



DETS

Certificate of Analysis

Certificate Number 24-02529

Issued: 12-Feb-24

Client Mason Evans Partnership
95 Morrison Street
Glasgow
G5 8BE

Our Reference 24-02529

Client Reference P22-271

Order No Scott Armstrong

Contract Title (P22-271) Rotterdam Wharf, Glasgow

Description One Water sample.

Date Received 07-Feb-24

Date Started 07-Feb-24

Date Completed 12-Feb-24

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By



Kirk Bridgewood
General Manager



Summary of Chemical Analysis

Water Samples

Our Ref 24-02529

Client Ref P22-271

Contract Title (P22-271) Rotterdam Wharf, Glasgow

Lab No	2296428
Sample ID	BH03
Depth	
Other ID	
Sample Type	WATER
Sampling Date	05/02/2024
Sampling Time	n/s

Test	Method	LOD	Units	
Metals				
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	0.30
Boron, Dissolved	DETSC 2306*	12	ug/l	150
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	< 0.03
Calcium, Dissolved	DETSC 2306	0.09	mg/l	49
Chromium, Dissolved	DETSC 2306	0.25	ug/l	0.42
Copper, Dissolved	DETSC 2306	0.4	ug/l	1.1
Lead, Dissolved	DETSC 2306	0.09	ug/l	0.13
Magnesium, Dissolved	DETSC 2306	0.02	mg/l	8.4
Mercury, Dissolved (Low Level)	DETSC 2324	0.001	ug/l	0.0017
Nickel, Dissolved	DETSC 2306	0.5	ug/l	2.5
Selenium, Dissolved	DETSC 2306	0.25	ug/l	2.5
Zinc, Dissolved	DETSC 2306	1.3	ug/l	180
Inorganics				
pH	DETSC 2008		pH	7.3
Cyanide, Total Low Level	DETSC 2131	0.1	ug/l	0.4
Dissolved, Oxygen	DETSC 2048*	0.1	mg/l	10.4
Dissolved Organic Carbon	DETSC 2085	2	mg/l	< 2.0
Total Hardness as CaCO3	DETSC 2303	0.1	mg/l	157
Sulphate as SO4	DETSC 2055	0.1	mg/l	42
Sulphide	DETSC 2208	10	ug/l	110
Petroleum Hydrocarbons				
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C12-C16	DETSC 3072*	1	ug/l	1.1
Aliphatic C16-C21	DETSC 3072*	1	ug/l	17
Aliphatic C21-C35	DETSC 3072*	1	ug/l	8.1
Aliphatic C5-C35	DETSC 3072*	10	ug/l	26
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0
Aromatic C16-C21	DETSC 3072*	1	ug/l	< 1.0
Aromatic C21-C35	DETSC 3072*	1	ug/l	< 1.0
Aromatic C5-C35	DETSC 3072*	10	ug/l	< 10
TPH Ali/Aro Total C5-C35	DETSC 3072*	10	ug/l	26
PAHs				
Naphthalene	DETSC 3304	0.05	ug/l	< 0.05
Acenaphthylene	DETSC 3304	0.01	ug/l	< 0.01
Acenaphthene	DETSC 3304	0.01	ug/l	< 0.01

Summary of Chemical Analysis

Water Samples

Our Ref 24-02529

Client Ref P22-271

Contract Title (P22-271) Rotterdam Wharf, Glasgow

Lab No	2296428
Sample ID	BH03
Depth	
Other ID	
Sample Type	WATER
Sampling Date	05/02/2024
Sampling Time	n/s

Test	Method	LOD	Units	
Fluorene	DETSC 3304	0.01	ug/l	< 0.01
Phenanthrene	DETSC 3304	0.01	ug/l	0.02
Anthracene	DETSC 3304	0.01	ug/l	< 0.01
Fluoranthene	DETSC 3304	0.01	ug/l	0.01
Pyrene	DETSC 3304	0.01	ug/l	0.02
Benzo(a)anthracene	DETSC 3304*	0.01	ug/l	< 0.01
Chrysene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	< 0.01
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	< 0.01
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	< 0.01
PAH Total	DETSC 3304	0.2	ug/l	< 0.20
Phenols				
Total Phenol	DETSC 3451*	0.5	ug/l	< 0.50

Information in Support of the Analytical Results

Our Ref 24-02529
 Client Ref P22-271
 Contract (P22-271) Rotterdam Wharf, Glasgow

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2296428	BH03 WATER	05/02/24	GB 1L x2, GV, PB 1L	pH/Cond (1 days)	

Key: G-Glass P-Plastic B-Bottle V-Vial

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
 Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

Appendix 07

**Gas / Groundwater Monitoring Data
(18/12/23 – 04/03/24)**



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:		P22/271																		
Site:		Rotterdam Wharf, Port Dundas, Glasgow																		
Date:		18/12/2023																		
Readings taken by:		DM																		
Background Data		Weather Conditions		Raining																
		Ground Conditions (dry/wet):		Wet																
		Air Temperature (°C)		12																
		Atmospheric Pressure (mB) (start):		1012																
		Atmospheric Pressure (mB) (finish):		1011																
		O2 (%)		20																
Time (hh:mm)		10:00																		
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ² (mbgl)	DoW ⁴ (m)	Pr ³		R ⁴	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH01	30	-	5.9	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	3.15	6.70	N	N	N	N
	60	-	5.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	5.5	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	5.5	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH02	30	-	18.6	-	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	6.20	19.00	N	N	N	N
	60	-	18.5	-	0.3	-	0.0	-	0.0	-	0.0	0.0								
	90	-	18.5	-	0.3	-	0.0	-	0.0	-	0.0	0.0								
	120	-	18.5	-	0.3	-	0.0	-	0.0	-	0.0	0.0								
BH03	30	-	17.3	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.25	11.60	N	N	N	N
	60	-	17.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	17.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	17.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH04	30	-	17.6	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	7.20	22.80	N	N	N	N
	60	-	17.6	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	17.6	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	17.6	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH05	30	-	19.5	-	0.2	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.30	7.65	3	Y	Y	N
	60	-	19.5	-	0.2	-	0.0	-	0.0	-	0.0	0.0								
	90	-	19.5	-	0.2	-	0.0	-	0.0	-	0.0	0.0								
	120	-	19.5	-	0.2	-	0.0	-	0.0	-	0.0	0.0								
BH06	30	-	14.6	-	1.1	-	1.9	-	0.0	-	0.0	43.2	0.0	0.0	7.90	10.60	N	N	N	N
	60	-	14.6	-	1.1	-	1.9	-	0.0	-	0.0	43.4								
	90	-	14.6	-	1.1	-	1.9	-	0.0	-	0.0	43.6								
	120	-	14.6	-	1.1	-	1.9	-	0.0	-	0.0	43.6								



Gas and Groundwater Monitoring Results

Project Number:	P22/271																			
Site:	Rotterdam Wharf, Port Dundas, Glasgow																			
Date:	18/12/2023																			
Readings taken by:	DM																			
Background Data	Weather Conditions										Raining									
	Ground Conditions (dry/wet):										Wet									
	Air Temperature (°C)										12									
	Atmospheric Pressure (mB) (start):										1012									
	Atmospheric Pressure (mB) (finish):										1011									
	O2 (%)										20									
Time (hh:mm)										10:00										
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mbgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH07	30	-	17.8	-	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	Dry	2.40	N	N	N	N
	60	-	17.9	-	0.3	-	0.0	-	0.0	-	0.0	0.0								
	90	-	17.9	-	0.3	-	0.0	-	0.0	-	0.0	0.0								
	120	-	17.9	-	0.3	-	0.0	-	0.0	-	0.0	0.0								
BH08	30	-	14.9	-	1.2	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.90	4.00	N	N	N	N
	60	-	14.6	-	1.3	-	0.0	-	0.0	-	0.0	0.0								
	90	-	14.2	-	1.4	-	0.0	-	0.0	-	0.0	0.0								
	120	-	14.0	-	1.5	-	0.0	-	0.0	-	0.0	0.0								
	180	-	13.8	-	1.5	-	0.0	-	0.0	-	0.0	0.0								
Remarks	BH01 - kept flooding with water.																			
Borehole Damage Record/ Installation Record																Key: 1 – Peak 2 – Steady state 3 – Groundwater depth 4 – Depth of well			5 – Purged well volumes 6 – Recharge (yes/no) 7 – Sampled (yes/no)	
Borehole Condition Statement																				
Gas Monitor Model:												Serial No:		Recalibration Due:						
GFM 430 / GFM436												12984		28.02.2024						
PID Model:												Serial No:		Recalibration Due:						
MiniRAE Light												-		-						

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High	Notes
MiniRAE Lite	100	ppm	50	100	The instrument is factory calibrated with standard calibration gas and is programmed with default alarm limits.



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:	P22/271																			
Site:	Rotterdam Wharf, Port Dundas, Glasgow																			
Date:	09/01/2024																			
Readings taken by:	AW																			
Background Data	Weather Conditions												Cloudy							
	Ground Conditions (dry/wet):												Wet / icy							
	Air Temperature (°C)												2							
	Atmospheric Pressure (mB) (start):												1010							
	Atmospheric Pressure (mB) (finish):												1010							
	O2 (%)												21							
Time (hh:mm)												09:50								
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mbgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH01	30	-	17.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0	1.5	0.0	3.40	6.40	I	N	N	N
	60	-	17.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	17.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	17.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH02	30	-	20.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0	2.2	0.0	9.90	18.70	N	N	N	N
	60	-	20.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	20.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	20.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH03	30	-	19.9	-	0.0	-	0.0	-	0.0	-	0.0	0.0	1.2	0.0	2.30	9.60	N	N	N	N
	60	-	19.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	19.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	19.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH04	30	-	21.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.4	0.0	7.00	23.00	N	N	N	N
	60	-	21.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	21.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	21.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH05	30	-	20.1	-	0.2	-	0.0	-	0.0	-	0.0	0.0	1.1	0.0	2.90	7.60	3	Y	n	N
	60	-	20.1	-	0.2	-	0.0	-	0.0	-	0.0	0.0								
	90	-	20.1	-	0.2	-	0.0	-	0.0	-	0.0	0.0								
	120	-	20.1	-	0.2	-	0.0	-	0.0	-	0.0	0.0								
BH06	30	-	17.5	-	0.5	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	8.00	10.20	N	N	N	N
	60	-	18.3	-	0.1	-	0.0	-	0.0	-	0.0	0.0								
	90	-	19.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	19.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0								



Gas and Groundwater Monitoring Results

Project Number:	P22/271																			
Site:	Rotterdam Wharf, Port Dundas, Glasgow																			
Date:	09/01/2024																			
Readings taken by:	AW																			
Background Data	Weather Conditions												Cloudy							
	Ground Conditions (dry/wet):												Wet / icy							
	Air Temperature (°C)												2							
	Atmospheric Pressure (mB) (start):												1010							
	Atmospheric Pressure (mB) (finish):												1010							
	O2 (%)												21							
Time (hh:mm)												09:50								
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mbgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH07	30	-	19.2	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	Dry	2.40	N	N	N	N
	60	-	20.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	20.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	20.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH08	30	-	20.2	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.90	4.00	1.5	N	N	N
	60	-	20.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	21.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	21.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
Remarks																				
Borehole Damage Record/ Installation Record																Key: 1 – Peak 2 – Steady state 3 – Groundwater depth 4 – Depth of well		5 – Purged well volumes 6 – Recharge (yes/no) 7 – Sampled (yes/no)		
Borehole Condition Statement																				
Gas Monitor Model:												Serial No:		Recalibration Due:						
GFM 430 / GFM436												12984		28.02.2024						
PID Model:												Serial No:		Recalibration Due:						
MiniRAE Light												-		-						

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High	Notes
MiniRAE Lite	100	ppm	50	100	The instrument is factory calibrated with standard calibration gas and is programmed with default alarm limits.



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:		P22/271																		
Site:		Rotterdam Wharf, Port Dundas, Glasgow																		
Date:		22/01/2024																		
Readings taken by:		DM																		
Background Data		Weather Conditions		Raining																
		Ground Conditions (dry/wet):		Wet																
		Air Temperature (°C)		6																
		Atmospheric Pressure (mB) (start):		987																
		Atmospheric Pressure (mB) (finish):		987																
		O2 (%)		19.6																
Time (hh:mm)		11:00																		
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ² (mbgl)	DoW ⁴ (m)	Pr ³		R ⁴	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH01	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BH02	30	-	13.9	-	0.3	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	13.7	-	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	5.10	19.00	3	Y	Y	0.0
	90	-	13.7	-	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	3	Y	Y	0.0
	120	-	13.7	-	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	3	Y	Y	0.0
BH03	30	-	17.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	17.2	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	90	-	17.2	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	120	-	17.2	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
BH04	30	-	17.1	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	17.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	90	-	17.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	120	-	17.7	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
BH05	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BH06	30	-	11.7	-	2.2	-	1.5	-	0.0	-	0.0	35.8	-	-	-	-	-	-	-	
	60	-	11.6	-	2.2	-	1.5	-	0.0	-	0.0	35.9	26.9	0.0	7.85	10.60	3	Y	Y	0.0
	90	-	11.6	-	2.2	-	1.5	-	0.0	-	0.0	35.9	26.9	0.0	7.85	10.60	3	Y	Y	0.0
	120	-	11.6	-	2.2	-	1.5	-	0.0	-	0.0	35.9	26.9	0.0	7.85	10.60	3	Y	Y	0.0



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:	P22/271																			
Site:	Rotterdam Wharf, Port Dundas, Glasgow																			
Date:	22/01/2024																			
Readings taken by:	DM																			
Background Data	Weather Conditions												Raining							
	Ground Conditions (dry/wet):												Wet							
	Air Temperature (°C)												6							
	Atmospheric Pressure (mB) (start):												987							
	Atmospheric Pressure (mB) (finish):												987							
	O2 (%)												19.6							
Time (hh:mm)												11:00								
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mbgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH07	30	-	16.5	-	1.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	Dry	2.40	N	N	N	0.0
	60	-	16.4	-	1.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	16.3	-	1.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	16.3	-	1.0	-	0.0	-	0.0	-	0.0	0.0								
BH08	30	-	16.5	-	1.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	3.10	3.90	N	N	N	0.0
	60	-	16.6	-	1.1	-	0.0	-	0.0	-	0.0	0.0								
	90	-	17.1	-	0.8	-	0.0	-	0.0	-	0.0	0.0								
	120	-	17.8	-	0.7	-	0.0	-	0.0	-	0.0	0.0								
	180	-	18.6	-	0.5	-	0.0	-	0.0	-	0.0	0.0								
Remarks	BH01 - there was a lorry parked on top of the hole so couldn't get to it. BH05 - the bung was off the hole so wasn't able to monitor the gas.																			
Borehole Damage Record/ Installation Record																Key: 1 - Peak 2 - Steady state 3 - Groundwater depth 4 - Depth of well			5 - Purged well volumes 6 - Recharge (yes/no) 7 - Sampled (yes/no)	
Borehole Condition Statement																				
Gas Monitor Model:												Serial No:		Recalibration Due:						
GFM 430 / GFM436												12984		28.02.2024						
PID Model:												Serial No:		Recalibration Due:						
MiniRAE Light												SN-590-904260		14.02.2024						

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High	Notes
MiniRAE Lite	100	ppm	50	100	The instrument is factory calibrated with standard calibration gas and is programmed with default alarm limits.



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:		P22/271																		
Site:		Rotterdam Wharf, Port Dundas, Glasgow																		
Date:		05/02/2024																		
Readings taken by:		LM																		
Background Data	Weather Conditions		Overcast																	
	Ground Conditions (dry/wet):		Wet																	
	Air Temperature (°C)		10																	
	Atmospheric Pressure (mB) (start):		1005																	
	Atmospheric Pressure (mB) (finish):		1004																	
	O2 (%)		20																	
Time (hh:mm)		11:00																		
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ² (mbgl)	DoW ⁴ (m)	Pr ³		R ⁴	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH01	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BH02	30	-	15.2	-	0.4	-	4.8	-	0.0	-	0.0	>>>>	-	-	-	-	-	-	-	
	60	-	15.2	-	0.4	-	4.9	-	0.0	-	0.0	>>>>	6.0	0.0	10.35	18.80	3	Y	Y	0.0
	90	-	15.6	-	0.4	-	4.9	-	0.0	-	0.0	98.2	-	-	-	-	-	-	-	
	120	-	17.7	-	0.2	-	2.4	-	0.0	-	0.0	55.0	-	-	-	-	-	-	-	
BH03	30	-	18.3	-	0.1	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	18.2	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.35	9.45	3	Y	Y	0.0
	90	-	18.1	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	-	-	-	-	-	
	120	-	18.1	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	-	-	-	-	-	
BH04	30	-	16.8	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	17.1	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	-	7.40	N	N	N	0.0
	90	-	16.8	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	-	-	-	-	-	
	120	-	16.8	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	-	-	-	-	-	
BH05	30	-	19.8	-	0.1	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	19.9	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.30	7.55	3	Y	Y	0.0
	90	-	19.8	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	-	-	-	-	-	
	120	-	19.8	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	-	-	-	-	-	
BH06	30	-	11.3	-	1.6	-	1.4	-	0.0	-	0.0	33.5	-	-	-	-	-	-	-	
	60	-	11.0	-	1.6	-	1.5	-	0.0	-	0.0	34.3	6.9	3.1	-	-	-	-	-	
	90	-	11.0	-	1.6	-	1.5	-	0.0	-	0.0	34.7	-	-	-	-	-	-	-	
	120	-	11.0	-	1.6	-	1.5	-	0.0	-	0.0	34.6	-	-	-	-	-	-	-	



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:	P22/271																			
Site:	Rotterdam Wharf, Port Dundas, Glasgow																			
Date:	05/02/2024																			
Readings taken by:	LM																			
Background Data	Weather Conditions												Overcast							
	Ground Conditions (dry/wet):												Wet							
	Air Temperature (°C)												10							
	Atmospheric Pressure (mB) (start):												1005							
	Atmospheric Pressure (mB) (finish):												1004							
	O2 (%)												20							
Time (hh:mm)												11:00								
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mbgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH07	30	-	18.4	-	0.6	-	0.6	-	0.0	-	0.0	0.0	0.0	0.0	Dry	2.45	-	-	-	0.0
	60	-	18.3	-	0.7	-	0.7	-	0.0	-	0.0	0.0								
	90	-	18.3	-	0.6	-	0.6	-	0.0	-	0.0	0.0								
	120	-	18.3	-	0.6	-	0.6	-	0.0	-	0.0	0.0								
BH08	30	-	-	-	-	-	-	-	-	-	-	-	-	-	3.95	4.80	-	-	-	-
	60	-	-	-	-	-	-	-	-	-	-	-								
	90	-	-	-	-	-	-	-	-	-	-	-								
	120	-	-	-	-	-	-	-	-	-	-	-								
Remarks	BH01 was obstructed by an HGV so was inaccessible.																			
Borehole Damage Record/ Installation Record																Key: 1 – Peak 2 – Steady state 3 – Groundwater depth 4 – Depth of well			5 – Purged well volumes 6 – Recharge (yes/no) 7 – Sampled (yes/no)	
Borehole Condition Statement	BH06 had bailer dropped by previous visitor. BH04 dropped on this visit. BH08 flooded on arrival.																			
Gas Monitor Model:												Serial No:		Recalibration Due:						
GFM 430 / GFM436												13781		09.02.2024						
PID Model:												Serial No:		Recalibration Due:						
MiniRAE Light												590-904260		14/02/2024						

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High	Notes
MiniRAE Lite	100	ppm	50	100	The instrument is factory calibrated with standard calibration gas and is programmed with default alarm limits.



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:	P22/271																			
Site:	Rotterdam Wharf, Port Dundas, Glasgow																			
Date:	19/02/2024																			
Readings taken by:	DM																			
Background Data	Weather Conditions												Cloudy							
	Ground Conditions (dry/wet):												Wet							
	Air Temperature (°C)												9							
	Atmospheric Pressure (mB) (start):												1019							
	Atmospheric Pressure (mB) (finish):												1017							
	O2 (%)												20.1							
Time (hh:mm)												11:30								
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mBgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH01	30	-	7.7	-	0.9	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	-	-	-	-	0.0	
	60	-	7.4	-	0.9	-	0.0	-	0.0	-	0.0	0.0								
	90	-	7.3	-	0.9	-	0.0	-	0.0	-	0.0	0.0								
	120	-	7.2	-	0.8	-	0.0	-	0.0	-	0.0	0.0								
	150	-	7.2	-	0.8	-	0.0	-	0.0	-	0.0	0.0								
BH02	30	-	15.1	-	0.4	-	1.1	-	0.0	-	0.0	25.8	0.0	0.0	9.80	18.50	3	Y	N	0.0
	60	-	15.0	-	0.4	-	1.1	-	0.0	-	0.0	25.2								
	90	-	15.1	-	0.4	-	1.0	-	0.0	-	0.0	23.3								
	120	-	15.1	-	0.4	-	1.0	-	0.0	-	0.0	22.5								
	180	-	15.1	-	0.4	-	1.0	-	0.0	-	0.0	20.5								
BH03	30	-	17.6	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	4.30	9.60	3	Y	N	0.0
	60	-	17.5	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	90	-	17.5	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
	120	-	17.5	-	0.0	-	0.0	-	0.0	-	0.0	0.0								
BH04	30	-	10.5	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	11.35	18.70	N	N	N	0.0
	60	-	10.2	-	0.1	-	0.0	-	0.0	-	0.0	0.0								
	90	-	10.2	-	0.1	-	0.0	-	0.0	-	0.0	0.0								
	120	-	10.2	-	0.1	-	0.0	-	0.0	-	0.0	0.0								
BH05	30	-	18.6	-	0.1	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.30	7.55	3	Y	N	0.0
	60	-	18.9	-	0.1	-	0.0	-	0.0	-	0.0	0.0								
	90	-	19.0	-	0.1	-	0.0	-	0.0	-	0.0	0.0								
	120	-	19.0	-	0.1	-	0.0	-	0.0	-	0.0	0.0								
BH06	30	-	9.4	-	2.1	-	1.7	-	0.0	-	0.0	40.4	0.0	0.0	7.90	9.50	N	N	N	0.0
	60	-	9.5	-	2.1	-	1.7	-	0.0	-	0.0	40.7								
	90	-	9.1	-	2.1	-	1.8	-	0.0	-	0.0	42.1								
	120	-	8.9	-	2.2	-	1.9	-	0.0	-	0.0	43.5								
	240	-	8.4	-	2.3	-	1.9	-	0.0	-	0.0	43.9								



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:	P22/271																								
Site:	Rotterdam Wharf, Port Dundas, Glasgow																								
Date:	19/02/2024																								
Readings taken by:	DM																								
Background Data	Weather Conditions												Cloudy												
	Ground Conditions (dry/wet):												Wet												
	Air Temperature (°C)												9												
	Atmospheric Pressure (mB) (start):												1019												
	Atmospheric Pressure (mB) (finish):												1017												
	O2 (%)												20.1												
Time (hh:mm)												11:30													
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results							
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mbgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷					
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²											
BH07	30	-	17.0	-	0.9	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	Dry	2.40	N	N	N	0.0					
	60	-	17.0	-	0.9	-	0.0	-	0.0	-	0.0	0.0													
	90	-	17.0	-	0.9	-	0.0	-	0.0	-	0.0	0.0													
	120	-	17.0	-	0.9	-	0.0	-	0.0	-	0.0	0.0													
BH08	30	-	14.7	-	1.4	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.90	3.90	I	N	N	0.0					
	60	-	16.3	-	0.9	-	0.0	-	0.0	-	0.0	0.0													
	90	-	17.3	-	0.7	-	0.0	-	0.0	-	0.0	0.0													
	120	-	18.0	-	0.6	-	0.0	-	0.0	-	0.0	0.0													
	210	-	19.3	-	0.2	-	0.0	-	0.0	-	0.0	0.0													
Remarks	BH01 - couldn't get the bung off as it was jammed in the tube so couldn't dip.																								
Borehole Damage Record/ Installation Record																Key: 1 - Peak 2 - Steady state 3 - Groundwater depth 4 - Depth of well			5 - Purged well volumes 6 - Recharge (yes/no) 7 - Sampled (yes/no)						
Borehole Condition Statement																									
Gas Monitor Model:	GFM 430 / GFM436											Serial No:		12984							Recalibration Due:			28.02.2024	
PID Model:	MiniRAE Light											Serial No:		SN: 594-903171							Recalibration Due:			(Hired out)	

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High	Notes
MiniRAE Lite	100	ppm	50	100	The instrument is factory calibrated with standard calibration gas and is programmed with default alarm limits.



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:	P22/271																			
Site:	Rotterdam Wharf, Port Dundas, Glasgow																			
Date:	04/03/2024																			
Readings taken by:	LM																			
Background Data	Weather Conditions												Clear							
	Ground Conditions (dry/wet):												Wet							
	Air Temperature (°C)												5							
	Atmospheric Pressure (mB) (start):												1004							
	Atmospheric Pressure (mB) (finish):												1003							
	O2 (%)												20.8							
Time (hh:mm)												10:20								
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mbgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH01	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BH02	30	-	15.3	-	0.4	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	15.4	-	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	9.95	18.55	2.0	N	N	N/A
	90	-	15.5	-	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	2.0	N	N	N/A
	120	-	15.5	-	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	2.0	N	N	N/A
BH03	30	-	18.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	17.9	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	2.55	9.40	3.0	Y	N	N/A
	90	-	18.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	3.0	Y	N	N/A
	120	-	18.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	3.0	Y	N	N/A
BH04	30	-	11.5	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	11.2	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.4	0.2	11.20	18.45	N	N	N	N/A
	90	-	11.3	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.4	0.2	11.20	18.45	N	N	N	N/A
	120	-	11.2	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.4	0.2	11.20	18.45	N	N	N	N/A
BH05	30	-	19.5	-	0.0	-	0.0	-	0.0	-	0.0	0.0	-	-	-	-	-	-	-	
	60	-	19.4	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.5	0.0	2.45	7.45	3.0	Y	N	N/A
	90	-	19.4	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.5	0.0	2.45	7.45	3.0	Y	N	N/A
	120	-	19.4	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.5	0.0	2.45	7.45	3.0	Y	N	N/A
BH06	30	-	11.3	-	2.4	-	1.4	-	0.0	-	0.0	32.6	-	-	-	-	-	-	-	
	60	-	10.9	-	2.0	-	1.4	-	0.0	-	0.0	33.3	0.0	0.0	8.00	10.55	N	N	N	N/A
	90	-	10.6	-	2.1	-	1.4	-	0.0	-	0.0	33.8	0.0	0.0	8.00	10.55	N	N	N	N/A
	120	-	10.4	-	2.1	-	1.4	-	0.0	-	0.0	34.1	0.0	0.0	8.00	10.55	N	N	N	N/A



Geo-Environmental Consultants

Gas and Groundwater Monitoring Results

Project Number:	P22/271																			
Site:	Rotterdam Wharf, Port Dundas, Glasgow																			
Date:	04/03/2024																			
Readings taken by:	LM																			
Background Data	Weather Conditions												Clear							
	Ground Conditions (dry/wet):												Wet							
	Air Temperature (°C)												5							
	Atmospheric Pressure (mB) (start):												1004							
	Atmospheric Pressure (mB) (finish):												1003							
	O2 (%)												20.8							
Time (hh:mm)												10:20								
Borehole No.	Interval	Gas											Groundwater		Sampling			PID Results		
		Oxygen O ₂ (%)		Carbon Dioxide CO ₂ (%)		Methane CH ₄ (%)		Hydrogen Sulphide H ₂ S (PPM)		Carbon Monoxide CO (PPM)		Lower Explosive Limit (LEL)	Flow (l/hr)		Wd ³ (mbgl)	DoW ⁴ (m)	Pr ⁵		R ⁶	S ⁷
		P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²	P ¹	SS ²		P ¹	SS ²						
BH07	30	-	19.2	-	0.4	-	0.0	-	0.0	-	0.0	0.0	0.0	0.0	Dry	2.50	N	N	N	N/A
	60	-	19.2	-	0.4	-	0.0	-	0.0	-	0.0	0.0								
	90	-	19.2	-	0.4	-	0.0	-	0.0	-	0.0	0.0								
	120	-	19.2	-	0.4	-	0.0	-	0.0	-	0.0	0.0								
BH08	30	-	15.4	-	2.1	-	0.0	-	0.0	-	0.0	0.0	1.5	1.2	2.55	4.00	N	N	N	N/A
	60	-	16.9	-	1.3	-	0.0	-	0.0	-	0.0	0.0								
	90	-	17.5	-	1.1	-	0.0	-	0.0	-	0.0	0.0								
	120	-	18.0	-	0.9	-	0.0	-	0.0	-	0.0	0.0								
Remarks	Managed to access BH01 but I was unable to monitor as the valve was open. The hole had also filled with clay and I was unable to remove the bung even with a screwdriver. Retrieved a previously dropped bailer from BH06 but was unable to purge due to an HGV trailer parked on top.																			
Borehole Damage Record/ Installation Record																Key: 1 – Peak 2 – Steady state 3 – Groundwater depth 4 – Depth of well			5 – Purged well volumes 6 – Recharge (yes/no) 7 – Sampled (yes/no)	
Borehole Condition Statement																				
Gas Monitor Model:												Serial No:		Recalibration Due:						
GFM 430 / GFM436												13655		15.06.2023						
PID Model:												Serial No:		Recalibration Due:						
MiniRAE Light												-		-						

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High	Notes
MiniRAE Lite	100	ppm	50	100	The instrument is factory calibrated with standard calibration gas and is programmed with default alarm limits.

Appendix 08

**Geotechnical Laboratory Analysis Results
(MATtest Ltd, January and March 2024)
(Refs: 23/1390-01-1 and 24/256-01-1)**

LABORATORY TEST CERTIFICATE

10 Queenslie Point
Queenslie Industrial Estate
120 Stepps Road
Glasgow
G33 3NQ

Certificate No : 23/1390 - 01-1
To : Scott Armstrong
Client : Mason Evans Partnership
The Piazza
95 Morrison Street
Glasgow
G5 8BE

Tel: 0141 774 4032

email: info@mattest.org
Website: www.mattest.org

LABORATORY TESTING OF SOIL

Introduction

We refer to samples taken from Rotterdam Wharf, Scottish Opera, Glasgow and delivered to our laboratory on 05th January 2024.

Material & Source

Sample Reference : See Report Plates
Sampled By : Client
Sampling Certificate : Not Supplied
Location : See Report Plates
Description : See Page 2
Date Sampled : 04th to 09th December 2023
Date Tested : 05th January 2024 Onwards
Source : P22/271 - Rotterdam Wharf, Scottish Opera, Glasgow

Test Results


As Detailed On Page 2 to Page 23 inclusive

Comments

The results contained in this report relate to the sample(s) as received
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
All remaining samples for this project will be disposed of 28 days after issue of this test certificate

Remarks

Approved for Issue


T McLelland (Director)

Date 23/01/2024

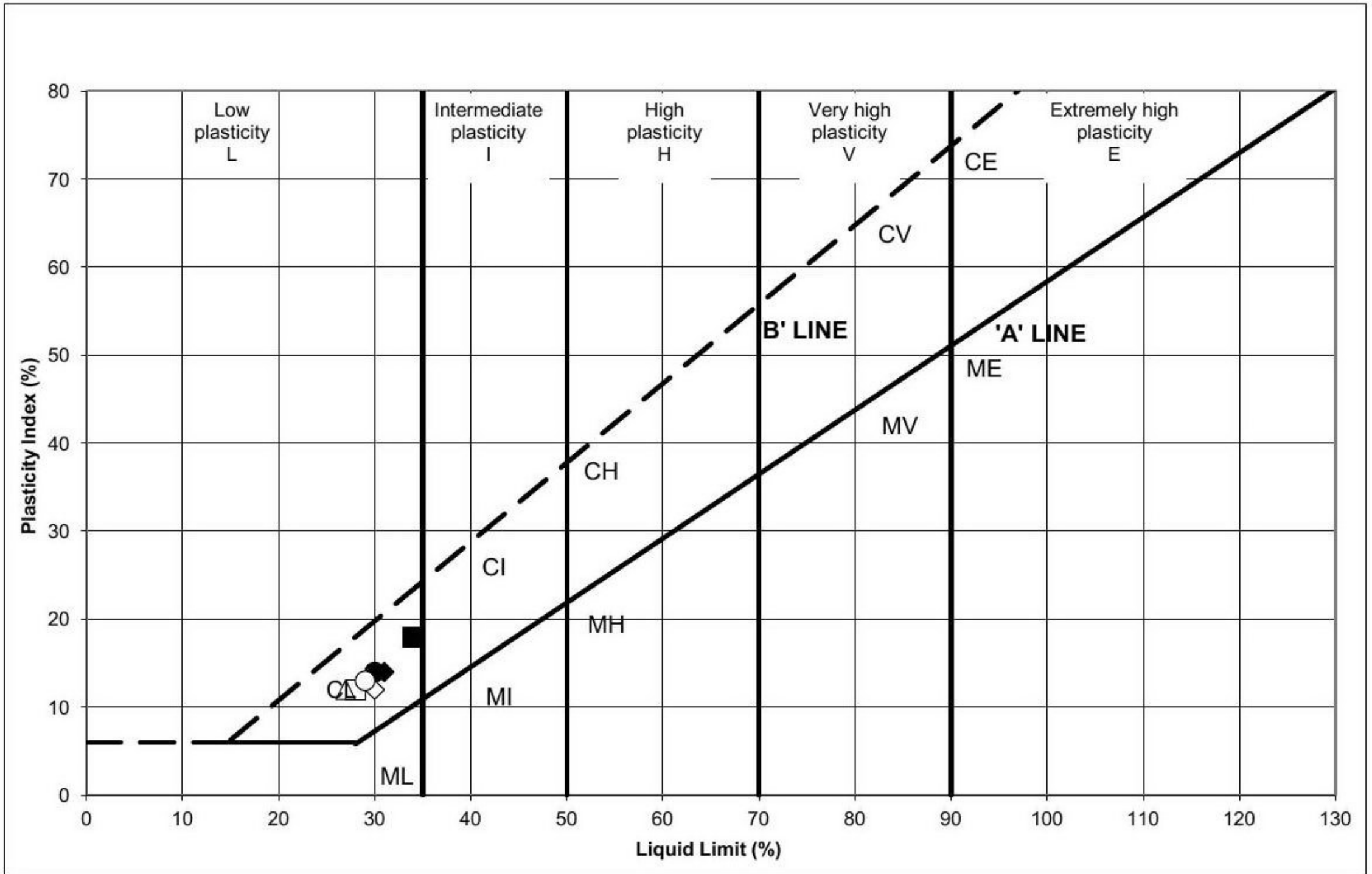
BOREHOLE	SAMPLE	DEPTH (m)	SAMPLE DESCRIPTION
BH01A	B	1.20-1.65	Brown clayey fine to coarse SAND and GRAVEL with recycled aggregate and cobbles.
BH01A	U	3.00-3.45	Brown gravelly very sandy CLAY. Gravel is fine to coarse.
BH02	U	5.00-5.45	Brown gravelly very sandy CLAY. Gravel is fine to coarse.
BH03	U	11.50-11.95	Brown very gravelly very sandy CLAY. Gravel is fine to coarse.
BH04	U	3.00-3.45	Brown very gravelly very sandy CLAY. Gravel is fine to coarse.
BH05	U	4.00-4.45	Brown very gravelly very sandy CLAY. Gravel is fine to coarse.
BH05	U	12.60-13.05	Brown very gravelly very silty very sandy CLAY. Gravel is fine to coarse.
BH06	B	1.20-1.65	Brown clayey fine to coarse SAND and GRAVEL with cobbles.
BH06	U	4.00-4.45	Brown gravelly very sandy CLAY. Gravel is fine to coarse.
BH07	B	2.00-2.45	Brown clayey fine to coarse SAND and GRAVEL / CRUSHED ROCK.
BH08	U	3.00-4.00	Brown gravelly very sandy CLAY. Gravel is fine to coarse.

SUMMARY OF SAMPLE DESCRIPTIONS

BOREHOLE	SAMPLE	DEPTH (m)	WATER CONTENT (%)
BH01A	U	3.00-3.45	24.4
BH02	U	5.00-5.45	15.5
BH03	U	11.50-11.95	12.7
BH04	U	3.00-3.45	15.0
BH05	U	4.00-4.45	12.7
BH05	U	12.60-13.05	13.4
BH06	U	4.00-4.45	11.9
BH08	U	3.00	13.9

Tested in accordance with BS 1377 - 2 : 2022 : Clause 4.1

SUMMARY OF WATER CONTENT TEST RESULTS

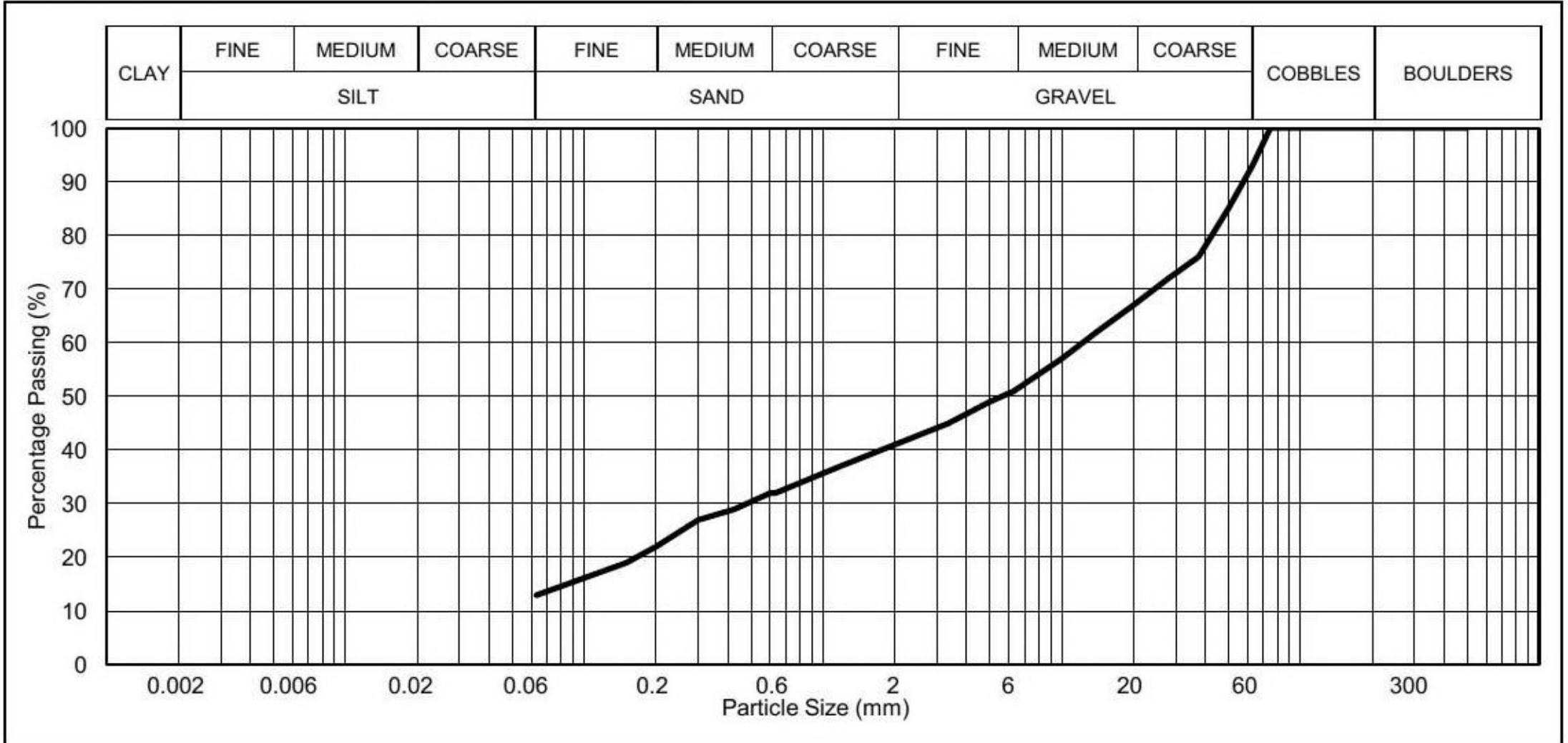


Symbol	Borehole	Sample	Depth	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing 0.425mm Sieve	Remarks
■	BH01A	U	3.00-3.45	24.4	34	16	18	87	Clay with low plasticity
◆	BH02	U	5.00-5.45	15.5	31	17	14	78	Clay with low plasticity
▲	BH03	U	11.50-11.95	12.7	28	16	12	70	Clay with low plasticity
●	BH04	U	3.00-3.45	15.0	30	16	14	75	Clay with low plasticity
□	BH05	U	4.00-4.45	12.7	28	16	12	76	Clay with low plasticity
◇	BH05	U	12.60-13.05	13.4	30	18	12	74	Clay with low plasticity
△	BH06	U	4.00-4.45	11.9	27	15	12	78	Clay with low plasticity
○	BH08	U	3.70	13.9	29	16	13	82	Clay with low plasticity
×									
✱									

All samples were tested in accordance with BS 1377 - 2 : 2022 : Clause 5.2 and 6
 All samples were washed on a 0.425mm test sieve prior to test.

SUMMARY OF ATTERBERG LIMITS TEST RESULTS

Borehole	BH01A
Sample	B
Depth (m)	1.20-1.65



SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)					
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)				
		Not Applicable							
		Lower %	Upper %						
500.0	100	-	-	0.0200					
300.0	100	-	-	0.0063					
125.0	100	-	-	0.0020					
90.0	100	-	-						
75.0	100	-	-						
63.0	93	-	-						
50.0	85	-	-						
37.5	76	-	-						
28.0	72	-	-						
20.0	67	-	-						
14.0	62	-	-						
10.0	57	-	-						
6.3	51	-	-						
5.0	49	-	-						
3.350	45	-	-						
2.000	41	-	-						
1.180	37	-	-						
0.630	32	-	-						
0.600	32	-	-						
0.425	29	-	-						
0.300	27	-	-						
0.200	22	-	-						
0.150	19	-	-						
0.063	13	-	-						

GRADING CLASSIFICATION (SHW TABLE 6/2)				
-				
Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.				

PERCENTAGE SOIL TYPES				
CLAY	SILT †	SAND	GRAVEL	COBBLES
/	13	28	52	7

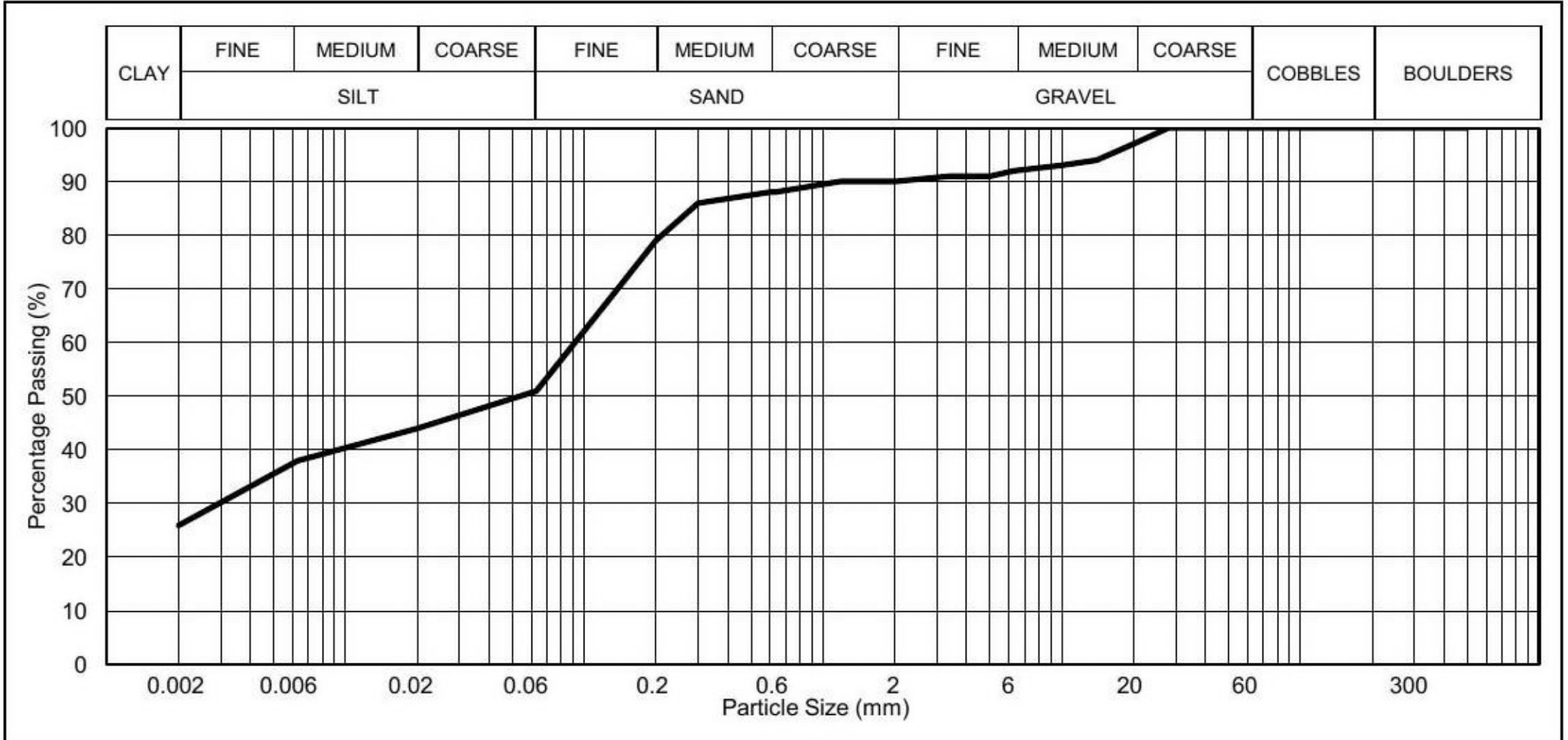
UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)		
D10	D60	Specification
-	-	

UNIFORMITY COEFFICIENT	
-	-

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns
 Sample does not meet minimum mass requirement for material type

Borehole	BH01A
Sample	U
Depth (m)	3.00-3.45

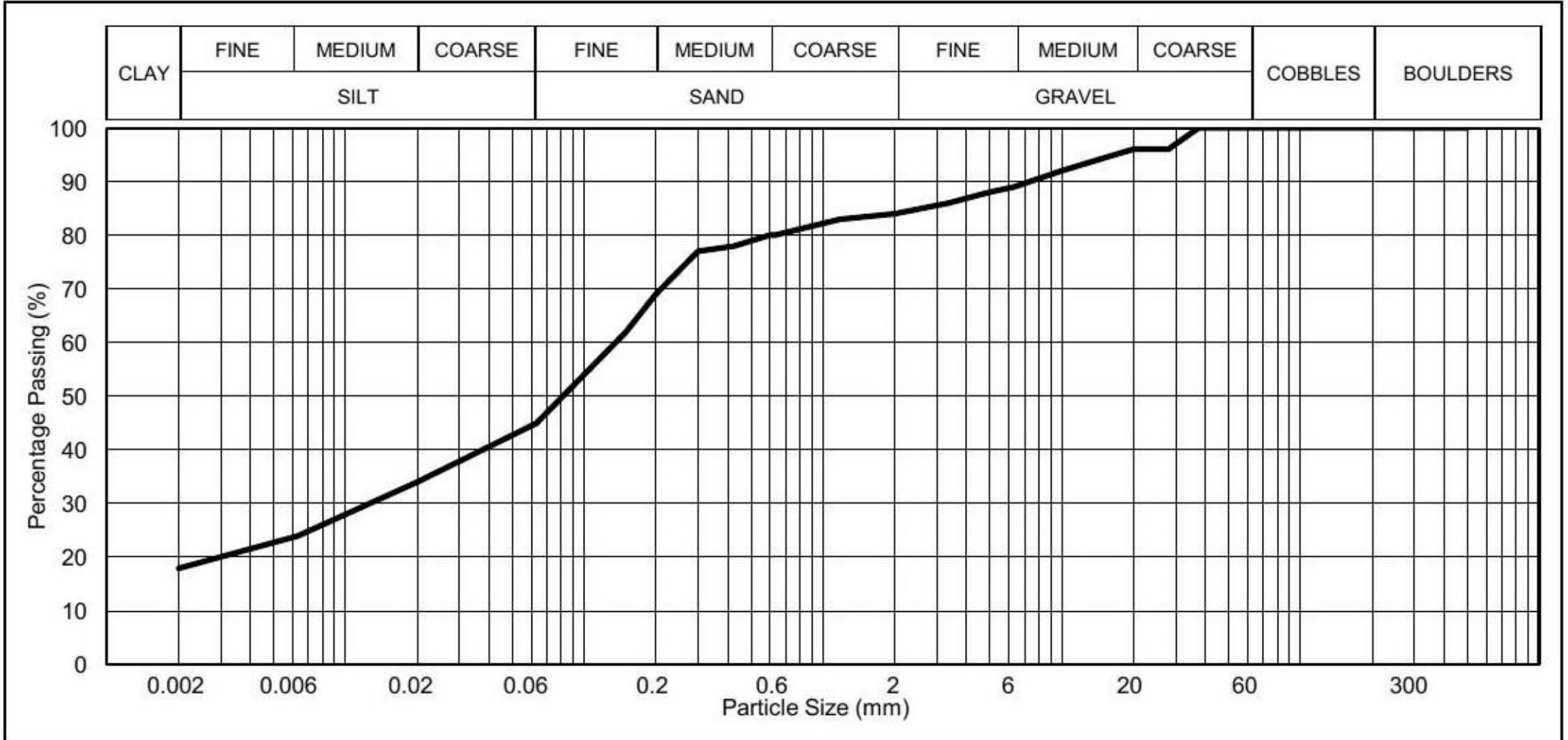


SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)					
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)				
		Not Applicable							
		Lower %	Upper %						
500.0	100	-	-	0.0200	44				
300.0	100	-	-	0.0063	38				
125.0	100	-	-	0.0020	26				
90.0	100	-	-						
75.0	100	-	-	GRADING CLASSIFICATION (SHW TABLE 6/2)					
63.0	100	-	-	-					
50.0	100	-	-						
37.5	100	-	-						
28.0	100	-	-						
20.0	97	-	-	Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.					
14.0	94	-	-						
10.0	93	-	-	PERCENTAGE SOIL TYPES					
6.3	92	-	-	CLAY	SILT †	SAND	GRAVEL	COBBLES	
5.0	91	-	-	26	25	39	10	0	
3.350	91	-	-						
2.000	90	-	-						
1.180	90	-	-	UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)					
0.630	88	-	-	D10		D60		Specification	
0.600	88	-	-	-		-			
0.425	87	-	-	UNIFORMITY COEFFICIENT					
0.300	86	-	-						
0.200	79	-	-						
0.150	72	-	-						
0.063	51	-	-						

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Borehole	BH02
Sample	U
Depth (m)	5.00-5.45

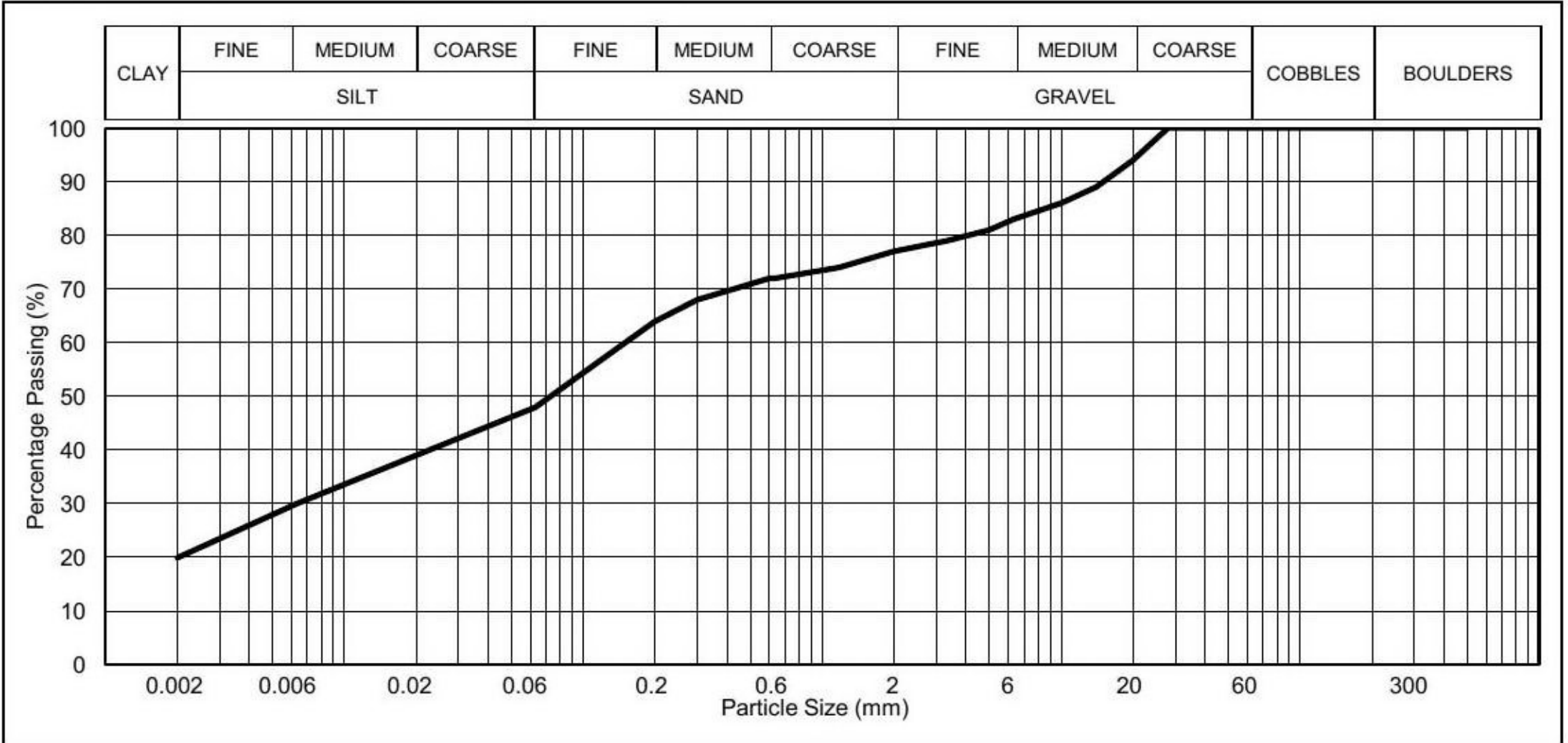


SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)					
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)				
		Not Applicable							
		Lower %	Upper %						
500.0	100	-	-	0.0200	34				
300.0	100	-	-	0.0063	24				
125.0	100	-	-	0.0020	18				
90.0	100	-	-						
75.0	100	-	-	GRADING CLASSIFICATION (SHW TABLE 6/2)					
63.0	100	-	-	-					
50.0	100	-	-	Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.					
37.5	100	-	-						
28.0	96	-	-						
20.0	96	-	-						
14.0	94	-	-						
10.0	92	-	-	PERCENTAGE SOIL TYPES					
6.3	89	-	-	CLAY	SILT †	SAND	GRAVEL	COBBLES	
5.0	88	-	-	18	27	39	16	0	
3.350	86	-	-						
2.000	84	-	-						
1.180	83	-	-	UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)					
0.630	80	-	-	D10		D60		Specification	
0.600	80	-	-	-		-			
0.425	78	-	-	UNIFORMITY COEFFICIENT					
0.300	77	-	-	-					
0.200	69	-	-						
0.150	62	-	-						
0.063	45	-	-						

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Borehole	BH03
Sample	U
Depth (m)	11.50-11.95

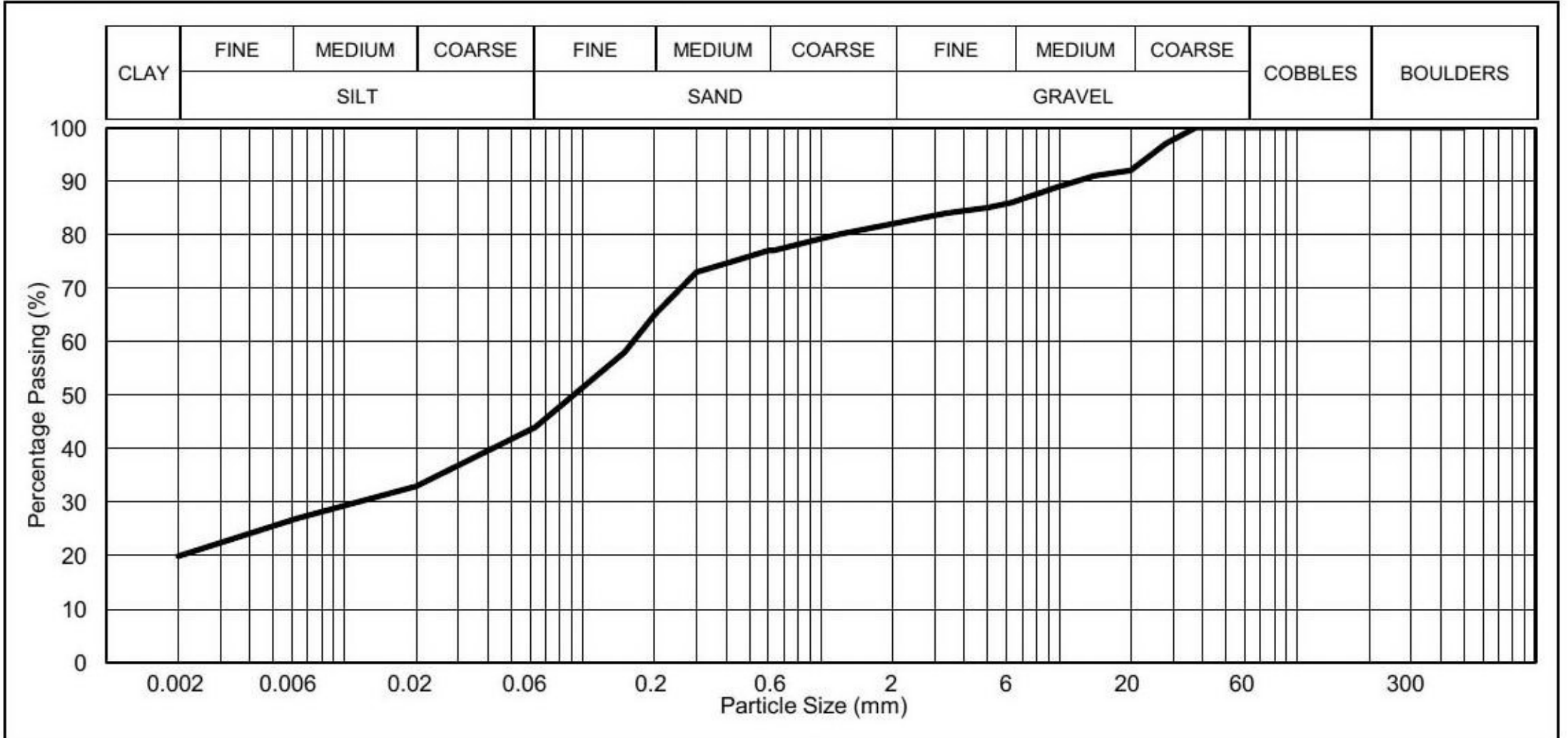


SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)					
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)				
		Not Applicable							
		Lower %	Upper %						
500.0	100	-	-	0.0200	39				
300.0	100	-	-	0.0063	30				
125.0	100	-	-	0.0020	20				
90.0	100	-	-						
75.0	100	-	-	GRADING CLASSIFICATION (SHW TABLE 6/2)					
63.0	100	-	-	-					
50.0	100	-	-						
37.5	100	-	-						
28.0	100	-	-						
20.0	94	-	-	Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.					
14.0	89	-	-						
10.0	86	-	-	PERCENTAGE SOIL TYPES					
6.3	83	-	-	CLAY	SILT †	SAND	GRAVEL	COBBLES	
5.0	81	-	-	20	28	29	23	0	
3.350	79	-	-						
2.000	77	-	-						
1.180	74	-	-	UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)					
0.630	72	-	-	D10		D60		Specification	
0.600	72	-	-	-		-			
0.425	70	-	-	UNIFORMITY COEFFICIENT					
0.300	68	-	-	-					
0.200	64	-	-						
0.150	60	-	-						
0.063	48	-	-						

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Borehole	BH04
Sample	U
Depth (m)	3.00-3.45

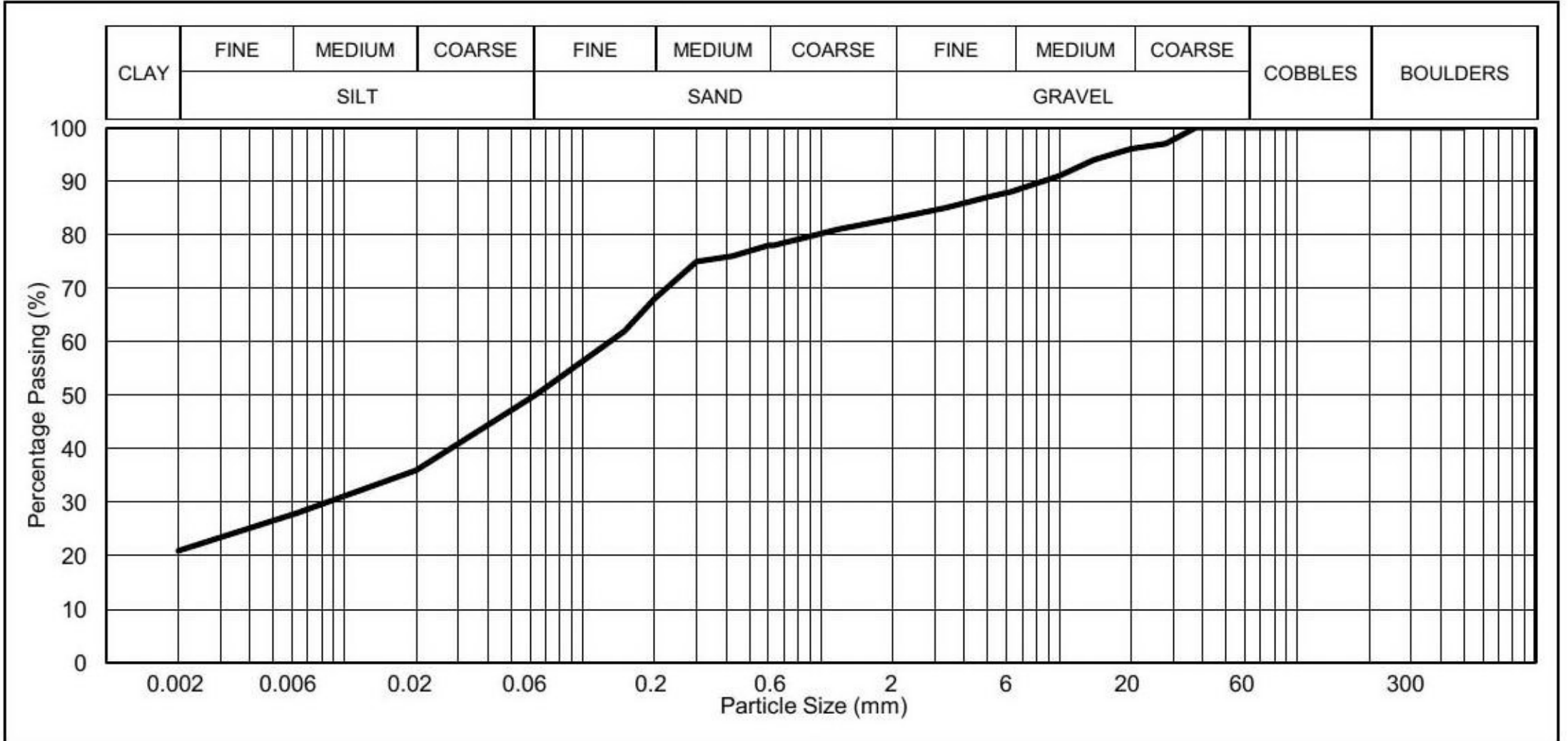


SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)				
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)			
		Not Applicable						
		Lower %	Upper %					
500.0	100	-	-	0.0200	33			
300.0	100	-	-	0.0063	27			
125.0	100	-	-	0.0020	20			
90.0	100	-	-					
75.0	100	-	-	GRADING CLASSIFICATION (SHW TABLE 6/2)				
63.0	100	-	-	-				
50.0	100	-	-					
37.5	100	-	-					
28.0	97	-	-					
20.0	92	-	-	Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.				
14.0	91	-	-					
10.0	89	-	-	PERCENTAGE SOIL TYPES				
6.3	86	-	-	CLAY	SILT †	SAND	GRAVEL	COBBLES
5.0	85	-	-	20	24	38	18	0
3.350	84	-	-					
2.000	82	-	-					
1.180	80	-	-	UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)				
0.630	77	-	-	D10		D60		Specification
0.600	77	-	-	-		-		
0.425	75	-	-	-		-		
0.300	73	-	-	UNIFORMITY COEFFICIENT				
0.200	65	-	-	-				
0.150	58	-	-					
0.063	44	-	-					

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Borehole	BH05
Sample	U
Depth (m)	4.00-4.45

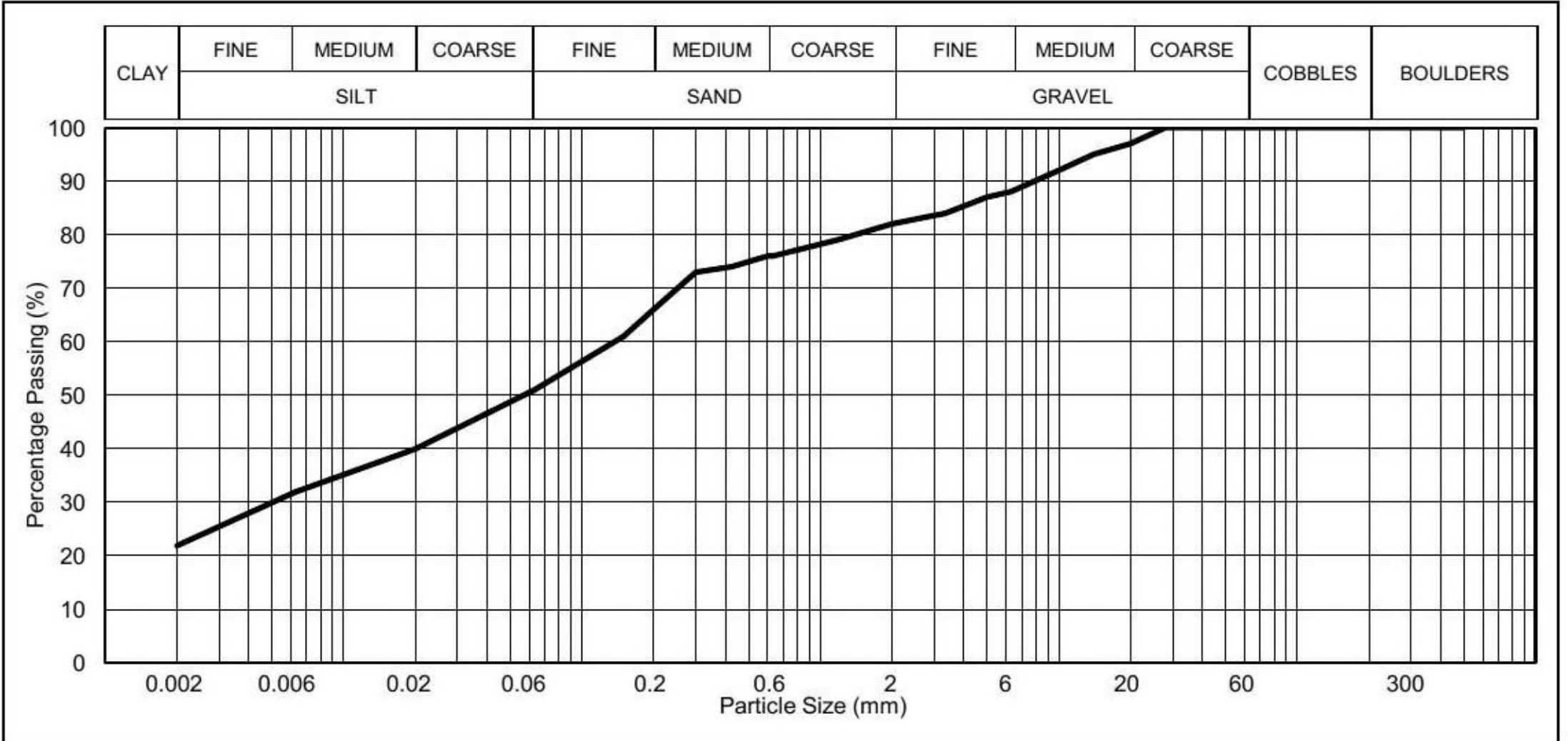


SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)					
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)				
		Not Applicable							
		Lower %	Upper %						
500.0	100	-	-	0.0200	36				
300.0	100	-	-	0.0063	28				
125.0	100	-	-	0.0020	21				
90.0	100	-	-						
75.0	100	-	-	GRADING CLASSIFICATION (SHW TABLE 6/2)					
63.0	100	-	-	Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.					
50.0	100	-	-						
37.5	100	-	-						
28.0	97	-	-						
20.0	96	-	-						
14.0	94	-	-						
10.0	91	-	-	PERCENTAGE SOIL TYPES					
6.3	88	-	-	CLAY	SILT †	SAND	GRAVEL	COBBLES	
5.0	87	-	-	21	29	33	17	0	
3.350	85	-	-						
2.000	83	-	-						
1.180	81	-	-	UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)					
0.630	78	-	-	D10		D60		Specification	
0.600	78	-	-	-		-			
0.425	76	-	-						
0.300	75	-	-	UNIFORMITY COEFFICIENT					
0.200	68	-	-						
0.150	62	-	-						
0.063	50	-	-						

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Borehole	BH05
Sample	U
Depth (m)	12.60-13.05

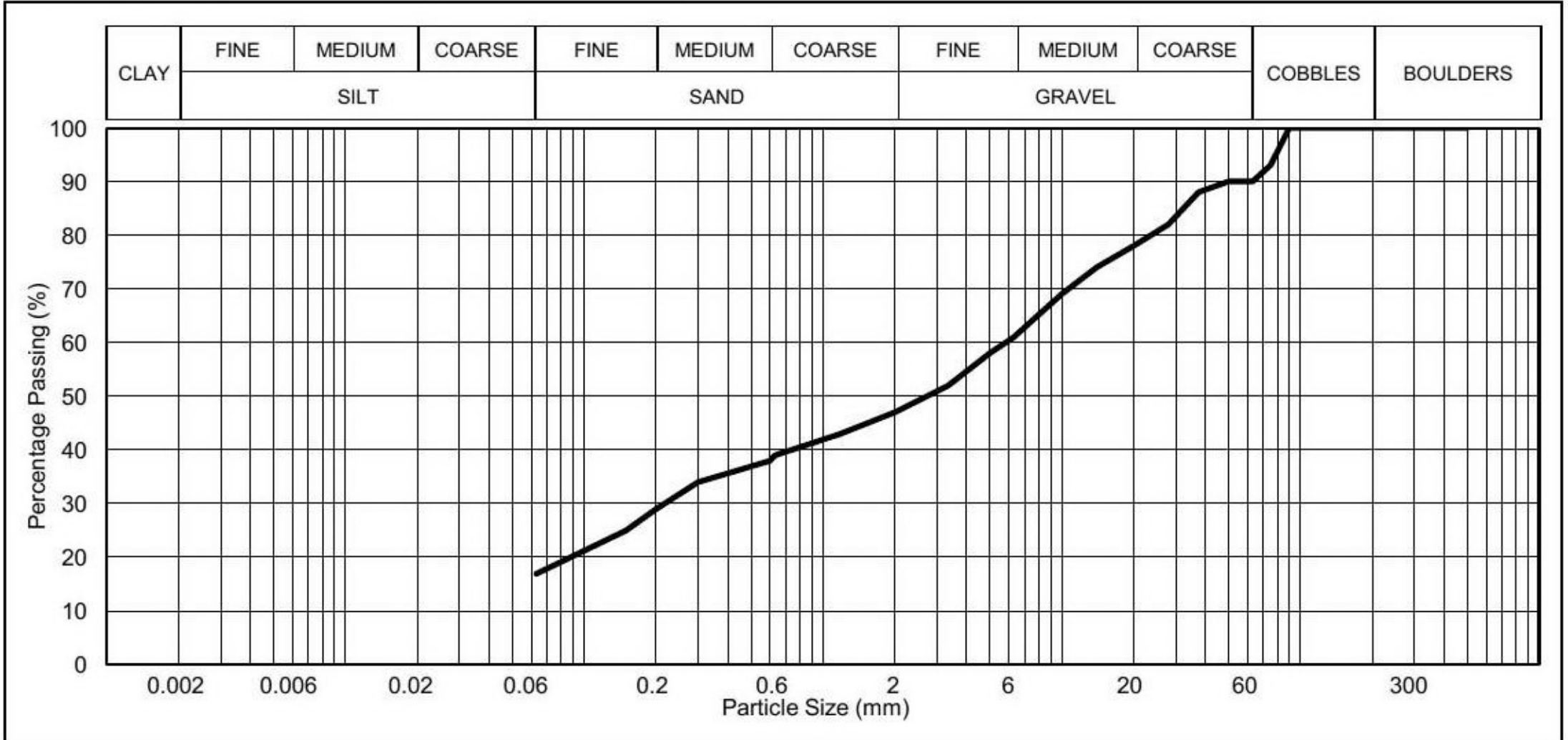


SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)					
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)				
		Not Applicable							
		Lower %	Upper %						
500.0	100	-	-	0.0200	40				
300.0	100	-	-	0.0063	32				
125.0	100	-	-	0.0020	22				
90.0	100	-	-						
75.0	100	-	-				GRADING CLASSIFICATION (SHW TABLE 6/2)		
63.0	100	-	-				-		
50.0	100	-	-						
37.5	100	-	-				Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.		
28.0	100	-	-						
20.0	97	-	-						
14.0	95	-	-						
10.0	92	-	-						
6.3	88	-	-						
5.0	87	-	-						
3.350	84	-	-						
2.000	82	-	-						
1.180	79	-	-						
0.630	76	-	-						
0.600	76	-	-						
0.425	74	-	-						
0.300	73	-	-						
0.200	66	-	-						
0.150	61	-	-						
0.063	51	-	-						
				PERCENTAGE SOIL TYPES					
				CLAY	SILT †	SAND	GRAVEL	COBBLES	
				22	29	31	18	0	
				UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)					
				D10		D60		Specification	
				-		-			
				UNIFORMITY COEFFICIENT				-	-

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Borehole	BH06
Sample	B
Depth (m)	1.20-1.65

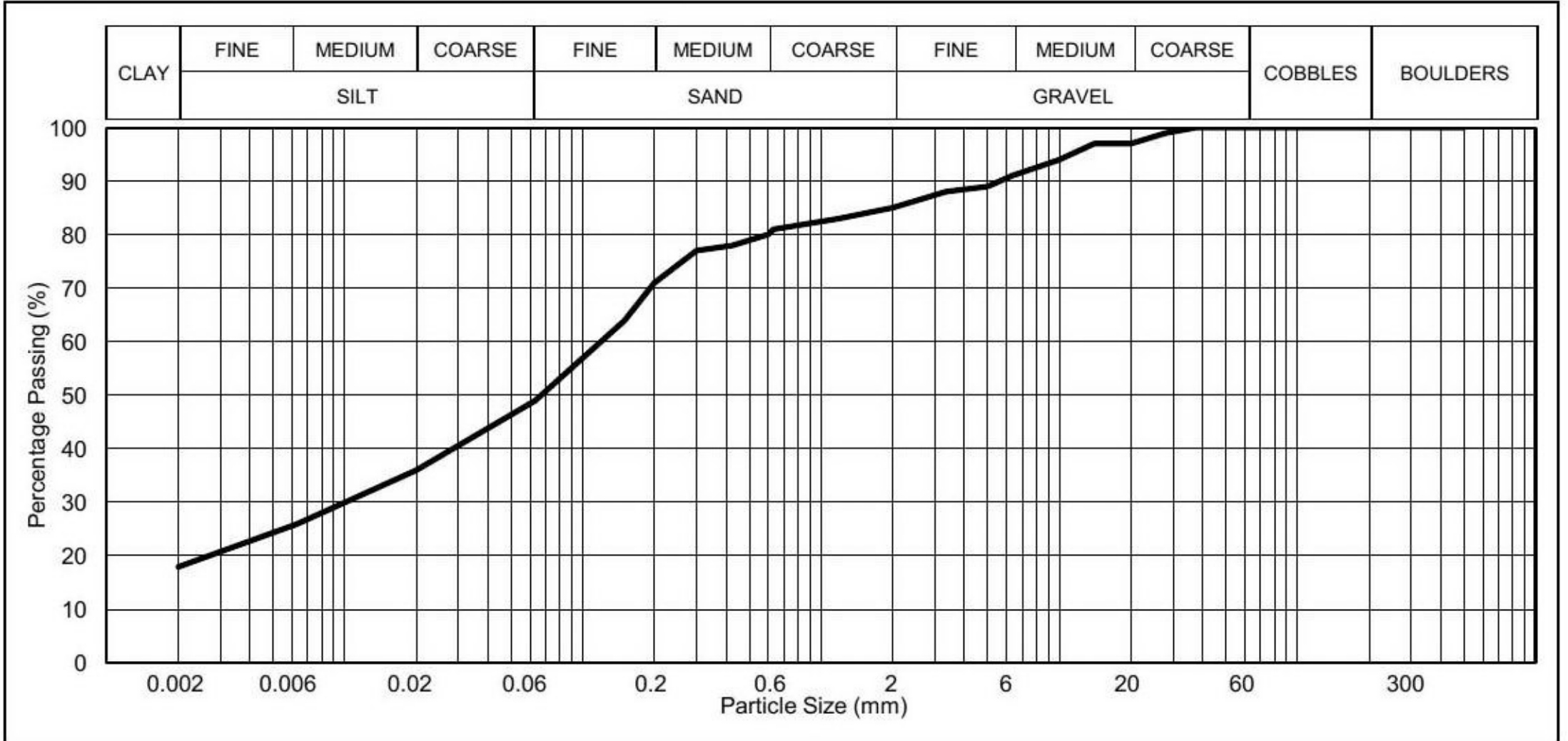


SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)				
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)			
		Lower %	Upper %					
500.0	100	-	-	0.0200				
300.0	100	-	-	0.0063				
125.0	100	-	-	0.0020				
90.0	100	-	-					
75.0	93	-	-	GRADING CLASSIFICATION (SHW TABLE 6/2)				
63.0	90	-	-	-				
50.0	90	-	-	Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.				
37.5	88	-	-					
28.0	82	-	-					
20.0	78	-	-					
14.0	74	-	-					
10.0	69	-	-	PERCENTAGE SOIL TYPES				
6.3	61	-	-	CLAY	SILT †	SAND	GRAVEL	COBBLES
5.0	58	-	-	/	17	30	43	10
3.350	52	-	-					
2.000	47	-	-					
1.180	43	-	-	UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)				
0.630	39	-	-	D10		D60		Specification
0.600	38	-	-	-		-		
0.425	36	-	-	UNIFORMITY COEFFICIENT				
0.300	34	-	-					-
0.200	29	-	-					
0.150	25	-	-					
0.063	17	-	-					

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns
 Sample does not meet minimum mass requirement for material type

Borehole	BH06
Sample	U
Depth (m)	4.00-4.45

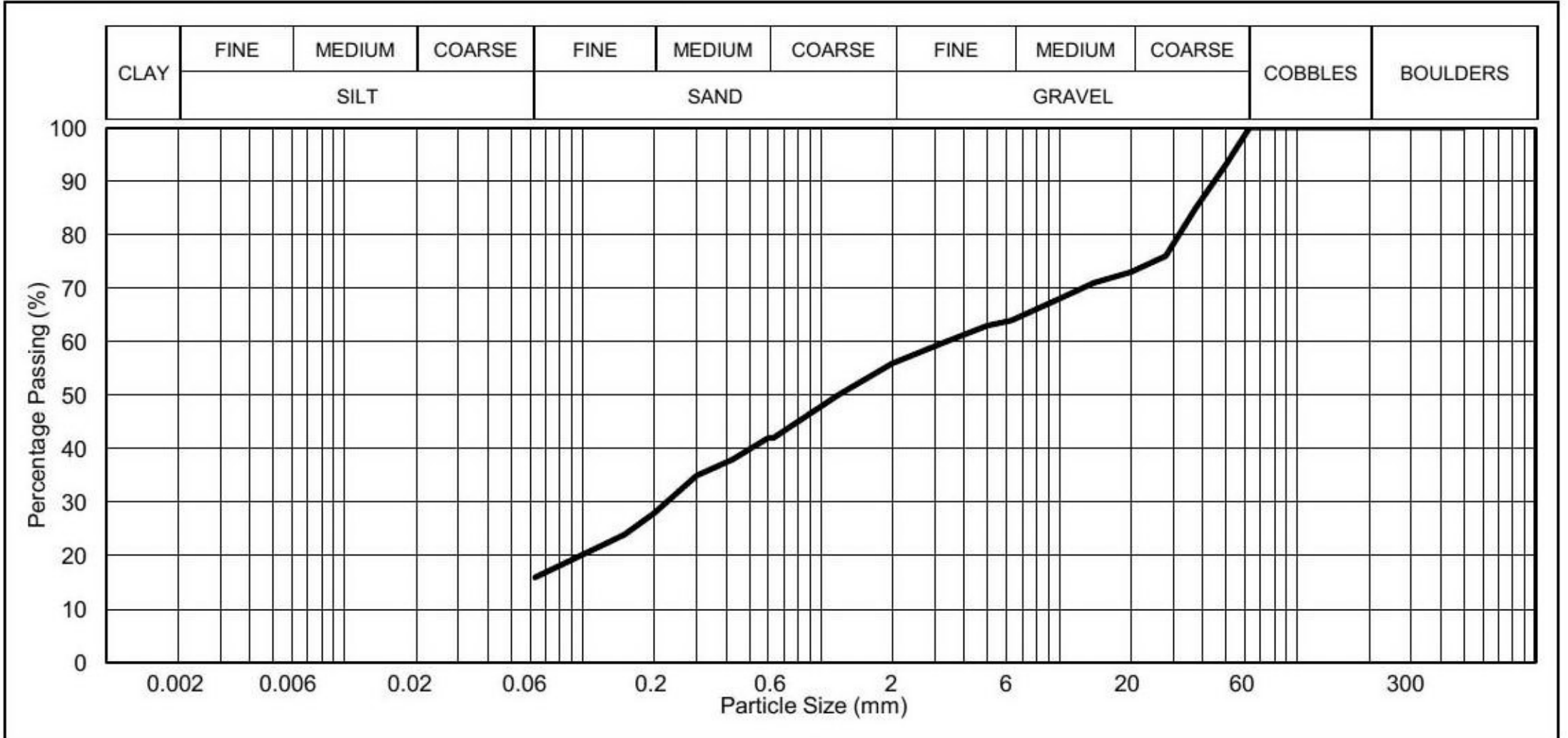


SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)					
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)				
		Not Applicable							
		Lower %	Upper %						
500.0	100	-	-	0.0200	36				
300.0	100	-	-	0.0063	26				
125.0	100	-	-	0.0020	18				
90.0	100	-	-						
75.0	100	-	-	GRADING CLASSIFICATION (SHW TABLE 6/2)					
63.0	100	-	-	-					
50.0	100	-	-						
37.5	100	-	-						
28.0	99	-	-						
20.0	97	-	-	Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.					
14.0	97	-	-						
10.0	94	-	-	PERCENTAGE SOIL TYPES					
6.3	91	-	-	CLAY	SILT †	SAND	GRAVEL	COBBLES	
5.0	89	-	-	18	31	36	15	0	
3.350	88	-	-						
2.000	85	-	-						
1.180	83	-	-	UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)					
0.630	81	-	-	D10		D60		Specification	
0.600	80	-	-	-		-			
0.425	78	-	-	UNIFORMITY COEFFICIENT					
0.300	77	-	-						
0.200	71	-	-						
0.150	64	-	-						
0.063	49	-	-						

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Borehole	BH07
Sample	B
Depth (m)	2.00-2.45



SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)					
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)				
		Not Applicable							
		Lower %	Upper %						
500.0	100	-	-	0.0200					
300.0	100	-	-	0.0063					
125.0	100	-	-	0.0020					
90.0	100	-	-						
75.0	100	-	-						
63.0	100	-	-						
50.0	93	-	-						
37.5	85	-	-						
28.0	76	-	-						
20.0	73	-	-						
14.0	71	-	-						
10.0	68	-	-						
6.3	64	-	-						
5.0	63	-	-						
3.350	60	-	-						
2.000	56	-	-						
1.180	50	-	-						
0.630	42	-	-						
0.600	42	-	-						
0.425	38	-	-						
0.300	35	-	-						
0.200	28	-	-						
0.150	24	-	-						
0.063	16	-	-						

GRADING CLASSIFICATION (SHW TABLE 6/2)				
-				
Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.				

PERCENTAGE SOIL TYPES				
CLAY	SILT †	SAND	GRAVEL	COBBLES
/	16	40	44	0

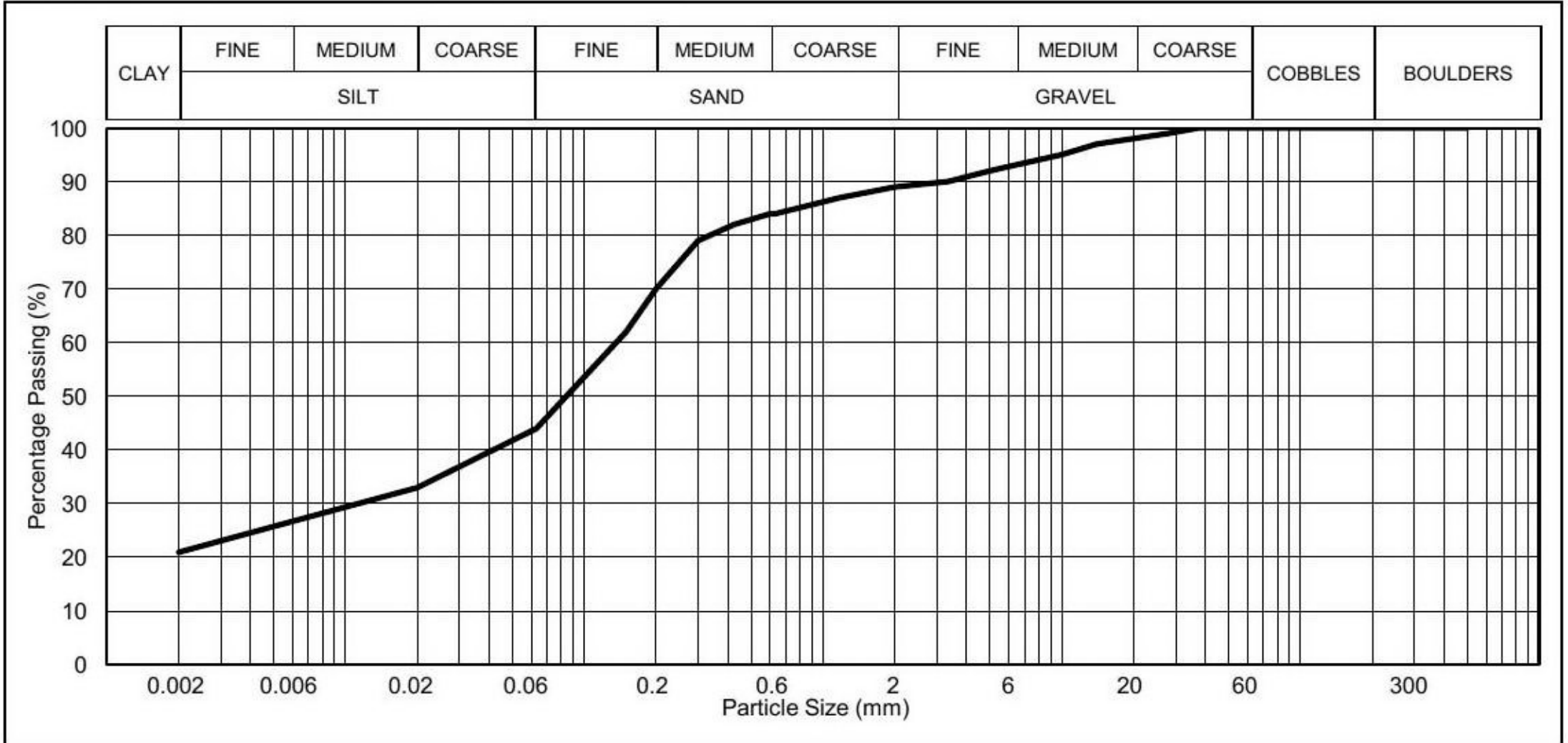
UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)		
D10	D60	Specification
-	-	

UNIFORMITY COEFFICIENT	
-	-

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns
 Sample does not meet minimum mass requirement for material type

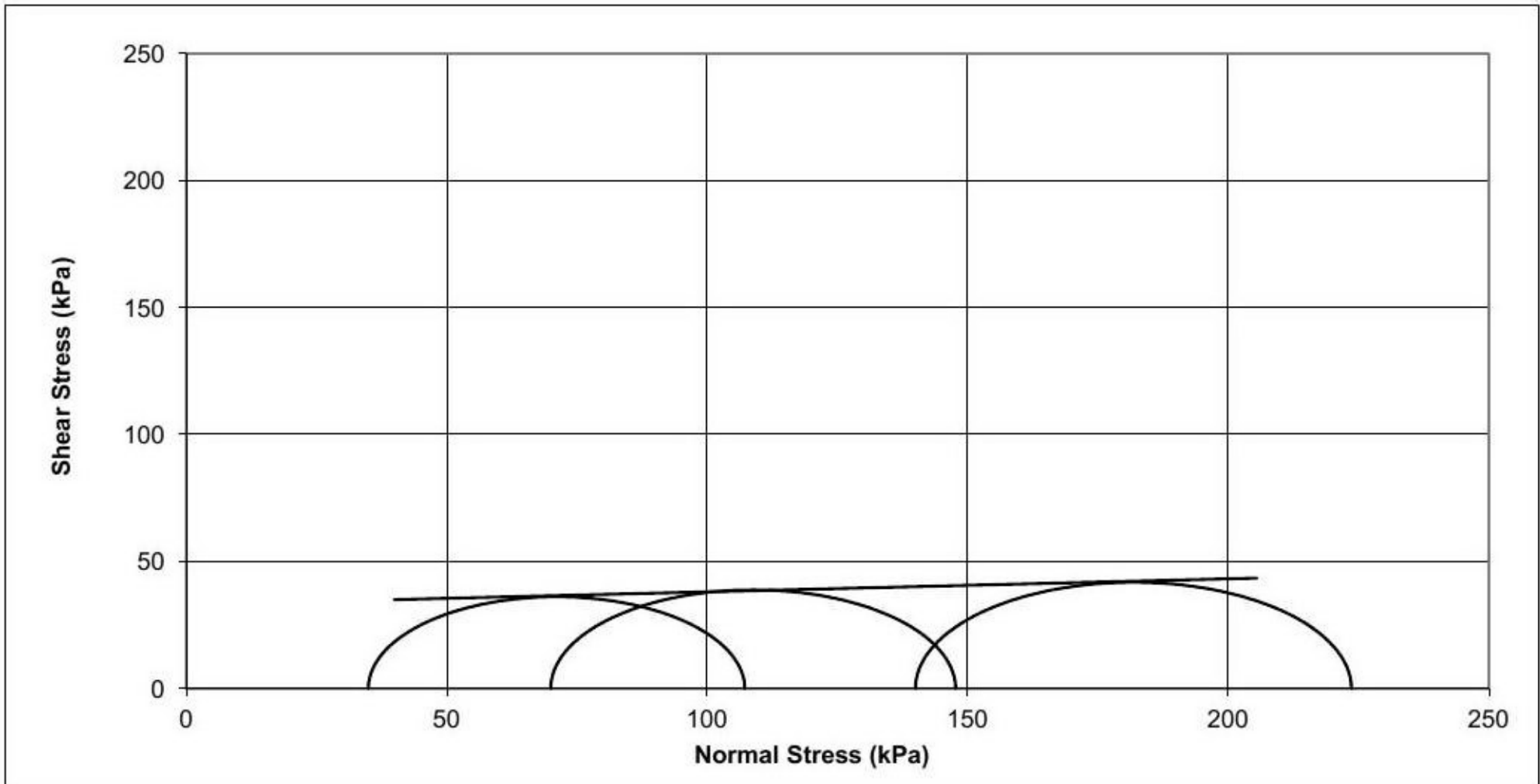
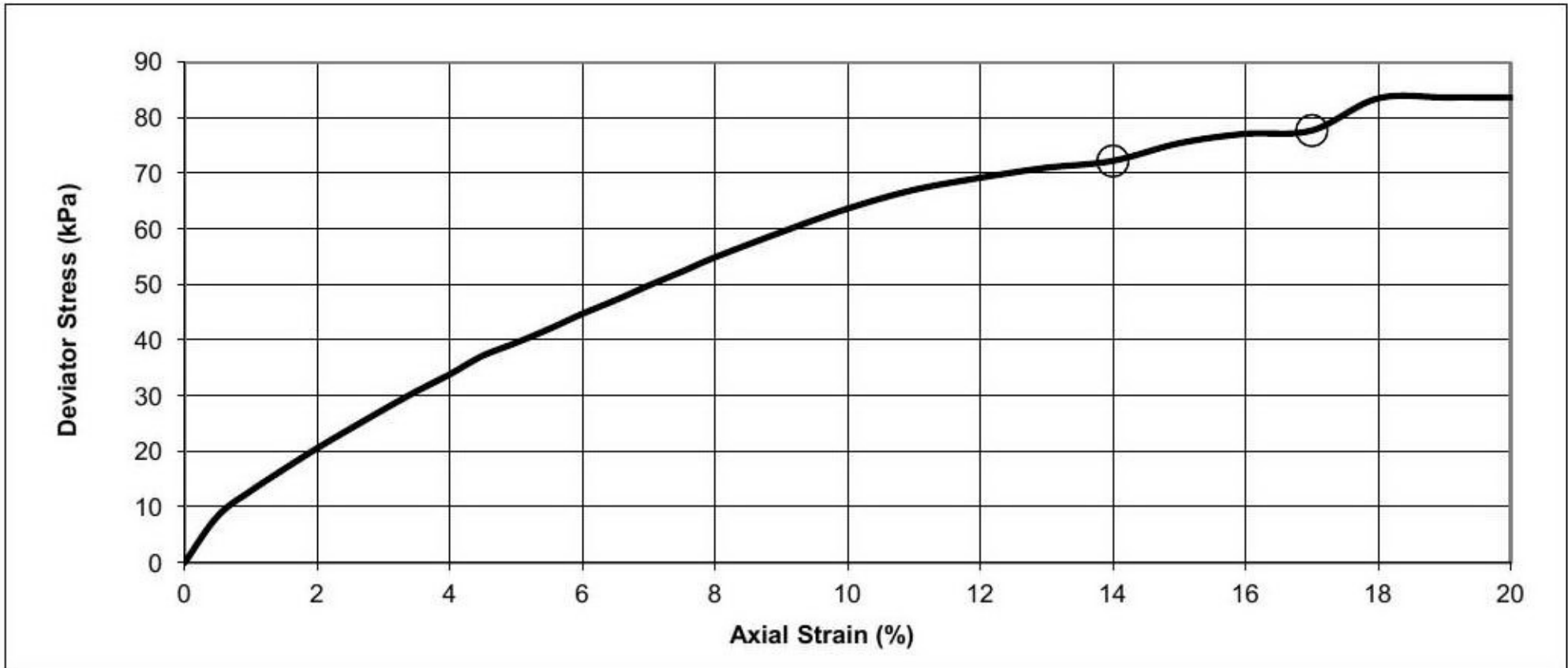
Borehole	BH08
Sample	U
Depth (m)	3.00-3.70



SIEVING				SEDIMENTATION (Assumed ps of 2.65Mg/m ³)						
Sieve Size (mm)	Percentage Passing (%)	Specification		Particle Size (mm)	Percentage Passing (%)					
		Not Applicable								
		Lower %	Upper %							
500.0	100	-	-	0.0200	33					
300.0	100	-	-	0.0063	27					
125.0	100	-	-	0.0020	21					
90.0	100	-	-							
75.0	100	-	-	GRADING CLASSIFICATION (SHW TABLE 6/2) - Grading classification proves the material has met the relevant grading requirements only. Further testing may be required to assess compliance with SHW.						
63.0	100	-	-							
50.0	100	-	-							
37.5	100	-	-							
28.0	99	-	-							
20.0	98	-	-							
14.0	97	-	-							
10.0	95	-	-	PERCENTAGE SOIL TYPES						
6.3	93	-	-							
5.0	92	-	-	CLAY	SILT †	SAND	GRAVEL	COBBLES		
3.350	90	-	-	21	23	45	11	0		
2.000	89	-	-							
1.180	87	-	-	UNIFORMITY COEFFICIENT (SHW TABLE 6/1 NOTE 5)						
0.630	84	-	-							
0.600	84	-	-	D10	D60		Specification			
0.425	82	-	-	-	-					
0.300	79	-	-	UNIFORMITY COEFFICIENT					-	-
0.200	70	-	-							
0.150	62	-	-							
0.063	44	-	-							

Remarks

† Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns



Failure Conditions				
Cell pressure	kPa	35	70	140
Membrane correction	kPa	0.6	0.7	0.7
Strain at failure	%	14.0	17.0	19.0
Failure Type		Intermediate	Intermediate	Intermediate
Corrected deviator stress	kPa	72	78	84
Undrained shear stress	kPa	36	39	42

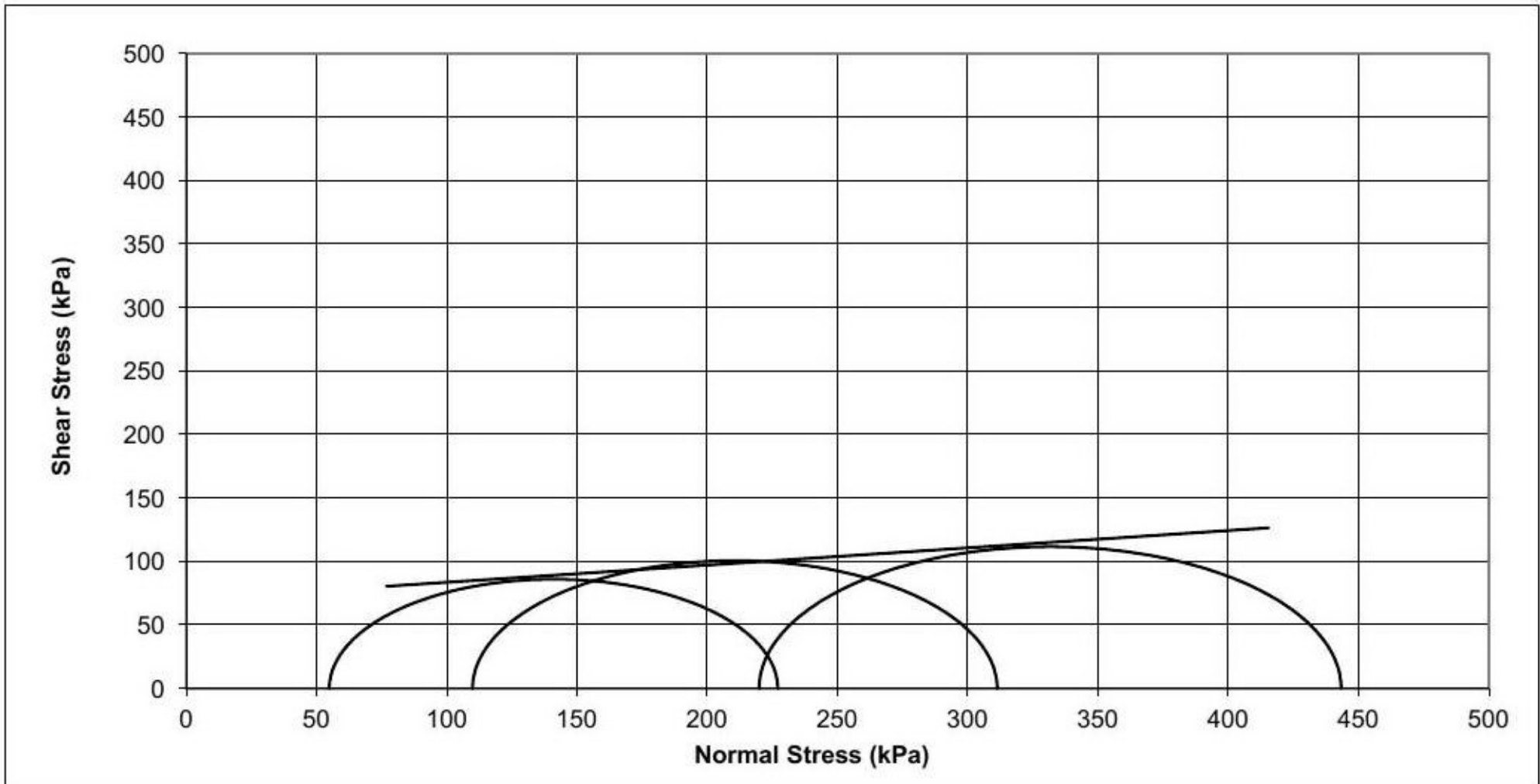
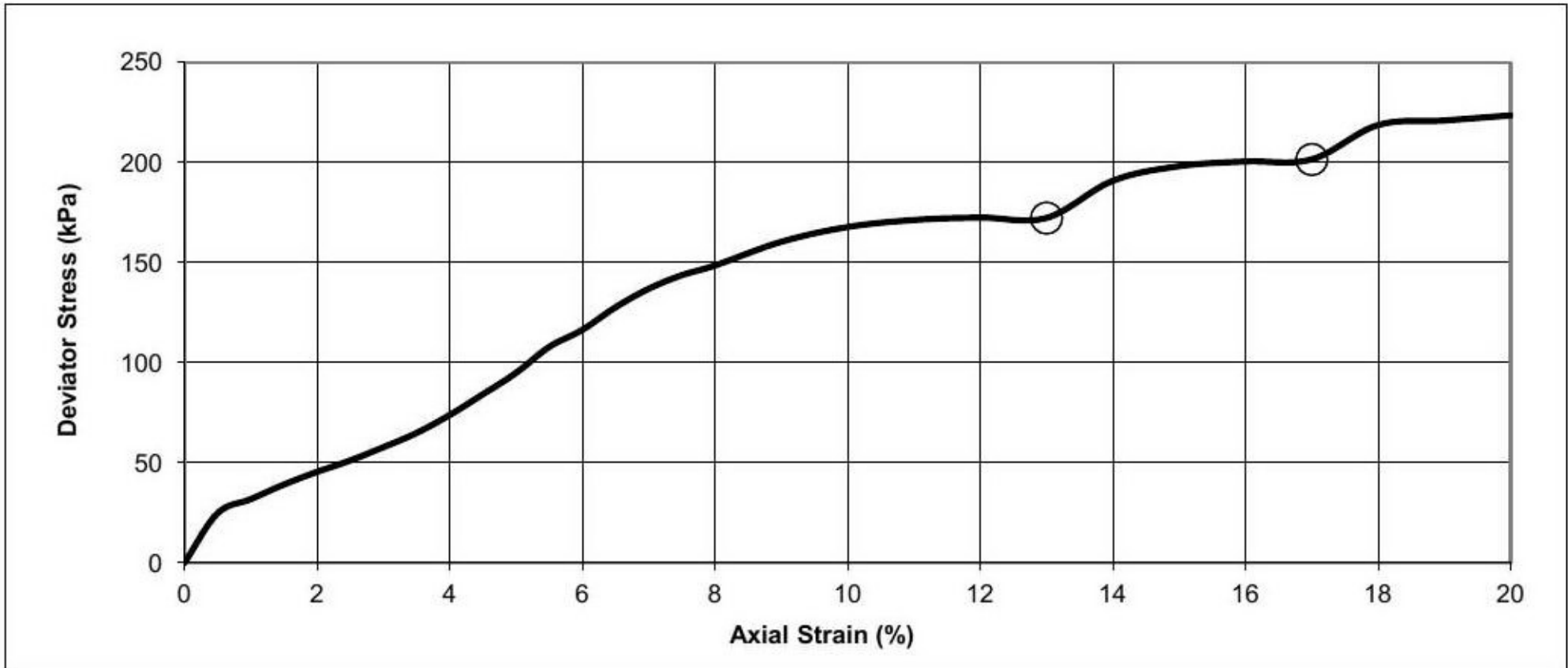
Cohesion	kPa	32.9	Friction Angle	°	2.9
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Initial Conditions					Borehole BH01A Sample U Depth (m) 3.00-3.45	
Sample length	mm	200.28	Rate of strain	%/min		2.0
Sample diameter	mm	100.52	Bulk Density	Mg/m ³		2.13
Membrane type		Latex	Dry Density	Mg/m ³		1.80
Membrane thickness	mm	0.20	Moisture Content	%	19	

Undisturbed sample, taken directly from the sample tube and retaining axial orientation

DETERMINATION OF MULTI STAGE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

Tested in accordance with BS 1377 : Part 7 : 9.0 : 1990



Failure Conditions				
Cell pressure	kPa	55	110	220
Membrane correction	kPa	0.6	0.7	0.7
Strain at failure	%	13.0	17.0	20.0
Failure Type		Plastic	Plastic	Plastic
Corrected deviator stress	kPa	172	201	223
Undrained shear stress	kPa	86	101	112

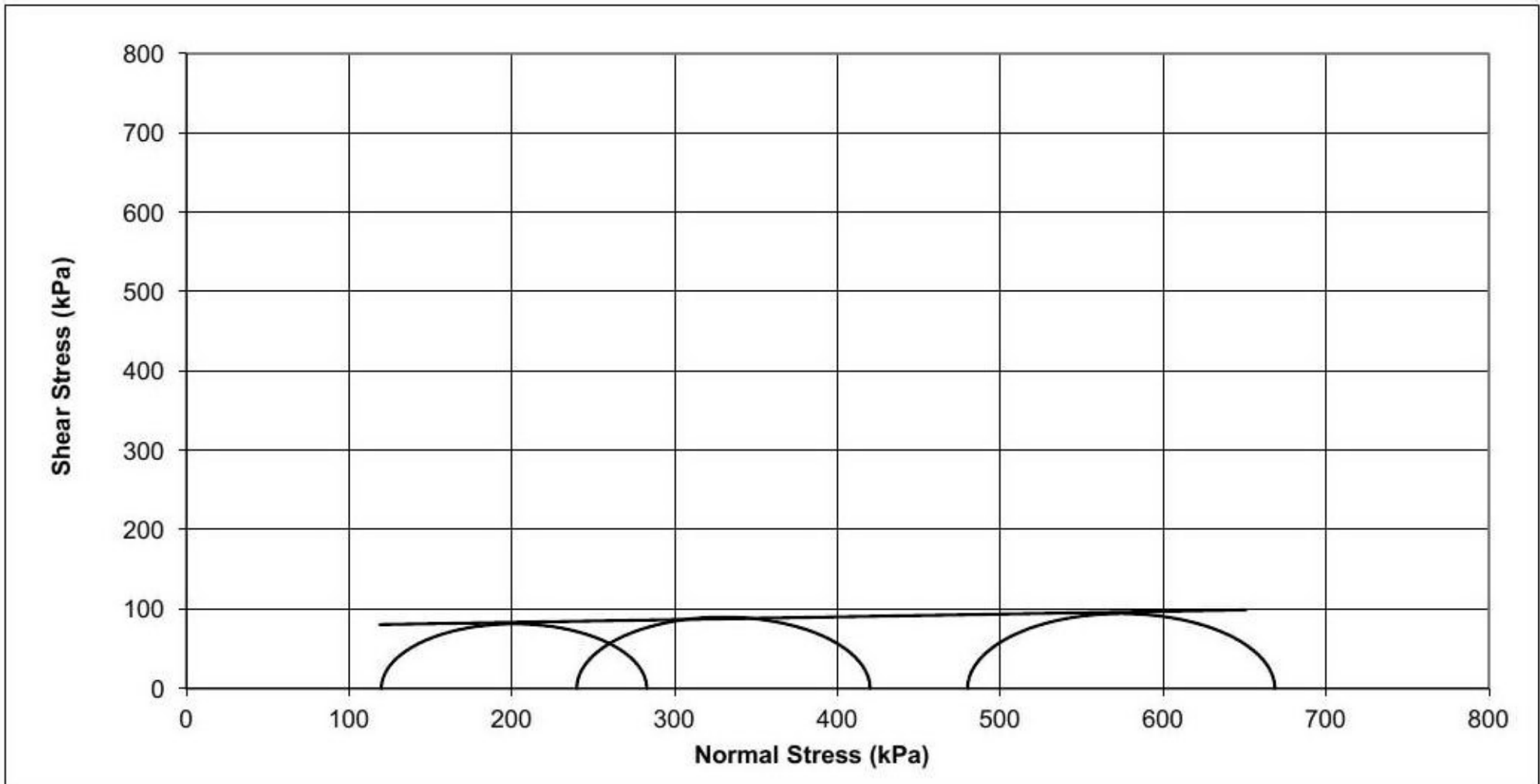
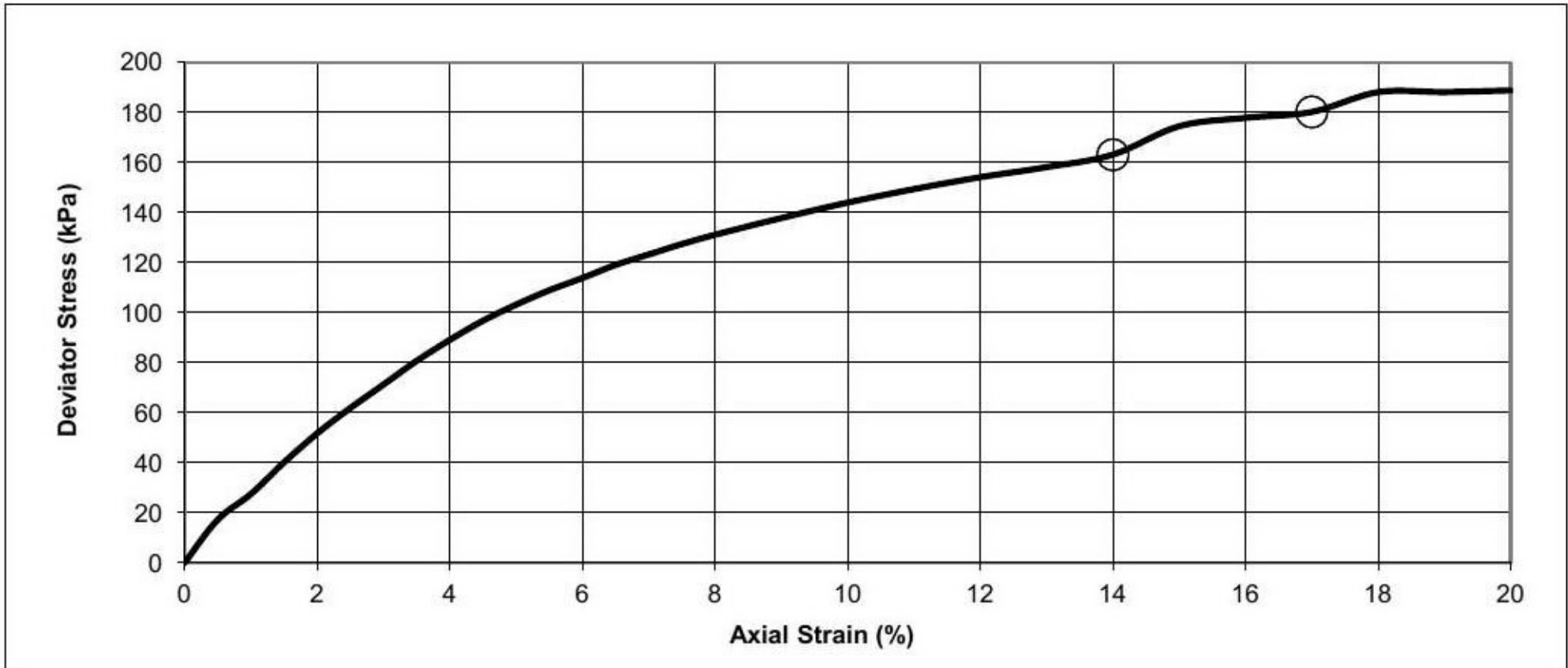
Cohesion	kPa	70.0	Friction Angle	°	7.7
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Initial Conditions					Borehole	BH02	
Sample length	mm	199.79	Rate of strain	%/min			2.0
Sample diameter	mm	99.96	Bulk Density	Mg/m ³			2.12
Membrane type		Latex	Dry Density	Mg/m ³			1.82
Membrane thickness	mm	0.20	Moisture Content	%	16	Depth (m)	5.00-5.45

Undisturbed sample, taken directly from the sample tube and retaining axial orientation

DETERMINATION OF MULTI STAGE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

Tested in accordance with BS 1377 : Part 7 : 9.0 : 1990



Failure Conditions				
Cell pressure	kPa	120	240	480
Membrane correction	kPa	0.6	0.6	0.7
Strain at failure	%	14.0	17.0	20.0
Failure Type		Intermediate	Intermediate	Intermediate
Corrected deviator stress	kPa	163	180	189
Undrained shear stress	kPa	81	90	94

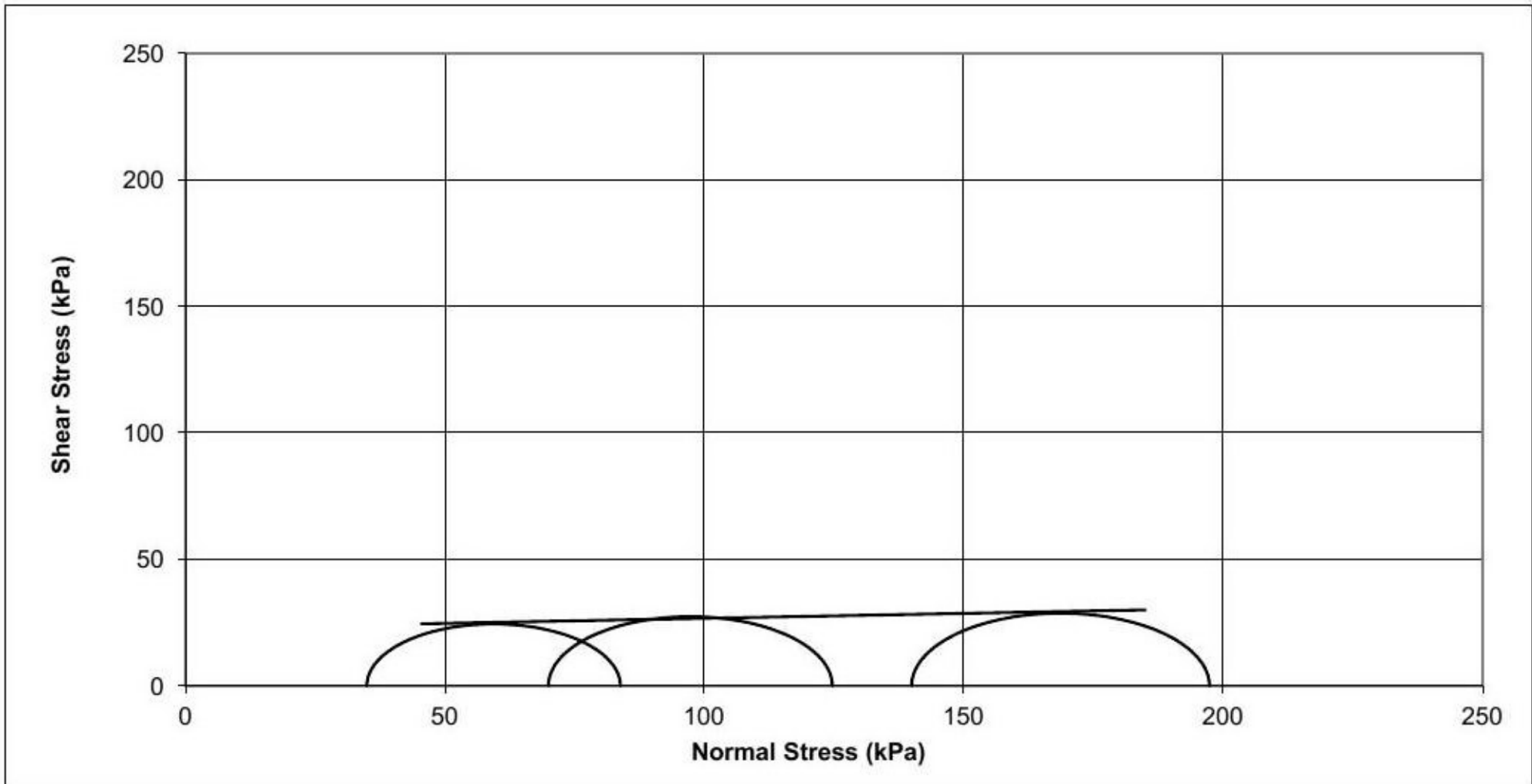
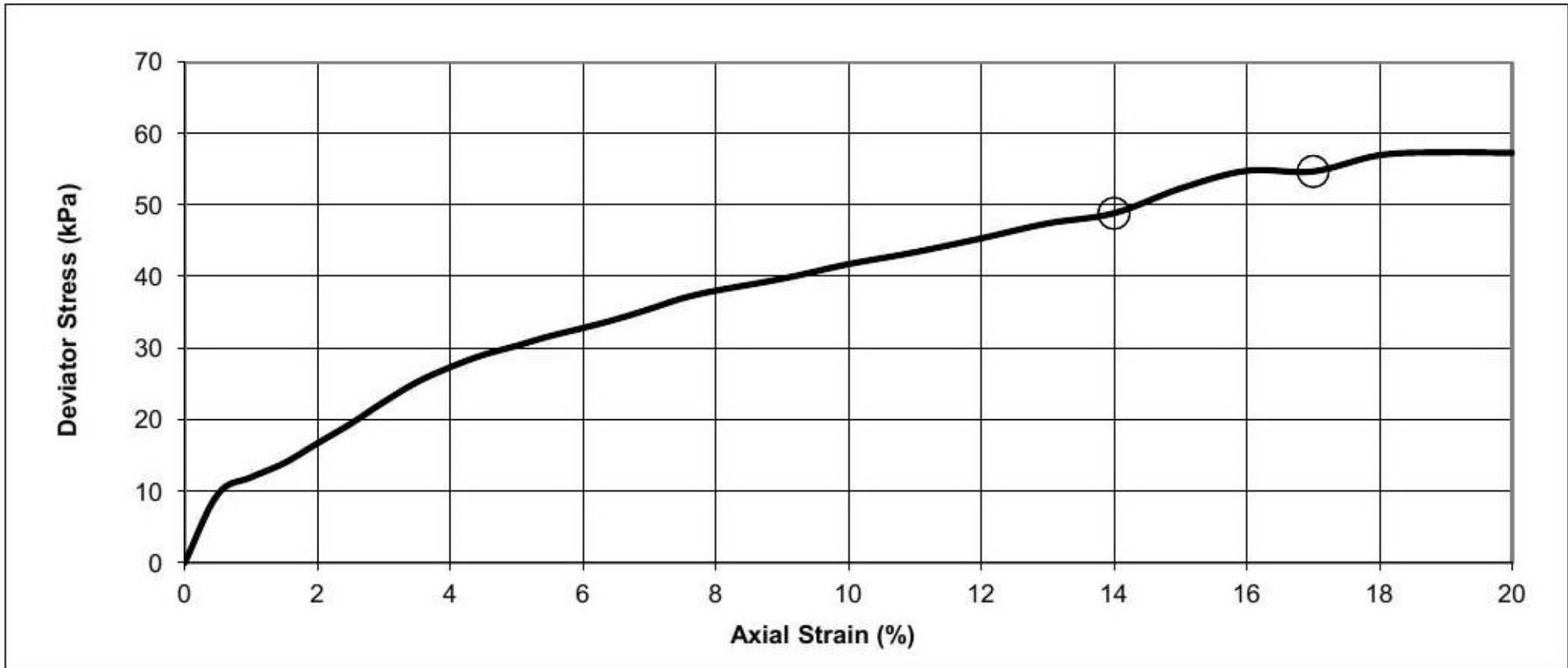
Cohesion	kPa	76.4	Friction Angle	°	2.0
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Initial Conditions							
Sample length	mm	201.23	Rate of strain	%/min	2.0	Borehole	BH03
Sample diameter	mm	104.72	Bulk Density	Mg/m ³	2.14	Sample	U
Membrane type		Latex	Dry Density	Mg/m ³	1.89	Depth (m)	11.50-
Membrane thickness	mm	0.20	Moisture Content	%	13		11.95

Undisturbed sample, taken directly from the sample tube and retaining axial orientation

DETERMINATION OF MULTI STAGE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

Tested in accordance with BS 1377 : Part 7 : 9.0 : 1990



Failure Conditions				
Cell pressure	kPa	35	70	140
Membrane correction	kPa	0.6	0.7	0.7
Strain at failure	%	14.0	17.0	19.0
Failure Type		Plastic	Plastic	Plastic
Corrected deviator stress	kPa	49	55	57
Undrained shear stress	kPa	24	27	29

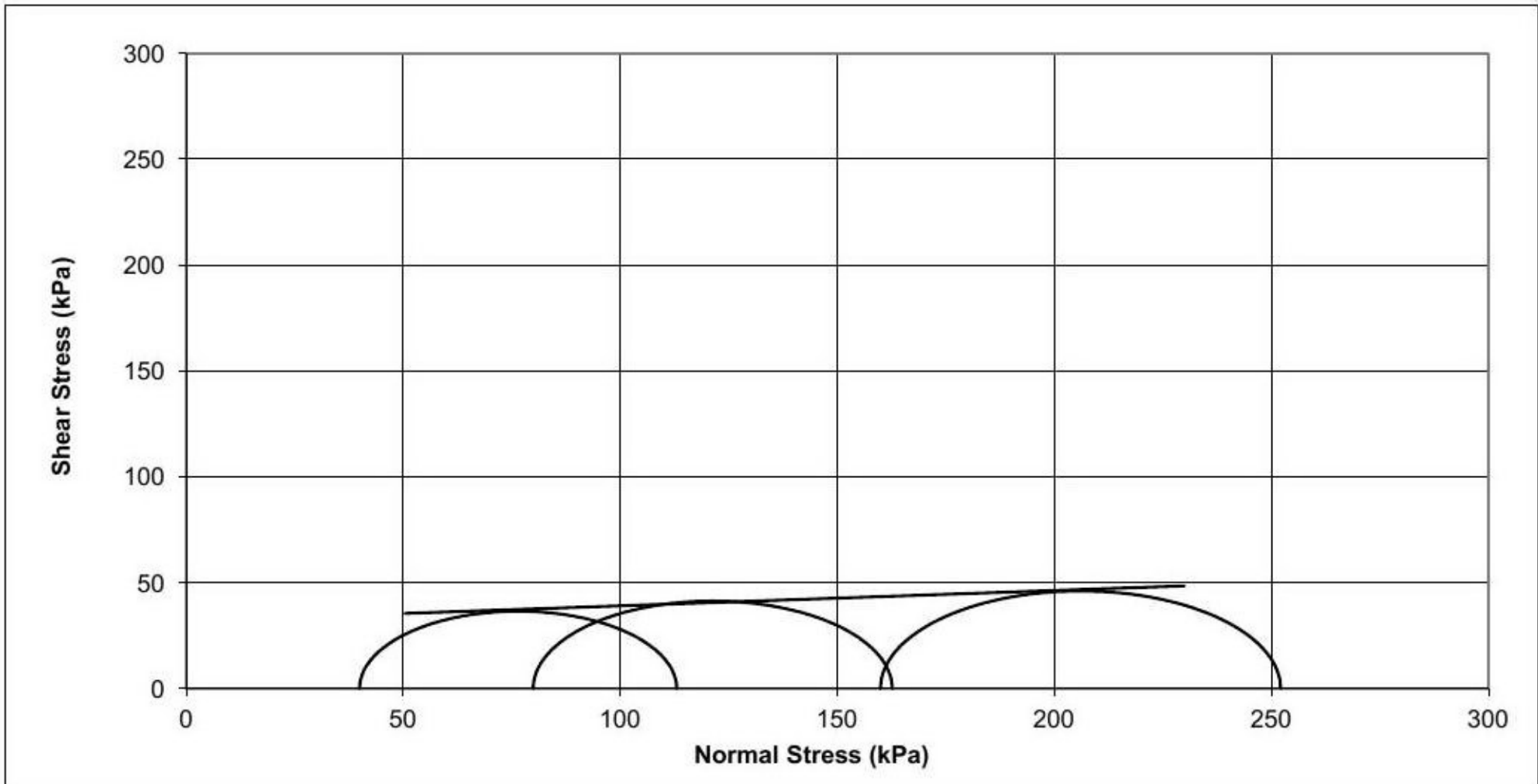
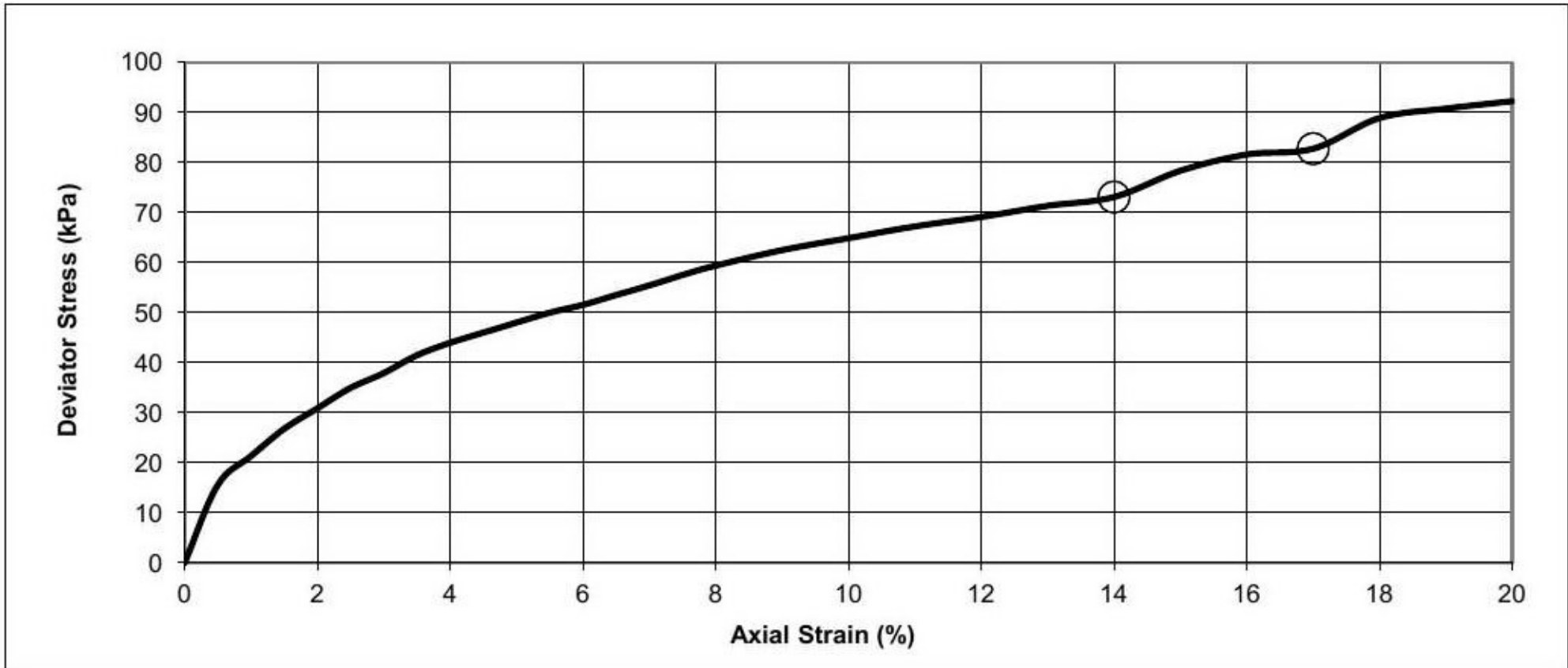
Cohesion	kPa	22.7	Friction Angle	°	2.3
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Initial Conditions					Borehole	
Sample length	mm	202.50	Rate of strain	%/min	1.0	BH04
Sample diameter	mm	100.24	Bulk Density	Mg/m ³	2.25	Sample U
Membrane type		Latex	Dry Density	Mg/m ³	1.96	Depth (m) 3.00-3.45
Membrane thickness	mm	0.20	Moisture Content	%	15	

Undisturbed sample, taken directly from the sample tube and retaining axial orientation

DETERMINATION OF MULTI STAGE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

Tested in accordance with BS 1377 : Part 7 : 9.0 : 1990



Failure Conditions				
Cell pressure	kPa	40	80	160
Membrane correction	kPa	0.6	0.7	0.7
Strain at failure	%	14.0	17.0	20.0
Failure Type		Plastic	Plastic	Plastic
Corrected deviator stress	kPa	73	83	92
Undrained shear stress	kPa	37	41	46

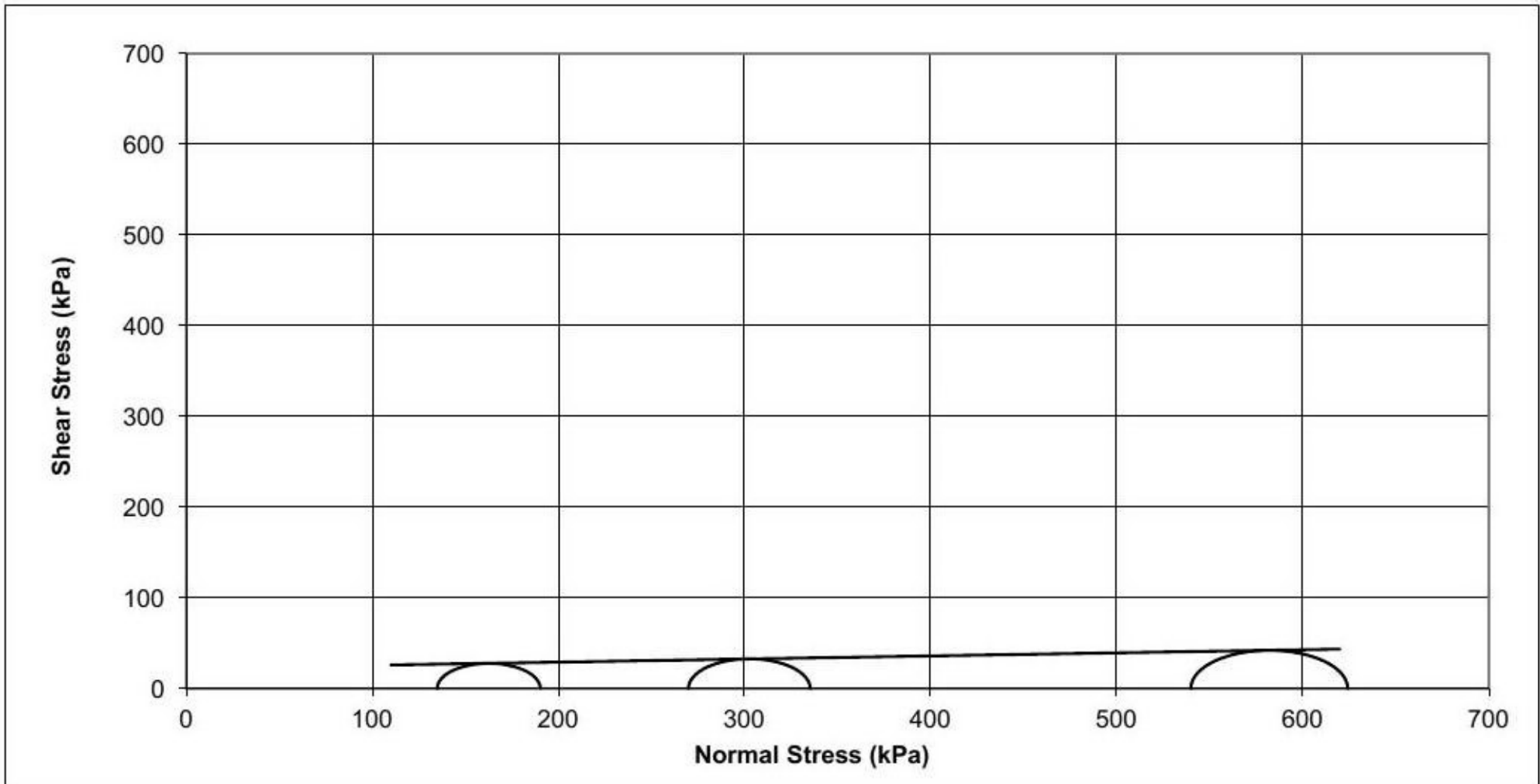
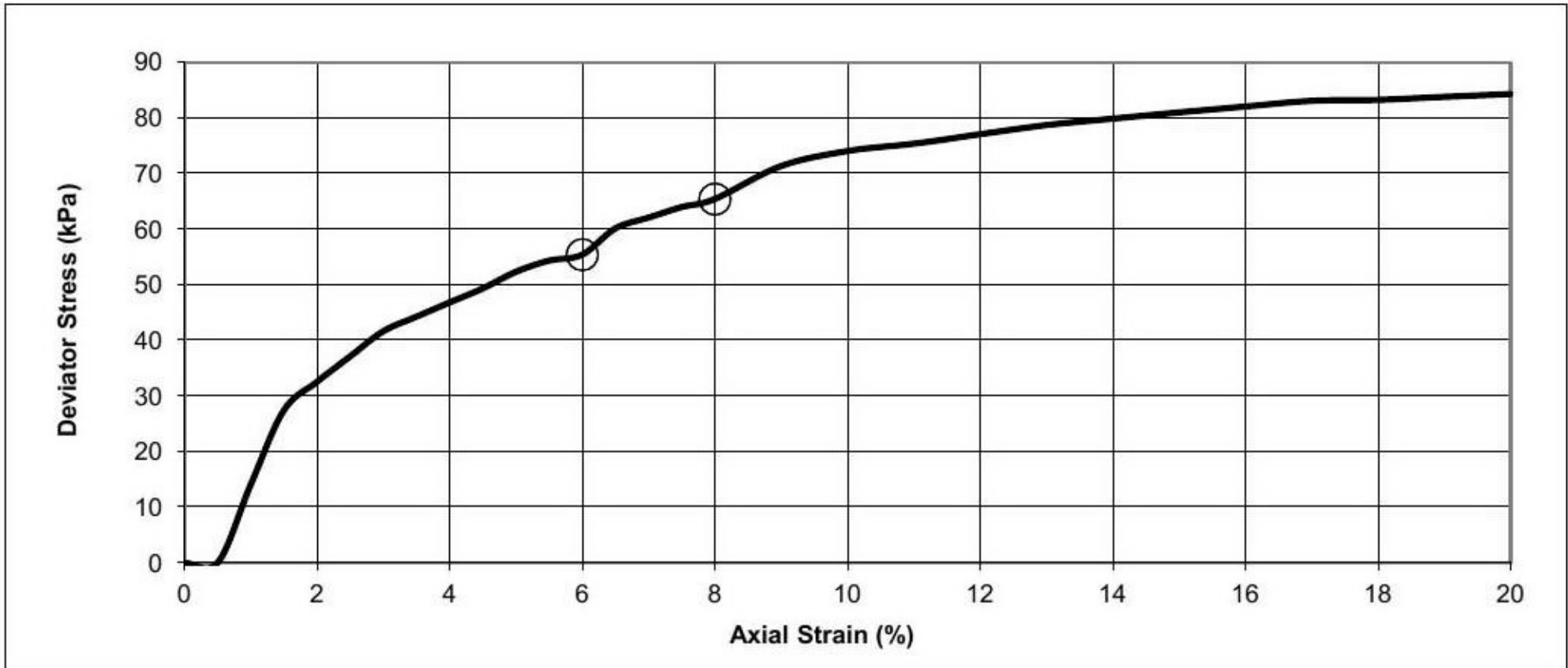
Cohesion	kPa	31.8	Friction Angle	°	4.1
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Initial Conditions					Borehole	
Sample length	mm	203.95	Rate of strain	%/min	2.0	BH05
Sample diameter	mm	102.51	Bulk Density	Mg/m ³	1.96	Sample U
Membrane type		Latex	Dry Density	Mg/m ³	1.73	Depth (m) 4.00-4.45
Membrane thickness	mm	0.20	Moisture Content	%	13	

Undisturbed sample, taken directly from the sample tube and retaining axial orientation

DETERMINATION OF MULTI STAGE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

Tested in accordance with BS 1377 : Part 7 : 9.0 : 1990



Failure Conditions				
Cell pressure	kPa	135	270	540
Membrane correction	kPa	0.3	0.4	0.7
Strain at failure	%	6.0	8.0	20.0
Failure Type		Plastic	Plastic	Plastic
Corrected deviator stress	kPa	55	65	84
Undrained shear stress	kPa	28	33	42

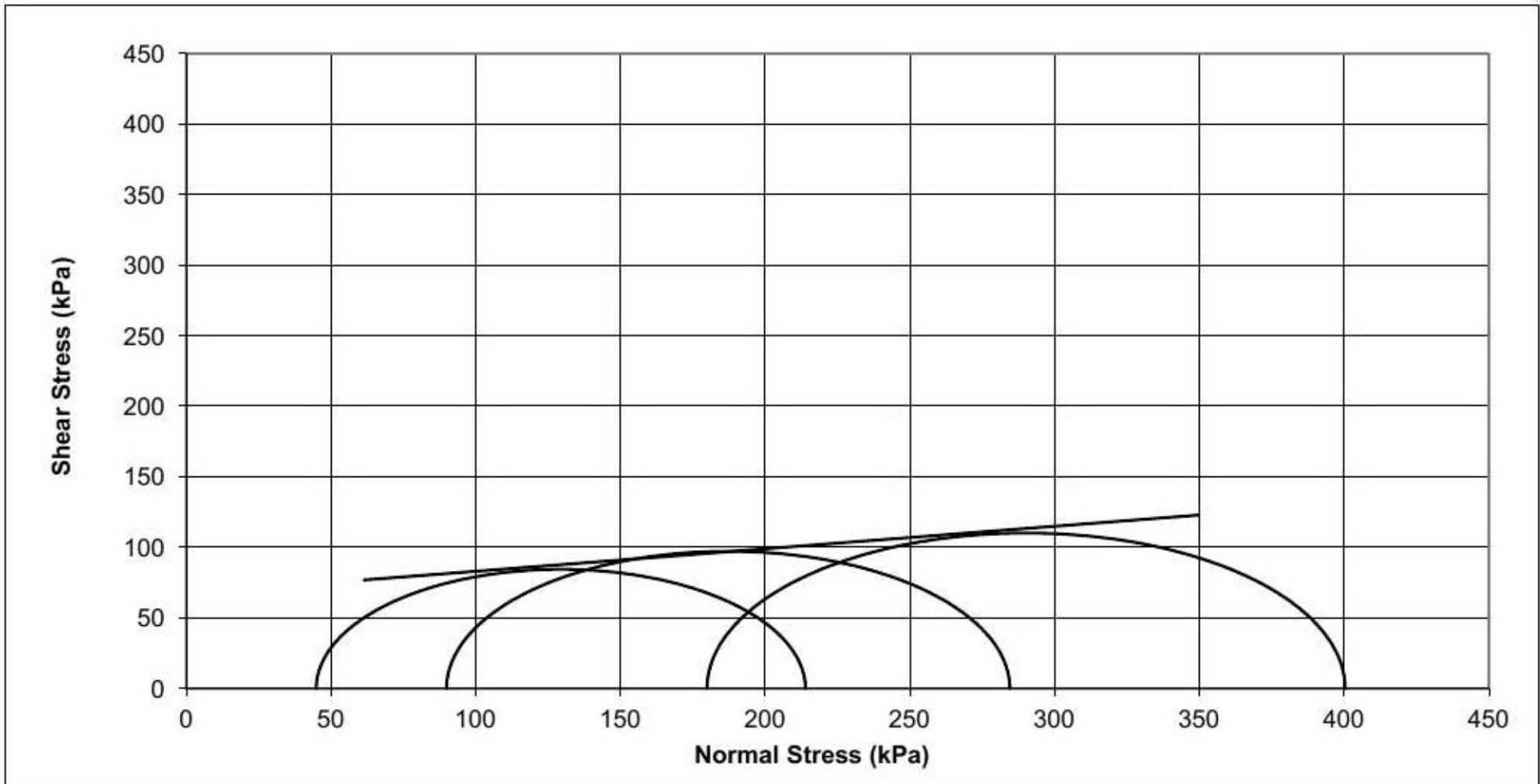
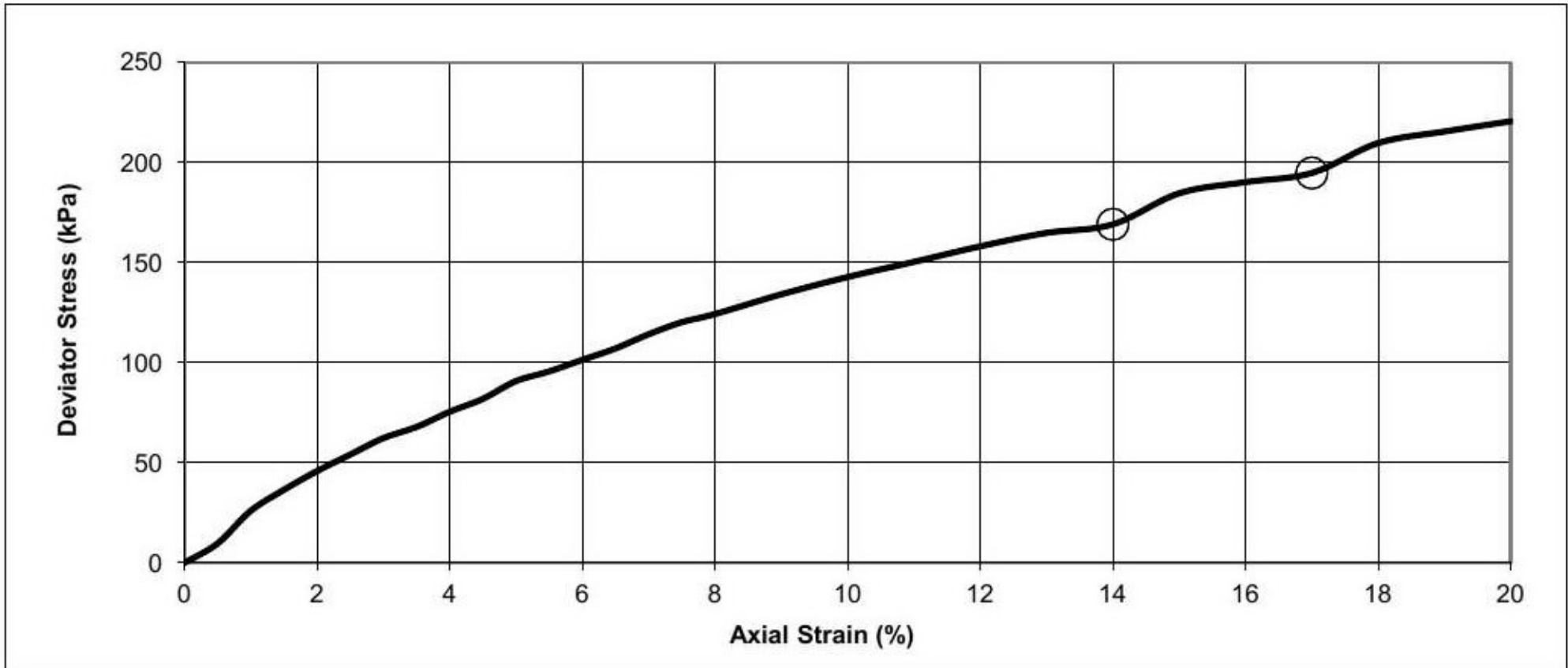
Cohesion	kPa	22.2	Friction Angle	°	2.0
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Initial Conditions							
Sample length	mm	203.04	Rate of strain	%/min	2.0	Borehole	BH05
Sample diameter	mm	102.07	Bulk Density	Mg/m ³	2.18	Sample	U
Membrane type		Latex	Dry Density	Mg/m ³	1.92	Depth (m)	12.60-
Membrane thickness	mm	0.20	Moisture Content	%	13		13.05

Undisturbed sample, taken directly from the sample tube and retaining axial orientation

DETERMINATION OF MULTI STAGE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

Tested in accordance with BS 1377 : Part 7 : 9.0 : 1990



Failure Conditions				
Cell pressure	kPa	45	90	180
Membrane correction	kPa	0.6	0.7	0.8
Strain at failure	%	14.0	17.0	20.0
Failure Type		Plastic	Plastic	Plastic
Corrected deviator stress	kPa	169	195	220
Undrained shear stress	kPa	84	97	110

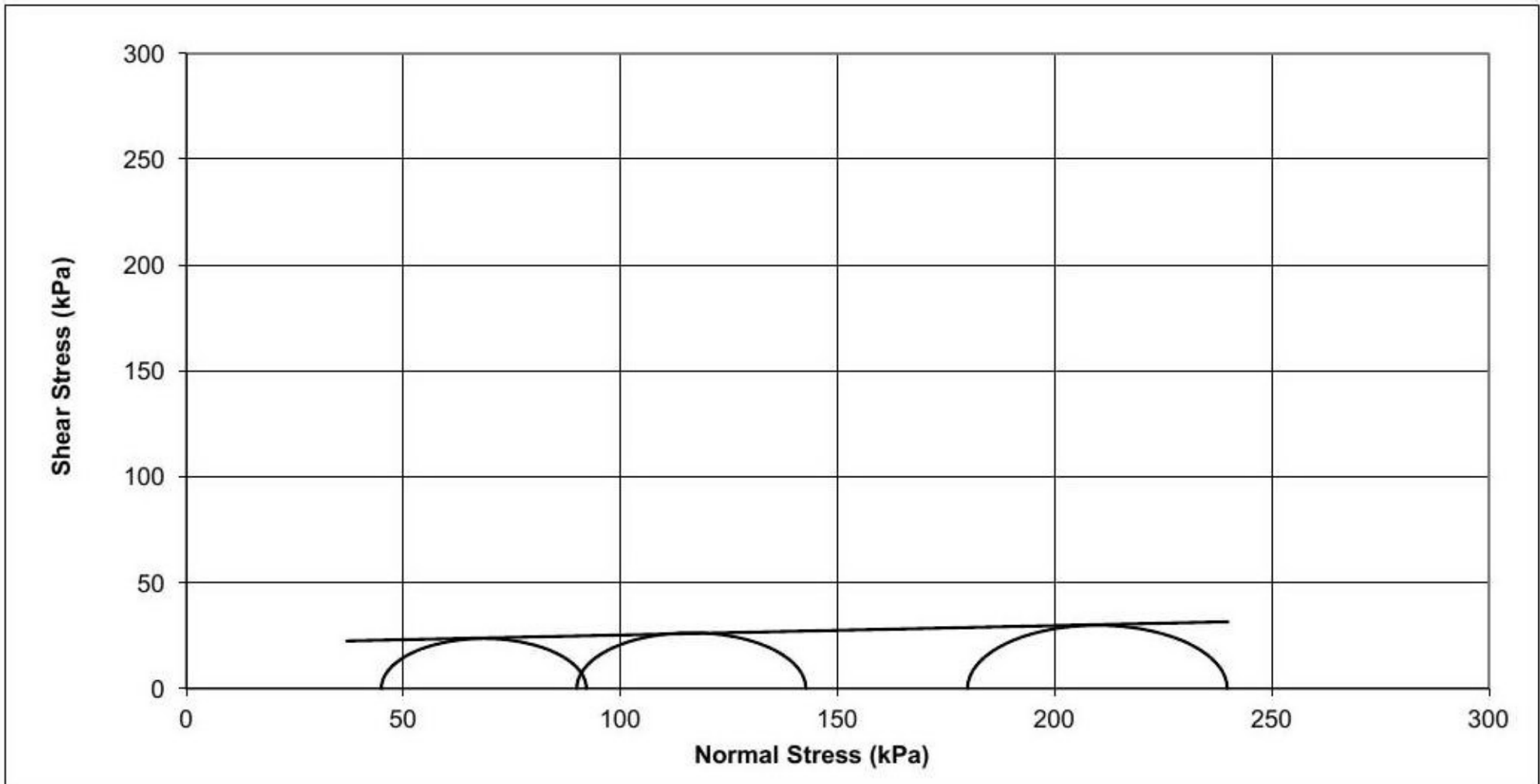
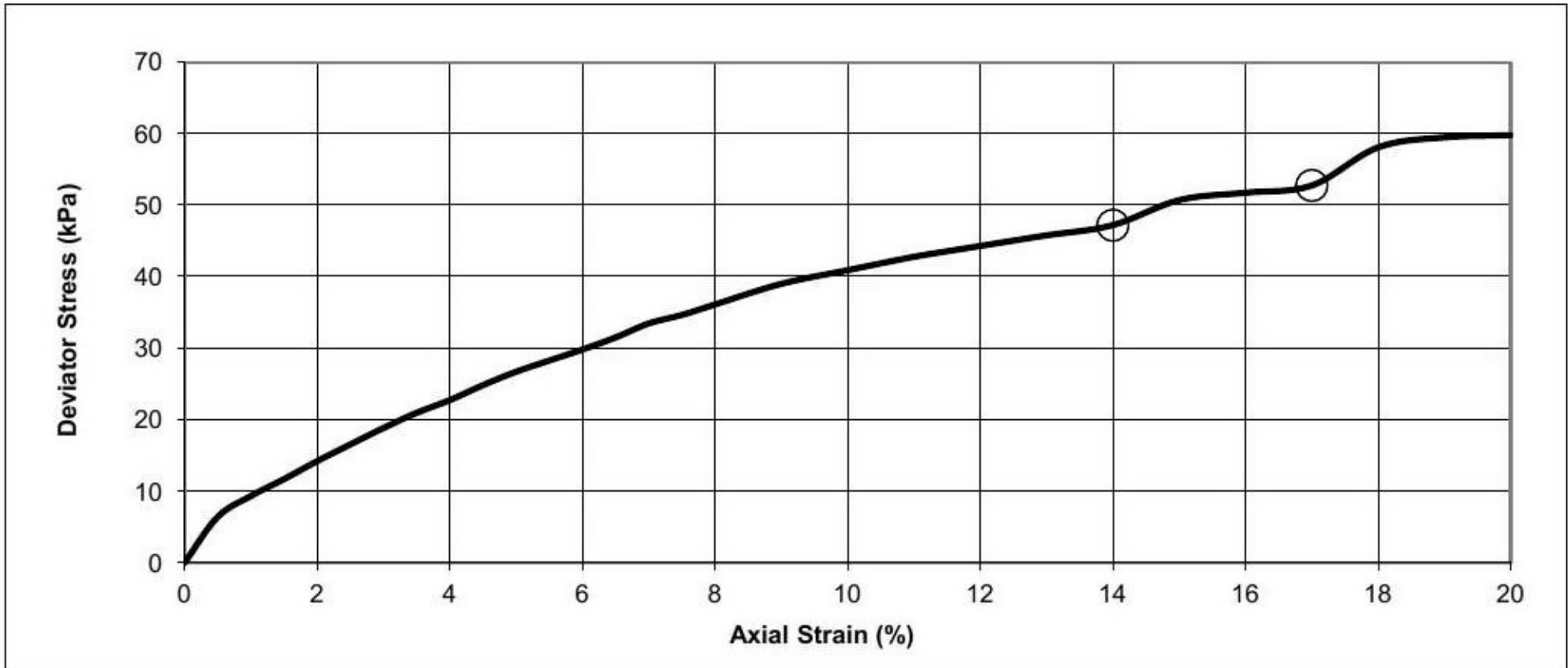
Cohesion	kPa	67.2	Friction Angle	°	9.1
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Initial Conditions					Borehole	BH06	
Sample length	mm	199.49	Rate of strain	%/min			2.0
Sample diameter	mm	99.52	Bulk Density	Mg/m ³			2.22
Membrane type		Latex	Dry Density	Mg/m ³			1.98
Membrane thickness	mm	0.20	Moisture Content	%	12	Depth (m)	4.00-4.45

Undisturbed sample, taken directly from the sample tube and retaining axial orientation

DETERMINATION OF MULTI STAGE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

Tested in accordance with BS 1377 : Part 7 : 9.0 : 1990



Failure Conditions				
Cell pressure	kPa	45	90	180
Membrane correction	kPa	0.7	0.8	0.9
Strain at failure	%	14.0	17.0	20.0
Failure Type		Plastic	Plastic	Plastic
Corrected deviator stress	kPa	47	53	60
Undrained shear stress	kPa	24	26	30

Cohesion	kPa	20.9	Friction Angle	°	2.5
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Initial Conditions					Borehole	BH08	
Sample length	mm	168.82	Rate of strain	%/min			2.0
Sample diameter	mm	83.95	Bulk Density	Mg/m ³			2.22
Membrane type		Latex	Dry Density	Mg/m ³			1.94
Membrane thickness	mm	0.20	Moisture Content	%	15	Depth (m)	3.80

Undisturbed sample, taken directly from the sample tube and retaining axial orientation

DETERMINATION OF MULTI STAGE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

Tested in accordance with BS 1377 : Part 7 : 9.0 : 1990

LABORATORY TEST CERTIFICATE

10 Queenslie Point
Queenslie Industrial Estate
120 Stepps Road
Glasgow
G33 3NQ

Certificate No : 24/256 - 01-1
To : Scott Armstrong
Client : Mason Evans Partnership
1st Floor
100 Brand Street
Glasgow
G51 1DG

Tel: 0141 774 4032

email: info@mattest.org
Website: www.mattest.org

LABORATORY TESTING OF ROCK

Introduction

We refer to samples taken from Scottish Opera and delivered to our laboratory on 27th February 2024.

Material & Source

Sample Reference : See Report Plates
Sampled By : Client
Sampling Certificate : Not Supplied
Location : See Report Plates
Description : Rock Cores
Date Sampled : Not Supplied
Date Tested : 27th February 2024 Onwards
Source : P22/271 - Scottish Opera

Test Results

As Detailed On Page 2 to Page 7 inclusive

Comments

The results contained in this report relate to the sample(s) as received
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
All remaining samples for this project will be disposed of 28 days after issue of this test certificate

Remarks

Approved for Issue

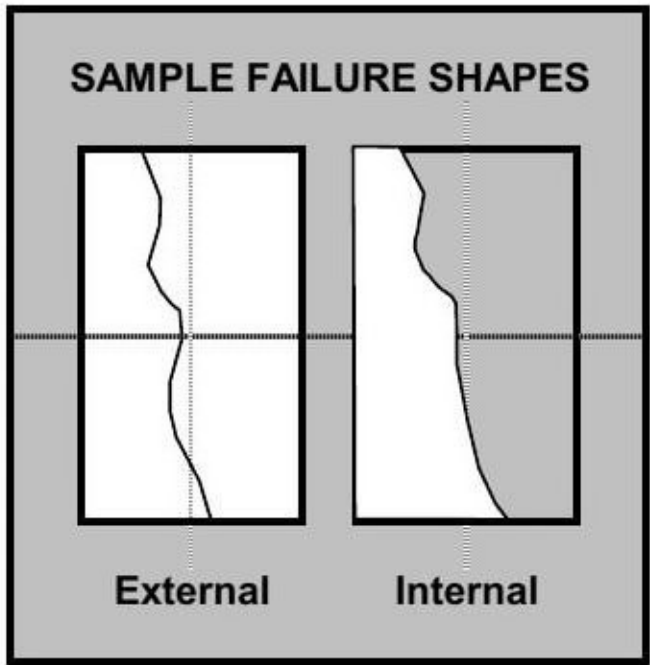


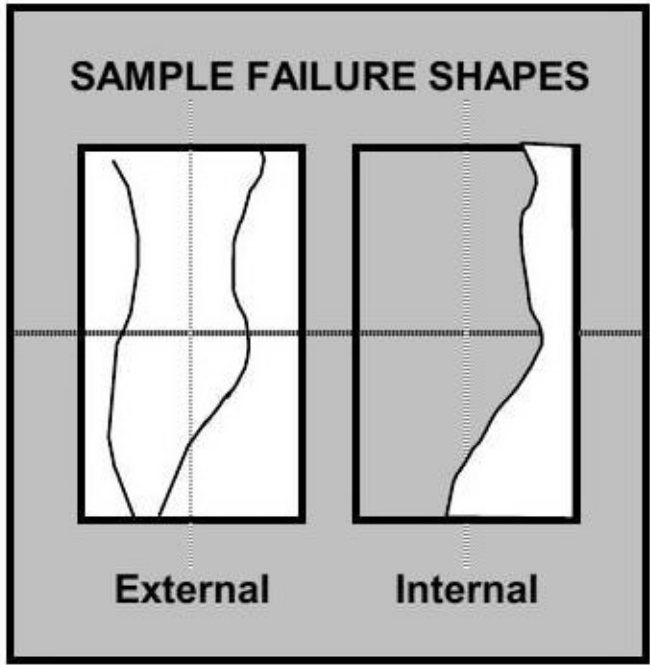
T McLelland (Director)

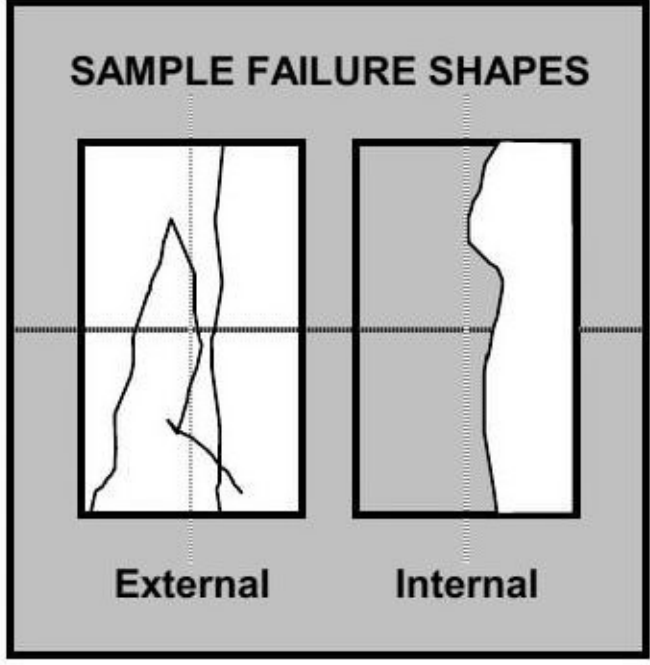
Date 05/03/2024



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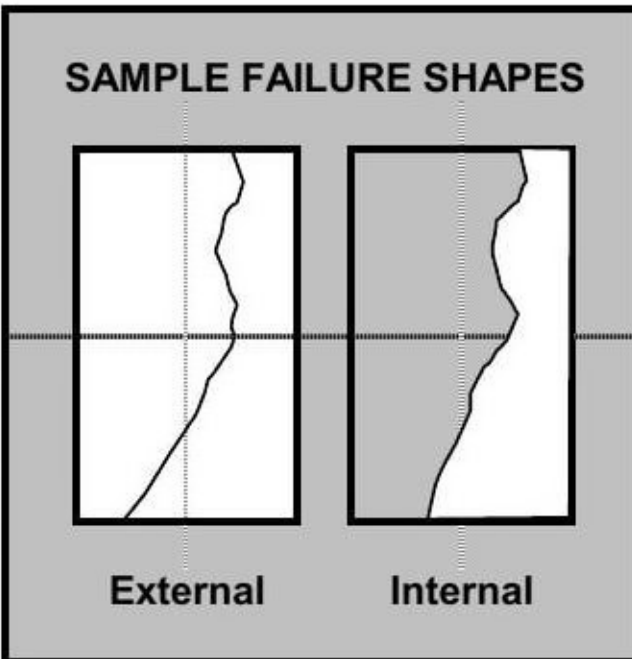
BOREHOLE		R01	
SAMPLE		C	
DEPTH	m	8.00	
SAMPLE DIAMETER	mm	71.44	
SAMPLE HEIGHT	mm	146.43	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	4.06	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	100.8	
UNCONFINED COMPRESSIVE STRENGTH	MPa	25.1	
WATER CONTENT (ISRM Suggested Methods)	%	1.8	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.35	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.30	

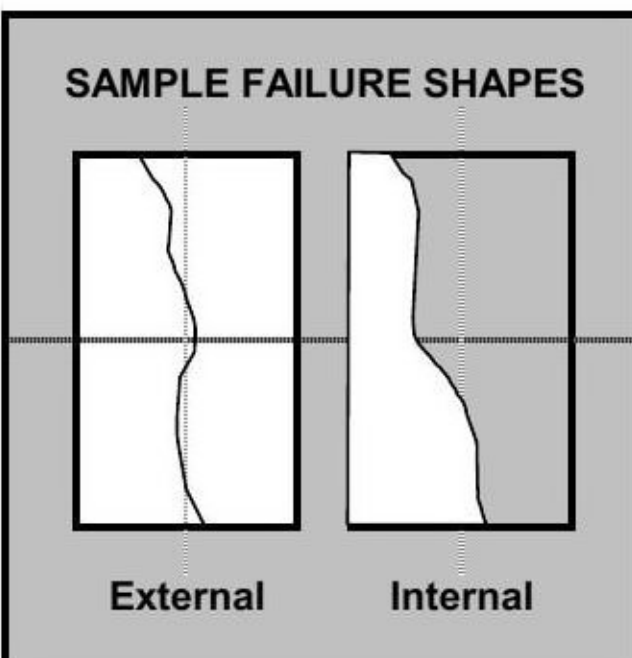
BOREHOLE		R01	
SAMPLE		C	
DEPTH	m	13.50	
SAMPLE DIAMETER	mm	71.23	
SAMPLE HEIGHT	mm	148.92	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.3	
TEST DURATION	min.sec	2.01	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	35.4	
UNCONFINED COMPRESSIVE STRENGTH	MPa	8.9	
WATER CONTENT (ISRM Suggested Methods)	%	1.7	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.52	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.48	

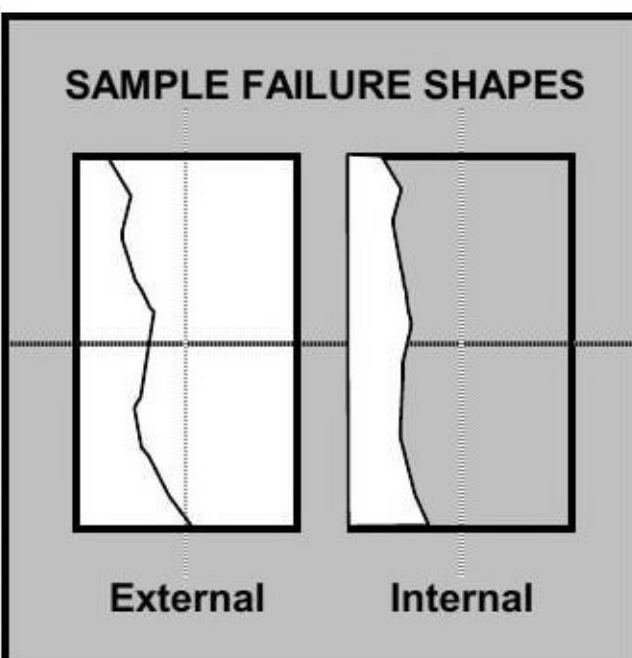
BOREHOLE		R01	
SAMPLE		C	
DEPTH	m	16.40	
SAMPLE DIAMETER	mm	71.41	
SAMPLE HEIGHT	mm	144.80	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	6.44	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	165.9	
UNCONFINED COMPRESSIVE STRENGTH	MPa	41.4	
WATER CONTENT (ISRM Suggested Methods)	%	1.2	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.37	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.34	

Tested in accordance with ASTM D7012 - 23

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

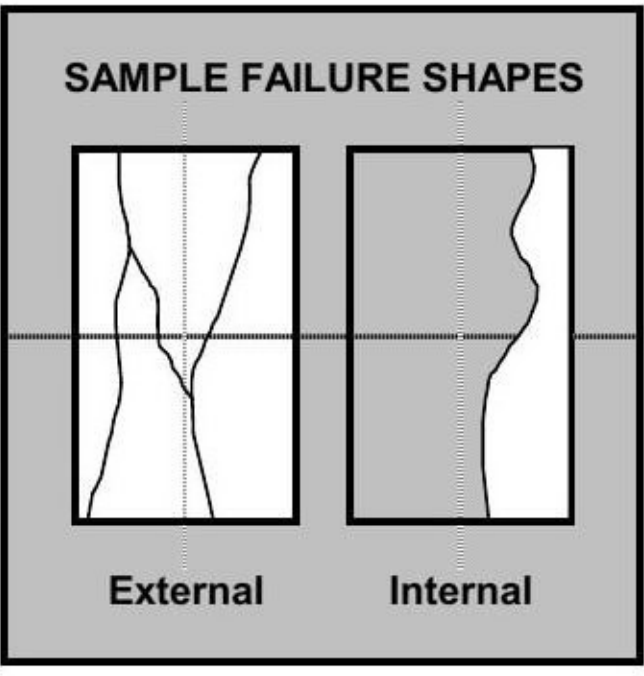
BOREHOLE		R02	SAMPLE FAILURE SHAPES 
SAMPLE		C	
DEPTH	m	12.20	
SAMPLE DIAMETER	mm	71.84	
SAMPLE HEIGHT	mm	147.23	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	2.03	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	47.3	
UNCONFINED COMPRESSIVE STRENGTH	MPa	11.7	
WATER CONTENT (ISRM Suggested Methods)	%	4.0	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.36	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.27	

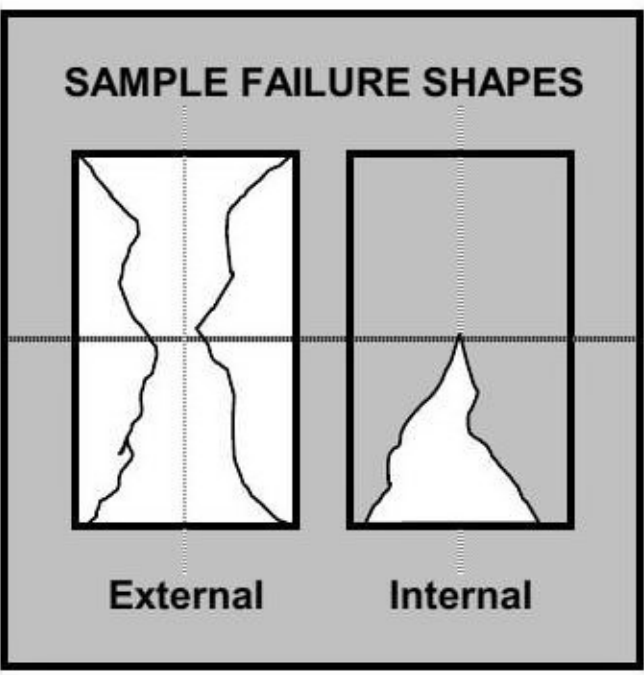
BOREHOLE		R02	SAMPLE FAILURE SHAPES 
SAMPLE		C	
DEPTH	m	15.60	
SAMPLE DIAMETER	mm	71.80	
SAMPLE HEIGHT	mm	145.21	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	4.15	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	102.4	
UNCONFINED COMPRESSIVE STRENGTH	MPa	25.3	
WATER CONTENT (ISRM Suggested Methods)	%	5.9	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.48	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.34	

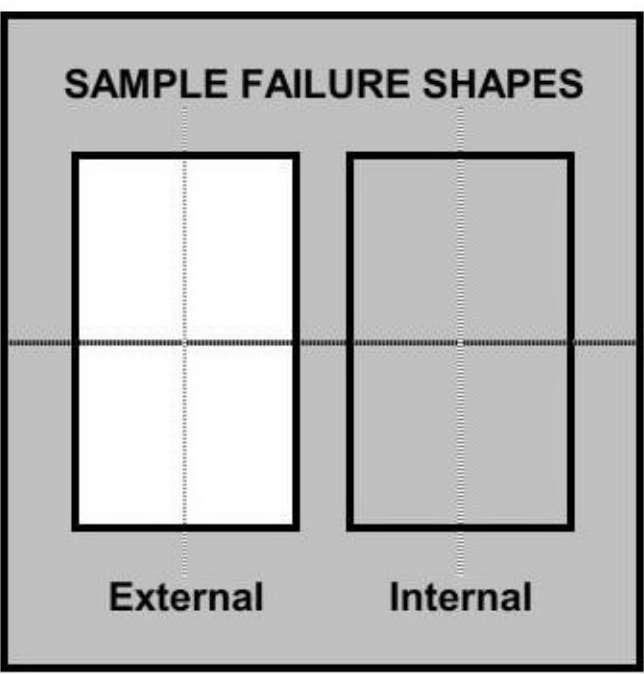
BOREHOLE		R02	SAMPLE FAILURE SHAPES 
SAMPLE		C	
DEPTH	m	20.00	
SAMPLE DIAMETER	mm	71.86	
SAMPLE HEIGHT	mm	147.39	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	3.20	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	82.7	
UNCONFINED COMPRESSIVE STRENGTH	MPa	20.4	
WATER CONTENT (ISRM Suggested Methods)	%	2.2	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.56	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.50	

Tested in accordance with ASTM D7012 - 23

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

BOREHOLE		R03	<p>SAMPLE FAILURE SHAPES</p>  <p>External Internal</p>
SAMPLE		C	
DEPTH	m	15.50	
SAMPLE DIAMETER	mm	72.21	
SAMPLE HEIGHT	mm	146.74	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	4.10	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	104.9	
UNCONFINED COMPRESSIVE STRENGTH	MPa	25.6	
WATER CONTENT (ISRM Suggested Methods)	%	7.3	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.34	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.18	

BOREHOLE		R03	<p>SAMPLE FAILURE SHAPES</p>  <p>External Internal</p>
SAMPLE		C	
DEPTH	m	22.25	
SAMPLE DIAMETER	mm	72.44	
SAMPLE HEIGHT	mm	145.85	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	3.10	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	80.1	
UNCONFINED COMPRESSIVE STRENGTH	MPa	19.4	
WATER CONTENT (ISRM Suggested Methods)	%	7.4	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.36	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.19	

BOREHOLE			<p>SAMPLE FAILURE SHAPES</p>  <p>External Internal</p>
SAMPLE			
DEPTH	m		
SAMPLE DIAMETER	mm		
SAMPLE HEIGHT	mm		
TEST CONDITION			
RATE OF LOADING	kN/s		
TEST DURATION	min.sec		
DATE OF TESTING			
LOAD FRAME USED			
LOAD DIRECTION WITH RESPECT TO LITHOLOGY			
FAILURE LOAD	kN		
UNCONFINED COMPRESSIVE STRENGTH	MPa		
WATER CONTENT (ISRM Suggested Methods)	%		
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³		
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³		

Tested in accordance with ASTM D7012 - 23

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

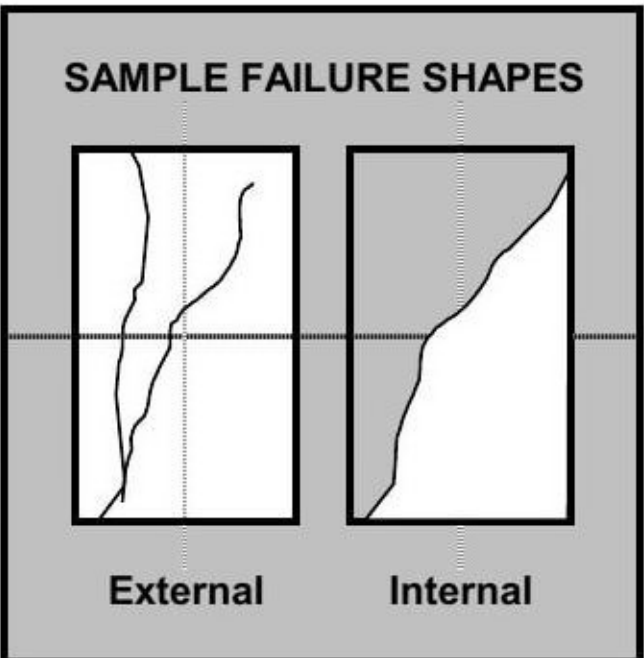
BOREHOLE		R04	<p>SAMPLE FAILURE SHAPES</p> <p>External Internal</p>
SAMPLE		C	
DEPTH	m	16.30	
SAMPLE DIAMETER	mm	71.87	
SAMPLE HEIGHT	mm	143.51	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.5	
TEST DURATION	min.sec	4.25	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	114.9	
UNCONFINED COMPRESSIVE STRENGTH	MPa	28.3	
WATER CONTENT (ISRM Suggested Methods)	%	8.3	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.25	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.08	

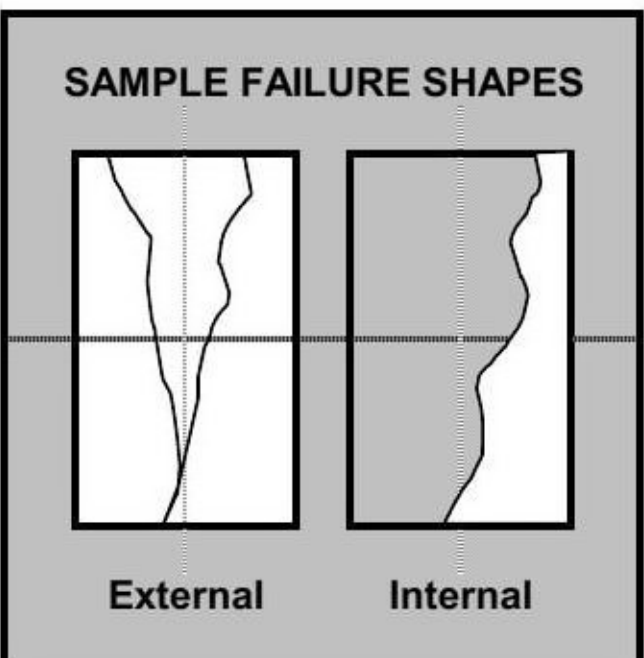
BOREHOLE		R04	<p>SAMPLE FAILURE SHAPES</p> <p>External Internal</p>
SAMPLE		C	
DEPTH	m	19.90	
SAMPLE DIAMETER	mm	71.87	
SAMPLE HEIGHT	mm	144.07	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	4.02	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	105.2	
UNCONFINED COMPRESSIVE STRENGTH	MPa	25.9	
WATER CONTENT (ISRM Suggested Methods)	%	8.2	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.26	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.09	

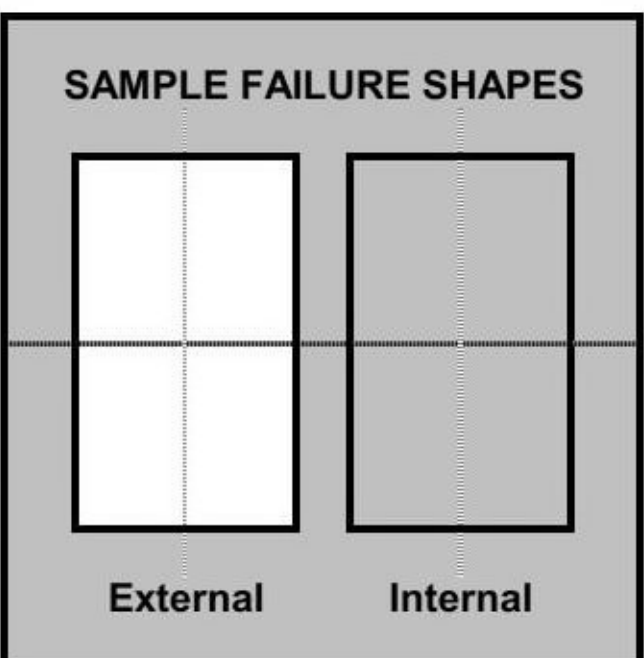
BOREHOLE			<p>SAMPLE FAILURE SHAPES</p> <p>External Internal</p>
SAMPLE			
DEPTH	m		
SAMPLE DIAMETER	mm		
SAMPLE HEIGHT	mm		
TEST CONDITION			
RATE OF LOADING	kN/s		
TEST DURATION	min.sec		
DATE OF TESTING			
LOAD FRAME USED			
LOAD DIRECTION WITH RESPECT TO LITHOLOGY			
FAILURE LOAD	kN		
UNCONFINED COMPRESSIVE STRENGTH	MPa		
WATER CONTENT (ISRM Suggested Methods)	%		
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³		
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³		

Tested in accordance with ASTM D7012 - 23

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

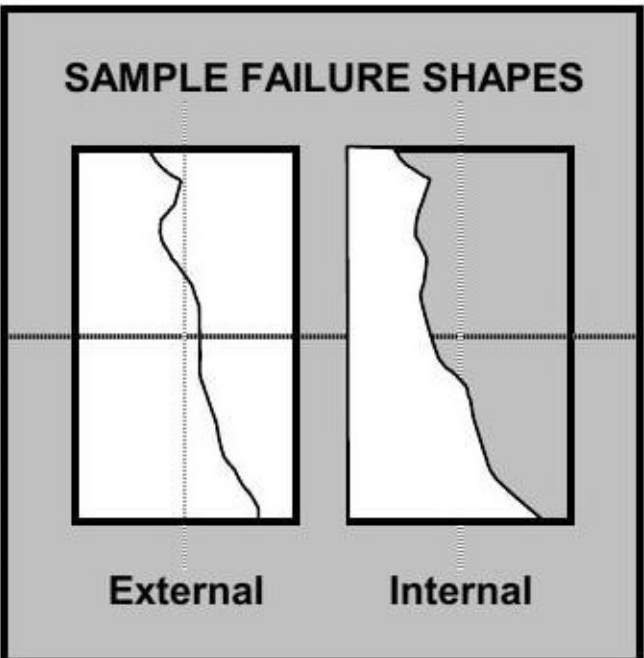
BOREHOLE		R05	<p style="text-align: center;">SAMPLE FAILURE SHAPES</p>  <p style="text-align: center;">External Internal</p>
SAMPLE		C	
DEPTH	m	17.60	
SAMPLE DIAMETER	mm	70.61	
SAMPLE HEIGHT	mm	146.53	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	4.03	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	100.6	
UNCONFINED COMPRESSIVE STRENGTH	MPa	25.7	
WATER CONTENT (ISRM Suggested Methods)	%	0.5	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.15	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.14	

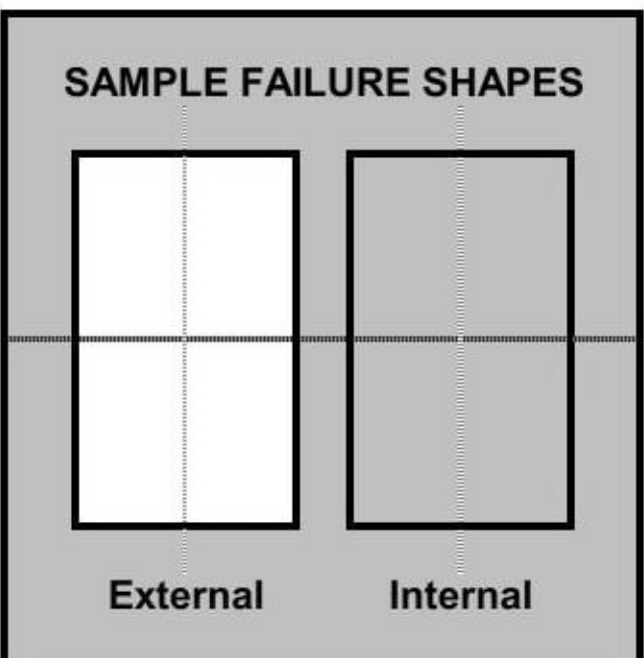
BOREHOLE		R05	<p style="text-align: center;">SAMPLE FAILURE SHAPES</p>  <p style="text-align: center;">External Internal</p>
SAMPLE		C	
DEPTH	m	21.50	
SAMPLE DIAMETER	mm	71.04	
SAMPLE HEIGHT	mm	146.60	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.4	
TEST DURATION	min.sec	5.35	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	141.0	
UNCONFINED COMPRESSIVE STRENGTH	MPa	35.6	
WATER CONTENT (ISRM Suggested Methods)	%	7.0	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.27	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.12	

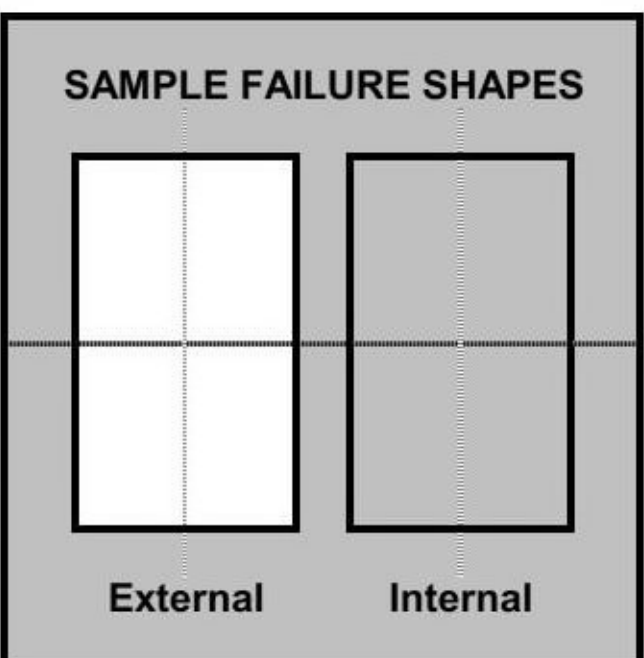
BOREHOLE			<p style="text-align: center;">SAMPLE FAILURE SHAPES</p>  <p style="text-align: center;">External Internal</p>
SAMPLE			
DEPTH	m		
SAMPLE DIAMETER	mm		
SAMPLE HEIGHT	mm		
TEST CONDITION			
RATE OF LOADING	kN/s		
TEST DURATION	min.sec		
DATE OF TESTING			
LOAD FRAME USED			
LOAD DIRECTION WITH RESPECT TO LITHOLOGY			
FAILURE LOAD	kN		
UNCONFINED COMPRESSIVE STRENGTH	MPa		
WATER CONTENT (ISRM Suggested Methods)	%		
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³		
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³		

Tested in accordance with ASTM D7012 - 23

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

BOREHOLE		R06	SAMPLE FAILURE SHAPES 
SAMPLE		C	
DEPTH	m	12.00	
SAMPLE DIAMETER	mm	71.41	
SAMPLE HEIGHT	mm	146.83	
TEST CONDITION		As Received	
RATE OF LOADING	kN/s	0.5	
TEST DURATION	min.sec	3.55	
DATE OF TESTING		04/03/2024	
LOAD FRAME USED		2000kN	
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown	
FAILURE LOAD	kN	106.1	
UNCONFINED COMPRESSIVE STRENGTH	MPa	26.5	
WATER CONTENT (ISRM Suggested Methods)	%	5.3	
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³	2.43	
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³	2.30	

BOREHOLE			SAMPLE FAILURE SHAPES 
SAMPLE			
DEPTH	m		
SAMPLE DIAMETER	mm		
SAMPLE HEIGHT	mm		
TEST CONDITION			
RATE OF LOADING	kN/s		
TEST DURATION	min.sec		
DATE OF TESTING			
LOAD FRAME USED			
LOAD DIRECTION WITH RESPECT TO LITHOLOGY			
FAILURE LOAD	kN		
UNCONFINED COMPRESSIVE STRENGTH	MPa		
WATER CONTENT (ISRM Suggested Methods)	%		
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³		
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³		

BOREHOLE			SAMPLE FAILURE SHAPES 
SAMPLE			
DEPTH	m		
SAMPLE DIAMETER	mm		
SAMPLE HEIGHT	mm		
TEST CONDITION			
RATE OF LOADING	kN/s		
TEST DURATION	min.sec		
DATE OF TESTING			
LOAD FRAME USED			
LOAD DIRECTION WITH RESPECT TO LITHOLOGY			
FAILURE LOAD	kN		
UNCONFINED COMPRESSIVE STRENGTH	MPa		
WATER CONTENT (ISRM Suggested Methods)	%		
BULK DENSITY (ISRM Suggested Methods)	Mg/m ³		
DRY DENSITY (ISRM Suggested Methods)	Mg/m ³		

Tested in accordance with ASTM D7012 - 23

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

Appendix 09

Groundwater Modelling Results

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Acenaphthene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	1.30E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	2.04E+02	days	Howard et al
Calculated decay rate λ	3.40E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	2.17E-01	l/kg	see options
Longitudinal dispersivity ax	2.50E+01	m	see options
Transverse dispersivity az	2.50E+00	m	see options
Vertical dispersivity av	2.50E-01	m	see options

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	2.17E+02	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	2.17E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Variable	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity ax	2.50E+01	2.50E+01	6.99E-01	m
Transverse dispersivity az	2.50E+00	2.50E+00	6.99E-01	m
Vertical dispersivity ay	2.50E-01	2.50E-01	6.99E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed

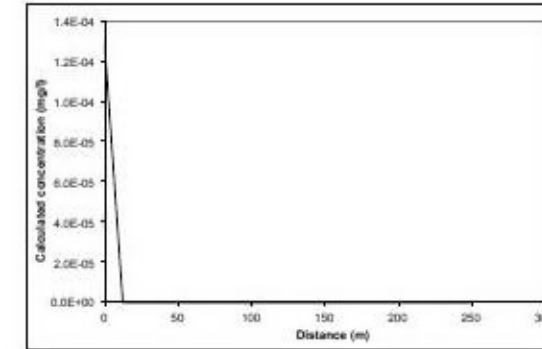
Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rf	1.92E+00	fraction
Decay rate used λ	1.77E-03	d ⁻¹
Rate of contaminant flow due to retardation u	9.02E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	No impact	mg/l	For comparison with measured groundwater concentration,
Domenico - Steady state			
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.30E-04
12.5	0.00E+00
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used.

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	assess
Version:	3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Acenaphthylene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	C ₀ 3.80E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water	t _{1/2} 1.20E+02	days	Howard et al
Calculated decay rate	λ 5.78E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 1.75E+02	m	Width of site
Plume thickness at source	Sy 7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness	da 1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials	ρ 2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer	n 5.00E-01	fraction	Freeze and Cherry (1979) Table 2.4
Hydraulic gradient	i 1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer	K 8.84E-06	m/d	Freeze and Cherry (1979) Table 2.2
Distance (lateral) to compliance point perpendicular to flow direction	x 2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (depth) to compliance point perpendicular to flow direction	z	m	
Time since pollutant entered groundwater	t 1.00E+100	days	time variant options only
Partition coefficient	Kd 4.61E-02	l/kg	see options
Longitudinal dispersivity	ax 2.50E+01	m	see options
Transverse dispersivity	az 2.50E+00	m	see options
Vertical dispersivity	ay 2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 1.73E-06	m/d
Retardation factor	RF 1.19E+00	fraction
Decay rate used	λ 4.84E-03	d ⁻¹
Rate of contaminant flow due to retardation	u 1.45E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C ₀₀ 0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{ED})	AF	breakthrough at compliance point

Remedial Targets

Remedial Target	Value	Unit	Notes
Remedial Target	No impact	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	250	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀ 0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

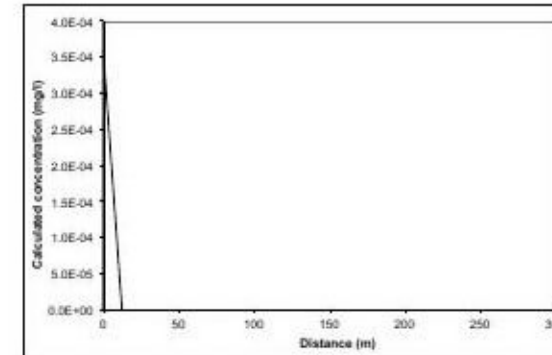
Soil water partition coefficient	Kd	l/kg	
Fraction of organic carbon in aquifer	foc	fraction	1.00E-03
Organic carbon partition coefficient	Koc	l/kg	4.61E+01
Soil water partition coefficient	Kd	l/kg	4.61E-02

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity	ax	2.50E+01	6.88E+00	m
Transverse dispersivity	az	2.50E+00	5.39E-01	m
Vertical dispersivity	ay	2.50E-01	5.39E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.14}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	3.6E-04
12.5	0.00E+00
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used.

Site being assessed:	Rotterdam Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	#####
Version:	3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Anthracene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	1.00E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	9.20E+02	days	Howard et al
Calculated decay rate λ	7.54E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	3.17E-01	l/kg	see options
Longitudinal dispersivity ax	2.50E+01	m	see options
Transverse dispersivity az	2.50E+00	m	see options
Vertical dispersivity av	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rf	2.34E+00	fraction
Decay rate used λ	3.22E-04	d ⁻¹
Rate of contaminant flow due to retardation u	7.39E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	No impact	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

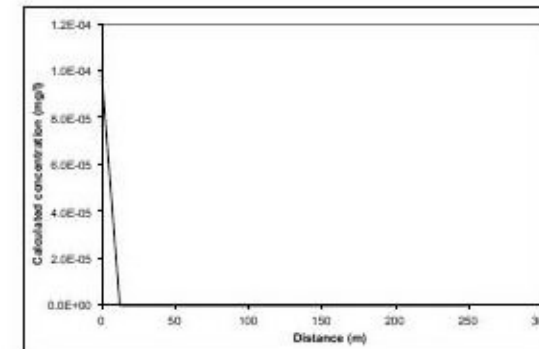
Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	3.17E+02	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	3.17E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity ax	2.50E+00	2.50E+01	0.00E+00	m
Transverse dispersivity az	2.50E+00	2.50E+00	0.00E-01	m
Vertical dispersivity ay	2.50E-01	2.50E-01	0.00E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	05/03/2024
Version:	3.2

Calculated concentrations for distance-concentration graph

Domenico - Steady state

Distance	Concentration
0	1.0E-04
12.5	2.33E-231
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Benzo(a)anthracene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	1.10E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	1.36E+03	days	Howard et al
Calculated decay rate λ	5.09E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	1.48E+00	l/kg	see options
Longitudinal dispersivity α _x	2.50E+01	m	see options
Transverse dispersivity α _z	2.50E+00	m	see options
Vertical dispersivity α _y	2.50E-01	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rf	7.25E+00	fraction
Decay rate used λ	7.03E-05	d ⁻¹
Rate of contaminant flow due to retardation u	2.38E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	No impact	mg/l	For comparison with measured groundwater concentration,
Domenico - Steady state			
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 1.48E+00 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} 1.00E-03 fraction

Organic carbon partition coefficient K_{oc} 1.48E+03 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

acid dissociation constant pKa

Fraction of organic carbon in aquifer f_{oc}

Soil water partition coefficient Kd 1.48E+00 l/kg

Define dispersivity (click brown cell and use pull down list)

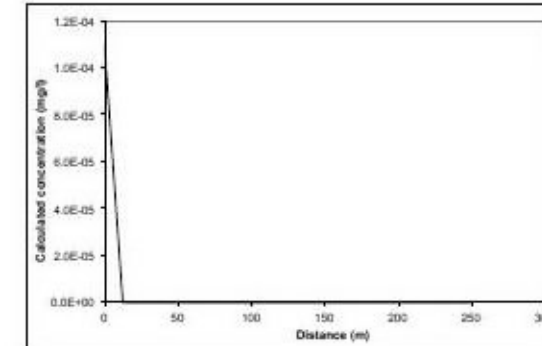
Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity α _x	2.50E+00	2.50E+01	m
Transverse dispersivity α _z	2.50E+00	2.50E+00	m
Vertical dispersivity α _y	2.50E-01	2.50E-01	m

Note values of dispersivity must be > 0

For calculated value, assumes α_x = 0.1 * x, α_z = 0.01 * x, α_y = 0.001 * x

Xu & Eckstein (1995) report α_x = 0.83(log₁₀x)^{2.414}, α_z = α_x/10, α_y = α_x/100 are assumed



Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance Concentration

mg/l

0 1.1E-04

12.5 6.03E-191

25.0 0.00E+00

37.5 0.00E+00

50.0 0.00E+00

62.5 0.00E+00

75.0 0.00E+00

87.5 0.00E+00

100.0 0.00E+00

112.5 0.00E+00

125.0 0.00E+00

137.5 0.00E+00

150.0 0.00E+00

162.5 0.00E+00

175.0 0.00E+00

187.5 0.00E+00

200.0 0.00E+00

212.5 0.00E+00

225.0 0.00E+00

237.5 0.00E+00

250.0 0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed: Rottenham Wharf, Port Dundas, Glasgow
 Completed by: SA
 Date: 05/03/2024
 Version: 3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Benzo(a)pyrene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Initial contaminant concentration in groundwater at plume core	C ₀	1.30E-04	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	1.06E+03	days	Highest recorded value
Calculated decay rate	λ	6.55E-04	days ⁻¹	Howard et al
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.75E+02	m	Width of site
Plume thickness at source	Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness	da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials	ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer	n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient	i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer	K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance (lateral) to compliance point	x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (depth) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+100	days	Time variant options only
Parameters values determined from options				
Partition coefficient	Kd	4.02E+00	l/kg	see options
Longitudinal dispersivity	ax	2.50E+01	m	see options
Transverse dispersivity	az	2.50E+00	m	see options
Vertical dispersivity	ay	2.50E-01	m	see options

Calculated Parameters

Groundwater flow velocity	v	1.73E-08	mid
Retardation factor	Rf	1.80E+01	fraction
Decay rate used	λ	3.64E-05	d ⁻¹
Rate of contaminant flow due to retardation	u	9.61E-10	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion	C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	No impact	mg/l	For comparison with measured groundwater concentration,
Domenico - Steady state			
Distance to compliance point	250	m	
Concentration of contaminant at compliance point	C ₀₀ /C _T	0.00E+00	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 4.02E+00 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} 1.00E-03 fraction

Organic carbon partition coefficient K_{oc} 4.02E+03 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

acid dissociation constant pKa

Fraction of organic carbon in aquifer f_{oc}

Soil water partition coefficient Kd 4.02E+00 l/kg

Define dispersivity (click brown cell and use pull down list)

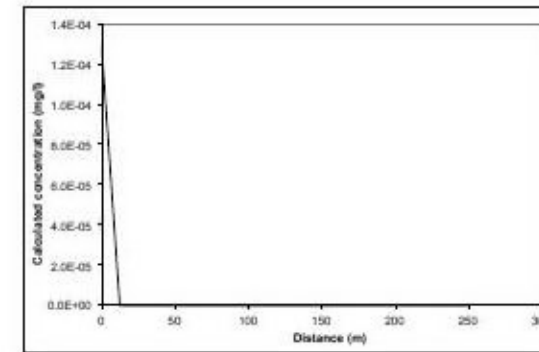
Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	2.50E+01	2.50E+01	2.50E+01	m
Transverse dispersivity	az	2.50E+00	2.50E+00	2.50E+00	m
Vertical dispersivity	ay	2.50E-01	2.50E-01	2.50E-01	m

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Domenico - Steady state	
From calculation sheet	
Distance	Concentration
	mg/l
0	1.3E-04
12.5	7.22E-216
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	22/03/2024
Version:	3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Benzo(b)fluoranthene	from Level 1
Target Concentration	C _T 1.00E-04	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	1.30E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	1.22E+03	days	Howard et al
Calculated decay rate λ	5.69E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	4.41E-01	l/kg	see options
Longitudinal dispersivity ax	2.50E+01	m	see options
Transverse dispersivity az	2.50E+00	m	see options
Vertical dispersivity av	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rt	2.86E+00	fraction
Decay rate used λ	1.99E-04	d ⁻¹
Rate of contaminant flow due to retardation u	6.04E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	No impact	mg/l	For comparison with measured groundwater concentration,
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

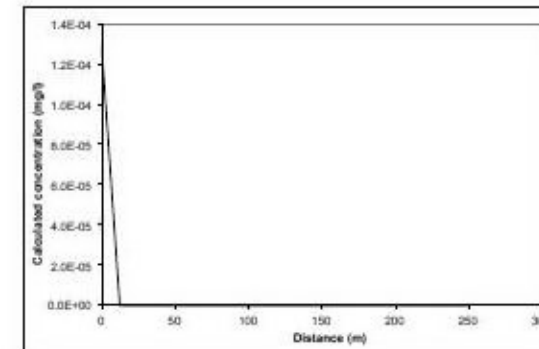
Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	4.41E+02	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	4.41E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Enter value	Calc value	Xu & Eckstein	Unit
ax	2.50E+01	2.50E+01	m
az	2.50E+00	2.50E+00	m
ay	2.50E-01	2.50E-01	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.3E-04
12.5	1.84E-201
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used.

Site being assessed: Rottenham Wharf, Port Dundas, Glasgow
Completed by: SA
Date: 05/03/2024
Version: 3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Cadmium	from Level 1
Target Concentration	C _T 1.00E-03	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	C ₀ 1.40E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water	t _{1/2} 9.99E+99	days	Assumed no decay
Calculated decay rate	λ 6.94E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 1.75E+02	m	Width of site
Plume thickness at source	Sy 7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness	da 1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials	ρ 2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer	n 5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient	i 1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer	K 8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point	x 2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t 1.00E+100	days	Time variant options only
Parameters values determined from options			
Partition coefficient	Kd 3.98E+03	l/kg	see options
Longitudinal dispersivity	ax 2.50E+01	m	see options
Transverse dispersivity	az 2.50E+00	m	see options
Vertical dispersivity	ay 2.50E-01	m	see options

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Soil water partition coefficient	Kd 3.98E+03	l/kg
Entry if specify partition coefficient (option)		
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	fraction
Organic carbon partition coefficient	Koc	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd 3.98E+03	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Enter value	Calc value	Xu & Eckstein	m
ax 2.50E+01	2.50E+01	6.96E-06	m
az 2.50E+00	2.50E+00	6.96E-01	m
ay 2.50E-01	2.50E-01	6.96E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed

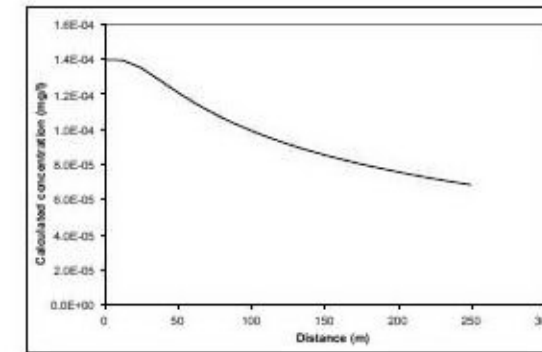
Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 1.73E-08	mid
Retardation factor	Rf 1.68E+04	fraction
Decay rate used	λ 4.13E-105	d ⁻¹
Rate of contaminant flow due to retardation	u 1.03E-12	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion	C ₀₀ 6.87E-05	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF 2.04E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Remedial Target	2.04E-03	mg/l	For comparison with measured groundwater concentration,
Domenico - Steady state			
Distance to compliance point	250	m	
Concentration of contaminant at compliance point	C ₀₀ /C _T 6.87E-05	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.40E-04
12.5	1.40E-04
25.0	1.35E-04
37.5	1.28E-04
50.0	1.21E-04
62.5	1.15E-04
75.0	1.09E-04
87.5	1.04E-04
100.0	9.96E-05
112.5	9.56E-05
125.0	9.20E-05
137.5	8.87E-05
150.0	8.58E-05
162.5	8.31E-05
175.0	8.06E-05
187.5	7.83E-05
200.0	7.61E-05
212.5	7.41E-05
225.0	7.22E-05
237.5	7.04E-05
250.0	6.87E-05

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	20240305
Version:	3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Chrysene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	1.30E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	2.00E+03	days	Howard et al
Calculated decay rate λ	3.47E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	9.92E-01	l/kg	see options
Longitudinal dispersivity ax	2.50E+01	m	see options
Transverse dispersivity az	2.50E+00	m	see options
Vertical dispersivity av	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rf	5.19E+00	fraction
Decay rate used λ	6.68E-05	d ⁻¹
Rate of contaminant flow due to retardation u	3.33E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	No impact	mg/l	For comparison with measured groundwater concentration,
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

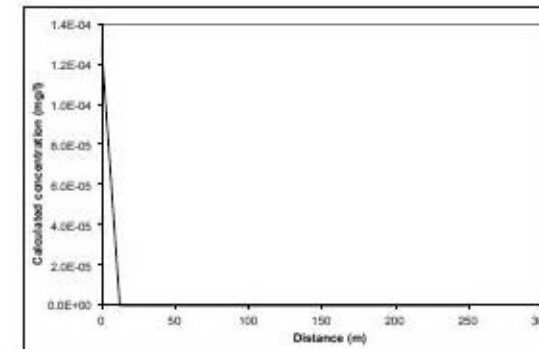
Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	9.92E+02	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	9.92E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity ax	2.50E+01	2.50E+01	6.99E-01	m
Transverse dispersivity az	2.50E+00	2.50E+00	6.99E-01	m
Vertical dispersivity ay	2.50E-01	2.50E-01	6.99E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.3E-04
12.5	2.86E-158
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used.

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	assess
Version:	3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Fluoranthene	from Level 1
Target Concentration	C _T 1.00E-04	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	2.80E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	8.80E+02	days	Howard et al
Calculated decay rate λ	7.88E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	5.90E-01	l/kg	see options
Longitudinal dispersivity ax	2.50E+01	m	see options
Transverse dispersivity az	2.50E+00	m	see options
Vertical dispersivity av	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rf	3.49E+00	fraction
Decay rate used λ	2.26E-04	d ⁻¹
Rate of contaminant flow due to retardation u	4.95E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	No impact	mg/l	For comparison with measured groundwater concentration,
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

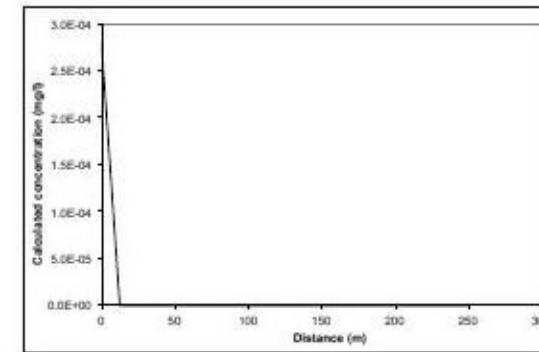
Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	5.90E+02	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	5.90E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity ax	2.50E+00	2.50E+01	6.99E-08	m
Transverse dispersivity az	2.50E+00	2.50E+00	6.99E-01	m
Vertical dispersivity ay	2.50E-01	2.50E-01	6.99E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	2.8E-04
12.5	4.99E-236
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used.

Site being assessed: Rottenham Wharf, Port Dundas, Glasgow
Completed by: SA
Date: 05/03/2024
Version: 3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Fluorene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	1.30E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	1.20E+02	days	Howard et al
Calculated decay rate λ	5.78E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	2.37E-01	l/kg	see options
Longitudinal dispersivity α _x	2.50E+01	m	see options
Transverse dispersivity α _z	2.50E+00	m	see options
Vertical dispersivity α _y	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rf	2.00E+00	fraction
Decay rate used λ	2.89E-03	d ⁻¹
Rate of contaminant flow due to retardation u	8.63E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	No impact	mg/l	For comparison with measured groundwater concentration,
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

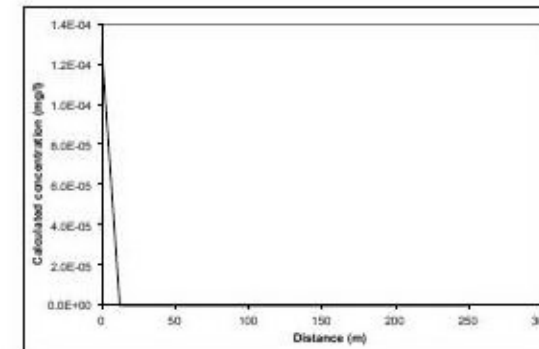
Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	2.37E+02	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	2.37E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity α _x	2.50E+00	2.50E+01	0.00E+00	m
Transverse dispersivity α _z	2.50E+00	2.50E+00	0.00E-01	m
Vertical dispersivity α _y	2.50E-01	2.50E-01	0.00E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes α_x = 0.1 * x, α_z = 0.01 * x, α_y = 0.001 * x
Xu & Eckstein (1995) report α_x = 0.83(log₁₀x)^{2.414}, α_z = α_x/10, α_y = α_x/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.3E-04
12.5	0.00E+00
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed: Rottenham Wharf, Port Dundas, Glasgow
Completed by: SA
Date: 05/03/2024
Version: 3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Mercury	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	C ₀ 4.00E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water	t _{1/2} 9.99E+99	days	Assumed no decay
Calculated decay rate	λ 6.94E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 1.75E+02	m	Width of site
Plume thickness at source	Sy 7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness	da 1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials	ρ 2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer	n 5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient	i 1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer	K 8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point	x 2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t 1.00E+100	days	Time variant options only
Parameters values determined from options			
Partition coefficient	Kd 6.31E+03	l/kg	see options
Longitudinal dispersivity	ax 2.50E+01	m	see options
Transverse dispersivity	az 2.50E+00	m	see options
Vertical dispersivity	ay 2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 1.73E-08	mid
Retardation factor	Rf 2.66E+04	fraction
Decay rate used	λ 2.61E-105	d ⁻¹
Rate of contaminant flow due to retardation	u 6.49E-13	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion	C ₀₀ 1.96E-04	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF 2.04E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	2.04E-05	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	250	m	
Concentration of contaminant at compliance point	C ₀₀ /C _T 1.96E-04	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

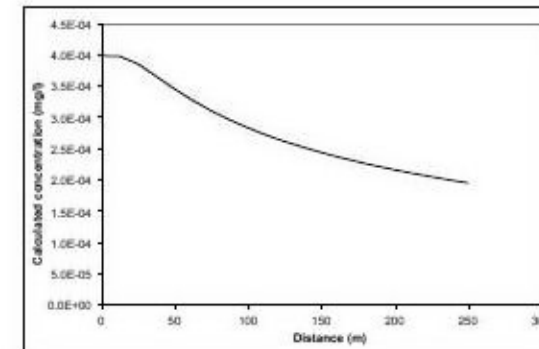
Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd 6.31E+03	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	fraction
Organic carbon partition coefficient	Koc	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd 6.31E+03	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity	ax 2.50E+01	2.50E+01	6.99E-06	m
Transverse dispersivity	az 2.50E+00	2.50E+00	6.99E-01	m
Vertical dispersivity	ay 2.50E-01	2.50E-01	6.99E-03	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used.

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	2024/03/05
Version:	3.2

Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Concentration
	mg/l
0	4.0E-04
12.5	3.99E-04
25.0	3.86E-04
37.5	3.67E-04
50.0	3.47E-04
62.5	3.28E-04
75.0	3.12E-04
87.5	2.97E-04
100.0	2.84E-04
112.5	2.73E-04
125.0	2.63E-04
137.5	2.54E-04
150.0	2.45E-04
162.5	2.37E-04
175.0	2.30E-04
187.5	2.24E-04
200.0	2.17E-04
212.5	2.12E-04
225.0	2.06E-04
237.5	2.01E-04
250.0	1.96E-04

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Naphthalene	from Level 1
Target Concentration	C _T 5.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	8.40E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	2.58E+02	days	Howard et al
Calculated decay rate λ	2.69E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	4.99E-02	l/kg	see options
Longitudinal dispersivity ax	2.50E+01	m	see options
Transverse dispersivity az	2.50E+00	m	see options
Vertical dispersivity av	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rf	1.21E+00	fraction
Decay rate used λ	2.22E-03	d ⁻¹
Rate of contaminant flow due to retardation u	1.43E-08	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	No impact	mg/l	For comparison with measured groundwater concentration,
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

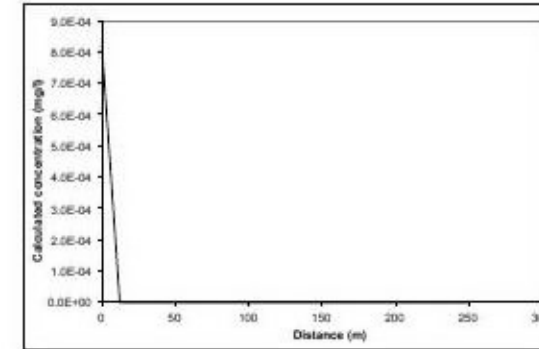
Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	4.99E+01	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	4.99E-02	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Enter value	Calc value	Xu & Eckstein	Unit
ax	2.50E+01	2.50E+01	m
az	2.50E+00	2.50E+00	m
ay	2.50E-01	2.50E-01	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	8.4E-04
12.5	0.00E+00
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed: Rottenham Wharf, Port Dundas, Glasgow
Completed by: SA
Date: 05/03/2024
Version: 3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Phenanthrene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	2.30E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	4.02E+02	days	Howard et al
Calculated decay rate λ	1.73E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient Kd	4.55E-01	l/kg	see options
Longitudinal dispersivity ax	2.50E+01	m	see options
Transverse dispersivity az	2.50E+00	m	see options
Vertical dispersivity av	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rf	2.92E+00	fraction
Decay rate used λ	5.91E-04	d ⁻¹
Rate of contaminant flow due to retardation u	5.92E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	No impact	mg/l	For comparison with measured groundwater concentration,
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

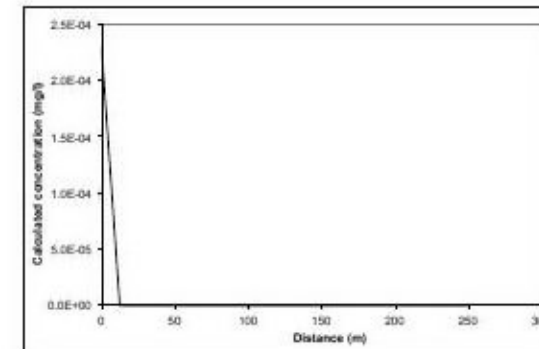
Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	4.55E+02	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	4.55E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Enter value	Calc value	Xu & Eckstein	Unit
ax	2.50E+01	2.50E+01	m
az	2.50E+00	2.50E+00	m
ay	2.50E-01	2.50E-01	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	2.3E-04
12.5	0.00E+00
25.0	0.00E+00
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	assess
Version:	3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Pyrene	from Level 1
Target Concentration	C _T 1.00E-05	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	2.30E-04	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	3.80E+03	days	Howard et al
Calculated decay rate λ	1.83E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	time variant options only
Partition coefficient Kd	6.72E-01	l/kg	see options
Longitudinal dispersivity ax	2.50E+01	m	see options
Transverse dispersivity az	2.50E+00	m	see options
Vertical dispersivity av	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor Rt	3.84E+00	fraction
Decay rate used λ	4.76E-05	d ⁻¹
Rate of contaminant flow due to retardation u	4.51E-09	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	breakthrough at compliance point	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	No impact	mg/l	For comparison with measured groundwater concentration,
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	0.00E+00	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

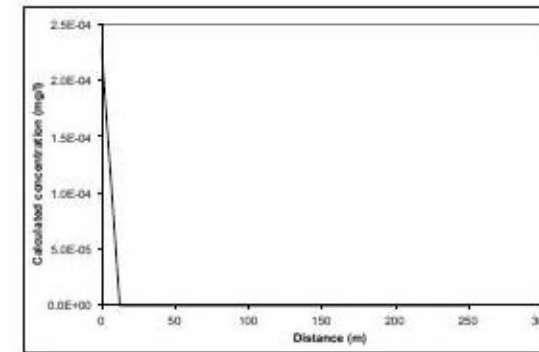
Soil water partition coefficient Kd		l/kg
Fraction of organic carbon in aquifer f _{oc}	1.00E-03	fraction
Organic carbon partition coefficient K _{oc}	6.72E+02	l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value pH		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient Kd	6.72E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity ax	2.50E+00	2.50E+01	6.98E-08	m
Transverse dispersivity az	2.50E+00	2.50E+00	6.98E-01	m
Vertical dispersivity ay	2.50E-01	2.50E-01	6.98E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	2.3E-04
12.5	7.20E-116
25.0	2.19E-227
37.5	0.00E+00
50.0	0.00E+00
62.5	0.00E+00
75.0	0.00E+00
87.5	0.00E+00
100.0	0.00E+00
112.5	0.00E+00
125.0	0.00E+00
137.5	0.00E+00
150.0	0.00E+00
162.5	0.00E+00
175.0	0.00E+00
187.5	0.00E+00
200.0	0.00E+00
212.5	0.00E+00
225.0	0.00E+00
237.5	0.00E+00
250.0	0.00E+00

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	assess
Version:	3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Selenium	from Level 1
Target Concentration	C _T 1.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	C ₀ 1.50E-02	mg/l	Highest recorded value
Half life for degradation of contaminant in water	t _{1/2} 9.99E+99	days	Assumed no decay
Calculated decay rate	λ 6.94E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 1.75E+02	m	Width of site
Plume thickness at source	Sy 7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness	da 1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials	ρ 2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer	n 5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient	i 1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer	K 8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point	x 2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t 1.00E+100	days	Time variant options only
Parameters values determined from options			
Partition coefficient	Kd 2.00E+03	l/kg	see options
Longitudinal dispersivity	ax 2.50E+01	m	see options
Transverse dispersivity	az 2.50E+00	m	see options
Vertical dispersivity	ay 2.50E-01	m	see options

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Soil water partition coefficient	Kd 2.00E+03	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	fraction
Organic carbon partition coefficient	Koc	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd 2.00E+03	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Variable	Enter value	Calc value	Xu & Eckstein	Unit
Longitudinal dispersivity	ax 2.50E+01	2.50E+01	6.99E-08	m
Transverse dispersivity	az 2.50E+00	2.50E+00	6.99E-01	m
Vertical dispersivity	ay 2.50E-01	2.50E-01	6.99E-03	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed

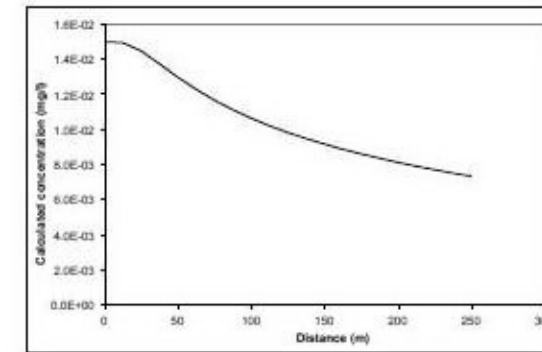
Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 1.73E-08	mid
Retardation factor	Rf 8.42E+03	fraction
Decay rate used	λ 8.24E-105	d ⁻¹
Rate of contaminant flow due to retardation	u 2.05E-12	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion	C ₀₀ 7.37E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF 2.04E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Remedial Target	2.04E-02	mg/l	For comparison with measured groundwater concentration,
Domenico - Steady state			
Distance to compliance point	250	m	
Concentration of contaminant at compliance point	C ₀₀ /C _T 7.37E-03	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.



Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.5E-02
12.5	1.50E-02
25.0	1.45E-02
37.5	1.38E-02
50.0	1.30E-02
62.5	1.23E-02
75.0	1.17E-02
87.5	1.11E-02
100.0	1.07E-02
112.5	1.02E-02
125.0	9.85E-03
137.5	9.51E-03
150.0	9.19E-03
162.5	8.90E-03
175.0	8.63E-03
187.5	8.39E-03
200.0	8.15E-03
212.5	7.94E-03
225.0	7.74E-03
237.5	7.55E-03
250.0	7.37E-03

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used.

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	20080808
Version:	3.2

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Sulphate	from Level 1
Target Concentration	C _T 2.50E+02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	3.40E+02	mg/l	Highest recorded value
Half life for degradation of contaminant in water t _{1/2}	9.99E+99	days	Assumed no decay
Calculated decay rate λ	6.94E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.75E+02	m	Width of site
Plume thickness at source Sy	7.50E+00	m	50% aquifer thickness
Saturated aquifer thickness da	1.50E+01	m	Thickness of flooded superficial soils
Bulk density of aquifer materials ρ	2.11E+00	g/cm ³	Based on recorded geotech results
Effective porosity of aquifer n	5.00E-01	fraction	Freze and Cherry (1979) Table 2.4
Hydraulic gradient i	1.00E-03	fraction	No water table present
Hydraulic conductivity of aquifer K	8.64E-06	mid	Freeze and Cherry (1979) Table 2.2
Distance to compliance point x	2.50E+02	m	250 m (Section 7.3 SEPA WAT-PS-10-01)
Distance (lateral) to compliance point perpendicular to flow direction z		m	
Distance (depth) to compliance point perpendicular to flow direction y		m	
Time since pollutant entered groundwater t	1.00E+100	days	Time variant options only
Partition coefficient K _d	2.14E+01	l/kg	see options
Longitudinal dispersivity α _x	2.50E+01	m	see options
Transverse dispersivity α _z	2.50E+00	m	see options
Vertical dispersivity α _y	2.50E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.73E-08	mid
Retardation factor R _f	9.13E+01	fraction
Decay rate used λ	7.60E-103	d ⁻¹
Rate of contaminant flow due to retardation u	1.89E-10	mid
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀₀	1.67E+02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED) AF	2.04E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Domenico - Steady state	5.09E+02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	250	m	
Concentration of contaminant at compliance point C ₀₀ /C _T	1.67E+02	mg/l	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

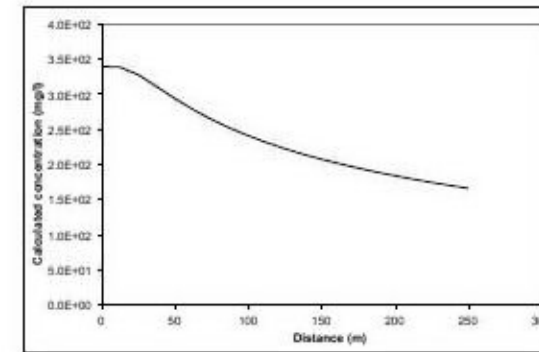
Soil water partition coefficient K _d	2.14E+01	l/kg
Fraction of organic carbon in aquifer f _{oc}		fraction
Organic carbon partition coefficient K _{oc}		l/kg
Sorption coefficient for related species K _{oc,r}		l/kg
Sorption coefficient for ionised species K _{oc,i}		l/kg
pH value		
acid dissociation constant pKa		
Fraction of organic carbon in aquifer f _{oc}		fraction
Soil water partition coefficient K _d	2.14E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Variable	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity α _x	2.50E+01	2.50E+01	m
Transverse dispersivity α _z	2.50E+00	2.50E+00	m
Vertical dispersivity α _y	2.50E-01	2.50E-01	m

Note values of dispersivity must be > 0
For calculated value, assumes α_x = 0.1 * x, α_z = 0.01 * x, α_y = 0.001 * x
Xu & Eckstein (1995) report α_x = 0.83(log₁₀x)^{2.114}, α_z = α_x/10, α_y = α_x/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used.

Site being assessed:	Rottenham Wharf, Port Dundas, Glasgow
Completed by:	SA
Date:	05/03/2024
Version:	3.2

Calculated concentrations for distance-concentration graph

Domenico - Steady state

Distance	Concentration
	mg/l
0	3.4E+02
12.5	3.39E+02
25.0	3.28E+02
37.5	3.12E+02
50.0	2.95E+02
62.5	2.79E+02
75.0	2.65E+02
87.5	2.53E+02
100.0	2.42E+02
112.5	2.32E+02
125.0	2.23E+02
137.5	2.15E+02
150.0	2.08E+02
162.5	2.02E+02
175.0	1.96E+02
187.5	1.90E+02
200.0	1.85E+02
212.5	1.80E+02
225.0	1.75E+02
237.5	1.71E+02
250.0	1.67E+02

Appendix 10

Historical Atmospheric Pressure Data (courtesy of [weatheronline.co.uk](https://www.weatheronline.co.uk))

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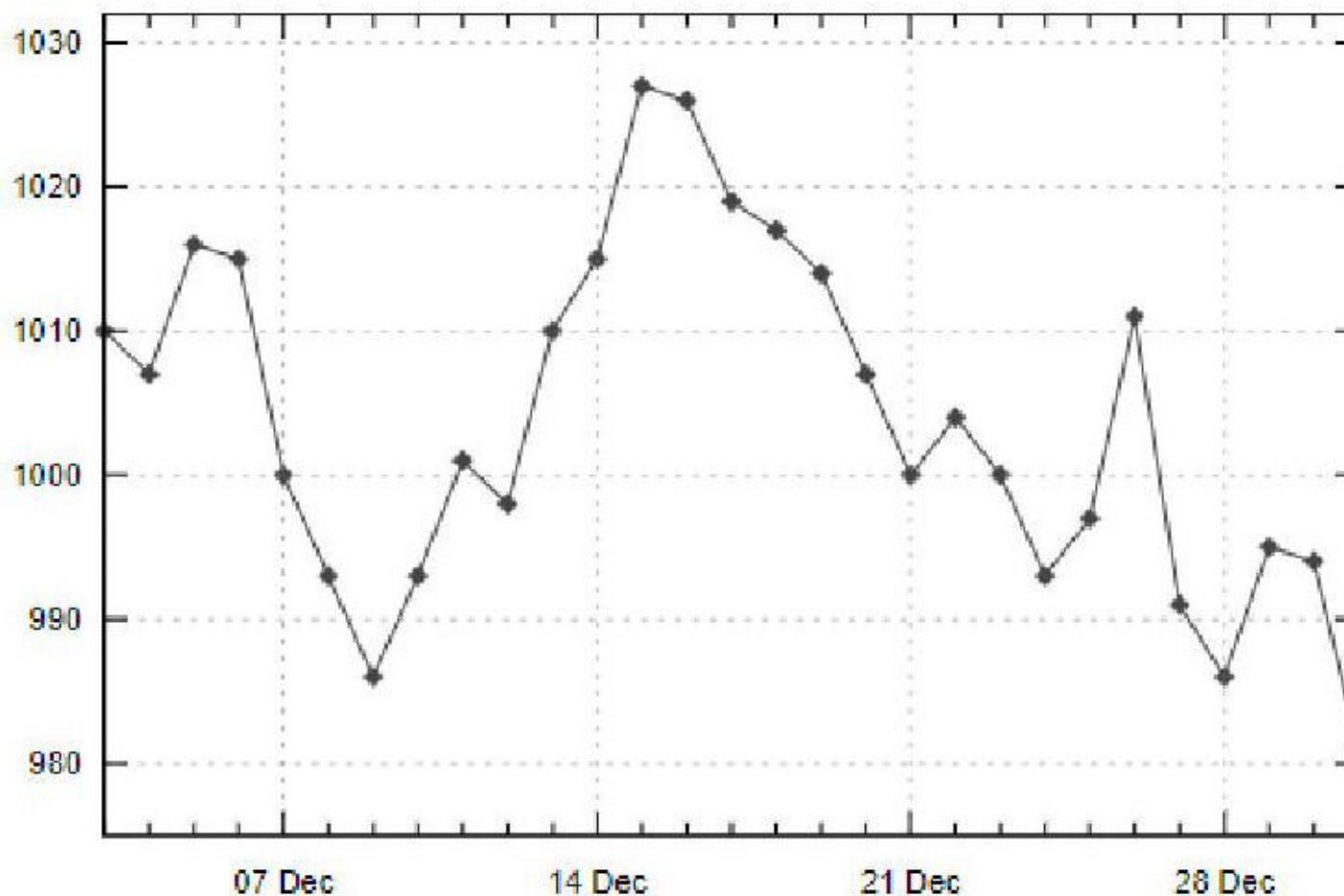


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Glasgow Airport
 Pressure [hPa]: 03.12.2023 - 31.12.2023
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Weeks December 2023

Max temperature	[P] Wind speed
Min temperature	[P] Wind direction
Max temperature/Min temperature	[P] Wind direction Histogram
UV index	[P] Wind rose
Pressure	
Relative humidity	

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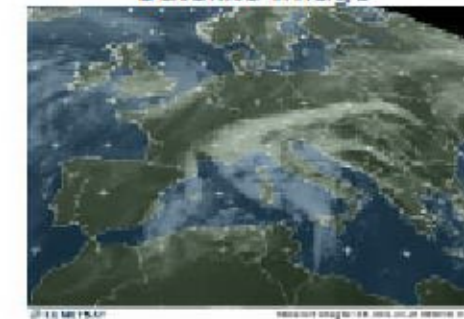
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Radar



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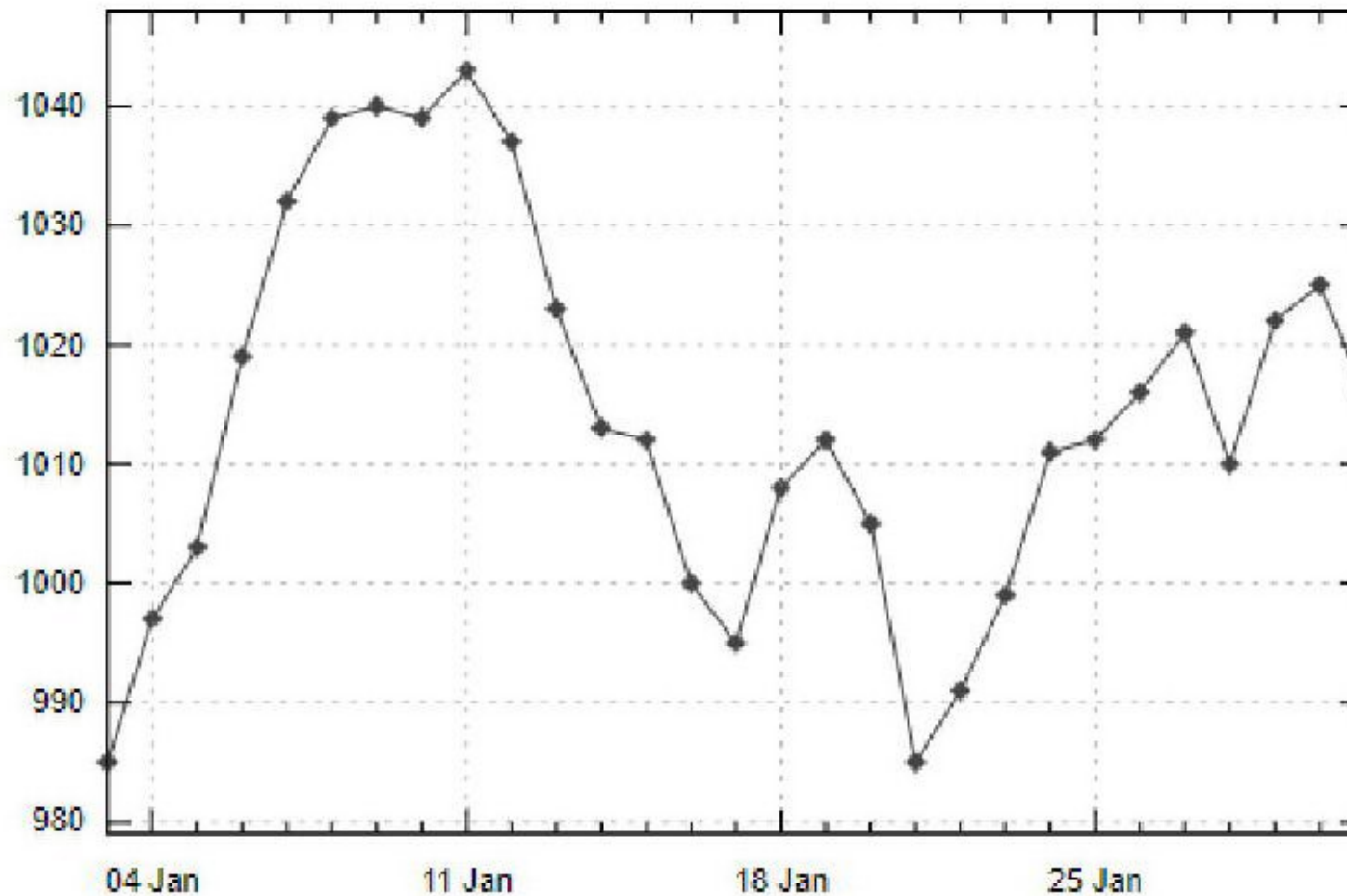
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Pressure [hPa]: 03.01.2024 - 31.01.2024

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Weeks January 2024

Max temperature	[P] Wind speed
Min temperature	[P] Wind direction
Max temperature/Min temperature	[P] Wind direction Histogram
UV index	[P] Wind rose
Pressure	
Relative humidity	

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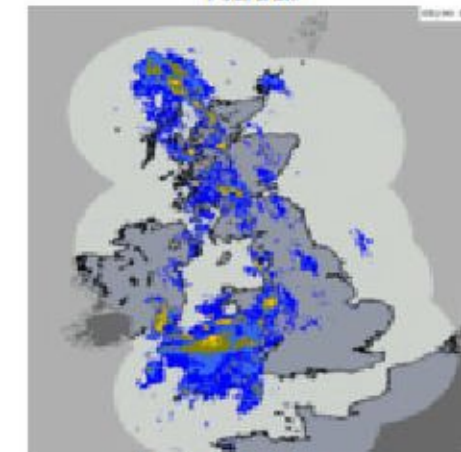
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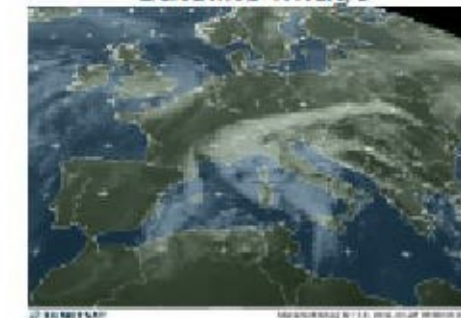
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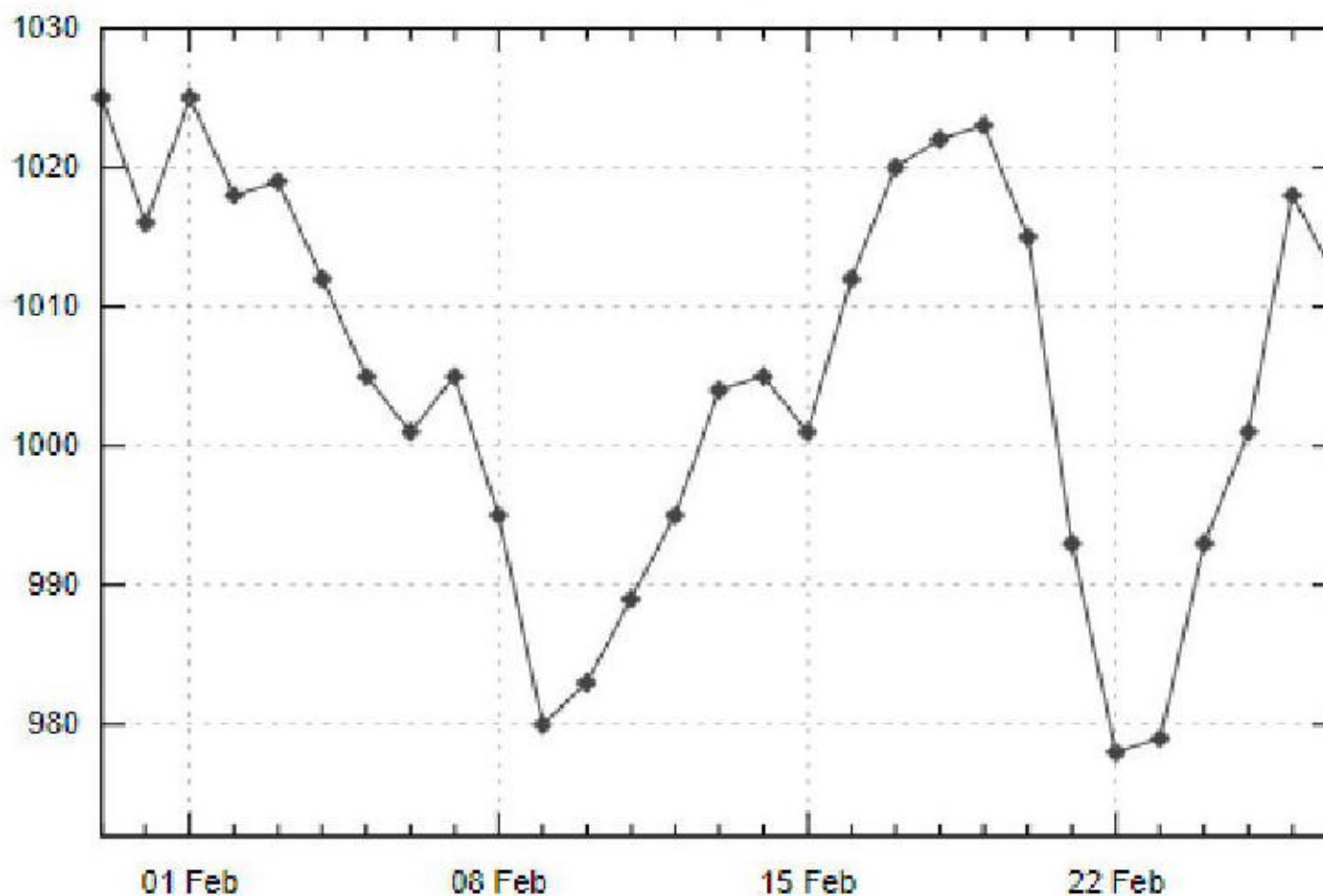
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Pressure [hPa]: 30.01.2024 - 27.02.2024

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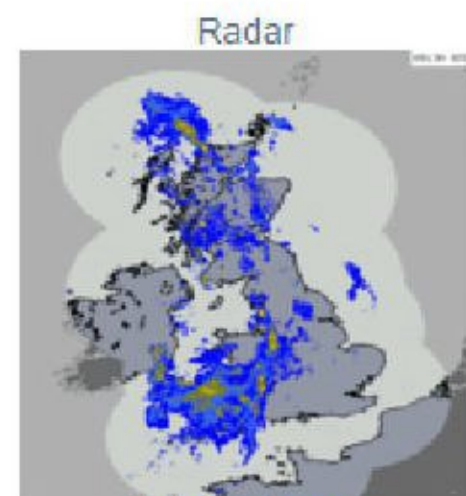
Weeks February 2024

Max temperature	[P] Wind speed
Min temperature	[P] Wind direction
Max temperature/Min temperature	[P] Wind direction Histogram
UV index	[P] Wind rose
Pressure	
Relative humidity	

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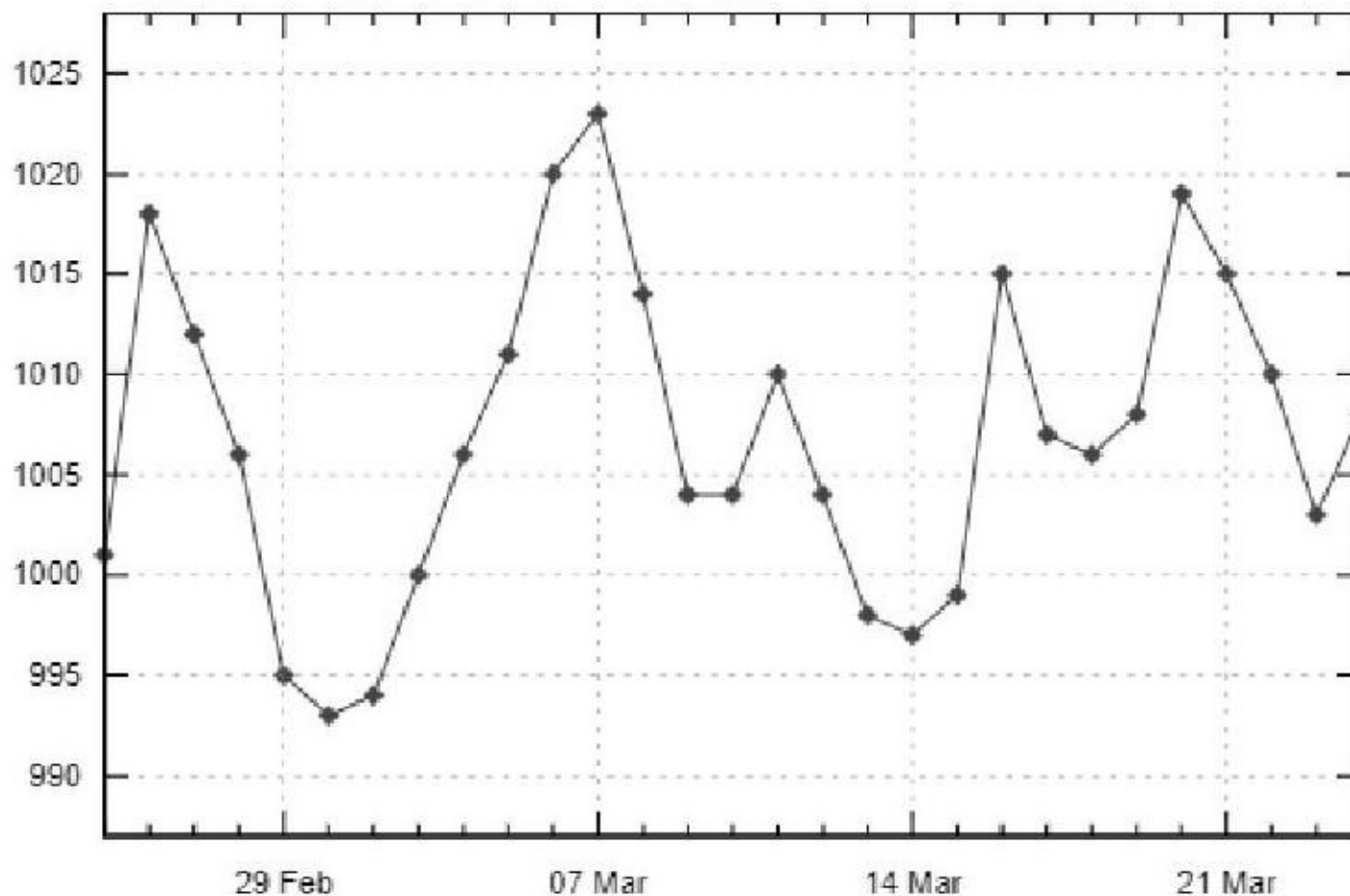
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 - Ardrossan
 - Aviemore
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 - Ballachulish
 - Bamburgh
 - Barra
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Glasgow Airport
 Pressure [hPa]: 25.02.2024 - 24.03.2024
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Weeks March 2024

Max temperature	[P] Wind speed
Min temperature	[P] Wind direction
Max temperature/Min temperature	[P] Wind direction Histogram
UV index	[P] Wind rose
Pressure	
Relative humidity	

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