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Analytical Report Number : 16-86234

Project / Site name: Burrows Yard

Samples received on: 21/01/2016

Your job number: G762

Samples instructed on: 21/01/2016

Your order number:

Analysis completed by: 29/01/2016

Report Issue Number: 1

Report issued on: 29/01/2016

Samples Analysed: 9 soil samples

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Signed:

Emma Winter
Assistant Reporting Manager
For & on behalf of i2 Analytical Ltd.

Other office located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Analytical Report Number: 16-86234

Project / Site name: Burrows Yard

Lab Sample Number				527019	527020	527021	527022	527023
Sample Reference				QTP06	QTP08	QTP10	QTP11	QTP12
Sample Number				7	7	7	7	7
Depth (m)				2.00-2.30	2.50-3.00	2.50-3.00	2.00-2.50	2.30-2.70
Date Sampled				Deviating	Deviating	Deviating	Deviating	Deviating
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	30	35	25	17	20
Total mass of sample received	kg	0.001	NONE	1.4	1.1	1.1	0.98	1.2

General Inorganics

pH	pH Units	N/A	MCERTS	8.2	7.4	5.8	9.3	7.3
Total Sulphate as SO ₄	mg/kg	50	MCERTS	910	620	610	1600	350
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.20	0.11	0.11	0.17	0.039
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	25	32	42	120	31
Total Sulphur	mg/kg	50	NONE	480	1500	330	1100	180
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	2	NONE	4.5	2.5	6.7	5.8	2.6

Heavy Metals / Metalloids

Magnesium (water soluble)	mg/kg	5	NONE	15	25	< 5.0	5.3	6.1
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Analytical Report Number: 16-86234

Project / Site name: Burrows Yard

Lab Sample Number				527024	527025	527026	527027	
Sample Reference				QTP14	QTP15	QTP18	QTP19	
Sample Number				4	4	4	4	
Depth (m)				0.50-1.00	1.00-1.50	1.00-1.50	1.00-1.50	
Date Sampled				Deviating	Deviating	Deviating	Deviating	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	15	18	21	20	
Total mass of sample received	kg	0.001	NONE	1.1	1.3	1.1	0.84	

General Inorganics

pH	pH Units	N/A	MCERTS	7.2	7.0	4.2	7.4	
Total Sulphate as SO ₄	mg/kg	50	MCERTS	98	690	36000	1100	
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.030	0.13	1.8	0.15	
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	15	29	33	41	
Total Sulphur	mg/kg	50	NONE	150	280	15000	750	
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	2	NONE	5.8	3.2	7.0	9.1	

Heavy Metals / Metalloids

Magnesium (water soluble)	mg/kg	5	NONE	< 5.0	8.9	49	19	
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Analytical Report Number : 16-86234

Project / Site name: Burrows Yard

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Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
527019	QTP06	7	2.00-2.30	Grey clay and sand.
527020	QTP08	7	2.50-3.00	Grey clay.
527021	QTP10	7	2.50-3.00	Grey clay and sand.
527022	QTP11	7	2.00-2.50	Black gravelly loam.
527023	QTP12	7	2.30-2.70	Light brown clay.
527024	QTP14	4	0.50-1.00	Light brown clay.
527025	QTP15	4	1.00-1.50	Light brown clay.
527026	QTP18	4	1.00-1.50	Grey clay.
527027	QTP19	4	1.00-1.50	Black gravelly loam.

Analytical Report Number : 16-86234

Project / Site name: Burrows Yard

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests. 2:1 extraction.	L082-PL	D	MCERTS
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Nitrate, water soluble, in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewater & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	D	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total sulphate (as SO ₄ in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30°C.

**Lara Weaver**

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Analytical Report Number : 16-86235

Project / Site name: Burrow's Yard

Samples received on: 21/01/2016

Your job number: G762

Samples instructed on: 21/01/2016

Your order number:

Analysis completed by: 28/01/2016

Report Issue Number: 1

Report issued on: 28/01/2016

Samples Analysed: 5 soil samples

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Signed:

Emma Winter
Assistant Reporting Manager
For & on behalf of i2 Analytical Ltd.

Other office located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Analytical Report Number: 16-86235

Project / Site name: Burrow's Yard

Lab Sample Number				527028	527029	527030	527031	527032
Sample Reference				QBH01	QBH03	QBH04	QBH05	QBH06
Sample Number				11	8	7	8	8
Depth (m)				3.00-3.50	2.00-2.50	2.50-3.00	2.30-2.80	2.20-2.60
Date Sampled				03/12/2015	07/12/2015	08/12/2015	10/12/2015	08/12/2015
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	24	19	24	21	19
Total mass of sample received	kg	0.001	NONE	1.0	1.3	1.0	1.2	1.3

General Inorganics

pH	pH Units	N/A	MCERTS	7.9	5.8	7.5	8.0	7.8
Total Sulphate as SO ₄	mg/kg	50	MCERTS	560	1000	240	430	970
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.15	0.35	0.059	0.12	0.24
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	130	58	28	27	37
Total Sulphur	mg/kg	50	NONE	440	550	190	230	790
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	2	NONE	2.3	2.5	2.1	5.7	< 2.0

Heavy Metals / Metalloids

Magnesium (water soluble)	mg/kg	5	NONE	20	22	9.9	26	9.5
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Analytical Report Number : 16-86235

Project / Site name: Burrow's Yard

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
527028	QBH01	11	3.00-3.50	Grey clay.
527029	QBH03	8	2.00-2.50	Brown clay with gravel.
527030	QBH04	7	2.50-3.00	Grey clay and sand.
527031	QBH05	8	2.30-2.80	Grey clay.
527032	QBH06	8	2.20-2.60	Brown clay and loam.

Analytical Report Number : 16-86235

Project / Site name: Burrow's Yard

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests. 2:1 extraction.	L082-PL	D	MCERTS
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Nitrate, water soluble, in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewater & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	D	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total sulphate (as SO ₄ in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30°C.

**Lara Weaver**

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Analytical Report Number : 16-86257

Project / Site name: Burrows Yard

Samples received on: 21/01/2016

Your job number: G762

Samples instructed on: 21/01/2016

Your order number:

Analysis completed by: 29/01/2016

Report Issue Number: 1

Report issued on: 29/01/2016

Samples Analysed: 4 soil samples

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Signed:

Emma Winter
Assistant Reporting Manager
For & on behalf of i2 Analytical Ltd.

Other office located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Analytical Report Number: 16-86257

Project / Site name: Burrows Yard

Lab Sample Number				527158	527159	527160	527161	
Sample Reference				QWS03	QWS07	QWS14	QWS14	
Sample Number				7	6	6	4	
Depth (m)				2.60-3.00	1.35-1.80	1.70-2.30	1.00-1.20	
Date Sampled				03/12/2015	07/12/2015	07/12/2015	07/12/2015	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	20	21	20	21	
Total mass of sample received	kg	0.001	NONE	1.5	1.3	1.8	1.4	

General Inorganics

pH	pH Units	N/A	MCERTS	7.6	7.7	6.8	8.0	
Total Sulphate as SO ₄	mg/kg	50	MCERTS	500	910	1200	2600	
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.10	0.18	0.53	0.44	
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	35	34	84	54	
Total Sulphur	mg/kg	50	NONE	280	490	2500	1500	
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	2	NONE	4.7	6.6	2.6	2.5	

Heavy Metals / Metalloids

Magnesium (water soluble)	mg/kg	5	NONE	< 5.0	22	21	20	
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Analytical Report Number : 16-86257

Project / Site name: Burrows Yard

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Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
527158	QWS03	7	2.60-3.00	Grey clay.
527159	QWS07	6	1.35-1.80	Brown clay and loam.
527160	QWS14	6	1.70-2.30	Grey clay with oil / petroleum.
527161	QWS14	4	1.00-1.20	Brown loam and clay with gravel and vegetation.

Analytical Report Number : 16-86257

Project / Site name: Burrows Yard

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests. 2:1 extraction.	L082-PL	D	MCERTS
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Nitrate, water soluble, in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewater & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	D	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total sulphate (as SO ₄ in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	NONE

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For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

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Analytical Report Number : 16-86542

Project / Site name: Burrow's Yard

Samples received on: 22/01/2016

Your job number: G762

Samples instructed on: 26/01/2016

Your order number:

Analysis completed by: 03/02/2016

Report Issue Number: 1

Report issued on: 03/02/2016

Samples Analysed: 6 water samples

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Signed:

Emma Winter
Assistant Reporting Manager
For & on behalf of i2 Analytical Ltd.

Other office located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Analytical Report Number: 16-86542

Project / Site name: Burrow's Yard

Lab Sample Number	528932	528933	528934	528935	528936
Sample Reference	QBH04	QBH04	QBH05	QBH05	QBH06
Sample Number	1	1	1	1	1
Depth (m)	1.57	2.60-3.50	1.72	1.55-3.00	1.29
Date Sampled	19/01/2016	21/01/2016	20/01/2016	21/01/2016	20/01/2016
Time Taken	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status		

General Inorganics

pH	pH Units	N/A	ISO 17025	7.0	7.0	7.1	7.1	7.6
Total Cyanide	µg/l	10	ISO 17025	< 10	< 10	< 10	< 10	< 10
Sulphate as SO ₄	µg/l	45	ISO 17025	61400	80400	241000	56900	144000
Total Organic Carbon (TOC)	mg/l	0.1	ISO 17025	170	1.58	7.01	3.60	189
Hardness - Total	mgCaCO ₃ /l	1	ISO 17025	305	315	519	337	261

Total Phenols

Total Phenols (monohydric)	µg/l	10	ISO 17025	< 10	< 10	< 10	< 10	< 10
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Speciated PAHs

Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Total PAH

Total EPA-16 PAHs	µg/l	0.16	NONE	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16
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Heavy Metals / Metalloids

Arsenic (dissolved)	µg/l	1	ISO 17025	3.5	3.5	4.6	3.9	6.1
Boron (dissolved)	µg/l	10	ISO 17025	70	140	410	290	100
Cadmium (dissolved)	µg/l	0.08	ISO 17025	0.18	0.31	0.31	0.19	< 0.08
Chromium (dissolved)	µg/l	0.4	ISO 17025	1.2	0.9	0.8	0.8	0.8
Copper (dissolved)	µg/l	0.7	ISO 17025	2.9	4.6	9.0	1.6	5.1
Lead (dissolved)	µg/l	1	ISO 17025	1.9	1.7	2.8	3.4	4.5
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nickel (dissolved)	µg/l	0.3	ISO 17025	5.2	6.1	6.8	4.2	1.1
Tin (dissolved)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (dissolved)	µg/l	0.4	ISO 17025	31	98	30	12	1.5

Calcium (dissolved)	mg/l	0.012	ISO 17025	100	97	160	100	84
Magnesium (dissolved)	mg/l	0.005	ISO 17025	13	18	27	19	13



Analytical Report Number: 16-86542

Project / Site name: Burrow's Yard

Lab Sample Number	528932	528933	528934	528935	528936
Sample Reference	QBH04	QBH04	QBH05	QBH05	QBH06
Sample Number	1	1	1	1	1
Depth (m)	1.57	2.60-3.50	1.72	1.55-3.00	1.29
Date Sampled	19/01/2016	21/01/2016	20/01/2016	21/01/2016	20/01/2016
Time Taken	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status		

Monoaromatics

Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	43.3	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	6.9	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	5.6	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Petroleum Hydrocarbons

TPH1 (C10 - C40)	µg/l	10	NONE	< 10	< 10	< 10	280	< 10
TPH-CWG - Aliphatic >C5 - C6	µg/l	10	NONE	< 10	< 10	< 10	70	< 10
TPH-CWG - Aliphatic >C6 - C8	µg/l	10	NONE	< 10	< 10	< 10	160	< 10
TPH-CWG - Aliphatic >C8 - C10	µg/l	10	NONE	< 10	< 10	< 10	40	< 10
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10	270	< 10
TPH-CWG - Aromatic >C5 - C7	µg/l	10	NONE	< 10	< 10	< 10	43	< 10
TPH-CWG - Aromatic >C7 - C8	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C8 - C10	µg/l	10	NONE	< 10	< 10	< 10	63	< 10
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10	240	< 10
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10	39	< 10
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10	380	< 10

Chlorinated Solvents

Total Chlorinated Solvents	µg/l	50	NONE	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0
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Analytical Report Number: 16-86542

Project / Site name: Burrow's Yard

Lab Sample Number	528932	528933	528934	528935	528936
Sample Reference	QBH04	QBH04	QBH05	QBH05	QBH06
Sample Number	1	1	1	1	1
Depth (m)	1.57	2.60-3.50	1.72	1.55-3.00	1.29
Date Sampled	19/01/2016	21/01/2016	20/01/2016	21/01/2016	20/01/2016
Time Taken	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status		

VOCs

Chloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	µg/l	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorofluoromethane	µg/l	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,2-dichloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,2-Dichloropropane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloropropene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-dichloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	43.3	< 1.0
Tetrachloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromomethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromodichloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,3-dichloropropene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,3-dichloropropene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichloropropane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromochloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromoethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-Xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	6.9	< 1.0
Styrene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tribromomethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	5.6	< 1.0
1,1,2,2-Tetrachloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Isopropylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
n-Propylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Chlorotoluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
4-Chlorotoluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3,5-Trimethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
tert-Butylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trimethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
sec-Butylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p-Isopropyltoluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Butylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromo-3-chloropropane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hexachlorobutadiene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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The results included within the report are representative of the samples submitted for analysis.

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Analytical Report Number: 16-86542

Project / Site name: Burrow's Yard

Lab Sample Number	528932	528933	528934	528935	528936
Sample Reference	QBH04	QBH04	QBH05	QBH05	QBH06
Sample Number	1	1	1	1	1
Depth (m)	1.57	2.60-3.50	1.72	1.55-3.00	1.29
Date Sampled	19/01/2016	21/01/2016	20/01/2016	21/01/2016	20/01/2016
Time Taken	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status		

PCBs by GC-MS

PCB Congener 28	µg/l	0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
PCB Congener 52	µg/l	0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
PCB Congener 101	µg/l	0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
PCB Congener 118	µg/l	0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
PCB Congener 138	µg/l	0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
PCB Congener 153	µg/l	0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
PCB Congener 180	µg/l	0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

PCBs by GC-MS

Total PCBs	µg/l	0.14	NONE	< 0.14	< 0.14	< 0.14	< 0.14	< 0.14
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U/S = Unsuitable Sample I/S = Insufficient Sample



Analytical Report Number: 16-86542

Project / Site name: Burrow's Yard

Lab Sample Number				528937				
Sample Reference				QBH06				
Sample Number				1				
Depth (m)				2.645-2.50				
Date Sampled				21/01/2016				
Time Taken				None Supplied				
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status					

General Inorganics

pH	pH Units	N/A	ISO 17025	7.2				
Total Cyanide	µg/l	10	ISO 17025	< 10				
Sulphate as SO ₄	µg/l	45	ISO 17025	44300				
Total Organic Carbon (TOC)	mg/l	0.1	ISO 17025	17.9				
Hardness - Total	mgCaCO ₃ /l	1	ISO 17025	430				

Total Phenols

Total Phenols (monohydric)	µg/l	10	ISO 17025	10				
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Speciated PAHs

Naphthalene	µg/l	0.01	ISO 17025	1.40				
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01				
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01				
Fluorene	µg/l	0.01	ISO 17025	< 0.01				
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01				
Anthracene	µg/l	0.01	ISO 17025	< 0.01				
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Pyrene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01				
Chrysene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01				
Indeno(1,2,3-cd)pyrene	µg/l	0.01	NONE	< 0.01				
Dibenz(a,h)anthracene	µg/l	0.01	NONE	< 0.01				
Benzo(ghi)perylene	µg/l	0.01	NONE	< 0.01				

Total PAH

Total EPA-16 PAHs	µg/l	0.16	NONE	1.40				
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Heavy Metals / Metalloids

Arsenic (dissolved)	µg/l	1	ISO 17025	7.4				
Boron (dissolved)	µg/l	10	ISO 17025	430				
Cadmium (dissolved)	µg/l	0.08	ISO 17025	0.16				
Chromium (dissolved)	µg/l	0.4	ISO 17025	0.6				
Copper (dissolved)	µg/l	0.7	ISO 17025	1.5				
Lead (dissolved)	µg/l	1	ISO 17025	3.3				
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5				
Nickel (dissolved)	µg/l	0.3	ISO 17025	6.0				
Tin (dissolved)	µg/l	1	ISO 17025	< 1.0				
Zinc (dissolved)	µg/l	0.4	ISO 17025	22				

Calcium (dissolved)	mg/l	0.012	ISO 17025	130				
Magnesium (dissolved)	mg/l	0.005	ISO 17025	24				



Analytical Report Number: 16-86542

Project / Site name: Burrow's Yard

Lab Sample Number				528937				
Sample Reference				QBH06				
Sample Number				1				
Depth (m)				2.645-2.50				
Date Sampled				21/01/2016				
Time Taken				None Supplied				
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status					

Monoaromatics

Benzene	µg/l	1	ISO 17025	184				
Toluene	µg/l	1	ISO 17025	< 1.0				
Ethylbenzene	µg/l	1	ISO 17025	3.0				
p & m-xylene	µg/l	1	ISO 17025	12.0				
o-xylene	µg/l	1	ISO 17025	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	559				

Petroleum Hydrocarbons

TPH1 (C10 - C40)	µg/l	10	NONE	220				
TPH-CWG - Aliphatic >C5 - C6	µg/l	10	NONE	40				
TPH-CWG - Aliphatic >C6 - C8	µg/l	10	NONE	180				
TPH-CWG - Aliphatic >C8 - C10	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	220				
TPH-CWG - Aromatic >C5 - C7	µg/l	10	NONE	180				
TPH-CWG - Aromatic >C7 - C8	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C8 - C10	µg/l	10	NONE	60				
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	170				
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	44				
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	460				

Chlorinated Solvents

Total Chlorinated Solvents	µg/l	50	NONE	< 50.0				
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Analytical Report Number: 16-86542

Project / Site name: Burrow's Yard

Lab Sample Number				528937				
Sample Reference				QBH06				
Sample Number				1				
Depth (m)				2.645-2.50				
Date Sampled				21/01/2016				
Time Taken				None Supplied				
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status					
VOCs								
Chloromethane	µg/l	1	ISO 17025	< 1.0				
Chloroethane	µg/l	1	ISO 17025	< 1.0				
Bromomethane	µg/l	1	ISO 17025	< 1.0				
Vinyl Chloride	µg/l	1	NONE	< 1.0				
Trichlorofluoromethane	µg/l	1	NONE	< 1.0				
1,1-Dichloroethene	µg/l	1	ISO 17025	< 1.0				
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/l	1	ISO 17025	< 1.0				
Cis-1,2-dichloroethene	µg/l	1	ISO 17025	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	560				
1,1-Dichloroethane	µg/l	1	ISO 17025	< 1.0				
2,2-Dichloropropane	µg/l	1	ISO 17025	< 1.0				
Trichloromethane	µg/l	1	ISO 17025	< 1.0				
1,1,1-Trichloroethane	µg/l	1	ISO 17025	< 1.0				
1,2-Dichloroethane	µg/l	1	ISO 17025	< 1.0				
1,1-Dichloropropene	µg/l	1	ISO 17025	< 1.0				
Trans-1,2-dichloroethene	µg/l	1	ISO 17025	< 1.0				
Benzene	µg/l	1	ISO 17025	185				
Tetrachloromethane	µg/l	1	ISO 17025	< 1.0				
1,2-Dichloropropane	µg/l	1	ISO 17025	< 1.0				
Trichloroethene	µg/l	1	ISO 17025	< 1.0				
Dibromomethane	µg/l	1	ISO 17025	< 1.0				
Bromodichloromethane	µg/l	1	ISO 17025	< 1.0				
Cis-1,3-dichloropropene	µg/l	1	ISO 17025	< 1.0				
Trans-1,3-dichloropropene	µg/l	1	ISO 17025	< 1.0				
Toluene	µg/l	1	ISO 17025	< 1.0				
1,1,2-Trichloroethane	µg/l	1	ISO 17025	< 1.0				
1,3-Dichloropropane	µg/l	1	ISO 17025	< 1.0				
Dibromochloromethane	µg/l	1	ISO 17025	< 1.0				
Tetrachloroethene	µg/l	1	ISO 17025	< 1.0				
1,2-Dibromoethane	µg/l	1	ISO 17025	< 1.0				
Chlorobenzene	µg/l	1	ISO 17025	< 1.0				
1,1,1,2-Tetrachloroethane	µg/l	1	ISO 17025	< 1.0				
Ethylbenzene	µg/l	1	ISO 17025	3.8				
p & m-Xylene	µg/l	1	ISO 17025	12.2				
Styrene	µg/l	1	ISO 17025	< 1.0				
Tribromomethane	µg/l	1	ISO 17025	< 1.0				
o-Xylene	µg/l	1	ISO 17025	< 1.0				
1,1,2,2-Tetrachloroethane	µg/l	1	ISO 17025	< 1.0				
Isopropylbenzene	µg/l	1	ISO 17025	< 1.0				
Bromobenzene	µg/l	1	ISO 17025	< 1.0				
n-Propylbenzene	µg/l	1	ISO 17025	< 1.0				
2-Chlorotoluene	µg/l	1	ISO 17025	< 1.0				
4-Chlorotoluene	µg/l	1	ISO 17025	< 1.0				
1,3,5-Trimethylbenzene	µg/l	1	ISO 17025	< 1.0				
tert-Butylbenzene	µg/l	1	ISO 17025	< 1.0				
1,2,4-Trimethylbenzene	µg/l	1	ISO 17025	14.3				
sec-Butylbenzene	µg/l	1	ISO 17025	< 1.0				
1,3-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0				
p-Isopropyltoluene	µg/l	1	ISO 17025	< 1.0				
1,2-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0				
1,4-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0				
Butylbenzene	µg/l	1	ISO 17025	< 1.0				
1,2-Dibromo-3-chloropropane	µg/l	1	ISO 17025	< 1.0				
1,2,4-Trichlorobenzene	µg/l	1	ISO 17025	< 1.0				
Hexachlorobutadiene	µg/l	1	ISO 17025	< 1.0				
1,2,3-Trichlorobenzene	µg/l	1	ISO 17025	< 1.0				



Analytical Report Number: 16-86542

Project / Site name: Burrow's Yard

Lab Sample Number				528937				
Sample Reference				QBH06				
Sample Number				1				
Depth (m)				2.645-2.50				
Date Sampled				21/01/2016				
Time Taken				None Supplied				
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status					

PCBs by GC-MS

PCB Congener 28	µg/l	0.02	NONE	< 0.02				
PCB Congener 52	µg/l	0.02	NONE	< 0.02				
PCB Congener 101	µg/l	0.02	NONE	< 0.02				
PCB Congener 118	µg/l	0.02	NONE	< 0.02				
PCB Congener 138	µg/l	0.02	NONE	< 0.02				
PCB Congener 153	µg/l	0.02	NONE	< 0.02				
PCB Congener 180	µg/l	0.02	NONE	< 0.02				

PCBs by GC-MS

Total PCBs	µg/l	0.14	NONE	< 0.14				
------------	------	------	------	--------	--	--	--	--

U/S = Unsuitable Sample I/S = Insufficient Sample



Analytical Report Number : 16-86542

Project / Site name: Burrow's Yard

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Boron in water	Determination of boron by acidification followed by ICP-OES. Accredited matrices: SW PW GW	In-house method based on MEWAM	L039-PL	W	ISO 17025
BTEX and MTBE in water	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Monohydric phenols in water	Determination of phenols in water by continuous flow analyser. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
PCB's By GC-MS in water	Determination of PCB by extraction with acetone and hexane followed by GC-ECD.	In-house method based on USEPA 8082	L028-PL	W	NONE
pH in water	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L005-PL	W	ISO 17025
Speciated EPA-16 PAHs in water	Determination of PAH compounds in water by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L0102B-PL	W	NONE
Sulphate in water	Determination of sulphate in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Total Chlorinated Solvents in water	Determination of chlorinated solvents in water by headspace GC-MS. Accredited Matrices SW, GW, PW.	In-house method based on USEPA8260	L036-PL	W	ISO 17025
Total cyanide in water	Determination of total cyanide by distillation followed by colorimetry. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Total Hardness of water	Determination of hardness in waters by calculation from calcium and magnesium. Accredited Matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L045-PL	W	ISO 17025
Total organic carbon in water	Determination of dissolved organic carbon in water by TOC/DOC NDIR analyser.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L037-PL	W	ISO 17025
TPH1 (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS.	In-house method	L070-UK	W	NONE
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-UK	W	NONE
Volatile organic compounds in water	Determination of volatile organic compounds in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30°C.

APPENDIX X – PHOTO IONISATION DETECTOR RESULTS

Site: Burrows Yard

Site Number: G762

PID results



Exploratory Hole	Sample Number	Average (ppmv)	Peak (ppmv)	Depth (metres)
QBH01	ES1	28.3	-	0.3
QBH01	ES2	20.1	-	0.6
QBH01	ES3	19.7	-	1.0
QBH01	ES6	14.3	20.0	2.0
QBH01	ES9	28.9	32.7	3.0
QBH02	ES1	369.0	536.0	0.3
QBH02	ES2	92.8	311.0	0.6
QBH02	ES3	11.9	13.2	1.0
QBH02	ES6	22.1	27.5	2.0
QBH03	ES1	13.2	15.8	0.3
QBH03	ES2	16.8	22.5	0.6
QBH03	ES3	12.5	14.1	1.0
QBH03	ES6	12.3	24.6	2.0
QBH03	ES9	24.6	63.7	3.0
QBH04	ES1	1.2	3.1	0.3
QBH04	ES2	2.5	4.2	0.6
QBH04	ES3	1.5	4.3	1.0
QBH04	ES5	2.4	4.4	2.0
QBH05	ES1	17.8	19.1	0.3
QBH05	ES3	19.4	20.1	1.0
QBH05	ES6	17.2	19.5	2.0
QBH05	ES9	8.8	13.8	2.9
QBH06	ES1	3.8	5.4	0.3
QBH06	ES2	3.1	5.0	0.6
QBH06	ES3	3.6	4.5	1.0
QBH06	ES6	8.1	12.4	2.0
QBH06	ES9	25.5	35.7	3.0

Site: Burrows Yard
Site Number: G762
PID results



Exploratory Hole	Sample Number	Average (ppmv)	Peak (ppmv)	Depth (metres)
QWS02	ES1	14.3	-	0.3
QWS02	ES2	15.9	-	0.6
QWS02	ES3	21.2	-	1.0
QWS02	ES5	4.5	21.4	1.5
QWS03	ES1	36.4	-	0.3
QWS03	ES2	28.3	-	0.6
QWS03	ES3	37.0	-	1.0
QWS03	ES3	13.9	27.1	1.5
QWS03	ES6	10.8	18.1	2.5
QWS03	ES8	9.7	12.1	3.7
QWS04	ES1	18.7	-	0.3
QWS04	ES2	16.0	-	0.6
QWS04	ES3	12.2	-	1.0
QWS04	ES5	25.0	48.5	2.0
QWS05A	ES1	41.1	-	0.3
QWS05A	ES2	36.5	-	0.6
QWS05A	ES4	36.0	-	1.0
QWS05A	ES6	36.1	-	1.8
QWS05A	ES7	50.4	-	1.9
QWS05A	ES8	26.4	-	2.2
QWS05A	ES9	27.9	-	2.5
QWS06	ES1	17.7	19.1	0.3
QWS06	ES2	15.3	19.1	0.6
QWS06	ES3	17.3	20.1	1.0
QWS06	ES5	6.2	17.4	1.4
QWS07	ES1	33.2	97.2	0.3
QWS07	ES2	10.0	32.1	0.6
QWS07	ES3	54.2	200.0	1.0
QWS07	ES5	5.8	10.1	1.3
QWS07	ES7	14.7	20.3	1.8
QWS10	ES1	19.2	-	0.3
QWS10	ES2	17.6	-	0.6
QWS10	ES3	17.4	-	1.0
QWS10	ES5	3.4	4.1	1.4
QWS10	ES6	3.9	4.5	1.9
QWS10	ES7	14.4	17.3	2.3
QWS11	ES1	13.2	-	0.3
QWS11	ES2	16.6	-	0.6
QWS11	ES3	21.8	-	1.0
QWS11	ES5	8.2	23.1	1.4
QWS11	ES6	17.2	33.4	2.0
QWS12	ES1	17.0	20.0	0.3
QWS12	ES2	11.6	13.7	0.6
QWS12	ES3	16.9	21.7	1.0
QWS12	ES5	6.5	10.0	1.8
QWS12	ES6	3.9	7.1	2.8
QWS13	ES1	5.2	7.5	0.3
QWS13	ES2	4.5	5.2	0.6
QWS13	ES3	5.4	6.2	1.1
QWS13	ES5	6.0	6.2	2.0
QWS13	ES6	5.2	5.7	3.0
QWS140	ES1	31.5	51.3	0.3
QWS140	ES2	6.3	20.0	0.6
QWS140	ES3	13.6	20.0	1.0
QWS140	ES5	8.6	12.1	1.6
QWS14N	ES1	14.3	18.1	0.2
QWS14N	ES2	17.4	18.6	0.4
QWS14N	ES3	20.8	22.9	1.0
QWS14N	ES5	17.5	21.1	2.0
QWS14N	ES6	18.5	19.5	2.5
QWS16	ES1	13.7	32.5	0.3
QWS16	ES2	18.5	26.3	0.6

Site: Burrows Yard

Site Number: G762

PID results



Exploratory Hole	Sample Number	Average (ppmv)	Peak (ppmv)	Depth (metres)
QTP01	ES5	6.5	10.0	1.8
QTP01	ES6	3.9	7.1	2.8
QTP02	ES1	17.0	18.3	0.5
QTP02	ES2	24.9	36.6	1.9
QTP02A	ES1	38.0	49.0	0.3
QTP02A	ES2	26.7	43.0	1.0
QTP02A	ES3	26.2	30.7	2.1
QTP04	ES1	32.0	61.4	0.3
QTP04	ES2	11.0	18.3	0.6
QTP04	ES3	22.0	33.0	1.0
QTP04	ES5	24.0	42.9	2.0
QTP05	ES1	1.4	3.3	0.3
QTP05	ES2	1.1	2.0	0.6
QTP05	ES3	1.8	2.4	1.0
QTP05	ES5	1.9	26.0	2.0
QTP05	ES6	2.9	3.6	2.3
QTP05	ES8	4.4	5.7	3.0
QTP06	ES1	4.8	7.4	0.3
QTP06	ES2	8.1	10.1	0.6
QTP06	ES3	9.0	12.5	1.0
QTP06	ES5	14.5	17.2	1.7
QTP06	ES6	9.7	11.8	2.0
QTP07	ES1	12.7	14.9	0.3
QTP07	ES2	11.3	17.0	0.6
QTP07	ES3	7.8	9.7	1.0
QTP07	ES8	4.4	5.3	1.4
QTP07	ES5	12.1	17.3	2.0
QTP07	ES6	9.8	12.9	2.4
QTP08	ES1	16.6	21.1	0.3
QTP08	ES2	17.0	17.7	0.6
QTP08	ES3	17.5	18.9	1.0
QTP08	ES5	16.5	18.1	1.7
QTP08	ES6	15.2	17.0	2.0
QTP08	ES8	14.6	16.7	3.0
QTP09	ES1	8.5	14.0	0.3
QTP09	ES2	12.3	15.2	0.6
QTP09	ES3	10.7	14.7	1.0
QTP09	ES5	57.3	95.2	2.0
QTP09	ES6	397.0	472.0	3.0
QTP10	ES1	15.3	17.4	0.3
QTP10	ES2	9.5	10.8	0.6
QTP10	ES3	14.9	18.9	0.8

QTP10	ES5	55.7	134.0	1.5
QTP10	ES6	78.3	165.0	2.4
QTP10	ES8	233.0	312.0	2.8
QTP11	ES1	15.7	17.6	0.3
QTP11	ES2	7.2	8.4	0.6
QTP11	ES3	15.7	18.3	1.0
QTP11	ES5	14.6	17.1	1.6
QTP11	ES6	9.2	11.9	2.5
QTP11	ES8	16.6	18.6	3.2
QTP12	ES2	16.3	16.9	0.6
QTP12	ES5	30.7	38.1	1.6
QTP12	ES6	37.5	45.8	2.5
QTP12	ES8	25.3	30.5	3.2
QTP15	ES1	14.8	16.0	0.3
QTP15	ES2	15.1	19.0	0.6
QTP15	ES3	18.4	23.1	1.0
QTP15	ES6	21.4	23.6	2.2
QTP15	ES7	16.3	18.5	2.6
QTP15	ES8	19.2	19.8	3.1
QTP16	ES1	11.4	12.1	0.3
QTP16	ES2	13.5	14.3	0.6
QTP16	ES3	14.2	15.4	1.0
QTP16	ES5	14.4	15.6	1.8
QTP16	ES7	17.5	18.2	3.0
QTP17	ES1	13.4	17.9	0.4
QTP17	ES2	14.4	20.9	0.8
QTP17	ES3	12.7	19.5	1.5
QTP17	ES5	11.4	15.0	2.4
QTP17	ES6	15.4	17.7	3.0
QTP18	ES1	3.3	6.7	0.4
QTP18	ES2	3.9	5.1	0.6
QTP18	ES3	3.3	4.2	1.0
QTP18	ES5	3.3	4.1	1.8
QTP19	ES1	3.5	4.1	0.3
QTP19	ES2	3.3	3.8	0.5
QTP19	ES3	3.7	4.3	1.0
QTP19	ES5	3.8	4.6	1.8
QTP20	ES1	2.7	3.2	0.3
QTP20	ES2	3.5	46.0	0.6
QTP20	ES3	2.1	2.4	1.0
QTP20	ES5	2.3	3.0	2.0
QTP21	ES1	18.4	19.9	0.3
QTP21	ES2	15.2	18.7	0.6
QTP21	ES3	17.2	19.0	1.0
QTP21	ES4	18.9	20.5	2.0
QTP21	ES5	16.0	17.5	3.0

Site: Burrows Yard
 Site Number: G762
 PID results



Exploratory Hole	Sample Number	Average (ppmv)	Peak (ppmv)	Depth (metres)
QTT01	ES2	10.9	17.1	0.6
QTT01	ES3	55.1	97.4	1.0
QTT01	ES4	22.9	50.0	1.6
QTT01	ES5	382.0	493.0	2.5
QTT01	ES6	262.0	434.0	3.6
QTT01B	ES9	98.3	120.0	2.5
QTT02	ES1	2.9	9.7	0.3
QTT02	ES2	2.4	3.6	0.5
QTT02	ES3	2.7	5.1	1.5
QTT02	ES4	3.2	4.5	2.5
QTT03	ES1	4.1	4.5	0.5
QTT03	ES2	3.9	4.4	1.0
QTT03	ES3	4.4	5.3	2.0

Site: Burrows Yard

Site Number: G762

PID results



Exploratory Hole	Sample Number	Average (ppmv)	Peak (ppmv)	Depth (metres)
M1	-	3.9	5.3	-
M2	-	3.2	3.8	-
M2	-	4.5	5.5	-
M3	-	4.3	4.8	-
M4	-	3.6	4.1	-
M5	-	3.2	3.6	-

APPENDIX XI – ESP LTD 2015 REPORT

**PROPOSED RESIDENTIAL AND RETAIL
DEVELOPMENT
AFAN WAY, PORT TALBOT**

ENVIROTREAT TECHNOLOGIES LIMITED

**PRELIMINARY GEO-ENVIRONMENTAL
RISK ASSESSMENT**

Prepared for:

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**PROPOSED RESIDENTIAL AND RETAIL DEVELOPMENT
AFAN WAY, PORT TALBOT**

ENVIROTREAT TECHNOLOGIES LIMITED

**PRELIMINARY GEO-ENVIRONMENTAL
RISK ASSESSMENT**

Date	Status	Written By	Checked and Approved By
June 2015	First Issue – Draft	Jeremy Hucker	Matthew Eynon
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SUMMARY

Envirotrat Technologies Ltd (hereafter known as the Client) are proposing to undertake remedial works to facilitate the redevelopment of the subject site as residential properties and retail units. The Earth Science Partnership Ltd (ESP) were instructed by the Client to undertake a review of available geo-environmental information including a number of previous investigations and assessments undertaken at the site between 2002 and 2008, and prepare a Preliminary Geo-environmental Risk Assessment for the proposed development. No intrusive investigation, sampling or site reconnaissance visit has been undertaken as part of this assessment.

The proposed development will comprise residential properties in the north and central area and two retail units in the south-east, with residential apartments above one unit.

The assessment of the available information has suggested that the site is underlain by soils and groundwater which contain levels of contaminants which could pose an unacceptable risk to both future site users and controlled waters and, in particular, the River Afan.

The former petrol filling station (PFS) area of the site has been subjected to substantial levels of investigation between 2002 and 2008. Unacceptably elevated levels in terms of human health risk of arsenic, petroleum hydrocarbons, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene and dibenzo[ah]anthracene have been identified.

The most likely original source of petroleum hydrocarbons beneath the former PFS (the former underground fuel tanks) were removed in 2006, and the fuel pumps and supply pipes appear to have been removed shortly after. However, secondary sources of petroleum contamination have been identified as elevated levels within the soils and dissolved in the groundwater and, in particular, up to 1.3m of free product hydrocarbons in the west of the PFS (Borehole E4) between 2004 to 2008. These contaminants remain as a potential risk to the water quality within the River Afan. Due to access restrictions, it has not been possible to confirm whether such contamination (and in particular, free product) remains beneath the site now.

The remainder of the site was formerly predominantly occupied by a Council Yard, and was subjected to less investigation. The investigation undertaken indicated unacceptably elevated levels in terms of human health risk of vanadium, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene and dibenzo[ah]anthracene.

There are a number of potential sources of hazardous ground gas beneath the site and the previous investigation (GIL, 2004) recommended the provision of gas protection measures in future developments, particularly on the former PFS. However, no monitoring data has been available for review so the scale of protection required cannot be confirmed.

We consider that further investigation would be required across the site to evaluate the scale of contamination present within the soils and groundwater in the area of the PFS, particularly by petroleum hydrocarbons, and across the former Council Yard. This should comprise trial pitting and the installation and monitoring of gas and groundwater wells. An assessment of the present risks to controlled waters and human health would be required for both zones. Based on the available information, we anticipate that remediation will be required prior to development, and would be designed on the basis of the conclusions of the risk assessments.

The future investigation and remediation should be undertaken in accordance with CLR 11 (2004).

**PROPOSED RESIDENTIAL AND RETAIL DEVELOPMENT
AFAN WAY, PORT TALBOT**

PRELIMINARY GEO-ENVIRONMENTAL RISK ASSESSMENT

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ENCLOSURES

PLATES

FIGURE 1	Site Location Plan
FIGURE 2	Proposed Layout
FIGURE 3a	Historical Site Layout
FIGURE 3b	Former Petrol Filling Station Layout

**PROPOSED RESIDENTIAL AND RETAIL DEVELOPMENT
AFAN WAY, PORT TALBOT**

PRELIMINARY GEO-ENVIRONMENTAL RISK ASSESSMENT

ENCLOSURES (cont)

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APPENDIX B	Environmental Data Report (2015)
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APPENDIX G2	Council Yard Tar Tank – NPTC correspondence (2007)
APPENDIX H1	Exploratory Hole Records from Previous Investigations (GIL, 2007c)
APPENDIX H2	Monitoring Results (GIL, 2007c)
APPENDIX H3	Laboratory Test Results (GIL, 2007c)
APPENDIX I	Contamination Remediation Report (Lee, 2008)
APPENDIX J	Coal Authority Mining Report
APPENDIX K	Electronic Copy of Report (on CD)

GENERAL NOTES

1.0 INTRODUCTION AND OBJECTIVES

1.1 Background

Envirotrat Technologies Ltd (hereafter known as the Client) are proposing to undertake remedial works to facilitate the redevelopment of the subject site as residential properties and retail units. The Earth Science Partnership Ltd (ESP), Consulting Engineers, Geologists and Environmental Scientists, were instructed by the Client to undertake a review of available geo-environmental information including a number of previous investigations and assessments of the site, and prepare a Preliminary Geo-environmental Risk Assessment for the proposed development. No intrusive investigation or sampling has been undertaken as part of this assessment, although data from previous investigations (undertaken between 2002 and 2007) has been assessed. The site location is shown on Figure 1.

The proposed development can be divided in two general zones, as shown on Figure 2:

- A **Retail Zone** in the south-east, comprising a retail unit in the south-west (Unit A) and a combined retail and residential unit in the south-east (Unit B, comprising a retail ground floor and two storeys of residential apartments above), along with associated parking for shoppers and residents. The retail zone will be accessed off Afan Way on the south-eastern boundary, with the residential parking access off Water Street on the north-eastern boundary.
- A **Residential Zone** in the north-west, comprising one- and two-storey private dwellings with associated private gardens and a new access off Isaacs Place on the western boundary.

1.2 Objective and Scope of Works

The site has been subject to a number of planning permissions for previously proposed retail developments. However, we understand that, partly due to the change to the proposed use (to include residential properties), these are no longer applicable. We are not aware of any planning approvals for the proposed development at this stage, but we anticipate that an approval would be conditioned requiring an investigation, risk assessment and provision of a remedial strategy and validation for risk mitigation works in accordance with the guidelines presented in CLR11 (Environment Agency, 2004).

This assessment has been designed to evaluate the available information on the ground conditions and re-assess the data in terms of the proposed development as part of a Preliminary Risk Assessment. However, due to the change to a more sensitive land use (residential), and the time elapsed since the previous investigations (over ten years), a further phase of investigation is likely to be required – see Section 6.0.

The scope of works for this study was mutually developed with the Client by ESP within an agreed budget, and comprised a desk study review of updated (obtained in June 2015) available historical Ordnance Survey maps, updated (2015) environmental data, geological maps, memoirs, and the reports on previous investigations and assessments undertaken at the site (obtained from Neath Port Talbot County Borough Council, NPTC). Details of the reports reviewed are provided in Section 2.4.

The previous investigation data has been used in a revised assessment of risks to human health (using up-to-date assessment criteria for the newly proposed land use), and as a preliminary evaluation of risks to controlled waters. However, it must be appreciated by the reader that the previous investigation data (e.g. laboratory results) is over ten years old in some instances, and was collected prior to site clearance, and that the concentrations and distribution of contamination beneath the site may have changed in the intervening time.

The contract was awarded on the basis of a competitive tender quotation. The terms of reference for the assessment are as laid down in the Earth Science Partnership proposal of 15th May 2015. The investigation and assessment was undertaken in May and June 2015. Due to contractual issues, no visit inside the site boundary was possible. The visible areas of the site were viewed from the locked gate on the north-western boundary with Water Street.

1.3 Risk Assessment Methodology

The assessment was partly conducted to formulate an opinion as to the potential for hazardous substances (contamination) or conditions to exist on, at or near the site at levels or in a situation likely to warrant mitigation or consideration appropriate to the proposed end use. The risk assessment methodology used to achieve this is based on guidance published by CIRIA (2001) and is discussed in more detail in Section 3.1 of this report.

1.4 Limitations of Report

This report represents the findings of the brief relating to the proposed end use as detailed in Section 1.1. The brief did not require an assessment of the implications for any other end use, nor is the report a comprehensive site characterisation and should not be construed as such. In particular, the assessment does not consider geotechnical aspects of the development (e.g. foundation options). Should an alternative end use be considered, the findings of the assessment should be re-examined relating to this use. Where preventative, ameliorative or remediation works are required, professional judgement will be used to make recommendations that satisfy the site specific requirements in accordance with good practice guidance.

Consultation with regulatory authorities will be required with respect to proposed works as there may be overriding regional or policy requirements which demand additional work to be undertaken. It should be noted that both regulations and their interpretation by statutory authorities are continually changing.

This report represents the findings and opinions of experienced geo-environmental and geotechnical specialists. Earth Science Partnership does not provide legal advice and the advice of lawyers may also be required.

1.5 Digital Copy of Report

A digital copy of this report (in pdf format) is included on a CD in Appendix K.

2.0 DESK STUDY, WALKOVER SURVEY AND PRELIMINARY RISK ASSESSMENT

The information presented in this section was obtained from desk-based research of sources detailed in the text. A desk study was previously undertaken at the site (in 2004 – see Section 2.4) but given the time period which has elapsed since this was published (11 years), up-to-date desk study information has been obtained from various sources as described in the text, including historical maps and an environmental data report which are presented in Appendices A and B respectively. Further desk study reports/data/records are included as subsequent appendices as referenced in the text.

As discussed in Section 1.2, no site visit inside the boundary has been possible in preparing this assessment. We made a visit to the site in June 2015, and found the boundaries to comprise wooden hoardings generally preventing views inside. The visible area was viewed from the site entrance on Water Street and views are shown in the Plates section of this report. A recent aerial photograph is also presented in the Plates section.

2.1 Site Location and Description

The site is located between Afan Way, Isaacs Place and Water Street in Port Talbot. The National Grid Reference of the centre of the site is (SS) 275966 189794 and the postcode of the former petrol station on site was SA12 6LL. A Site Location Plan is presented as Figure 1.

It is bounded by:

- To the north-east: Water Street, followed by terraced residential properties;
- To the south-west: Isaacs Place, followed by terraced residential properties, and a former industrial works to the south-west; and
- To the south-east: Afan Way, followed by a MacDonalds restaurant, and a tyre depot.

The site comprises a triangular shaped parcel of land of around 150m length (north-west to south-east) along Isaacs Place, 130m length (south-west to north-east) along Afan Way, and 180m length (east-west) along Water Street. The site area is around 1.2ha.

The site is presently derelict, with the abandoned, portal frame structures of two previously proposed retail units (Plates 4 to 6) along the western boundary. The ground around these structures appears to comprise gravel surfacing overgrown with weeds, bushes and grasses. A recent aerial photograph (Plate 3) suggests that the remainder of the site appears in a similar overgrown state, with no significant above-ground structures remaining. Some storage of materials including pipes is evident just inside the gate (Plate 4). Anecdotal evidence from the Client suggests that potential asbestos containing materials are present on the ground surface in areas.

The site lies in the estuary of the River Afan and the general topography in the area is relatively flat. A previous investigation (GIL, 2004 – see Section 2.3) provided site levels at that time. Site levels were reported to fall from west to east across the site, being some 1.0 to 1.3m above the adjacent Water Street in the north-west. Reported elevations varied between 5.6m OD (in the east) and 6.8m OD (in the north-west).

The ground levels may have changed during the previous partial development, and we are not aware of any recent topographic survey. However, based on our visual observations, we do not consider that ground levels are likely to have changed significantly (by more than 1 to 2m) since 2004.

We have not had sight of current plans showing the locations of recorded underground services in the vicinity of the site. However, in 2004 GIL (see Section 2.3) reported the following:

- A large diameter drainage pipe running north-west to south-east through the centre of the site (see Figure 2 and 3b). The invert is reported to be between 1.93m OD (i.e. around 4.3m depth) in the centre of the site and 1.91m OD (5.2m depth) to the east of the site (at the tyre depot). The apparent fall is therefore from north-west to south-east i.e. towards the River Afan.
- An electricity sub-station was located in the south-western margins of the site, with 11kV and other cables running along the south-eastern boundary.
- Further underground services associated with the former Council depot were also reported

2.2 Site History

2.2.1 Published Historical Maps

The site history has been assessed from a review of available historical Ordnance Survey County Series and National Grid maps. Extracts from the historical maps are presented in Appendix A.

Table 1: Review of Historical Maps

Date	On-Site	In Vicinity of Site
1877 – 1881	The site was occupied by the Burrows Tin Plate Works comprising a large building (some 60m by 25m area) on the western boundary. A series of apparent terraced dwellings are shown in the central area of the northern boundary. Further unidentified smaller buildings are shown in the east of the site and the southern corner.	The road to the north was named Water Street with the Port Talbot Chemical Works on the northern side. The Afon Vale Tin Plate Works was located to the east, with a gas works further east. A lane is shown immediately to the west of the site, with apparent parkland further west. A track runs along the southern boundary, with the land to the south-east falling down to marshy ground, probably the estuary of the River Afan. A stream channel crosses the land some 60m south of the site.
1897-1899	The 1899 edition of the map shows the tin plate works to have expanded (with the main building now some 90m by 20m in area) and to have been renamed the Glanwalia Works. Further development of the works is shown in the west of the site, including railway sidings accessing the site from the southern corner, and an apparent pond in the central area. The dwellings remain on the northern boundary, but apart from a small building in the eastern corner, the eastern area appears undeveloped.	By 1899, the tin plate works to the east is indicated to have become disused, and the chemical works is no longer shown to the north. The road to the north of the site is named Scythian Road, and has terraced properties along its northern side. The land to the south and south-east of the site had been apparently filled and was crossed by railway lines. The Port Talbot Iron Foundry is shown to the south-west.

Table 1: Review of Historical Maps (cont)

Date	On-Site	In Vicinity of Site
1914 - 1950	By 1917 the site had apparently become fully developed, with further expansion of the main works building (to some 130m by 20m area). The former pond had apparently been backfilled and built over. No indication of the use is given but subsequent maps indicate that it remained a tin plate works. An above ground tank is shown in the central area on the 1939 edition. This tank is no longer shown by 1950, but two additional above ground tanks are indicated, along with two wells, and the works is named as the Boro Tinplate Works. The Talbot Works (manufacturing bakery equipment) is shown in the east of the site.	The land to the south/south-east is shown to be undeveloped with a railway siding along the south-eastern boundary. Isaacs Terrace and streets of terraced houses are shown to the west. By 1939, further development had taken place to the south/south-east, indicated to be slaughter houses and a metal works by 1950. Water Street is shown on the northern boundary and an engineering works, garages and a further part of the Talbot Works are shown to the south-west.
1961 - 1990	The former tinplate works is now shown to have been a Corporation Yard. The former tanks are no longer shown and the railway appears to have been dismantled inside the site. A platform is indicated in the central area and the former Talbot Works is now labelled as a 'Works'. A mortuary is shown to the east of the terraced houses on the northern boundary. By 1967 the works in the east is indicated to have been a Sign Posts Works, and the wells are no longer identified. The dwellings on the northern boundary had been demolished by 1974, being replaced by further buildings (probably associated with the Council yard), although the mortuary remained. An electricity sub-station is shown in the southern corner from 1990.	The industrial units to the south-west are now named as a works and three warehouses. Further unnamed development is also shown to the south. By 1967, the works to the south-west was a Bottle Tops Works, and a new bridge is shown over the River Afan some 60m to the south. The north-western bank of the river alongside the bridge had been straightened and apparently comprised revetment. A road is shown leading from Water Street to the new river bridge to the south - by 1974, this had become a formal road named Afan Way. An abattoir, tyre depot and repair works are shown to the south and a metal closure works to the south-west.
1991 - 2004	The Corporation Yard remained until recent redevelopment, with a petrol station filling located in the eastern corner.	No significant changes
2004 - present	At the time of the 2004 investigation (see Section 2.3), the Council Yard remained operational, and is understood to have closed shortly after (2005?). The petrol filling station was no longer operating in July 2004. Aerial photographs (Plates 1 and 2) suggest that the Council Yard was no longer in operation in 2006, and all buildings on site had been demolished by 2010, with the current portal frame structures evident on the western boundary.	No significant changes

The identified historical features, including the layout of the main former tinplate works building, and the locations of the backfilled pond and identified former tanks are presented on Figure 3a.

2.2.2 Petrol Filling Station

The available information indicates that the petrol filling station (PFS) operated between 1991 and 2004 in the east of the site. The former tank, pump and fuel supply lines layout of the PFS has been provided by Neath Port Talbot County Borough Council and a copy is presented as Figure 3b. See Section 3.2.1 for further discussion on the historical layout of the petrol station.

2.3 Hydrology

2.3.1 Surface Water Features

The nearest major surface water feature to the site is the River Afan which flows from north-east to south-west some 80m to the south-east at its closest point. A weir is shown on the river some 120m to the south-east of the site and the river is indicated to be tidal up to this weir. Historical maps indicate that tributary streams to the river formerly flowed across the land to the south-east of the site, but these have been filled over for over a century – see Section 2.2.

The website of the Environment Agency (EA, June 2015) indicates that the water quality within the river upstream of the weir has been classified as moderate in terms of current ecological quality and is not assessed in terms of current chemical quality.

2.3.2 Surface Water Abstractions

The environmental data report (Appendix B) indicates that the closest surface water abstraction to the site is some 110m to the south-east, and comprises an abstraction by Tata Steel from the river for their works.

2.3.3 Flooding

From a review of flooding maps presented on the Environment Agency website (EA, June 2015), the risk from flooding by water from the estuary of the River Afan is classified as Low. Water Street and Isaacs Place are indicated to be at risk from flooding by surface water.

However, the EA website also indicates that the site lies:

- within Flood Zone 3 (Zone C1 in Wales) - land assessed as having a 1 in 100 or greater annual probability of flooding or a 1 in 200 or greater annual probability of flooding from the sea in any year;
- in an area benefiting from flood defences; and
- in a flood warning area.

On the above basis, we recommend that further enquiries be made to Natural Resources Wales to identify whether a Flood Consequence Assessment is required.

2.4 Previous Investigations and Assessments

A number of previous investigations and assessments have previously been undertaken at the site. Part and full copies of available reports have been provided by the Environmental Services department of Neath Port Talbot County Borough Council (NPTC). These assessments are summarised below and relevant extracts from the reports are discussed in detail in the following sections with salient information (borehole records, test results, monitoring data etc.) presented in the appendices.

The previous investigations were undertaken when the site was divided physically into three main areas shown on Figure 3a:

1. Petrol Filling Station (PFS) - in the east;
2. Council Yard – in the main northern and central area;
3. Skelton Thomas premises – between the Council Yard and the PFS.

2.4.1 Ecologia Environmental Solutions Ltd, 2002

Ecologica reportedly undertook an intrusive investigation at the then operational petrol filling station (PFS) in the east of the site in 2002. A copy of this report has not been available for review in undertaking this assessment, but its contents are summarised in detail by others (GIL, 2004), and the information contained therein has been used in this assessment.

The investigation was reportedly undertaken in response to a reported loss of diesel at the PFS, with water being found being pumped into customer's cars. It was estimated that around 7,500 litres of diesel had been lost in total. The investigation comprised a review of an environmental data report (Envirocheck), a site reconnaissance, the construction of six boreholes in October 2002 to between 6.0 and 7.4m depth using hollow stem auger techniques, the installation of five monitoring and sampling wells, and laboratory testing.

The Ecologia borehole positions are presented on Figure 4, and the borehole records and laboratory test results (on soil and groundwater samples) presented in Appendices C1 and C2 respectively. For the purposes of this assessment, the Ecologia boreholes BH1 to BH6 have been designated Boreholes E1 to E6. It should be appreciated that the position and record of Borehole E5 has not been identified.

2.4.2 Babbie Group, March 2004

The Babbie Group were commissioned by NPTC to complete a desk study assessment of the petrol filling station (PFS) site to assist the Council in their determination of the PFS site under Part IIA of the Environmental Protection Act, 1990.

The desk study comprised a review of historical maps, an Envirocheck (environmental data) report, information obtained from statutory bodies such as the Environment Agency and the Local Authority Petroleum Officer, and concluded with a preliminary risk assessment.

Most of the desk study information contained in the Babbie assessment has been updated in preparing this report (e.g. new historical maps and environmental data has been obtained). Therefore, we consider that the main contents of the Babbie report are no longer salient to this assessment. However, where relevant, the findings and conclusions have been referenced in the following sections.

2.4.3 Ground Investigation Ltd, November 2004

Ground Investigation Ltd were appointed by the previous developer of the site (the Dovey Group) to undertake a review of the Ecologia investigation and Babbie assessment reports, and undertake a further Phase Two intrusive investigation. The intrusive investigation comprised machine excavated trial pits, cable percussion boreholes, windowless sample boreholes, the installation of gas and groundwater wells, geo-environmental laboratory testing, and an assessment of risks to future site users (of a retail development) and controlled waters.

A part copy of the GIL report has been provided, which appears to be missing several pages of text and gas and groundwater monitoring results. The GIL borehole and trial pit positions are presented on Figure 4, and the exploratory hole records and the laboratory test results (on soil, leachate and groundwater samples) are presented in Appendices D1 and D2 respectively.

2.4.4 Ground Investigation Ltd, December 2006

Ground Investigation Ltd were appointed by the previous developer of the site to undertake validation of the excavation following the removal of the underground fuel tanks on the former petrol filling station (PFS) in the east of the site in 2006.

At the time of the validation exercise all the above ground structures on the former PFS had been demolished, and three tanks were removed as follows:

- Tank A: a single skin, two chambered, steel tank of 2.8m diameter and 4.8m length, surrounded by concrete which showed visible signs of hydrocarbon impact. One chamber was foam filled, the other was empty.
- Tank B: a single skin, three chambered, steel tank of 2.8m diameter and 9.0m length, surrounded by concrete which showed visible signs of hydrocarbon impact. All three chambers were foam filled.
- Tank C: a single skin, three chambered, steel tank of 2.8m diameter and 9.0m length, surrounded by concrete which showed visible signs of hydrocarbon impact. All three chambers were foam filled.

Samples of the Made Ground and Alluvium surrounding and below the tank were collected for laboratory analysis. A trial trench (TP101) was also excavated for some 6m to the south-east of the former tanks to investigate the extent of hydrocarbon impact on the shallow soils. A PID was used throughout the exercise to measure in-situ levels of hydrocarbon vapours.

The GIL trench position is presented on Figure 4, and the GIL validation report is presented in Appendix E.

2.4.5 Ground Investigation Ltd, November 2007a

Ground Investigation Ltd were appointed by the previous developer of the site in 2007 to undertake validation of the excavation following the removal of the underground fuel tanks on the Council depot in the centre of the site.

Preciously two tanks had been reported in the area of former fuel pumps in the centre of the former Council yard (see Figure 3a). Excavation prior to GIL's involvement apparently identified a single, foam filled, two chamber tank of single skin, steel construction (Tank 1) and 2.8m diameter and 7.8m length. Further investigation by GIL failed to identify a second tank in the area and it was postulated that the double tank was misinterpreted as a two separate tanks.

As the excavation had not been validated following the removal of the tank, GIL excavated two trial pits in the area of the excavation and identified a reinforced concrete surround to the former tank to a depth of 3.5m. Further excavation was undertaken in the area of a suspected second underground fuel tank (Tank 2) beneath the former Council building just to the south-west of Tank 1. A brick-lined, sand-filled bund was identified on a basal concrete slab from 2.2 to 3.4m depth, which was postulated to be the enclosure of the former Tank 2 which was reportedly removed in the 1980s.

Samples of the soils around the former tanks were collected and analysed for petroleum hydrocarbons and a screen of contaminants typically found on brownfield sites in the UK.

The GIL trial pit positions are presented on Figure 4, and the GIL validation report is presented in Appendix F. It should be appreciated that for the purposes of this report the trial pits excavated in this phase of works have been renamed as follows:

- Tank 1, Pit 1 (GIL, 2007a) becomes TP1/1.
- Tank 1, Pit 2 (GIL, 2007a) becomes TP1/2.
- Tank 2, Pit 1 (GIL, 2007a) becomes TP2/1.

2.4.6 Ground Investigation Ltd, November 2007b

Ground Investigation Ltd were appointed by the previous developer of the site in 2007 to undertake an investigation of an old tar tank in the north-west of the former Council depot part of the site – see Figure 3a.

No historical record of the tar tank had been identified, but it was found to be semi-circular in shape, some 6.2m in depth and 3m in diameter. It was filled with a tar-like liquid, and 660 litres of the liquid were pumped out and disposed of off-site. Prior to disposal, sampling and analysis was undertaken to determine the chemistry of the tar.

Further monitoring wells were installed around and down-hydraulic gradient of the tank to allow monitoring and sampling/analysis of the groundwater in the area.

The GIL well positions are presented on Figure 4, and the GIL validation report is presented in Appendix G.

2.4.7 Ground Investigation Ltd, November 2007c

Ground Investigation Ltd were appointed by the previous developer of the site to undertake a further, detailed assessment of potential pollution risks to controlled waters from contaminants present beneath the former petrol filling station (PFS) in 2007.

The further investigation included the excavation of further trial pits (TP201 to TP208) and the installation and monitoring of groundwater wells (WS101 to WS107) with response zones generally within the Fluvio-glacial Gravels. The results of the monitoring and testing were used in a Level Two and Level Three assessment of risks to controlled waters (and particular the River Afan).

The GIL borehole and trial pit positions are presented on Figure 4, and the exploratory hole records, and monitoring of the installed wells and the laboratory test results (on groundwater samples) are presented in Appendices H1, H2 and H3 respectively.

2.4.8 Lee Remediation Ltd, July 2008

Lee Remediation Ltd (LRL) were appointed by Jehu Project Services to provide a further assessment of contamination risks and recommendations for remediation on the former petrol filling station area of the site in 2008 following GIL's investigations and recommendations for remedial works.

The assessment mainly comprised a review of the previous investigations in the area, however, one additional trial trench and seven trial pits were excavated to observe and sample the shallow soils in the area. The LRL trial pit positions are presented on Figure 4, and the exploratory hole records and laboratory test results (on soil samples) presented in Appendices I1 and I2.

2.4.9 Note on the Use of Previous Investigation Data

The GIL investigation of 2004 was undertaken whilst the Council depot was still in use and the petrol filling station was still in place (although closed). Since that time, all former above ground structures have been removed and the site surface has been apparently regraded substantially (Plate 3). All depths referred to from previous investigations relate to the ground levels at the time of the investigations, and are likely to differ from the present ground levels. We are not aware of any up to date topographic survey which could be used to correlate strata depths etc. to current ground levels.

2.5 Geology

2.5.1 Published Geology

The published geological map for the area of the site (1:10,560 scale, SS78NE) indicates the site to be underlain by Estuarine Alluvium overlying bedrock of the Llynfi Beds of the Upper Coal Measures. Our local knowledge suggests that glacial soils are likely to lie between the alluvium and the bedrock to a depth of around 20 to 25m.

Reference to the up-to-date mapping available on the website of the British Geological Survey (BGS, June 2015) indicates a similar succession, but the Estuarine Alluvium is renamed Tidal Flats Deposits.

2.5.2 Records of Previous Investigation

As discussed in Section 2.4 and shown on Figure 4, a large number of boreholes and trial pits have previously been completed on the site during the various phases of investigation.

The ground conditions across the site are summarised by GIL (2004 and 2007c) as follows:

- **Made Ground:** present to depths between 1.3 and 3.3m (beneath the then ground level), and comprising predominantly coarse-grained materials dominated by sand and gravels but with some cobbles and boulders, with many fragments of brick and concrete. Fragments of ash, timber, rope, clinker, steel sheet, coal and pottery were identified. Old in-situ foundations were observed in TP2 and several pits identified a series of old floor slabs. Slag gravel was identified in places and large quantities of brick and masonry were identified in some exploratory holes.
- **Probable Old Pond Deposits:** encountered in the centre of the site (WS2, WS3a and BH2) immediately beneath the Made Ground at depths of 1.4m (WS3a) and 2.5m (BH2, WS3a) as a 0.2 to 1.0m thick band of a brown, peaty silt and clay of soft consistency with gravel and fragments of brick, concrete, coal and ash. Given the nature and location of the strata we concur with GIL's postulation that this material is likely to represent an old pond deposit.
- **Tidal Flat Deposits (formerly Estuarine Alluvium):** encountered beneath the Made Ground (and Old Pond Deposits) at depths of 1.5 to 3.3m and comprised predominantly silt/clay. An initial 0.6 to 1.0m thick desiccated crust of firm or soft-to-firm consistency was present in places over alluvial clays of very soft, soft or soft-to-firm consistency. The clay was blue grey in colour with oxidized brown rootlets traces. The alluvial clay layer was found to be of total thickness (including the desiccated crust) of between 1.2 and 3.0m and was laminated with bands and lenses of sand and gravel, with some sand bands up to 500mm thickness.
- **Fluvio-glacial Gravels:** encountered in the area of the petrol filling station beneath the Tidal Flat Deposits from proven depths of between 3.2 and 5.0m. The stratum comprised a silty sand and gravel with some cobbles.

The summary of the stratum beneath the Council Yard is not included in the copy of the GIL (2004) report provided for review, however, based on the presented exploratory hole records, the gravels are present at depths of between 3.6 and 4.7m. A particle size analysis on the stratum from BH1 indicated it to comprise 77% medium coarse gravel, 13% cobbles, 8% sand and only 2% silt and clay, with a D_{10} value (the size below which 10% of the particles were identified) of 0.4mm.

2.6 Hydrogeology

2.6.1 Aquifer Classification

Reference to the aquifer maps published on the Environment Agency website (EA, June 2015) indicates that the superficial deposits beneath the site (Tidal Flat Deposits) are classed as a Secondary Undifferentiated Aquifer, whilst the bedrock (Coal Measures) are classed as a Secondary A Aquifer.

Secondary A Aquifers generally correspond with the previously classified minor aquifers, and comprise permeable layers capable of supporting water at a local, rather than strategic, scale and in some cases form an important base flow to rivers. Secondary A Aquifers are sensitive to pollution.

Secondary Undifferentiated Aquifers are assigned by the Environment Agency where it has not been possible to categorise an aquifer in either Secondary A or B. In most cases this is attributable to a unit being classified as both minor and non-aquifers in different locations due to the variable characteristics of the rock type. These strata can be sensitive to pollution.

2.6.2 Abstractions and Groundwater Vulnerability

The environmental data report and the groundwater resource maps on the EA website (EA, June 2015) indicate that there are no groundwater abstractions or Source Protection Zones within 1km of the site.

The groundwater vulnerability is shown by the Environment Agency (EA, June 2015) to be 'minor aquifer high'

2.6.3 Groundwater Bodies Identified in Previous Investigations

The groundwater bodies encountered in the previous investigations are summarised by GIL (2004 and 2007c). A moderate to fast inflow was generally recorded in the upper horizons of the Fluvio-glacial Gravels at depths of between 3.7 and 4.6m. On encountering water, the levels rose by between 100 and 800mm in 10 to 20 minutes.

Monitoring of installed wells indicated groundwater levels at 2.6 to 4.2m depth, with monitoring on the petrol filling station site (the closest part to the River Afan) suggesting only limited tidal impact on the groundwater beneath the site.

2.6.4 Groundwater Movement

Groundwater movement within the Tidal Flat Deposits and underlying glacial soils will be controlled by intergranular flow, whilst in the Coal Measures bedrock fracture flow is likely to be dominant.

GIL (2004) used the results of monitoring to identify a general hydraulic gradient across the site, and suggested groundwater flows to the south/south-west with a hydraulic gradient of 0.003. Subsequent monitoring of wells installed following the discovery of the tar tank in September 2007 confirmed a groundwater flow towards the south/south-west, with a hydraulic gradient of around 0.002 (GIL, 2007b). Similar monitoring of wells around the former petrol filling station in the east in October 2007 similarly confirmed suggested groundwater flows to the south-west with a hydraulic gradient of 0.002. Therefore, it would seem reasonable to assume a groundwater flow to the south-west at a hydraulic gradient of 0.002 for the whole site in 2007.

Given the groundwater flow direction and site setting, we consider that the groundwater beneath the site may be providing base flow to the River Afan.

2.7 Environmental Setting

The site exists in a historically industrial, and current urban setting. An environmental data report has been obtained for the site and is presented in Appendix B. The salient data is summarised in Table 2 below.

Table 2: Summary of Environmental Data

Item	On the Site	In the Immediate Vicinity
Sensitive Land Uses (SSSI, Nature Reserves, SAC etc.)	None identified.	None recorded within 1km of the site.
Discharge Consents	None identified.	No Red List Discharge Consents recorded within 1km of site. Eight licensed discharge consents within 50m, associated with discharges via culverts and overflows probably to River Afan. Most have now expired.
Pollution Incidents	None identified.	The only recorded incident within 100m of the site was a discharge of food and drink matter to land in September 2001, some 60m to the south-east, classed as a Category 3 (minor) impact to land.
Environmental Permits	None identified.	None recorded within 500m of the site.
Historical Industrial Land	The site was formerly occupied by a tin plate works, a Council yard and a petrol station ¹ – see further Sections 2.2 and 3.2.	The site was formerly located in an industrial area and many past industrial sites are located in the vicinity including a chemical works, abattoir, slaughter house, iron foundry, railway land and unspecified works. See Sections 2.2.
Current Industrial Land	The site is current undeveloped ² .	Nearby current industries include curtain and blind manufacture, a tyre depot, electronic equipment, and containers and storage.
Waste Management Facilities	None identified.	A scrap yard was formerly located some 100m to the east and a recycling centre some 200m to the south-east (to the south-east of the river).

Notes to Table 2:

1. The environmental data report indicates the presence of a dock on the site on historical maps dating from 1914 and 1921. No evidence of such a dock has been observed on historical maps obtained as part of this assessment – see Section 2.2 and Appendix A.
2. The environmental data report indicated that the Afan Way Service Station (petrol filling station) is present on site. As discussed in Section 3.2.1, this closed in 2004 and the infrastructure was removed in 2006.

3.0 CONCEPTUAL SITE MODEL

3.1 Background

The following Conceptual Site Model lists the potential sources of geo-environmental risk, the receptors at risk and the pathways between the two, and has been prepared based on the desk study information (historical maps, environmental data report) and available information from previous investigations (including ground and groundwater conditions, laboratory test results etc.). These are discussed in the following sections.

3.2 Potential Sources of Contamination

Given the past industrial use of the site, a number of former contamination sources have been identified as listed in Table 3 and shown on Figure 5. The critical sources are discussed further in the following sections.

Table 3: Potential Sources of Contamination

Source Ref	Source Type	Location on Site	Status	Comments
S1	Underground fuel tank ¹	Former Petrol Filling Station	Removed from site in 2006	GIL Tank A. See below.
S2	Underground fuel tank ¹	Former Petrol Filling Station	Removed from site in 2006	GIL Tank B. See below.
S3	Underground fuel tank ¹	Former Petrol Filling Station	Removed from site in 2006	GIL Tank C. See below.
S4	Underground fuel tank ¹	Former Council Yard (central area)	Removed in 2007	GIL Tank 1. See below.
S5	Underground fuel tank ¹	Former Council Yard (central area)	Probably removed in 1980s.	GIL Tank 2. See below.
S6	Underground tar tank ¹	Former Council Yard (northern area)	Emptied in 2007.	GIL 'tar tank'. See below.
S7	Above ground fuel tank ¹ (red diesel)	Former Council Yard (southern area)	Not present in 2004.	Anecdotal evidence only. No further information
S8	Above ground 'turps' tank ¹	Former Council Yard (southern area)	Not present in 2004.	Anecdotal evidence only. No further information
S9	Above ground tank – unspecified contents ¹	Former Council Yard (western area)	Not present in 2004.	Shown on historical map of 1950. No further information
S10	Above ground tank – unspecified contents ¹	Former Council Yard (central area)	Not present in 2004.	Shown on historical map of 1950. No further information
S11	Underground fuel supply lines ¹	Former Petrol Filling Station	Present in 2004. May have been removed	
S12	Underground fuel supply lines ¹	Former Council Yard (central area)	No information.	Postulated only.
S13	Backfilled Pond	Former Council Yard (central area)	Backfilled prior to 1917.	Shown on historical map of 1899. No further information

Table 3: Potential Sources of Contamination (cont)

Source Ref	Source Type	Location on Site	Status	Comments
S14	Historical Tank	Former Council Yard (central area)	Not present in 2004.	Shown on historical map of 1939. No further information
S15	Electricity Substation	Former Council Yard (southern area)	Identified in 2004.	Shown on historical map from 1975. No further information
S16	General Made Ground	Across site.		

Notes to Table 3:

1. Includes soils and groundwater impacted around tanks.

3.2.1 Former Petrol Station – Tanks A to C (Sources S1, S2, S3 and S11):

GIL (2004) provide a summary of the history of the petrol filling station formerly located in the east of the site.

At the time of the 2004 investigation, the petrol station had closed but the infrastructure remained, comprising three pump islands (although the pumps had been removed), a tank farm in the north-west, a car wash and a kiosk. A copy of the former petrol station layout has been provided by NPTC and is presented in Figure 3b.

The underground fuel storage tanks were reportedly installed in 1991 and reportedly comprised three steel tanks of around 3m diameter, two with three chambers, and one with two chambers. Photographs within the Ecologia report apparently suggest the tanks were founded at around 3 to 4m depth bgl.

As discussed in Section 2.2.2, the petrol station is believed to have ceased trading in early 2004 and a 'certificate of inertion' provided in the GIL (2004) report indicates that the following tanks were filled with RG22 foam in June 2004:

- 3 no 4,000 gallon (18,200 litre) tanks;
- 2 no 3,000 gallon (13,650 litre) tanks; and
- 1 no 9,000 gallon (40,950 litre) tank.

These appear to represent six of the eight chambers in the three reported tanks. No details are provided on the filling of the other two chambers. GIL report that the Local Authority Petroleum Officer indicated that he was satisfied with the decommissioning of the tanks.

The tanks were removed from site in December 2006 by the previous developer, and GIL undertook an investigation of the surrounding soils immediately after removal (GIL, 2006). The excavated tanks were indicated to comprise:

- **Tank A:** double chambered, single skin, steel, tank of 2.8m diameter and 4.8m length, located within a concrete surround. The southern chamber was filled with foam whilst the northern chamber was empty.
- **Tank B:** a three chambered, single skin, steel tank of 2.8m diameter and 9.0m length, located within a concrete surround. All three chambers were filled with foam.
- **Tank C:** a three chambered, single skin, steel tank of 2.8m diameter and 9.0m length, located within a concrete surround. All three chambers were filled with foam.

The tank types on removal correlates with the information from installation (see above).

Nearby exploratory holes indicate the Fluvio-glacial Gravels to be present at depths of between 3.5m (TP4) and 4.8m (BH E1) so, given a tank diameter of 2.8m, we consider that the concrete base for the tanks is likely to have been founded on the Fluvio-glacial Gravels.

Following removal, hydrocarbon staining was observed by GIL on the concrete and in the surrounding fine-grained alluvium. Water with a slight hydrocarbon staining was observed at 2.2 to 3.0m depth.

Readings taken with a PID in the surrounding Made Ground and fine-grained alluvial soils were generally 50ppm or below, however, an elevated level of volatile organic compounds (VOCs), which include volatile petroleum hydrocarbons, of 1,876ppm was recorded in the alluvium at 2.3m depth some 6m from the tank excavation in soils which displayed a strong hydrocarbon odour (Sample S7).

Four samples of alluvium around and below the tanks were analysed and evidence of petroleum hydrocarbons, including BTEX compounds (benzene, toluene, ethylbenzene, xylene) and MTBE (an additive to unleaded petrol) were identified in all four samples, with particularly high levels of BTEX compounds within Sample S7 (which indicated a high PID reading and strong hydrocarbon odours).

In our experience, the fuel supply lines running between the tanks and the pumps are commonly a source of leakage of petroleum. These are generally located just under the surface (less than 500mm depth) and their reported positions on the petrol filling station are shown on Figure 3b.

Investigations in 2004 and 2007 around the petrol filling station identified a significant impact on soils and groundwater in the vicinity by petroleum hydrocarbons. The evidence reported by GIL (2006 and 2007c) are summarised in Table 4, along with the observations made by LRL in 2008.

Table 4: Reported Evidence of Hydrocarbon Impact in Exploratory Holes

Expl Hole	Depth (m)	Location on PFS	Strata	PID Reading (ppm)	Nature of Contamination
2002 Investigation (Ecologia)					
E1	1.7 – 3.0	Northern margins	Alluvium	37 – 64	HC odour.
	2.8		Alluvium	n/a	180mm free phase on groundwater.
E4	2.0 – 5.0	South-western boundary.	Alluvium & FGG	222 – 3,364	Strong HC odour in alluvium.
	4.2		FGG	n/a	Up to 1.3m of free phase HC identified on groundwater.
E6	3.1 - 3.8	South-eastern margins	FGG	n/r	Strong organic odour.

Table 4: Reported Site Evidence of Hydrocarbon Impact in Exploratory Holes (cont.)

Expl Hole	Depth (m)	Location on PFS	Strata	PID Reading (ppm)	Nature of Contamination
2004 Investigation (GIL)					
TP1	2.1 – 2.7	Southern margins – adjacent to pump island.	Alluvium	10 – 75	HC staining within sand bands. No noticeable staining on clay.
TP2	3.8	Western corner, close to tanks.	FGG	0	HC film on groundwater.
TP5	1.9 – 2.7	South-eastern margins, adjacent to pump island	Alluvium	106 – 360	HC odour associated with peat.
	2.7 – 4.0		Alluvium	105 – 678	HC staining within sand bands. No noticeable staining on clay.
	4.1		FGG	22 – 60	HC film on groundwater.
2006 Investigation (GIL – tank removal)					
TP101	GL – 1.6	Tanks to pump islands	Made Ground	55	None observed.
	1.9 – 2.5		Alluvium	120 - 870	Strong HC odour.
2007 Investigation (GIL)					
TP201	2.1 – 2.6	Middle of pump islands.	Alluvium	32 – 55	HC staining and strong odour.
TP202	1.65 – 2.5	Northern margins.	Alluvium	8.5 – 49	HC staining and strong odour.
TP205a	1.7 – 2.5	South-western boundary. Adjacent to Borehole E4	Alluvium	32 – 67	Strong HC odour.
	2.5 – 3.0		Alluvium	525	Saturated with HC, Very strong odour.
TP205b	1.8 – 2.3	South-western boundary. Adjacent to Borehole E4	Alluvium	6 – 48	Strong HC odour.
	2.3 – 2.6		Alluvium	360	Saturated with HC, Very strong odour.
TP207	1.8 - 2.6	10m to south-west of PFS.	Alluvium	244 - 250	Strong HC odour.
2008 Investigation (LRL)					
LP2	2.2 – 3.1	Northern margins.	Alluvium	652	Free product ingress at 2.3m, HC ‘impacted’ clay.
LP7	3.3	Pump islands, adjacent to BH E6	Alluvium	n/r	Free phase ingress at 3.3m.

Notes to Table 4:

1. Ecologia depths approximate only and taken from borehole records.
2. PFS: Petrol Filling Station.
3. PID: Photo-ionisation detector, measures levels of volatile organic compounds, including petroleum hydrocarbons.
4. HC: petroleum hydrocarbon.
5. FGG: Fluvio-glacial Gravels.

It should be noted that although the above exploratory holes identified contamination of shallow soils and groundwater by petroleum hydrocarbons several of the exploratory holes have identified no evidence of such contamination (e.g. E3 and LT1 adjacent to the former tank farm, LP6 in the centre of the former pump islands and close to the fuel supply pipes, and TP3 and TP4 in the north of the site).

Lee Remediation (2008) postulate that there are two sources of petroleum contamination beneath the site:

- **Source A:** diesel contamination of the soils and groundwater in the north of the site, around Borehole E1 and LP2. This is based on 180mm free phase on the groundwater in Borehole E1 (in 2004), up to 10,000mg/kg of >C₁₀ (mainly aliphatic) petroleum hydrocarbons in the soils, and up to 18mg/l of dissolved phase >C₁₂ aliphatic hydrocarbons in the groundwater.
- **Source B:** petroleum contamination of the soils and groundwater in the south-west of the former petrol station, concentrated around Borehole E4, TP205a, TP205b and LP7. This is based on up to 1.3m thickness of free phase product on the groundwater in Borehole E4 and up to 400mg/kg of petroleum range hydrocarbons in the soils. The presence of MTBE in the free product suggests an unleaded fuel source.

A third area of minor contamination of the alluvial soils by petroleum hydrocarbons around TP5, to the east of the pump islands, was also identified.

GIL (2004 and 2007) suggest that the very large thickness of free product within the well in Borehole E4 may be the results of the well acting as a sump draining sand lenses within the alluvial soils and, therefore, may not be representative of the general levels of contamination in the area.

The most likely original sources of the petroleum contamination (the fuel tanks) were removed in 2006 (nine years ago). Monitoring shortly after this date (2007 and 2008) indicated remnant impacts on the soil and groundwater in the area, which may pose an unacceptable risk to human health and controlled waters. These risks are assessed further in Sections 3.7 and 3.8.

Based on the above and published guidance, the particular potential contaminants of concern in the area of the former petrol station would be:

- Petroleum hydrocarbons aliphatic/aromatic C₆₋₃₅ compounds, including benzene, toluene, ethylbenzene and xylenes.
- MTBE.
- Lead and copper;
- Polyaromatic hydrocarbons (PAH);
- Asbestos;
- Ethylene glycol (antifreeze); and
- Chlorinated solvents.

3.2.2 Council Yard – Tanks 1 and 2 (Sources S4, S5 and S12):

During their 2004 investigation, GIL indicated the presence of a pump island with three fuel pumps in the centre of the yard – see Figure 3a. GIL (2004) reported that Council staff indicated that the fuel tanks were, at that time, located beneath the pump island, however, previously they had been located beneath a covered area on the eastern side of the former tinplate works building. These were reportedly relocated to the area in the centre of the Council yard in the mid-1980s to allow the construction of a two-storey office block. Anecdotal evidence suggested that the original tanks were not excavated and removed.

GIL (2004) also report that the tanks beneath the pump island were investigated by a specialist petroleum consultancy in 2004 (whilst still in operation) which revealed:

- One single chamber tank of 5,000 gallons (22,730 litres) containing unleaded fuel; and
- One double chamber tank, split into a 3,000 gallon (13,637 litres) chamber containing diesel (DERV) and a 2,000 gallon (9,093 litres) chamber containing gas oil (red diesel).

Both tanks were reportedly 2.74m in diameter with a cover of around 740mm. Therefore, based on these dimensions, the base of the tanks would be expected to be at around 2.5m bgl.

The fuel tanks in the Council Yard were removed by the previous developer in September 2007. GIL (2007a) attended site after their removal in order to investigate the soils beneath and around the former underground tanks. Only one tank was identified in excavations as follows:

- **Tank 1:** a double chamber, single skin, steel tank of 2.8m diameter and 7.8m length founded in a concrete surround, which had been filled with foam. No decommissioning certificates have been identified.

The tank had been cut following excavation, so additional chambers cannot be discounted, and GIL considered that only one tank was present beneath the pump island.

The tank excavation was re-excavated and no evidence of petroleum hydrocarbons was identified in the surrounding and underlying alluvial soils either visually or with the PID.

The excavation indicated the Fluvio-glacial Gravels to be present at a depth of around 3.0m so, given a tank diameter of 2.8m, we consider that the base of Tank 1 is likely to have been within the Fluvio-glacial Gravels.

A further excavation was undertaken by GIL at the reported position of the former tank, beneath the eastern side of the former tinplate works building (which had been demolished by 2007). This tank was named as 'Tank 2' by GIL, and a brick-lined, sand-filled bund was identified on a basal concrete slab from 2.2 to 3.4m below ground level. In our experience, this is typical of underground fuel tank constructions dating from the 1950s/1960s. No tank was identified and appears to have been removed previously (possibly in the mid-1980s when the office block was built). A slight hydrocarbon staining and odour was observed in the sand within the excavation, but no VOCs were identified using the PID.

The excavation indicated the Fluvio-glacial Gravels to be present at a depth of around 2.7m so, given a tank diameter of 2.8m, we consider that the base of Tank 2 is also likely to have been within the Fluvio-glacial Gravels.

Three samples of the surrounding Made Ground and fine-grained alluvial soils were analysed for a similar range of petroleum hydrocarbons to those on the petrol filling station, plus a range of contaminants typically found on brownfield sites in the UK. It should be noted that for the purposes of this assessment, the pits have been renamed as follows:

- TP T1/1: Tank 1, Pit 1;
- TP T1/2: Tank 1, Pit2; and
- TP T2/1 Tank 2, Pit 1.

The available laboratory testing indicated no evidence of BTEX or MTBE compounds, and no aliphatic or aromatic petroleum hydrocarbons below C₁₂. Low levels of C₁₂₋₁₆ aromatic hydrocarbons and C₁₆₋₂₁ and C₂₁₋₃₅ aromatic and aliphatic compounds.

The original source of the petroleum contamination (the tanks) was removed in the mid-1980s (apparently) and in 2007 (eight years ago). Monitoring at that time (2007) indicated limited impact on the soil and groundwater in the area, however, this impact could still pose an unacceptable risk to human health and controlled waters. These risks are assessed further in Sections 3.7 and 3.8.

Based on the above and published guidance, the particular potential contaminants of concern in the area of the former Council Yard underground tanks and fuel pumps would be:

- Petroleum hydrocarbons aliphatic/aromatic C₆₋₃₅ compounds, including benzene, toluene, ethylbenzene and xylenes.
- Lead;
- Polyaromatic hydrocarbons (PAH); and
- Chlorinated solvents.

3.2.3 Underground Tar Tank – Source S6

During construction of the existing portal frame structures on site, an old, previously unidentified, tar tank was discovered. As discussed in Section 2.4.6, no historical record of the tar tank had been identified, but it was found to be semi-circular in shape, some 6.2m in depth and 3m in diameter. It was filled with a tar-like liquid, and 660 litres of the liquid were pumped out and disposed of off-site. On removing the tar contents, the groundwater responded suggesting the base of the tank is in hydraulic connection with the groundwater within the Fluvio-glacial Gravels.

Prior to disposal, sampling and analysis was undertaken by GIL (2007b) to determine the chemistry of the tar, which was found to have comprised predominantly higher carbon band petroleum compounds above C₂₁ (around 29%), with a trace of C₁₆₋₂₁ hydrocarbons.

No BTEX, volatile organic (VOC), semi-volatile organic (SVOC) or PCB compounds were detected. These results suggest that the liquid was a tar or pitch type substance, and it was postulated by GIL that it was used for the preservation of timbers.

Five monitoring wells were installed within the site boundary on the down-hydraulic gradient (south) side of the tank (DH1 to DH4, DH6) and one installed up hydraulic gradient of the tank (DH5). The positions of the wells are shown on Figure 4. Sampling and analysis of the groundwater from these wells has indicated no detectable levels of BTEX, VOC, SVOC or PCB contamination in the groundwater to the south of the old tank, but has identified low levels (marginally above the EA stipulated assessment criteria value of 10µg/l) of C₁₂₋₁₆ aromatic hydrocarbons in the groundwater to the south-west (DH2) and C₁₆₋₂₁ aromatic compounds in the groundwater to the south (DH2, DH4 and DH6). C₁₆₋₂₁ aliphatic hydrocarbons were also identified in DH6 (on the western boundary) and C₂₁₋₃₅ compounds were elevated in all wells, but were significantly more elevated in DH6 (the well further down hydraulic gradient).

The original source of any petroleum contamination (the contents of the tar tank) was removed in 2007 (eight years ago). At the time of the investigation, the water remained within the tar tank structure. We have no information on whether the tar tank structure and any remnant tar contamination therein was removed.

Monitoring at the time of discovery (2007) indicated limited impact on the groundwater in the area, and the Contaminated Land Officer at the time (NPTC) was satisfied that following the works undertaken, there would be no further risk to human health, and subject to the remaining tank content is removed (believed to be tar stained water), she would have had no objection discharging the associated planning condition – see Appendix G. She also recommended that the Environment Agency be consulted.

Based on the above and published guidance, the particular potential contaminants of concern in the area of the former tar tank would be:

- Petroleum hydrocarbons aliphatic/aromatic C₁₈₋₃₅ compounds;
- Polyaromatic hydrocarbons (PAH).

3.2.4 Above Ground Tanks – Source S7 to-S10

Four above ground tanks have been identified within the former Council Yard on historical maps or through anecdotal evidence (including fuel and ‘turps’ tanks in the south). No information has been found on these tanks and no specific investigation has been undertaken in the areas, apparently mainly due to access restrictions at the time of the investigation. However, nearby boreholes (e.g. WS5 close to Source S9, and WS2 and WS3 near Source S10) have not identified any significant evidence of contamination.

Based on the above and published guidance, the particular potential contaminants of concern in the area of the former Council Yard above ground tanks would be:

- Petroleum hydrocarbons aliphatic/aromatic C₆₋₃₅ compounds, including benzene, toluene, ethylbenzene and xylenes;
- Chlorinated solvents; and
- Polyaromatic hydrocarbons (PAH).

3.2.5 Former Pond, Above Ground Tank, Sub-station and General Made Ground– Sources S13 to S16

Evidence of the former pond has been identified in Boreholes WS2, WS3a and BH2 constructed in the Council Yard (see Section 2.5.2). The pond backfill comprises predominantly slag and ash gravel with some brick and concrete fragments, with some suspected asbestos materials identified.

No information on or evidence of the above ground tank in the former pond area has been identified. However, no exploratory holes have been constructed in this area to date.

No visual or olfactory evidence of contaminants was identified within the pond backfill or the general Made Ground across the site. However, given these soils include man-made materials and the site has been used for industrial purposes for over 100 years, the presence of isolated pockets of contaminants cannot be discounted. Such a pocket may be present in the north of the site around Borehole BH1, where petroleum hydrocarbons predominantly from the range C₁₆₋₃₅ were identified at 1.5 to 2.0m depth in the Made Ground. The source of this contamination is not clear. Therefore, the presence of contaminants at levels which could pose an acceptable risk to human health and controlled waters cannot be discounted. These risks are assessed further in Sections 2.7 and 2.8.

Based on the above and published guidance, the particular potential contaminants of concern in the area of the general Made Ground would be:

- Petroleum hydrocarbons aliphatic/aromatic C₆₋₃₅ compounds;
- Heavy metals, including tin;
- Polyaromatic hydrocarbons (PAH);
- Sulphur compounds;
- Ammonium;
- Asbestos; and
- Chlorinated solvents.

An electricity sub-station was located in the south-west of the site. Potential contaminants in the shallow soils in this area could include petroleum and polyaromatic hydrocarbons and PCBs.

3.3 Potential Sources of Hazardous Ground Gas

The site is not located within 250m of an existing or former recorded landfill. However, the site history suggests that the site has been reclaimed from the estuary of the River Afan and its past contaminative use could have led to the creation of the following potential sources of hazardous ground gases:

- Hydrocarbon impacted soils and groundwater, particularly around past above and below ground fuel storage tanks. Petroleum hydrocarbon vapours may be present, and as hydrocarbons degrade they can generate combustible and noxious gases (e.g. methane and carbon dioxide);
- The backfill of a historic pond (dating from prior to 1917), beneath the central part of the site – see Figure 3a. Any organic materials within the backfill or in the basal Old Pond Deposits could be generating combustible and noxious gases (e.g. methane and carbon dioxide);
- The general Made Ground, identified to depths of up to 3.3m beneath the site. Any organic materials within the backfill could be generating combustible and noxious gases (e.g. methane and carbon dioxide);
- The underlying Tidal Flat Deposits - organic layers within the alluvium could generate combustible and noxious gases.
- Chlorinated solvents - unweathered solvents can generate hazardous volatile organic vapours, whilst combustible and noxious gases can be generated as they degrade.

Based on the guidelines presented by Wilson et al (2009), the above potential gas sources would generally be classified as of very low/low gas generation potential. However, areas of hydrocarbon impacted soils or groundwater could be classed as moderate to high gas generation potential

As discussed in Section 2.5.1, the site is underlain by bedrock of the Upper Coal Measures bedrock, which contains several seams of coal (and bands of ironstone). A mining report has been obtained from the Coal Authority and is presented in Appendix J. This indicates that based on the available Coal Authority records:

- The property is not within the zone of likely physical influence on the surface from past underground workings.
- The property is not within the likely zone of influence of any present underground coal workings.
- There are no known coal mine entries within, or within 20m of, the boundary of the site.
- There are no recorded claims within 50m of the site boundary.

Based on the above, we consider that the risk from hazardous gas originating from abandoned mine workings beneath the site is low.

3.4 Potential Sources of Radon

Radon is a colourless, odourless, radioactive gas, which can pose a risk to human health. It originates in the bedrock beneath the site, where uranium and radium rich minerals are naturally present, and can move through fractures in the bedrock, and overlying superficial deposits, to collect in spaces within/beneath structures.

Reference to the UK radon maps published by Public Health England (PHE, June 2015) indicates that the site lies in an area classified as a maximum radon potential of between 1 and 3%. These maps indicate the worst level of radon potential, based on existing information gathered mainly from residential properties within the 1km square in which the site is located. It is designed as a preliminary evaluation only.

Reference to BRE 211 (Scivyer, 2007) indicates that the site lies in a 1km square where no radon protection measures are required for new buildings (domestic or non-domestic).

The recent environmental data report suggests that the site does not lie in a radon affected area.

3.5 Potential Receptors

As discussed in Section 1.1, the proposed site development will comprise retail units in the south and residential properties with private gardens, landscaping and vehicle parking areas in the north. The site is located some 80m from the River Afan and above a Secondary Undifferentiated Aquifer.

The most vulnerable receptors with regards to any contamination or hazardous ground gas present are considered to be:

- Future residents in the north, the critical receptors being young children playing in private garden areas;
- Future employees and site visitors (e.g. shoppers) in the south, the critical receptors being employees outside during their break periods;
- Construction and maintenance workers;
- Buried concrete; and
- The surface water in the River Afan.

It should be noted that the currently proposed development includes more vulnerable human receptors (residents) than in the previous development proposals (retail only) and a potential increased level of risk from any contamination present.

3.6 Potential Migration Pathways

The following are considered the most likely migration pathways with regard to any contamination or hazardous ground gas present beneath the site.

Site Users:

- Ingestion of soils and inhalation of dust in garden areas.
- Ingestion of soils and inhalation of dust in landscaping areas.
- Ingestion of edible plants and dust associated with such plants.
- Dermal contact with contaminated soils.
- Exposure to asbestos containing materials within the shallow soils.
- Potential explosive risk from flammable ground gas/vapours on site.
- Potential explosive risk from toxic ground gas/vapours on site.
- Chronic exposure to unacceptable levels of radon.
- Organic contaminants permeating from soils and groundwater into plastic water supply pipes.

Construction and Maintenance Workers:

- Exposure to asbestos containing materials within the shallow soils;
- Ingestion of soils and inhalation of dust across site.
- Dermal contact with contaminated soils.
- Potential explosive risk from flammable or toxic ground gas/vapours from on-site sources.

River Afan:

- Leaching of mobile contaminants to the groundwater beneath the site, and then on to the nearby surface water course.

Buildings:

- Sulphate attack on buried concrete.
- Potential explosive risk from flammable ground gas/vapours from on-site sources.

3.7 Risks to Human Health

3.7.1 Background

As discussed previously the assessments of human health risk undertaken previously by GIL (2004) were based on a retail land use and were completed in 2004. The proposed land use (including residential) is more sensitive to contamination than the previously proposed retail use (which formed the basis of the previous assessment) and, since 2004, UK assessment criteria have been updated significantly. Therefore, a new assessment of the chronic (long term) risks to health has been undertaken for the proposed development using current assessment criteria.

As discussed in Section 1.2, the reader should be aware that the following assessment has been undertaken on data collected in 2002 to 2008, and much of it prior to demolition of the previous structures. Therefore, the data assessed may not be representative of the levels and distribution of contamination across the site at the present time (particularly from asbestos- see Section 3.7.4).

Notwithstanding the above, we consider a reassessment of the available data for the newly proposed site use is warranted and provides an indication of the risks which are likely to be present.

3.7.2 Methodology

This assessment has used the laboratory test data presented in the previous investigation reports and methodologies and frameworks determined by the Environment Agency within documents SR2, SR3, SR4 and the CLEA Technical Review published to support the Contaminated Land Exposure Assessment Model (CLEA). Where applicable, reference has been made to the supporting toxicological reports (TOX Series) and the Soil Guideline Value reports (SGV Series). It is assumed that the reader is familiar with the above documents and it is not intended to repeat these described methodologies in detail, for further information, please refer directly to the specific documents.

In order to provide an initial 'screen' to identify elevated levels of contaminants, a Generic Quantitative Risk Assessment (GQRA) has been undertaken using the most appropriate Generic Assessment Criteria (GAC) determined by assessment of exposure frequency/duration relevant to the critical receptor.

3.7.3 Assessment Criteria

In 2014, DEFRA published the Category 4 Screening Levels (C4SL) for use in Part 2a determinations. The C4SL are designed to be more pragmatic, but still strongly precautionary, assessment criteria compared to the previous assessment criteria (SGV – see below) used to assess chronic human health risks. They are designed for use in deciding whether land is suitable for use and definitely not contaminated, and DEFRA and the Welsh Government have recommended that they be used in assessing human health risks during the planning regime (i.e. as part of standard development investigations).

However, the C4SL have been calculated for a limited number of contaminants at this stage, and range of land uses including residential, commercial and public open space, but are based on a 'low level' of risk rather than the 'minimal level' of risk adopted by the Environment Agency in preparing their Soil Guideline Values (SGV). At the time of writing, the use of the C4SL in planning has not yet been accepted by many parties, including some regulators. The C4SL have also only been published for a limited number of contaminants. The C4SL have not been adopted in this assessment.

In this assessment, where available, the Soil Guideline Values (SGV) published by the Environment Agency have been adopted as the Generic Assessment Criteria (GAC) in the first instance. However, the SGV are only available for a limited number of contaminants for three proposed land uses (residential, commercial and allotments - not public open space). Where no SGV is available, the Suitable For Use Levels (S4ULs) published in January 2015 by the Chartered Institute of Environmental Health (CIEH) and Land Quality Management (LQM) have been adopted (LQM/CIEH, 2014).

These assessment criteria adopt updated toxicological data and exposure models, but the same 'minimal level' of risk as the SGV (i.e. unlike the C4SL). The S4ULs have been published for a large number of contaminants typically found on brownfield sites in the UK, and for the same range of land uses as the C4SL, i.e. including public open space scenarios.

At the time of writing there is no published SGV, S4UL or CL:AIRE/EIC guideline value for lead. For the purposes of this assessment, and in the absence of any other current authoritative guidance, the Category 4 Screening Level (C4SL) value published by DEFRA has been adopted.

Details of the source of the GAC adopted for each contaminant are presented on the assessment table below.

The proposed development comprises conventional residential properties with private gardens in the north and central areas (the 'Residential Zone') and retail units with flat style accommodation in the south (the 'Retail Zone') - see Figure 2. For the purposes of this assessment, the GAC appropriate for the residential land use with plant uptake used in the assessment of the Residential Zone. In the Retail Zone, the proposed development includes a combined retail/residential structure (Unit B). The ground floor will comprise a retail unit with upper floors comprising residential dwellings. Given this, we consider that the assessment criteria for public open space around residential dwellings is appropriate for the assessment of human health risks in this area.

The GAC for most organic compounds are dependent on the organic content of the soil. Only limited analysis of soil organic content has been undertaken in the shallow soils to date, but this suggests that organic content is around 1%. Therefore, for the purposes of this assessment, GAC for a soil organic content of 1% have been adopted.

3.7.4 Generic Quantitative Risk Assessment

The results of the Generic Quantitative Risk Assessments for the Residential and Retail Zones are presented in Tables 5a and 5b below:

Residential Zone:

Laboratory test results are available within the proposed Residential Zone from the shallow soils in GIL Boreholes BH1, WS5 and WS7 and TPT1/1, TP1/2 and TP2/1 only. A total of eight samples from six sampling positions have been analysed for varying contaminants.

Table 5a: Summary of Geo-environmental Soil Results - Residential Zone

Determinand	Range Recorded	GAC	Source of GAC	Exceedances
Metals and Semi-metals				
Arsenic	18 - 23mg/kg	32mg/kg	SGV ²	None of 4
Boron	<0.5 - 18mg/kg	290mg/kg	S4UL ³	None of 4
Cadmium	<0.1 - 0.5mg/kg	10mg/kg	SGV ²	None of 4
Chromium (total) ⁴	13 - 890mg/kg	910mg/kg	S4UL ³	None of 4
Copper	32 - 262mg/kg	2,400mg/kg	S4UL ³	None of 4
Lead	24 - 170mg/kg	200mg/kg	C4SL ⁵	None of 4
Mercury ⁶	0.12 - 0.22mg/kg	170mg/kg	SGV ²	None of 4
Nickel	9 - 53mg/kg	130mg/kg	SGV ²	None of 4
Selenium	<0.5 - 1.4mg/kg	350mg/kg	SGV ²	None of 4
Vanadium	35 - 1,098mg/kg	410mg/kg	S4UL ³	1 of 3
Zinc	63 - 303mg/kg	3,700mg/kg	S4UL ³	None of 4
Polyaromatic Hydrocarbons (PAH)				
Acenaphthene	<5mg/kg	210mg/kg	S4UL ^{3,7}	None of 5
Acenaphthylene	<5mg/kg	170mg/kg		None of 5
Anthracene	<5mg/kg	2,400mg/kg		None of 5
Benzo(a)anthracene	<5 - 10mg/kg	7.2mg/kg		2 of 5
Benzo(a)pyrene	<1 - 10mg/kg	2.2mg/kg		3 of 5
Benzo(b)fluoranthene	1 - 13mg/kg	2.6mg/kg		2 of 5
Benzo(ghi)perylene	<5 - 7mg/kg	320mg/kg		None of 5
Benzo(k)fluoranthene	<5 - 8mg/kg	77mg/kg		None of 5
Chrysene	<5 - 14mg/kg	15mg/kg		None of 5
Dibenzo(a,h)anthracene	<1 - 12mg/kg	0.24mg/kg		3 of 5
Fluoranthene	<5 - 20mg/kg	280mg/kg		None of 5
Fluorene	<5 - 5mg/kg	170mg/kg		None of 5
Indeno(123-cd)pyrene	<5 - 7mg/kg	27mg/kg		None of 5
Naphthalene	<5mg/kg	2.3mg/kg		None of 5
Phenanthrene	<5 - 16mg/kg	95mg/kg		None of 5
Pyrene	<5 - 15mg/kg	620mg/kg		None of 5
BTEX Compounds				
Benzene	<0.025mg/kg	0.087mg/kg	S4UL ^{3,7}	None of 5
Toluene	<0.025mg/kg	130mg/kg		None of 5
Ethyl benzene	<0.025mg/kg	47mg/kg		None of 5
Total Xylene ⁸	<0.05mg/kg	56mg/kg		None of 1
m/p Xylene ⁸	<0.025mg/kg	56mg/kg		None of 4
o Xylene ⁸	<0.025mg/kg	60mg/kg		None of 4
Aliphatic Petroleum Hydrocarbons (Equivalent Carbon Number)				
Ali EC 5-6	<0.2mg/kg	42mg/kg	S4UL ^{3,7}	None of 4
Ali EC 6-8	<0.4mg/kg	100mg/kg		None of 4
Ali EC 8-10	<10mg/kg	27mg/kg		None of 8
Ali EC 10-12	<10mg/kg	130mg/kg*		None of 4
Ali EC 12-16	<10mg/kg	1,100mg/kg*		None of 4
Ali EC 16-35	<20 - 424mg/kg	65,000mg/kg*		None of 4

Table 5a: Summary of Geo-environmental Soil Results -Residential Zone (cont.)

Determinand	Range Recorded	GAC	Source of GAC	Exceedances
Aromatic Petroleum Hydrocarbons (Equivalent Carbon Number)				
Aro EC 8-10	<10mg/kg	34mg/kg	S4UL ^{3,7}	None of 4
Aro EC 10-12	<10mg/kg	74mg/kg		None of 4
Aro EC 12-16	<10mg/kg	140mg/kg		None of 4
Aro EC 16-21	<10 - 34mg/kg	260mg/kg		None of 4
Aro EC 21-35	<10 - 99mg/kg	1,100mg/kg		None of 4
Other Organic Compounds				
Phenol	<0.5mg/kg	280mg/kg	S4UL ^{3,7}	None of 4

Retail Zone:

Laboratory test results are available within the proposed Retail Zone from the shallow soils in a substantial number of boreholes and trial pits undertaken by Ecologia, GIL and LRL. A total of 26 samples from 22 sampling positions have been analysed for varying contaminants.

Table 5b: Summary of Geo-environmental Soil Results – Retail Zone

Determinand	Range Recorded	GAC	Source of GAC	Exceedances
Metals and Semi-metals				
Arsenic	18 - 123mg/kg	79mg/kg	S4UL ²	1 of 6
Boron	<0.5 - 1.0mg/kg	21,000mg/kg	S4UL ²	None of 6
Cadmium	0.3 - 2.1mg/kg	120mg/kg	S4UL ²	None of 6
Chromium (total) ⁴	18 - 29mg/kg	1,500mg/kg	S4UL ²	None of 6
Copper	42 - 500mg/kg	12,000mg/kg	S4UL ²	None of 6
Lead	172 - 521mg/kg	630mg/kg	C4SL ⁵	None of 6
Mercury ⁶	<0.1 - 2.4mg/kg	120mg/kg	S4UL ²	None of 6
Nickel	12 - 40mg/kg	230mg/kg	S4UL ²	None of 6
Selenium	0.7 - 2.0mg/kg	1,100mg/kg	S4UL ²	None of 6
Vanadium	16 - 48mg/kg	2,000mg/kg	S4UL ²	None of 6
Zinc	466 - 3,986mg/kg	81,000mg/kg	S4UL ²	None of 6
Polyaromatic Hydrocarbons (PAH)				
Acenaphthene	<1 - 5mg/kg	15,000mg/kg	S4UL ^{3,7}	None of 18
Acenaphthylene	<1 - 19mg/kg	15,000mg/kg		None of 18
Anthracene	<1 - 74mg/kg	74,000mg/kg		None of 18
Benzo(a)anthracene	<1 - 93mg/kg	29mg/kg		1 of 18
Benzo(a)pyrene	<1 - 54mg/kg	5.7mg/kg		3 of 18
Benzo(b)fluoranthene	<1 - 100mg/kg	7.1mg/kg		2 of 18
Benzo(ghi)perylene	<1 - 36mg/kg	640mg/kg		None of 18
Benzo(k)fluoranthene	<1 - 33mg/kg	190mg/kg		None of 18
Chrysene	<1 - 96mg/kg	57mg/kg		1 of 18
Dibenzo(a,h)anthracene	<1 - 13mg/kg	0.57mg/kg		2 of 18
Fluoranthene	<1 - 227mg/kg	3,100mg/kg		None of 18
Fluorene	<1 - 28mg/kg	9,900mg/kg		None of 18
Indeno(123-cd)pyrene	<1 - 41mg/kg	82mg/kg		None of 18
Naphthalene	<1 - 4mg/kg	4,900mg/kg		None of 18
Phenanthrene	<1 - 223mg/kg	3,100mg/kg		None of 18
Pyrene	<1 - 158mg/kg	7,400mg/kg		None of 18

Table 5b: Summary of Geo-environmental Soil Results – Retail Zone (cont)

Determinand	Range Recorded	GAC	Source of GAC	Exceedances
BTEX Compounds				
Benzene	<0.01 – 55mg/kg	72mg/kg	S4UL ^{3,7}	None of 26
Toluene	<0.01 – 1,411mg/kg	56,000mg/kg		None of 26
Ethyl benzene	<0.01 – 418mg/kg	24,000mg/kg		None of 26
Xylene ⁸	<0.01 – 2,292mg/kg	41,000mg/kg		None of 26
Aliphatic Petroleum Hydrocarbons (Equivalent Carbon Number)				
Ali EC 5-6	<0.25 – 4.9mg/kg	570,000mg/kg*	S4UL ^{3,7}	None of 14
Ali EC 6-8	<0.5 – 482mg/kg	600,000mg/kg		None of 14
Ali EC 8-10	<0.25 – 520mg/kg	13,000mg/kg		None of 17
Ali EC 10-12	<20 – 1,200mg/kg	13,000mg/kg		None of 14
Ali EC 12-16	<10 – 3,900mg/kg	13,000mg/kg		None of 14
Ali EC 16-35	<10 – 3,200mg/kg	250,000mg/kg		None of 14
Aromatic Petroleum Hydrocarbons (Equivalent Carbon Number)				
Aro EC 5-7	<0.01 – 0.61mg/kg	56,000mg/kg	S4UL ^{3,7}	None of 5
Aro EC 7-8	<0.01 – 1.0mg/kg	56,000mg/kg		None of 5
Aro EC 8-10	<20 - 487mg/kg	5,000mg/kg		None of 14
Aro EC 10-12	<20 - 219mg/kg	5,000mg/kg		None of 14
Aro EC 12-16	<20 - 550mg/kg	5,100mg/kg		None of 14
Aro EC 16-21	<10 - 430mg/kg	3,800mg/kg		None of 14
Aro EC 21-35	<10 – 3,810mg/kg	3,800mg/kg		1 of 14
Other Organic Compounds				
Phenol	<0.5 – 1.4mg/kg	760mg/kg	S4UL ^{3,7}	None of 6

Notes to Tables 5a and 5b:

1. Assessment for residential land use with home-grown produce (Table 4a) and public open space (landscaping around residential units, without growth of home-grown produce - Table 4b).
2. CLR SGV: Soil Guideline Value published by Environment Agency.
3. S4ULs Suitable 4 Use Levels. Copyright Land Quality Management Limited, reproduced with permission; Publication No. S4UL3156. All Rights Reserved.
4. In the absence of Chromium VI, all chromium present likely to be Chromium III. GAC for Chromium III adopted.
5. C4SL: Category 4 Screening Level. No current SGV, S4UL or CLAIRE/EIC assessment criteria for lead. Category 4 Screening Level adopted in assessment.
6. GAC for inorganic mercury adopted.
7. GAC for organic compounds based on 1% soil organic content.
8. GAC for xylene based on p-xylene (lowest S4UL).
9. Exceedances highlighted in red and bold.
10. Laboratory results presented in Appendices C2, D2, E, F, H3 and I.

3.7.4 Asbestos

No assessment criteria are currently available for asbestos in soil. The previous (albeit limited) investigations have identified no evidence of asbestos in the proposed residential area and chrysotile at 'low levels' (5 to 15%) in only one sampling position in the Retail Zone (WS3a). However, given the age of the former buildings on site, asbestos materials are anticipated to have been present in their construction.

We have no information on the demolition of the previous buildings and in particular whether an asbestos survey was completed and all asbestos was removed in a correct manner prior to demolition. However, as discussed in Section 2.1, the Client has advised us that they have observed suspected asbestos materials on the current site surface. We have been unable to confirm this due to a lack of access to the site (see Section 1.2).

3.7.5 Conclusions of Assessment

Residential Zone

Only limited investigation of the shallow soils has been undertaken within the proposed residential zone. The previous investigation was undertaken whilst the previous buildings were standing and the Council Yard was operating, so this is likely to have been due to logistical issues and restricted access.

Our assessment of the available historic investigation data indicates potential unacceptable risks to future residents from elevated levels of vanadium and the PAH compounds benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene and dibenzo[ah]anthracene. Given the nature of these metals and compounds where identified previously, they are likely to remain at similar levels (without substantial degradation with time).

As discussed in Section 3.7.4, anecdotal evidence suggests that potential asbestos containing materials are present across the site surface.

Retail Zone:

The proposed retail zone, and particularly the area of the former petrol filling station, has been subject to significantly more investigation than the residential zone. Our assessment of the available historic data has identified potential risks to future site users from arsenic, C₂₁₋₃₅ aromatic petroleum hydrocarbons and the PAH compounds benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene and dibenzo[ah]anthracene, although these contaminated were not found to be widespread (generally they were elevated in one or two samples out of up to 18 analysed). Chrysotile asbestos was also identified in one sample analysed.

At this stage, we consider that remedial measures are likely to be required across the site to reduce the risks to future users.

3.8 Risks to Controlled Waters

3.8.1 Background

GIL completed a Level Three assessment of risks to controlled waters (using the Environment Agency methodology) for the petrol station site (2007c). The assessment concluded the following:

- Free phase petroleum hydrocarbons are present within the fine-grained alluvial soils, and on the groundwater within the underlying Fluvio-glacial Gravels.
- Dissolved petroleum hydrocarbons are present within the groundwater.
- The extent of petroleum hydrocarbon contamination within the alluvial soils is limited to the area of the former filling station.
- The evidence suggests that a plume of dissolved hydrocarbons within the groundwater extends outside the site boundary beneath Afan Way (towards the River Afan).
- Concentrations of benzene, toluene and xylene within the groundwater are elevated above the calculated remedial targets for the River Afan.
- Free phase hydrocarbons are present, particularly around one well on the south-western boundary (Borehole E4).

- Elevated concentrations of zinc are present within the groundwater to the south-west of the petrol filling station.
- The risks to the River Afan are unacceptable and remedial measures would be required to reduce the levels of contaminants within the soils and groundwater and mitigate the risks to the river.

We are aware from correspondence provided by NPTC that the GIL investigation and risk assessment report was submitted to the Environment Agency (now Natural Resources Wales) for review, but that the Agency had a number of queries, particularly regarding the site model, and the absence of a remediation options appraisal, remedial strategy and implementation plans (as required by CLR11). GIL responded to these queries in March 2008 with an explanation of the methodology and site model used and conclusions drawn, but we are not aware of any further response by the Agency.

We understand from the original project team (RNL, 2015) that the objective of employing Lee Remediation was to undertake the necessary works to provide the required pre-remedial documentation such as a remediation options appraisal, remedial strategy and implementation plans (in accordance with CLR11) and then implement the remedial works. However, due to commercial reasons, no remedial works were ever undertaken.

The results of the testing on groundwater around the old tar tank in the north of the site were compared to assessment criteria applicable to the protection of controlled waters by GIL, (GIL, 2007b), but a formal controlled water risk assessment was not completed.

3.8.2 Former Petrol Filling Station Site

There is no doubt that in 2007/2008 the levels of petroleum hydrocarbon contamination beneath the petrol filling station site were sufficiently elevated, and associated with free phase hydrocarbons, to pose an unacceptable risk to controlled water and, in particular, the River Afan.

The original source of the contamination (the fuel tanks, pumps and supply pipes) have now been removed from the site for almost ten years, however, the remnant contamination of the soils and groundwater and, in particular, the free phase hydrocarbons remain a source of contamination which may need to be remediated. No access has been possible onto the site to check for the current presence of petroleum hydrocarbons in any wells that may remain.

The available investigation data dates from between 2002 and 2008, i.e. between 7 and 13 years ago. Unlike metals and most PAH compounds, petroleum hydrocarbons will degrade in the environment with time, and the concentration and location of the contamination source present on site today may be different from that present on site during the investigations through natural processes (e.g. biodegradation). However, in our experience, we consider that it is likely that significant quantities of petroleum hydrocarbons will remain in the soils and groundwater.

Given the above, we do not consider that a further assessment of the historical investigation data at this stage would provide a true representation of the current risks to controlled waters and the River Afan from contaminants at the site.

We consider that such an assessment would almost certainly not be accepted by NRW. Further up-to-date information on the contamination sources on site would need to be obtained through further investigation – see Section 6.0.

3.8.3 Remainder of Site

Only limited assessment of the risks to controlled waters has been undertaken to date (around the former tar tank). The previously proposed development (all retail) comprised substantially hard surfacing so the amount of infiltration into the soils following development would have been limited. However, the current development comprises residential properties with private gardens and landscaping which will include substantially increased areas through which infiltration can pass. This infiltration could leach any mobile contaminants from the Made Ground and other shallow soils and impact deleteriously on the groundwater and, in turn, the River Afan.

There is insufficient historic information at this stage to undertake an assessment of risks to controlled waters on the remainder of the site, and further investigation would be required to provide the data necessary to undertake a Level Three assessment of risks – see Section 6.0.

3.9 Ground Gas

3.9.1 Background

As part of their 2004 investigation, GIL included the installation and monitoring of 13 no. gas wells across the site. The wells were reportedly monitored on two occasions for ground gas, but the results are not included within the copy of the report we have been provided to review.

GIL (2004) comment in their report text that the wells were monitored for levels of methane, carbon dioxide, volatile organic compounds (VOCs) and oxygen, however, no monitoring results have been available for review as part of this assessment. The GIL discussion in their report text on their site works and these monitoring visits indicate the following:

- Levels of VOCs during investigation were generally below detection, but up to 678ppm was identified on the former PFS site;
- Levels of VOCs during monitoring were 31ppm or less on the former PFS site, and between 2 and 16ppm on the former Council Yard;
- Levels of methane were generally below detection, but up to 2.5% on the former PFS site;
- Levels of carbon dioxide were up to 5.1%, with the more elevated results mainly on the former PFS site;
- Levels of oxygen ranged from 12 to 21%; and
- Levels of hydrogen sulphide and carbon monoxide were below detection.

GIL concluded that the monitoring had indicated low levels of methane and carbon dioxide across the former Council Yard, but elevated levels beneath the former PFS. It was also identified that any bioremediation (man-induced or natural) within the soils beneath the site could lead to an increase in the levels of methane and carbon dioxide. GIL recommended that gas protection measures be included in the future development of the former PFS.

3.9.2 Former Petrol Station Site

We concur with the conclusions and recommendations of GIL for the former PFS and consider that at present, gas protection measures would be required for any development on this area of the site. Without the monitoring data (which is absent from our copy of the report), we are unable to provide further guidance on the scale of protection required for the retail/residential unit proposed.

The petroleum hydrocarbons within the soils and groundwater beneath the site are likely to form a major source of hazardous gas, particularly as they degrade with time. If these soils were to be remediated, and the levels of petroleum hydrocarbons reduced (see Section 3.8.3), the source of such gases may also be reduced. However, the alluvial soils are likely to also contain organic material and, therefore, could remain a source of hazardous ground gas. Further gas monitoring wells should be installed on the former PFS and monitored before, during and after remediation to provide a representative data set for assessment.

3.9.3 Remainder of Site

In terms of gas risk (Wilson et al, 2009), the sensitivity of the development on the north and central area of the site has increased from 'low' (retail units) to 'high' (private dwellings). We are not clear as to the number of wells that have been installed and monitored within the 'Residential Zone', but we consider that there are only likely to have been three wells at most (BH1, WS5 and WS7). It appears that these wells were monitored on only two occasions.

We consider that there is insufficient data to allow an assessment of risks from hazardous ground gas in the residential zone and the south-east of the retail zone (away from the PFS). Further gas wells should be installed and monitored – see Section 6.0.

3.9.4 Radon

Based on the available information (Section 3.4), no radon protection is required.

3.10 Sulphate/Pyrite Risks to Structures

From their investigation, GIL (2004) suggest that the following characteristic values are applicable with regards to sulphate attack on buried concrete:

- Water soluble sulphate 757mg/l;
- Total potential sulphate 2.2%.

pH values varied between 6.9 and 11.0, suggesting near neutral to alkaline soil conditions. GIL assessed the class of concrete required using BRE SD1 dated 2001. Since their report a new version of SD1 (2007) has been published.

Based on the above characteristic values, under the new SD1 guidance, the Design Class for the site would be DS-4, and the Aggressive Chemical Environment for Concrete Class would be AC-4, assuming mobile groundwater.

If bioremediation is undertaken at the site, pH values may reduce and if they fall below 5.5, the class of concrete required may need to be advanced. Sulphate levels could also change.

4.0 RISK EVALUATION AND PLAUSIBLE POLLUTANT LINKAGES

4.1 Background

The land use history of the site and surrounding area, as established from the desk study and walkover, has identified a number of potential contamination linkages due to ground conditions or former operations either on, adjacent to, or in the vicinity of the site.

4.2 Introduction to Risk Evaluation Methodology

The methodology set out in CIRIA C552 (2001), *Contaminated Land Risk Assessment – A Guide to Good Practice*, has been used to assess whether or not risks are acceptable, and to determine the need for collating further information or remedial action.

The assessment is a quantitative method of interpreting findings to date based on the results of the previous investigations, and evaluating risk. The methodology requires the classification of:

- The magnitude of the potential consequence (severity) of risk occurring (Table 6); and
- The magnitude of the probability (likelihood) of risk occurring (Table 7).

Table 6: Classification of Consequence

Classification	Definition	Examples
Severe	• Short-term (acute) risk to human health likely to result in <i>Significant Harm</i>. • Short-term risk of pollution to a sensitive water resource. • Catastrophic damage to buildings/property. • Short-term risk to ecosystem, or organism forming part of that ecosystem.	• High concentrations of Cyanide at surface of informal recreation area. • Major spillage of contaminants from site into controlled water. • Explosion causing building collapse.
Medium	• Chronic damage to human health. • Pollution of sensitive water resource. • A significant change to ecosystem, or organism forming part of that ecosystem.	• Contaminant concentrations exceed assessment criteria. • Leaching of contaminants to Principal or Secondary aquifer. • Death of species within nature reserve.
Mild	• Pollution of non-sensitive water resources. • Significant damage to crops, buildings, structures. • Damage to sensitive buildings, structures or the environment.	• Pollution of Secondary Undifferentiated groundwater sources. • Damage to building rendering it unsafe to occupy.
Minor	• Harm, although not necessarily significant harm, which may result in financial loss, or expenditure to resolve. • Non permanent risks to human health (easily prevented by means of PPE). • Easily repairable effects of damage to buildings and structures.	• The presence of contaminants at such concentrations that PPE is required during site works. • The loss of plants in a landscaping scheme. • Discoloration of concrete.

Table 7: Classification of Probability

Classification	Definition
High Likelihood	There is a pollutant linkage and an event that either appears very likely in the short term and almost inevitable over the longer term. Or, there is already 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 longer term.
Low Likelihood	There is a pollutant 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 an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollutant linkage, but circumstances are such that it is improbable that an event would occur, even in the very long term.

The classifications defined above are then compared to indicate the risk presented by each pollutant linkage, allowing evaluation of a risk category (see Tables 8 and 9 below).

Table 8: Risk Categories – Comparison of Consequence against Probability

		Consequence			
		Severe	Medium	Mild	Minor
Probability	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

Table 9: Description of Risk Categories

Classification	Description
Very High Risk	- There is a probability that severe harm could arise to a designated receptor from an identified hazard. Or, there is evidence that severe harm to a designated receptor is currently happening. - The risk, if realised, is likely to result in a substantial liability. - Urgent investigation (if not already undertaken) and remedial action are likely to be required.
High Risk	- Harm is likely to arise to a designated receptor from an identified hazard. - Realisation of the risk is likely to present a substantial liability. - Urgent investigation (if not already undertaken) is required, and remedial action may be necessary in the short term and are likely over the longer term.
Moderate Risk	- It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur, it is more likely that the harm would be mild. - Investigation (if not already undertaken) is normally required to clarify the risk and to determine potential liability. Some remedial action may be required in the longer term.

Table 9: Description of Risk Categories (cont)

Classification	Description
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a very low possibility that harm could arise at a receptor. In the event of such harm being realised, it is not likely to be severe.

The methodology described above has been used to establish Plausible Pollutant Linkages (PPL) based on the Conceptual Site Model generated for the site and proposed development, and to evaluate the risks posed by those linkages, using information known about the site, at this desk study stage. This is presented as Tables 10a and 10b in Section 4.3.

4.3 Tabulated Risk Evaluation and Plausible Pollutant Linkages

Table 10a: Risk Evaluation & Plausible Pollutant Linkages (PPL) – Retail Zone, including Former Petrol Filling Station.

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Potential contaminants in shallow soils, inc. free product hydrocarbons.	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users	Medium – potential for chronic levels.	Likely ²	Moderate Risk	See Section 3.7
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Medium – non-standard PPE may be required	Likely ²	Moderate Risk	
	Leaching of soil contaminants/free product	Impact on Groundwater	Medium – site lies on Secondary aquifer	High Likelihood ³	High Risk	See Section 3.8
	Leaching of soil contaminants/free product	Impact on River Afan	Severe – evidence of past pollution of river from hydrocarbons	High Likelihood ³	Very High Risk	
Asbestos in shallow soils	Ingestion of fibres	Construction/ Maintenance Workers	Medium – potential for chronic levels	Likely ⁴	Moderate Risk	See Section 3.7.4
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	High Likelihood ⁵	Moderate Risk	See Section 3.10
Hazardous ground gas/vapours	Asphyxiation/poisoning. Injury due to explosion.	Site Users.	Severe – acute risk.	High Likelihood ⁶	Very High Risk	See Section 3.9
	Damage through explosion.	Building/Property	Severe – acute risk.		Very High Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.	Severe – acute risk.		Very High Risk	
Radon gas	Migration into Buildings	Site Users	Medium – potential for chronic levels	Unlikely	Low Risk	See Section 3.9.4

Notes:

1. Methodology and details of risk consequence, probability and category based on CIRIA C552 (2001) and presented in Section 4.2
2. Unacceptably elevated levels of arsenic, petroleum hydrocarbons and PAH compound have been identified in previous investigations. .
3. The groundwater has already been impacted by petroleum hydrocarbons. Free phase and dissolved hydrocarbons have been identified in the previous investigations.
4. Chrysotile asbestos has been identified in shallow soils the previous investigations.
5. Testing has indicated that the shallow soils contain sulphates/pyrite.
6. Several sources of hazardous ground gas are present, including petroleum hydrocarbons which can lead to increases in hazardous gas levels as they degrade.
7. Radon risk identified in environmental data report (Section 3.4).

Table 10b: Risk Evaluation & Plausible Pollutant Linkages (PPL) – Residential Zone

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Potential contaminants in shallow soils	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users	Medium – potential for chronic levels.	Likely ²	Moderate Risk	See Section 6.0
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Medium – non-standard PPE may be required	Likely ²	Moderate Risk	
	Leaching of soil contaminants	Impact on Groundwater	Medium – site lies on Secondary aquifer	Low Likelihood ³	Moderate/ Low Risk	See Section 6.0
	Leaching of soil contaminants	Impact on River Afan	Medium – site lies 80m from river.	Low Likelihood ³	Moderate/ Low Risk	
Asbestos in shallow soils	Ingestion of fibres	Construction/ Maintenance Workers	Medium – potential for chronic levels	Likely ⁴	Moderate Risk	See Section 6.0
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	High Likelihood ⁵	Moderate Risk	See Section 6.0
Hazardous ground gas/vapours	Asphyxiation/poisoning. Injury due to explosion.	Site Users (residents)	Severe – acute risk.	Likely ⁶	High Risk	See Section 6.0
	Damage through explosion.	Building/Property	Severe – acute risk.		High Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.	Severe – acute risk.		High Risk	
Radon gas	Migration into Buildings	Site Users (residents)	Medium – potential for chronic levels	Unlikely	Low Risk	None required.

Notes:

1. Methodology and details of risk consequence, probability and category based on CIRIA C552 (2001) and presented in Section 4.2
2. Unacceptably elevated levels of vanadium and PAH compounds have been identified in previous investigations. However, only limited investigation has been undertaken to date.
3. No evidence of significant impact on the groundwater has been identified in the limited investigations undertaken to date.
4. No asbestos has been identified in shallow soils the previous investigations. However, asbestos materials are reportedly present across the site surface.
5. Testing has indicated that the shallow soils contain sulphates/pyrite.
6. Several sources of hazardous ground gas are present, including a backfilled pond.
7. Radon risk identified in environmental data report (Section 3.4).

5.0 PRELIMINARY ASSESSMENT OF REMEDIAL REQUIREMENTS

As discussed in the previous sections, there is currently insufficient up-to-date information on the contamination sources beneath the site to allow a full assessment of remedial requirements. However, in 2008, Lee Remediation Ltd undertook an assessment of remediation requirements on the former petrol filling station (PFS) site. No specific assessment appears to have been prepared for the remainder of the site.

In the report, Lee recommended the following remedial and risk mitigation measures for the former PFS site:

- Removal of free product hydrocarbons from 1.2m diameter ring wells constructed to the Fluvio-glacial Gravels;
- Excavation and ex-situ bioremediation of hydrocarbon impacted soils;
- Confirmatory monitoring of groundwater over a period of up to 6 months;
- The provision of vapour protection measures in new buildings on the former PFS, including a gas membrane and passively ventilated sub-floor layer; and
- Protection to water supply pipes.

Although the above would appear to represent the type of remedial and mitigation measures that are likely to be suitable for the proposed development, further investigation would be required to confirm the presence and scale of pollution linkages at this present time and, hence, the exact nature of remedial and risk mitigation works required.

The future investigation and remediation should be undertaken in accordance with CLR 11 (2004) and would require the following:

- Generic Quantitative Risk Assessment – to be included as part of the investigation;
- Detailed Quantitative Risk Assessment (if required);
- Remedial Options Appraisal;
- Remediation Strategy;
- Implementation Plan;
- Verification Report; and
- Monitoring Reports (if required).

6.0 RECOMMENDED FURTHER WORK

We recommend that the further investigation should include the following (as a minimum):

- Re-establishment of any old monitoring wells still available.
- Asbestos survey of shallow soils to identify risks to future site users and investigation workers.
- A preliminary assessment of risks from buried ordnance. Reference to UXO risk maps available on-line (Zetica, 2015) suggests that the site is located within a **moderate** risk region.
- Trial pitting across the Residential Zone to allow inspection and sampling of near surface soils - much of this area appears to have been inaccessible during the previous investigations. Particular areas to be targeted include the areas of the backfilled pond and former above ground tanks.
- Trial trenching in area of former tar tank in north-west of site – to determine current nature of tank and any contaminated water therein.
- Trial pitting in area of former petrol filling station to allow examination and sampling of shallow soils, particularly in area of former Borehole E4.
- Installation of monitoring wells across both Residential and south-west of Retail Zones to allow monitoring for ground gases around areas of backfilled pond and above ground tanks.
- Installation of monitoring wells across former petrol filling station to allow monitoring and sampling of groundwater to delineate hydrocarbon plume and levels of petroleum hydrocarbons therein.
- Measurement of aquifer properties such as hydraulic conductivity of the Gravels stratum.
- Laboratory analysis of a minimum of two rounds groundwater samples, for a range of contaminants including petroleum hydrocarbons, PAH compounds, metals (including tin), and chlorinated solvents.
- Laboratory analysis of a minimum of twenty samples of shallow soils across Residential Zone and ten samples across Retail Zone for a range of contaminants including petroleum hydrocarbons, PAH compounds, metals (including tin), and chlorinated solvents.
- A minimum of six gas monitoring visits.
- A generic assessment of risks to human health for both zones.
- A Level Three assessment of risks to controlled waters (River Afan).

7.0 CONCLUSIONS

The assessment of the available information has suggested that the site is underlain by soils and groundwater which contain levels of contaminants which could pose an unacceptable risk to both future site users and controlled waters and, in particular, the River Afan.

The former petrol filling station (PFS) area of the site has been subjected to substantial levels of investigation between 2002 and 2008. Unacceptably elevated levels of arsenic, petroleum hydrocarbons, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene and dibenzo[ah]anthracene have been identified in terms of human health risk.

The most likely original source of petroleum hydrocarbons beneath the former PFS (the former underground fuel tanks) were removed in 2006, and the fuel pumps and supply pipes appear to have been removed shortly after. Therefore, the primary source of such hydrocarbons was removed nine years ago. However, secondary sources of petroleum contamination have been identified as elevated levels within the soils and dissolved in the groundwater and, in particular, up to 1.3m of free product hydrocarbons in the west of the PFS (Borehole E4) between 2004 to 2008. These contaminants remain as a potential risk to the water quality within the River Afan. Due to access restrictions, it has not been possible to confirm whether such contamination (and in particular, free product) remains beneath the site now.

The remainder of the site was formerly predominantly occupied by a Council Yard, and was subjected to less investigation. The investigation undertaken indicated unacceptably elevated levels of vanadium, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene and dibenzo[ah]anthracene in terms of human health risk.

There are a number of potential sources of hazardous ground gas beneath the site and the previous investigation (GIL, 2004) recommended the provision of gas protection measures in future developments, particularly on the former PFS. However, no monitoring data has been available for review so the scale of protection cannot be confirmed.

We consider that further investigation would be required across the site to evaluate the scale of contamination present within the soils and groundwater in the area of the PFS, particularly by petroleum hydrocarbons, and across the former Council Yard. An assessment of the present risks to controlled waters and human health would be required. Based on the available information, we anticipate that remediation will be required prior to development, and would be designed on the basis of the results of the risk assessments.

The future investigation and remediation should be undertaken in accordance with CLR 11 (2004).

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PLATES

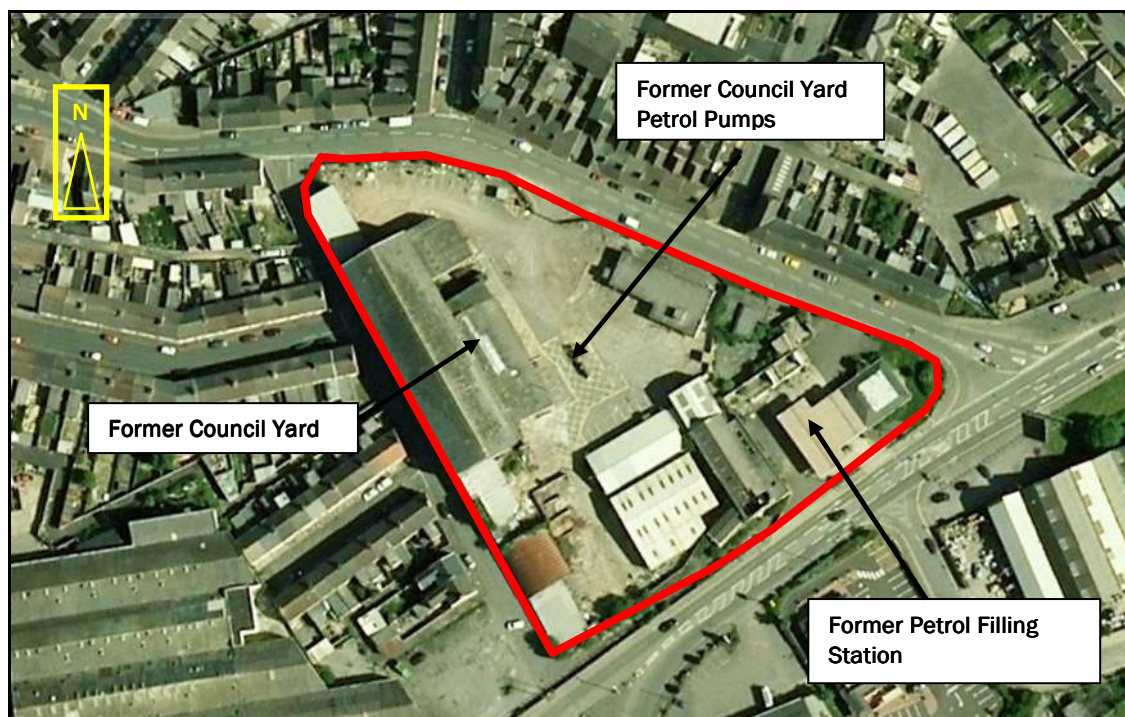


Plate 1: Aerial photograph of 2006
(after Google Earth)



Plate 2: Aerial photograph of 2010
(after Google Earth)

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PLATES



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Plate 3: Recent aerial photograph (2015)
(after Google Earth)



Plate 4: View of southern structure from gate

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Plate 5: Area between structures, from gate.



Plate 6: Northern structure, from gate.

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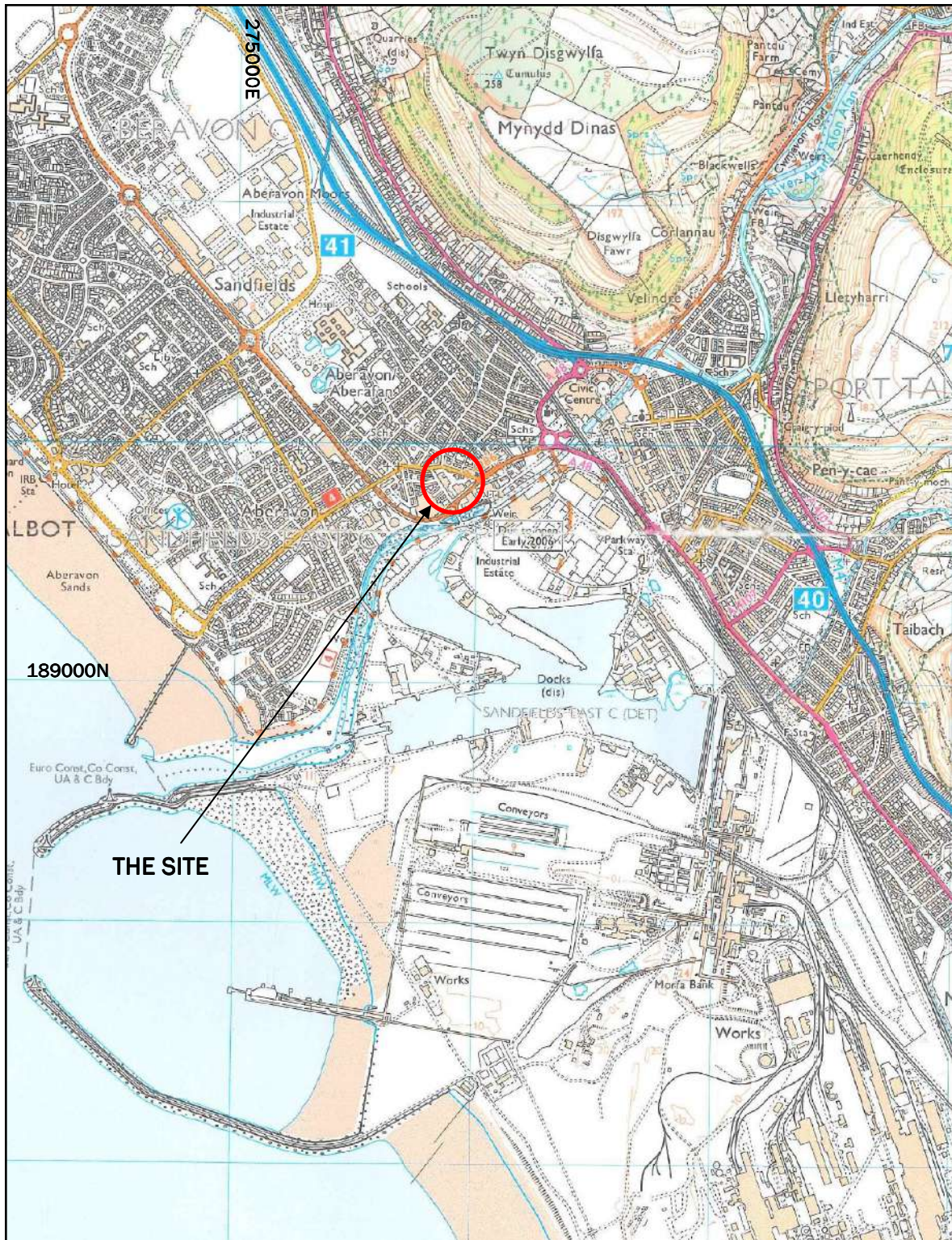


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FIGURES



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SCALE: 1: 25,000 (approx. at A4)

FIGURE 1: SITE LOCATION PLAN



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