of precise 'complex flow control' arrangements where the pre-developed hydrology is aligned to the post-developed site.

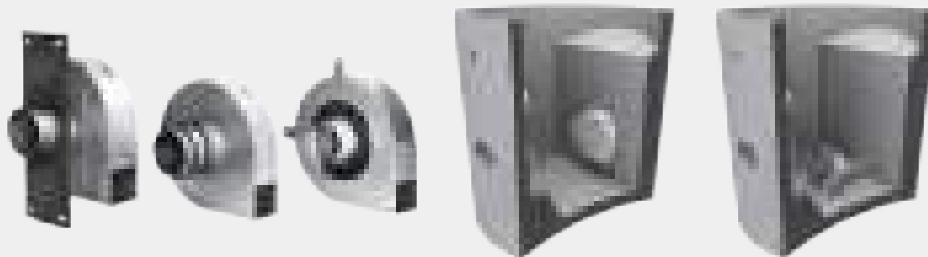
Low Flows

There are now a variety of industry guidance documents applied at national and regional levels and they are not totally consistent in terms of their stance on minimum flow rates or minimum flow control sizes.

The approaches range from BS8582:2013, which states "controls smaller than 25 mm are possible if protected [from blockage]" up to the advice given by water companies, which can set a minimum acceptable opening size for adoptable flow controls for surface water only systems of >50 mm for protected orifices and >100 mm for unprotected orifices. **Please get in touch to find out about our low flow solutions.**

Installation options

Hydro-Brake® Optimum has a range of mounting options for ease of installation or can be supplied ready fitted into a manhole chamber (with or without a weir wall) for simple plug-and-play installation. There are no set-up or commissioning requirements.



A CRH COMPANY

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Email: stormwater@hydro-int.com

Web: hydro-int.com

Patent: www.hydro-int.com/patents



Try customising your own Hydro-Brake® Optimum with the free online design tool at:

→ hydro-int.design



Appendix D

SAB Correspondence



Mr Charles Rees
Glanville Consultants,
3 Grovelands Business Centre,
Boundary Way,
Hemel Hempstead
Hertfordshire
HP2 7TE

Huw Williams
Senior SAB and Land Drainage Engineer
Our Reference: SAB-PRE-25-0002
Telephone: 01685 725000
Email: SAB@merthyr.gov.uk
Date: 20/05/2025

FLOOD AND WATER MANAGEMENT ACT 2010 (Schedule 3 – Sustainable Drainage)
PRE-APPLICATION REVIEW AND ADVICE

Application Number: SAB-PRE-25-0002

Proposal: Fast food restaurant with associated drive-thru and vehicular parking

Location: Heads of the Valleys Road, Pengarnddu Industrial Estate, Merthyr Tydfil. CF48 2AT.

Dear Applicant/ Agent,

Further to your valid submission for SAB pre-application advice made on 03/03/2025, please find enclosed the pre-application informative report providing feedback on the proposals providing feedback on proposals and details of what further information may be required in support of any future full SAB application.

Huw Williams is your case officer, and we would be grateful if you would quote the application reference number SAB-PRE-25-0002 in any future correspondence.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'Huw Williams', is written over a light blue rectangular background.

Huw Williams

Senior SAB and Land Drainage Engineer

Background

The Flood and Water Management Act 2010 (Schedule 3) came into effect in Wales on 7th January 2019, requiring new developments to include Sustainable Drainage Systems (SuDS) that comply with national standards (*Statutory Standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems (2018)*).

From 7th January 2019, new developments of more than one dwelling or where the area covered by construction work equals or exceeds 100 square metres require approval before construction can commence. Approval is considered by the Sustainable Drainage Approval Body (SAB).

Adoption and management arrangements, including funding mechanisms for maintenance of SuDS infrastructure and all drainage elements are to be agreed by the SAB as part of this approval. The objective being to ensure SuDS infrastructure is correctly maintained and functions effectively for its design life.

An application for Sustainable Drainage Approval is required to comply with:

- Flood and Water Management Act 2010 (Schedule 3)
- Statutory Standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems (2018)

The SuDS approach mimics natural drainage, managing surface runoff at or close to the surface and as close to its source as practicable, controlling the flow (volume and rate of runoff) and providing a range of additional benefits. It contrasts with traditional drainage techniques, which are based on underground pipes to convey rainwater away from properties as quickly as possible. The use of SuDS is a way of helping to achieve sustainable development in both new and existing developments.

Key elements of the SuDS design approach include:

- Drainage systems should be considered at the earliest stages of site design to influence the layout of roads, buildings and public open spaces.
- Planning of a new site layout should be informed by the topography and the requirements of surface water management systems to both effectively drain and treat the runoff.
- Any existing watercourse, ditches, and other drainage features both within and adjoining the site should help inform proposals.
- SuDS should work as a management train to control flow rates and reduce volumes of runoff, providing treatment to protect water quality and opportunities to encourage biodiversity and amenity.
- Well designed, easy to maintain SuDS will deliver a range of important benefits for the local environment, the development and local communities.
- Surface based sustainable drainage components are visible in their operation and performance and are generally simpler and easier to operate, monitor and maintain.
- Take account of existing flood risk management policies and procedures.

Submitted Documentation

- 2025.02.14 - Surface Water Netowrk Calculations (5.5ls Outfall)
- 13888_AEW_2685_F003_Feasibility Site Layout Option 3
- 4240241 - SuDs Pre-application Approval Form
- 4240241-SK04-P2_Proposed Drainage Layout
- 4240241-SK05-P1_Proposed Levels Layout and Exceedance Routes

SAB Proposal Comments

Standard S1 – Surface water destination

Level 1 – Rainwater collected for use

- G1.4 Water is a valuable resource and rainwater should be collected (harvested) for non-potable use where practicable. This not only reduces potable water demand, but it can also reduce the volume of surface water runoff requiring disposal. One or more of the following **exception criteria** needs to be demonstrated if rainwater harvesting (RWH) is not used:
 1. There is no foreseeable demand for non-potable water on the site throughout its design life;
 2. There is no foreseeable need to harvest water at the site as the relevant water undertaker's water resources and drought management plans do not identify potential stresses on mains water supplies;
 3. The use of rainwater harvesting is not a viable/ cost-effective part of the solution for managing surface water runoff on the site, taking account of the potential water supply benefits of such a system.
- G1.5 Rainwater harvesting tanks can be sized for capturing the runoff from large rainfall events as well as water supply. The design of rainwater harvesting systems for management of large events should be in accordance with BS 8515 appendix A (2009, revision 2013)6. This can contribute to a significant reduction in runoff volume, helping to meet the requirements of volume control of runoff (Standard S2).
- G1.6 In most cases, rainwater harvesting alone will not be adequate to deal with the site drainage and provision will be required for an overflow to a Level 2 or lower priority destination.
- G1.7 RWH systems, whether designed for water supply or surface water management as well, will contribute effectively to meeting the criterion on Interception (Standard S2).

SAB observations

No consideration has been given to the use of rainwater harvesting for the development. If this method is to be discounted, evidence of its unsuitability needs to be demonstrated in support of the full SAB application.

Level 2 – Discharge of surface water to the ground

- G1.8 Surface runoff not collected for use in accordance with Level 1 should be discharged by infiltration (a process that allows water to percolate into the ground) to the maximum extent possible at any location across the site. A lower priority destination should only be used for any residual runoff that cannot be served by infiltration provided one or more of the following **exception criteria** can be demonstrated:
 - **Permeability:** the use of infiltration drainage is not practicable due to the lack of permeability of the soil for disposing of runoff;
 - **Ground Instability:** the use of infiltration drainage would result in a risk of instability through ground movement or subsidence;
 - **Pollution of groundwater or receiving surface waters:** the use of infiltration drainage would pose an unacceptable risk of pollution of groundwater or surface water bodies:
 - as a result of existing contaminants on the site being mobilised; or
 - as a result of activities in the area draining to the infiltration device (for example an area where there is the storage or handling of chemicals or fuels); or
 - as a result of the sensitivity of the groundwater or surface waterbody;
 - **Groundwater flooding:** the use of infiltration drainage would result in an unacceptable risk of flooding from groundwater;
 - **Infiltration into a combined sewer:** the use of infiltration may cause ingress of flow into a combined sewer which might result in an increased risk of flooding or pollution on the site or downstream.
- Guidance on meeting the exception criteria can be found within the clauses from page 9 within the statutory national standards for SuDS at:
<https://gov.wales/national-standards-sustainable-drainage-systems-suds>

SAB observations

A ground investigation has not been provided with the pre application. A GI including infiltration testing to BRE Digest 365 and an assessment of the suitability of infiltration as a discharge method for the site needs to be supplied prior to the full SAB application.

Level 3 – Discharge to a surface water body

G1.31 Surface runoff not collected for use in accordance with Level 1 or discharged to ground in accordance with Level 2 should be discharged to a receiving surface water body. A lower priority destination should only be used provided one or more of the following **exception criteria** can be shown to apply:

- **Access:** It is not reasonably practicable to convey the surface runoff to the water body – See Box 1 for further guidance;
- **Drainage by use of pumps:** Discharge to a surface water body would require the use of pumping, and discharge to a lower level destination would not require pumping and could be delivered more cost-effectively.– see Box 2 for further guidance;
- **Increase in flood risk:** The discharge would result in an unacceptable increase in the risk of flooding – see Box 3 for further guidance.

SAB observations

The current proposal does not seek to discharge to a surface water body.

Level 4 – Discharge to a surface water sewer or highway drain**SAB observations**

The current proposal does not seek to discharge to a surface water sewer or highway drain. All potential opportunities to discharge to surface water drainage in the area need to be investigated and presented prior to the full SAB application.

Level 5 – Discharge to combined sewer**SAB observations**

The current proposal seeks to discharge surface water via pumping to a Dŵr Cymru Welsh Water (DCWW) foul sewer. This proposal is not agreeable to the SAB.

In accordance with Section 106 of the Water Industry Act, connecting surface water to a foul sewer is unacceptable and would be objected to by DCWW. An alternative outfall for the site's surface water will need to be provided at full application stage.

In line with Welsh Government's Statutory Standards for SuDS, pumping needs to be avoided where possible. All other options to drain the site must be investigated and evidenced before the SAB could consider a pumped solution.

Standard S2 – Surface water runoff hydraulic control

The aim of Standard S2 is to manage the surface water runoff from and on a site to protect people on the site from flooding from the drainage system for events up to a suitable return period, to mitigate any increased flood risk to people and property downstream of the site as a result of the development, and to protect the receiving water body from morphological damage.

S2 Surface water runoff hydraulic control:

1. Surface water should be managed to prevent, so far as possible, any discharge from the site for the majority of rainfall events of less than 5mm.
2. The surface water runoff rate for the 1 in 1 year return period event (or agreed equivalent) should be controlled to help mitigate the negative impacts of the development runoff on the morphology and associated ecology of the receiving surface water bodies.
3. The surface water runoff (rate and volume) for the 1% (1 in 100 year +30%) return period event (or agreed equivalent) should be controlled to help mitigate negative impacts of the development on flood risk in the receiving water body.

4. The surface water runoff for events up to the 1% (1 in 100 year) return period (or agreed equivalent) should be managed to protect people and property on and adjacent to the site from flooding from the drainage system.
5. The risks (both on site and off site) associated with the surface water runoff for events greater than the 1% (1 in 100 year) return period should be considered. Where the consequences are excessive in terms of social disruption, damage or risk to life, mitigating proposals should be developed to reduce these impacts.
6. Drainage design proposals should be examined for the likelihood and consequences of any potential failure scenarios (e.g. structural failure or blockage), and the associated flood risks managed where possible.

Clauses relating to the Guidance related to the guidance for hydraulic control can be found on page 20 of the Statutory Standards for Sustainable Drainage Systems at:

<https://gov.wales/national-standards-sustainable-drainage-systems-suds>

SAB observations

Some attenuation storage is provided across three groups of permeable paving parking bays in the northeastern portion of the site. Surface water generated by the Q100 +40% CC event is to be retained on site using a below ground cellular attenuation tanks with flows restricted in a pump chamber to a rate of 5.5 l/s. The application form implies that 5.5l/s is the greenfield rate for the site but no evidence of this has been provided. Simple checks indicate that the QBAR rate for the site is approximately 3.5l/s. Greenfield rates need to be evidenced prior to full application stage and all return periods should be limited to QBAR. Approval of discharge at the determined greenfield rate will be subject to the provision of evidence of capacity modelling of the downstream network.

The introduction of permeable parking bays for areas of the site will provide interception for the first 5mm of rainfall, but the majority of the site is hard surfaced and has no source control. A small bioretention strip is proposed alongside the drive through lanes, but as the impermeable surface area draining to it is more than 5 times the vegetated surface area it cannot be deemed to provide interception. Significant improvements need to be made to the interception provision on the site. Consideration should be given to a green roof, and larger areas at ground level dedicated to bioretention. Compliance with the interception requirements of the Statutory Standards should be evidenced in support of the full SAB application.

Standard S3 - Water Quality

Standard S3 addresses the drainage design requirements to minimise the potential pollution risk posed by the surface water runoff to the receiving water body.

S3 Surface water quality management

Treatment for surface water runoff should be provided to prevent negative impacts on the receiving water quality and/or protect downstream drainage systems, including sewers.

Guidance for S3 can be found from page 29 of the Statutory Standards for Sustainable Drainage Systems at:

<https://gov.wales/national-standards-sustainable-drainage-systems-suds>

SAB observations

Permeable block paving proposed for some of the parking bays will provide sufficient at source treatment for the runoff those areas manage. A petrol interceptor is proposed to provide treatment for runoff from most of the remaining site areas prior to the water reaching the attenuation system. The maintenance requirements for interceptors are very high and these systems present an increased risk of contaminant re-mobilisation and discharge.

We encourage the use of source control SuDS components in a management train to provide water quality improvement. Consideration should be given to maximising source control SuDS to manage pollution and runoff volumes across the site.

Standard S4 – Amenity

Standard S4 addresses the design of SuDS components to ensure that, where possible, they enhance the provision of high quality, attractive public space which can help provide health and wellbeing benefits, they improve liveability for local communities and they contribute to improving the climate resilience of new developments.

S4 - Amenity

The design of the surface water management system should maximise amenity benefits.

Guidance on standard S4 can be found from page 38 of the Statutory Standards for Sustainable Drainage Systems at:

<https://gov.wales/national-standards-sustainable-drainage-systems-suds>

SAB observations

The overall amenity benefit of the current proposal is minimal. A very narrow bioretention strip and permeable parking bays provide limited benefit. More extensive use of bioretention and consideration given to a green roof could substantially increase the amenity benefit of the proposal. Vegetated drainage components should be integrated within usable spaces of the development to boost the amenity rating.

Standard S5 – Biodiversity

Standard S5 addresses the design of SuDS to ensure, where possible, they create ecologically rich green and blue corridors in developments and enrich biodiversity value by linking networks of habitats and ecosystems together. Biodiversity should be considered at the early design stage of a development to ensure the potential benefits are maximised.

S5 - Biodiversity

The design of the surface water management system should maximise biodiversity benefits.

Guidance on standard S5 can be found from page 41 of the Statutory Standards for Sustainable Drainage Systems at:

<https://gov.wales/national-standards-sustainable-drainage-systems-suds>

SAB observations

The overall biodiversity rating of the current proposal is poor. A narrow bioretention strip is the only green SuDS feature proposed for the site. Consideration needs to be given to the provision of more green source control features within the development, this could be achieved using a green roof and more extensive bioretention features. The inclusion of such features with careful design consideration of species type that provide various habitats and will ensure that users of the site will have access to an environment that improves wellbeing and provides necessary resilience. Vegetated surface drainage features should include native species that are appropriate for the area with known benefits for local biodiversity.

A full landscaping plan including named species, densities and specifications should be provided to support the full application.

Standard S6 – Design of Drainage for Construction, Operation and Maintenance and Structural Integrity

Standard S6 deals with designing robust surface water drainage systems so they can be easily and safely constructed, maintained and operated, taking account of the need to minimise negative impacts on the environment and natural resources.

S6 – Design of drainage for Construction, Operation and Maintenance

- All elements of the surface water drainage system should be designed so that they can be constructed easily, safely, cost-effectively, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).
- All elements of the surface water drainage system should be designed to ensure maintenance and operation can be undertaken (by the relevant responsible body) easily, safely, cost effectively, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).
- The surface water drainage system should be designed to ensure structural integrity of all elements under anticipated loading conditions over the design life of the development site, taking into account the requirement for reasonable levels of maintenance.

Guidance on standard S6 can be found from page 44 of the Statutory Standards for Sustainable Drainage Systems at:

<https://gov.wales/national-standards-sustainable-drainage-systems-suds>

SAB observations

The proposed drainage strategy relies heavily on proprietary products and below ground features. These features are complex to install, high cost and will require specialist contractors to ensure they are installed effectively. If a tank is retained as part of the full SAB design, it must be fully lined with twin heat welded joints on all areas of the membrane. Sections and standard details have not been provided for any of the SuDS components making it challenging to comment further on constructability. Standard details and sections need to be submitted to the SAB in support of the full application.

The current design carries a large maintenance burden due to the reliance on attenuation tanks and interceptors. A drainage strategy focussed on surface level SuDS with visible maintenance requirements should be considered. A fully costed maintenance plan should be provided to the SAB and the client, and confirmation of who will be responsible for maintaining SuDS features should also be provided. Consideration should be given to the phasing of construction to ensure the proposed SuDS are suitably protected.

Conclusion

In its current form, the proposal would be refused by the SAB. It appears that minimal consideration has been given to the statutory national standards. The proposed discharge method is not appropriate, discharge rates are not suitably evidenced, and biodiversity and amenity benefit are poorly considered.

The points noted below should be actioned, and information provided to the SAB in order to reassess the pre-application. Due to the quality of the submission, a full application is not recommended at this stage.

- More detail on the discharge hierarchy and evidence for meeting exception criteria for each level
 - Provision of a full ground investigation including infiltration testing to BRE 365.
 - All potential opportunities to discharge to surface water drainage in the area need to be investigated and presented
 - Evidence of initial communication with DCWW if their assets are to be a discharge location
- Provision of greenfield runoff rate calculations
- Consideration given to the incorporation of more source control, green SuDS

The points below are noted to indicate the additional information that will be required in support of the full SAB application once the above issues are rectified.

- Provision of a full landscaping plan including named species, densities and specifications
- Details and site-specific sections for proposed SuDS features
- Provision of a fully costed maintenance plan
- A construction management plan should be provided which includes how the SuDS will be phased appropriately and protected during construction

Consultee Responses

No external organisations or statutory consultees have been consulted on this pre-application advice report.

Non-Performance bond

The applicant should be made aware that a non-performance bond **may** be required for the proposed development. Construction estimates should be provided in support of a full SAB application.

Adoption criteria

There is no mandatory requirement for surface water drainage systems to be adopted by Merthyr Tydfil CBC SAB. At this stage no request has been received by the developer client to adopt surface water features and they are to be operated and maintained by the property owner.

Hertfordshire

|

Oxfordshire

|

Cambridgeshire

|

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