

Table 15 Summary of *Soil* Contaminants and Exceedances in the *Retail* Zone

Determinand	Results Range (mg/kg) in historical investigations	Results Range (mg/kg) in QGL investigations	LQM/CIEH S4ULs (2015) (mg/kg) Public Open Spaces around Residential Dwellings ⁽²⁾	Exceedances from historical Investigations	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigation	Strata in QGL investigation
Retail Zone							
Arsenic	18-123	<1.0 - 68	79	Yes	No	-	-
Boron (water soluble)	<0.5 – 1.0	0.3 – 5.9	21000	No	No	-	-
Cadmium	0.3 – 2.1	<0.2 – 5.2	120	No	No	-	-
Chromium Total / III ⁽³⁾	18 - 29	7.8 - 100	7.7	Yes	Yes	M4 QTP06 0.6m QTP07 1.4m QTP07 2.00 QTP08 0.60m QTP09 0.60m QTP09 2.0m QTP10 1.50m QTP11 0.30m QTP12 0.60m QTP21 0.30m QTT01 1.0m QTT01 2.50m QTT02 0.45m QTT02 1.50m	Made Ground Made Ground Made Ground Sandy CLAY Made Ground Made Ground Sandy Clay Sandy Clay Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground Sandy Clay
Copper	42 - 500	11 - 760	12000	No	No	-	-
Lead ⁽⁴⁾	172 - 521	15 - 1800	630	Yes	Yes	QTP06 0.6m QTP07 1.4m QTP08 0.60m QTP10 1.50m	Made Ground Made Ground Made Ground Sandy Clay
Mercury	<0.1 – 2.4	<0.3 – 0.6	120	No	No	-	-
Nickel	12 - 40	15 - 52	230	No	No	-	-
Tin	No data	730 - 12000	No data	-	-	-	-
Zinc	466 - 3986	120 - 8400	81000	No	No	-	-
Inorganics							
pH ⁽⁶⁾	No data	5.8 – 9.3	-	-	-	-	-

Determinand	Results Range (mg/kg) in historical investigations	Results Range (mg/kg) in QGL investigations	LQM/CIEH S4ULs (2015) (mg/kg) Public Open Spaces around Residential Dwellings ⁽²⁾	Exceedances from historical Investigations	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigation	Strata in QGL investigation
Retail Zone							
Total Cyanide ⁽⁵⁾	No data	<1 - 6	34 ⁽⁹⁾	No	No		
Water Soluble Sulphate (2:1 Leachate Equivalent) (g/l)	No data	0.048 – 0.72	0.5	-	No	-	-
Organic Matter	No data	0.9 – 8.0	-	-	-	-	-
Total Sulphate as SO ₄ ⁽⁶⁾	No data	240 - 2600	2400	-	Yes	QWS04 1.0 – 2.0m	Made Ground
Water Soluble Sulphate (2:1 Leachate Equivalent) ⁽⁶⁾ (g/l)	No data	0.039 – 0.53	No data	-	-	-	-
Water Soluble Chloride (2:1)	No data	27 - 84	No data	-	-	-	-
Total Sulphur	No data	180 - 2500	No data	-	-	-	-
Water Soluble Nitrate (2:1) as NO ₃	No data	<2.0 – 6.7	No data	-	-	-	-
Total Phenols							
Total Phenols (monohydric) ⁽⁸⁾	<0.5 – 1.4	<1.0 – 3.8	440	No	No	-	-
Speciated PAHs							
Naphthalene	<1 - 4	<0.05 – 4.6	4900	No	No	-	-
Acenaphthylene	<1 - 19	<0.10 – 0.53	15000	No	No	-	-
Acenaphthene	<1 - 5	<0.1 – 0.98	15000	No	No	-	-
Fluorene	<1 - 28	<0.1 – 0.50	9900	No	No	-	-
Phenanthrene	<1 - 223	0.67 – 3.7	3100	No	No	-	-
Anthracene	<1 - 74	<0.1 – 3.9	74000	No	No	-	-
Fluoranthene	<1 - 227	0.5 - 8	3100	Yes	No	-	-
Pyrene	<1 - 158	0.45 – 17	7400	Yes	No	-	-
Benzo(a)anthracene	<1 - 93	0.36 - 97	29	No	Yes	-	-
Chrysene	<1 - 96	0.48 - 77	57	No	Yes	QTP07 1.40m	Made Ground

Determinand	Results Range (mg/kg) in historical investigations	Results Range (mg/kg) in QGL investigations	LQM/CIEH S4ULs (2015) (mg/kg) Public Open Spaces around Residential Dwellings ⁽²⁾	Exceedances from historical Investigations	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigation	Strata in QGL investigation
Retail Zone							
Benzo(b)fluoranthene	<1 - 100	<0.1 - 38	7.1	Yes	Yes	QTP07 1.40m QTP08 0.60m	Made Ground
Benzo(k)fluoranthene	<1 - 33	<0.1 - 45	190	No	No	-	-
Benzo(a)pyrene	<1 - 54	0.26 - 140	5.7	Yes	Yes	QTP07 1.40m	Made Ground
Indeno(1,2,3-cd)pyrene	<1 - 41	<0.1 - 52	82	No	No	-	-
Dibenz(a,h)anthracene	<1 - 13	<0.1 - 50	0.57	Yes	Yes	QTP07 1.40m QTP08 0.60m	Made Ground Made Ground
Benzo(ghi)perylene	<1 - 36	<0.05 - 98	640	No	No	-	-
Mono aromatics							
Benzene	<0.01 - 55	<1.0	72	No	No	-	-
Toluene	<0.01 - 1411	<1.0 - 23	56000	No	No	-	-
Ethylbenzene	<0.01 - 418	<1.0 - 790	24000	No	No	-	-
p & m-xylene ⁽¹⁰⁾	<0.01 - 2292	<1.0 - 3200	41000 (m-Xylene) 41000 (p-Xylene)	No	No	-	-
o-xylene	No data	<1.0 - 1400	41000	No	No	-	-
MTBE (Methyl Tertiary Butyl Ether)	No data	<1.0 - <10	No data	No	No	-	-
Petroleum Hydrocarbons							
TPH C10 - C40	No data	<10 - 12000					
TPH-CWG - Aliphatic >EC5 - EC6	<0.25 - 4.9	<0.1 - <10	570000	No	No	-	-
TPH-CWG - Aliphatic >EC6 - EC8	<0.5 - 482	<0.1 - <10	600000	No	No	-	-
TPH-CWG - Aliphatic >EC8 - EC10	<0.25 - 520	<0.1 - <10	13000	No	No	-	-
TPH-CWG - Aliphatic >EC10 - EC12	<20 - 1200	<1.0 - <10	13000	No	No	-	-
TPH-CWG - Aliphatic >EC12 - EC16	<20 - 1200	<2.0 - 660	13000	No	No	-	-
TPH-CWG - Aliphatic >EC16 - EC21	<10 - 3900	<8.0 - 180	250000	No	No	-	-
TPH-CWG - Aliphatic >EC21 - EC35	<10 - 3200	<10 - 4000	250000	No	No	-	-

Determinand	Results Range (mg/kg) in historical investigations	Results Range (mg/kg) in QGL investigations	LQM/CIEH S4ULs (2015) (mg/kg) Public Open Spaces around Residential Dwellings ⁽²⁾	Exceedances from historical Investigations	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigation	Strata in QGL investigation
Retail Zone							
TPH-CWG - Aromatic >EC5 - EC7	<0.01 – 0.61	<0.1 - <10	56000	No	No	-	-
TPH-CWG - Aromatic >EC7 - EC8	<0.01 – 1.0	<0.1 - <10	56000	No	No	-	-
TPH-CWG - Aromatic >EC8 - EC10	<20 - 487	<0.1 - <10	5000	No	No	-	-
TPH-CWG - Aromatic >EC10 - EC12	<20 - 219	<1.0 - <10	5000	No	No	-	-
TPH-CWG - Aromatic >EC12 - EC16	<20 - 550	<2.0 – 4.0	5100	No	No	-	-
TPH-CWG - Aromatic >EC16 - EC21	<10 - 430	<10 – 54	3800	No	No	-	-
TPH-CWG - Aromatic >EC21 - EC35	<10 - 3810	<10 - 2300	3800	No	No	-	-
Chlorinated Solvents							
Total Chlorinated Solvents (µg/mg)	No data	<100	-	-	-	-	-

Notes:

- (1) QGL means Quantum Geotechnical Limited (2). GAC from LQM/CIEH S4ULs 2015. (3) Historic investigations – in the absence of Chromium VI, all chromium present likely to be Chromium III, GAC for Chromium III adopted. QGL investigation tested for Total Chromium. (4). GAC from DEFRA C4SL. (5) WAC GAC from BRE 2005 (6). Cyanide GAC from AtRisk adopting most sensitive end use for acute risk. (7) Historical investigation state Phenols only were tested. (8) Historic investigations state Boron was tested. (9) Petroleum Hydrocarbons should be assessed as Aliphatic and Aromatic compounds - the most sensitive threshold values were utilised. (10) All Units mg/kg unless otherwise stated

Retail Zone – Soil Contaminant Test Result Highlights

In Trial Pit QTP10 at 0.80m depth in stiff blueish grey mottled brown sandy Clay, a raised concentration of Chromium Total was encountered at a level of 100mg/kg. In Trial Pit QTP08 at 0.60m depth in Made Ground, elevated levels of Tin was encountered at a value of 12000mg/kg.

In Trial Pit QTP07 at 1.40m depth, in Made Ground, and in Trial Trench QTT01 at 1.0m and 2.50m depth, in sandy Clay and Gravels respectively, elevated Petroleum Hydrocarbons were encountered but none exceeded threshold values.

Asbestos screening identified Asbestos to be present on site within the Made Ground material;

Windowless Sample Holes			Mounds			Trial Pits/ Trenches		
ID	Depth (mbgl)	Asbestos Type	ID	Depth (mbgl)	Asbestos Type	ID	Depth (mbgl)	Asbestos Type
QWS07	0.3	Chrysotile – Loose Fibres	Mound 4	n/a	Amosite – Insulation Lagging	QTP08	0.6	Chrysotile – Loose Fibres
QWS11	0.3					QTT01	1.0	
QWS14N	0.3	Chrysotile – Hard / Cement Type Material, Insulation, Lagging						
QWS14	1.6	Chrysotile – Loose fibres						

Slightly elevated levels of 0.002 – 0.006mg/kg of Polychlorinated biphenyls (PCBs) were encountered in Trial Pit QTP12 at 0.60m depth, in Made Ground.

Elevated Volatile Compounds including Isopropylbenzene, Bromobenzene, 1,3,5 – Trimethylbenzene, 1,2,4 – Trimethylbenzene, sec-Butylbenzene, p – Isopropyltoluene, 1,4- Dichlorobenzene were encountered in Trial Trench QTT01 at 2.50m depth, in sandy Clay. No other Volatile Organic Compounds (VOCs) were encountered above the respective limit of detection levels.

6.2. Risk to Controlled Waters Assessment

6.2.1. General

The risk to controlled waters, i.e. nearby watercourses, is defined by the potential for any contaminants present on site to leach from the soils beneath the site.

The results of the soil leachate testing on several samples identified on site in the residential and retail zones are shown in Table 16 and 17.

Table 18 and 19 summarises the testing completed on the groundwater samples recovered across the site during the fieldworks period.

The result ranges are presented together with the threshold levels given by the United Kingdom Drinking Water Standards (UKDWS) as well as the Environmental Quality Standards (EQS) guideline values.

Available generic threshold levels for soil leachate and groundwater comparisons are limited for the assessment of individual speciated hydrocarbons.

Table 16: Summary of *Soil Leachate* Chemical Analysis in the *Residential* Zone

Determinand	Units	Results Range (µg/l) in QGL investigations	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations	Strata in QGL investigations
Residential								
Arsenic	µg/l	<1.1 - 68	50	25	10	Yes	WS04 2.00m QWS07 0.30m QTP17 1.90m QTP02 1.90m	Made Ground Made Ground Made Ground Made Ground
Cadmium	µg/l	<0.08	5	2.5	5	No	-	-
Chromium	µg/l	1.1 - 12	5 - 250	15	50	Yes	WS04 2.00m	Made Ground
Copper	µg/l	9.0 - 19	1-28	5	2000	Yes	WS04 2.00m QWS07 0.30m QTP17 1.90m QTP02 1.90m QTP03 9.0m QBH03 0.60m	Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground
Lead	µg/l	<1.0 - 16	4 - 250	25	10	Yes	QWS07 0.30m QTP17 1.90m QTP02 1.90m QTP03 9.0m QBH03 0.60m	Made Ground Made Ground Made Ground Made Ground Made Ground
Mercury	µg/l	<0.5	1	0.3	1	No	-	-
Nickel	µg/l	<0.3 – 2.5	50-200	30	20	No	-	-
Tin	µg/l	<0.1 – 7.9	<i>Not Available</i>	<i>Not Available</i>	10	No	-	-
Zinc	µg/l	4.5 - 24	8 – 500	<i>Not Available</i>	5000	Yes	QWS04 2.00m QWS07 0.30m QBH03 0.60m	Made Ground Made Ground Made Ground

Determinand	Units	Results Range (µg/l) in QGL investigations	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations	Strata in QGL investigations
Residential								
Boron	µg/l	10 - 940	2,000	7,000	1,000	No	-	-
Calcium	µg/l	57	Not Available	Not Available	Not Available	-	-	-
Magnesium	µg/l	2.9	Not Available	Not Available	Not Available	-	-	-
pH		8.1 – 8.9	Not Available	Not Available	9.5	No	-	-
Total cyanide	µg/l	<10	1 (5)	1 (5)	50 ug CN/l	No*	-	-
Sulphate as SO ₄	µg/l	5120 - 120000	Not Available	Not Available	Not Available	-	-	-
Total Phenol	µg/l	<10	6.53 - 20.6	0.0005	Not Available	No*	-	-
TPH C10 – C40	µg/l	<10	Not Available	Not Available	<10	No*	-	-
Napthalene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Acenaphthylene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Acenaphthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Fluorene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Phenanthrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Anthracene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Fluoranthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Pyrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Benzo(a)anthracene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Chrysene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Benzo(b)fluoranthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Benzo(k)fluoranthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Benzo(a)pyrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-
Indeno(1,2,3-cd)pyrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-	-

Determinand	Units	Results Range (µg/l) in QGL investigations	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations	Strata in QGL investigations
Residential								
Dibenz(a,h)anthracene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Benzo(ghi)perylene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Total PAH Speciated	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	0.1	No*	-	-

¹Figures for Environmental Quality Standards (EQS) are Annual Average Concentrations derived from the Environment Agency

²UK Drinking Water Standards taken from; Water Supply (Water Quality) Regulations 1989 (SI 1989/1147) (as amended), and Water Supply (Water Quality) Regulations 2000 (SI 2000/3184) (as amended). NT – Not Tested. I/S – Insufficient Sample.

Table 17 Summary of *Soil Leachate* Chemical Analysis in the *Retail* Zone

Determinand	Units	Results Range (µg/l) in QGL investigations	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations	Strata in QGL investigations
Retail								
Arsenic	µg/l	<1.1 - 12	50	25	10	Yes	QTP10 0.80m QTP11 0.30m	Made Ground Made Ground
Cadmium	µg/l	<0.08 – 0.10	5	2.5	5	No	-	-
Chromium	µg/l	1.0 - 54	5 - 250	15	50	Yes	QTP10 0.80m	Made Ground
Copper	µg/l	8.1 - 13	1-28	5	2000	Yes	QWS14 1.60m QTP10 0.80m QTP11 0.30m QTP06 0.60m QTP08 0.60m QTP09 0.60m QBH06 1.00m QBH06 2.00m	Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground
Lead	µg/l	2.8 - 25	4 - 250	25	10	Yes	QWS14 1.60m QTP10 0.80m QTP11 0.30m QTP06 0.60m QTP08 0.60m QTP09 0.60m QBH06 1.00m	Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground
Mercury	µg/l	<0.5	1	0.3	1	No*	-	-
Nickel	µg/l	<0.3 – 2.0	50-200	30	20	No	-	-
Tin	µg/l	<1.0 - 90	Not Available	Not Available	10	Yes	QTP06 0.60m QTP08 0.60m	Made Ground Made Ground

Determinand	Units	Results Range (µg/l) in QGL investigations	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations	Strata in QGL investigations
Retail								
Zinc	µg/l	3.2 - 130	8 – 500	<i>Not Available</i>	5000	Yes	QTP10 0.80m QTP11 0.30m QTP06 0.60m QTP08 0.60m QTP09 0.60m QBH06 1.00m QBH06 2.00m	Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground Made Ground
Boron	µg/l	<10 - 31	2,000	7,000	1,000	No	-	-
pH		7.9 – 8.7	<i>Not Available</i>	<i>Not Available</i>	9.5	No	-	-
Total cyanide	µg/l	<10	1 (5)	1 (5)	50 ug CN/l	No*	-	-
Sulphate as SO ₄	µg/l	5360 - 13000	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Total Phenol	µg/l	<10	6.53 - 20.6	0.0005	<i>Not Available</i>	No*	-	-
TPH C10 – C40	µg/l	<10	<i>Not Available</i>	<i>Not Available</i>	<10	No	-	-
Napthalene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Acenaphthylene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Acenaphthene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Fluorene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Phenanthrene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Anthracene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Fluoranthene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Pyrene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Benzo(a)anthracene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Chrysene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-

Determinand	Units	Results Range (µg/l) in QGL investigations	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations	Strata in QGL investigations
Retail								
Benzo(b)fluoranthene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Benzo(k)fluoranthene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Benzo(a)pyrene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Indeno(1,2,3-cd)pyrene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Dibenz(a,h)anthracene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Benzo(ghi)perylene	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	<i>Not Available</i>	-	-	-
Total PAH Speciated	µg/l	<0.01	<i>Not Available</i>	<i>Not Available</i>	0.1	No	-	-

¹Figures for Environmental Quality Standards (EQS) are Annual Average Concentrations derived from the Environment Agency

²UK Drinking Water Standards taken from; Water Supply (Water Quality) Regulations 1989 (SI 1989/1147) (as amended), and Water Supply (Water Quality) Regulations 2000 (SI 2000/3184) (as amended). NT – Not Tested. I/S – Insufficient Sample.

Residential & Retail– Soil Leachate Contaminant Test Result Highlights

In Trial Pits QTP06 at 0.60m and QTP08 at 0.60m depth, elevated Tin leachate levels, 83 - 90µg/l were recorded as sampled from the Made Ground.

No Total Chlorinated Solvent, VOCs, Total PCBs or Monoaromatics were encountered above the respective limit of detection levels in samples tested from the residential or retail areas except in Trial Trench QTT02 at 2.50m depth where 4.1µg/l p- and m xylene and 5.0µg/l of o-xylene was encountered in the natural Clay.

Table 18: Summary of *Groundwater* Chemical Analysis in *Residential* Areas

Determinand	Units	Site Results Range (µg/l) Groundwater	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations
Residential							
Speciated PAH	µg/l	<0.01 - 1600	Not Available	Not Available	0.1	Yes	QTT03 2.00m
Napthalene	µg/l	1600	10	5	Not Available	Yes	QTT03 2.00m
Acenaphthylene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Acenaphthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Fluorene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Phenanthrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Anthracene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Fluoranthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Pyrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Benzo(a)anthracene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Chrysene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Benzo(b)fluoranthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Benzo(k)fluoranthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Benzo(a)pyrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Indeno(1,2,3-cd)pyrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Dibenz(a,h)anthracene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Benzo(ghi)perylene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
TPH C10 – C40	µg/l	550000	Not Available	Not Available	<10	Yes	QTT03 2.00m
TPH-CWG - Aliphatic >C5 - C6	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C6 - C8	µg/l	<10	Not Available	Not Available	Not Available	-	-

Determinand	Units	Site Results Range (µg/l) Groundwater	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations
Residential							
TPH-CWG - Aliphatic >C8 - C10	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C10 - C12	µg/l	93000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C12 - C16	µg/l	220000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C16 - C21	µg/l	110000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C21 - C35	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic (C5 - C35)	µg/l	430000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C5 - C7	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C7 - C8	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C8 - C10	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C10 - C12	µg/l	73000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C12 - C16	µg/l	49000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C16 - C21	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C21 - C35	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic (C5 - C35)	µg/l	120000	Not Available	Not Available	Not Available	-	-
pH		7.1 – 7.7	Not Available	Not Available	9.5	No	-
Total Cyanide ³	µg/l	<10	1 (5)	1 (5)	50 µg CN/l	No*	-
Sulphate as SO ₄	µg/l	133000 – 506000	Not Available	Not Available	Not Available	-	-
Total Organic Carbon	µg/l	6.53 - 20.6	Not Available	Not Available	Not Available	-	-
Hardness	µg/l	264 – 861	Not Available	Not Available	Not Available	-	-
Total Phenols ⁴	µg/l	<10 – 24	0.0005	Not Available	Not Available	-	-

Determinand	Units	Site Results Range (µg/l) Groundwater	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations
Residential							
Arsenic (Dissolved)	µg/l	<0.15 – 29.6	0.05	Not Available	10	Yes	QTT03 2.00m QTP02A 1.52m
Boron (Dissolved)	µg/l	68 – 670	2	Not Available	1 mg B/l	Yes	QTT03 2.00m QTP19 1.90m QTP02A 1.52m
Cadmium (Dissolved)	µg/l	0.08 – 0.14	0.005	Not Available	5 µg Cd/l	No	-
Chromium (Dissolved)	µg/l	0.3 – 0.5	0.005 to 0.25	Not Available	50 µg Cr/l	No	-
Copper (Dissolved)	µg/l	5.9 – 19	0.001 to 0.028	Not Available	2.0 mg Cu/l	Yes	QTT03 2.00m QTP19 1.90m QTP02A 1.52m
Lead (Dissolved)	µg/l	1.7 – 13	Not Available	Not Available	Not Available	-	-
Mercury (Dissolved)	µg/l	<0.05 – 27	0.001	Not Available	1.0 µg Hg/l	Yes*	QTP02A 1.52m
Nickel (Dissolved)	µg/l	4.6 – 55	0.05 – 0.2	Not Available	20 µg Ni/l	Yes	QTT03 2.00m QTP19 1.90m QTP02A 1.52m
Tin (Dissolved) ⁵	µg/l	<0.02 – 4.9	25	10	Not Available	No	-
Zinc (Dissolved)	µg/l	7.5 - 840	0.08 – 0.125	Not Available	Not Available	Yes	QTT03 2.00m QTP19 1.90m QTP02A 1.52m
Calcium (Dissolved)	µg/l	85 – 310	Not Available	Not Available	Not Available	-	-
Magnesium (Dissolved)	µg/l	13 - 23	Not Available	Not Available	Not Available	-	-

¹Figures for Environmental Quality Standards (EQS) are Annual Average Concentrations derived from the Environment Agency-

²UK Drinking Water Standards taken from; Water Supply (Water Quality) Regulations 1989 (SI 1989/1147) (as amended), and Water Supply (Water Quality) Regulations 2000 (SI 2000/3184) (as amended).³Cyanide UK Non-statutory EQSs Freshwater annual average: 1 µg/l Freshwater maximum acceptable concentration: 5 µg/l Saltwater annual average: 1 µg/l (1) Saltwater maximum acceptable concentration: 5 µg/l (1) Tentative. These values are for free cyanide (HCN and CN⁻). Driver Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances Sub-driver Proposed Aquatic Environmental Quality Standards

⁴ Phenol 'Good' standard for rivers and freshwater lakes: 7.7 ug/l (1) 'Good' standard for rivers and freshwater lakes: 46 ug/l (2, 3) 'Good' standard for transitional and coastal waters: 7.7 ug/l (1) 'Good' standard for transitional and coastal waters: 46 ug/l (2, 3) (1) Annual mean. (2) 95th percentile. Driver Directive establishing a framework for Community action in the field of water policy (Water Framework Directive) Sub-driver the River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010

⁵ Freshwater annual average: 25µg/l (Total Tin) and Saltwater annual average: 10ug/l (Dissolved Tin)

NT – Not Tested. I/S – Insufficient Sample.

Table 19 Summary of *Groundwater* Chemical Analysis in *Retail* Areas

Determinand	Units	Site Results Range (µg/l) Groundwater	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations
Retail							
Speciated PAH	µg/l	<0.16- 10100	Not Available	Not Available	0.1	Yes*	QTT01 3.50m QTT01B 3.70m
Napthalene	µg/l	<0.01 – 8710	10	5	Not Available	Yes	QTT01 3.50m QTT01B 3.70m
Acenaphthylene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Acenaphthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Fluorene	µg/l	<0.01 – 744	Not Available	Not Available	Not Available	-	-
Phenanthrene	µg/l	<0.01 – 458	Not Available	Not Available	Not Available	-	-
Anthracene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Fluoranthene	µg/l	<0.01 – 96	Not Available	Not Available	Not Available	-	-
Pyrene	µg/l	<0.01 – 103	Not Available	Not Available	Not Available	-	-
Benzo(a)anthracene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Chrysene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Benzo(b)fluoranthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Benzo(k)fluoranthene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Benzo(a)pyrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Indeno(1,2,3-cd)pyrene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
Dibenz(a,h)anthracene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-

Determinand	Units	Site Results Range (µg/l) Groundwater	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations
Benzo(ghi)perylene	µg/l	<0.01	Not Available	Not Available	Not Available	-	-
TPH C10 – C40	µg/l	280- 4200000	Not Available	Not Available	<10	Yes	QTT01 3.50m QTT01B 3.70m QTT02 4.00m QBH05 1.55- 3.00
TPH-CWG - Aliphatic >C5 - C6	µg/l	<10 - 48000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C6 - C8	µg/l	440 – 440000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C8 - C10	µg/l	4600 - 2400000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C10 - C12	µg/l	<10 - 660000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C12 - C16	µg/l	96000 - 2400000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C16 - C21	µg/l	650000 - 1400000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic >C21 - C35	µg/l	<10 - 43000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aliphatic (C5 - C35)	µg/l	3800000 - 8900000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C5 - C7	µg/l	<10 -19000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C7 - C8	µg/l	<10 - 17000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C8 - C10	µg/l	44000 - 1500000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C10 - C12	µg/l	42000 - 610000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C12 - C16	µg/l	310000 - 490000	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C16 - C21	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic >C21 - C35	µg/l	<10	Not Available	Not Available	Not Available	-	-
TPH-CWG - Aromatic (C5 - C35)	µg/l	920000 - 2400000	Not Available	Not Available	Not Available	-	-
Benzene	µg/l	<1.0 – 19400	Not Available	Not Available	1	Yes	QTT01 3.50m QBH05 1.55 – 3.00m
Toluene ³	µg/l	<1.0 – 16900	Not Available	Not Available	50 ug/l (1) - 380 ug/l (2, 3) 40 ug/l (1) - 370 ug/l (2, 3)	Yes	QTT01 3.50m

Determinand	Units	Site Results Range (µg/l) Groundwater	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations
Ethylbenzene	µg/l	<1.0 - 121000	Not Available	Not Available	Not Available	-	-
p & m-xylene	µg/l	<1.0 - 183000	Not Available	Not Available	Not Available	-	-
o-xylene	µg/l	<1.0 - 192000	Not Available	Not Available	Not Available	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/l	<1.0	Not Available	Not Available	Not Available	-	-
pH		6.9 – 7.0	Not Available	Not Available	9.5	No	-
Total Cyanide ⁴	µg/l	<10	1 (5)	1 (5)	50 ug CN/l	No*	-
Sulphate as SO ₄	µg/l	20200 - 268000	Not Available	Not Available	250 mg SO ₄ /l	Yes	QTT01B 3.70m QTT02 4.00m QBH04 1.57m QBH04 2.60 – 3.50m QBH05 1.55- 3.00m QBH05 1.55 – 3.00m QBH06 1.29m
Total Organic Carbon	µg/l	27.9 - 129	Not Available	Not Available	Not Available	-	-
Hardness	µg/l	452 - 506	Not Available	Not Available	Not Available	-	-
Total Phenols ⁵	µg/l	<10 - 66	Not Available	Not Available	Not Available	-	-
Arsenic (Dissolved)	µg/l	25 – 28.7	0.05	Not Available	10	-	-
Boron (Dissolved)	µg/l	220 - 480	0.05	Not Available	1 mg B/l	Yes	QTT01B 3.70m QTT02 4.00m QBH04 1.57m QBH04 2.60 – 3.50m QBH05 1.55- 3.00m QBH05 1.55 – 3.00m QBH06 1.29m
Cadmium (Dissolved)	µg/l	<0.02 – 0.09	2	Not Available	5 µg Cd/l	No	-

Determinand	Units	Site Results Range (µg/l) Groundwater	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations
Chromium (Dissolved)	µg/l	<0.2 – 0.6	0.005	<i>Not Available</i>	50 ug Cr/l	Yes*	QTT01B 3.70m QTT02 4.00m QBH04 1.57m QBH04 2.60 – 3.50m QBH05 1.55- 3.00m QBH05 1.55 – 3.00m QBH06 1.29m
Copper (Dissolved)	µg/l	6.0 – 9.2	0.005 to 0.25	<i>Not Available</i>	2.0 mg Cu/l	Yes*	QTT01B 3.70m QTT02 4.00m QBH04 1.57m QBH04 2.60 – 3.50m QBH05 1.55- 3.00m QBH05 1.55 – 3.00m QBH06 1.29m
Lead (Dissolved)	µg/l	3.2 – 11	0.001 to 0.028	<i>Not Available</i>	10 ug Pb/l	Yes	QTT02 4.00m
Mercury (Dissolved)	µg/l	<0.05		<i>Not Available</i>	1.0 ug Hg/l	No	-
Nickel (Dissolved)	µg/l	1.4 – 6.1	0.001	<i>Not Available</i>	20 ug Ni/l	Yes	QTT01B 3.70m QTT02 4.00m QBH04 1.57m QBH04 2.60 – 3.50m QBH05 1.55- 3.00m QBH05 1.55 – 3.00m QBH06 1.29m
Tin (Dissolved) ⁶	µg/l	<0.2	0.05 – 0.2	<i>Not Available</i>	<i>Not Available</i>	No*	-

Determinand	Units	Site Results Range (µg/l) Groundwater	Environmental Quality Standards – Freshwater ¹	Environmental Quality Standards – Saltwater ¹	UK Drinking Water Standards ²	Exceedances from QGL Investigation	Borehole and Depth of Exceedance in QGL investigations
Zinc (Dissolved)	µg/l	5.1 – 180	25	10	Not Available	Yes	QTT02 4.00m QBH04 1.57m QBH04 2.60 – 3.50m QBH05 1.55- 3.00m QBH05 1.55 – 3.00m
Calcium (Dissolved)	µg/l	140 – 150	0.08 – 0.125	Not Available	Not Available	Yes	QTT01B 3.70m QTT02 4.00m QBH04 1.57m QBH04 2.60 – 3.50m QBH05 1.55- 3.00m QBH05 1.55 – 3.00m QBH06 1.29m
Magnesium (Dissolved)	µg/l	24 - 30	Not Available	Not Available	Not Available	-	-

¹Figures for Environmental Quality Standards (EQS) are Annual Average Concentrations derived from the Environment Agency

²UK Drinking Water Standards taken from; Water Supply (Water Quality) Regulations 1989 (SI 1989/1147) (as amended), and Water Supply (Water Quality) Regulations 2000 (SI 2000/3184) (as amended).

³Toluene 'Good' standard for rivers and freshwater lakes: 50 ug/l (1) 'Good' standard for rivers and freshwater lakes: 380 ug/l (2, 3) 'Good' standard for transitional and coastal waters: 40 ug/l (1) 'Good' standard for transitional and coastal waters: 370 ug/l (2, 3) (1) Annual mean. (2) 95th percentile. The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010

⁴Cyanide UK Non-statutory EQSs Freshwater annual average: 1 ug/l Freshwater maximum acceptable concentration: 5 ug/l Saltwater annual average: 1 ug/l (1) Saltwater maximum acceptable concentration: 5 ug/l (1) Tentative. These values are for free cyanide (HCN and CN⁻). Driver Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances Sub-driver Proposed Aquatic Environmental Quality Standards

⁵Phenol 'Good' standard for rivers and freshwater lakes: 7.7 ug/l (1) 'Good' standard for rivers and freshwater lakes: 46 ug/l (2, 3) 'Good' standard for transitional and coastal waters: 7.7 ug/l (1) 'Good' standard for transitional and coastal waters: 46 ug/l (2, 3) (1) Annual mean. (2) 95th percentile. Driver Directive establishing a framework for Community action in the field of water policy (Water Framework Directive) Sub-driver The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010

⁶Freshwater annual average :25µg/l(Total Tin) and Saltwater annual average: 10ug/l (Dissolved Tin)

NT – Not Tested. I/S – Insufficient Sample.

Residential & Retail – Groundwater Contaminant Test Result Highlights

Extremely high concentrations of speciated Total Petroleum Hydrocarbons were recorded in all groundwater samples tested from both areas of the site across both the Aliphatic and Aromatic Carbon chains ranges. Increased concentrations were recorded in the Retail area, particularly from exploratory holes located within the vicinity of the former Petrol Filling Station.

In Trial Trenches QTT01 at 3.50m, QTT01B at 3.70m and QTT03 at 2.00m depth, elevated and exceedances of Naphthalene (Speciated PAH), 5830, 8710 and 1600 µg/l, respectively were recorded. In addition QTT01B at 3.70m depth recorded elevated Flourene, Phranthrene, and Pyrene (Speciated PAHs),

In Trial Trenches QTT01 at 3.50m, QTT01B at 3.70m and QTT02 at 4.00m depth, elevated VOCs were encountered.

In Trial Trenches QTT01 at 3.50m and ATT01B at 3.70m depth elevated Monoaromatics were encountered.

Neither PCBs, VOCs, Monoaromatics nor Total Chlorinated Solvents were encountered above the above the respective limit of detection levels in samples tested from the residential area.

6.3. Land Gas & Groundwater Assessment

Monitoring of land-gas concentrations being emitted from the installed standpipes, groundwater levels and any residing hydrocarbons has been undertaken on three monthly post-fieldwork visits using the GA2000 Gas Analyser, Electronic Water Dip Meter and Oil/ Water Interface Meter.

Monitoring was undertaken on the following dates; 19/01/16, 23/03/16 & 25/04/16. Additional three monitoring visits are to be completed through May to July'16. The results of these remaining three visits will be presented in an Addendum report.

A summary of the monitoring results are displayed below (Table 20) with full details presented in Appendix VI.

Table 20: Land-gas & Groundwater Monitoring Results

Borehole Installation	Response Zone		Results Range of Determinands								
	Top Depth (m)	Bottom Depth (m)	O ₂ (% v/v)	CO ₂ (% v/v)	CH ₄ (% v/v)	H ₂ S (ppm)	CO	Flow Rate (l/hr)	Atmospheric Pressure (mb)	Water Level (mbgl)	Oil/ Hydrocarbon Level (mbgl)
50mm Ø Installations											
QBH01	1	2.9	16.60 – 19.00	0.30 – 4.70	0 – 0.10	0	0	0 – 0.10	1016 - 1021	2.20 – 2.25	2.200
QBH02	1	2	20.20 - 21.20	0 – 0.40	0 – 0.10	0	0	0 – 0.10	1015 - 1022	1.89 – 1.97	1.890
QBH03	1	2	20.70 – 21.10	0.30 – 0.80	0 – 0.10	0	0	0	1015 - 1025	1.59 – 1.76	-
QBH04	1	2	17.00 – 21.10	0.30 – 2.90	0 – 0.10	0	0	0 – 0.10	1015 - 1022	1.57 – 2.08	-
QBH05	1	2	19.00 – 20.20	1.20 – 1.50	0 – 0.10	0	0	0	1015 - 1023	1.70 – 1.74	-
QBH06	0.5	2	18.20 – 21.10	1.20 - 4.10	0 – 0.10	0	0	0 - 0.30	1015 - 1022	Dry – 2.60	-
QTP02A	1	2.4	19.9 – 20.90	0.50 – 1.00	0 – 0.10	0	0	0 – 0.10	1016 - 1022	Dry – 1.88	1.600
QTT02	2	4	20.40 – 21.10	0.20 – 0.80	0 – 0.10	0	0	0 – 0.20	1015 - 1022	2.20 – 2.50	-
QWS02	0.9	2	18.10 – 18.80	0.50 – 0.70	0 – 0.10	0	0	0	1016 - 1022	Dry	Dry
QWS06	0.25	1.75	17.10 – 18.20	2.80 – 3.00	0	0	0	0	1015 - 1021	Dry	Dry
QWS07	0.25	1.25	19.30 – 20.20	1.30 – 1.40	0	0	0	0 – 0.10	1015 - 1022	1.50 – 1.65	-
QWS10	1	1.9	20.80 – 21.20	0.10 – 0.30	0 – 0.10	0	0	0 – 0.10	1015 - 1023	1.80 – 1.85	1.560
QWS12	0.5	3	17.90 – 21.00	0.20 – 3.10	0 – 0.10	0	0	0 – 0.20	1015 - 1023	Dry – 1.90	-
QWS14 N	0.2	1.2	21.10	0.10 – 0.20	0 – 0.10	0	0	0 – 0.20	1015 - 1022	Dry - 1.72	-

Borehole Installation	Response Zone		Results Range of Determinands								
	Top Depth (m)	Bottom Depth (m)	O ₂ (% v/v)	CO ₂ (% v/v)	CH ₄ (% v/v)	H ₂ S (ppm)	CO	Flow Rate (l/hr)	Atmospheric Pressure (mb)	Water Level (mbgl)	Oil/ Hydrocarbon Level (mbgl)
	19mm Ø Installations										
QBH01	4	8	21.0 – 21.20	0.10	0	0	0	0 – 0.10	1016 – 1021	2.94 – 3.10	-
QBH02	3.5	6.5	20.70 – 21.10	0.20 – 1.20	0	0	0	0	1015 – 1022	6.10 – 6.70	-
QBH03	3.1	6.5	20.80 – 21.20	0.20 – 0.30	0 – 0.10	0	0	0	1015 – 1025	2.85 – 2.91	-
QBH04	3.5	7.7	20.80 – 21.20	0 – 0.10	0 – 0.10	0	0	0 – 0.10	1015 – 1025	2.55 – 2.72	-
QBH05	3	6.6	20.80 – 21.20	0 – 0.10	0	0	0	0	1015 – 1021	2.50 – 2.53	-
QBH06	2.5	6.5	1015 – 1022	1.20 – 4.10	0 – 0.10	0	0	0 – 0.10	1015 – 1022	1.35 – 2.60	-

The potential risks posed by any recorded presence of potentially harmful gases can be assessed on a semi-quantitative basis by reference to the guidance in documents CIRIA 665 and BS8485. The assessment comprises multiplying the maximum measured steady gas flow rate (expressed as litres per hour) by the maximum steady gas concentration (expressed as percentage-by-volume; divided by 100) to derive a Gas Screening Value (GSV). The GSV can then be used to determine a risk classification and a Characteristic Situation for the site as defined in Table 21 below.

Table 21: Land Gas Risk Classifications & Characteristic Situation

Characteristic Situation	Risk Classification	Gas Screening Value (l/hr) - GSV
1	Very low	<0.07
2	Low	>0.07, <0.7
3	Moderate	>0.7, <3.5
4	Moderate to High	>3.5, <15
5	High	>15, <70
6	Very High	>70

The Gas Screening Value for Methane is 0.0002 l/hr and Carbon dioxides is 0.094 l/hr indicating the site is in site in Characteristic Situation 1, indicating a very low risk classification, *no special protective measures are required*. This assessment however is based solely on the first three monitoring visit results and therefore will require revision upon completion of the monitoring exercise, which Quantum shall undertake and submit as an Addendum.

However, the PID screening results from the soil samples obtained from site and in recognition of the very high hydrocarbon concentrations does pose a significant risk of harmful volatile vapour gases emitting from the shallow soils. As a consequence, remedial measures are required to reduce the hydrocarbons in the

shallow soils and based on post-remediation chemical testing of any residual contaminants, the requirement for any special gas protective measures must be re-assessed as there is likely to be the requirement for a Volatile Organic Compound vapour membrane and measures to be implemented.

The determined groundwater levels appear to remain static, at least throughout the fieldworks and post-fieldwork monitoring period. Previous report by Ground Investigation Limited in 2004, determined a groundwater hydraulic gradient of 0.003 towards the south/south-west. This was confirmed as being 0.002 in a later investigation and report at the former filling station following removal of the tar tank in the north of the site. As such it was reasonable to assume that this gradient would apply across the site flowing a south-west direction. This would suggest that based on the Fluvial Glacial deposits revealed at relatively shallow depth and the shallow groundwater levels recorded that the nearby River Afan would be at risk from contamination entering the groundwater on site and providing base flow to the river. Similarly, the old brick culvert that dissects the site north-west to south-east, depending on condition of the culvert may also be at risk.

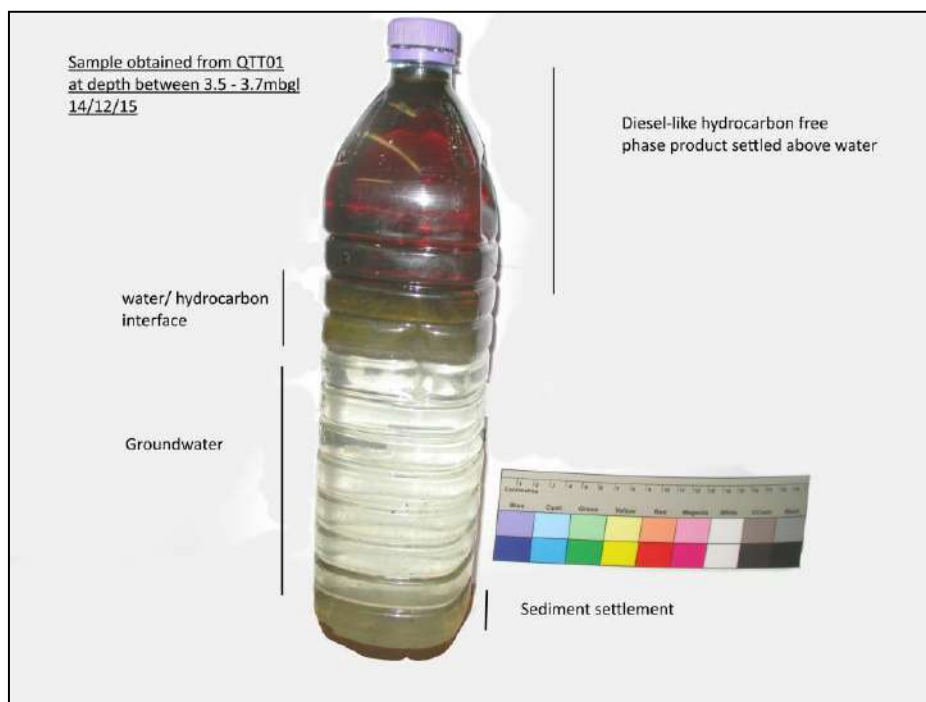
Groundwater monitoring data retrieved from the QGL ground investigation also identified a marginal hydraulic gradient to the south to the magnitude of average 0.002 as per previous studies, with a peak of 0.007 determined. However, connectivity is questionable based on the observations made during the borehole and trial pitting exercises undertaken.

Significant volumes of free phase product hydrocarbons were recorded resting above the groundwater both during the fieldworks and also in post-fieldwork monitoring. Up to 50mm was recorded in post-fieldwork resting above the groundwater in QTP02A in the north and QWS10 in the south.

The soil leachate results across site did not record elevated Total Petroleum Hydrocarbons and only occasional marginally raised Polycyclic Aromatic Hydrocarbons. However, the groundwater samples obtained and tested during the investigation and from post-fieldwork sampling recorded extremely high concentrations. This would indicate that the hydrocarbons are in free phase liquid form and also mixed with the shallow groundwater. The highest concentrations were attributed to the northern area of site i.e. area of the former tar tank (emptied in 2007 but could not be located in the QGL investigation – possibly removed also in 2007) and more so to the south-eastern area towards the former filling station i.e. QTT01/A and QTT02, where voluminous quantities of free product were recorded flowing into the trenches (please refer to individual logs and photos in the Appendices for more information).

Photograph 1 below is a sample of the hydrocarbon collected from QTT01 at 3.5mbgl. The odour, colour and hydrocarbon chemical analysis suggests a diesel range product. Under a controlled environment at QGL laboratories, it was possible to ignite this hydrocarbon with a direct flame, indicating the high concentration and 'purity' of the liquid.

Photograph 1: Hydrocarbon sample obtained from QTT01



**Photograph 2: QTT01 from which the
aforementioned hydrocarbon was
obtained.**

Such highly concentrated hydrocarbons is considered to pose a significant risk to both human health and the environment. The presence of free phase hydrocarbons most notably within the underlying granular Alluvium and Fluvial Glacial deposits after almost 9 to 10 years following removal of the filling station underground fuel tanks in the south and emptying of the tar tank in the north indicates that there has been very little change if any since the earlier ground investigations. It also suggests that movement or flow of the hydrocarbons is negligible, similarly the groundwater flow must either be static or is not entraining the free product hydrocarbon with movement.

The overlying clay rich material, typically the shallow Alluvium deposits or intermixed Made Ground/ Alluvium layer, was observed to act as an aquiclude to the groundwater and hydrocarbons. Upon breaching this layer and excavating or drilling through, the groundwater rose fast and bubbling and foaming was observed in several trenches where hydrocarbons were recorded.

Remediation of the highly contaminated hydrocarbon areas on site is required. This is discussed further in Section 6.5.

6.4. Contamination Discussion

6.4.1. Human Health Risk Considerations – RESIDENTIAL AREAS

- Unacceptable levels of Petroleum Hydrocarbons were encountered within soil samples from Windowless Sample QWS04, in the proposed residential zones, within the former Council Yard area.
- Unacceptable levels of Heavy Metals i.e. Chromium and Lead were encountered in soil samples taken within the proposed residential zone, in the Made Ground and underlying natural ground. Elevated concentrations were recorded across the proposed residential area and not curtailed to any one particular area.
- Unacceptable levels of Polycyclic Aromatic Hydrocarbons were encountered within soil samples across the south, centre and north of the site in the proposed residential zones.
- Asbestos was detected in various forms i.e. Chrysotile and Amosite, across the proposed residential area at depths between ground level and 2mbgl within the Made Ground (see Section 6.1.1. Table 14 highlights).

Based on the findings of the soil tests undertaken across the proposed residential area as set out on Figure 2 at the rear of Appendix I as supplied by the Client at time of investigation, there are significant human health risks to future site residents/ users with several contaminants exceeding the residential with plant uptake criteria assessment. Most notably the Polycyclic Aromatic Hydrocarbons. The elevated contaminants do appear to be contained with the overlying Made Ground, although due to past groundwork historical activity, perhaps through earlier demolition of buildings, the underlying upper layers of the natural Alluvium deposits have become intermixed with the lower lying Made Ground materials and as such contaminants have become entrained to depths in excess of 2mbgl.

The Petroleum Hydrocarbons did not record any significantly raised concentrations from the soil tests, indicating that such hydrocarbons are more prevalent in the liquid phase.

The pollutant linkages identified in the CSM in Section 6.1, have been confirmed through this latest phase of ground investigation. Whilst several sources may have been removed between 2004 to 2007, the residual contaminants that are considered to have originated from these sources remain at unacceptably elevated concentrations and therefore the risk to human health in residential areas remains significant.

Depending on Remediation strategies employed, there remains a risk of harmful gases, particularly volatile vapours relating to hydrocarbons in liquid form residing in the Made Ground and underlying Natural strata. As such inhalation pathway risk is significant.

Remediation is required to mitigate the risks to Human Health in the proposed Residential Area. This is discussed further in Section 6.5.

6.4.2. Human Health Risk Considerations – RETAIL AREAS

Whilst the assessment criteria for Retail (Commercial) end use is less stringent than that of Residential end use, a few contaminants have recorded elevated concentrations above the generic published thresholds.

- Unacceptable levels of Polycyclic Aromatic Hydrocarbons were encountered within soil samples across the south, centre and north of the site in the proposed retail zones.
- Raised Tin and Chromium Total concentrations, albeit in isolation, in the Made Ground.

No Petroleum Hydrocarbons within the soil samples tested recorded concentrations above the applicable threshold levels.

Asbestos in cement and fibrous forms were identified across the proposed Retail Area posing significant human health risk.

Based on the above, pollutant linkages are realised, with the main source being the Made Ground. The liquid phase hydrocarbons within the Retail areas as detailed in Section 6.4.1. remain a risk through harmful vapour emissions.

Remediation is required to mitigate the risks to Human Health in the proposed Retail Area. This is discussed further in Section 6.5.

6.4.3. Environmental Risk Considerations – RESIDENTIAL AREAS

The over-riding contaminants identified throughout previous ground investigations and this most recent supplementary investigation is Petroleum Hydrocarbons and less o Polycyclic Aromatic Hydrocarbons as determined from the water samples obtained.

Soil Leachate testing recorded elevated heavy metal concentrations within the Made Ground indicating these to be potential mobile and pose a threat to the underlying groundwater and nearby controlled waterways.

- Unacceptable levels of heavy metals i.e. Arsenic, Chromium, Copper, Lead and Zinc were encountered in the leachate analysis within the north and centre of the site within the proposed residential area.

However, soil leachate testing did not record any significant concentrations of Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons. It was the water samples that recorded extremely high concentrations of Hydrocarbons in various forms throughout the full Carbon range tested i.e. C5-C40. A general increase in concentrations in the Aliphatic and Aromatic Carbon range of between C8 – C21 is noted and the olfactory and visual records taken during the investigation indicate a strong diesel-like hydrocarbon prevailing in the

southern and northern areas.

- Unacceptable levels of heavy metals, Napthalene and Hydrocarbons were encountered in the water samples taken from Trial Trench QTT03 within the Made Ground, near to the former tar tank, within the residential zone. In addition, Unacceptable levels of heavy metals were encountered in the centre of the site in the former (now infilled) pond area.

In light of the above, there is a significant risk realised to the environment, predominantly the aquatic environment and any controlled waterways. A source-pathway-receptor linkage has been concluded, with the groundwater and the River Afan at most risk.

Biodegradation from naturally processes of the hydrocarbons within the groundwater does not appear to have been significant in the last 10years with concentrations remaining extremely high as per earlier studies.

Remediation is required to mitigate Environmental and Controlled Water Risks in the proposed Residential Area most notably in the northern region near the former tar tank location. This is discussed further in Section 6.5.

6.4.4. Environmental Risk Considerations – RETAIL AREAS

Similar to the proposed Residential Area, the soil leachate analysis for the proposed Retail area in the south and south-west of the site, recorded raised heavy metal concentrations but no raised hydrocarbon related analytes.

- Unacceptable levels of heavy metals i.e. Arsenic, Chromium, Copper, Lead, Tin and Zinc were encountered in the leachate analysis within the south and former petrol station area in the proposed retail area.

It was the water samples obtained that recorded the raised hydrocarbon concentrations focusing towards the former petrol filling station area, as originally identified in past studies.

- Unacceptable levels of Heavy Metals, Polycyclic Aromatic Hydrocarbons, Heavy Metals, Hydrocarbons and Mono aromatics were encountered in the water samples taken from exploratory holes located in the proposed retail zone and the Former Petrol Station.

As with the Residential Area, the concentrations and extent of the hydrocarbons logged in this investigation do not appear to have changed significantly over the past 10 years. The southern area of the site and towards the former petrol filling station area recorded the highest hydrocarbon concentrations on the site as a whole. The presence of free phase hydrocarbons in QWS10 in the most south-westerly corner of the site, some 60-70 m, away from the former petrol filling station (perceived source of the hydrocarbons) suggests that the previously identified hydraulic gradient towards the south/south-west is prevalent, and would also indicate through such potential movement that hydrocarbon pollution extends beyond the site boundary,

particularly so as this was often recorded within the natural Fluvial Glacial granular deposits circa 3.5 mbgl. Horizontal movement though must be considered exceptionally slow based on the volume of hydrocarbon free phase product encountered towards the perceived former filling station source area.

It cannot be discounted that based on the volume of hydrocarbons observed/ recorded that an additional source rather than just the former filling station may be responsible. The volume of hydrocarbons and extent suggests that significant leaking of the former filling station underground fuel tanks took place over a prolonged period which may well be the case.

Remediation is required to mitigate Environmental and Controlled Water Risks in the proposed Retail Area most notably in the southern and south-western areas. This is discussed further in Section 6.5.

6.4.5. *Environmental & Human Health Risk Considerations – Summary*

Findings from this investigation indicated that there is minimal, if any, change to the contaminative status of the site since previous ground investigations with the heavy metals and Asbestos prevalent in the soil (Made Ground) across the entire site and also considered to be leachable (mobile) based on soil leachate test results.

Whilst occasional raised heavy metals are recorded in the groundwater samples, it is the Hydrocarbon species that are the dominant contaminant in the groundwater, existing as free phase product resting above the groundwater and also as dissolved product within the groundwater. Two distinct areas across the site recorded extremely elevated hydrocarbons (both PAH and TPH), areas surrounding the Former Petrol Filling Station and Tar tank.

In summary, the site poses unacceptable health risks to site users, future residents as well as the environmental and controlled waters. The potential sources, pathways and receptors outlined in Section 6.1 all remain valid, none have been discounted through this supplementary investigation. Remediation of the site prior to any development is considered necessary to reduce the risks posed by the various sources and sever the pollutant linkages as identified in the CSM.

6.5. Recommendations on Remediation of Contaminated Land

Prior to development of the site, remediation and risk mitigation measures need to be implemented for both human health and environmental purposes.

In 2008 Lee Remediation Ltd undertook an assessment of remediation requirements solely on the former petrol filling station area in the southern area of the site.

Lee Remediation Ltd recommended the following for the former petrol filling station area as summarised from their report;

- 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 Petrol Filling Station, including a gas membrane and passively ventilated sub-floor layer; and
- Protection to water supply pipes.

Based on this methodology, it is likely that this similar method may be adopted for the northern area of the site near the former tar tank where hydrocarbon levels were also extremely high i.e. QTP02 area.

However, this may alleviate the risks posed by the hydrocarbons however, the Made Ground, also harbours raised heavy metal constituents which have been deemed leachable and Asbestos.

In the proposed Retail areas, only isolated raised values with the soil samples for Chromium and Tin were identified within the Made Ground and based on the end development, the pathway to site end users to these raised metals can be severed by hard standing and/or imported soft landscaping. However, this would need to prevent the potential leaching of these metals and therefore an appropriate remediation strategy must be adopted to manage the Made Ground.

The Residential Area also recorded raised soil heavy metal concentrations within the Made Ground to depths in excess of 2mbgl which were also deemed leachable (mobile). Such concentrations exceeded the relevant residential end use assessment criteria significantly with extremely high Arsenic and Chromium levels. With the proposed new residential development having garden areas and the exposure times and vulnerability of end receptors, the risk to residents/ residential area is far greater than that posed to the proposed Retail Area.

Therefore, the Made Ground across the site will require Remediation to reduce metal concentrations, hydrocarbons, remove Asbestos and limit the leachability of such contaminants. An appropriate method of remediation is required to be devised tying in with the hydrocarbon remediation methodology detailed above

by Lee Remediation in 2008. A specialist Remediation company should provide appraised remedial options, a clear strategy and an implementation plan. This would be followed up by a Verification and Validation assessment to corroborate that the remediation has been undertaken as per the strategy and that it has been successful in achieving the set remedial targets.

It is possible that the in-situ or on site remediation of the Made Ground may be economically non-viable and as such offsite disposal of all Made Ground following the hydrocarbon remediation works and replacement with imported inert fill material may be the more suitable option. Large mounds of excavated soils remain on site as well as the two steel portal frames that would require demolition including the associated foundations.

The removal and replacement of the Made Ground would be beneficial to the construction of the proposed new houses and commercial units. As detailed in Section 7 Geotechnical Engineering Appraisal, it is likely that shallow foundations will be adopted for all new builds which would require ground improvement works to be undertaken. By performing this in conjunction with the Remediation works, this may present a more efficient and economical means of improving the ground and cleaning up the Made Ground. It may also provide opportunity for visual structural inspection of the existing old culvert that dissects the site.

Any remediation undertaken must take into consideration the possibility and all likelihood that hydrocarbon contamination from the site has extended outside of the site boundaries.

The geo-environmental laboratory test results indicate the risks posed to construction operatives including remediation operatives from chemical contaminants within the Made Ground is high. Operatives working with, or likely to come into contact with made ground with the potential to harness raised concentrations of contaminants, should observe particular precautions concerning personal hygiene. Litter and buried fly tipped waste including sharps are abundant and extra care and vigilance should be taken.

All site workers should be issued with the appropriate personal protective equipment and should be instructed in safe working methods. Instructions should be issued in the recognition of potentially hazardous materials including oily and odorous soil and water and also any discoloured or fibrous substances. Operatives should be warned to avoid contact between hands and mouth before washing. The consumption of food must be confined to designated clean areas with suitable welfare including washing facilities should be provided.

6.5.1. Offsite Waste Disposal Assessment

As detailed above, whether it be the Remediation works or the Construction works, it is possible that offsite disposal of excavated spoils will take place. This may include the shallow lying Made Ground and the stockpile mounds of excavated soils which are heavily masked by vegetation on the central and north-eastern areas of site.

For the purpose of landfill the waste is classified into three main types: inert; non-hazardous; and hazardous. There are several specific requirements related to each main waste type. In general, under current legislation as a waste producer the owner or developer of the site has the following responsibilities:

- ensuring that waste from the site is tested and classified
- ensuring that the site is registered with the Environment Agency/ Natural Resource Wales
- ensuring that waste is pre-treated and disposed of at a licensed facility
- keeping accurate records of all waste classification, transfer and disposal
- submitting full copies of those records for inclusion in validation reports
- maintaining those records for potential future regulatory inspection

In order to assess the classification for off-site disposal of any excess or contaminated soils, samples of the material are subject to a waste acceptance criteria (WAC) test. Suitable disposal facilities can include treatment and recycling centres as well as landfill sites.

6 No. Full WAC Inert Tests were undertaken on selected samples. The samples and classification are recorded below:

Sample ID	Location on Site	Sample Depth (mbgl)	Sample Soil Type	Waste Disposal Classification
QTT01, 4	South-east area	1.6	Made Ground	Stable Non-Reactive Hazardous Waste in non-hazardous landfill
QTT02, 1	East area	0.4	Made Ground	Stable Non-Reactive Hazardous Waste in non-hazardous landfill
QTP01, 1	North-west area	0.3	Made Ground	Inert Waste Landfill
QTP21, 2	Central	0.6	Made Ground	Stable Non-Reactive Hazardous Waste in non-hazardous landfill
M2, 1	North-east area	Surface	Made Ground	Inert Waste Landfill
M4, 1	East area	Surface	Made Ground	Stable Non-Reactive Hazardous Waste in non-hazardous landfill

However, please note that the recorded presence of Asbestos may dictate that all material destined for offsite disposal must be treated as Hazardous and be taken to a hazardous waste receiving facility unless further Asbestos quantification testing is undertaken to determine the % by volume of Asbestos in the range of any excavation depths to determine if it may be deemed as non-hazardous based on concentrations recorded.

Remediation processes may also alter the WAC classification, and therefore post-remediation may require re-testing for offsite classification.

All chemical laboratory test results should be forwarded to the intended waste receiving facility to ensure that classification of the material is in line with their requirements.

7. GEOTECHNICAL ENGINEERING APPRAISAL

7.1. General

Whilst full details of the proposed development are unknown at time of writing and layout subject to change, the proposed development has been taken as being that indicated in 'Figure 2: Proposed Site Layout' as presented by the Client and located at the rear of Appendix I. It is anticipated that the proposed residential area typically the north/north-west area of site as depicted in Figure 3A Appendix I, will comprise mixed semi-detached two storey houses and apartment blocks of conventional block build. Whilst the Retail (commercial) development towards the south/south-east area of site is likely to comprise steel portal frame buildings with part block construction.

The following Section 7 provides geotechnical parameters and recommendations for the new builds based on limited information at time of writing. Anticipated loading of any new build is unknown and therefore the following recommendations are general in nature and may require review pending final design stage and layout.

7.2. Engineering Properties of Strata

The soils on site comprised varying thicknesses of made ground overlying estuarine deposits over fluvial deposits. The engineering properties each strata is summarised below:

7.2.1. Made Ground

The geotechnical in-situ test results undertaken within the Made Ground deposits are summarised in Table 22.

Table 22: Summary of Made Ground In-situ and Laboratory Test Results

Made Ground	Range	Mean	No. Tests
California Bearing Ratio	4.5 - 28	11.8	12
Moisture Content (%)	7.5 - 23	15.6	12
Standard Penetration Test (N value)			

The in situ and laboratory tests on the made ground deposits encountered correspond with the engineering descriptions presented on exploratory hole logs within Appendix III.

7.2.2. Estuarine Deposits

The geotechnical laboratory and in-situ test results undertaken on Estuarine Deposits are summarised in Table 23.

Table 23: Summary of Estuarine Alluvium Deposits In-situ and Laboratory Test Results

Estuarine Alluvium Deposits		Range	Mean	No. Tests
Particle Size Distribution	Cobbles (%)	0	0	8
	Gravel (%)	0 – 1	1	8
	Sand (%)	3 – 25	17.8	8
	Silt (%)	21 – 50	34	6
	Clay (%)	28 – 58	49	6
	Silt and Clay (%)	2 - 8	5	2
Moisture Content (%)		22 - 48	36.5	16
Liquid Limit (%)		34 - 76	53.38	8
Plastic Limit (%)		17 - 49	23	8
Plasticity Index (%)		17 - 49	30.38	8
M_v	(m^2 / MN)			
	Pressure range			
	0 – 50 kPa	0.67 – 2.1	1.31	5
	50 - 100 kPa	0.33 – 0.73	0.62	5
	100 – 200 kPa	0.19 – 0.53	0.40	5
C_v	(m^2/yr)			
	Pressure range			
	0 – 50 kPa	0.36 – 7	3.14	5
	50 - 100 kPa	0.18 – 7.2	2.55	5
	100 – 200 kPa	0.24 - 10	3.14	5
Bulk Density (Mg / m^3)		1.76 – 2.01	1.89	8
Dry Density (Mg / m^3)		1.19 – 1.52	1.37	8
Cell Pressure (kPa)		60 - 80	66.67	3
Cohesion (kPa)		12 - 22	16.67	3
Failure Strain (%)		12.3 – 17.6	15.37	3

The Particle Size Distribution of the samples of Estuarine Fluvial Deposits indicates the material to be slightly gravely sandy very silty CLAY generally consistent with the description provided within the engineering logs except the sample taken at 2.0 – 2.50m depth which is indicated to be slightly clayey sandy GRAVEL. The SPT 'N' values undertaken within the Estuarine Alluvium Deposits ranged in values from 1 to 15.

7.2.3. Fluvial Gravels Deposits

The geotechnical laboratory and in-situ test results undertaken on Fluvial Gravels Deposits are summarised in Table 24.

Table 24: Summary of Granular Alluvial Deposits In-situ and Laboratory Test Results

Cohesive Alluvial Deposits		Range	Mean	No. Tests
Particle Size Distribution	Cobbles (%)	8 - 14	11.3	6
	Gravel (%)	68 - 73	71	6
	Sand (%)	11 – 17	16.17	6
	Silt and Clay (%)	1 - 2	1.83	6
Moisture Content (%)		5.6 – 6.3	5.96	2

The Particle Size Distribution of the samples of Fluvial Gravels Deposits indicates the material to be generally slightly silty slightly clayey sandy GRAVEL with medium cobble content consistent with the description provided within the engineering logs. The SPT 'N' values undertaken within the Fluvial Gravels Deposits ranged in values from 38 to excess of 50. The SPT 'N' values indicate the Fluvial Gravels Deposits to have an estimated Effective Angle of Friction (Φ') of 38°.

7.3. Earthworks

7.3.1. Site Preparation

Prior to commencing the earthworks/ groundwork for the development, all live services on and in the vicinity of the site should be accurately located and protected or if required diverted. The ends of existing drains or sewers, which may be made redundant by the development, should be sealed in order to prevent any residual or persisting seepages from adversely affecting the integrity and or stability of the formations/ foundations. Service conduits and surface voids resulting from the sites preparation works should be filled and well compacted with acceptable granular material (DoT Type 1 or similar approved).

Please note that site preparation will be dictated by the remediation strategy and processes that have been undertaken prior to the construction of suitable founding formations and as such the planning and design of the earthworks and site preparation must be undertaken in direct consultation with the remediation processes.

All areas of existing hardstanding shall be excavated and removed. Disposal of Bituminous or Asphalt materials shall be done so at a licenced waste receiving facility with full documentation provided.

Earthworks shall be carried out in accordance with BS 6031: 2009 Code of Practice for Earthworks. Workmanship for excavation shall comply with BS 8000: Part 1, sections 3.1, 3.2 and 3.3.

Materials arising from excavations shall wherever suitable, be retained on site for filling. Surplus material, or material unsuitable for fill/ landscaping, shall only be removed from site at the request of the Contract Administrator.

Prior to any remediation taking place it is evident from this ground investigation that high levels of contaminants reside within the shallow Made Ground as well as Asbestos fragments and much fly tipped materials including hypodermic needles. During the earthworks/ site preparation phase material excavated shall be visually and olfactory assessed for the presence of contamination throughout the construction phases even following remediation processes.

All material that is considered to exhibit signs of residual contamination encountered during site prep and following the remediation phase, shall be stockpiled appropriately and separately tested to establish for re-

deposition or disposal offsite. Material to be retained on site shall be stockpiled. Materials deemed to be unsuitable due to contamination, shall only be removed from site at the request of the Contract Administrator.

Any existing foundations or ledges of hard rock, roots of trees or former pipelines or services at the base of the proposed development area shall be excavated and replaced with compacted general fill which shall be compacted to the same specification as adopted for subsequent compaction works.

It is anticipated that shallow foundations will be adopted across the site for both residential and retail as per Section 7.5.1, and therefore it is likely that removal of the shallow Made Ground whether it be in full or to a predefined reduced level will be required to permit construction of a suitable founding medium. The depth of Made Ground to be removed will be dictated in part by the Remediation strategies employed, however, from a geotechnical aspect, the Made Ground is extremely variable and a substantial thickness would either have to be removed and replaced with a suitable engineering fill i.e. Type 1, spread and consolidated in layers in accordance with Tables 6/1 and 6/4 Volume 1 Specification for Highways Works, or some form of ground improvement treatment of the Made Ground through excavation, sorting and re-compacting would be required.

When reducing the site levels to accommodate a newly constructed formation for the new builds to be founded upon, proof rolling of the underlying material would be required. Proof rolling will require undertaking prior to excavation for foundations.

Any localised soft spots encountered (typically with a CBR Value <2% or Shear Strength of <50 KPa) should be removed and replaced with suitable excavated or imported granular material or Type 1 stone. Any large areas of soft material, indications of soil pumping or rutting should be reported to the Engineer. No tree roots greater than 5mm diameter, no root balls and no masses of fibrous roots shall remain at the base of the excavation.

In areas of fill, suitable excavated or imported material, in this case advised as Type 1, is to be spread and consolidated in layers in accordance with Tables 6/1 and 6/4 Volume 1 Specification for Highways Works.

Determination that sufficient proof rolling has been undertaken may be assessed through both visual assessment of the reduced formation and where required, undertaking in-situ testing to confirm any perceived areas of anomaly or areas where additional passes are required. Visual inspection would include recognition of any surface depressions, soft spots, hard spots, marked variation in soils exposed, loose material, rutting and pumping.

In-situ test in the form of plate CBRs distributed across the formation would provide quantitative measure of the proof rolling being adequate. A value of >3% would be deemed sufficient.

A separator membrane of suitable strength and chemical resistance should be installed between and residual