
Project:	Wrexham Delivery Office		
Our reference:	100404109	Your reference:	
Prepared by:	C Williams	Date:	20 May 2021
Approved by:	A Simpson	Checked by:	V Sin
Subject:	Review of human health risks from vapour inhalation		

1 Introduction

Plans have been submitted to Wrexham Council for alterations to the existing Post Office at Regent Street in Wrexham. Planning permission has been granted but is subject to pre-commencement planning conditions relating to contamination present within the underlying ground. This Note addresses the potential for risks to human health to arise from inhalation of vapours arising from petroleum hydrocarbon contamination of the underlying sediments and groundwater. This Note has been prepared as a supplement to "Discharge of planning conditions relating to contaminated land" prepared by Mott MacDonald in February 2021 and should be read in conjunction with that report which presents the background to the project which is not repeated here.

Ground investigations at the Wrexham Sorting Office undertaken by Core Geotechnics detected the presence of petroleum hydrocarbons within the underlying ground and groundwater. The source of this contamination is an underground fuel storage tank. This tank was used to store diesel fuel for use in mail delivery vehicles and was decommissioned in 2007. Further borehole installations were specified by Mott McDonald along the western site boundary to obtain groundwater samples for analysis.

2 Conceptual Site Model

The proposed development is an extension to the main sorting office to replace an existing building which will be demolished. The ground conditions beneath the site comprise several metres of granular Made Ground used to form a regulation layer over the natural glaciofluvial deposits (sands and gravels). The bedrock geology comprises the Etruria Formation which comprises mudstones. This stratum has not been encountered during any ground investigation. Groundwater is present within the glaciofluvial deposits and flow is towards the south-southeast to the River Gwenfro which is culverted beneath Wrexham centre.

This Note discusses risks arising from vapour inhalation within the proposed development and also considers the existing development which will remain in occupation. Vapours from volatile compounds can be generated from soil bound contamination and also from contaminants dissolved in groundwater or forming an immiscible layer on top of the groundwater (free product). These vapours can then migrate upwards and enter buildings through gaps in foundations such as service entries. The contaminant linkage being considered is:

Fuel leaks from the UST (S2) → Vapour inhalation (P1) → Occupants of the development (R1)

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The conceptual model for the site is discussed in detail in the main report (Section 2.1.1).

Not all hydrocarbon contaminants will be relevant when considering vapour inhalation pathways. The degree to which a chemical can enter the vapour phase is governed by its physico-chemical properties and the properties of the soil matrix. The CIRIA VOC Handbook¹ considers a substance to be volatile if its air-water partition coefficient (K_{aw}) is greater than 4×10^{-4} .

¹ CIRIA C682 The VOCs Handbook. Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination.

3 Data Review

3.1 Soil

Core Geotechnics submitted soil samples for laboratory analysis for a range of contaminants including petroleum hydrocarbons. The results are summarised in Table 3.1. The Generic Assessment Criteria (GAC) selected are for a commercial end use. Criteria for a sandy loam soil with 1% soil organic matter have been chosen as a conservative assessment. Where analysis is not speciated and described as gasoline range (GRO), diesel range (DRO) or oil the lowest criteria of those speciated fractions included has been adopted. So, for DRO which covers the range C10 to C24 the lowest GAC is 9700mg/kg for Aliphatic C10-C12.

Table 3.1: Summary of Soil Quality

	Unit	GAC	WS01	WS01	WS02	WS02	WS03	WS03	WS03	WS03	WS04	WS04	WS04
		Depth (m)	0.3-0.6	0.8	0.5-0.8	0.9-1.0	0.6-1.0	1.5	3.0-4.0	4.0-5.0	0.6-0.7	0.8	2.7
Aliphatic EC 5-6	mg/kg	3200							<0.1				<0.01
Aliphatic EC >6-8	mg/kg	7800							11				<0.01
Aliphatic EC >8-10	mg/kg	2000							18				<0.01
Aliphatic EC >10-12	mg/kg	9700							390				<1.5
Aliphatic EC >12-16	mg/kg	59000							950				<1.2
Aliphatic EC >16-35	mg/kg	1600000							1260				<4.9
Aromatic EC 5-7	mg/kg	26000							0.02				<0.01
Aromatic EC >7-8	mg/kg	56000							5.7				<0.01
Aromatic EC >8-10	mg/kg	3500							57				<0.01
Aromatic EC >10-12	mg/kg	16000							59				<0.9
Aromatic EC >12-16	mg/kg	36000							240				<0.5
Aromatic EC >16-21	mg/kg	28000							290				<0.6
Aromatic EC >21-35	mg/kg	28000							84				<1.4
C05-C10 GRO	mg/kg	2000	0.2	<0.1	0.1		<0.1	<0.1			0.1		
C10-C24 DRO	mg/kg	9700	22	<10	390		<10	<10			<10		
C24-C40 Oil	mg/kg	28000	45	<10	390		<10	<10			<10		

	Unit	GAC	WS01	WS01	WS02	WS02	WS03	WS03	WS03	WS03	WS04	WS04	WS04
Acenaphthene	mg/kg	84000			1.7						<0.1	<0.1	
Acenaphthylene	mg/kg	83000			0.2						<0.1	<0.1	
Fluorene	mg/kg	63000			1.5						<0.1	<0.1	
Naphthalene	mg/kg	190	0.2	<0.1	0.1	<0.1	<0.1	<0.1			<0.1	<0.1	

None of the soil bound concentrations are present above thresholds protective of human health for a commercial end use. These generic thresholds are derived using the CLEA model² which includes vapour inhalation.

3.2 Groundwater

Groundwater samples were obtained by Core Geotechnics from three boreholes during their ground investigation in September 2020. Three sets of samples have subsequently been obtained from the MW-Series monitoring wells constructed in February 2021 (Lab results are appended). The GAC used are those published by SoBRA³ for a commercial end use.

Table 3.2: Summary of Groundwater Quality

		Date	08/09/20	21/09/20	21/09/20	18/02/21	18/02/21	25/02/21	04/03/21	04/03/21	04/03/21	10/03/21	10/03/21	10/03/21
			WS04	WS01	WS02	MW1	MW2	MW3	MW1	MW2	MW3	MW1	MW2	MW3
	GACgwap	Units												
Petroleum Hydrocarbons														
Aliphatic C5-C6	190,000	µg/l	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Aliphatic C6-C8	150,000	µg/l	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Aliphatic C8-C10	5700	µg/l	<0.1	<0.1	<0.1	< 0.1	64	< 0.1	< 0.1	< 0.1	320	< 0.1	< 0.1	< 0.1
Aliphatic C10-C12	3600	µg/l	170	<1.0	<1.0	< 1.0	3200	< 1.0	< 1.0	< 10.0	98	< 1.0	61	1200
Aromatic C5-C7	20,000,000	µg/l	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Aromatic C7-C8	21,000,000	µg/l	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

² Environment Agency Updated technical background to the CLEA model Science Report SCO50021/SR3

³ Society for Brownfield Risk Assessment Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater Ver 1.0 February 2017

			Date	08/09/20	21/09/20	21/09/20	18/02/21	18/02/21	25/02/21	04/03/21	04/03/21	04/03/21	10/03/21	10/03/21	10/03/21
				WS04	WS01	WS02	MW1	MW2	MW3	MW1	MW2	MW3	MW1	MW2	MW3
Aromatic C8-C10	190,000	µg/l		<0.1	<0.1	<0.1	< 0.1	93	< 0.1	< 0.1	< 0.1	340	< 0.1	< 0.1	< 0.1
Aromatic C10-C12	660,000	µg/l		8.8	<1.0	<1.0	< 1.0	1300	< 1.0	< 1.0	< 10.0	20	< 1.0	170	340
Aromatic C12-C16	3,700,000	µg/l		190	<1.0	<1.0	< 1.0	5600	< 1.0	< 1.0	98	640	< 1.0	940	2800
PAHs															
Naphthalene	23,000	µg/l				<0.1	< 0.05	< 0.50	3.7	< 0.05	< 0.50	0.81	< 0.05	< 0.05	< 0.05
Acenaphthylene	20,000,000	µg/l				<0.1	< 0.01	0.55	0.13	< 0.01	< 0.10	< 0.10	< 0.01	< 0.01	< 0.01
Acenaphthene	15,000,000	µg/l				0.01	< 0.01	0.95	0.22	< 0.01	< 0.10	< 0.10	< 0.01	< 0.01	< 0.01
Fluorene	18,000,000	µg/l				0.03	< 0.01	0.28	0.27	< 0.01	0.51	< 0.10	< 0.01	< 0.01	< 0.01

No concentrations exceed their assessment criterion.

4 Discussion

Ground investigations have indicated the presence of petroleum hydrocarbons within subsurface soils and as a dissolved phase in groundwater at the Wrexham Sorting Office. The proposed development of the site will comprise a new extension to an existing building. The development will be isolated from the underlying contamination by the floor slab and existing hard surfaced car park areas and so direct contact with any residual contamination will not be possible. However, there remains a risk that volatile components of the hydrocarbons present could enter the vapour phase from contamination sorbed onto soil particles and from dissolved phase in groundwater.

Soil bound concentrations of contaminants have been assessed against GAC derived using the CLEA model for a commercial end use. These criteria include the indoor and outdoor vapour inhalation pathway as well as other exposure pathways (direct contact and ingestion) and so provide a further level of conservatism. No soil bound concentrations of any volatile compound were found at concentrations in excess of their assessment criterion and it is considered that soil bound concentrations of contaminants do not present a significant risk to human health from the vapour inhalation pathway.

Dissolved phase concentrations of contaminants have been assessed against GAC_{gw vap} derived using the CLEA model for a commercial end use. These criteria include the indoor and outdoor vapour inhalation pathway. No dissolved phase concentrations of any volatile compound in groundwater were found at concentrations in excess of their assessment criterion and it is considered that dissolved phase concentrations of contaminants do not present a significant risk to human health from the vapour inhalation pathway.

5 Conclusions

No further remedial action is required with regards to risks associated with vapour inhalation.

A. Lab Results for Monitoring Wells MW1-3



Certificate of Analysis

Certificate Number 21-04829

Issued: 11-Mar-21

Client Dunelm Geotechnical & Environmental Ltd
Chambers Business Centre
Chapel Road
Oldham
OL8 4QQ

Our Reference 21-04829

Client Reference M948

Order No NW8082M948RB

Contract Title Wrexham Delivery Office

Description 3 Water samples.

Date Received 08-Mar-21

Date Started 08-Mar-21

Date Completed 11-Mar-21

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

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

Approved By

Adam Fenwick
Contracts Manager



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Summary of Chemical Analysis

Water Samples

Our Ref 21-04829

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1813573	1813574	1813575
Sample ID	MW1	MW2	MW3
Depth			
Other ID			
Sample Type	EW	EW	EW
Sampling Date	04/03/2021	04/03/2021	04/03/2021
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Metals						
Arsenic, Dissolved	DETS 2306	0.16	ug/l	0.45	0.65	1.1
Boron, Dissolved	DETS 2306*	12	ug/l	13	63	34
Cadmium, Dissolved	DETS 2306	0.03	ug/l	< 0.03	0.09	0.13
Calcium, Dissolved	DETS 2306	0.09	mg/l	60	98	62
Chromium, Dissolved	DETS 2306	0.25	ug/l	0.74	0.32	0.33
Copper, Dissolved	DETS 2306	0.4	ug/l	2.9	1.5	2.6
Manganese, Dissolved	DETS 2306	0.22	ug/l	34	140	1100
Mercury, Dissolved	DETS 2306	0.01	ug/l	< 0.01	< 0.01	< 0.01
Nickel, Dissolved	DETS 2306	0.5	ug/l	1.0	1.4	1.5
Zinc, Dissolved	DETS 2306	1.3	ug/l	1.6	4.4	5.1
Inorganics						
pH	DETS 2008		pH	6.9	6.9	7.2
Dissolved Organic Carbon	DETS 2085	2	mg/l	4.4	< 2.0	4.3
Petroleum Hydrocarbons						
Aliphatic C5-C6	DETS 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C6-C8	DETS 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C8-C10	DETS 3322	0.1	ug/l	< 0.1	< 0.1	320
Aliphatic C10-C12	DETS 3072*	1	ug/l	< 1.0	< 10.0	98
Aliphatic C10-C44	DETS 3072*	1	ug/l	< 1.0	410	4000
Aliphatic C12-C16	DETS 3072*	1	ug/l	< 1.0	180	1600
Aliphatic C16-C21	DETS 3072*	1	ug/l	< 1.0	180	1900
Aliphatic C21-C35	DETS 3072*	1	ug/l	< 1.0	42	390
Aliphatic C35-C44	DETS 3072*	1	ug/l	< 1.0	< 10.0	< 10.0
Aromatic C5-C7	DETS 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C7-C8	DETS 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C8-C10	DETS 3322	0.1	ug/l	< 0.1	< 0.1	340
Aromatic C10-C12	DETS 3072*	1	ug/l	< 1.0	< 10.0	20
Aromatic C12-C16	DETS 3072*	1	ug/l	< 1.0	98	640
Aromatic C16-C21	DETS 3072*	1	ug/l	< 1.0	210	1300
Aromatic C21-C35	DETS 3072*	1	ug/l	< 1.0	85	610
Aromatic C35-C44	DETS 3072*	1	ug/l	< 1.0	< 10.0	< 10.0
Aromatic C10-C44	DETS 3072*	1	ug/l	< 1.0	390	2600
Ali/Aro C10-C44	DETS 3072*	1	ug/l	< 1.0	800	6600
PAHs						
Naphthalene	DETS 3304	0.05	ug/l	< 0.05	< 0.50	0.81
Acenaphthylene	DETS 3304	0.01	ug/l	< 0.01	< 0.10	< 0.10
Acenaphthene	DETS 3304	0.01	ug/l	< 0.01	< 0.10	< 0.10
Fluorene	DETS 3304	0.01	ug/l	< 0.01	0.51	< 0.10
Phenanthrene	DETS 3304	0.01	ug/l	< 0.01	0.17	0.78
Anthracene	DETS 3304	0.01	ug/l	0.01	0.16	0.70
Fluoranthene	DETS 3304	0.01	ug/l	0.08	0.14	0.65

Summary of Chemical Analysis

Water Samples

Our Ref 21-04829

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1813573	1813574	1813575
Sample ID	MW1	MW2	MW3
Depth			
Other ID			
Sample Type	EW	EW	EW
Sampling Date	04/03/2021	04/03/2021	04/03/2021
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Pyrene	DETSC 3304	0.01	ug/l	0.09	0.19	0.46
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	0.02	< 0.10	0.16
Chrysene	DETSC 3304	0.01	ug/l	0.02	0.14	0.29
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	0.03	0.18	0.18
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	0.01	0.14	0.16
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	0.02	< 0.10	< 0.10
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	0.01	< 0.10	< 0.10
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.10	< 0.10
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	0.02	< 0.10	< 0.10
PAH Total	DETSC 3304	0.2	ug/l	0.36	< 2.00	4.2

Information in Support of the Analytical Results

Our Ref 21-04829
Client Ref M948
Contract Wrexham Delivery Office

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
1813573	MW1 WATER	04/03/21		GB 1L, GV	pH/Cond/TDS (1 days)	
1813574	MW2 WATER	04/03/21		GV, PB 1L	pH/Cond/TDS (1 days)	
1813575	MW3 WATER	04/03/21		GV, PB 1L	pH/Cond/TDS (1 days)	

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

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

Disposal

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

End of Report



Certificate of Analysis

Certificate Number 21-05249

Issued: 17-Mar-21

Client Dunelm Geotechnical & Environmental Ltd
Chambers Business Centre
Chapel Road
Oldham
OL8 4QQ

Our Reference 21-05249

Client Reference M948

Order No NW8082M948RB

Contract Title Wrexham Delivery Office

Description 3 Water samples.

Date Received 12-Mar-21

Date Started 12-Mar-21

Date Completed 17-Mar-21

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

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

Approved By

Adam Fenwick
Contracts Manager



Summary of Chemical Analysis

Water Samples

Our Ref 21-05249

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1816220	1816221	1816222
Sample ID	MW1	MW2	MW3
Depth			
Other ID			
Sample Type	WATER	WATER	WATER
Sampling Date	10/03/2021	10/03/2021	10/03/2021
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Metals						
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	0.61	0.57	2.3
Boron, Dissolved	DETSC 2306*	12	ug/l	38	55	39
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	0.05	0.11	0.61
Calcium, Dissolved	DETSC 2306	0.09	mg/l	79	110	130
Chromium, Dissolved	DETSC 2306	0.25	ug/l	2.5	1.1	1.0
Copper, Dissolved	DETSC 2306	0.4	ug/l	4.0	3.8	6.3
Manganese, Dissolved	DETSC 2306	0.22	ug/l	42	150	1100
Mercury, Dissolved	DETSC 2306	0.01	ug/l	< 0.01	< 0.01	0.01
Nickel, Dissolved	DETSC 2306	0.5	ug/l	1.3	2.5	2.5
Zinc, Dissolved	DETSC 2306	1.3	ug/l	3.5	6.4	9.4
Inorganics						
pH	DETSC 2008		pH	7.7	7.7	7.5
Dissolved Organic Carbon	DETSC 2085	2	mg/l	6.0	2.1	3.2
Petroleum Hydrocarbons						
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	61	1200
Aliphatic C10-C44	DETSC 3072*	1	ug/l	< 1.0	750	16000
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	310	6400
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	320	6400
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	58	1700
Aliphatic C35-C44	DETSC 3072*	1	ug/l	< 1.0	< 1.0	< 1.0
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	170	340
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	940	2800
Aromatic C16-C21	DETSC 3072*	1	ug/l	6.3	1200	4900
Aromatic C21-C35	DETSC 3072*	1	ug/l	1.7	290	1800
Aromatic C35-C44	DETSC 3072*	1	ug/l	< 1.0	< 1.0	2.7
Aromatic C10-C44	DETSC 3072*	1	ug/l	8.2	2600	9800
Ali/Aro C10-C44	DETSC 3072*	1	ug/l	8.2	3300	26000
PAHs						
Naphthalene	DETSC 3304	0.05	ug/l	< 0.05	< 0.05	< 0.05
Acenaphthylene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Acenaphthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Fluorene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Phenanthrene	DETSC 3304	0.01	ug/l	0.02	< 0.01	< 0.01
Anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Fluoranthene	DETSC 3304	0.01	ug/l	0.09	< 0.01	< 0.01
Pyrene	DETSC 3304	0.01	ug/l	0.11	< 0.01	< 0.01

Summary of Chemical Analysis

Water Samples

Our Ref 21-05249

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1816220	1816221	1816222
Sample ID	MW1	MW2	MW3
Depth			
Other ID			
Sample Type	WATER	WATER	WATER
Sampling Date	10/03/2021	10/03/2021	10/03/2021
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	0.02	< 0.01	< 0.01
Chrysene	DETSC 3304	0.01	ug/l	0.02	< 0.01	< 0.01
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
PAH Total	DETSC 3304	0.2	ug/l	0.27	< 0.20	< 0.20

Information in Support of the Analytical Results

Our Ref 21-05249
 Client Ref M948
 Contract Wrexham Delivery Office

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
1816220	MW1 WATER	10/03/21		GB 1L, GV, PB 1L	pH/Cond/TDS (1 days)	
1816221	MW2 WATER	10/03/21		GB 1L, GV, PB 1L	pH/Cond/TDS (1 days)	
1816222	MW3 WATER	10/03/21		GB 1L, GV, PB 1L	pH/Cond/TDS (1 days)	

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

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

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report



Certificate of Analysis

Certificate Number 21-04246

Issued: 04-Mar-21

Client Dunelm Geotechnical & Environmental Ltd
Chambers Business Centre
Chapel Road
Oldham
OL8 4QQ

Our Reference 21-04246

Client Reference M948

Order No NW8082M948RB

Contract Title Wrexham Delivery Office

Description One Water sample.

Date Received 01-Mar-21

Date Started 01-Mar-21

Date Completed 04-Mar-21

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

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

Approved By

Adam Fenwick
Contracts Manager



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Summary of Chemical Analysis

Water Samples

Our Ref 21-04246

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1808926
Sample ID	MW3
Depth	6.00
Other ID	
Sample Type	EW
Sampling Date	25/02/2021
Sampling Time	n/s

Test	Method	LOD	Units	
Metals				
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	0.59
Boron, Dissolved	DETSC 2306*	12	ug/l	46
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	0.32
Calcium, Dissolved	DETSC 2306	0.09	mg/l	91
Chromium, Dissolved	DETSC 2306	0.25	ug/l	0.52
Copper, Dissolved	DETSC 2306	0.4	ug/l	2.8
Manganese, Dissolved	DETSC 2306	0.22	ug/l	1700
Mercury, Dissolved	DETSC 2306	0.01	ug/l	0.02
Nickel, Dissolved	DETSC 2306	0.5	ug/l	2.9
Zinc, Dissolved	DETSC 2306	1.3	ug/l	15
Inorganics				
pH	DETSC 2008		pH	7.3
Dissolved Organic Carbon	DETSC 2085	2	mg/l	4.3
Petroleum Hydrocarbons				
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C10-C44	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C35-C44	DETSC 3072*	1	ug/l	< 1.0
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0
Aromatic C16-C21	DETSC 3072*	1	ug/l	< 1.0
Aromatic C21-C35	DETSC 3072*	1	ug/l	< 1.0
Aromatic C35-C44	DETSC 3072*	1	ug/l	< 1.0
Aromatic C10-C44	DETSC 3072*	1	ug/l	< 1.0
Ali/Aro C10-C44	DETSC 3072*	1	ug/l	< 1.0
PAHs				
Naphthalene	DETSC 3304	0.05	ug/l	3.7
Acenaphthylene	DETSC 3304	0.01	ug/l	0.13
Acenaphthene	DETSC 3304	0.01	ug/l	0.22
Fluorene	DETSC 3304	0.01	ug/l	0.27
Phenanthrene	DETSC 3304	0.01	ug/l	0.28
Anthracene	DETSC 3304	0.01	ug/l	0.04
Fluoranthene	DETSC 3304	0.01	ug/l	0.07

Summary of Chemical Analysis

Water Samples

Our Ref 21-04246

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1808926
Sample ID	MW3
Depth	6.00
Other ID	
Sample Type	EW
Sampling Date	25/02/2021
Sampling Time	n/s

Test	Method	LOD	Units	
Pyrene	DETSC 3304	0.01	ug/l	0.04
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	< 0.01
Chrysene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	< 0.01
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	< 0.01
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	< 0.01
PAH Total	DETSC 3304	0.2	ug/l	4.8

Information in Support of the Analytical Results

Our Ref 21-04246
Client Ref M948
Contract Wrexham Delivery Office

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
1808926	MW3 6.00 WATER	25/02/21		GB 1L, GV, PB 1L	pH/Cond/TDS (1 days)	
Key: G-Glass P-Plastic B-Bottle V-Vial DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.						

Disposal

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

End of Report



Certificate of Analysis

Certificate Number 21-03799

Issued: 01-Mar-21

Client Dunelm Geotechnical & Environmental Ltd
Chambers Business Centre
Chapel Road
Oldham
OL8 4QQ

Our Reference 21-03799

Client Reference M948

Order No NW8082M948RB

Contract Title Wrexham Delivery Office

Description 2 Water samples.

Date Received 23-Feb-21

Date Started 23-Feb-21

Date Completed 01-Mar-21

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

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

Approved By

Adam Fenwick
Contracts Manager



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Summary of Chemical Analysis

Water Samples

Our Ref 21-03799

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1806093	1806094
Sample ID	MW1	MW2
Depth	6.00	6.00
Other ID		
Sample Type	EW	EW
Sampling Date	18/02/2021	18/02/2021
Sampling Time	n/s	n/s

Test	Method	LOD	Units		
Metals					
Arsenic, Dissolved	DETS 2306	0.16	ug/l	< 0.16	0.37
Boron, Dissolved	DETS 2306*	12	ug/l	< 12	63
Cadmium, Dissolved	DETS 2306	0.03	ug/l	< 0.03	< 0.03
Calcium, Dissolved	DETS 2306	0.09	mg/l	68	95
Chromium, Dissolved	DETS 2306	0.25	ug/l	0.66	< 0.25
Copper, Dissolved	DETS 2306	0.4	ug/l	1.1	0.6
Manganese, Dissolved	DETS 2306	0.22	ug/l	99	560
Mercury, Dissolved	DETS 2306	0.01	ug/l	< 0.01	< 0.01
Nickel, Dissolved	DETS 2306	0.5	ug/l	< 0.5	1.4
Zinc, Dissolved	DETS 2306	1.3	ug/l	4.1	4.0
Inorganics					
pH	DETS 2008		pH	7.5	7.2
Dissolved Organic Carbon	DETS 2085	2	mg/l	2.3	< 2.0
Petroleum Hydrocarbons					
Aliphatic C5-C6	DETS 3322	0.1	ug/l	< 0.1	< 0.1
Aliphatic C6-C8	DETS 3322	0.1	ug/l	< 0.1	< 0.1
Aliphatic C8-C10	DETS 3322	0.1	ug/l	< 0.1	64
Aliphatic C10-C12	DETS 3072*	1	ug/l	< 1.0	3200
Aliphatic C10-C44	DETS 3072*	1	ug/l	< 1.0	22000
Aliphatic C12-C16	DETS 3072*	1	ug/l	< 1.0	9600
Aliphatic C16-C21	DETS 3072*	1	ug/l	< 1.0	8100
Aliphatic C21-C35	DETS 3072*	1	ug/l	33	1400
Aliphatic C35-C44	DETS 3072*	1	ug/l	< 1.0	< 1.0
Aromatic C5-C7	DETS 3322	0.1	ug/l	< 0.1	< 0.1
Aromatic C7-C8	DETS 3322	0.1	ug/l	< 0.1	< 0.1
Aromatic C8-C10	DETS 3322	0.1	ug/l	< 0.1	93
Aromatic C10-C12	DETS 3072*	1	ug/l	< 1.0	1300
Aromatic C12-C16	DETS 3072*	1	ug/l	< 1.0	5600
Aromatic C16-C21	DETS 3072*	1	ug/l	< 1.0	5800
Aromatic C21-C35	DETS 3072*	1	ug/l	< 1.0	1100
Aromatic C35-C44	DETS 3072*	1	ug/l	< 1.0	< 1.0
Aromatic C10-C44	DETS 3072*	1	ug/l	< 1.0	14000
Ali/Aro C10-C44	DETS 3072*	1	ug/l	< 1.0	37000
PAHs					
Naphthalene	DETS 3304	0.05	ug/l	< 0.05	< 0.50
Acenaphthylene	DETS 3304	0.01	ug/l	< 0.01	0.55
Acenaphthene	DETS 3304	0.01	ug/l	< 0.01	0.95
Fluorene	DETS 3304	0.01	ug/l	< 0.01	0.28
Phenanthrene	DETS 3304	0.01	ug/l	0.01	< 0.10
Anthracene	DETS 3304	0.01	ug/l	< 0.01	< 0.10
Fluoranthene	DETS 3304	0.01	ug/l	0.07	0.76

Summary of Chemical Analysis

Water Samples

Our Ref 21-03799

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1806093	1806094
Sample ID	MW1	MW2
Depth	6.00	6.00
Other ID		
Sample Type	EW	EW
Sampling Date	18/02/2021	18/02/2021
Sampling Time	n/s	n/s

Test	Method	LOD	Units		
Pyrene	DETSC 3304	0.01	ug/l	0.08	1.3
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	0.03	0.33
Chrysene	DETSC 3304	0.01	ug/l	0.03	0.55
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	0.05	0.11
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	0.02	< 0.10
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	0.04	< 0.10
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	0.04	< 0.10
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.10
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	0.05	< 0.10
PAH Total	DETSC 3304	0.2	ug/l	0.46	4.8

Information in Support of the Analytical Results

Our Ref 21-03799
 Client Ref M948
 Contract Wrexham Delivery Office

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1806093	MW1 6.00 WATER	18/02/21	GB 1L, GV, PB 1L	Aliphatics/Aromatics (4 days), pH/Cond/TDS (1 days), PAH MS (4 days)	
1806094	MW2 6.00 WATER	18/02/21	GB 1L, GV, PB 1L	Aliphatics/Aromatics (4 days), pH/Cond/TDS (1 days), PAH MS (4 days)	

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

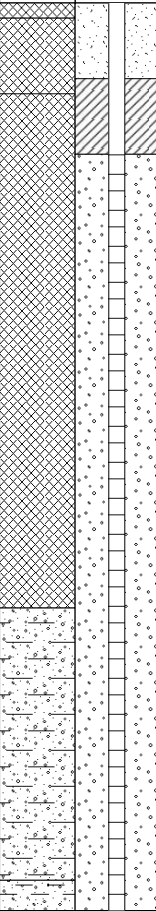
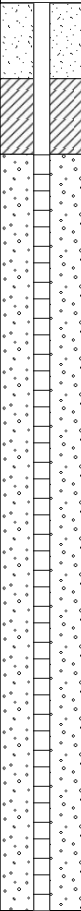
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Disposal

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

End of Report

				BOREHOLE RECORD				Borehole MW1				
Contract No: M948		Site: Wrexham Delivery Office				GL (m AOD) 82.24 Easting: 333071.60		Scale 1:50 Northing: 350684.70				
Client: Bowmer & Kirkland Ltd				Driller: MH		Logged By: JM		Sheet 1 of 1				
Method: Cable Percussive Boring				Checked By: RB		Dates: 18/02/2021 - 19/02/2021						
SAMPLE DETAILS					(Casing) Groundwater	STRATA RECORD Description	Depth (m)	Level (m AOD)	Legend	Well/ Backfill		
Type	Depth From-To (m)	Insitu Testing										
ES	0.50				MADE GROUND: Black macadam.	(0.10) 0.10	82.14					
ES	1.00			1	MADE GROUND: Yellowish brown and light grey sandy gravel with a medium cobble and/or boulder content. Gravel is angular to subangular fine to coarse of sandstone. Cobbles are angular of sandstone.	(1.40)						
				18/02/2021 1700 (0.00) Dry 19/02/2021 0800 (0.00) Dry								
ES	2.00			2	MADE GROUND: Brown slightly clayey sandy gravel. Gravel is angular to subrounded fine to coarse of sandstone, limestone and quartzite.	1.50 (1.50)	80.74					
ES	3.00			3	Very soft brown sandy gravelly CLAY. Gravel is subangular to rounded fine to coarse of sandstone, limestone, siltstone and quartzite.	3.00 (1.00)	79.24					
					3.00-4.00m: Slightly oily sheen noted, no odour.							
ES	4.00			4	Brown and grey fine to coarse SAND and GRAVEL. Gravel is subangular to rounded fine to medium of sandstone, siltstone, limestone and quartzite.	4.00 (2.00)	78.24					
ES	5.00			5								
ES	6.00			6	End of Borehole at 6.00 m	6.00	76.24					
				6								
				7								
				8								
				9								
				10								
Ground Water (m)					Chiselling / Hard Strata		Casing Depths		Hole Diameter		General Remarks 1. Hand dug inspection pit to 1.20m.	
Depth Struck (m)	Casing Depth (m)	Water Level	Minutes	Water sealed (m)	From (m)	To (m)	Time (hr)	Diameter (mm)	Depth (m)	Diameter (mm)		Depth (m)
3.50		3.50	0							150		6.00
5.50		5.50	20									
Log last updated 04/03/2021												

				BOREHOLE RECORD				Borehole MW2				
Contract No: M948		Site: Wrexham Delivery Office				GL (m AOD) 83.56 Easting: 333025.80		Scale 1:50 Northing: 350672.40				
Client: Bowmer & Kirkland Ltd				Driller: MH		Logged By: JM		Sheet 1 of 1				
Method: Cable Percussive Boring				Checked By: RB		Dates: 18/02/2021						
SAMPLE DETAILS					(Casing) Groundwater	STRATA RECORD Description		Depth (m)	Level (m AOD)	Legend	Well/ Backfill	
Type	Depth From-To (m)	Insitu Testing										
ES	0.50			1	MADE GROUND: Black macadam. MADE GROUND: Grey slightly sandy gravel. Gravel is angular to subangular fine to medium of limestone.		(0.10) 0.10 (0.50)	83.46				
ES	1.00				MADE GROUND: Brown and grey clayey sandy gravel. Gravel is angular to subrounded fine to coarse of limestone, brick, sandstone and siltstone.		0.60	82.96				
ES	2.00				2			(3.40)				
ES	3.00			3								
ES	4.00					4						
ES	5.00				5		Brown slightly clayey sandy GRAVEL. Gravel is subangular to rounded fine to coarse of sandstone, siltstone, limestone and quartzite. <i>At 4.00m: Strong hydrocarbon odour noted. Slightly clayey slightly sandy with low cobble content.</i>		4.00	79.56		
ES	6.00			6			Firm brown sandy gravelly CLAY. Gravel is subangular to rounded fine to coarse of sandstone, siltstone, limestone and quartzite. End of Borehole at 6.00 m		5.80 (0.20) 6.00	77.76 77.56		
						7						
					8							
				9								
						10						
Ground Water (m)					Chiselling / Hard Strata		Casing Depths		Hole Diameter		General Remarks 1. Hand dug inspection pit to 1.20m.	
Depth Struck (m)	Casing Depth (m)	Water Level	Minutes	Water sealed (m)	From (m)		To (m)	Time (hr)	Diameter (mm)	Depth (m)		Diameter (mm)
4.00	4.00	4.00	20					150	6.00	150		6.00
5.80	5.80	5.80	0									
Log last updated 04/03/2021												

				BOREHOLE RECORD				Borehole MW3				
Contract No: M948		Site: Wrexham Delivery Office				GL (m AOD) 83.14		Scale 1:50				
						Easting: 333034.40		Northing: 350636.90				
Client: Bowmer & Kirkland Ltd				Driller: JT		Logged By: JM		Sheet 1 of 1				
Method: Cable Percussive Boring				Checked By: RB		Dates: 25/02/2021						
SAMPLE DETAILS					(Casing) Groundwater	STRATA RECORD Description	Depth (m)	Level (m AOD)	Legend	Well/ Backfill		
Type	Depth From-To (m)	Insitu Testing										
ES	0.50				MADE GROUND: Black macadam. MADE GROUND: Light brown and grey sandy gravel with a low cobble and/or boulder content. Gravel is angular to subangular fine to coarse of sandstone and limestone. Cobbles are angular of limestone.	(0.10) 0.10 (0.10) 0.20 (0.10) 0.30	83.04 82.94 82.84					
ES	1.00			1	MADE GROUND: Brown and grey sandy gravel. Gravel is angular to subrounded fine to medium of sandstone, limestone, brick, slate and quartzite.							
ES	2.00			2	MADE GROUND: Brown clayey sandy gravel. Sand is predominantly of ash. Gravel is angular to subrounded fine to medium of sandstone, siltstone, limestone and brick.	(2.70)						
ES	3.00			3	Brown sandy GRAVEL. Gravel is subangular to rounded fine to coarse of sandstone, siltstone, limestone and quartzite.	3.00	80.14					
ES	4.00			4		(3.00)						
ES	5.00			5								
ES	6.00			6	End of Borehole at 6.00 m	6.00	77.14					
				7								
				8								
				9								
				10								
Ground Water (m)					Chiselling / Hard Strata			Casing Depths		Hole Diameter		General Remarks 1. Hand dug inspection pit to 1.20
Depth Struck (m)	Casing Depth (m)	Water Level	Minutes	Water sealed (m)	From (m)	To (m)	Time (hr)	Diameter (mm)	Depth (m)	Diameter (mm)	Depth (m)	
3.00	3.00	2.40	20		5.30	5.50	00:45	150	6.00	150	6.00	
Log last updated 04/03/2021												