

Appendix D – Geotechnical Laboratory Testing Results

- 2018 Investigation
 - Envirolab, Final Analytical Test Report 18-07336-1
 - Envirolab, Final Analytical Test Report 18-07505-1
- 2021 Pre-Demolition Investigation
 - Envirolab, Final Analytical Test Report 21-01179-1
- 2021 Post-Demolition Investigation
 - Envirolab, Final Analytical Test Report 21/09479
 - Ian Farmer, Final Test Report 2280724/1

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07336
Issue Number: 1

Date: 27 September, 2018

Client: Curtins Consulting
Merchant Exchange
17-19 Whitworth Street
Manchester
UK
M1 5WG

Project Manager: Matthew Holroyd/Siobhán Hyde
Project Name: Swan House Manchester
Project Ref: B067266.201
Order No: EBMA1394
Date Samples Received: 12/09/18
Date Instructions Received: 13/09/18
Date Analysis Completed: 26/09/18

Prepared by:


Melanie Marshall
Laboratory Coordinator

Approved by:


Georgia King
Admin & Client Services Supervisor

Envirolab Job Number: 18/07336

Client Project Name: Swan House Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07336/1	18/07336/2	18/07336/3	18/07336/4					Units	Method ref
Client Sample No	D1	D2	D1	D2						
Client Sample ID	WS06	WS06	WS07	WS07						
Depth to Top	3.00	4.70	1.90	3.80						
Depth To Bottom	3.25	4.90	2.00	4.00						
Date Sampled	10-Sep-18	11-Sep-18	11-Sep-18	11-Sep-18						
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D						
Sample Matrix Code	3	3	3	5						
% Stones >10mm _A	<0.1	<0.1	<0.1	<0.1					% w/w	A-T-044
pH BRE _D ^{M#}	8.42	8.49	8.46	8.56					pH	A-T-031s
Sulphate BRE (water sol 2:1) _D ^{M#}	41	47	62	36					mg/l	A-T-026s
1.01 % Moisture BS1377 1990 pt2 cl3.2 _A [#]	-	Appended	Appended	-						Subcon SS
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4 _A [#]	-	Appended	Appended	-						Subcon SS

REPORT NOTES

General:

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed.

Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

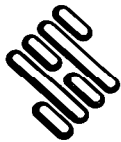
Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.



STRUCTURAL SOILS LTD
TEST REPORT



Report No. 783379 R1a

Date 01-October-2018 Contract 18/07336

Client Envirolab Ltd
Address Units 7 & 8 Sandpits Business Park
Mottram Road
Hyde
SK14 3AR

For the Attention of Iain Haslock

Samples submitted by client 14/09/2018
Testing Started 14/09/2018
Testing Completed 26/09/2018

Client Reference 18/07336
Client Order No. P0739027
Instruction Type Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2 (superseded)**
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4

* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

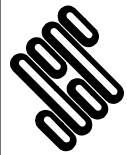
Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of.
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd, The Potteries, Pottery Street, Castleford, WF10 1NJ Tel.01977 552255. E-mail mark.athorne@soils.co.uk

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	% <425um	Description of Sample
WS06	18/07336/2	B	4.70	19	40	18	22	97	Brown slightly gravelly CLAY
WS07	18/07336/3	B	1.90	19	39	16	23	97	Brown slightly gravelly CLAY



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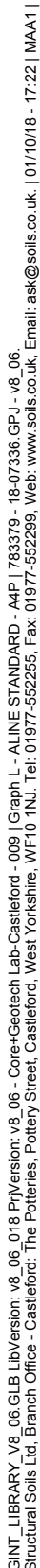
Contract:

18/07336

Contract Ref:

783379





TESTING VERIFICATION CERTIFICATE



1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with the Structural Soils Ltd Laboratory Quality Management System, results sheets and summaries of results issued by the laboratory are checked by an approved signatory. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **01/10/2018 17:23:23**.

Testing reported after this date is not covered by this Verification Certificate.

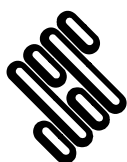
Approved Signatory
Mark Athorne (Laboratory Manager)

(Head Office)
Bristol Laboratory
Unit 1A, Princess Street
Bedminster
Bristol
BS3 4AG

Castleford Laboratory
The Potteries, Pottery Street
Castleford
West Yorkshire
WF10 1NJ

Hemel Laboratory
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Tonbridge Laboratory
Anerley Court, Half Moon Lane
Hildenborough
Tonbridge
TN11 9HU



**STRUCTURAL
SOILS LTD**

Contract:

18/07336

Job No:

783379



FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07505
Issue Number: 1

Date: 02 October, 2018

Client: Curtins Consulting
Merchant Exchange
17-19 Whitworth Street
Manchester
UK
M1 5WG

Project Manager: Matthew Holroyd/Siobhán Hyde
Project Name: Swan House, Manchester
Project Ref: B067266.201
Order No: EBMA1405
Date Samples Received: 14/09/18
Date Instructions Received: 18/09/18
Date Analysis Completed: 02/10/18

Prepared by:


Melanie Marshall
Laboratory Coordinator

Approved by:


Danielle Brierley
Client Manager

Envirolab Job Number: 18/07505

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07505/1	18/07505/2	18/07505/3	18/07505/4	18/07505/5	18/07505/6			Units	Method ref
Client Sample No	1	2	2	3	1	2				
Client Sample ID	WS01	WS01	WS01	WS03	WS02	WS02				
Depth to Top	1.90	3.50	4.70	4.80	1.80	3.80				
Depth To Bottom	2.00		5.00	5.00	2.00	4.00				
Date Sampled	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	14-Sep-18	14-Sep-18				
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D				
Sample Matrix Code	3	3	5	6	5A	5				
% Stones >10mm _A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			% w/w	A-T-044
pH BRE _D ^{M#}	8.18	8.57	8.62	8.42	8.37	8.43			pH	A-T-031s
Sulphate BRE (water sol 2:1) _D ^{M#}	81	47	48	102	87	66			mg/l	A-T-026s
1.01 % Moisture BS1377 1990 pt2 cl3.2 _A [#]	-	Appended	-	Appended	-	Appended				Subcon SS
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4 _A [#]	-	Appended	-	Appended	-	Appended				Subcon SS

REPORT NOTES

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Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

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Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.



STRUCTURAL SOILS LTD
TEST REPORT



Report No. 783389 R1

Date 02-October-2018 Contract 18/07505

Client Envirolab Ltd
Address Units 7 & 8 Sandpits Business Park
Mottram Road
Hyde
SK14 3AR

For the Attention of Iain Haslock

Samples submitted by client 19/09/2018
Testing Started 21/09/2018
Testing Completed 02/10/2018

Client Reference 18/07505
Client Order No. P0739062
Instruction Type Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2 (superseded)**
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4

* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

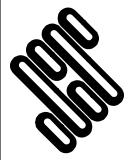
Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of.
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd, The Potteries, Pottery Street, Castleford, WF10 1NJ Tel.01977 552255. E-mail mark.athorne@soils.co.uk

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	% <425um	Description of Sample
WS01	18/07505/2	B	3.50	18	41	20	21	96	Brwon slightly gravelly CLAY
WS02	18/07505/6	B	3.80	19	39	20	19	98	Brown slightly gravelly CLAY
WS03	18/07505/4	B	4.80	18	35	18	17	93	Brown slightly gravelly CLAY



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SOILS LTD

Contract:

18/07505

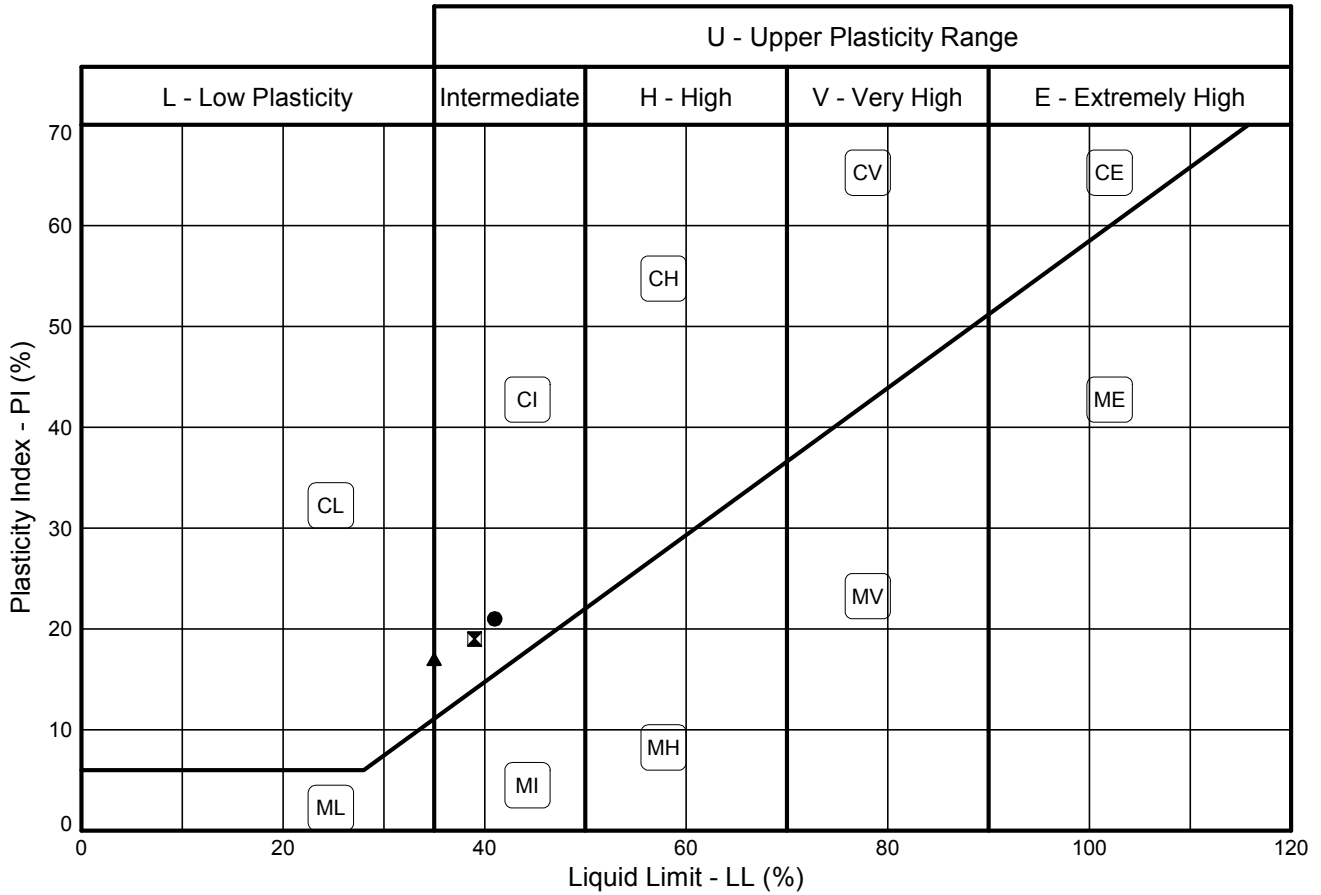
Contract Ref:

783389



PLASTICITY CHART - PI Vs LL

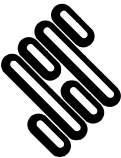
In accordance with BS5930:2015
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC %	LL %	PL %	PI %	<425um %	Lab location	
Exploratory Position ID	Sample	Depth (m)										
●	WS01	18/07505/2B	3.50	3.2/4.3/5.3/5.4	4.2.4	18	41	20	21	96		C
⊠	WS02	18/07505/6B	3.80	3.2/4.3/5.3/5.4	4.2.4	19	39	20	19	98		C
▲	WS03	18/07505/4B	4.80	3.2/4.3/5.3/5.4	4.2.4	18	35	18	17	93		C

# Tested in accordance with the following clauses of BS1377-2:1990.	+ Tested in accordance with the following clauses of BS1377-2:1990.
3.2 - Moisture Content	4.2.3 - Natural State
4.3 - Cone Penetrometer Method	4.2.4 - Wet Sieved
4.4 - One Point Cone Penetrometer Method	
4.6 - One Point Casagrande Method	
5.3 - Plastic Limit Method	
5.4 - Plasticity Index	
	Key: * = Non-standard test, NP = Non plastic.

Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)

 STRUCTURAL SOILS The Potteries Pottery Street Castleford W. Yorkshire WF10 1NJ	Compiled By		Date
	M. Fisher		MAUREEN FISHER
	Contract		Contract Ref:
	18/07505		783389
			AGS

TESTING VERIFICATION CERTIFICATE



1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with the Structural Soils Ltd Laboratory Quality Management System, results sheets and summaries of results issued by the laboratory are checked by an approved signatory. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **02/10/2018 12:19:37**.

Testing reported after this date is not covered by this Verification Certificate.

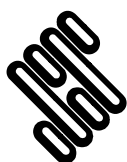
Approved Signatory
Mark Athorne (Laboratory Manager)

(Head Office)
Bristol Laboratory
Unit 1A, Princess Street
Bedminster
Bristol
BS3 4AG

Castleford Laboratory
The Potteries, Pottery Street
Castleford
West Yorkshire
WF10 1NJ

Hemel Laboratory
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Tonbridge Laboratory
Anerley Court, Half Moon Lane
Hildenborough
Tonbridge
TN11 9HU



**STRUCTURAL
SOILS LTD**

Contract:

18/07505

Job No:

783389



FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 21/01179
Issue Number: 1
Date: 25 February, 2021

Client: Curtins Consulting (Manchester)
Merchant Exchange
17-19 Whitworth Street
Manchester
UK
M1 5WG

Project Manager: EBMA/Phil Winterburn/Philippa Neesham
Project Name: Swan House
Project Ref: B077409
Order No: EBMA2690
Date Samples Received: 05/02/21
Date Instructions Received: 08/02/21
Date Analysis Completed: 25/02/21

Prepared by:


Melanie Marshall
Laboratory Coordinator

Approved by:


Sophie France
Client Service Manager

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/1	21/01179/2	21/01179/3	21/01179/4	21/01179/5	21/01179/6	21/01179/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH101A	BH101A	BH101A	BH101A	BH101A	BH101A	BH101A			
Depth to Top	24.1	26.14	26.93	29.84	30.66	32.86	36.93			
Depth To Bottom	24.32	26.27	27.17	30	31.01	33.27	37.15			
Date Sampled	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21			
Sample Type	Solid	Solid	Solid	Solid	Solid	Solid	Solid			
Sample Matrix Code	7	7	7	7	7	7	7			
% Stones >10mm _A	-	-	-	<0.1	-	-	-	% w/w	0.1	A-T-044
pH _D ^{M#}	-	-	-	8.34	-	-	-	pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	-	-	-	0.03	-	-	-	g/l	0.01	A-T-026s
10.03a Point Load (PL) Index of a Single Specimen (Rock Sample) ISRM SM 1974-2006 _A [#]	-	Appended	Appended	Appended	-	-	Appended	N/A		Subcon SS
10.04 Uniaxial / Unconfined Compressive Strength (Rock Sample) ISRM SM 1974-2006 _A [#]	Appended	-	-	-	Appended	Appended	-	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/8	21/01179/9	21/01179/10	21/01179/11	21/01179/12	21/01179/13	21/01179/14	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH101A	BH101A	BH103	BH103	BH103	BH103	BH103			
Depth to Top	38.73	35.85	25.78	28.2	30.12	32.29	34.28			
Depth To Bottom	38.97	35.99	26	28.38	30.33	32.46	34.46			
Date Sampled	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21			
Sample Type	Solid	Solid	Solid	Solid	Solid	Solid	Solid			
Sample Matrix Code	7	7	7	7	7	7	7			
% Stones >10mm _A	-	<0.1	-	-	<0.1	-	<0.1	% w/w	0.1	A-T-044
pH _D ^{M#}	-	8.30	-	-	8.01	-	7.67	pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	-	0.02	-	-	0.01	-	0.02	g/l	0.01	A-T-026s
10.03a Point Load (PL) Index of a Single Specimen (Rock Sample) ISRM SM 1974-2006 _A [#]	Appended	-	Appended	-	Appended	-	Appended	N/A		Subcon SS
10.04 Uniaxial / Unconfined Compressive Strength (Rock Sample) ISRM SM 1974-2006 _A [#]	-	Appended	-	Appended	-	Appended	-	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/15	21/01179/16	21/01179/17	21/01179/18	21/01179/19	21/01179/20	21/01179/21	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH103	BH103	BH102	BH102	BH102	BH102	BH102			
Depth to Top	37.28	39.08	27.78	29	31.52	33.06	34.34			
Depth To Bottom	37.6	39.25	27.96	29.16	31.77	33.44	34.5			
Date Sampled	27-Jan-21	27-Jan-21	01-Feb-21	01-Feb-21	01-Feb-21	01-Feb-21	01-Feb-21			
Sample Type	Solid	Solid	Solid	Solid	Solid	Solid	Solid			
Sample Matrix Code	7	7	7	7	7	7	7			
% Stones >10mm _A	-	-	<0.1	-	-	-	-	% w/w	0.1	A-T-044
pH _D ^{M#}	-	-	7.48	-	-	-	-	pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	-	-	<0.01	-	-	-	-	g/l	0.01	A-T-026s
10.03a Point Load (PL) Index of a Single Specimen (Rock Sample) ISRM SM 1974-2006 _A [#]	-	Appended	-	Appended	-	Appended	-	N/A		Subcon SS
10.04 Uniaxial / Unconfined Compressive Strength (Rock Sample) ISRM SM 1974-2006 _A [#]	Appended	-	Appended	-	Appended	-	Appended	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/22	21/01179/23	21/01179/24	21/01179/25	21/01179/26	21/01179/27	21/01179/28	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH102	BH102	BH101A	BH101A	BH101A	BH101A	BH101A			
Depth to Top	35.83	39.68	1	5	12	9	8.5			
Depth To Bottom	36.09	39.88	1.1	5.45	12.45	9.45	8.6			
Date Sampled	01-Feb-21	01-Feb-21	19-Jan-21	19-Jan-21	20-Jan-21	20-Jan-21	20-Jan-21			
Sample Type	Solid	Solid	Soil - D	Soil - U	Soil - U	Soil - D	Soil - D			
Sample Matrix Code	7	7		5A	5A		5A			
% Stones >10mm _A	-	<0.1	-	<0.1	<0.1	-	2.6	% w/w	0.1	A-T-044
pH _D ^{M#}	-	8.09	-	8.93	9.14	-	9.18	pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	-	0.02	-	0.06	0.04	-	0.07	g/l	0.01	A-T-026s
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4 _A [#]	-	-	Appended	Appended	-	Appended	-	%	1	Subcon SS
1.01 % Moisture BS1377 1990 pt2 cl3.2 _A [#]	-	-	Appended	Appended	Appended	Appended	-	%	0.1	Subcon SS
4.01 Dimensional Consolidation (5 stages) (75mm) BS1377-5:3 _A [#]	-	-	-	-	Appended	-	-	N/A		Subcon SS
4.06a potential remoulding charge at as received moisture _A	-	-	-	-	Appended	-	-	N/A		Subcon SS
4.06b potential remoulding charge at specified moisture / density _A	-	-	-	-	Appended	-	-	N/A		Subcon SS
5.02c QUT Multistage (mm supplied) BS1377 1990 pt7 cl9 _A [#]	-	-	-	Appended	Appended	-	-	N/A		Subcon SS
10.03a Point Load (PL) Index of a Single Specimen (Rock Sample) ISRM SM 1974-2006 _A [#]	-	Appended	-	-	-	-	-	N/A		Subcon SS
10.04 Uniaxial / Unconfined Compressive Strength (Rock Sample) ISRM SM 1974-2006 _A [#]	Appended	-	-	-	-	-	-	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/29	21/01179/30	21/01179/31	21/01179/32	21/01179/33	21/01179/34	21/01179/35	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH102	BH102	BH102	BH102	BH102	BH102	BH102			
Depth to Top	2	3	4.5	7	11.5	17.5	13			
Depth To Bottom	2.6	3.45	4.6	7.1	11.6	17.6	13.1			
Date Sampled	25-Jan-21	25-Jan-21	25-Jan-21	25-Jan-21	25-Jan-21	25-Jan-21	25-Jan-21			
Sample Type	Soil - D	Soil - U	Soil - D	Soil - D	Soil - D	Soil - B	Soil - B			
Sample Matrix Code				5A		4A	4A			
% Stones >10mm _A	-	-	-	<0.1	-	<0.1	<0.1	% w/w	0.1	A-T-044
pH _D ^{M#}	-	-	-	9.24	-	9.14	9.19	pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	-	-	-	0.03	-	<0.01	<0.01	g/l	0.01	A-T-026s
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4 _A [#]	Appended	-	Appended	Appended	Appended	-	-	%	1	Subcon SS
1.01 % Moisture BS1377 1990 pt2 cl3.2 _A [#]	Appended	-	Appended	Appended	Appended	-	-	%	0.1	Subcon SS
5.02c QUT Multistage (mm supplied) BS1377 1990 pt7 cl9 _A [#]	-	Appended	-	-	-	-	-	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/36	21/01179/37	21/01179/38					Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH103	BH103	BH103							
Depth to Top	5	19	10.5							
Depth To Bottom	5.45	19.1	10.95							
Date Sampled	22-Jan-21	22-Jan-21	22-Jan-21							
Sample Type	Soil - U	Soil - B	Soil - D							
Sample Matrix Code		4A								
% Stones >10mm _A	-	1.2	-					% w/w	0.1	A-T-044
pH _D ^{M#}	-	9.38	-					pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	-	<0.01	-					g/l	0.01	A-T-026s
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4 _A [#]	-	-	Appended					%	1	Subcon SS
1.01 % Moisture BS1377 1990 pt2 cl3.2 _A [#]	Appended	-	Appended					%	0.1	Subcon SS
1.10a PSD (Grading/63um/sand fraction/wet sieve) BS1377 pt 2 1990 cl 9.2 _A [#]	-	Appended	-					%	0.1	Subcon SS
4.01 Dimensional Consolidation (5 stages) (75mm) BS1377-5:3 _A [#]	Appended	-	-					N/A		Subcon SS
4.06a potential remoulding charge at as received moisture _A	Appended	-	-					N/A		Subcon SS
4.06b potential remoulding charge at specified moisture / density _A	Appended	-	-					N/A		Subcon SS
5.02c QUT Multistage (mm supplied) BS1377 1990 pt7 cl9 _A [#]	Appended	-	-					N/A		Subcon SS

REPORT NOTES

General

This report shall not be reproduced, except in full, without written approval from Envirolab.

The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Curtins Consulting (Manchester), Merchant Exchange, 17-19 Whitworth Street , Manchester, UK, M1 5WG
Project: Swan House
Clients Project No: B077409

Project No: 21/01179
Date Received: 08/02/2021 (am)
Cool Box Temperatures (°C): 5.5 & 6.2

Lab Sample ID	21/01179/25	21/01179/26
Client Sample No		
Client Sample ID/Depth	BH101A 5-5.45m	BH101A 12-12.45m
Date Sampled	19/01/21	20/01/21
Deviation Code		
F	✓	✓

Key

F Maximum holding time exceeded between sampling date and analysis for analytes listed below

HOLDING TIME EXCEEDANCES

Lab Sample ID	21/01179/25	21/01179/26
Client Sample No		
Client Sample ID/Depth	BH101A 5-5.45m	BH101A 12-12.45m
Date Sampled	19/01/21	20/01/21
Sulphate (water sol 2:1)	✓	✓

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

F.A.O.

Final Test Report - 2280408 / 1

Site: Swan House
Job Number: 2280408
Originating Client: Envirolab Ltd
Originating Reference: 2280408
Date Sampled: 19/01/2021
Date Scheduled: 10/02/2021
Date Testing Started: 12/02/2021
Date Testing Finished: 24/02/2021

Previous Reports		Amendments	Date Issued

Amendments:

Authorised By:



Tim Robinson
Quality Supervisor

Report Issue Date: 25/02/2021



Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

Page: 2

**Determination of Water Content, Liquid Limit and Plastic Limit
and Derivation of Plasticity and Liquidity Index**

Borehole / Trial Pit	Depth (m)	Sample	Natural Moisture Content %	Natural - Stones removed by hand Sieved - Washed on 425 µm sieve			Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
				Natural / Sieved	Percentage Passing %	Moisture Content %						
BH101A	1.00	D	34	Natural	100	34	54	25	29	0.31	CH	Brown silty CLAY
BH101A	5.00	U	22	Natural	98	22	40	20	20	0.11	CI	Brown slightly silty, gravelly CLAY
BH101A	9.00	D	15	Natural	96	15	33	16	17	-0.03	CL	Brown slightly gravelly, silty CLAY
BH101A	12.00	U	14									Brown silty CLAY
BH102	2.00	D	18	Natural	99	18	42	19	23	-0.04	CI	Brown silty CLAY
BH102	4.50	D	18	Natural	97	18	39	18	21	0.02	CI	Brown slightly gravelly, silty CLAY
BH102	7.00	D	16	Natural	96	16	32	14	18	0.13	CL	Brown silty CLAY
BH102	11.50	D	18	Natural	97	18	40	20	20	-0.08	CI	Brown slightly gravelly, silty CLAY
BH103	5.00	U	20									Brown silty CLAY
BH103	10.50	D	15	Natural	100	15	33	17	16	-0.13	CL	Brown silty CLAY

Method of Preparation: BS 1377 : Part 1 : 1990 : Clause 7 Preparation of disturbed samples for testing
BS 1377 : Part 1 : 2016 : Clause 8.4.3 Preparation of samples for plasticity tests
BS 1377 : Part 2 : 1990 : Clause 4.2 Preparation of samples for plastic limit tests

Method of Test: BS 1377 : Part 2 : 1990 : Clause 3.2 Determination of moisture content
BS 1377 : Part 2 : 1990 : Clause 4.3 or 4.4 Determination of the liquid limit
BS 1377 : Part 2 : 1990 : Clause 5.3 Determination of the plastic limit and plasticity index



Results reported relate only to the samples tested.

Site: Swan House

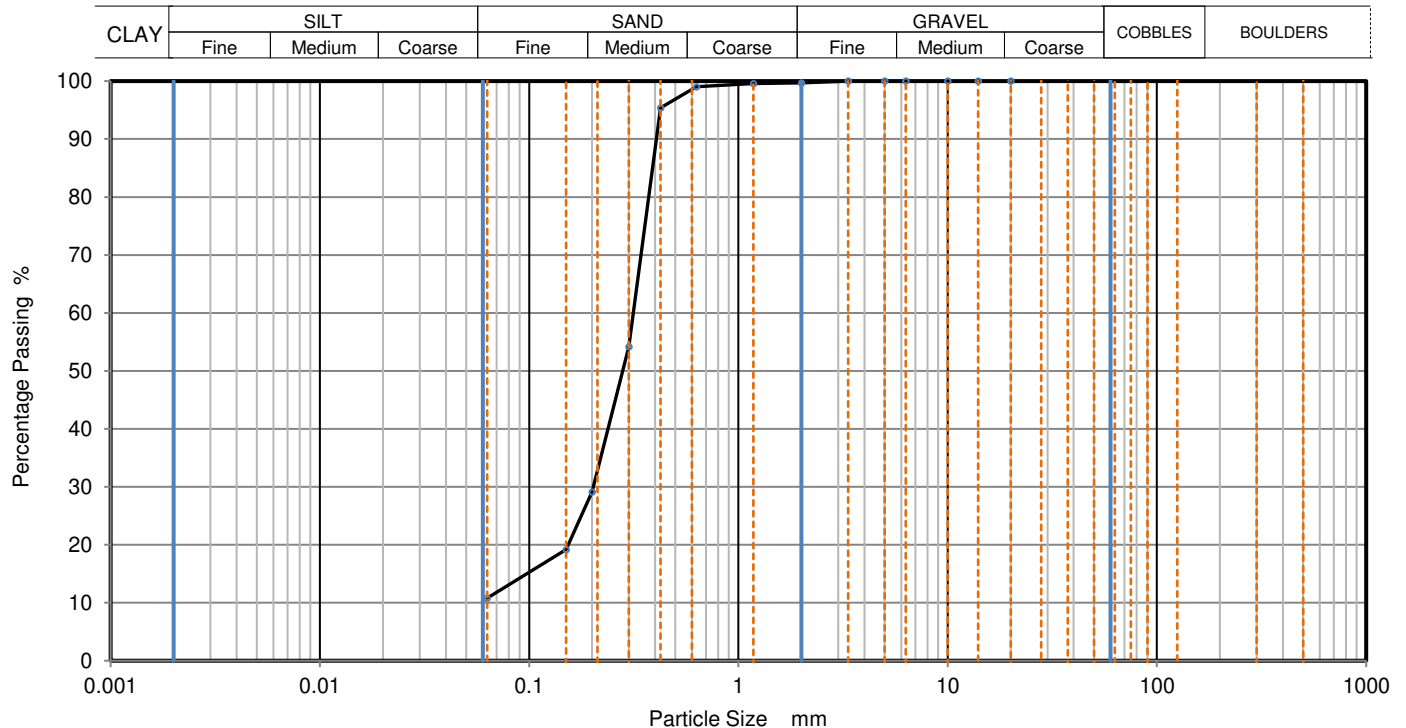
Job Number: 2280408

Client: Envirolab Ltd

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH103	19.00	D	Wet Sieve	Brown silty SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.63	99		
0.425	95		
0.3	54		
0.2	29		
0.15	19		
0.063	11		

Dry Mass of sample, g
114

Sample Proportions	% dry mass
Very coarse	0
Gravel	0
Sand	89
Fines <0.063mm	11

Grading Analysis		
D100	mm	3.35
D60	mm	0.315
D30	mm	0.203
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Method of Preparation: BS EN 17892:Part4:2016, clause 5.2.2 Preparation of samples for wet sieving test

Method of Test: BS EN 17892:Part4:2016, clause 5.2.3 Determination of particle size distribution by wet sieving method

Result reported relates only to the sample tested.

Site: Swan House

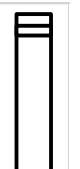
Job Number: 2280408

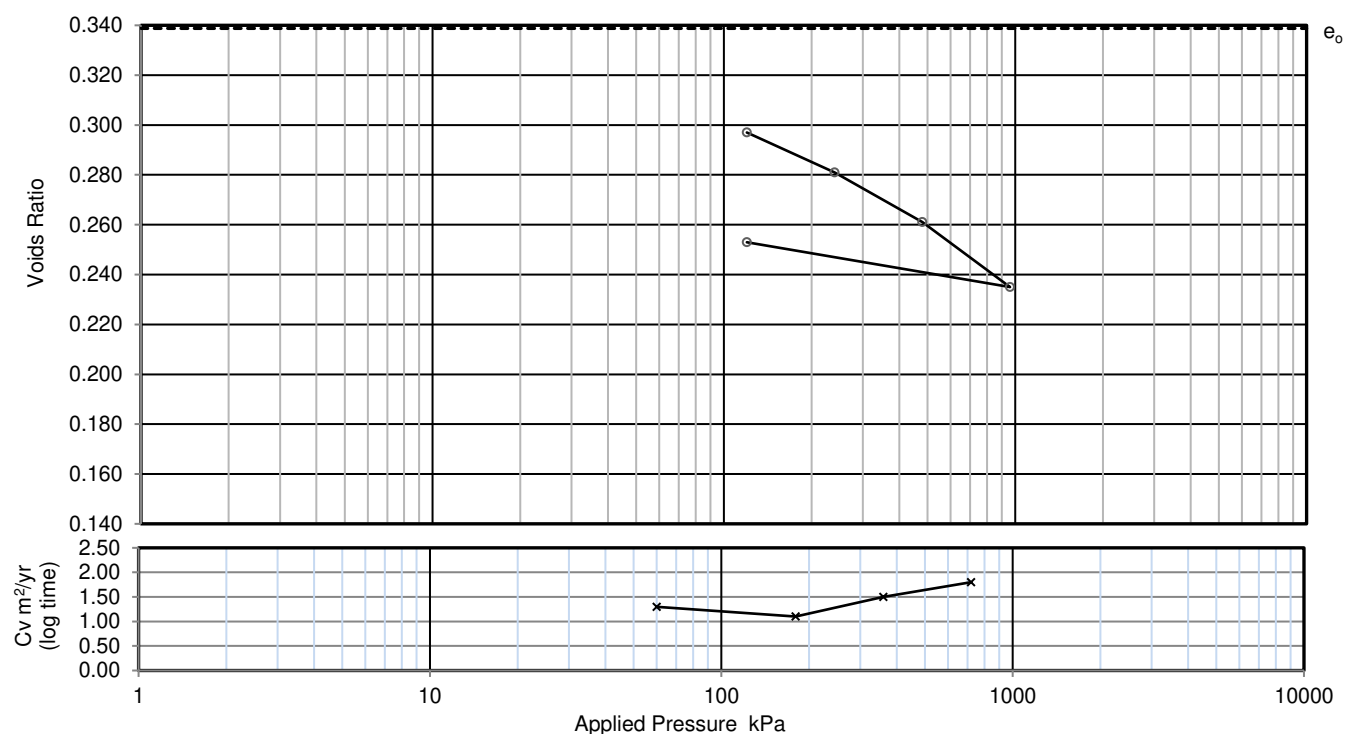
Client: Envirolab Ltd

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DETERMINATION OF THE ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Borehole / Trial Pit	Depth (m)	Sample	Description
BH101A	12.00	U	Brown silty CLAY

Initial Specimen		Length of Sample (mm)	357.15	Diameter (mm)	74.94
		Depth from top of specimen (mm)	41.61	Particle density (Mg/m ³)	2.65 assumed
		Condition of Sample:	Undisturbed	Swelling Pressure (kPa)	
		Orientation:	Vertical	Lab Temp. (°C)	20



Applied Pressure kPa	Mv m²/MN	Cv (t50, log) m²/yr	Cv (t90, root) m²/yr	Csec	Voids ratio
0.0	-	-	-	-	0.339
120	0.26	1.3	15	0.00041	0.297
240	0.1	1.1	2.8	0.00065	0.281
480	0.067	1.5	2.6	0.0013	0.261
960	0.043	1.8	2.3	0.0019	0.235
120	0.017				0.253

	Initial	Final
Height (mm)	19.91	18.63
Moisture Content (%)	15	14
Bulk density (Mg/m ³)	2.28	2.40
Dry density (Mg/m ³)	1.98	2.12
Voids Ratio	0.339	0.253
Degree of Saturation (%)	120	143

Remarks:

Method of Preparation: BS 1377:Part 5:1990, clause 3.3 Preparation of specimen
BS 1377:Part 5:1990, clause 3.4 Preparation and assembly of apparatus

Method of Test: BS 1377:Part 5:1990, clause 3.5 Determination of the one-dimensional consolidation properties



Site: Swan House

Job Number: 2280408

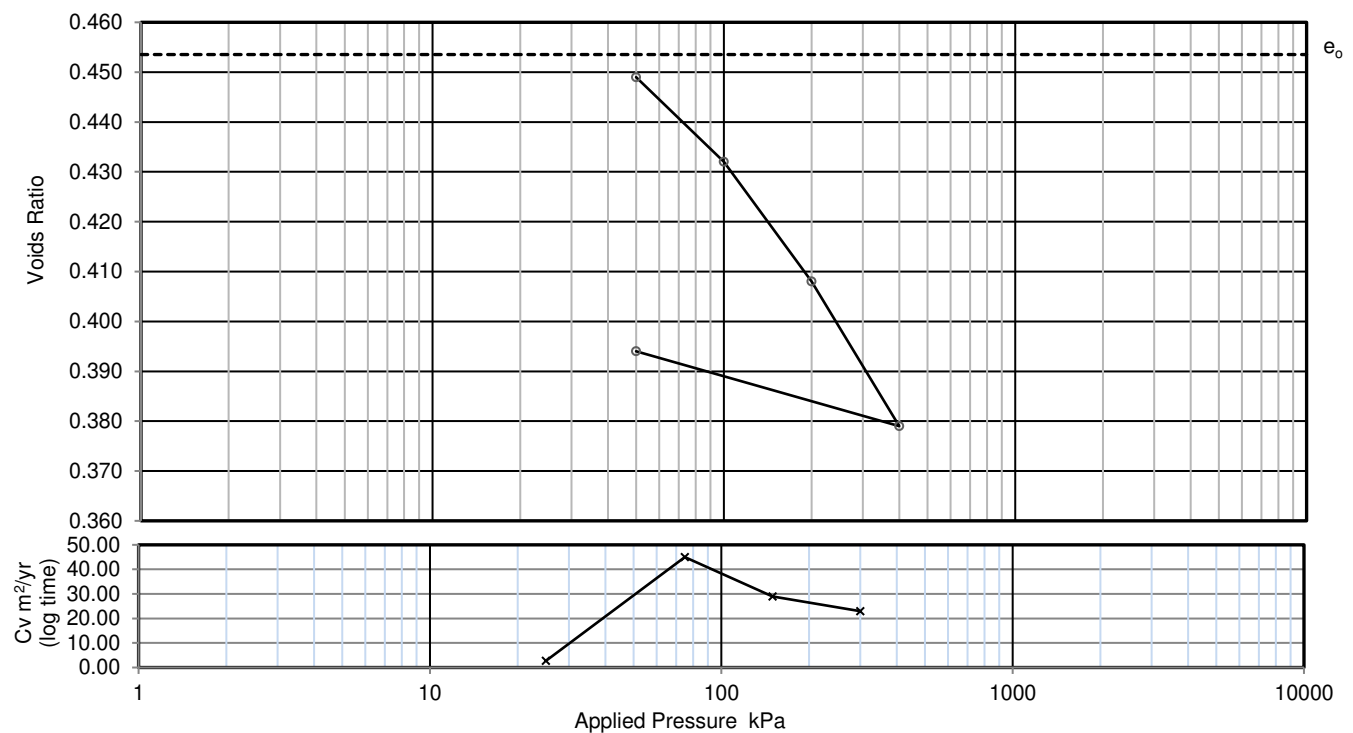
Client: Envirolab Ltd

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DETERMINATION OF THE ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Borehole / Trial Pit	Depth (m)	Sample	Description
BH103	5.00	U	Brown silty CLAY

Initial Specimen		Length of Sample (mm)	438.54
		Depth from top of specimen (mm)	269.95
		Condition of Sample:	Undisturbed
		Orientation:	Vertical
		Diameter (mm)	74.74
		Particle density (Mg/m³)	2.65 assumed
		Swelling Pressure (kPa)	
		Lab Temp. (°C)	20



Applied Pressure kPa	Mv m²/MN	Cv (t50, log) m²/yr	Cv (t90, root) m²/yr	Csec	Voids ratio
0.0	-	-	-	-	0.454
50	0.064	2.7	26	0.00067	0.449
100	0.24	45	30	0.0015	0.432
200	0.16	29	26	0.0019	0.408
400	0.11	23	45	0.0025	0.379
50	0.032				0.394

	Initial	Final
Height (mm)	20.29	19.46
Moisture Content (%)	19	19
Bulk density (Mg/m ³)	2.17	2.26
Dry density (Mg/m ³)	1.82	1.90
Voids Ratio	0.454	0.394
Degree of Saturation (%)	113	128

Remarks:

Method of Preparation: BS 1377:Part 5:1990, clause 3.3 Preparation of specimen
BS 1377:Part 5:1990, clause 3.4 Preparation and assembly of apparatus

Method of Test: BS 1377:Part 5:1990, clause 3.5 Determination of the one-dimensional consolidation properties



Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

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Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

Borehole / Trial Pit	Depth (m)	Sample	Description
BH101A	5.00	U	Brown slightly silty, gravelly CLAY

Initial Sample	Original Length (mm)	424.39		
	Depth from Top (mm)	22.71		
	Condition	Undisturbed		
	Orientation	Vertical		
Length (mm)		209.30		
Diameter (mm)		101.91		
Moisture Content (%)		22.4		
Bulk Density (Mg/m ³)		2.15		
Dry Density (Mg/m ³)		1.75		
Membrane Thickness (mm)		0.18		
Membrane Type		Latex		
Rate of Strain (%/min)		1.91		
Test Results	Stage Number	1	2	3
	Cell Pressure (kPa)	25	50	100
	Axial Strain (%)	11	13	20
	Membrane Corr. (kPa)	0.4	0.5	0.7
	Deviator Stress ($\sigma_1 - \sigma_3$)f (kPa)	154	172	202
	Undrained Shear Strength, $c_u = \frac{1}{2}(\sigma_1 - \sigma_3)f$ (kPa)	77	86	101
	Mode of Failure	Plastic		

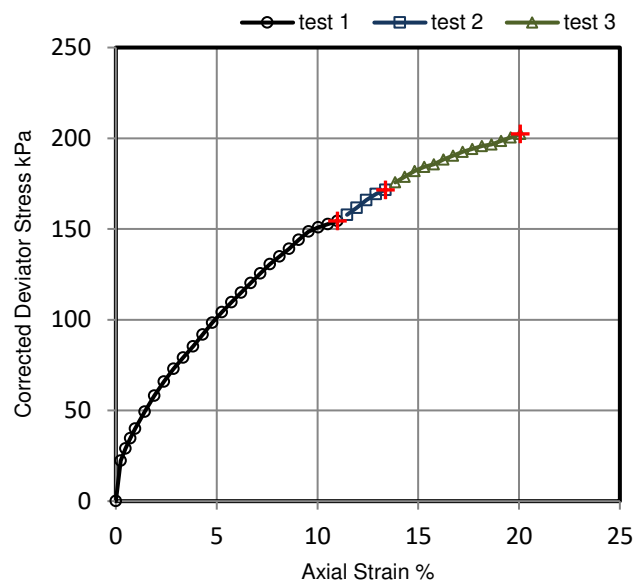
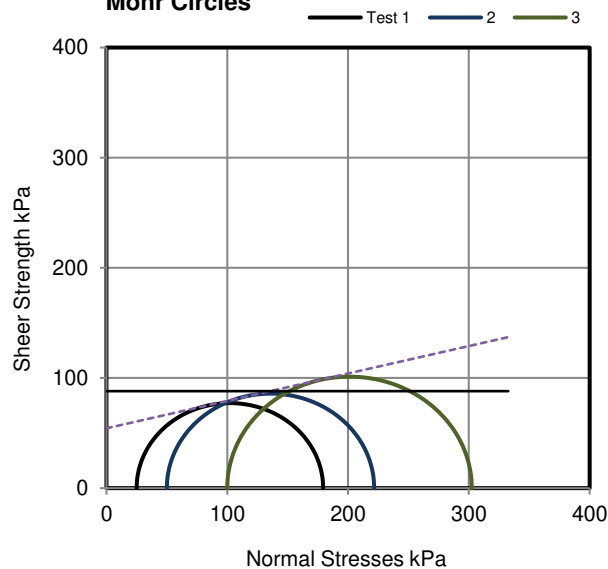
 $\phi_u = 0$

Average c_u 88 kPa

Linear Regression

 ϕ_u 14.0 °

 c_u 54 kPa

Deviator Stress v Axial Strain

Mohr Circles


Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:9.4 Determination of undrained shear strength in triaxial compression with
multistage loading and without measurement of pore pressure (Definitive method)

Result reported relates only to the sample tested.



Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

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Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

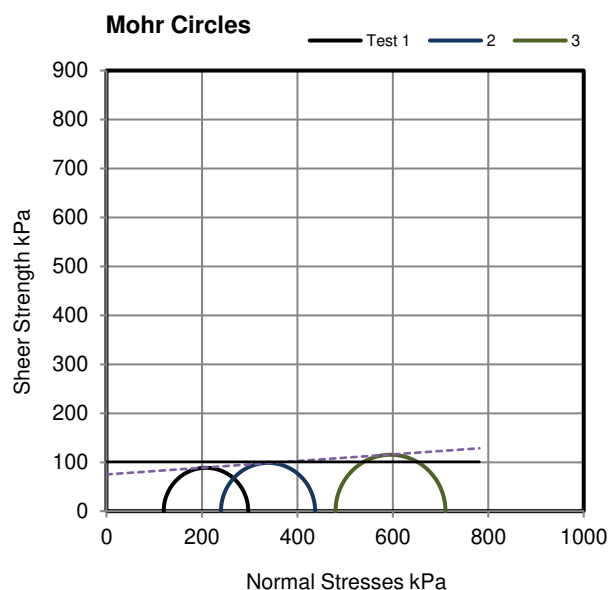
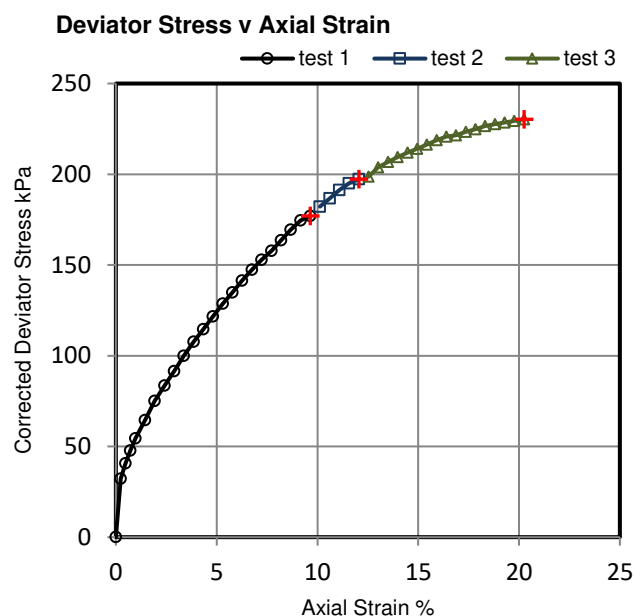
Borehole / Trial Pit	Depth (m)	Sample	Description
BH101A	12.00	U	Brown silty CLAY

Initial Sample	Original Length (mm)	357.15		
	Depth from Top (mm)	130.01		
	Condition	Undisturbed		
	Orientation	Vertical		
Length (mm)		207.43		
Diameter (mm)		102.31		
Moisture Content (%)		14.2		
Bulk Density (Mg/m ³)		2.19		
Dry Density (Mg/m ³)		1.92		
Membrane Thickness (mm)		0.28		
Membrane Type		Latex		
Rate of Strain (%/min)		1.93		
Test Results	Stage Number	1	2	3
	Cell Pressure (kPa)	120	240	480
	Axial Strain (%)	10	12	20
	Membrane Corr. (kPa)	0.6	0.7	1.1
	Deviator Stress ($\sigma_1 - \sigma_3$)f (kPa)	177	197	230
	Undrained Shear Strength, $c_u = \frac{1}{2}(\sigma_1 - \sigma_3)f$ (kPa)	89	99	115
	Mode of Failure	Plastic		

 $\phi_u = 0$

Average c_u 101 kPa

Linear Regression

 ϕ_u 3.9 °
 c_u 75 kPa


Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:9.4 Determination of undrained shear strength in triaxial compression with
multistage loading and without measurement of pore pressure (Definitive method)

Result reported relates only to the sample tested.

Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

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Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

Borehole / Trial Pit	Depth (m)	Sample	Description
BH102	3.00	U	Brown silty CLAY

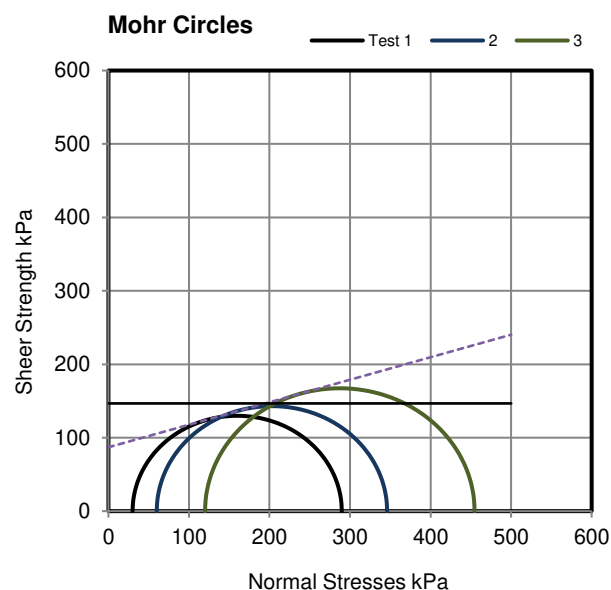
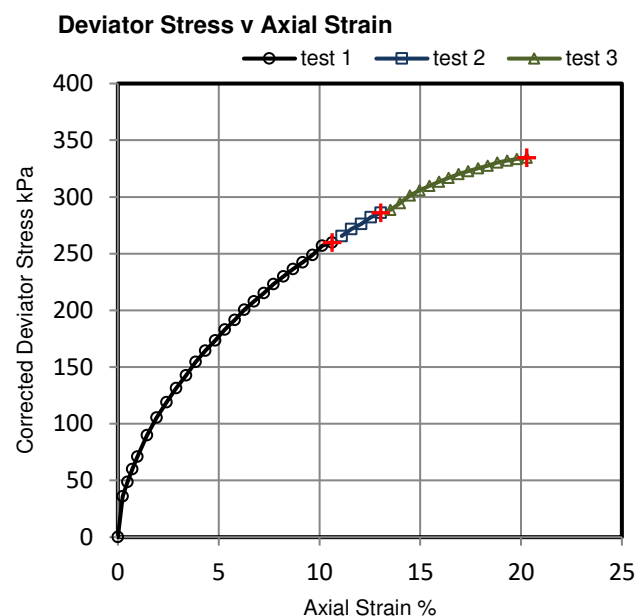
Initial Sample	Original Length (mm)	312.91		
	Depth from Top (mm)	35.49		
	Condition	Undisturbed		
	Orientation	Vertical		
Length (mm)		207.13		
Diameter (mm)		102.44		
Moisture Content (%)		17		
Bulk Density (Mg/m ³)		2.12		
Dry Density (Mg/m ³)		1.81		
Membrane Thickness (mm)		0.3		
Membrane Type		Latex		
Rate of Strain (%/min)		1.93		
Test Results	Stage Number	1	2	3
	Cell Pressure (kPa)	30	60	120
	Axial Strain (%)	11	13	20
	Membrane Corr. (kPa)	0.7	0.8	1.1
	Deviator Stress ($\sigma_1 - \sigma_3$)f (kPa)	260	286	335
	Undrained Shear Strength, $c_u = \frac{1}{2}(\sigma_1 - \sigma_3)f$ (kPa)	130	143	167
	Mode of Failure	Plastic		

 $\phi_u = 0$

Average c_u 147 kPa

Linear Regression

 ϕ_u 17.0 °

 c_u 87 kPa


Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:9.4 Determination of undrained shear strength in triaxial compression with
multistage loading and without measurement of pore pressure (Definitive method)

Result reported relates only to the sample tested.

Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

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Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

Borehole / Trial Pit	Depth (m)	Sample	Description
BH103	5.00	U	Brown silty CLAY

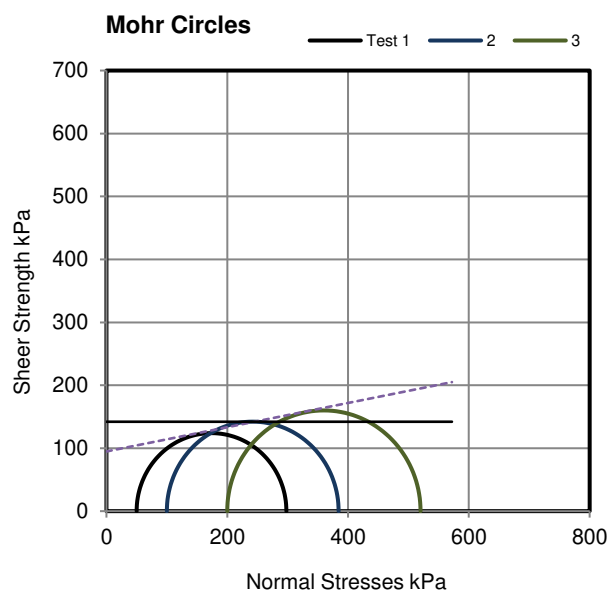
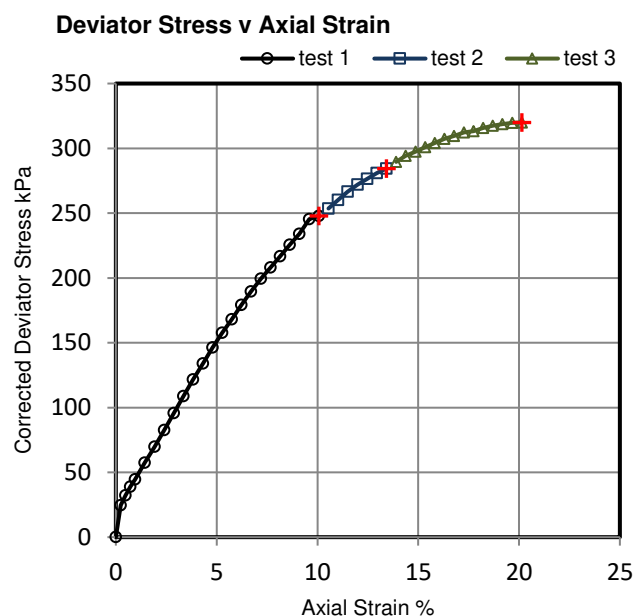
Initial Sample	Original Length (mm)	438.54		
	Depth from Top (mm)	41.38		
	Condition	Undisturbed		
	Orientation	Vertical		
Length (mm)		208.60		
Diameter (mm)		101.39		
Moisture Content (%)		19.6		
Bulk Density (Mg/m ³)		2.15		
Dry Density (Mg/m ³)		1.80		
Membrane Thickness (mm)		0.26		
Membrane Type		Latex		
Rate of Strain (%/min)		1.92		
Test Results	Stage Number	1	2	3
	Cell Pressure (kPa)	50	100	200
	Axial Strain (%)	10	13	20
	Membrane Corr. (kPa)	0.6	0.7	1.0
	Deviator Stress ($\sigma_1 - \sigma_3$)f (kPa)	248	284	320
	Undrained Shear Strength, $c_u = \frac{1}{2}(\sigma_1 - \sigma_3)f$ (kPa)	124	142	160
	Mode of Failure	Plastic		

 $\phi_u = 0$

Average c_u 142 kPa

Linear Regression

 ϕ_u 10.9 °

 c_u 95 kPa


Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:9.4 Determination of undrained shear strength in triaxial compression with multistage loading and without measurement of pore pressure (Definitive method)

Result reported relates only to the sample tested.





Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

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ROCK INDEX TESTS - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock description / Rock type	Natural Water Content ¹ %	Caliper ²		Buoyancy ³		Natural Bulk density Mg/m ³	Remarks
					Dry density Mg/m ³	Porosity %	Dry density Mg/m ³	Porosity %		
BH101A	26.14	C	Red SANDSTONE	10.1						
BH101A	26.93	C	Red SANDSTONE	10.8						
BH101A	29.84	C	Red SANDSTONE	12.1						
BH101A	36.93	C	Red SANDSTONE	11.2						
BH101A	38.73	C	Red SANDSTONE	10.7						
BH102	29.00	C	Red SANDSTONE	11.6						
BH102	33.06	C	Red SANDSTONE	11.3						
BH102	39.68	C	Red SANDSTONE	10.2						
BH103	25.78	C	Red SANDSTONE	12.4						
BH103	30.12	C	Red SANDSTONE	10.8						
BH103	34.28	C	Red SANDSTONE	14.4						
BH103	39.08	C	Red SANDSTONE	13.4						

Notes 1. ISRM p87 test 1, water content at 105 ± 3 oC, specimen as received at the laboratory 3. ISRM p88 test 3, Porosity/density determination using saturation and buoyancy
2. ISRM p87 test 2, Porosity/density determination using saturation and caliper 2/3. pore volume determined by water saturation

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water content of a rock sample

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water content of a rock sample

Results reported relate only to the samples tested.

Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

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UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions ²			Bulk Density ² Mg/m ³	Water Content 1 %	Uniaxial Compression ³				Remarks
				Dia. mm	Length mm	H/D			Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
BH101A	24.10	C	Red SANDSTONE	85.7	181.0	*2.1	2.09	11.1	as received	0.5026	AC	7.0	
BH101A	30.66	C	Red SANDSTONE	85.9	192.2	*2.2	2.12	13.2	as received	0.5004	S	12.5	
BH101A	32.86	C	Red SANDSTONE	86.2	231.5	2.7	2.18	13.7	as received	0.4971	AC	13.6	
BH101A	35.85	C	Red SANDSTONE	85.1	95.1	*1.1	2.13	18.7	as received	0.5095	AC	6.1	
BH102	27.78	C	Red SANDSTONE	85.9	136.7	*1.6	2.14	11.9	as received	0.5003	MS	9.6	
BH102	31.52	C	Red SANDSTONE	84.8	111.7	*1.3	2.11	12.7	as received	0.5131	MS	7.6	
BH102	34.34	C	Red SANDSTONE	85.1	138.9	*1.6	2.18	14.0	as received	0.5098	S	8.2	
BH102	35.83	C	Red SANDSTONE	85.3	150.9	*1.8	2.14	10.9	as received	0.5069	MS	11.2	
BH103	28.20	C	Red SANDSTONE	85.4	95.7	*1.1	2.07	13.5	as received	0.5057	MS	3.7	
BH103	32.29	C	Red SANDSTONE	86.8	153.2	*1.8	2.05	11.0	as received	0.4896	AC	5.2	
BH103	37.28	C	Red SANDSTONE	87.5	216.2	2.5	2.04	12.3	as received	0.4825	MS	11.8	

Notes 1 ISRM p87 test 1, water content at 105 ± 3 °C, specimen as tested for UCS

*Denotes length diameter ratio outside ISRM specification

2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

Mode of failure :

3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

S - Single shear MS - multiple shear

above notes apply unless annotated otherwise in the remarks

AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Results reported relate only to the samples tested.

Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
BH101A	26.14	C	Red SANDSTONE As received	D	PL	YES	85.8	85.2	85.2	82.2	0.7	85.2	0.10	0.12	
BH101A	26.14	C	Red SANDSTONE As received	A	PD	YES		85.5	81.6	64.6	1.7	94.3	0.19	0.25	
BH101A	26.93	C	Red SANDSTONE As received	D	PL	YES	87.1	85.6	85.6	84.6	0.5	85.6	0.06	0.08	
BH101A	26.93	C	Red SANDSTONE As received	A	PD	YES		86.1	95.3	83.3	0.8	102.2	0.08	0.11	
BH101A	29.84	C	Red SANDSTONE As received	D	U	YES	53.7	86.3	86.3	84.3	0.8	86.3	0.11	0.15	
BH101A	29.84	C	Red SANDSTONE As received	A	U	YES		86.3	55.8	48.8	1.5	78.3	0.25	0.31	
BH101A	36.93	C	Red SANDSTONE As received	D	PL	YES	106.4	86.5	86.5	84.5	1.0	86.5	0.13	0.17	
BH101A	36.93	C	Red SANDSTONE As received	A	PD	NO		86.4	104.1	94.1	2.1	107.0	0.18	0.26	
BH101A	38.73	C	Red SANDSTONE As received	D	U	YES	145.0	86.8	86.8	84.8	0.4	86.8	0.06	0.07	
BH101A	38.73	C	Red SANDSTONE As received	A	U	NO		84.0	129.3	123.3	1.4	117.6	0.10	0.15	
BH102	29	C	Red SANDSTONE As received	D	U	YES	87.8	85.6	85.6	81.6	0.4	85.6	0.06	0.07	
BH102	29	C	Red SANDSTONE As received	A	U	YES		85.9	86.1	80.1	1.0	97.0	0.10	0.14	
BH102	33.06	C	Red SANDSTONE As received	D	PL	YES	100.7	86.5	86.5	85.5	0.0	86.5	0.01	0.01	
BH102	33.06	C	Red SANDSTONE As received	A	PD	NO		86.2	99.0	90.0	1.7	104.2	0.16	0.22	
BH102	39.68	C	Red SANDSTONE As received	D	U	YES	84.2	86.8	86.8	73.8	1.7	86.8	0.23	0.29	
BH102	39.68	C	Red SANDSTONE As received	A	U	YES		88.0	86.8	64.8	2.4	98.6	0.24	0.33	
BH103	25.78	C	Red SANDSTONE As received	D	U	YES	56.6	85.0	85.0	77.0	0.2	85.0	0.03	0.04	
BH103	25.78	C	Red SANDSTONE As received	A	U	YES		85.6	63.4	51.4	0.7	83.1	0.10	0.12	
BH103	30.12	C	Red SANDSTONE As received	D	U	YES	104.7	85.4	85.4	74.4	0.5	85.4	0.07	0.09	
BH103	30.12	C	Red SANDSTONE As received	A	U	YES		86.0	98.0	84.0	0.8	103.6	0.07	0.10	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block

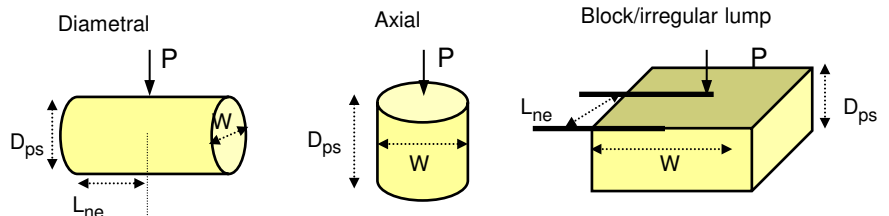
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random

Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Results reported relate only to the samples tested.

Site: Swan House

Job Number: 2280408

Client: Envirolab Ltd

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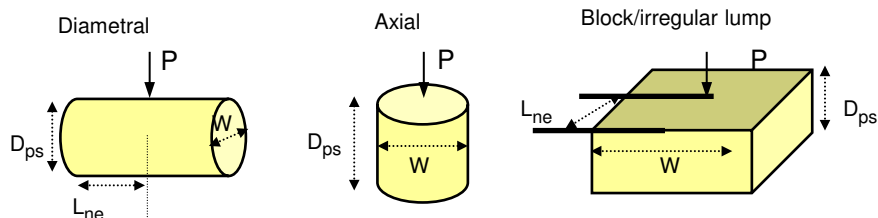
Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
BH103	34.28	C	Red SANDSTONE As received	D	PL	YES	86.0	84.3	84.3	70.3	0.8	84.3	0.12	0.15	
BH103	34.28	C	Red SANDSTONE As received	A	PD	YES		84.5	74.1	58.1	1.4	89.3	0.17	0.22	
BH103	39.08	C	Red SANDSTONE As received	D	U	YES	67.0	85.6	85.6	72.6	0.6	85.6	0.09	0.11	
BH103	39.08	C	Red SANDSTONE As received	A	U	YES		86.6	58.8	44.8	0.8	80.5	0.12	0.15	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random

Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, $F = (De/50)^{0.45}$ for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Results reported relate only to the samples tested.



Final Test Report - 2280408 / 1

Site: Swan House

Job Number: 2280408

Originating Client: Envirolab Ltd

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

This test report shall not be reproduced, except in full and only with the written permission of Ian Farmer Associates Ltd.

Samples will be retained for 28 days from date of issue of the final test report before being disposed of, unless we receive written instruction to the contrary.

Report Issue Date: 25/02/2021

Appendix E – Ground Gas Monitoring Results

- 2018 Investigation
 - Visits 1 – 6, September 2018 – January 2019
 - Gas Monitor Calibration certificate, serial no. 321234
- 2021 Pre-Demolition Investigation.
 - Visits 1 – 4, February to March 2021
 - Gas Monitor Calibration certificate, serial no 326664

Curtins

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

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Fax: 0161 228 7902

**GAS MONITORING LOG SHEET**

Project: Swan House, Manchester **Date:** 25/09/2018
Job Number: B067266.201 **Visit:** 1
Client: Foundation Real Estate **Weather:** Sunny
Barometric State: Falling **Ground Conditions:** Boreholes located inside

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	1027	0.0	0.0	0.0	0.0	1.0	1.0	18.0	1	1	Dry	4.15	
WS02	1027	0.0	0.0	0.0	0.0	4.3	4.3	13.1	0	1	Dry	4.95	
WS03	1028	0.0	0.0	0.0	0.0	0.0	0.0	20.7	1	1	2.73	2.75	
WS04	1028	0.0	0.0	0.0	0.0	0.3	0.3	20.3	0	0	Dry	2.23	
WS06	1029	0.0	0.0	0.0	0.0	1.4	1.4	17.0	0	0	2.73	4.75	
WS07	1029	0.0	0.0	0.0	0.0	0.4	0.4	18.3	1	1	1.23	4.85	

Notes**Logged by**

SH

*1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.**All other gases recorded at 'steady state' unless otherwise stated*

Curtins

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GAS MONITORING LOG SHEET

Project:	Swan House, Manchester	Date:	10/10/2018
Job Number:	B067266.201	Visit:	2
Client:	Foundation Real Estate	Weather:	Sunny
Barometric State:	Falling	Ground Conditions:	Boreholes located inside

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	1003	0.0	0.0	0.0	0.0	1.9	1.9	17.00	1	5	Dry	4.13	1
WS02	1004	0.0	0.0	0.0	0.0	4.6	4.6	14.10	1	3	4.61	4.82	
WS03	1004	0.0	0.0	0.0	0.0	0.0	0.0	20.80	2	0	2.7	2.89	
WS04	1004	0.0	0.0	0.0	0.0	0.3	0.3	20.30	0	5	Dry	2.23	
WS06	1005	-0.2	0.0	0.0	0.0	1.0	1.0	19.80	0	3	2.46	3.70	
WS07	1006	0.0	0.0	0.0	0.0	0.3	0.3	20.7	0	3	1.19	4.74	

Notes

1 - Steady state flow rate achieved after 1 second.

Logged by

MH

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.

All other gases recorded at 'steady state' unless otherwise stated

Curtins

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GAS MONITORING LOG SHEET

Project: Swan House, Manchester**Date:** 23/10/2018**Job Number:** B067266.201**Visit:** 3**Client:** Foundation Real Estate**Weather:** Overcast, breezy**Barometric State:** Falling**Ground Conditions:** Boreholes located inside

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	1021	0.0	0.0	0.0	0.0	1.8	1.8	17.6	0	0	Dry	4.10	
WS02	1021	0.0	0.0	0.0	0.0	4.4	4.4	14.7	2	0	4.55	4.85	
WS03	1021	0.0	0.0	0.0	0.0	0.3	0.2	20.5	0	0	2.70	2.95	
WS04	1021	0.0	0.0	0.0	0.0	0.3	0.3	20.4	0	6	Dry	2.24	
WS06													1
WS07													1

Notes

1 - borehole inaccessible

Logged by

SH

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.

All other gases recorded at 'steady state' unless otherwise stated

Curtins

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GAS MONITORING LOG SHEET

Project: Swan House, Manchester**Date:** 13/11/2018**Job Number:** B067266.201**Visit:** 4**Client:** Foundation Real Estate**Weather:** Clear**Barometric State:** Steady**Ground Conditions:** Boreholes located inside

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	998	0.3	0.0	0.0	0.0	2.1	2.1	17.9	0	0	Dry	4.13	
WS02	999	0.0	0.0	0.0	0.0	4.8	4.8	14.6	0	0	4.52	4.88	
WS03	998	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0	0	2.75	3.14	
WS04	999	0.7	0.0	0.0	0.0	2.0	2.0	20.3	0	0	Dry	2.24	
WS06	999	0.0	0.0	0.0	0.0	0.9	0.9	19.9	0	0	2.60	4.72	
WS07	1000	0.0	0.0	0.0	0.0	0.1	0.1	20.5	0	0	1.24	2.76	

Notes**Logged by**

MH

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.

All other gases recorded at 'steady state' unless otherwise stated

Curtins

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

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Fax: 0161 228 7902

**GAS MONITORING LOG SHEET****Project:** Swan House, Manchester**Date:** 23/01/2019**Job Number:** B067266.201**Visit:** 5**Client:** Foundation Real Estate**Weather:** Foggy & cold**Barometric State:** Steady**Ground Conditions:** Boreholes located inside

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	997	-0.6	-0.6	0.0	0.0	1.9	1.9	18.8	2	1	Dry	4.10	
WS02	997	-0.6	-0.6	0.0	0.0	5.4	5.4	15.0	1	0	4.45	4.90	
WS03	998	-0.6	-0.6	0.0	0.0	0.2	0.2	20.8	2	1	2.75	3.15	
WS04	997	-0.6	-0.6	0.0	0.0	0.3	0.3	20.5	7	7	Dry	2.25	
WS06	997	-0.6	-0.6	0.0	0.0	0.9	0.9	20.1	2	0	3.00	4.70	
WS07	997	-0.6	-0.6	0.0	0.0	0.7	0.7	18.7	2	0	1.20	4.75	

Notes**Logged by**

JB

*1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.**All other gases recorded at 'steady state' unless otherwise stated*

Curtins

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Tel: 0161 236 2394

Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project: Swan House, Manchester**Date:** 31/01/2019**Job Number:** B067266.201**Visit:** 6**Client:** Foundation Real Estate**Weather:** Sunny**Barometric State:** Falling**Ground Conditions:** Boreholes located inside

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01													1
WS02	983	0.0	0.0	0.0	0.0	5.0	5.0	15.7	0	0	5.31	5.70	
WS03	984	0.0	0.0	0.0	0.0	0.1	0.1	20.9	1	0	2.75	3.12	
WS04	985	0.1	0.0	0.0	0.0	0.3	0.3	20.7	1	0	Dry	3.00	
WS06													1
WS07													1

Notes

1 No access to the basement.

Logged by

RT

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.

All other gases recorded at 'steady state' unless otherwise stated

TEST DATE AND CONDITIONS			
Date	18/12/18		
Atmospheric Pressure	986	mB	
Ambient Temperature	22	°C	
EnviroNics Serial No.	5089		

**GFM430 Final Inspection & Calibration
Check Certificate**

GAS DATA LTD

Unit 4, Fairfield Court

Seven Stars Estate

Wheler Rd

Coventry

CV3 4LJ

Tel 02476303311

Fax 02476307711



Customer	Curtins Consulting
Certificate Number	120678
Order Number	321234

Serial Number	10357
Software Version	G430-00.0024/0013

Recalibration DUE Date
18/12/19

Instrument Checks					
Keyboard	✓		Display Contrast	✓	
Pump Flow In	400	Accept > 200 cc/min	Pump Flow @ -200mB	300	Accept > 200 cc/min
Clock Set / Running	✓		Labels Fitted	✓	

Gas Checks						
Sensor	CH ₄		CO ₂		O ₂	
	Instrument Gas	True Gas Value %	Instrument Gas	True Gas Value %	Instrument Gas	True Gas Value %
	Readings %		Readings %		Readings %	
	59.7	60	40.4	40	20.9	20.9
	Accept ±3.0		Accept ±3.0		Accept ±0.5	
	5	5	5	5	6	6
	Accept ±0.3		Accept ±0.3		Accept ±0.3	
Zero Reading 100% N ₂	0	0	0	0	0	0
	Accept ±0.0		Accept ±0.0		Accept ±0.1	

Optional Gas Checks						
Applied Gas & Range		Concentration Tested @ (ppm)	Instrument Readings (ppm)			
Toxic Gas	Range (ppm)		Zero Reading		Instrument Gas Reading	
H ₂ S	5000	1500	0	Accept ±0.0	1500	Accept ±5.0
CO	2000	1000	0	Accept ±0.0	1000	Accept ±5.0

Cross Gas Effects									
Applied Gas (ppm)		Instrument Readings (ppm)							
Toxic Gas	Concentration	Toxic 1:	H2S	Toxic 2:	CO	Toxic 3:			
H2S	1500	1500		0					
CO	1000	80		1000					
Pressure Checks									
Atmospheric Pressure [AP] (mB)					Static Pressure [SP] (mB)				
Current Atmospheric		Instrument Atmospheric			Applied Pressure (mB)		Instrument Pressure (mB)		
Pressure (mB)		Pressure Reading (mB)							
All Ports		Open Ports		986	Accept ± 2.0	0.0mB	N/A	Accept ± 0.0	
AP Port (Internal)		+800 mB		800	Accept ± 5.0	+50mB	N/A	Accept ± 2.0	
AP Port (Internal)		+1200mb		1200	Accept ± 5.0	-100mB	N/A	Accept ± 2.0	
Flow Checks									
Borehole Flow					Differential Pressure				
Applied Reading (l/h)		Instrument Reading (l/h)			Applied Pressure (Pa)		Instrument Reading (Pa)		
-30	-30.1	Accept ± 3.0			-321	-319	Accept ± 50		
-3	-3	Accept ± 1.0			-15	-15	Accept ± 6.0		
0	0	Accept ± 0.0			0	0	Accept ± 0.5		
3	3.1	Accept ± 0.5			15	16	Accept ± 3.0		
30	29.8	Accept ± 3.0			320	312	Accept ± 50		
60	59.8	Accept ± 6.0			964	955	Accept ± 130		
90	90.1	Accept ± 9.0			1908	1925	Accept ± 250		
		Temperature Checks							
		Calibration Temperature			Instrument Temperature Reading °C				
		Applied Temperature °C							
		-10			-10	Accept ± 2.0			
		0			0	Accept ± 1.0			
		30			30	Accept ± 1.0			
		60			60	Accept ± 1.0			
		100			100	Accept ± 1.0			

Technician:
Jack Rutland

Date Tested:
19/12/18

The instrument identified by the serial number stated above has been tested by Gas Data personnel for calibration accuracy on the date and under the ambient conditions stated. Gas Data Ltd internal BS EN ISO9001:2015 compliant workshop procedures were followed to apply known calibration test gases, gas flow rates, pressures and temperatures of the values stated. The results displayed on the instrument at each stage are recorded above.

TEST DATE AND CONDITIONS	
Date	18.12.18
Atmospheric Pressure	986 mB
Ambient Temp	22 °C
EnviroNics Serial No.	50801

GAS DATA LTD

Unit 4, Fairfield Court
Seven Stars Estate
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CV3 4LJ

Tel 02476303311 Fax 02476307711



GFM430 -1 OUTWARD INSPECTION & QUALITY CHECK SHEET

INSTRUMENT DETAILS			
SO Number	Instrument Type	Instrument Serial Number + SW Version	Job Number(s)
221234	GFM430	10357 G430-00.0124/0013	120518

Calibration Technician

Date 18.12.18

Inspection Technician

Date 19.12.18

INSTRUMENT CHECKS		Pass (P), Fail (F) or not applicable (NA)	INSTRUMENT PACKING LIST		Tick if included
Function Tests	Dust Caps Fitted	P	Instrument		✓
	Keyboard Test (All Keys)	P	Leather Case		X
	Backlight	P	Instrument Strap		✓
	Clock Set / Running	P	AC Battery Charger (UK)		X
	Comms Test	P	AC Battery Charger (EURO)		X
	Pump Flow Test (In & Out)	P	AC Battery Charger (US)		X
	Overall Leak Test (30mB)	n/a	AC Battery Charger (AUS)		X
	Battery Charge Test	P	Hard Carry Case		X
	Service Date set to?	18.12.19	Gas Sample Tube - (new issue)		✓
Channel Test	Data Logging Enabled?	P	Flow Sample Tube - (new issue)		✓
	Verify CH4/LEL	P	Spares Pot		X
	Verify CO2	P	Allen Key		X
	Verify O2	P	Temperature Probe		X
	Verify LEL	P	Vane Anemometer		X
	Verify 1 st Option Gas H2S	P	USB Cable		X
	Verify 2 nd Option Gas CO	P	USB Memory stick		X
	Verify 3 rd Option Gas	N/A	SiteMan Software Ver 4.15		X
	Verify 4 th Option Gas	N/A	Internal Filter Pack Qty		X
	Verify Atmospheric pressure	P	External Filter Pack Qty		X
	Verify static pressure	N/A	Field Guide		X
	Verify differential pressure	P	Operation Manual (hard copy)		X
	Verify flow	P	Extra Items: 108 Sample Tube		
	Verify temperature probe input	P			
DataBase Checks	Verify vane anemometer input	P	Comments:		
	Jobcard(s) completed and signed	P			
	Jobcard(s) booked off database	P			
	Calibration certificate completed	P			
Label Checks	Complete & print QI record	n/a			
	No. of Calibration label fitted	GDC 08508			
H2S Range	Warranty label fitted				
	H2S Range from Sales Order	5000 ppm			
	H2S Range from Cal Cert	5000 ppm			
	Over-range value correct?	P			

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	Swan House Additional GI	Date:	05/02/2021
Job Number:	B077409	Visit:	1
Client:	RGCM Ltd	Weather:	Sunny
Barometric State:	Steady	Ground Conditions:	Dry

[illegible]

Notes

- 1 - Steady state air flow rate remained at -0.7 l/hr after 1 minute.
- 2 - No pathway through gas bung for monitoring to be undertaken. Hole made in bung and replaced prior to visit 2.

Logged by _____

MH

1% gas volume = 10,000 ppm
Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.
All other gases recorded at 'steady state' unless otherwise stated

Curtins

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902

**GAS MONITORING LOG SHEET**

Project: Swan House Additional GI **Date:** 11/02/2021
Job Number: B077409 **Visit:** 2
Client: RGCM Ltd **Weather:** Sunny
Barometric State: Steady **Ground Conditions:** Dry

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
BH101A	1020	-1.0	-0.8	0.0	0.0	0.0	0.0	20.9	1	2	14.3	14.40	1
BH102	1020	0.0	0.0	0.0	0.0	0.0	0.0	20.8	0	2	24.63	25.67	
BH103	1020	0.0	0.0	2.2	2.2	0.4	0.4	10.9	1	2	3.59	4.94	
													2

Notes

1 - Steady state air flow rate fluctuated between -1.0 l/hr and -0.8 l/hr.
2 - Lower Explosive Limit = 50.7%

Logged by

MH

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.
All other gases recorded at 'steady state' unless otherwise stated

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	Swan House Additional GI	Date:	18/02/2021
Job Number:	B077409	Visit:	3
Client:	RGCM Ltd	Weather:	Cloudy
Barometric State:	Rising	Ground Conditions:	Dry

Borehole Reference	Barometric Pressure mb	Flow		Methane		Carbon Dioxide		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		l/hr		%		%							
		Max	SS	Max	SS	Max	SS						
BH101A	992	-1.0	-1.0	0.0	0.0	0.0	0.0	20.9	1	2	14.33	14.33	1 2, 3
BH102	991	0.0	0.0	0.0	0.0	0.6	0.6	20.4	2	2	24.29	25.23	
BH103	991	0.4	0.0	0.9	0.9	0.4	0.4	13.5	2	0	3.34	4.91	

1 - Water sample obtained from 24.29 - 25.23m bgl.
2 - Water sample obtained from 3.34 - 4.91m bgl. Slight hydrocarbon odour noted in water sample. Slight oily sheen noted in water sample.
3 - Lower Explosive Limit = 50.7%

MH

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.

All other gases recorded at 'steady state' unless otherwise stated

Curtins

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902

**GAS MONITORING LOG SHEET**

Project: Swan House Additional GI **Date:** 05/03/2021
Job Number: B077409 **Visit:** 4
Client: RGCM Ltd **Weather:** Overcast
Barometric State: Steady **Ground Conditions:** Dry

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
BH101A													1
BH102	1029	0.0	0.0	0.0	0.0	0.0	0.0	21.8	0	0	24.57	25.65	
BH103	1029	-0.1	-0.1	0.0	0.0	1.2	1.2	0.3	4	0	3.53	4.95	

Notes

1 Inaccessible, covered by a decontamination unit.

Logged by

NF

*1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.**All other gases recorded at 'steady state' unless otherwise stated*

TEST DATE AND CONDITIONS			
Date		10/09/2020	
Atmospheric Pressure		1005	mB
Ambient Temperature		22.3	°C
EnviroNics Serial No.		5089	

**GFM436 Final Inspection & Calibration
Check Certificate**

GAS DATA LTD

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Customer	Shaw City
Certificate Number	121993
Order Number	326664

Serial Number	12099
Software Version	G436-00.0027/0009

Recalibration DUE Date
10/09/21

Instrument Checks					
Keyboard	✓		Display Contrast	✓	
Pump Flow In	400	Accept > 200 cc/min	Pump Flow @ -200mB	300	Accept > 200 cc/min
Clock Set / Running	✓		Labels Fitted	✓	

Gas Checks						
Sensor	CH ₄		CO ₂		O ₂	
	Instrument Gas	True Gas Value %	Instrument Gas	True Gas Value %	Instrument Gas	True Gas Value %
	Readings %		Readings %		Readings %	
	59.8	60	39.7	40	20.9	20.9
	Accept ±3.0		Accept ±3.0		Accept ±0.5	
	5	5	5	5	6	6
	Accept ±0.3		Accept ±0.3		Accept ±0.3	
Zero Reading 100% N ₂	0	0	0	0	0	0
	Accept ±0.0		Accept ±0.0		Accept ±0.1	

Optional Gas Checks						
Applied Gas & Range		Concentration Tested @ (ppm)	Instrument Readings (ppm)			
Gas Type	Range (ppm)		Zero Reading		Instrument Gas Reading	
H ₂ S	5000	1500	0	Accept ±0.0	1500	Accept ±5.0
CO	2000	1000	0	Accept ±0.0	1000	Accept ±5.0
Hexane	2.0%	2.0%	0	Accept ±0.0	1.99	Accept ±10.0

TEST DATE AND CONDITIONS	
Date	10.9.20
Atmospheric Pressure	1005 mB
Ambient Temp	22.3 °C
EnviroNics Serial No.	5089

GAS DATA LTD

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Coventry
CV3 4LJ

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GFM436-1 OUTWARD INSPECTION & QUALITY CHECK SHEET

INSTRUMENT DETAILS			
SO Number	Instrument Type	Instrument Serial Number + SW Version	Job Number(s)
325664	GFM436	R099 G436-27/09	12193

Calibration Technician *J. R.*

Date 10.9.20

Inspection Technician *10.9.20*

Date 11.9.20

INSTRUMENT CHECKS		Pass (P), Fail (F) or not applicable (NA)	INSTRUMENT PACKING LIST		Tick if included
Function Tests	Dust Caps Fitted	P	Instrument		✓
	Keyboard Test (All Keys)	P	Leather Case		X
	Backlight	P	Instrument Strap		✓
	Clock Set / Running	P	AC Battery Charger (UK)		X
	Comms Test	P	AC Battery Charger (EURO)		X
	Pump Flow Test (In & Out)	P	AC Battery Charger (US)		X
	Overall Leak Test (30mB)	n/a	AC Battery Charger (AUS)		X
	Battery Charge Test	P	Gas Sample Pipe - (new issue)		X
	Service Date set to?	10.9.21	Flow Sample Pipe - (new issue)		X
Channel Tests	Data Logging Enabled?	P	Hard Carry Case		X
	Verify CH4/LEL/Hexane/PID	P	Allen Key		X
	Verify CO2	P	Spares Pot		X
	Verify O2	P	Temperature Probe		X
	Verify H2S	P	Vane Anemometer		X
	Verify CO	P	USB Cable		X
	Verify LEL	P	USB Memory stick		X
	Verify 1 st Option Gas	NA	SM V5 Software	Ver 5.05	X
	Verify Atmospheric pressure	P	Internal Filter Pack	Qty	X
	Verify differential pressure	P	External Filter Pack	Qty	X
	Verify flow	P	Field Guide		X
	Verify temperature probe input	P	Extra Items:		
	Verify vane anemometer input	P			
	Verify vane anemometer input	P			
DataBase Checks	Jobcard(s) completed and signed	P	Comments:		
	Jobcard(s) booked off database	P			
	Calibration certificate completed	P			
	Complete & print QI record	n/a			
Label Checks	No. of Calibration label fitted	GDC 08996	IN PELI CASE WITH GFM 12101 #13255		
	MCERTS label displayed	P			
	Warranty label fitted	P			
H2S Range	H2S Range from Sales Order	5000 ppm			
	H2S Range from Cal Cert	5000 ppm			
	Over-range value correct?	P			

Appendix F – GAC Screening Thresholds

- Curtins GAC Tier 1 Thresholds.

Adopted Soil Generic Assessment Criteria
Sandy loam with 1% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> home grown produce	Allotments	Commercial	Public open space near residential housing POS _{resi}	Public park POS _{park}
Metals						
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11,000	45	240,000	21,000	46,000
Cadmium	10⁽¹³⁾ 22	85⁽¹³⁾ 150	1.8 3.9	230 410	120 220	560 880
Chromium III	910	910	18,000	8,600	1,500	33,000
Chromium VI	6 21	6 21	1.8 170	33 49	7.7 21	220 250
Lead	200	310	80	2,300	630	1,300
Mercury (<i>elemental</i>)	1	1	26	26	16	26⁽⁸⁾ [30]
Mercury (<i>inorganic</i>)	170	240	80	3600	120	240
Nickel	130 ⁽¹⁰⁾	180 ⁽¹⁰⁾	53 ⁽¹¹⁾	980 ⁽¹⁰⁾	230	800
Vanadium	410	1200	91	9000	2000	5000
Copper	2400	7100	520	68000	12000	44000
Zinc	3700	40000	620	730000	81000	170000
Semi-Metals and non-metals						
Arsenic	32⁽¹²⁾ 37	35⁽¹²⁾ 40	43⁽¹²⁾ 49	640⁽¹²⁾ 640	79 79	170 170
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
EC ₅₋₅ - EC ₆	42	42	730	3200	570000	95000
EC ₆₋₆ - EC ₈	100	100	2300	7800	600000	150000
EC ₈₋₈ - EC ₁₀	27	27	320	2000	13000	14000
EC ₁₀₋₁₀ - EC ₁₂	130	130	2200	9700	13000	21000
EC ₁₂₋₁₂ - EC ₁₆	1100	1100	11000	59000	13000	25000
EC ₁₆₋₁₆ - EC ₃₅	65000	65000	260000	1600000	250000	450000
EC ₃₅₋₃₅ - EC ₄₄	65000	65000	260000	1600000	250000	450000
Aromatic risk banded hydrocarbons - TPHCWG method						
EC ₅₋₅ - EC ₇	70	370	13	26000	56000	76000
EC ₇₋₇ - EC ₈	130	860	22	56000	56000	87000
EC ₈₋₈ - EC ₁₀	34	47	8.6	3500	5000	7200
EC ₁₀₋₁₀ - EC ₁₂	74	250	13	16000	5000	9200
EC ₁₂₋₁₂ - EC ₁₆	140	1800	23	36000	5100	10000
EC ₁₆₋₁₆ - EC ₂₁	260	1900	46	28000	3800	7600
EC ₂₁₋₂₁ - EC ₃₅	1100	1900	370	28000	3800	7800
EC ₃₅₋₃₅ - EC ₄₄	1100	1900	370	28000	3800	7800
Aliph + Arom EC >44-70	1600	1900	1200	28000	3800	7800
Aromatic						
Benzene	0.08	0.3	0.017	28	72	90
Ethyl benzene	65	170	16	520⁽⁸⁾ [17000]	520⁽⁸⁾ [24000]	520⁽⁸⁾ [17000]
Toluene	120	610	22	860⁽⁸⁾ [59000]	860⁽⁸⁾ [56000]	860⁽⁸⁾ [87000]
Xylene ⁽⁹⁾	41	53	28	480⁽⁸⁾ [69000]	480⁽⁸⁾ [41000]	480⁽⁸⁾ [17000]
Phenol	180	310	66	760⁽¹⁴⁾ (31000)	760⁽¹⁴⁾ (10000)	760⁽¹⁴⁾ (7600)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	2.3	2.3	4.1	190	4900	1200
Acenaphthylene	170	2900	28	83000	15000	29000
Acenaphthene	210	3000	34	84000	15000	29000
Fluorene	170	2800	27	63000	9900	20000
Phenanthrene	95	1300	15	22000	3100	6200
Anthracene	2400	31000	380	520000	74000	150000
Fluoranthene	280	1500	52	23000	3100	6300
Pyrene	620	3700	110	54000	7400	15000
Benz(a)anthracene	7.2	11	2.9	170	29	49
Chrysene	15	30	4.1	350	57	93
Benzo(b)fluoranthene	2.6	3.9	0.99	44	7.1	13
Benzo(k)fluoranthene	77	110	37	1200	190	370
Benzo(a)pyrene	2.2	3.2	0.97	35	5.7	11
Indeno(123cd)pyrene	27	45	9.5	500	82	150
Dibenzo(ah)anthracene	0.24	0.31	0.14	3.5	0.57	1.1
Benzo(ghi)perylene	320	360	290	3900	640	1400
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	0.00064	0.00077	0.00055	0.059	3.5	4.8
Trichloroethene (TCE)	0.016	0.017	0.041	1.2	120	70
1,1,1,2 Tetrachlorethane	1.2	1.5	0.79	110	1400	1500
Tetrachlorethane (PCE)	0.18	0.18	0.65	19	1400	810
1,1,1 Trichlorethane	8.8	9	48	660	140000	57000

Notes

- All values above are in mg/kg
- Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters, numbers in italics are S4ULs, numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters and underlined numbers are C4SLs
- Soil organic matter (SOM) is assumed to be 1% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
- For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
- NA: Not applicable

Appendix G – Detailed UXO Risk Assessment Report

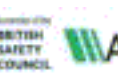


1ST LINE DEFENCE



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Swan Street, Manchester
Client	Curtins
Site Address	Swan Street, Manchester, M4 5JG
Report Reference	DA12456-00
Date	12 th February 2021
Originator	LG



Find us on Facebook, Twitter and LinkedIn

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Executive Summary

Site Location and Description

The site is located with the Northern Quarter of Manchester City Centre. Recent aerial photography dated 2019 shows the site is bound to the north-west by *Rochdale Road*, to the north-east by *Cable Street*, to the south-east by *Mason Street*, to the south and south-west by commercial properties situated on *Swan Street*.

A recent aerial photograph dated May 2019 shows the site to comprise an L-shaped, two-storey warehouse structure bound by the adjacent roadways of *Rochdale Road*, *Cable Street* and *Mason Street*.

The site is approximately centred on the OS grid reference: **SJ 84503 98863**.

Proposed Works

The exact extent and nature of the proposed works on site was available at the time of writing this report although initial intrusive works are understood to include three boreholes to 40.00m bgl.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows Chester Formation - Sandstone. Sedimentary Bedrock formed approximately 247 to 250 million years ago in the Triassic Period.

Site specific geotechnical information was not available to 1st Line Defence at the time of the production of this report. An assessment of maximum bomb penetration depth can be made once such data becomes available, or by a UXO specialist during on-site support.

It should be noted that the maximum depth that a bomb could reach may vary across a site and will be largely dependent on the specific underlying geological strata and its density.

UXO Risk Assessment

1st Line Defence has assessed that there is a **Low Risk** from items of German aerial delivered and anti-aircraft UXO and a **Negligible Risk** of Allied UXO across the site. This assessment is based on the following factors:

Risk of German aerial delivered UXO:

- During WWII, the site was located within the County Borough of Manchester which was subject to an overall low density of bombing, with an average of 29.0 bombs per 1000 acres according to official Home Office Bombing Statistics. Manchester was however still subject to a number of significant Luftwaffe raids, most notably the 'Christmas Blitz' of December 1940.
- Consulted historical records do not record any bomb incidents on site or in the immediate vicinity of the site boundary. The closest bombing incident recorded on the Manchester bomb damage map was a 'fire bomb' strike plotted approximately 70m north-east of the site in the vicinity of *Addington Street*.
- This is corroborated by the Manchester Emergency Committee's Log Book of Bombing Incidents 22-24 December 1940 within Graham Pythian's *Blitz Britain: Manchester and Salford*, which records no specific references to bombing incidents within or in the immediate vicinity of the site location, the nearest recorded incident being 100m to the south-east.
- During this period, the site was occupied by a large 'L-shaped' warehouse building that appears to have retained the same composition to today. It was bordered by a row of terraced residential properties to the south and by roadways in all other directions.
- The Manchester bomb damage map records no bomb damage to this structure on site. The outline of one terraced structure adjacent to the southern extent of the site boundary is highlighted in red indicating that the structure sustained some bomb damage. However, as this is not represented in the damage key and the structure appears structurally intact in the post-WWII era, the recorded damage is anticipated to have been minor in nature.

UXO Risk Assessment

- Several structures further to the north, east, south-east and west of the site are shown to have been demolished, but all were situated on the opposite side of roadways. The closest was situated approximately 10m south-east of the site on the opposite side of *Mason Street*, although no corresponding bombing incident is evident.
- Post-WWII era aerial photography largely corroborates the evidence presented within the Manchester bomb damage map, indicating that the structures within and in immediate proximity to the site appear to remain intact following WWII. The photography also reveals obvious areas of clearance across the wider area, the closest of which is shown to be on the opposite side of *Mason Street* and *Cable Street*, approximately 10m south-east and 10m north-east of the site respectively. However, none of these areas appear to have had any significant impact on the condition or usage of the site footprint. Given this, their distance and the fact that the site was separated by sections of roadway, these surrounding areas of clearance are not anticipated to significantly elevate the risk of UXO contamination on site.
- Owing to the fact that the structures occupying and immediately adjacent to the site, appear to have survived the war intact, it is anticipated that the ground cover within and in close proximity of the site would have been conducive to evidence of UXO. Furthermore, the adjacent roadways comprising hardstanding ground would have also been favourable to spotting indications of UXO, such as craters or entry holes.
- Due to the fact that the site comprised a warehouse structure adjacent to several main roads and in close proximity to the *Smithfield Market* within the northern quarter of Manchester city centre, the site and surrounding area are anticipated to have been subject to a good level of monitor and frequent access throughout WWII.

Risk of Allied UXO:

- There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however to those regarding aerial delivered ordnance.

Post-war development:

- Recent aerial photography dated May 2019 indicates that post-war redevelopment of the site has been limited. The structures currently occupying the site resemble those present in the immediate post-WWII era and in OS mapping from 1966 - 1969.
- The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. Within the footprints of post-WWII redevelopments, the risk from shallow-buried UXO (especially 1kg German incendiaries and British AA projectiles) should have been encountered/removed during initial excavations. However, the risk from deep-buried German UXBs will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at the Swan Street, Manchester:

All Works

- UXO Risk Management Plan
- Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

Glossary

Abbreviation	Definition
AA	Anti-Aircraft
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
DA	Delay-action
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot
GM	G Mine (Parachute mine)
HAA	Heavy Anti-Aircraft
HE	High Explosive
IB	Incendiary Bomb
JSEODOC	Joint Services Explosive Ordnance Disposal Operation Centre
LAA	Light Anti-Aircraft
LCC	London County Council
LRRB	Long Range Rocket Bomb (V-2)
LSA	Land Service Ammunition
NFF	National Filling Factory
OB	Oil Bomb
PAC	Pilotless Aircraft (V-1)
PB	Phosphorous Bomb
PM	Parachute Mine
POW	Prisoner Of War
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RFC	Royal Flying Corps
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SA	Small Arms
SAA	Small Arms Ammunition
SD2	Anti-personnel "Butterfly Bomb"
SIP	Self-Igniting Phosphorous
U/C	Unclassified bomb
UP	Unrotated Projectile (rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	Flying Bomb (Doodlebug)
V-2	Long Range Rocket
WAAF	Women's Auxiliary Air Force
X	Exploded

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1st Line Defence Limited

Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: Swan Street, Manchester

Client: Curtins

1. Introduction

1.1. Background

1st Line Defence has been commissioned by Curtins to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at the Swan Street site in Manchester.

Buried UXO can present a significant risk to construction works and development projects. The discovery of a suspect device during works can cause considerable disruption to operations as well as cause unwanted delays and expense.

UXO in the UK can originate from three principal sources:

1. Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.
2. Munitions deposited as a result of military training and exercises.
3. Munitions lost, burnt, buried or otherwise discarded either deliberately, accidentally, or ineffectively.

This report will assess the potential factors that may contribute to the risk of UXO contamination. If an elevated risk is identified at the site, this report will recommend appropriate mitigation measures, in order to reduce the risk to as low as is reasonably practicable. Detailed analysis and evidence will be provided to ensure an understanding of the basis for the assessed risk level and any recommendations.

This report complies with the guidelines outlined in *CIRIA C681*, 'Unexploded Ordnance (UXO) A Guide for the Construction Industry.'

2. Method Statement

2.1. Report Objectives

The aim of this report is to conduct a comprehensive assessment of the potential risk from UXO at Swan Street, Manchester. The report will also recommend appropriate site and work-specific risk mitigation measures to reduce the risk from explosive ordnance during the envisaged works to a level that is as low as reasonably practicable.

2.2. Risk Assessment Process

1st Line Defence has undertaken a five-step process for assessing the risk of UXO contamination:

1. The likelihood that the site was contaminated with UXO.
2. The likelihood that UXO remains on the site.
3. The likelihood that UXO may be encountered during the proposed works.
4. The likelihood that UXO may be initiated.
5. The consequences of initiating or encountering UXO.

In order to address the above, 1st Line Defence has taken into consideration the following factors:

- Evidence of WWI and WWII German aerial delivered bombing as well as the legacy of Allied occupation.
- The nature and conditions of the site during WWII.
- The extent of post-war development and UXO clearance operations on site.
- The scope and nature of the proposed works and the maximum assessed bomb penetration depth.
- The nature of ordnance that may have contaminated the proposed site area.

2.3. Sources of Information

Every reasonable effort has been made to ensure that relevant evidence has been consulted and presented in order to produce a thorough and comprehensible report for the client. To achieve this the following, which includes military records and archive material held in the public domain, have been accessed:

- The National Archives and Manchester Archives and Local Studies.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by Curtins.
- Available material from 33 Engineer Regiment (EOD) Archive (now 28 Regt).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

Research involved a visit to The National Archives and Manchester Archives and Local Studies.

3. Background to Bombing Records

3.1. General Considerations of Historical Research

This desktop assessment is based largely upon analysis of historical evidence. Every reasonable effort has been made to locate and present significant and pertinent information. 1st Line Defence cannot be held accountable for any changes to the assessed risk level or risk mitigation measures, based on documentation or other data that may come to light at a later date, or which was not available to 1st Line Defence during the production of this report.

It is often problematic and sometimes impossible to verify the completeness and accuracy of WWII-era records. As a consequence, conclusions as to the exact location and nature of a UXO risk can rarely be quantified and are, to a degree, subjective. To counter this, a range of sources have been consulted, presented and analysed. The same methodology is applied to each report during the risk assessment process. 1st Line Defence cannot be held responsible for any inaccuracies or the incompleteness in available historical information.

3.2. German Bombing Records

During WWII, bombing records were generally gathered locally by the police, Air Raid Precaution (ARP) wardens and military personnel. These records typically contained information such as the date, the location, the amount of damage caused and the types of bombs that had fallen during an air raid. This information was made either through direct observation or post-raid surveys. The Ministry of Home Security Bomb Census Organisation would then receive this information, which was plotted onto maps, charts, and tracing sheets by regional technical officers. The collective record set (regional bomb census mapping and locally gathered incidents records) would then be processed and summarised into reports by the Ministry of Home Security Research and Experiments Branch. The latter were tasked with providing the government 'a complete picture of air raid patterns, types of weapons used and damage caused- in particular to strategic services and installations such as railways, shipyards, factories and public utilities.'¹

The quality, detail and nature of record keeping could vary considerably between provincial towns, boroughs and cities. No two areas identically collated or recorded data. While some local authorities maintained records with a methodical approach, sources in certain areas can be considerably more vague, dispersed, and narrower in scope. In addition, the immediate priority was mostly focused on assisting casualties and minimising damage at the time. As a result, some records can be incomplete and contradictory. Furthermore, many records were even damaged or destroyed in subsequent air raids. Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are therefore not always reliable. Whereas records of attacks on military or strategic targets were often maintained separately and have not always survived.

3.3. Allied Records

During WWII, considerable areas of land were requisitioned by the War Office for the purpose of defence, training, munitions production and the construction of airfields. Records relating to military features vary and some may remain censored. Within urban environments datasets will be consulted detailing the location of munition production as well as wartime air and land defences. In rural locations it may be possible to obtain plans of military establishments, such as airfields, as well as training logs, record books, plans and personal memoirs. As with bombing records, every reasonable effort will be made to access records of, and ascertain any evidence of, military land use. However, there are occasions where such evidence is not available, as records may not be accessible, have been lost/destroyed, or simply were not kept in the first place.

¹ <http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/bomb-census-survey-records-1940-1945/>.

4. UK Regulatory Environment and Guidelines

4.1. General

There is no formal obligation requiring a UXO risk assessment to be undertaken for construction projects in the UK, nor is there any specific legislation stipulating the management or mitigation of UXO risk. However, it is implicit in the legislation outlined below that those responsible for intrusive works (archaeology, site investigation, drilling, piling, excavation etc.) should undertake a comprehensive and robust assessment of the potential risks to employees and that mitigation measures are implemented to address any identified hazards.

4.2. CDM Regulations 2015

The Construction (Design and Management) Regulations 2015 (CDM 2015) define the responsibilities of parties involved in the construction of temporary or permanent structures.

The CDM 2015 establishes a duty of care extending from clients, principle co-ordinators, designers, and contractors to those working on, or affected by, a project. Those responsible for construction projects may therefore be accountable for the personal or proprietary loss of third parties, if correct health and safety procedure has not been applied.

Although the CDM does not specifically reference UXO, the risk presented by such items is both within the scope and purpose of the legislation. It is therefore implied that there is an obligation for parties to:

- Provide an appropriate assessment of potential UXO risks at the site (or ensure such an assessment is completed by others).
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks presented by the project.
- Ensure the preparation of a suitably robust emergency response plan.

4.3. The 1974 Health and Safety at Work etc. Act

All employers have a responsibility under the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, to ensure the health and safety of their employees and third parties, so far as is reasonably practicable and conduct suitable and sufficient risk assessments.

4.4. CIRIA C681

In 2009, the Construction Industry Research and Information Association (CIRIA) produced a guide to the risk posed by UXO to the UK construction industry (CIRIA C681). CIRIA is a neutral, independent and not-for-profit body, linking organisations with common interests and facilitating a range of collaborative activities that help improve the industry.

The publication provides the UK construction industry with a defined process for the management of risks associated with UXO from WWI and WWII aerial bombardment. It is also broadly applicable to the risks from other forms of UXO that might be encountered. It focuses on construction professionals' needs, particularly if there is a suspected item of UXO on site, and covers issues such as what to expect from a UXO specialist. The guidance also helps clients to fulfil their legal duty under CDM 2015 to provide designers and contractors with project specific health and safety information needed to identify hazards and risks associated with the design and construction work. This report conforms to this CIRIA guidance and to the various recommendations for good practice referenced therein. It is

recommended that this document is acquired and studied where possible to allow a better understanding of the background to both the risk assessment process and the UXO issue in the UK in general.

4.5. Additional Legislation

In the event of a casualty resulting from the failure of an employer/client to address the risks relating to UXO, the organisation may be criminally liable under the Corporate Manslaughter and Corporate Homicide Act 2007.

5. The Role of Commercial UXO Contractors and The Authorities

5.1. Commercial UXO Specialists

The role of a UXO Specialist (often referred to as UXO Consultant or UXO Contractor) such as 1st Line Defence, is defined in CIRIA C681 as the provision of expert knowledge and guidance to the client on the most appropriate and cost-effective approach to UXO risk management at a site.

The principal role of UXO Specialists is to provide the client with an appropriate assessment of the risk posed by UXO for a specific project, and identify and carry out suitable methodology for the mitigation of any identified risks to reduce them to an acceptable level.

The requirement for a UXO Specialist should ideally be identified in the initial stages of a project, and it is recommended that this occur prior to the start of any detailed design. This will enable the client to budget for expenditure that may be required to address the risks from UXO, and may enable the project team to identify appropriate techniques to eliminate or reduce potential risks through considered design, without the need for UXO specific mitigation measures. The UXO Specialist should have suitable qualifications, levels of competency and insurances.

Please note 1st Line Defence has the capability to provide a complete range of required UXO risk mitigation services, in order to reduce a risk to as low as reasonably practicable. This can involve the provision of both ground investigation, and where appropriate, UXO clearance services.

5.2. The Authorities

The police have a responsibility to co-ordinate the emergency services in the event of an ordnance-related incident at a construction site. Upon inspection they may impose a safety cordon, order an evacuation, and call the military authorities Joint Services Explosive Ordnance Disposal Operation Centre (JSEODOC) to arrange for investigation and/or disposal. Within the Metropolitan Police Operational Area, SO15 EOD will be tasked to any discovery of suspected UXO. The request for Explosive Officer (Expo) support is well understood and practiced by all Metropolitan Boroughs. The requirement for any additional assets will then be coordinated by the Expo if required.

In the absence of a UXO specialist, police officers will usually employ such precautionary safety measures, thereby causing works to cease, and possibly requiring the evacuation of neighbouring businesses and properties.

The priority given to the police request will depend on the EOD teams judgement of the nature of the UXO risk, the location, people and assets at risk, as well as the availability of resources. The speed of response varies; authorities may respond immediately or in some cases it may take several days for the item of ordnance to be dealt with. Depending on the on-site risk assessment the item of ordnance may be removed from the site and/or destroyed by a controlled explosion.

Following the removal of an item of UXO, the military authorities will only undertake further investigations or clearances in high-risk situations. If there are regular UXO finds on a site the JSEODOC may not treat each occurrence as an emergency and will recommend the construction company puts in place alternative procedures, such as the appointment of a commercial contractor to manage the situation.

6. The Site

6.1. Site Location

The site is located with the Northern Quarter of Manchester City Centre. Recent aerial photography dated 2019 shows the site is bound to the north-west by *Rochdale Road*, to the north-east by *Cable Street*, to the south-east by *Mason Street*, to the south and south-west by commercial properties situated on *Swan Street*.

The site is approximately centred on the OS grid reference: **SJ 84503 98863**.

Site location maps are presented in **Annex A**.

6.2. Site Description

A recent aerial photograph dated May 2019 shows the site to comprise an L-shaped, two-storey warehouse structure bound by the adjacent roadways of *Rochdale Road*, *Cable Street* and *Mason Street*.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

7. Scope of the Proposed Works

7.1. General

The exact extent and nature of the proposed works on site was available at the time of writing this report although initial intrusive works are understood to include three boreholes to 40.00m bgl.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows Chester Formation - Sandstone. Sedimentary Bedrock of the Triassic Period. The superficial deposits are formed by Til, Devensian – Diamicton of the Quaternary Period.

8.2. Site Specific Geology

Site-specific geotechnical data was not available during the production of this report. While the British Geological Survey (BGS) source provides a historical borehole database, none of these logs were located either on or in the immediate vicinity of the site.

9. Site History

9.1. Introduction

The purpose of this section is to identify the composition of the site pre and post-WWII. It is important to establish the historical use of the site, as this may indicate the site's relation to potential sources of UXO as well as help with determining factors such as the land use, groundcover, likely frequency of access and signs of bomb damage.

9.2. Ordnance Survey Historical Maps

Relevant historical maps were obtained for this report and are presented in **Annex D**. See below for a summary of the site history shown on acquired mapping.

Pre-WWII		
Date	Scale	Description
1908	1:2,500	This OS map edition shows the site comprises a number of different sized structures within the northern, eastern and southern sections of the site. A <i>Public House</i> can be seen occupying the north-west sector, adjacent to <i>Rochdale Road</i> . A row of terraced commercial and residential structures can be seen bordering the south-western extent of the site boundary. A <i>Tramway</i> can be seen running along <i>Rochdale Road</i> and <i>Swan Street</i> . <i>Smithfield Market</i> , a <i>Wholesale Fish Market</i> and a <i>Clothes Market</i> are presented further south and south-east of the site. The wider vicinity as a whole was entirely developed through a large number of blocks built around a network of roadways.
1922 - 1932	1:2,500	This OS map edition corroborates the structural outlay of the site presented within 1908 OS mapping. The closest development that can be discerned in the vicinity, occurs approximately 15m north and north-east of the site, on the opposite side of <i>Cable Street</i> , in which several small structures have been cleared and redeveloped into two large commercial-style structures. Similar examples of structural clearance and consolidation were observable throughout the wider vicinity.

Post-WWII		
Date	Scale	Description
1951 - 1952	1:2,500	This OS map edition shows the site and surrounding vicinity to have undergone significant re-development since the pre-war era. Either an area of hard standing ground, or an unspecified structure occupies the approximate footprint of the site. Further to the north and west of the site, several <i>Ruins</i> and areas of clearance can be discerned. To the east of the site, several notable changes have occurred, in which clusters of smaller structures have either been cleared completely or re-developed into larger warehouse-style structures. Notably, a <i>Ruin</i> and an area of clearance can be seen on the opposite side of <i>Mason Street</i> approximately 10m south-east of the site boundary. The area south of the site appears to remain relatively unchanged in the post-war era, <i>Smithfield Market</i> and several other adjacent market structures can be seen beyond <i>Swan Street</i> .
1966 - 1969	1:1,250	This OS map edition shows the site to comprise a single <i>Warehouse</i> structure in the approximate footprint of the site boundary. To the immediate south of the site several terraced structures have been cleared and redeveloped into a single <i>Bank</i> structure. Further to the north, east and west of the site, several areas formerly occupied by cleared ground now comprise <i>Warehouse</i> or <i>Works</i> structures. No notable major changes have occurred further to the south of the site.

9.3. Pre-WWII Photography of the Site

Pre-WWII aerial photography has been obtained from the Aerofilms collection available from *Britain From Above*. This imagery provides a view of the site in 1937 (see **Annex E**). See below for a description:

Title of Photograph	Comments
Shudehill and environs, Manchester, 1937	This pre-war oblique aerial photograph from 1937 is of poor quality but appears to show the area in the approximate footprint of the site is in the process of being developed into a single warehouse-style structure. Scaffolding can be seen around the site in the foreground along <i>Rochdale Road</i> , whereas saw-style roofing can be seen to cover the area of the site beyond this, adjacent to <i>Cable Street</i> and <i>Mason Street</i> . The wider vicinity is shown to be heavily urbanised, with what appear to be several large, multi-storey residential-style structures to the north, east and west of the site. The distinctive saw-roof of <i>Smithfield Market</i> and surrounding environs can be seen to the south of the site beyond <i>Swan Street</i> .

9.4. City of Manchester Plan 1945

This historical plan of the central Manchester area in 1945 was obtained from the *University of Manchester*. The plan presents the structural outlay of the site and surrounding area in the immediate post-war era, as well as displaying the era in which the buildings were constructed (see **Annex F**). See below for a description:

Title of Historical Plan	Comments
City of Manchester Plan 1945	This historical plan of the central Manchester area shows the site to comprise a single structure that was constructed after 1932. Structures adjacent to the south-western extent of the site boundary that were constructed before 1850, are also shown to still be present. Several areas within close proximity and across the wider area to the north, east and west of the site are notably void of any structures. The closest of which can be seen approximately 10m south-east of the site on the opposite side of <i>Mason Street</i> and approximately 10m north-east on the opposite side of <i>Cable Street</i> .

10. Introduction to German Aerial Delivered Ordnance

10.1. General

During WWI and WWII, the UK was subjected to bombing which often resulted in extensive damage to city centres, docks, rail infrastructure and industrial areas. The poor accuracy of WWII targeting technology and the nature of bombing techniques often resulted in neighbouring areas to targets sustaining collateral damage.

In addition to raids which concentrated on specific targets, indiscriminate bombing of large areas also took place. This occurred most prominently in the London 'Blitz', though affected many other towns and cities. As discussed in the following sections, a proportion of the bombs dropped on the UK did not detonate as designed. Although extensive efforts were made to locate and deal with these UXBs at the time, many still remain buried and can present a potential risk to construction projects.

The main focus of research for this section of the report will concern German aerial delivered ordnance dropped during WWII, although WWI bombing will also be considered.

10.2. Generic Types of WWII German Aerial Delivered Ordnance

To provide an informed assessment of the hazards posed by any items of unexploded ordnance that may remain in situ on site, the table below provides information on the types of German aerial delivered ordnance most commonly used by the Luftwaffe during WWII. Images and brief summaries of the characteristics of these items of ordnance are listed in **Annex G**.

Generic Types of WWII German Aerial Delivered Ordnance		
Type	Frequency	Likelihood of detection
High Explosive (HE) bombs	In terms of weight of ordnance dropped, HE bombs were the most frequently deployed by the Luftwaffe during WWII.	Although efforts were made to identify the presence of unexploded ordnance following an air raid, often the damage and destruction caused by detonated bombs made observation of UXB entry holes impossible. The entry hole of an unexploded bomb can be as little as 20cm in diameter and was easily overlooked in certain ground conditions (see Annex H). Furthermore, ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded smaller bomb. UXBs therefore present the greatest risk to present-day intrusive works.
1kg Incendiary bombs (IB)	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these were dropped throughout WWII.	IBs had very limited penetration capability and in urban areas would often have been located in post-raid surveys. If they failed to initiate and fell in water, on soft vegetated ground, or bombed rubble, they could easily go unnoticed.
Large Incendiary bombs (IB)	These were not as common as the 1kg IBs, although they were more frequently deployed than PMs and AP bomblets.	If large IBs did penetrate the ground, complete combustion did not always occur and in such cases they could remain a risk to intrusive works.
Aerial or Parachute mines (PM)	These were deployed less frequently than HE and IBs due to size, cost and the difficulty of deployment.	If functioning correctly, PMs would generally have had a slow rate of descent and were very unlikely to have penetrated the ground. Where the parachute failed, mines would have simply shattered on impact if the main charge failed to explode. There have been extreme cases when these items have been found unexploded. However, in these scenarios, the ground was either extremely soft or the munition fell into water.
Anti-personnel (AP) bomblets	These were not commonly used and are generally considered to pose a low risk to most works in the UK.	SD2 bomblets were packed into containers holding between 6 and 108 submunitions. They had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.

10.3. Failure Rate of German Aerial Delivered Ordnance

It has been estimated that 10% of WWII German aerial delivered HE bombs failed to explode as designed. Reasons for why such weapons might have failed to function as designed include:

- Malfunction of the fuze or gain mechanism (manufacturing fault, sabotage by forced labour or faulty installation).
- Many were fitted with a clockwork mechanism that could become immobilised on impact.
- Failure of the bomber aircraft to arm the bombs due to human error or an equipment defect.
- Jettisoning the bomb before it was armed or from a very low altitude. This most likely occurred if the bomber aircraft was under attack or crashing.

From 1940 to 1945, bomb disposal teams reportedly dealt with a total of 50,000 explosive items of 50kg, over 7,000 anti-aircraft projectiles and 300,000 beach mines. Unexploded ordnance is still regularly encountered across the UK, see press articles in **Annex I**.

10.4. UXB Ground Penetration

An important consideration when assessing the risk from a UXB is the likely maximum depth of burial. There are several factors which determine the depth that an unexploded bomb will penetrate:

- Mass and shape of bomb.
- Height of release.
- Velocity and angle of bomb.
- Nature of the ground cover.
- Underlying geology.

Geology is perhaps the most important variable. If the ground is soft, there is a greater potential of deeper penetration. For example, peat and alluvium are easier to penetrate than gravel and sand, whereas layers of hard strata will significantly retard and may stop the trajectory of a UXB.

10.4.1. The J-Curve Effect Principle

J-curve is the term used to describe the characteristic curve commonly followed by an aerial delivered bomb dropped from height after it penetrates the ground. Typically, as the bomb is slowed by its passage through underlying soils, its trajectory curves towards the surface. Many UXBs are found with their nose cone pointing upwards as a result of this effect. More importantly, however, is the resulting horizontal offset from the point of entry. This is typically a distance of about one third of the bomb's penetration depth, but can be higher in certain conditions (see **Annex H**).

10.4.2. WWII UXB Ground Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by bomb disposal (BD) teams. Conclusions were drawn predicting the likely average and maximum depths of penetration of different sized bombs in different geological strata.

For example, the largest common German bomb (500kg) had a likely concluded penetration depth of 6m in sand or gravel but 11m in clay. The maximum observed depth for a 500kg bomb was 11.4m and for a 1,000kg bomb 12.8m. Theoretical calculations suggested that significantly greater penetration depths were probable.

10.4.3. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site of proposed works the following parameters have been used:

- WWII geology – Chester Formation - Sandstone. Sedimentary Bedrock.
- Impact angle and velocity – 10-15° from vertical and 270 metres per second.
- Bomb mass and configuration – The 500kg SC HE bomb, without retarder units or armour piercing nose (this was the largest of the common bombs used against Britain).

It has not been possible to determine maximum bomb penetration capabilities at this stage due to the lack of site-specific geotechnical information currently available. An assessment can be made once further information becomes available or by an UXO Specialist on-site.

10.5. V-Weapons

Hitler's 'V-weapon' campaign began from mid-1944. It used newly developed unmanned cruise missiles and rockets. The V-1, known as the *flying bomb* or *pilotless aircraft*, and the V-2, a long range rocket, were launched from bases in Germany and occupied Europe. A total of 9,251 V-1s and 1,115 V-2s were recorded in the United Kingdom.

Although these weapons caused considerable damage, their range was limited by their position of deployment across Europe and as a result the vast majority of V-weapon strikes were directed against targets in the south-east of England, predominantly in the London Boroughs and Home Counties. This limitation of capability meant targets in Manchester were generally too far to be considered for V-weapon strikes by the Luftwaffe.

The risk from V-weapons is therefore considered negligible and will not be further addressed in this report.

11. The Likelihood of Contamination from German Aerial Delivered UXBs

11.1. World War I

During WWI Britain was targeted and bombed by Zeppelin Airships, as well as Gotha and Giant fixed-wing aircraft. A WWI map of air raids and naval bombardments across England is presented in **Annex J**. This source does not record any WWI bombing incidents to have affected Manchester.

WWI bombs were generally smaller and dropped from a lower altitude than those used in WWII. This resulted in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density, the risk from WWI UXBs is considered low and will not be further addressed in this report.

11.2. World War II Bombing of the County Borough of Manchester

The Luftwaffe's main objective for the attacks on Britain was to inhibit the country's economic and military capability. To achieve this they targeted airfields, depots, docks, warehouses, wharves, railway lines, factories, and power stations. As the war progressed the Luftwaffe bombing campaign expanded to include the indiscriminate bombing of civilian areas in an attempt to subvert public morale.

During WWII the site was located within the County Borough of Manchester, which sustained an overall low density of bombing, as represented by bomb density data figures presented in section 11.3.

Manchester was not targeted with the same intensity and frequency as other major British cities such as Liverpool, Coventry, and Birmingham, however it was still subject to several major raids in the years 1940-1941. These raids tended to be focused on the Salford and Stretford areas of Greater Manchester, where the majority of the dock and industrial facilities were located. As a result, the centre of Manchester, including the northern quarter, in which the site was located, is not depicted in the Luftwaffe target imagery shown in **Annex K**. Whilst the site and surrounding area was not specifically targeted, it is likely that the area was subject to 'tip and run' raids whereby bombers dropped any remaining ordnance over areas adjacent to targets before attempting a return flight to continental Europe.

Records of bombing incidents in the civilian areas of the County Borough of Manchester were typically collected by Air Raid Precautions wardens and collated by Civil Defence personnel. Some other organisations, such as port and railway authorities, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the country most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

Records of bombing incidents are presented in the following sections.

11.3. WWII Home Office Bombing Statistics

The following table summarises the quantity of German aerial delivered bombs (excluding 1kg incendiaries and anti-personnel bombs) dropped on the County Borough of Manchester between 1940 and 1945.

Record of German Ordnance Dropped on the County Borough of Manchester		
Area Acreage		27,255
Weapons	High Explosive bombs (all types)	712
	Parachute mines	18
	Oil bombs	7
	Phosphorus bombs	0
	Fire pots	0
	Pilotless aircraft (V-1)	1
	Long range rocket bombs (V-2)	0
Total		738
Number of Items per 1,000 acres		27.1

Source: Home Office Statistics

This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the risk relating to IBs is lesser than that relating to larger HE bombs, they were similarly designed to inflict damage and injury. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. Although Home Office statistics did not record these types of ordnance, both should not be overlooked when assessing the general risk to personnel and equipment.

11.4. Manchester Bomb Damage Map

A bomb census map compiled by Manchester City Council showing high explosive (HE) and incendiary bomb strikes as well as recorded damage and demolished structures within the borough was obtained from Manchester University Library. The section showing the area of the site is presented in **Annex L**.

Manchester Bomb Damage Map – Annex L	
Date Range	Comments
22 nd – 24 th December 1940	This map, which only shows bombing incidents and damage from the largest air raids on Manchester in late December 1940, does not display any bombing or damage within the site location. The closest bombing incident recorded was a ‘fire bomb’ strike plotted approximately 70m north-east of the site in the vicinity of <i>Addington Street</i>. The outline of one terraced structure adjacent to the southern extent of the site boundary, on Swan Street, is highlighted in red indicating that the structure sustained some bomb damage. However, as this is not represented in the damage key, this is anticipated to have been minor in nature. Several structures further to the north, east, south-east and west of the site are shown to have been demolished, the closest of which was situated approximately 10m south-east of the site on the opposite side of <i>Mason Street</i>, although no corresponding bombing incident is evident.

11.5. Manchester Emergency Committee Log Book of Bombing Incidents

The published source *Blitz Britain: Manchester and Salford* by Graham Phythian was obtained and consulted in regards to the site and surrounding area. This publication contains a transcription of ARP incident records for Manchester, taken from the Manchester Emergency Committee’s Log of Bombing Incidents. This record set also only covers the raid known as the ‘Manchester Blitz’ on the 22nd and 23rd December 1940. Only two incidents are recorded at a location close to the site, which are transcribed in the table below. Example imagery of these entries are presented in **Annex M**.

Manchester Emergency Committee Log Book of Bombing Incidents – Annex M		
Date	Bomb Type	Comments
8:20pm 22 nd December 1940	Incendiary	Smithfield Market Shower of incendiary bombs in the vicinity of Smithfield Market at 8:20p.m. 22nd. Damage was caused to the roof and various stalls and offices in the Wholesale and Retail Fish and Produce Markets. Several premises in Swan St were extensively damaged by fire. Fires were extinguished by the fire brigade, and the incidents were later closed.
8:20pm 22 nd December 1940	Incendiary	Swan St, Between Oak St & Tib St Incendiary Bomb approx. 9:00p.m. 22nd. Serious damage caused to 19 – 19a – 23 & 21 Swan St, by fire. Incident now closed. 12:10pm 23rd. Approximately 100m south-east of the site.

11.6. Manchester Bomb Damage Cards

Bomb damage cards compiled by Manchester City Council during WWII were consulted at the Manchester Central Library. These reports recorded information such as the date, location, type and damage caused by major bomb incidents in Manchester. Whilst these records were consulted, no reference could be found to damage sustained on site or to any structures in the immediate proximity of the site. The two nearest incidents entries are transcribed in the table below and presented in **Annex N**.

Manchester Bomb Damage Cards – Annex N			
Date	Bomb Type	Location	Extent of Damage
Unknown Date	(detonated) S.C. (Sprengbombe Cylindrisch / High- Explosive bomb)	12, 14, 16 Cable Street, Ancoats. Approximately 60m south-east of the site.	N/A
31 st December 1940	D (detonated) S.C. (Sprengbombe Cylindrisch / High- Explosive bomb)	15, 17, 19, 21 Riga Street, Hulme. Approximately 120m north-west of the site.	15 - Average about 1'-0" (1 foot 0 inches) BA , debris to remove 17, 19, 21 - Floors 'Holed' and 'Off or Displaced'

11.7. Air Raid Damage Files

Air Raid Damage files for Manchester were obtained from The National Archives. These reports recorded information such as the date, time, type and damage caused by major bomb incidents in Manchester. These records were generally restricted to covering incidents from 1942 onwards and are therefore not considered comprehensive. No relevant information regarding the site area could be located.

11.8. WWII-Era Aerial Photography

WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England). This photography provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (**see Annex O**).

WWII-Era Aerial Photography	
Date	Description
7 th May 1946 Historic England	This aerial photograph presents the structural outlay of the site and surrounding area in the immediate post-WWII era. The site is shown to comprise a single structure in the approximate footprint of the site location. No obvious damage indicators such as collapsed/discoloured roofing were observable across the boundary. All terraced structures along the south-western extent of the site boundary are present and similarly lacked any obvious signs of damage. Several areas of clearance are clearly visible in the wider vicinity to the north, east, south-east and west of the site. The closest of which is located on the opposite side of <i>Cable Street</i> and <i>Mason Street</i> , approximately 10m north-east and south-east of the site respectively. See Annex O2 for a damage overlay of the site area.

11.9. Abandoned Bombs

A post air-raid survey of buildings, facilities, and installations would have included a search for evidence of bomb entry holes. If evidence of an entry hole was encountered, Bomb Disposal Officer Teams would normally have been requested to attempt to locate, render safe, and dispose of the bomb. Occasionally, evidence of UXBs was discovered but due to a relatively benign position, access problems, or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an 'abandoned bomb'.

Given the inaccuracy of WWII records, and the fact that these bombs were 'abandoned', their locations cannot be considered definitive or the lists exhaustive. The MoD states that 'action to make the devices safe would be taken only if it was thought they were unstable'. It should be noted that other than the 'officially' abandoned bombs, there will inevitably be UXBs that were never recorded.

1st Line Defence holds no records of officially registered abandoned bombs at or near the site of the proposed works.

11.10. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD) (now 29 Regt) is currently facing considerable delay. It has therefore not been possible to include any updated official information regarding bomb disposal/clearance tasks with regards to this site. A database of known disposal/clearance tasks has been referred to which does not make reference to such instances occurring within the site of proposed works. If any relevant information is received at a later date Curtins will be advised.

11.11. Evaluation of German Aerial Delivered UXO Records

Factors	Conclusion
Density of Bombing <i>It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.</i>	During WWII, the site was located within the County Borough of Manchester which was subject to an overall low density of bombing, with an average of 29.0 bombs per 1000 acres according to official Home Office Bombing Statistics. Whilst the site was situated a relative distance from Strategic Luftwaffe bombing targets such as Stretford Industrial area and Salford Docks, the site was in close proximity to Manchester's two main railway stations, which were obvious secondary bombing targets due to their strategic and logistical importance. Consulted historical records do not record any bomb incidents on site. The closest bombing incident recorded on the Manchester bomb damage map was a 'fire bomb' strike plotted approximately 70m north east of the site in the vicinity of <i>Addington Street</i>. This is corroborated by the Manchester Emergency Committee's Log Book of Bombing Incidents 22-24 December 1940 within Graham Pythian's <i>Blitz Britain: Manchester and Salford</i>, which records no specific references to bombing incidents within or in the immediate vicinity of the site location, the nearest recorded incident being 100m to the south.
Damage <i>If buildings or structures on a site sustained bomb or fire damage, any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same or later raids. Similarly, a high explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.</i>	The Manchester bomb damage map records one terraced structure adjacent to the southern extent of the site boundary as having sustained bomb damage, although this is anticipated to have been minor in nature. Several structures further to the north, east, south-east and west of the site are shown to have been demolished, the closest of which was situated approximately 10m south-east of the site on the opposite side of <i>Mason Street</i>. Post-WWII era aerial photography largely corroborates the evidence presented within the Manchester bomb damage map, indicating that the structures on and adjacent to the site appear to remain intact following WWII, including the aforementioned building to the immediate south. Several obvious areas of clearance can be seen across the wider area, the closest of which is shown to be on the opposite side of <i>Mason Street</i> and <i>Cable Street</i>, approximately 10m south-east and 10m north-east of the site respectively. See Annex O2 for a damage overlay
Ground Cover <i>The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.</i>	Owing to the fact that the structures occupying and immediately adjacent to the site, appear to have survived the war intact, it is anticipated that the ground cover within and in close proximity of the site would have been conducive to evidence of UXO. Furthermore, the adjacent roadways comprising hardstanding ground would have also been favourable to spotting indications of UXO, such as craters or entry holes.
Access Frequency <i>UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied. The importance of a site to the war effort is also an important consideration as such sites are likely to have been both frequently visited and subject to post-raid checks for evidence of UXO.</i>	Due to the fact that the site comprised a warehouse structure adjacent to several main roads and in close proximity to the <i>Smithfield Market</i> within the northern quarter of Manchester city centre, the site and surrounding area are anticipated to have been subject to a good level of monitor and frequent access. Such conditions typically allowed for regular post-raid checks for items of UXO.

Bomb Failure Rate	There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.
Abandoned Bombs	1 st Line Defence holds no records of abandoned bombs at or within the site vicinity.
Bombing Decoy sites	1 st Line Defence could find no evidence of bombing decoy sites within the site vicinity.
Bomb Disposal Tasks	1 st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

12. Introduction to Allied Explosive Ordnance

12.1. General

Many areas across the UK may be at risk from Allied UXO because of both wartime and peacetime military use. Typical military activities and uses that may have led to a legacy of military UXO at a site include former minefields, home guard positions, anti-aircraft emplacements, training and firing ranges, military camps, as well as weapons manufacture and storage areas.

Although land formerly used by the military was usually subject to clearance before returned to civilian use, items of UXO are sometimes discovered and can present a potential risk to construction projects.

It should be highlighted that there is no evidence that the site formerly had any military occupation or usage that could have led to contamination with such items of Allied ordnance. Despite this, urban areas, such as the location of the site, can be at risk from buried unexploded anti-aircraft projectiles fired during WWII – as addressed below.

12.2. Defending the UK From Aerial Attack

During WWII the War Office employed a number of defence tactics against the Luftwaffe from bombing major towns, cities, manufacturing areas, ports and airfields. These can be divided into passive and active defences (examples are provided in the table below).

Active Defences	Passive Defences
• Anti-aircraft gun emplacements to engage enemy aircraft. • Fighter aircraft to act as interceptors. • Rockets and missiles were used later during WWII.	• Blackouts and camouflaging to hinder the identification of Luftwaffe targets. • Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas. • Barrage balloons forced enemy aircraft to greater altitudes. • Searchlights were often used to track and divert adversary bomber crews during night raids.

Active defences such as anti-aircraft artillery present a greater risk of UXO contamination than passive defences. Unexploded ordnance resulting from dogfights and fighter interceptors is rarely encountered and difficult to accurately qualify.

12.2.1. Anti-Aircraft Artillery (AAA)

During WWII three main types of gun sites existed: heavy anti-aircraft (HAA), light anti-aircraft (LAA) and 'Z' batteries (ZAA). If the projectiles and rockets fired from these guns failed to explode or strike an aircraft they would descend back to land. The table below provides further information on the operation and ordnance associated with these type of weapons.

Anti-Aircraft Artillery				
Item	Description			
HAA	These large calibre guns such as the 3.7" QF (Quick Firing) were used to engage high flying enemy bombers. They often fired large HE projectiles, which were usually initiated by integral fuzes, triggered by impact, area, time delay or a combination of aforementioned mechanisms.			
LAA	These mobile guns were intended to engage fast, low flying aircraft. They were typically rotated between locations on the perimeters of towns and strategically important industrial works. As they could be moved to new positions with relative ease when required, records of their locations are limited. The most numerous of these were the 40mm Bofors gun which could fire up to 120 x 40mm HE projectiles per minute to over 1,800m.			
Variations in HAA and LSA Ammunition	Gun type	Calibre	Shell Weight	Shell Dimensions
	3.0 Inch	76mm	7.3kg	76mm x 356mm
	3.7 Inch	94mm	12.7kg	94mm x 438mm
	4.5 Inch	114mm	24.7kg	114mm x 578mm
	40mm	40mm	0.9kg	40mm x 311mm
Z-AA	The three inch unrotated rocket/projectile known as the UP-3 had initially been developed for the Royal Navy. The UP-3 was also used in ground-based single and 128-round launchers known as "Z" batteries. The rocket, containing a high explosive warhead was often propelled by cordite.			

The closest recorded HAA to the site was located approximately 1.46km north-east of the site, however the range of a projectile can be up to 15km. The site would also have been in range of mobile light anti-aircraft guns.

The conditions in which anti-aircraft projectiles may have fallen unnoticed within a site area are analogous to those regarding aerial delivered ordnance. Unexploded anti-aircraft projectiles could essentially have fallen indiscriminately anywhere within range of the guns. The chance of such items being observed, reported and removed during the war depends on factors such as land use, ground cover, damage and frequency of access – the same factors that govern whether evidence of a UXB is likely to have been noted. More information about these factors with regards to this particular site can be found in the German Aerial Delivered Ordnance section of this report.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Annex P**.

13. The Likelihood of Contamination from Allied Ordnance

13.1. Introduction

There are several factors that may serve to either affirm, increase, or decrease the level of risk within a site with a history of military usage. Such factors are typically dependent upon the proximity of the proposed area of works to training activities, munition productions and storage, as well as its function across the years.

This section will examine the history of the proposed site and assess to what degree, if any, the site could have become contaminated as a result of the military use of the surrounding area.

13.2. Evaluation of Contamination Risk from Allied UXO

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Allied UXO Contamination	Conclusion
Military Camps <i>Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.</i>	1 st Line Defence could find no evidence of a military camp within the site.
Anti-Aircraft Defences <i>Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.</i>	1 st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 1.46km north-east of the site, however the range of a projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are analogous to those regarding German aerial delivered ordnance.
Home Guard Activity <i>The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.</i>	1 st Line Defence has no evidence of any Home Guard activities on the site.
Defensive Positions <i>Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.</i>	There is no evidence of any defensive features formerly located on or bordering the site footprint.
Training or firing ranges <i>Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.</i>	There is no evidence of such features affecting the site.

Defensive Minefields <i>Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.</i>	There is no evidence of defensive minefields affecting the site.
Ordnance Manufacture <i>Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.</i>	No information of ordnance being stored, produced, or disposed of within the proposed site could be found.
Military Related Airfields <i>Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.</i>	The site was not situated within the perimeters or vicinity of a military airfield.

14. The Likelihood of UXO Contamination Summary

The following table assesses the likelihood that the site was contaminated by items of German aerial delivered and Allied ordnance. Factors such as the risk of UXO initiation, remaining, and encountering will be discussed later in the report.

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre and post-WWII Ordnance Survey maps, pre-WWII oblique aerial photography, city of Manchester plan 1945, Luftwaffe target imagery, Home Office bombing statistics, <i>Blitz Britain: Manchester and Salford</i> by Graham Pythian, Manchester bomb damage map, Manchester bomb damage cards, and WWII-era aerial photography. The record set is generally of satisfactory quality. The structural composition of the site and surrounding area prior to and after WWII was able to be corroborated across various sources. However, despite the fact that consulted records depict a clear indication of the war-time conditions on site, they do not appear to be comprehensive as there is significantly more damage and areas of clearance in the wider vicinity than what recorded bombing incidents can account for.
German Aerial Delivered Ordnance	- During WWII, the site was located within the County Borough of Manchester which was subject to an overall low density of bombing, with an average of 29.0 bombs per 1000 acres according to official Home Office Bombing Statistics. Manchester was however still subject to a number of significant Luftwaffe raids, most notably the 'Christmas Blitz' of December 1940. - Consulted historical records do not record any bomb incidents on site or in the immediate vicinity of the site boundary. The closest bombing incident recorded on the Manchester bomb damage map was a 'fire bomb' strike plotted approximately 70m north-east of the site in the vicinity of <i>Addington Street</i>. - This is corroborated by the Manchester Emergency Committee's Log Book of Bombing Incidents 22-24 December 1940 within Graham Pythian's <i>Blitz Britain: Manchester and Salford</i>, which records no specific references to bombing incidents within or in the immediate vicinity of the site location, the nearest recorded incident being 100m to the south-east. - During this period, the site was occupied by a large 'L-shaped' warehouse building that appears to have retained the same composition to today. It was bordered by a row of terraced residential properties to the south and by roadways in all other directions. - The Manchester bomb damage map records no bomb damage to this structure on site. The outline of one terraced structure adjacent to the southern extent of the site boundary is highlighted in red indicating that the structure sustained some bomb damage. However, as this is not represented in the damage key and the structure appears structurally intact in the post-WWII era, the recorded damage is anticipated to have been minor in nature. - Several structures further to the north, east, south-east and west of the site are shown to have been demolished, but all were situated on the opposite side of roadways. The closest was situated approximately 10m south-east of the site on the opposite side of <i>Mason Street</i>, although no corresponding bombing incident is evident. - Post-WWII era aerial photography largely corroborates the evidence presented within the Manchester bomb damage map, indicating that the structures within and in immediate proximity to the site appear to remain intact following WWII. The photography also reveals obvious areas of clearance across the wider area, the closest of which is shown to be on the opposite side of <i>Mason Street</i> and <i>Cable Street</i>, approximately 10m south-east and 10m north-east of the site respectively. However, none of these areas appear to have had any significant

	impact on the condition or usage of the site footprint. Given this, their distance and the fact that the site was separated by sections of roadway, these surrounding areas of clearance are not anticipated to significantly elevate the risk of UXO contamination on site. • Owing to the fact that the structures occupying and immediately adjacent to the site, appear to have survived the war intact, it is anticipated that the ground cover within and in close proximity of the site would have been conducive to evidence of UXO. Furthermore, the adjacent roadways comprising hardstanding ground would have also been favourable to spotting indications of UXO, such as craters or entry holes. • Due to the fact that the site comprised a warehouse structure adjacent to several main roads and in close proximity to the <i>Smithfield Market</i> within the northern quarter of Manchester city centre, the site and surrounding area are anticipated to have been subject to a good level of monitor and frequent access throughout WWII.
Allied Ordnance	• There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however to those regarding aerial delivered ordnance.

15. The Likelihood that UXO Remains

15.1. Introduction

It is important to consider the extent to which any explosive ordnance clearance (EOC) activities or extensive ground works have occurred on site. This may indicate previous ordnance contamination or reduce the risk that ordnance remains undiscovered.

15.2. UXO Clearance

1st Line Defence has found no evidence in the public domain or within internal records that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from the 33 EOD Regiment Archive (now part of 29 Regt). It should also be noted that in addition to 29 Regt archival information, 1st Line Defence also do not currently have access to data that may be relevant including 5131(BD)SQN Archive, SD Training Technical Advisory Section (TAS) and MACA Records (bomb disposal callouts).

If such information is available at a later date, it is recommended that it be reviewed as it will assist with understanding both levels and types of contamination likely to be present, and may indicate risk reduction in certain areas.

15.3. Post-War Redevelopment

Recent aerial photography dated May 2019 indicates that post-war redevelopment of the site has been limited. The structures currently occupying the site resemble those present in the immediate post-WWII era and in OS mapping from 1966 - 1969.

OS mapping from 1951 – 1952 shows the surrounding vicinity to have undergone significant re-development since the pre-war era. The same structure being built in 1937 oblique aerial photography and a 1945 plan of Manchester city centre occupies the approximate footprint of the site. Further to the north and west of the site, several *Ruins* and areas of clearance can be discerned. To the east of the site, several notable changes have occurred, in which clusters of smaller structures have either been cleared completely or re-developed into larger warehouse-style structures. Notably, a *Ruin* and an area of clearance can be seen on the opposite side of *Mason Street* approximately 10m south-east of the site boundary. The area further south of the site appears to remain relatively unchanged in the post-war era, *Smithfield Market* and several other adjacent market structures can be seen beyond *Swan Street*.

OS mapping from 1966 - 1969 shows no change to the structural outlay of the site, which comprises a single *Warehouse* structure in the approximate footprint of the site boundary. To the immediate south of the site several terraced structures have been cleared and redeveloped into a single *Bank* structure. Further to the north, east and west of the site, several areas formerly occupied by cleared ground now comprise *Warehouse* or *Works* structures. No notable major changes have occurred further to the south of the site in this era.

The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. Within the footprints of post-WWII redevelopments, the risk from shallow-buried UXO (especially 1kg German incendiaries and British AA projectiles) should have been encountered/removed during initial excavations. However, the risk from deep-buried German UXBs will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

16. The Likelihood of UXO Encounter

16.1. Introduction

For UXO to pose a risk at a site, there should be a means by which any potential UXO might be encountered on that site.

The likelihood of encountering UXO on the site of proposed would depend on various factors, such as the type of UXO that might be present and the intrusive works planned on site. In most cases, UXO is more likely to be present below surface (buried) than on surface.

In general, the greater the extent and depth of intrusive works, the greater the risk of encountering. The most likely scenarios under which items of UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The overall risk will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations.

Generally speaking, the risk of encountering any type of UXO will be minimal for any works planned within the footprint and down to the depth of post-war foundations and excavations.

17. The Likelihood of UXO Initiation

17.1. Introduction

UXO does not spontaneously explode. Older UXO devices will require an external event/energy to create the conditions for detonation to occur. The likelihood that a device will function can depend on a number of factors including the type of weaponry, its age and the amount of energy it is struck with.

17.2. Initiating Aerial Delivered Ordnance

Unexploded bombs do not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur.

In recent decades, there have been a number of incidents in Europe where Allied UXBs have detonated, and incidents where fatalities have resulted.. There have been several hypotheses as to the reason why the issue is more prevalent in mainland Europe – reasons could include the significantly greater number of bombs dropped by the Allied forces on occupied Europe, the preferred use by the Allies of mechanical rather than electrical fuzes, and perhaps just good fortune. The risk from UXO in the UK is also being treated very seriously in many sectors of the construction industry, and proactive risk mitigation efforts will also have affected the lack of detonations in the UK.

There are certain construction activities which make initiation more likely, and several potential initiation mechanisms must be considered:

UXB Initiation	
Direct Impact	Unless the fuze or fuze pocket is struck, there needs to be a significant impact e.g. from piling or large and violent mechanical excavation, onto the main body of the weapon to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
Re- starting the Clock	A small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion would have taken place within the fuze mechanism over the last 70+ years that would prevent clockwork mechanisms from functioning. Nevertheless, it was reported that the clockwork fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-start.
Friction Impact	The most likely scenario resulting in the detonation of a UXB is friction impact initiating the shock-sensitive fuze explosive. The combined effects of seasonal changes in temperature and general degradation over time can cause explosive compounds to crystallise and extrude out from the main body of the bomb. It may only require a limited amount of energy to initiate the extruded explosive which could detonate the main charge.

18. Consequences of Initiation/Encounter

18.1. Introduction

The repercussions of the inadvertent detonation of UXO during intrusive ground works, or if an item or ordnance is interfered with or disturbed, are potentially profound, both in terms of human and financial cost. A serious risk to life and limb, damage to plant and total site shutdown during follow-up investigations are potential outcomes. However, if appropriate risk mitigation measures are put in place, the chances of initiating an item of UXO during ground works is comparatively low.

The consequences of encountering UXO can be particularly notable in the case of high-profile sites (such as airports and train stations) where it is necessary to evacuate the public from the surrounding area. A site may be closed for anything from a few hours to a week with potentially significant cost in lost time. It should be noted that even the discovery of suspected or possible item of UXO during intrusive works (if handled solely through the authorities), may also involve significant loss of production

18.2. Consequences of Detonation

When considering the potential consequences of a detonation, it is necessary to identify the significant receptors that may be affected. The receptors that may potentially be at risk from a UXO detonation on a construction site will vary depending on the site specific conditions but can be summarised as follows:

- People – site workers, local residents and general public.
- Plant and equipment – construction plant on site.
- Services – subsurface gas, electricity, telecommunications.
- Structures – not only visible damage to above ground buildings, but potentially damage to foundations and the weakening of support structures.
- Environment – introduction of potentially contaminating materials.

19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

Taking into account the quality of the historical evidence, the assessment of the overall risk from unexploded ordnance is based on the following five considerations:

1. That the site was contaminated with unexploded ordnance.
2. That unexploded ordnance remains on site.
3. That such items will be encountered during the proposed works.
4. That ordnance may be initiated by the works operations.
5. The consequences of encountering or initiating ordnance.

19.2. Assessed Risk Level

1st Line Defence has assessed that there is an overall **Low Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is also an assessed **Negligible Risk** from all other types of Allied ordnance.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs		✓		
German 1kg Incendiary Bombs		✓		
Allied Anti-Aircraft Artillery Projectiles		✓		
Allied Land Service and Small Arms Ammunition	✓			

Please note – although the risk from unexploded ordnance on this site has been assessed as ‘Low’, this does not mean there is ‘no’ risk of encountering UXO. This report has been undertaken with due diligence, and all reasonable care has been taken to access and analyse relevant historical information. By necessity, when dealing historical evidence, and when making assessments of UXO risk, various assumptions have to be made which we have discussed and justified throughout this report. Our reports take a common-sense and practical approach to the assessment of risk, and we strive to be reasonable and pragmatic in our conclusions.

It should however be stressed that if any suspect items are encountered during the proposed works, 1st Line Defence should be contacted for advice/assistance, and to re-assess the risk where necessary. The mitigation measures outlined in the next section are recommended as a minimum precaution to alert ground personnel to the history of the site, what to look out for, and what measures to take in the event that a suspect item is encountered. It should also be noted that the conclusions of this report are based on the scope of works outlined in the ‘Proposed Works’ section of this report. Should the scope of works change or additional works be proposed, 1st Line Defence should be contacted to re-evaluate the risk.

20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at Swan Street, Manchester:

Type of Work	Recommended Mitigation Measure
All Works	UXO Risk Management Plan It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. Site Specific UXO Awareness Briefings to all personnel conducting intrusive works. As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.

In making this assessment and recommending these risk mitigation measures, if known, the works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited

12/02/2021

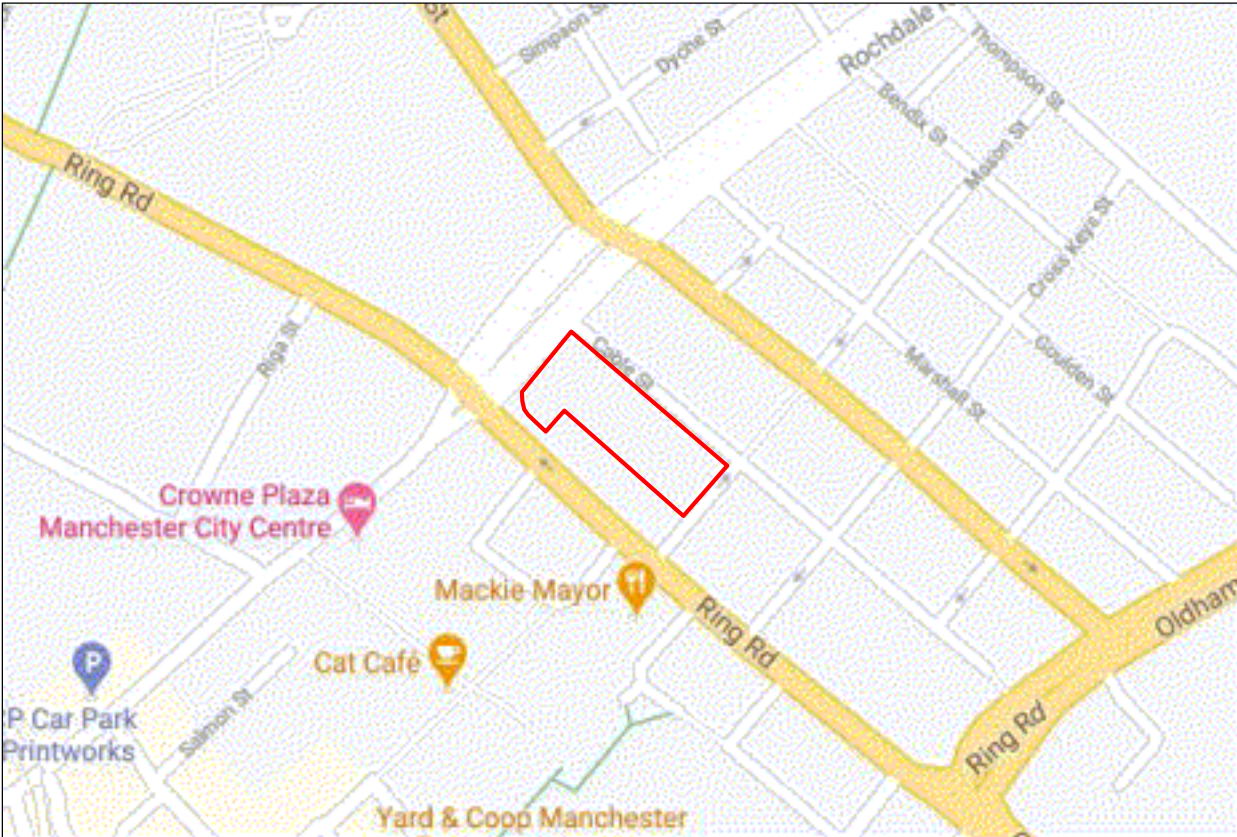
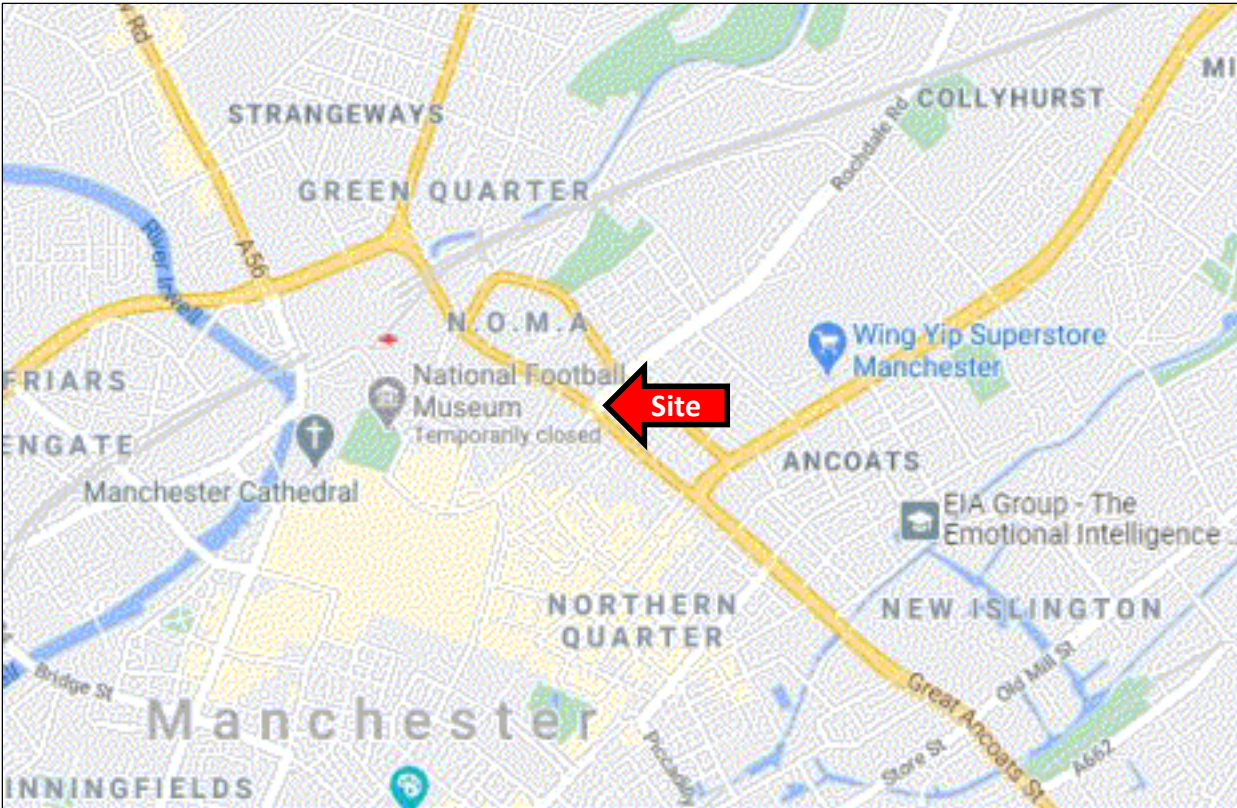
This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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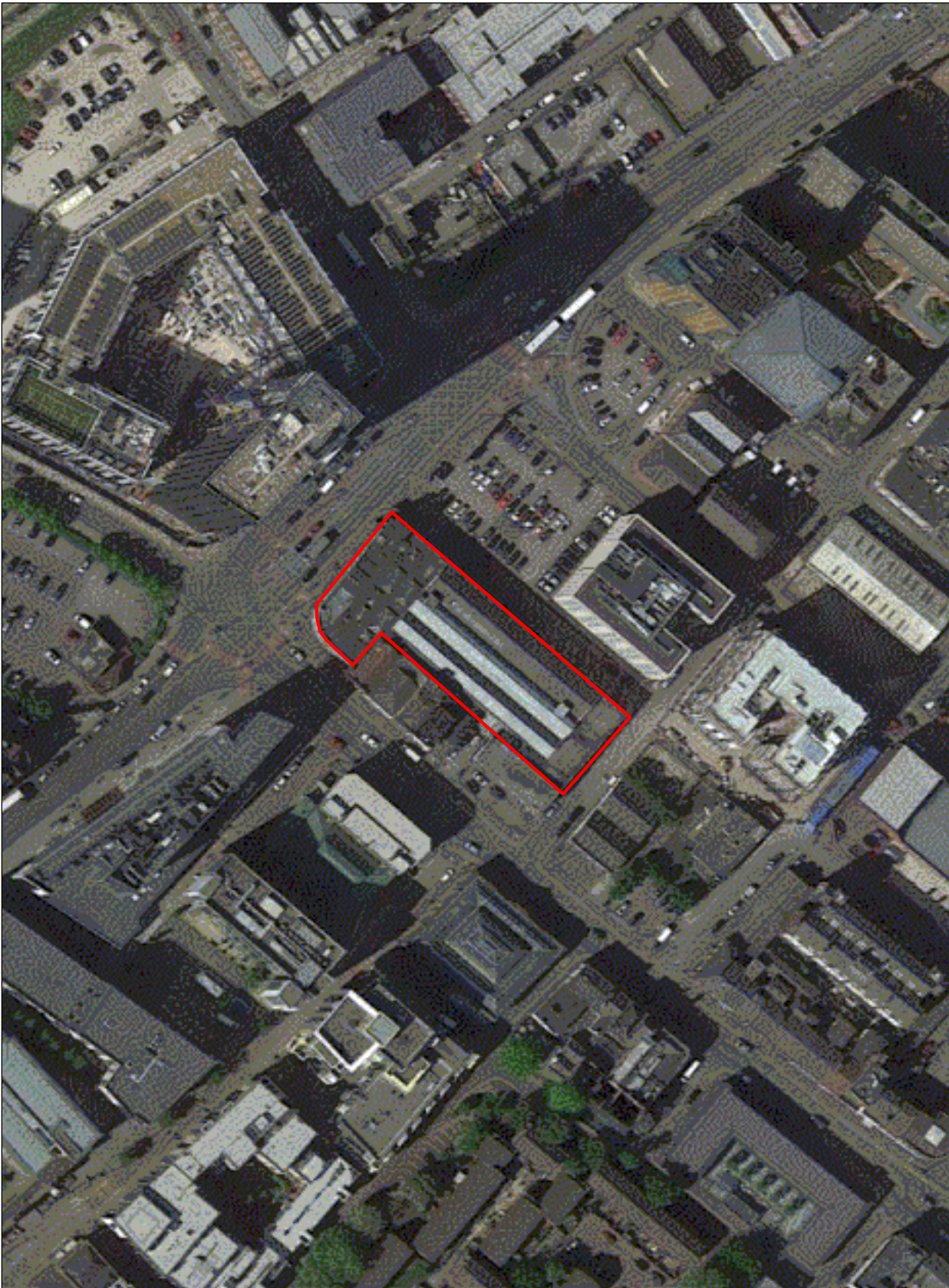
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Ref: **DA12456-00**

Source: Google Maps

 **Approximate site boundary**





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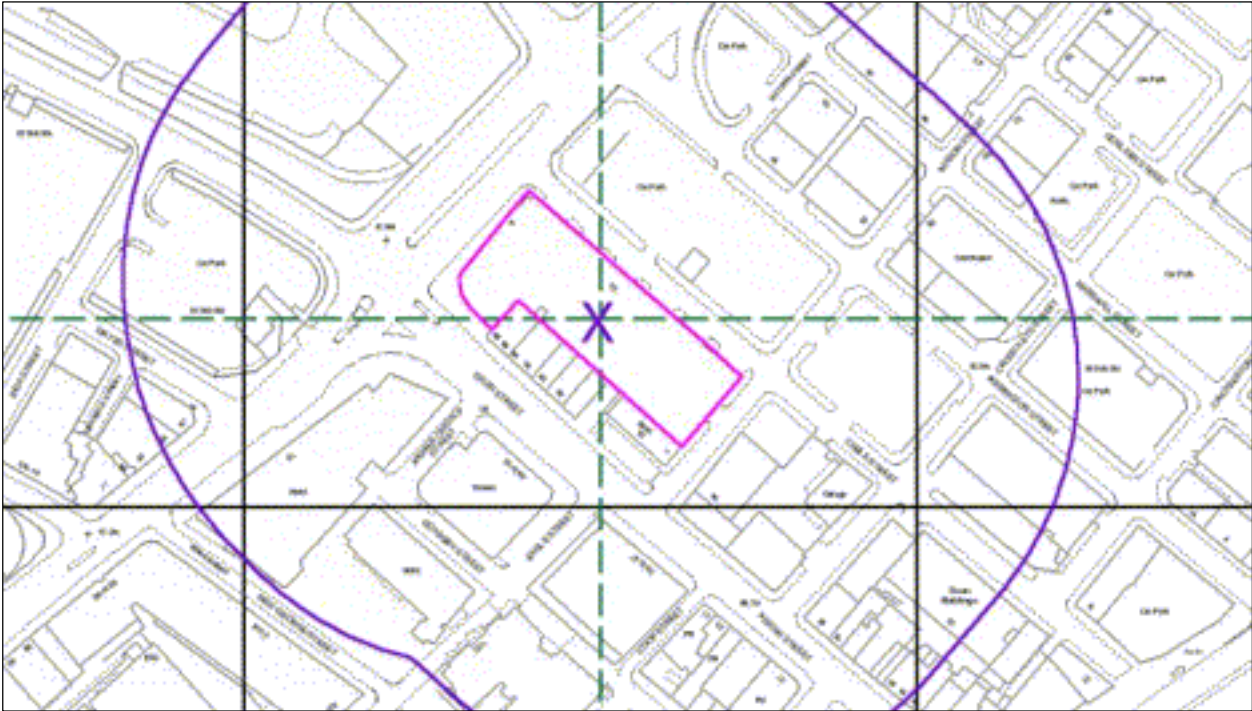
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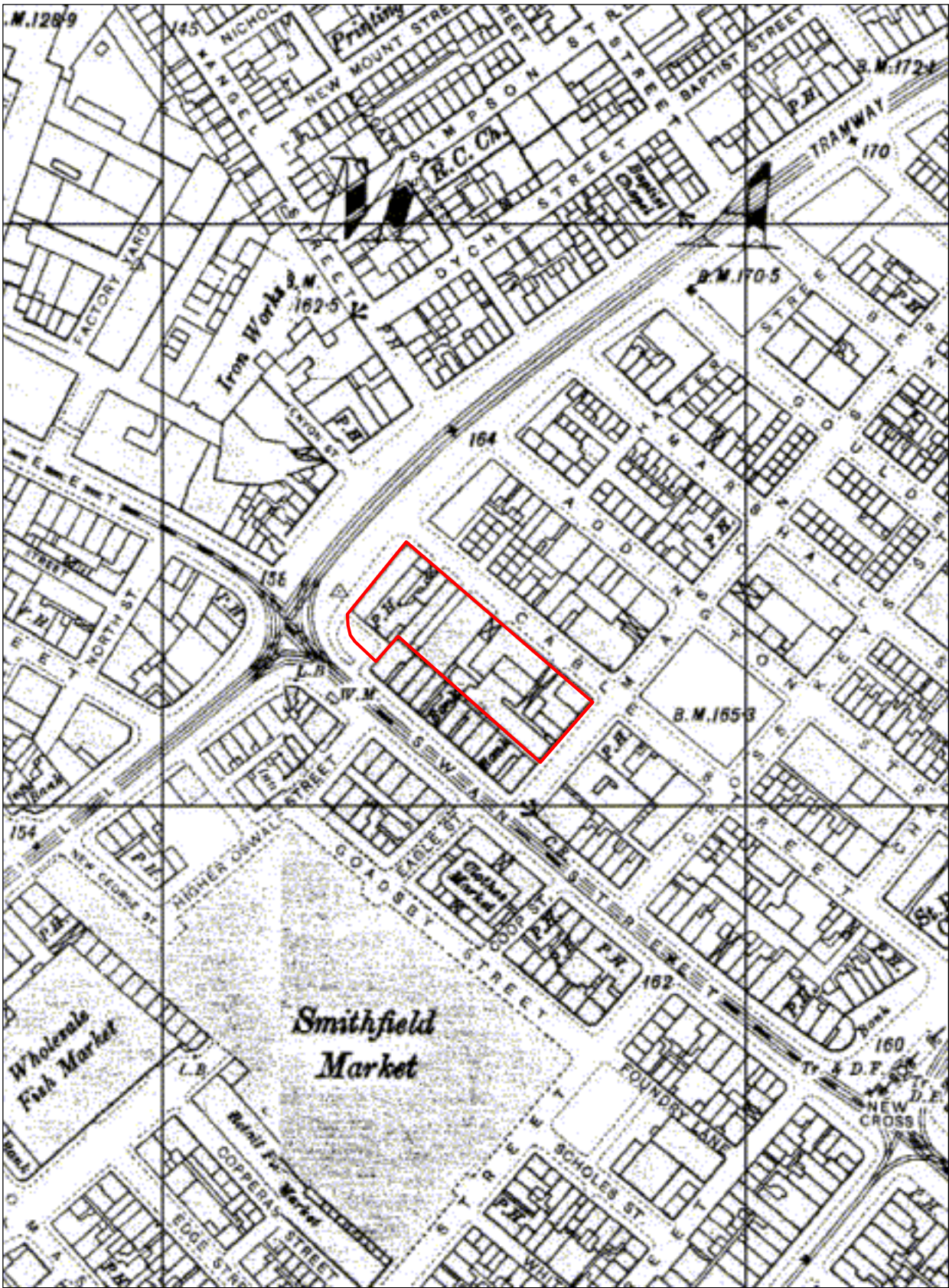
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Project: **Swan Street, Manchester**



Ref: **DA12456-00** Source: Google Earth™ Mapping Services





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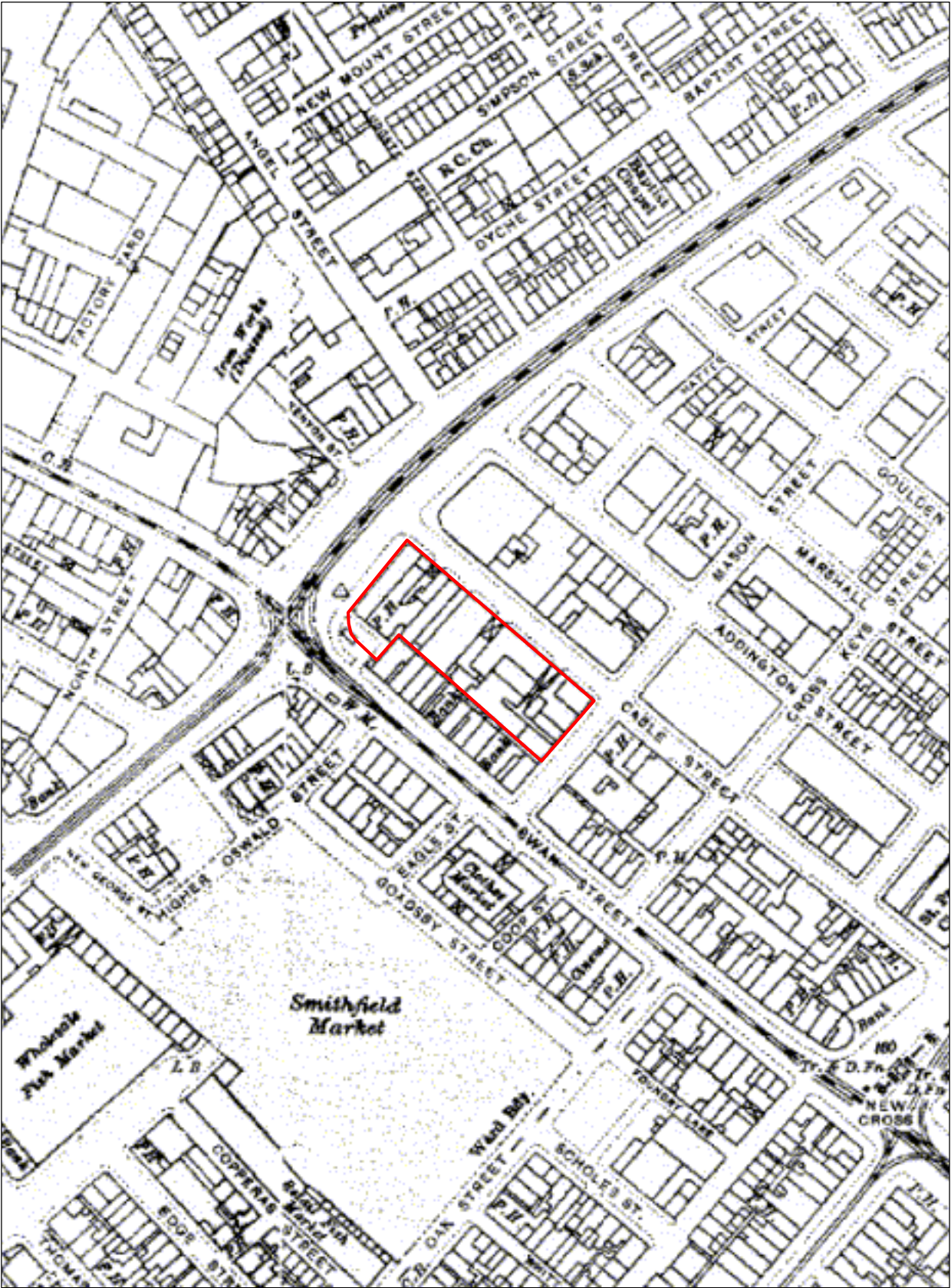
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Ref: DA12456-00

Source: Landmark Maps





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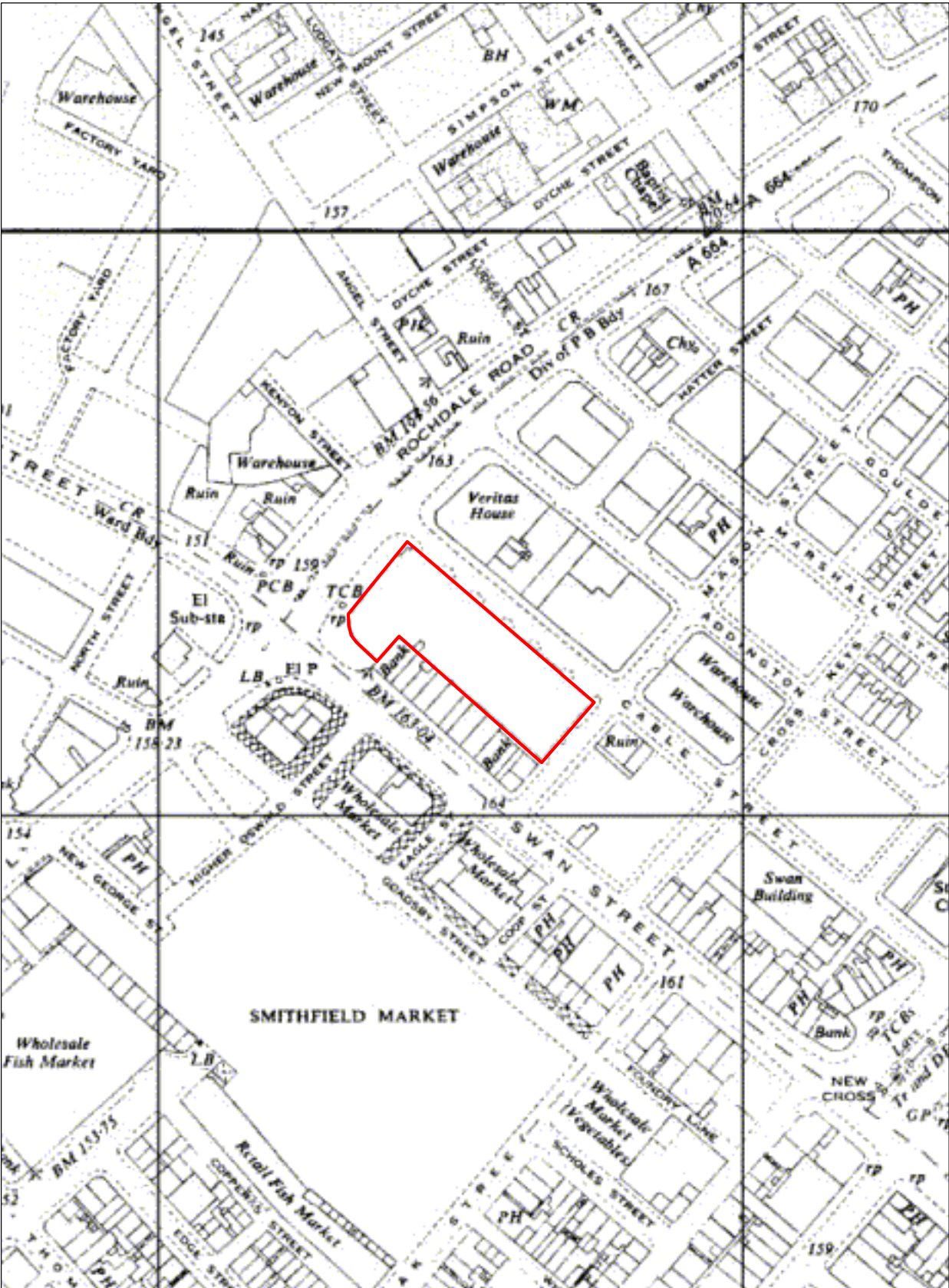
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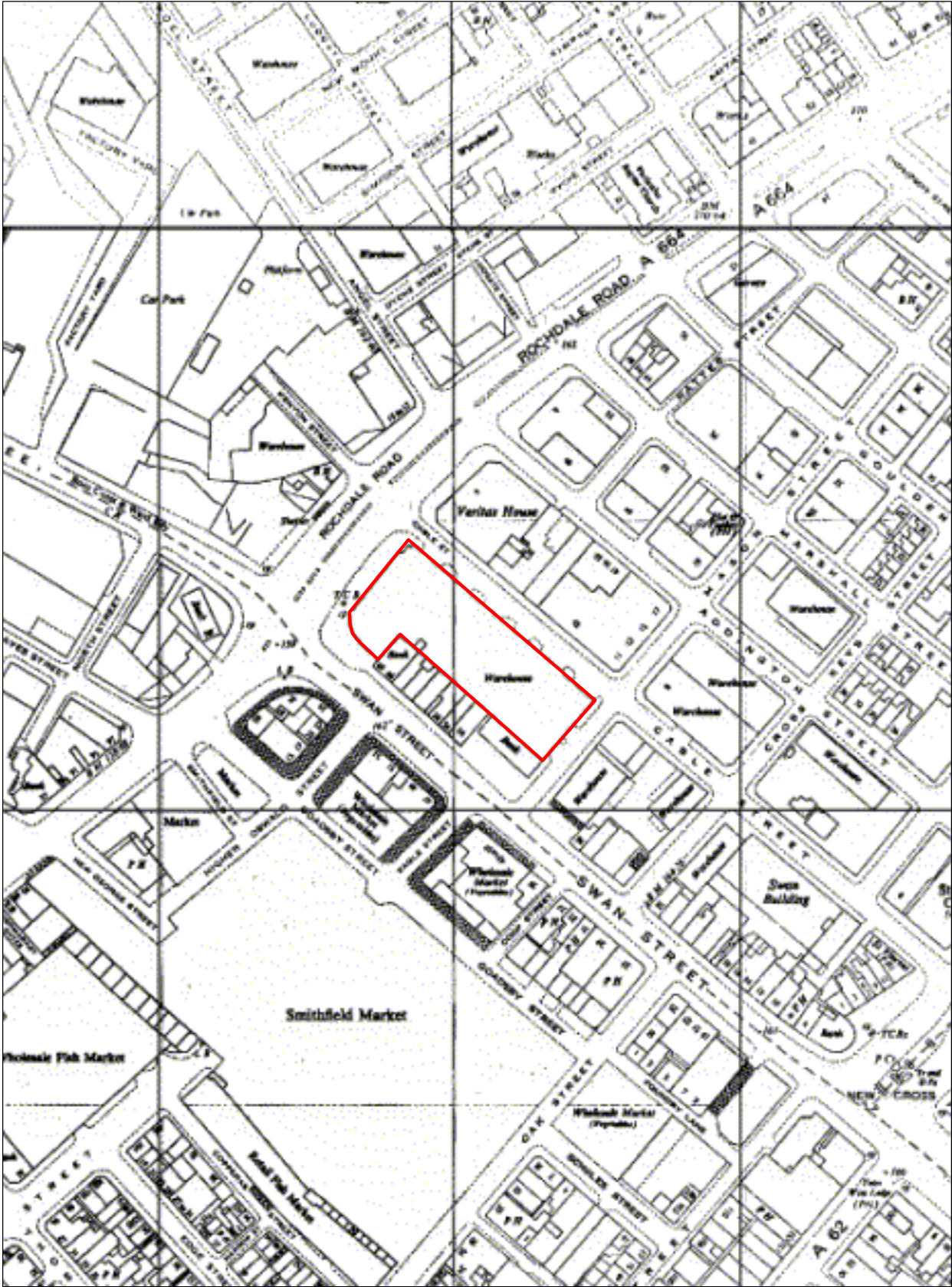
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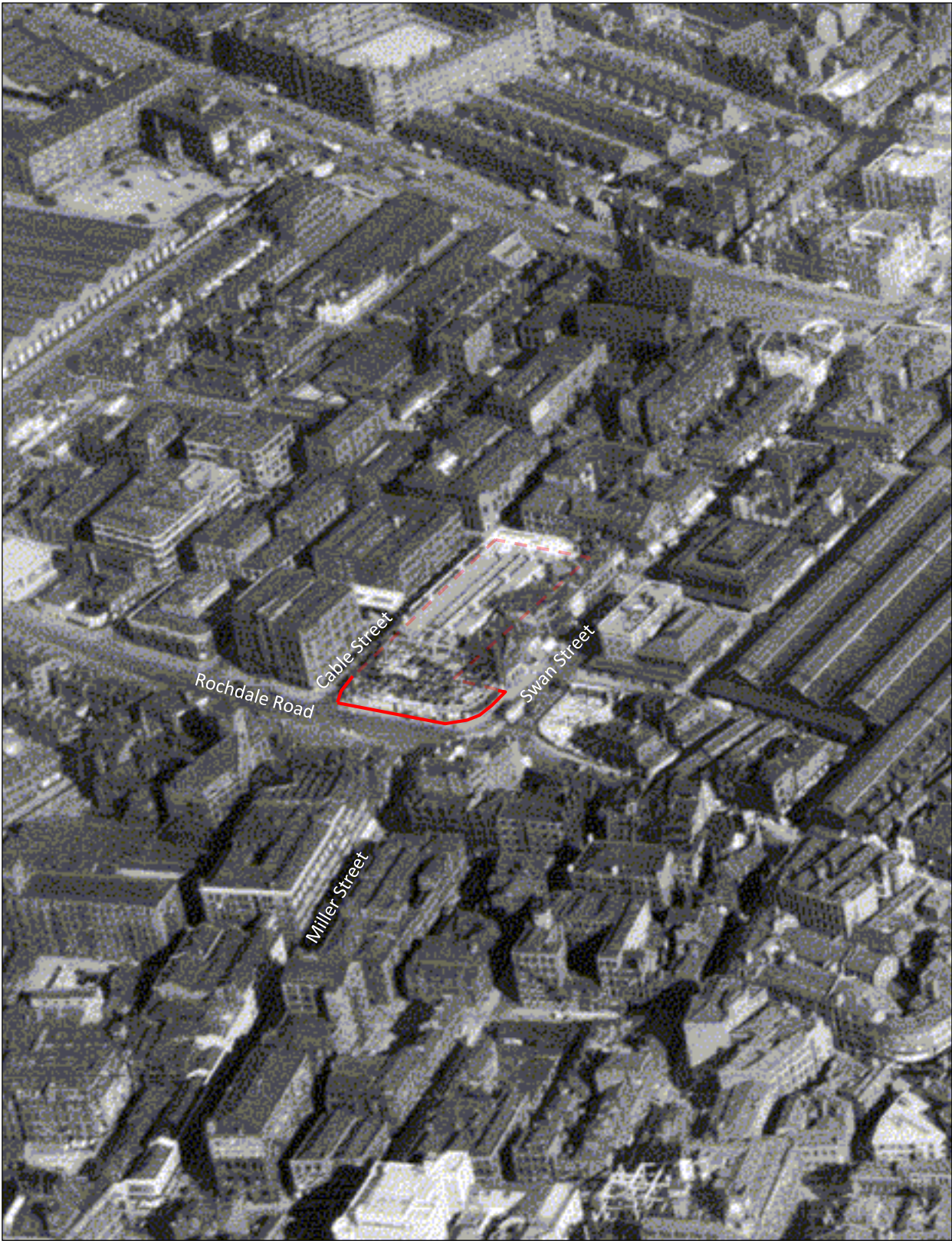




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Client: Curtins		 Approximate site boundary	
Project: Swan Street, Manchester			
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 **Approximate site boundary**



Project: **Swan Street, Manchester**

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Source: Britain from Above

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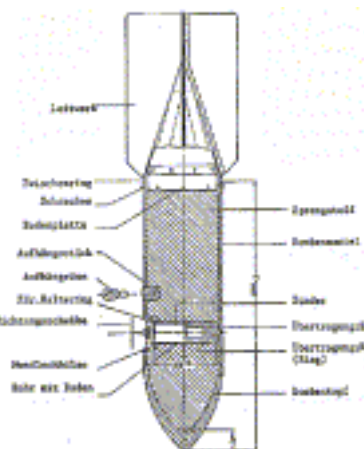
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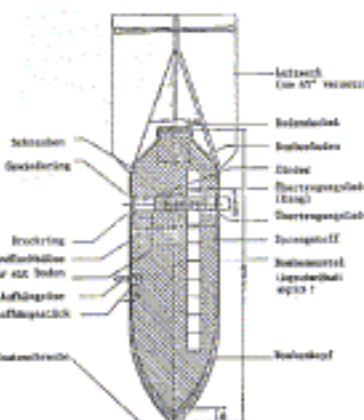
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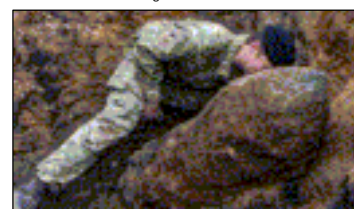
Bomb Weight	40-54kg (88-119lb)
Explosive Weight	25kg (55lb)
Fuze Type	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions	1,090 x 280mm (42.9 x 11.0in)
Body Diameter	200mm (7.87in)
Use	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.



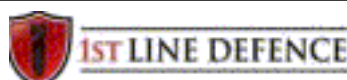
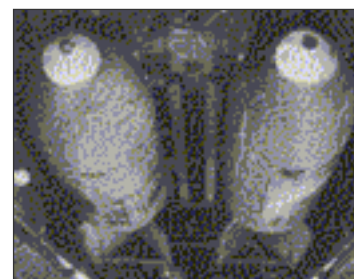
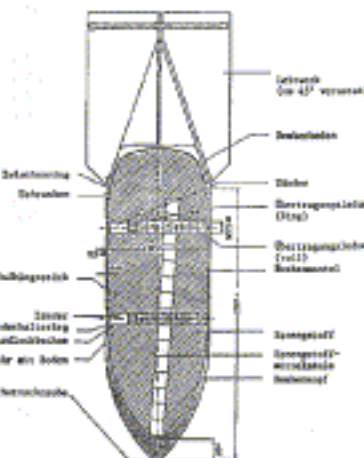
Bomb Weight	245-256kg (540-564lb)
Explosive Weight	125-130kg (276-287lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)
Body Diameter	368mm (14.5in)
Use	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.
Remarks	It could be carried by almost all German bomber aircraft, and was used to notable effect by the Junkers Ju-87 Stuka (Sturzkampfflugzeug or dive-bomber).



SC250 bomb being loaded onto German bomber



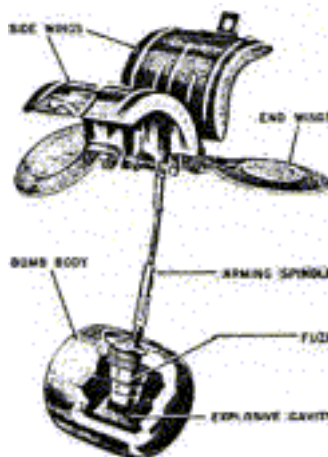
Bomb Weight	480-520kg (1,058-1,146lb)
Explosive Weight	250-260kg (551-573lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1957 x 640mm (77 x 25.2in)
Body Diameter	470mm (18.5in)
Use	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.
Remarks	40/60 or 50/50 Amatol TNT, triale. Bombs recovered with Triale filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming



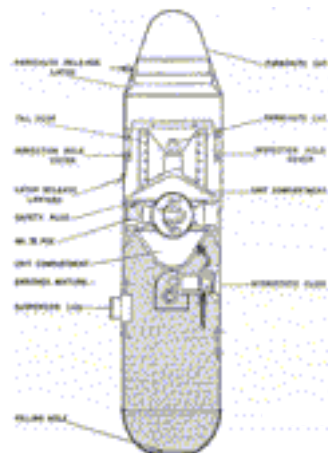
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Project:	Swan Street, Manchester		
Ref:	DA12456-00	Source:	Various sources

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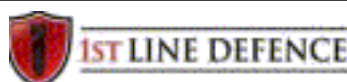
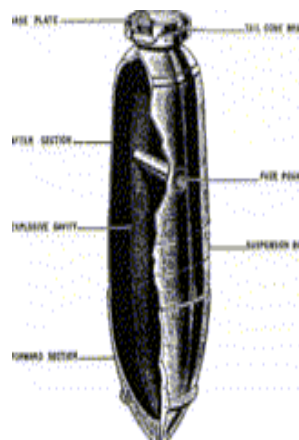
Bomb Weight	Approx. 2kg (4.41lb)
Explosive Weight	Approx. 7.5oz (225 grams) of Amatol surrounded by a layer of bituminous composition.
Fuze Type	41 fuze (time) , 67 fuze (clockwork time delay) or 70 fuze (anti-handling device)
Body Diameter	3in (7.62 cm) diameter, 3.1in (7.874) long
Use	Designed as an anti-personnel/ fragmentation weapon. They were delivered by air, being dropped in containers of 23-144 sub-munitions that opened at a predetermined height, thus scattering the bombs.
Remarks	Very rare. First used against Ipswich in 1940, but were also dropped on Kingston upon Hull, Grimsby and Cleethorpes in June 1943, amongst various other targets in UK. As the bombs fell the outer case flicked open by springs which caused four light metal drogues with a protruding 5 inch steel cable to deploy in the form of a parachute & wind vane which armed the device as it span.



Bomb Weight	Approx. 990kg (2176lb)
Explosive Weight	Approx. 705kg (1,554lb)
Fuze Type	Impact/ Time delay / hydrostatic pressure fuze
Dimensions	2.64m x 0.64m (3.04m with parachute housing)
Use	Against civilian, military and industrial targets. Used as blast bombs and designed to detonate above ground level to maximise damage to a wider area.
Remarks	Deployed a parachute when dropped in order to control its descent. Had the potential to cause extensive damage in a 100m radius.



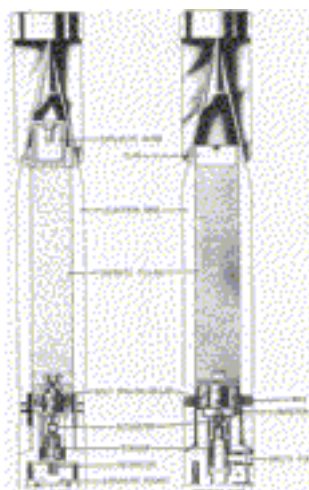
Bomb Weight	Approx. 993-1027kg (2,189-2,264lb)
Explosive Weight	Approx. 530-620kg (1168-1367lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Filling	Mixture of 40% amatol and 60% TNT, but when used as an anti-shiping bomb it was filled with Triolene 105, a mixture of 15% RDX, 70% TNT and 15% aluminium powder.
Bomb Dimensions	2800 x 654mm (110 x 25.8in)
Body Diameter	654mm (18.5in)
Use	SC type bombs are General Purpose Bombs used primarily for general demolition work. Constructed of parallel walls with comparatively heavy noses. They are usually of three piece welded construction.



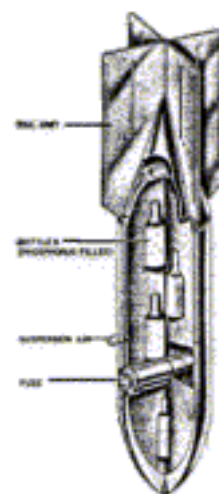
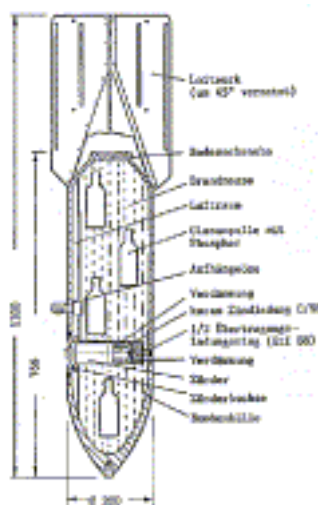
Client:	Curtins
Project:	Swan Street, Manchester
Ref:	DA12456-00
Source:	Various sources

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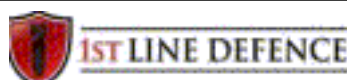
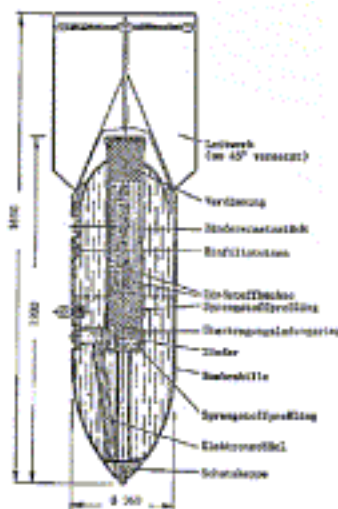
Bomb Weight	Approx. 1.0 - 1.3kg (2.2 and 2.9lb)
Explosive Weight	Approx. 680g (1.5lb) Thermite 8-15gm Explosive Nitropenta
Fuze Type	Impact fuze
Bomb Dimensions	350 x 50mm (13.8 x 1.97in)
Body Diameter	50mm (1.97in)
Use	As incendiary – dropped in clusters on towns and industrial complexes
Remarks	Magnesium alloy case. Sometimes fitted with high explosive charge. The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze.



Bomb Weight	Approx. 41kg (90.4lb)
Explosive Weight	Approx. 0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against any targets where an incendiary effect is required
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture



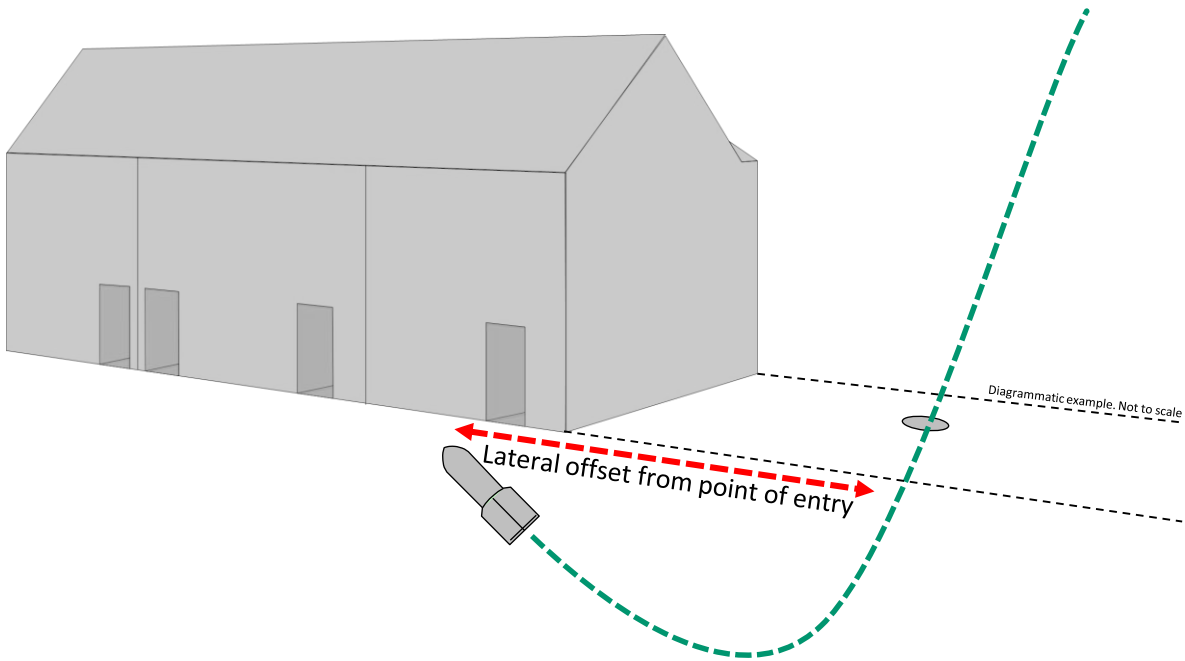
Bomb Weight	Approx. 125kg (276lb)
Explosive Weight	Approx. 1kg (2.2lb)
Fuze Type	Super-fast electrical impact fuze
Filling	Mixture of 30% petrol and 70% crude oil
Bomb Dimensions	1,650 x 512.2mm (65 x 20.2in)
Body Diameter	368mm (14.5in)
Use	Often used for surprise attacks on ground troops, against troop barracks and industrial installations. Thin casing – not designed for ground penetration



Client:	Curtins		
Project:	Swan Street, Manchester		
Ref:	DA12456-00	Source:	Various sources

Ref: DA12456-00	Source: Various sources
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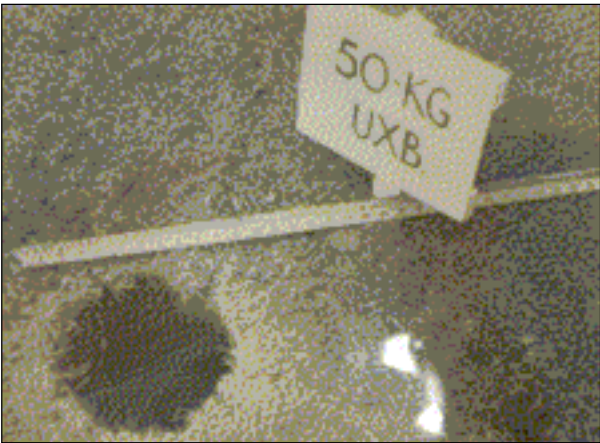
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Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites. The photograph above shows 250kg bomb found in Bermondsey pointing upwards, demonstrating 'J-curve'



One of the most common scenarios for UXO going unnoticed was when a UXB fell into a 'bomb site' (such as the area shown **Top Left**), the entry hole of the bomb obscured by any debris and rubble present. Note that the entry hole of a 50kg UXB could be as little as 20cm in diameter (**Left**).

BBC
NEWS

Bermondsey bomb: World War Two device safely removed



An unexploded World War Two bomb found in south London has been driven away safely under police and Army escort.

The 500lb (250kg) device was found on a building site in Grainge Walk, Bermondsey on Monday

March 2015

BBC
NEWS

Bethnal Green WW2 bomb: Experts remove unexploded device



An unexploded World War Two bomb that prompted the evacuation of 700 people in east London has been made safe and removed by the military.

Families spent the night in a school hall after the 500lb bomb was found in the basement of a building site on Temple Street, in Bethnal Green, on Monday afternoon.

A 200m (650ft) exclusion zone was set up around the device.

August 2016

BBC
NEWS

Bath WW2 bomb scare: Device defused, police say



A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

The discovery of the bomb on Thursday led to the evacuation of hundreds of homes and many road closures in the Lansdown area of the city.

A cordon around the site was lifted on Friday evening, more than 24 hours after residents were asked to leave their homes

May 2016

BBC
NEWS

London City Airport reopens after WW2 bomb moved



London City Airport has reopened after an unexploded 500kg World War Two bomb was safely moved from the area.

The device was discovered at the King George V Dock on Sunday during planned work at the east London airport.

All flights were cancelled on Monday after an exclusion zone was put in place, with the closure affecting up to 16,000 passengers and nearby residents being evacuated from their homes.

May 2015

BASF has confirmed that an explosive device, most likely a World War II-era bomb, caused the blast that left one person injured Tuesday at a plant construction site in Germany.

The explosion was reported at BASF's Ludwigshafen toluene diisocyanate (TDI) plant, which recently broke ground for a 300,000 metric tons per year TDI production plant and other construction to expand its facilities.



BASF Provides Some Details

Responding to a request from PointSquare News for more information on Wednesday (Feb. 27), BASF's manager of media relations and corporate communications Europe, Ursula von Stetten, wrote in an email, "So here [are] the facts: The detonation took place at 10:00 a.m. One person was injured; the injury is not serious. He will be kept in the hospital for some days.

"Cause of the detonation was an explosive device, presumably a bomb deriving from the Second World War. The device detonated when grounding work was done. No details on [a] delay [are] available. At the moment, the exact circumstances of the incident are [being] evaluated."

1st March 2013

WWII bomb injures 17 at Hattingen construction site



Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen. An excavator apparently drove over a 250-kilogramme (550 pound) American bomb, damaging surrounding buildings. Most of the injured suffered auditory trauma from the blast, and the excavator operator suffered injuries to his hands, police in the German state of North Rhine-Westphalia said.

"The hole was astounding small for such a large bomb full of so many explosives," Armin Gebhard, head of the Arnsberg department for military ordnance removal, told The Local. "But of course it damaged all the surrounding buildings too. We are really happy it wasn't worse."

19th September 2013



World War II bomb kills three in Germany



A special commission is investigating the causes of the explosion, while prosecutors are considering whether the team leader should face charges of manslaughter through culpable negligence, the BBC's Dana Lungeanu reports from Berlin.

The blast happened an hour before the defusing operation was due to start.

Officials said the three men who died were experienced sappers, or combat engineers, who over 20 years had defused up to 700 bombs.

More than 7,000 people were immediately evacuated when the 500kg bomb was found. Several schools, a kindergarten and local companies remain closed.

2nd June 2010



June 2006

SPIEGEL ONLINE

Blast Kills One

World War II Bomb Explodes on German Motorway

A highway construction worker in Germany accidentally struck an unexploded World War II bomb, causing an explosion which killed him and wrecked several passing cars.



A World War II bomb has exploded during construction work on a German highway, killing one worker and injuring several motorists who were driving past, police said.

The worker had been cutting through the road surface near the south-western town of Aschaffenburg when his machine struck the bomb and triggered it. Police said they weren't sure yet what type of bomb it was. "The explosion seems to have been too small for it to have been an aircraft bomb," a police spokesman said.

23rd October 2006



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Client:	Curtins	
Project:	Swan Street, Manchester	
Ref:	DA12456-00	Source: Various news sources
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Unexploded WW2 bomb forces Salford road closures

🕒 6 November 2015 | Manchester

[f](#) [t](#) [v](#) [✉](#) [Share](#)



The shell was discovered at the site of the former Royal Ordnance Factory in Green Lane, which has been demolished to make way for housing

An unexploded World War Two bomb has been found at a former munitions factory in Greater Manchester, leading to a partial evacuation of the area.

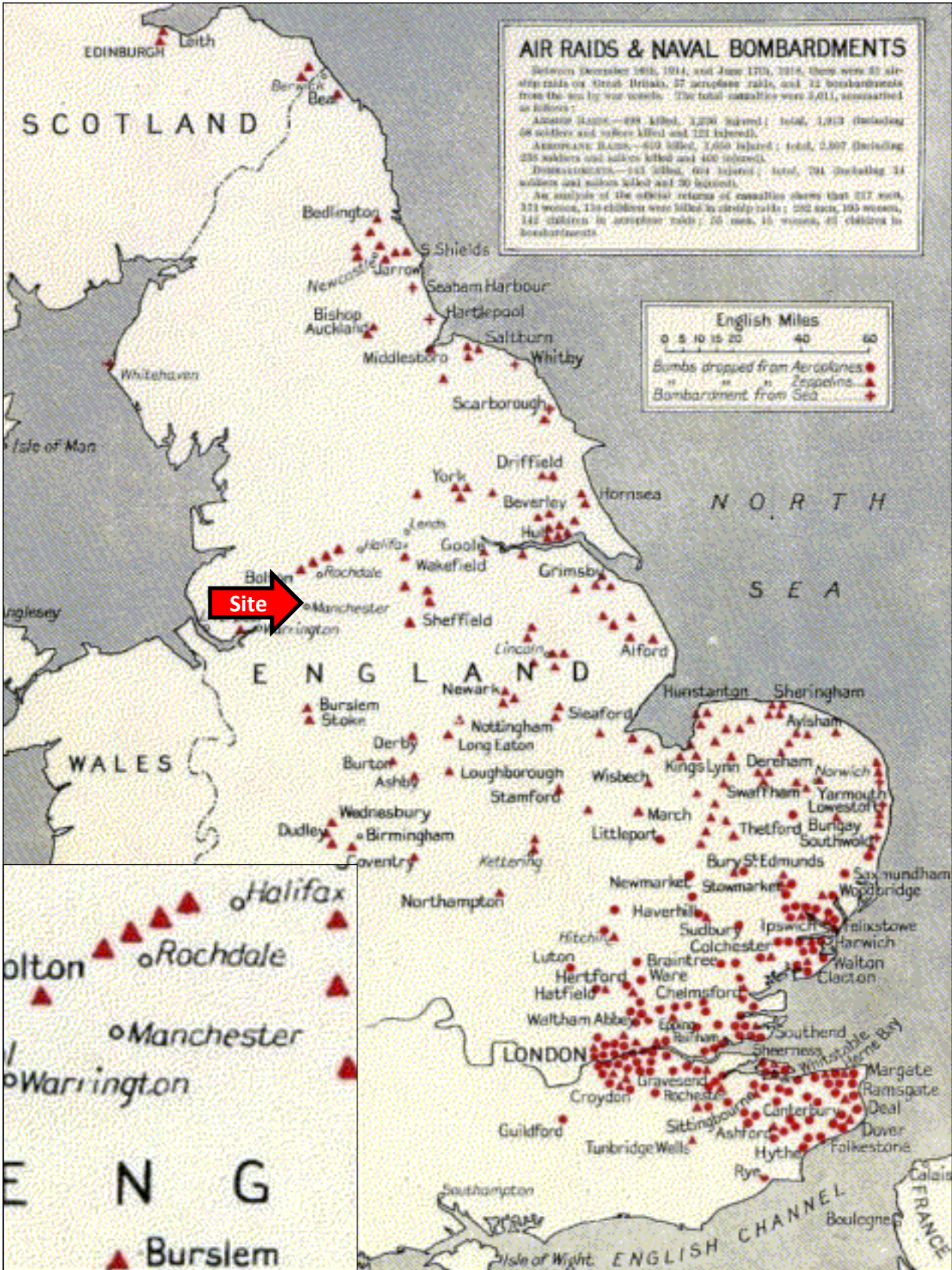
Army bomb disposal experts were called to the former Royal Ordnance Factory in Green Lane, Patricroft, Salford, at about 11:30 GMT.

Surrounding roads were closed while the mortar shell was examined.



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Client: Curtins		
Project: Swan Street, Manchester		
Ref: DA12456-00	Source: BBC News	



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Client: **Curtins**

Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: **J. Morris, German Air Raids on Britain**



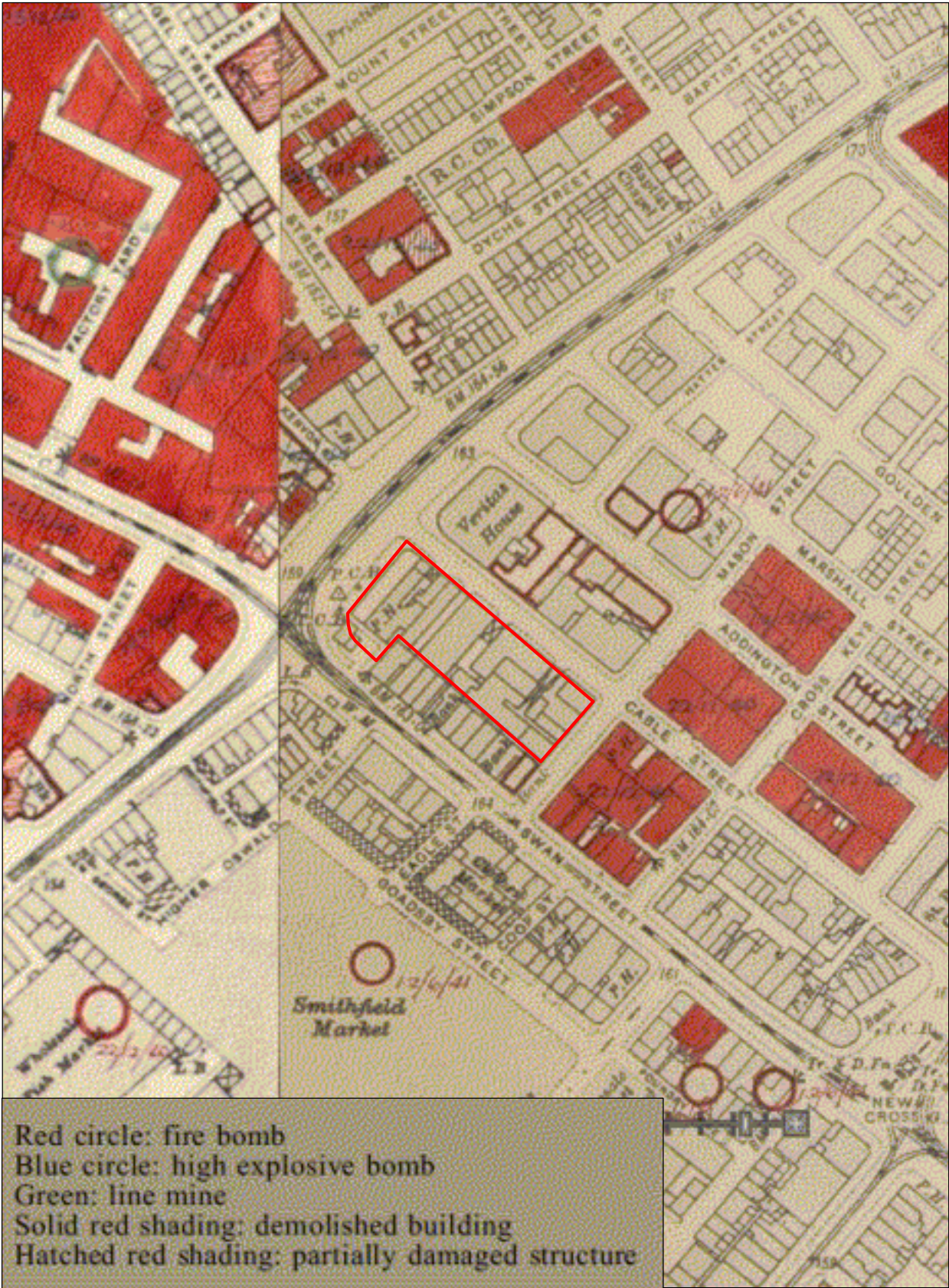
Luftwaffe Image, Unknown Date



The Salford Dockyards presented an obvious and lucrative target for the Luftwaffe and were resultantly bombed. On 23 March 1941. Among the merchant ships sunk in the attacks on the Salford Docks was SS Stella with its cargo of pig iron. The official handwritten record of incidents notes that three ships (unspecified) were sunk in this attack. Besides the three craft lost, five more cargo boats or liners suffered damage. the SS London II had its anti-mine equipment destroyed through incendiaries.

The docks were hit once more on the night of 7-8 May 1941 with No. 7 Dock and the wharf railways badly damaged. Although no ships were destroyed in this attack – four large merchant ships had narrow escapes from UXBs – the oil installations on both sides of the docks were set ablaze. Some tanks of whale oil were ruptured and some of the burning oil flooded on to the canal banks before being contained.

The site located approximately 3.5km north-east of the Salford Dockyards.



Red circle: fire bomb
Blue circle: high explosive bomb
Green: line mine
Solid red shading: demolished building
Hatched red shading: partially damaged structure



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Client:	Curtins	 Approximate site boundary
Project:	Swan Street, Manchester	
Ref:	DA12456-00	Source: Manchester University Library



22nd & 23rd December 1940

65. SMITHFIELD MARKET
[MAJOR INCIDENT – SEE NOS 74, 92, 100, 106, 171]
Shower of incendiary bombs in the vicinity of the Market at 8.20 p.m. 22nd. Damage was caused to the roof and various stalls and offices in the Wholesale and Retail Fish and Produce Markets. Several premises in Swan St were extensively damaged by fire. Fires were extinguished by the fire brigade, and the incidents were later closed.

Unknown distance south and south-east of site

80. SWAN ST, BETWEEN OAK ST & TIB ST
Incendiary bomb approx. 9.00 p.m. 22nd.
Serious damage caused to 19 – 19a – 23 & 21 Swan St, by fire. Incident now closed. 12.10 p.m. 23rd.

100m south-east of site

District <i>C</i>		<i>CABLE ST</i>										Incident Date	
Sector <i>20</i>		<i>ANCOATS</i>										Date Inspected <i>10 / 4 / 42</i>	
Card No.		Continued on Card No.										Inspector <i>Shibb</i>	
No.	H. H. & S. F.	Classifica- tion	TENANT	EXTENT OF DAMAGE								Re- Classification	
				Roofs	Chimneys	Walls	Floors	Ceilings	Doors	Windows	Frames	Class	Date
<i>12</i>		<i>B✓</i>	<i>D. S.C.</i>										
<i>14</i>		<i>B✓</i>	<i>D. S.C.</i>										
<i>16</i>		<i>B✓</i>	<i>D. S.C.</i>										

Approximately 10m east – 100m south-east of site

District <i>C</i>		<i>RIGA ST</i>										Incident Date	
Sector <i>11</i>		<i>HULME</i>										Date Inspected <i>9 / 4 / 42</i>	
Card No.		Continued on Card No.										Inspector <i>J.A.B.</i>	
No.	H. H. & S. F.	Classifica- tion	TENANT	EXTENT OF DAMAGE								Re- Classification	
				Roofs	Chimneys	Walls	Floors	Ceilings	Doors	Windows	Frames	Class	Date
<i>15</i>		<i>B✓</i>	<i>D SC masonry about 1'0" thick to be removed</i>										
<i>17</i>		<i>B✓</i>	<i>D SC</i>				<i>NO</i>						
<i>19</i>		<i>B</i>	<i>D SC</i>				<i>NO</i>					<i>A</i> <i>31/12/42 NO</i>	
<i>21</i>		<i>B✓</i>	<i>D SC</i>				<i>NO</i>						

Approximately 100m - 120m west of site

CODE REFERENCE			
<i>D</i> = Demolished	<i>F</i> = Fractured	<i>G</i> = Glazing	<i>H</i> = Holed
<i>O</i> = Off or Displaced	<i>P</i> = Plastering	<i>S</i> = Slight	<i>U</i> = Unsafe
WAR DAMAGE TO HOUSING, HOUSING DEPARTMENT, TOWN HALL, MANCHESTER, 2.			
9531 [4647]			



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Client: Curtins	
Project: Swan Street, Manchester	
Ref: DA12456-00	Source: Manchester Central Library



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Client: **Curtins**

Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: National Monuments Record Office (Historic England)

 **Approximate site boundary**





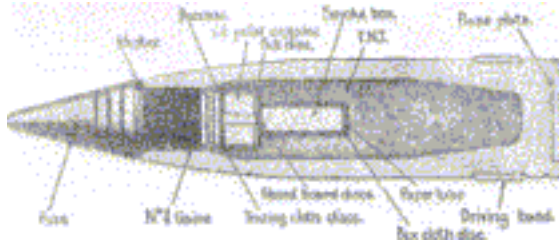
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Client: Curtins		 Approximate site boundary
Project: Swan Street, Manchester		
Ref: DA12456-00	Source: National Monuments Record Office (Historic England)	

Examples of Anti-Aircraft Projectiles

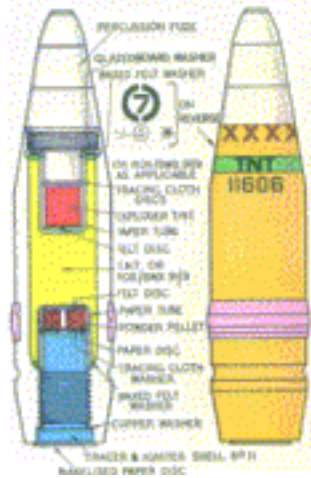
3.7 Inch QF Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	The 3.7in AA Mks 1-3 were the standard Heavy Anti-Aircraft guns of the British Army.
Ceiling	30,000ft to 59,000ft



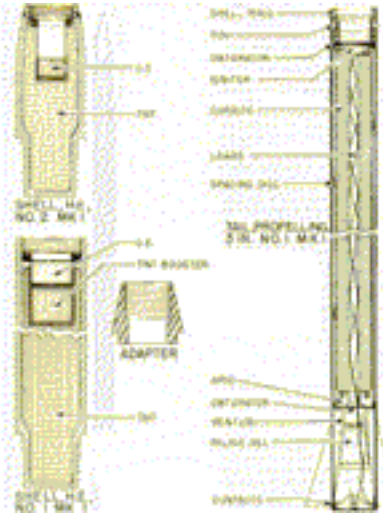
40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Impact Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40 x 180mm
Ceiling	23,000ft (7000m)
Remarks	Light quick fire high explosive anti-aircraft projectile. Each projectile fitted with small tracer element. If no target hit, shell would explode when tracer burnt out. Designed to engage aircraft flying below 2,000ft



3in Unrotated Projectile (UP) Anti-Aircraft Rocket ("Z" Battery)

HE Projectile Weight	3.4kg (7.6lb)
Explosive Weight	0.96kg (2.13lb)
Filling	High Explosive – TNT. Fitted with aerial burst fuzing
Dimensions of projectile	236 x 83mm (9.29 x 3.25in)
Remarks	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries. Shell consists of a steel cylinder reduced in diameter at the base and threaded externally to screw into the shell ring of the rocket motor



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Client: **Curtins**
Project: **Swan Street, Manchester**
Ref: **DA12456-00** Source: Various sources

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Appendix H – Risk Assessment Methodology

The site-specific risk assessment, presented in this report, follows the principle of establishing whether there is a viable linkage between a contaminant source to a potential receptor, via an exposure pathway.

The risk assessment corresponds with the total site area and incorporates both descriptive (qualitative) and, where available, numerical (quantitative) lines of evidence.

Risk assessment is the process of collating known information on a hazard or set of hazards to estimate actual or potential risk to receptors. The receptor may be humans, a water resource, a sensitive local ecosystem or future construction materials. Receptors can be connected to the source by one or several exposure pathways such as direct contact for example. Risks are generally managed by isolating the receptor or intercepting the exposure pathway or by isolating or removing the hazard.

Without the three essential components of a source, pathway and receptor there can be no risk. Therefore, the presence of contaminant source on a site does not necessarily mean there is a risk.

The risk assessment considers the likelihood of an event taking place (accounting for the presence of the source and receptor and the viability of the exposure pathway) in conjunction with the severity of the potential consequence (accounting for the potential severity of the hazard and the sensitivity of the receptor).

In the risk assessment, the consequence of the hazard has been classified as severe or medium or mild or minor and the probability (likelihood) of the circumstances occurring classified as high likelihood or likely or low likelihood or unlikely.

The consequences and probabilities are subsequently cross-correlated to give a qualitative estimation of the risk using Department of the Environment risk classifications as detailed in the table below and as referenced in CIRIA C552.

		Consequence			
		Severe	Medium	Mild	Minor
Probability (Likelihood)	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

In accordance with DoE guidance, the following categorisation of **consequence** has been developed.

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to an ecosystem or organisation forming part of such ecosystem.	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to Human Health. Pollution of sensitive water resources. A significant change in an ecosystem or organism forming part of such ecosystem.	Concentration of a contaminant from site exceeds the generic or site-specific assessment criteria. Leaching of contaminants from a site to a Principal or Secondary A aquifer. Death of a species within a designated nature reserve. Lesser toxic and asphyxiate effects
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/services or the environment.	Pollution of non-classified groundwater (inc. Secondary B aquifers). Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing, etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete.

In accordance with DoE guidance, the following categorisation of **probability** has been developed.

Classification	Definition
High Likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

In accordance with DoE guidance, the following categorisation of **risk** has been developed.

Classification	Definition
Very High Risk	There is a <i>high probability</i> that <i>severe harm</i> could arise to a designated receptor from an identified hazard at the site without appropriate further action.
High Risk	<i>Harm is likely to arise</i> to a designated receptor from an identified hazard at the site without appropriate further action.
Moderate Risk	<i>It is possible</i> that without appropriate further action <i>harm could arise</i> to a designated receptor. It is relatively <i>unlikely</i> that any such harm would be <i>severe</i> , and if any harm were to occur it is <i>more likely</i> that such harm would be <i>relatively mild</i> .
Low Risk	<i>It is possible</i> that <i>harm could arise</i> to a designated receptor from an identified hazard. It is <i>likely</i> that, at worst, if any harm was realised any effects would be <i>mild</i> .
Very Low Risk	The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

The term 'risk' in this instance refers to the risk that the source, pathway, receptor linkage for a given source of contamination is complete. It does not refer to immediate risk to individuals or features present on the site from potential contaminants and is intended to be used as a tool to assess the necessity of further investigation.

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