Pembrokeshire County Council Eco-Park

Phase 2 Baseline Assessment Report

On behalf of **Pembrokeshire County Council**

Pembrokeshire County Council
Cyngor Sir Benfro

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1 Introduction

1.1 Brief

1.1.1 Eunomia Research & Consulting Ltd, acting on behalf of The Waste and Resource Action Programme Cymru (WRAP) and Pembrokeshire County Council (PCC), has instructed Stantec to prepare a preliminary Phase 2 Ground Investigation Report for the proposed PCC Eco-Park, Amoco Road, Milford Haven to be referred to hereafter as 'the Site'.

1.1.2 This report has been prepared for the joint benefit of The Waste and Resource Action Programme Cymru (WRAP) and Pembrokeshire County Council and the contents should not be relied upon by others without the express written authority of Stantec. If any unauthorised third party makes use of this report they do so at their own risk and Stantec owes them no duty of care or skill.

1.1.3 The purpose of the report is to provide a baseline for the site evidencing historical contamination that is present in the soils and groundwater beneath the Site prior to the occupancy of the site as a waste transfer station. The report follows on from the H5 Site Condition Report (SCR) dated December 2019 (report prepared by PBA, now Stantec). Reference should be made to this report for completeness.

1.1.4 This report presents factual information obtained through completion of the ground investigation, characterisation of the underlying ground conditions and assessment of contamination in relation to human health and the environment.

1.1.5 Attention is drawn to the **Guidance Notes** included in final section, which provides advice for the readers of this report.

1.2 Site Location

1.2.1 The location of the site is illustrated in **Figure 1**. The proposed Environmental Permit Boundary and the site layout is illustrated on **Drawing 001** dated November 2019.

1.2.2 The Site is located approximately 3km north west of Milford Haven. The Site is at the northern extent of the Milford Haven Oil Refinery

1.2.3 The Site is centred at national grid reference SM 89010 209300 and covers an area of approximately 5,800 square metres.

1.3 Site Redevelopment

1.3.1 It is understood that the site is to be redeveloped from its existing use to a household, commercial and industrial Waste Transfer Station (WTS), Household Water Recycling Centre (HWRC) and vehicle depot with treatment consisting of manual sorting, separation, screening, baling, shredding, crushing or compaction of waste into different components for disposal (no more than 50 tonnes per day), or recovery. The items below are the permitted activities to be undertaken on site:

i) **R3**: Recycling or reclamation of organic substances which are not used as solvents.
ii) **R4**: Recycling/reclamation of metals and metal compounds.
iii) **R5**: Recycling or reclamation of other inorganic materials.
iv) **R13**: Storage of wastes pending the operations number R3 and R5.
v) **D9**: Physico-chemical treatment.
vi) **D14**: Repackaging prior to submission to any of the operations numbered D1 to D13.
vii) **D15**: Storage pending any of the operations numbered D1 to D14.

1.3.2 In addition to the activities above, waste collection vehicles will also be stored on-site, however this is classed as a non-permitted activity.

2 Land Use Information

2.1 Introduction

2.1.1 The following section presents a summary of findings gathered from site visits, published information and mapping, to inform on the Site setting including geology, hydrogeology, hydrology and historical land-use. Full details are presented in the PBA H5 SCR report ref 47244/3501/R1 (PBA now Stantec).

2.2 Site Setting

2.2.1 The Site is located east of the A470 and approximately 3km north west of the Milford Haven town centre. The Site is located at the northern extent of the Milford Haven Refinery site (currently identified as the Haven Waterway Enterprise Zone). The Site is bounded to the north by an unnamed minor road while the wider refinery site extends to the east, south and west.

2.2.2 A site visit undertaken on 19th November 2019 as part of the Site Condition Report assessment found the site to be in the following condition (photographs from this site visit are attached in **Appendix A**).

2.2.3 For the purposes of description, the site is split into three areas as identified in **Drawing 001**.

2.2.4 Area 1 is located in the northeast of the Site and is surfaced with a mixture of tarmac and gravel (Photographs 1 and 3). A helipad is present towards the centre of this area. At the time of inspection, Area 1 was being used for an ad-hoc overflow car parking, with shipping containers also stored in the north of the Site (Photograph 2). It is understood that this area has historically been used as a compound for contractors during construction and demolition works that have taken place across the wider refinery. A tiled floor possibly indicative of the presence of a former building were noted in the container storage area, although no evidence of such a feature is recorded on historical mapping (Photograph 2).

2.2.5 Area 2 is located in the west of the Site and is predominantly grass surfaced, bisected by concrete and macadam roads and footpaths (Photograph 4). A macadam helipad is located toward the northwest of the area (Photograph 5). A shed containing an electrical substation is located in the south of the area.

2.2.6 Area 3 is located in the southeast of the site and was entirely grass surfaced. This area sloped steeply towards the off-site refinery access road, with a ditch present along the southern boundary (falling south-eastwards off-site); at the time of inspection the ditch appeared to be dry. Mature trees were noted adjacent to the ditch although the species were not readily identifiable (Photograph 6)

2.3 Historical Land Use

On-Site

2.3.1 Up until the 1972 to 1973 map extract, the Site is shown as undeveloped and presumed agricultural land bisected by an unnamed road running north to south. The 1972 to 1973 map no longer shows the road passing through the Site.

2.3.2 The 1978 edition map shows the Site to fall within the curtilage of Milford Haven Oil Refinery, and a helipad is present in the western part of the Site. A small area of ‘marsh’ is recorded in the southeast of the Site.

2.3.3 The 1992 to 1994 map edition shows an additional helipad to be present in the western part of the Site.

2.3.4 No further significant changes are noted on maps published between 1994 and the present day.

2.3.5 Discussion with Puma Energy representatives during the course of the works identified that the Site area was used for the siting of offices during the construction of the Milford Haven Refinery and has since been used occasionally for storage.

Off-Site

2.3.6 In 1887 much of the immediate surroundings to the site were undeveloped, comprising agricultural fields, with the hamlets of Robeston Cross and Robeston West recorded some 50m to the north and 0.5km to the west of the Site respectively.

2.3.7 The surrounding area remains broadly unchanged until the 1978 edition map shows the development of the Milford Haven Oil Refinery, which extends broadly southwards from the southern Site boundary for over 1.5km. A railway line has also been constructed adjacent to the refinery, located 400m to the south at its closest point. The 1978 edition map also shows the development of a garden nursery 500m to the west of the Site.

2.3.8 No significant changes in land use are recorded in later map editions.

2.3.9 All of the above represent potentially contaminative former land uses in the locality of the site.

2.3.10 The Envirocheck report records that there have been no recorded pollution incidents on-site.

2.3.11 There are 13 integrated pollution control sites located within 1km of the site, related to the refinery operations. All of these are now shown as superseded or revoked

2.3.12 Six registered Radioactive Substance Sites are recorded within 800m of the site, all relating to activities within the refinery site to the south.

2.3.13 The entire Total Elf Fina refinery site area including the site and the area to the south is recorded in the Envirocheck report as a Local Authority Landfill site, however no other details are provided.

2.3.14 Small areas within the refinery areas are also recorded as landfill sites. The nearest of these is 630m south west registered to Amoco UK Ltd dated 1978 authorised for iron oxide, oil contaminated sludge, oil/water mixtures, spent bauxite and spent catalyst from cracking units. A further area is noted 820m west registered to Elf Oil UK Ltd from 1990 for the acceptance of oily waste arising on site.

2.4 Geology

Superficial Deposits and Solid Geology

2.4.1 There are no mapped superficial deposits covering the site.

2.4.2 The current BGS viewer portal shows the site to be underlain by bedrock of the Milford Haven Group which comprises marl with sporadic sandstone beds.

Made Ground

2.4.3 In addition to the above recorded geology, Made Ground is anticipated to be present on-site, albeit in a limited thickness. Made Ground is likely to be associated with former buildings (i.e. at the area where tiles are present at the surface) and current car parking and roads.

BGS Historic Borehole Data

2.4.4 There are no BSG historical boreholes records onsite. The nearest historical borehole record is approximately 700m south, adjacent to the eastern boundary of the refinery site. The borehole recorded topsoil followed by firm to stiff sandy gravelly clay for 6.5m followed by mudstone. No groundwater was recorded. The BGS mapping indicates the presence of till at the surface at the location of the historical borehole but records no superficial deposits at the site.

2.5 Hydrogeology

2.5.1 Table 2.1 summarises information recorded in the Envirocheck report contained within the PBA H5 SCR (November 2019) regarding the hydrogeology of the Site and groundwater vulnerability.

Table 2.1 Summary of Hydrogeology and Groundwater Vulnerability

Item	Details
Aquifer Classification	Bedrock – Secondary A Aquifer
Groundwater Vulnerability	The Envirocheck Report indicates that the site soil classification is of high leaching potential (although superficial deposits are likely to be very limited in thickness)
Depth to Groundwater	No historical borehole data is available to indicate the depth to groundwater. Ground investigation data on groundwater depth will be presented below.
Groundwater Flow Direction	Shallow ground fracture flow south towards the Milford Haven Waterway.
Source Protection Zone (SPZ)	The Site does not lie within a Source Protection Zone.
Licenced Discharge Consents	None recorded.
Abstraction Licences	None recorded.

2.6 Hydrology

Table 2.2 below provides a summary of the hydrology of the Site and immediate surrounding area.

Table 2.2 Summary of Hydrology Information

Item	Details
Nearest Surface Water Feature	A drainage ditch is present adjacent to the southern site boundary in Area 3 which flows broadly south-eastwards away from the site and wider refinery, eventually flowing into Scotch Bay in Milford Haven. Drainage channels and surface water lagoons are present within the former refinery site to the south. A small unnamed stream is shown on

Item	Details
	mapping just south of the site boundary running south. The Milford Haven Waterway (estuary) is located approximately 6.7km south.
Surface Water Quality	Unknown.
Licenced Discharge Consents	None within 500m of the site. Elf Oil, Elf Oil Refinery, 870m S Pembrokeshire Council Sewage Disposal, 910m NE Elf Oil, Elf Refinery, 990m SW
Abstraction Licences	None recorded within 500m. Eight recorded between 700m and 1000m south of the site all relating to surface water for use in agriculture.
Recorded Pollution Incidents	None recorded on Site. 9 recorded off-Site, nearest being 200m E due to chlorinated water at Milford Haven Dock entrance. A major incident relating to an oil pipeline leak occurred in 1995 780m S.

2.7 Flooding

2.7.1 The Envirocheck report does not indicate a risk from groundwater flooding within 1km of the site. The Natural Resource Wales data indicates that the site does not lie within a flood plain.

2.8 Summary

2.8.1 Identified potential on-site and off-site sources of contamination are included in the table below:

Table 2.3 Summary of Potential Sources of Contamination

On-Site – contamination types	Off-Site – contamination types
Activities Related to Refinery Operations – TPH, PAHs, VOCs, SVOCs (NB the active parts of the refinery site were located to the south, although a helipad and building of unknown use were present within the Site)	Oil Refinery (heavy metals, PAH, TPH, VOCs, SVOCs)
Made Ground – Potential material imported to the site to achieve levels, or associated with former buildings and infrastructure (asbestos, metals, phenols, sulphates and PAHs)	

3 Ground Investigation

3.1 Fieldwork

3.1.1 A ground investigation was undertaken by Stantec utilising specialist drilling contractors CC Ground Investigations between the 17th and 26th of June 2020. The ground investigation works comprised the elements presented in Table 3.1 below.

Table 3.1 Summary of Exploratory Holes

Scope of Works	No.	Exploratory Locations	Maximum Depth Range (m bgl*)
Windowless Sampler Boreholes	12	WS01 to WS12	4.00
Rotary Boreholes	5	BH01 to BH05	10
Trial Pits (machine excavated)	3	TP01 to TP03	2.2

**m bgl – metres below ground level*

3.1.2 An exploratory hole location plan is presented as **Figure 2** and borehole logs are presented as **Appendix B**.

Table 3.2 Rationale for Exploratory Locations

Exploratory Hole Number	Location Rationale
WS01 to WS12	To give reasonable coverage of the Site ground conditions and any general contamination. To enable in situ and laboratory-based testing.
BH01 to BH04	To penetrate deeper into bedrock and enable bedrock characterisation and to install monitoring wells for gas and groundwater monitoring
TP01 to TP03	To give a reasonable coverage of the Site ground conditions, general contamination and to enable infiltration testing.

3.2 Aim of the Investigation

3.2.1 The aim of the investigation was to provide quantification and assessment of any contamination within the soils or groundwater (if present) within the Site and to record and characterise / classify the baseline underlying ground conditions for current and future land users. This includes a preliminary assessment of potential contamination in soil, geotechnical conditions and drainage potential.

3.3 Investigation Methodology

3.3.1 Ground investigation works were undertaken by CC Ground Investigations Limited (CC), who provided an experienced engineer to supervise the work, log exploratory holes and collect samples. Stantec maintained telephone contact with CC during the works, discussing each hole and directing sampling and testing and installation of monitoring wells in general accordance with BS 5930:2015 and BS EN ISO 14688.

3.4 Scope of Investigation

3.4.1 The following section provides a summary of the investigation works completed in June 2020.

- Twelve windowless sampler boreholes to a maximum depth of 4m bgl.
- Five rotary boreholes to a maximum depth of 10m bgl,
- Installation of five gas and groundwater monitoring wells within the rotary boreholes. The windowless sampler boreholes were backfilled with arisings and covered by concrete.
- Geoenvironmental sampling and testing.
- Records of any visual or olfactory evidence of contamination.
- Three return visits to measure the depth to groundwater and record concentrations and flow rates of ground gases in the five installed boreholes.

3.5 Windowless Sampler Boreholes

3.5.1 Windowless sampler boreholes were completed at twelve locations within the Site. The boreholes were typically terminated due to refusals at depths of between 1 and 4m bgl within gravels of mudstone or sandstone.

3.5.2 No groundwater was recorded in the 12 boreholes. PID testing was undertaken on all samples collected.

3.5.3 The windowless sampler boreholes were backfilled with arisings upon completion.

3.6 Rotary Boreholes

3.6.1 Five rotary boreholes were completed to their target depth of 10m bgl.

3.6.2 PID testing was undertaken on all environmental samples collected.

3.6.3 No groundwater was recorded whilst drilling, although water flush was used to advance most of the boreholes.

3.6.4 All boreholes were installed using nominal 50mm diameter groundwater and ground gas monitoring pipework. The top one metre of the installations comprised a plain pipe with the remaining being slotted with a geosock. The pipework was encased in a gravel filter pack and sealed from ground level using one metre of bentonite pellets and a flush cover concreted in place

3.7 Trial Pits

3.7.1 Three trial pits were advanced with a JCB 3CX excavator to depths of between 1.65m bgl to 2.7 m bgl.

3.7.2 PID testing was undertaken on all environmental samples collected.

3.7.3 No groundwater was encountered in the trial pits which were subsequently used for soakaway testing.

3.8 Logging and Soil Sampling

3.8.1 Continuous soil cores were recovered from the windowless sampler boreholes in plastic liners, which were split to enable detailed logging. All exploratory locations were logged by the CC Ground Investigations Engineer in general accordance with BS 5930:2015 and BS EN ISO 14688.

3.8.2 Representative disturbed soil samples were retained during the investigation and transported in appropriate laboratory supplied sample containers, with full chain of custody to an accredited laboratory. All sample locations and depths are recorded on the borehole logs presented as **Appendix B**.

3.8.3 Environmental soil samples were retained from the soils encountered for laboratory analysis and onsite PID testing. Disposable latex gloves and clean sampling tools were used during handling of the recovered soils. To prevent cross contamination, all sampling jars and equipment were transported in clean plastic containers and stored separately from the retained samples.

3.9 Geo-Environmental Testing

3.9.1 i2 analytical Laboratories, who hold UKAS accreditation, were commissioned by Stantec to complete the geo-environmental testing. Testing comprised completion of a general contamination suite of testing to quantify potential contamination present on site from historical land use.

3.9.2 The geo-environmental laboratory test results for soils are presented as **Appendix C**.

4 Ground Conditions

4.1 Stratigraphy

4.1.1 The ground conditions encountered during the ground investigation are summarised below in Table 4.1 and presented in full in **Appendix B**.

Table 4.1 Summary of Encountered Stratigraphy

Strata	Top Depth (m bgl)	Base Depth (m bgl)
Topsoil	Ground Level	0.3. - 0.7 (in 3 out of 20 locations)
Made Ground	Ground level	0.1 – 0.7 (in 15 out of 20 locations)
Till	0.3	3.65 - Unproven – typically logged as increasingly dense gravel of mudstone (i.e. weathered bedrock)*
Bedrock (Mudstone)	0.1 – 3.65 (depth to top of bedrock or weathered bedrock)	Unproven

*Base not proven in some exploratory holes.

4.1.2 The encountered ground conditions were broadly as expected following review of the BGS and Envirocheck maps. The BGS does not anticipated the presence of superficial deposits. Although Till (clay) was encountered in some locations, most positions recorded gravel of mudstone or extremely weak mudstone recovered as gravel

4.2 Topsoil

4.2.1 Topsoil was encountered in three exploratory holes (BH01, BH20 and TP01) to a maximum depth the of 0.70m. Topsoil was found to generally comprise friable reddish brown slightly gravelly slightly sandy clay with roots.

4.3 Made Ground

4.3.1 Made Ground was encountered in the majority of locations. Made Ground was logged as concrete (sometimes reinforced), tarmacadam and a clayey gravel matrix. Anthropogenic inclusions within the gravel were rare, although a geotextile barrier was noted in 7 locations at depths of between 0.1 and 0.2m.

4.4 Till

4.4.1 Glacial till in the form of gravelly clay was encountered in 14 out of 20 locations to a maximum depth of 1.65m bgl. Typically, the till was overlying weathered bedrock in the form of mudstone gravel.

4.5 Groundwater

4.5.1 Groundwater was not generally encountered during the intrusive investigation works. Shallow seepage was recorded in three locations.

Post-fieldwork Groundwater Monitoring

4.5.2 Combined ground gas and groundwater monitoring was carried out on the five monitoring wells on three occasions (02/07/20, 10/07/20 and 17/07/20 The results of which are summarised in the table below and presented in full in **Appendix D**.

Table 4.2 Summary of Groundwater Monitoring Data

Borehole ID	Minimum Depth* to Water [Date]	Maximum Depth* to Water [Date]	Depth to Base*
BH01	3.73 [10.07]	4.59 [02.07]	7.86
BH02	3.96 [10.07]	5.19 [02.07]	9.81
BH03	2.96 [10.07]	4.75 [02.07]	8.82
BH04	2.95 [10.07]	4.02 [02.07]	9.67
BH05	5.23 [10.07]	46.04 [02.07]	9.78

**metres below ground level*

4.6 Visual and Olfactory Evidence of Contamination

4.6.1 Made Ground was present throughout the site in 15 out of 20 locations, generally in shallow deposits with a maximum of 0.7m. No visual or olfactory evidence of contamination was recorded.

4.6.2 PID readings were taken on environmental samples. PID readings were generally very low, with readings greater than 20ppm recorded at only two locations; WS03 (max reading 85.5ppm at 1.0m bgl in natural gravel) and WS07 (max reading 42.8ppm at 0.5 bgl in natural clay). Laboratory analysis was undertaken on soils to quantify the presence of volatile compounds.

Post-fieldwork Ground Gas Monitoring

4.6.3 Post-fieldwork ground gas monitoring was carried out on three occasions (02/07/20, 10/07/20 and 17/07/20 using a GA5000 Analyser.

4.6.4 Results of ground gas monitoring are presented in full in **Appendix D**. Table 4.3 below summarises the recorded results.

Table 4.3 Summary of Post-Fieldwork Ground Gas Monitoring

Exploratory Hole	Flow* (l/hr)	Carbon Dioxide* (%v/v)	Date	Oxygen** (%v/v)	Date	Methane* (%v/v)	Date
BH01	<0.1	3.3	17/07/20	16.6	17/07/20	0.2	02/07/20
BH02	<0.1	2.3	17/07/20	12.3	17/07/20	<0.1	All
BH03	<0.1	1.8	17/07/20	17.1	17/07/20	<0.1	All
BH04	<0.1	1.7	17/07/20	19.0	17/07/20	<0.1	All
BH05	<0.1	3.6	17/07/20	15.4	17/07/20	<0.1	All

**Maximum measured value.*
*** Minimum measured value.*
****Where measured gas concentration is shown to be <0.1 this indicates the actual concentration is below the limit of detection for the gas monitoring equipment.*

4.6.5 The three monitoring rounds were carried out during a period of relatively high pressure (>1000mb), but atmospheric pressure fluctuated during monitoring, with trends of falling pressure recorded before round three in particular.

4.6.6 No elevated concentrations of carbon dioxide or methane were recorded during the three monitoring visits. No detectable flow rates were recorded in any of the boreholes.

4.6.7 These preliminary results indicate that ground gas generation is not an issue at the site.

4.6.8 During the return monitoring visits three water samples were obtained from the installations in boreholes BH01 to BH05 on the 2nd of July 2020.

Infiltration Testing

4.6.9 Infiltration testing was conducted in each of the trial pits to gain an understanding of the permeability of the shallow strata beneath the site. Testing was conducted (where possible) in general accordance with BRE 365.

4.6.10 Results of the infiltration tests are summarised below and presented in **Appendix B.**

Table 4.4 Infiltration Test Results Summary

Trial Pit	Test Result (ms^{-1})			Comments
	Test 1	Test 2	Test 3	
TP01	1.06×10^{-4}	7.14×10^{-5}	6.24×10^{-5}	-
TP02	6.66×10^{-5}	4.48×10^{-5}	1.91×10^{-5}	Test 3 based on extrapolation of data
TP03	Fail	-	-	Insufficient infiltration to calculate data – failed test – only Test 1 conducted

5 Tier 2 Environmental Data Review and Risk Assessment

5.1 Approach

5.1.1 This report is to be used as a baseline record of contamination present at the site prior to use under Environmental Permit as a Waste Transfer Station. As such, a risk assessment of contamination is not strictly necessary. However, a generic quantitative risk assessment has been conducted in accordance with Stantec UK Ltd Methodology for the Assessment of Potentially Contaminated Land (**Appendix E**) for completeness using Commercial End Use scenario Generic Assessment Criteria (GAC) .

5.1.2 The measured concentrations of contaminants determined as part of the ground investigation have been compared with published criteria for a defined end use in order to assess the obtained data. If concentrations are below the screening criterion for a specified end use, the parameter is deemed not to be a potential hazard and is not considered further. A concentration above the screening criterion identifies the parameter as a possible hazard and indicates that either further assessment or risk management maybe required.

5.1.3 The measured soil concentrations have been compared against threshold criteria for commercial / industrial end use, appropriate for the site.

5.2 Soils

5.2.1 This dataset comprises soil sample analysis from Made Ground and natural deposits. The laboratory certificates for the analyses are presented in **Appendix C.**

Metals and Inorganics

5.2.2 Metals concentrations in all 27 samples analysed were measured at consistent low concentrations:

Table 5.1 Summary of Metal Concentrations (mg/kg) in Soil

	Minimum	Maximum
Arsenic	<1.0	8.3
Barium	<1.0	250
Beryllium	0.21	1.2
Cadmium	<0.2	<0.2
Total Chromium	13	44
Copper	12	64
Lead	1.7	28
Mercury	<0.3	<0.3
Nickel	7.6	53
Selenium	<0.1	<0.1
Vanadium	16	150
Zinc	24	87

5.2.3 Total cyanide was not measured above the laboratory method detection limit in any of the 19 samples analysed.

Petroleum Hydrocarbons

5.2.4 Total Petroleum Hydrocarbons (TPH) were below the detection limit of 10mg/kg in the 25 soil samples analysed.

Poly Aromatic Hydrocarbons (PAH)

5.2.5 Of the 19 samples analysed, PAH analysis did not identify concentrations of individual PAH compounds above the method detection limits of 0.05mg/l except in one sample where concentrations of fluoranthene, pyrene, benzo(a)anthracene and chrysene were recorded above the detection limits in a single sample from 0.2m bgl in TP01.

Volatile Organic Compounds (VOC) & Semi Volatile Organic Compounds (sVOC)

5.2.6 VOC and sVOC analysis was undertaken in six samples collected from BH01, BH05, TP02, WS05, WS08, WS10. None of the compounds were recorded at concentrations above the laboratory detection limits.

Asbestos

5.2.7 Twenty samples were tested for the presence of asbestos. None of the samples analysed were found to contain asbestos.

5.3 Assessment Criteria

5.3.1 The Stantec rationale for the selection of Generic Assessment Criteria (GAC) has been used for this assessment and is presented in **Appendix F**. The assessment criteria for a commercial/industrial end use has been used as this is the proposed end use.

5.3.2 Where the criterion for a parameter is dependent on soil organic matter (SOM) content, a value of 1% has been used which is considered to be a representative value for the dataset.

5.4 Results of Comparison to Generic Assessment Criteria

5.4.1 The results of soils screening are presented in Table 5.2 below.

Table 5.2 Summary of Geo-Environmental Testing Results (Soil)

Determinand	Maximum Recorded Value (mg/kg)	Commercial Assessment Criteria (mg/kg)	Pass/Fail of Assessment Criteria
Arsenic	5.4	640	Pass
Cadmium	<0.2	190	Pass
Chromium	40	8,600	Pass
Chromium (Hexavalent)	0.5	49	Pass
Copper	54	68,000	Pass

Determinand	Maximum Recorded Value (mg/kg)	Commercial Assessment Criteria (mg/kg)	Pass/Fail of Assessment Criteria
Lead	15	2,300	Pass
Mercury	<0.3	1,100	Pass
Nickel	41	980	Pass
Selenium	<1.0	12,000	Pass
Zinc	82	730,000	Pass
TPH	<10	-	Pass
PAH Compounds	0.40 (fluoranthene)	23000	Pass

5.4.2 Potential contaminant concentrations recorded at the Site were below the screening criteria for commercial land end use.

5.5 Review of Water Geo-Environmental Analysis Results

5.5.1 This dataset comprises analysis on a total of three water samples. Based on the site setting, outlined in Section 2 of this report, the chemical testing results have been assessed against 'Fresh Water' criteria using environmental quality standards (EQS).

5.5.2 The results of the water screening are presented in Table 5.2 below.

Table 5.3 Summary of Geo-Environmental Testing Results (Waters)

Determinand	Maximum Recorded Value	Exploratory Hole	Fresh Water Assessment Criteria	Pass/Fail of Assessment Criteria
pH	7.4	BH03	-	-
Arsenic	2.3µg/l	BH03	50µg/l	Pass
Cadmium	0.36µg/l	BH03	0.08µg/l	Fail
Copper	2.8µg/l	BH03	1.00µg/l	Fail
Lead	62µg/l	BH03	1.20µg/l	Fail
Mercury	< 0.050µg/l	All samples	0.07µg/l	Pass
Nickel	28µg/l	BH05	4µg/l	Fail
Zinc	8.8µg/l	WS108	10.9µg/l	Fail

5.5.3 In addition to the determinands listed in the table above, the samples analysed were found to be below the limit of detection for TPH, PAH, Phenols, VOCs and SVOCs.

5.6 Tier 2 Contamination Risk Assessment

Soils

5.6.1 No visual or olfactory evidence of ground contamination was recorded during the intrusive investigation.

5.6.2 A Photo Ionisation Detector (PID) for detecting the presence of volatile compounds was used on all samples during site works and the readings remained low.

5.6.3 Laboratory testing confirmed that concentrations of potential contaminants were either below detection limit, or very low.

5.6.4 On the basis of work completed to date, the ground investigation has not identified any potentially significant contamination in soils.

5.6.5 The testing indicated that the Made Ground beneath the site does not contain anthropogenic or contaminated material. Laboratory testing of soils did not find evidence of contamination resulting from leaks or spills occurring during the historical use of the site.

Groundwater

5.6.6 Chemical analysis on water samples obtained from the Site indicate that there are low concentrations of dissolved metal contaminants within the groundwater beneath the site.

5.6.7 No measurable concentrations of PAH, TPH, VOC, SVOC or phenols were recorded within the groundwater samples.

5.6.8 The elevated levels of metal contaminants are likely naturally occurring with no identified soil sources in the shallow ground or from other off site sources.

5.6.9 The concentrations of contaminants recorded above the adopted screening values were not considered to pose an unacceptable level of risk to Controlled Waters.

Human Health

5.6.10 Contamination testing of the near surface soils did not detect any exceedances of the adopted GAC. The risk to commercial end users of the site was therefore considered to be negligible.

5.6.11 Groundworkers have been identified as the human receptor most likely to come into direct contact with the underlying soils on site. However, based on the assumption that the site is to be largely covered in concrete hardstanding and workers are to be equipped with suitable personal protective equipment (PPE) with the implementation of a health and safety management scheme, the risk rating was considered to be **Very Low**.

Ground Gas

5.6.12 Following completion of the post-fieldwork ground gas monitoring, a preliminary Ground Gas assessment, in general accordance with BS 8485:2015 was undertaken. No elevated gas concentrations or flows were recorded and the Site was determined to fall within a Characteristic Situation (CS1) site. Sites falling within this category do not require the implementation of gas protection measures within buildings. The assessment indicates that the baseline ground gas risk recorded for the site is **Very Low**.

Radon

5.6.13 According to the Envirocheck report, the Site is within an intermediate probability radon aera (in which 5 – 10% of homes are estimated to be at or above the action level). Basic radon protection measures may be necessary in the construction of new buildings.

6 Summary and Conclusions

6.1 Summary

6.1.1 A ground investigation was carried out comprising the drilling of five rotary boreholes to 10mbgl, 12 windowless sampler boreholes to a maximum depth of 4.00m bgl and three trial pits with soakaway testing. Groundwater and ground gas monitoring wells were installed within all five of the rotary borehole locations with the remained being backfilled with arisings.

6.1.2 Topsoil was encountered in three out of 20 locations, recorded to a maximum depth of 0.7m bgl.

6.1.3 The surface cover of turf, concrete and tarmacadam overlay Made Ground in 15 out of 20 locations. The maximum thickness of Made Ground recorded was 0.7m and generally comprised a clay and gravel matrix with very little evidence of anthropogenic inclusions. A geotextile barrier was noted below the placed material at a depth of between 0.1 and 0.2m in seven locations.

6.1.4 Natural gravelly clay was encountered in 14 out of 20 locations to a maximum depth of 1.65m bgl. However, the deeper deposits were difficult to distinguish from weathered bedrock, typically recorded as dense gravel of mudstone. Mudstone bedrock was recorded at between 0.1m bgl and 1.65m bgl.

6.1.5 There was no visual, olfactory or PID evidence of contamination in soils. Laboratory testing did not identify any elevated concentrations of potential organic or inorganic contaminants. No visual evidence of asbestos was noted during site work or under laboratory analysis.

6.1.6 Other than minor seepage in shallow soils, no groundwater strikes were recorded during ground investigation. Borehole monitoring found groundwater lying at a depth of between 3m and 5.2m bgl.

6.1.7 Water samples obtained from the post fieldwork monitoring indicated slightly elevated levels of dissolved metals in respect to environmental quality standards for freshwater. There were no exceedances with respect to hydrocarbons, phenol, VOC, sVOC and PAH compounds within the water samples analysed.

6.1.8 The three rounds of gas monitoring did not record any elevated concentrations of ground gases or flow rates.

6.2 Conclusions

6.2.1 The baseline site condition investigation has identified that there is very little presence of contamination beneath the site with some marginally elevated concentrations of PAH compounds identified in one soil sample and some marginally elevated concentrations of metal compounds (arsenic, nickel and lead) within some of the groundwater samples collected.

6.2.2 The work conducted provides a baseline record of the conditions of the site prior to redevelopment and use under Environmental Permit. The baseline is a record against which the future condition of the site can be compared.

6.2.3 Assessment of laboratory analysis results did not identify contamination above the Generic Assessment Criteria for a commercial end use scenario. Therefore, no remediation of contamination is required prior to redevelopment. Only minimal dissolved metals contamination was found to be present within groundwater beneath the site, which is not considered to have arisen from the Site's historical/current use.

7 Guidance for Report Readers

7.1.1 This report has been prepared within an agreed timeframe and to an agreed budget that will necessarily apply some constraints on its content and usage. The remarks below are presented to assist the reader in understanding the context of this report and any general limitations or constraints.

7.1.2 If there are any specific limitations and constraints, they are described in the report text. The opinions and recommendations expressed in this report are based on statute, guidance, and best practice current at the time of its publication. Stantec UK Ltd (Stantec) does not accept any liability whatsoever for the consequences of any future legislative changes or the release of subsequent guidance documentation, etc. Such changes may render some of the opinions and advice in this report inappropriate or incorrect and the report should be returned to us and reassessed if required for re-use after one year from date of publication. Following delivery of the report Stantec has no obligation to advise the Client or any other party of such changes or their repercussions.

7.1.3 Some of the conclusions in this report may be based on third party data. No guarantee can be given for the accuracy or completeness of any of the third party data used. Historical maps and aerial photographs provide a “snap shot” in time about conditions or activities at the site and cannot be relied upon as indicators of any events or activities that may have taken place at other times.

7.1.4 The conclusions and recommendations made in this report and the opinions expressed are based on the information reviewed and/or the ground conditions encountered in exploratory holes and the results of any field or laboratory testing undertaken. There may be ground conditions at the site that have not been disclosed by the information reviewed or by the investigative work undertaken. Such undisclosed conditions cannot be taken into account in any analysis and reporting.

7.1.5 This report has been written for the sole use of the Client stated at the front of the report in relation to a specific development or scheme. The conclusions and recommendations presented herein are only relevant to the scheme or the phase of project under consideration. This report shall not be relied upon or transferred to any other party without the express written authorisation of Stantec. Any such party relies upon the report at its own risk.

7.1.6 The interpretation carried out in this report is based on scientific and engineering appraisal carried out by suitably experienced and qualified technical consultants based on the scope of our engagement. We have not taken into account the perceptions of, for example, banks, insurers, other funders, laypeople, etc., unless the report has been prepared specifically for that purpose. Advice from other specialists may be required such as the legal, planning and architecture professions, whether specifically recommended in our report or not.

7.1.7 Public or legal consultations or enquiries, or consultation with any Regulatory Bodies (such as the Environment Agency, Natural England or Local Authority) have taken place only as part of this work where specifically stated.

Figures

Drawings

0 1000 2000
metres

Site Grid Ref: SM 889 093

PEMBROKESHIRE COUNTY COUNCIL
ECO-PARK
SITE LOCATION PLAN

Client

Date of 1st Issue	Drawn by
27.11.2019	davco
A4 Scale	Checked by
1:2000	MG
Figure Number	
001	

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Key

- Approximate Site Boundary
- Borehole Location
- Window Sample Location
- Trial Pit Location

PEMBROKESHIRE COUNTY COUNTIL
ECO-PARK
EXPLORATORY HOLE PLAN

Client: Pembrokeshire County Council / Cyngor Sir Benfro

Date of 1st Issue: 31.07.2020	Drawn by: davco
A3 Scale: 1:1250	Checked by: OB
Figure Number: 2	

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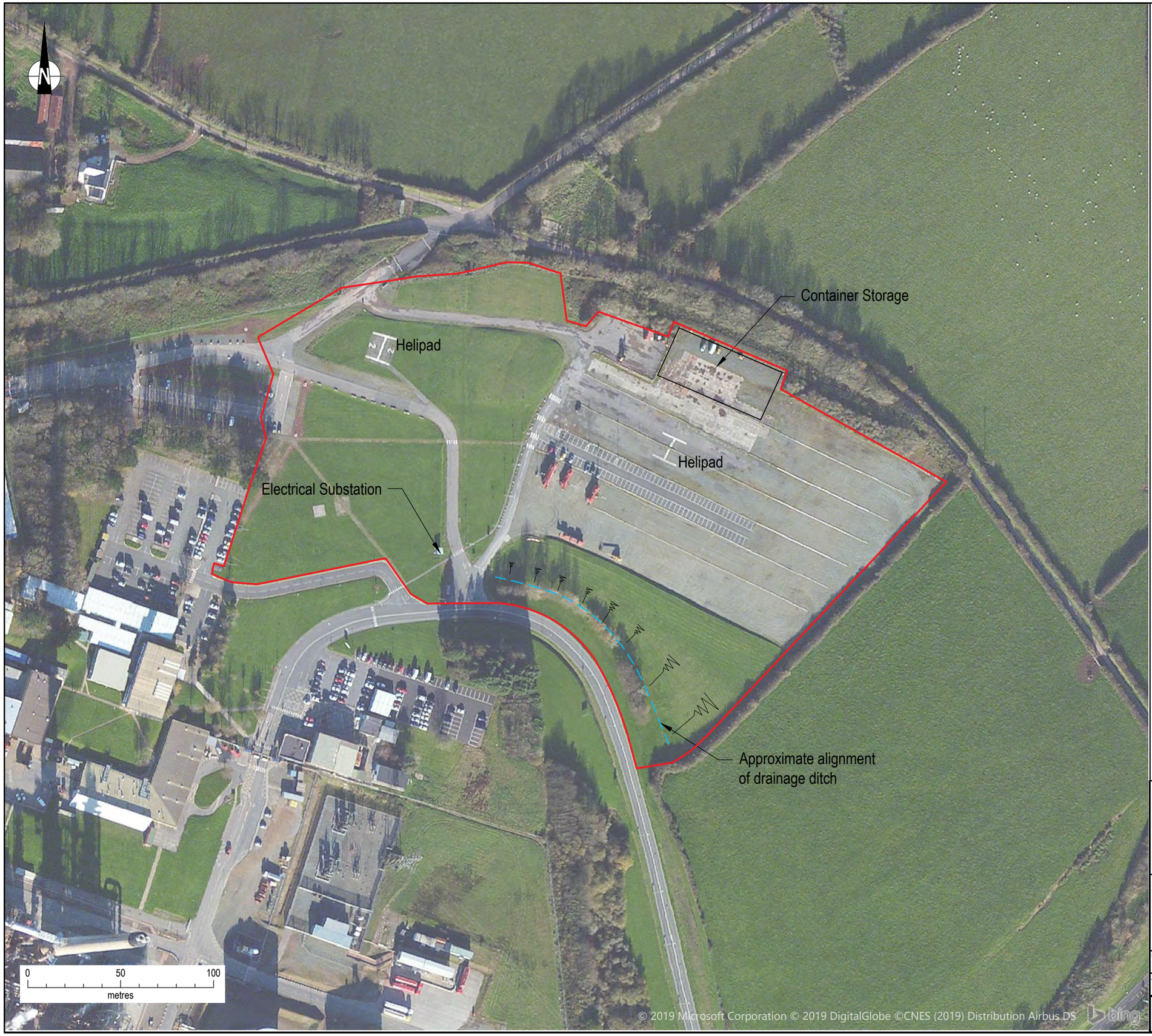

Key

Approximate Site Boundary

PEMBROKESHIRE COUNTY COUNCIL
ECO-PARK
SITE LAYOUT PLAN

Client

Pembrokeshire County Council
Cyngor Sir Benfro

Date of 1st Issue: 27.11.2019	Drawn by: davco
A3 Scale: 1:2000	Checked by: MG
Figure Number: 002	

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Appendix A Site Walkover Photos

Photograph 1: View looking northeast across Area 1.

Photograph 2: View of container storage in north of Area 1.

Photograph 3: View southwards across Area 1, from northern Site boundary

Photograph 4: View southwest across Area 2.

Photograph 5: View of Helipad in Area 2

Photograph 6: View eastwards across Area 1 and Area 3

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Cyngor Sir Benfro

Pembrokeshire County Council Eco-Park

SITE WALKOVER PHOTOGRAPHS

Date	26.11.19
Scale	NTS
Drawn by	MRG
Checked by	OB
Revision	1

Photograph 7: View across hardstanding area

Photograph 8: View of container storage in north of Area 1 looking west.

Photograph 9: View northwards of hardstanding area and container storage

Photograph 10: View east.

Photograph 11: View south east across hardstanding area

Photograph 12: View south of hardstanding

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SITE INVESTIGATION PHOTOGRAPHS

Date	31/07/20
Scale	NTS
Drawn by	GS
Checked by	OB
Revision	1

Photograph 13: Site skip and material storage for SI.

Photograph 14: View of container storage.

Photograph 15: Trial Pit TP01 following completion

Photograph 16: Former building footprint.

Photograph 17: Drilling set up during works

Photograph 18: Samples and cores following completion of drilling

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SITE INVESTIGATION PHOTOGRAPHS

Date	31/07/20
Scale	NTS
Drawn by	GS
Checked by	OB
Revision	1

Appendix B Borehole Logs

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ROTARY BOREHOLE LOG

Telephone: 01452 739165 , Fax: 01452 739220 , Email: info@ccground.co.uk

Borehole No. **BH01**

Sheet 1 of 2

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 188906 N 209395	Hole Type DS+RC
Location: Pembrokeshire		Level: 66.55mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 16/06/2020 End: 17/06/2020	Logged By MM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.20					TOPSOIL: Grass over soft friable light reddish brown slightly gravelly slightly sandy silty CLAY with occasional rootlets (<3mm). Gravel is angular to sub-angular fine to coarse of mudstone.	(0.70)		
		B	0.20 - 0.40								
		ES	0.20	C 57							
		B	0.40 - 0.70						0.70	65.85	
		ES	0.40					Extremely weak thinly laminated reddish brown MUDSTONE recovered as sandy silty clayey angular to sub-angular fine to coarse gravel.			
		SPT C	0.40 - 0.85						(0.60)		
1		B	0.70 - 0.90	C 37		82% 0% 0%					1
		B	0.90 - 1.30						1.30	65.25	
		C	0.90 - 2.00		C			Very weak thinly laminated reddish brown MUDSTONE. Discontinuities are randomly orientated extremely closely spaced planar rough partly open with black staining and brown clay infill.			
		SPT C	0.90 - 1.35						(0.70)		
		B	1.30 - 1.50								
2		C	2.00 - 3.00	C*500		95% 0% 0%			2.00	64.55	2
		SPT C	2.00 - 2.20					Weak thinly laminated reddish brown mottled green MUDSTONE. Discontinuities are sub-vertical extremely closely spaced planar rough with black staining and brown clay infill.			
		D	2.40		C						
		B	2.50 - 2.70								
3		C	3.00 - 4.00	C**		100% 10% 0%					3
		SPT C	3.00 - 3.17								
		D	3.40		C						
		B	3.50 - 3.70						(3.50)		
4		C	4.00 - 5.00	C*857		100% 11% 0%					4
		SPT C	4.00 - 4.85								
		D	4.40		C						
		B	4.50 - 4.70								
5		C	5.00 - 6.50	C**		100% 34% 10%		4.85m: 1No sub-horizontal planar rough discontinuity.			5
		SPT C	5.00 - 5.05								
		B	5.50 - 5.70					Medium strong thinly laminated light green SILTSTONE. Discontinuities are sub-vertical closely spaced planar rough occasionally infilled with clay discoloured black.	5.50	61.05	
		D	5.80		C				(0.80)		
6		B	6.30 - 6.50						6.30	60.25	6
		B	6.50 - 6.70	C*300		100% 36% 11%		Very weak thinly laminated light brown SANDSTONE. Discontinuities are sub-vertical extremely to very closely spaced planar smooth with black staining.			
		C	6.50 - 8.00						(0.85)		
		SPT C	6.50 - 6.69								
7		D	7.00					7.00-7.15m: Extremely weak.	7.15	59.40	7
					C			Weak thinly laminated dark reddish brown SILTSTONE. Discontinuities are sub-vertical very closely to closely spaced planar rough locally infilled with clay discoloured black.			
		B	7.50 - 7.70								
		D	7.80								
8											8

EQUIPMENT: Hand digging tools. Comacchio MC205 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.40m. Dry drilled using 140mm casing: 0.40-0.90m. Waterflush rotary coring using T6-116 coring barrel: 0.90-10.00m.
CASING: 140mm diameter to 0.90m.
GROUNDWATER: None encountered.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 1.00-10.00m. Plain 50mm ID HDPE pipe with bentonite pellet seal: 0.20-1.00m. Flush 150mm steel cover set in concrete: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 0.4ppm and 0.40m - 0.3ppm.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

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Borehole No. **BH01**

Sheet 2 of 2

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 188906 N 209395	Hole Type DS+RC
Location: Pembrokeshire		Level: 66.55mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 16/06/2020 End: 17/06/2020	Logged By MM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		C SPT C D	8.00 - 9.20 8.00 - 8.21 8.20	C*286	C	100% 18% 13%		Weak thinly laminated dark reddish brown SILTSTONE. Discontinuities are sub-vertical very closely to closely spaced planar rough locally infilled with clay discoloured black. *(continued from previous sheet)* 8.40-8.70m: Chemical dissolution void (<10mm).	(2.85)		
9		D B C SPT C	8.85 9.05 - 9.20 9.20 - 10.00 9.20 - 9.23	C**	C			8.85-9.05m: Weathered extremely weak light green mottled red marl. 9.20-10.00m: Discontinuities are sub-vertical medium spaced planar rough. 9.65-9.75m: Strong thinly laminated reddish light brown sandstone.			
10		SPT C	10.00 - 10.03	C**				Borehole completed at 10.00m	10.00	56.55	
11											
12											
13											
14											
15											
16											
17											

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
16/06/2020 17:30	9.20	0.90	1.50
17/06/2020 07:30	9.20	0.90	2.70
17/06/2020 10:00	10.00	0.90	1.80

CC ROTARY LOG C6725.GPJ CCGI GINT STD AGS 4_0.GDT 31/7/20 MA

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ROTARY BOREHOLE LOG

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Borehole No. **BH02**

Sheet 1 of 2

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 188993 N 209415	Hole Type DS+RC
Location: Pembrokeshire		Level: 66.99mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 17/06/2020 End: 18/06/2020	Logged By MM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.30					TOPSOIL: Grass over friable reddish brown gravelly slightly sandy silty CLAY. Gravel is angular to sub-angular fine to coarse of mudstone. 0.25-0.30m: 1No cobble. Cobble is light grey of sub-angular mudstone.	0.30	66.69	
		B	0.20 - 0.30								
		ES	0.20	C 54							
		B	0.30 - 0.50								
		SPT C	0.30 - 0.75						(0.80)		
		B	0.50 - 1.10								
1		ES	0.50					Firm reddish brown slightly sandy gravelly CLAY. Gravel is angular and sub-angular fine to coarse mudstone lithorelicts.	1.10	65.89	1
		ES	1.00								
		B	1.10 - 1.40								
		D	1.30					Very weak thinly laminated reddish brown MUDSTONE recovered as slightly sandy silty clayey angular to sub-angular fine to coarse gravel of mudstone.	1.40	65.59	
		C	1.40 - 2.50	C*333		100% 0% 0%					
		SPT C	1.40 - 1.62					Weak thinly laminated reddish brown MUDSTONE. Discontinuities are sub-horizontal extremely closely spaced planar rough locally infilled with clay discoloured black.	(0.60)		
		B	1.50 - 1.70								
		D	1.80		C						
2		B	2.00 - 2.20						2.00	64.99	2
		D	2.30					Medium strong thinly laminated light grey SILTSTONE. Discontinuities are sub-horizontal and sub-vertical extremely closely spaced planar rough with occasional black staining.			
		C	2.50 - 3.40	C*273		100% 0% 0%					
		SPT C	2.50 - 2.76								
		B	2.90 - 3.00		C			2.90-3.05m: Discontinuities are infilled with light pinkish brown clay. 3.00m: Discontinuities locally stained black.			
3		D	3.10								3
		C	3.40 - 4.20	C*857		100% 0% 0%					
		SPT C	3.40 - 3.50								
		B	3.50 - 3.70		C			3.60-4.10m: Thinly laminated light brown and light grey siltstone.			
		D	3.80								
4		C	4.20 - 5.50	C**		100% 0% 0%					4
		SPT C	4.20 - 4.29					4.20m: Medium strong.			
		B	4.50 - 4.70								
		D	4.80		C				(5.50)		
5								4.90-5.30m: Discontinuities are sub-horizontal extremely closely spaced planar rough with black staining and light brown clay infill.			5
		C	5.50 - 7.00	C**		100% 5% 0%					
		SPT C	5.50 - 5.58								
		B	5.70 - 5.90								
6		D	6.00		C						6
		C	7.00 - 8.50	C**		100% 23% 0%					
7		SPT C	7.00 - 7.04								7
					C			Strong thinly laminated reddish light brown MUDSTONE. Discontinuities are sub-vertical very closely to closely spaced planar rough with black staining.	7.50	59.49	
8											8

EQUIPMENT: Hand digging tools. Comacchio MC205 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.30m. Dry drilled using 140mm casing: 0.30-1.40m. Waterflush rotary coring using T6-116 coring barrel: 1.40-10.00m.
CASING: 140mm diameter to 1.40m.
GROUNDWATER: None encountered.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 1.00-10.00m. Plain 50mm ID HDPE pipe with bentonite pellet seal: 0.20-1.00m. Flush 150mm steel cover set in concrete: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 0.5ppm; 0.50m - 0.3ppm and 1.00m - 0.3ppm.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

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Borehole No. **BH02**

Sheet 2 of 2

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 188993 N 209415	Hole Type DS+RC
Location: Pembrokeshire		Level: 66.99mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 17/06/2020 End: 18/06/2020	Logged By MM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
					C			Strong thinly laminated reddish light brown MUDSTONE. Discontinuities are sub-vertical very closely to closely spaced planar rough with black staining. *(continued from previous sheet)*	(1.30)		
		C SPT C	8.50 - 10.00 8.50 - 8.58	C**		100% 8% 0%		8.40m: 1No chemical dissolution with voids (<15mm).	8.80	58.19	
9					C			Strong thinly laminated light grey SILTSTONE. Discontinuities are sub-vertical very closely spaced planar rough with black staining. 9.20m: 1No sub-vertical planar rough discontinuity infilled with light grey clay <2mm.	(0.70)		9
								Strong thinly laminated reddish light brown MUDSTONE. Discontinuities are sub-vertical closely spaced planar rough with black staining.	9.50 (0.50)	57.49	
10		SPT C	10.00 - 10.07	C**				10.00m: Dry. Borehole completed at 10.00m	10.00	56.99	10
11											11
12											12
13											13
14											14
15											15
16											16
17											17

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
17/06/2020 17:00	8.50	1.40	2.80
18/06/2020 08:00	8.50	1.40	5.50
18/06/2020 10:00	10.00	1.40	

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ROTARY BOREHOLE LOG

Telephone: 01452 739165 , Fax: 01452 739220 , Email: info@ccground.co.uk

Borehole No. **BH03**

Sheet 1 of 2

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189128 N 209363	Hole Type DS+RC
Location: Pembrokeshire		Level: 66.51mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 18/06/2020 End: 18/06/2020	Logged By MM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00					Light grey very sandy silty angular to sub-angular fine to coarse GRAVEL of igneous material with frequent rootlets (<3mm).	0.10	66.41	
		B	0.10 - 0.25					Extremely weak reddish brown MUDSTONE. Recovered as friable gravel slightly sandy silty clay.			
		ES	0.10	C 28							
		ES	0.20								
		B	0.25 - 1.10								
		SPT C	0.25 - 0.70						(1.50)		
1		ES	0.50								1
		D	0.75								
		ES	1.00	C 15							
		B	1.10 - 1.60								
		SPT C	1.10 - 1.55								
		D	1.30						1.60	64.91	
		B	1.60 - 2.10					Extremely weak reddish brown MUDSTONE. Recovered as slightly sandy silty clayey angular to sub-angular fine to coarse gravel of mudstone.	(0.50)		
2									2.10	64.41	2
		C	2.10 - 3.30	C 89		92%		Very weak thinly laminated reddish light brown MUDSTONE. Discontinuities are extremely closely spaced planar rough partly open with brown clay infill and black staining.			
		SPT C	2.10 - 2.54			0%					
		B	2.50 - 2.70		C	0%					
		D	2.80								
3											3
		C	3.30 - 4.40	C*134		100%					
		SPT C	3.30 - 3.70			0%					
		B	3.50 - 3.70			0%					
		D	3.80		C						
4											4
								4.20m: Medium strong.	(4.20)		
		C	4.40 - 5.50	C*429		100%		4.40-5.50m: Discontinuities are closely spaced.			
		SPT C	4.40 - 4.57			37%					
		B	4.60 - 4.80			0%					
		D	4.90		C						
5											5
		C	5.50 - 7.00	C*857		100%					
		SPT C	5.50 - 5.58			18%					
		B	5.70 - 5.90			0%					
6		D	6.00								6
					C						
		B	6.30 - 6.50					Weak thinly laminated orangish light brown MUDSTONE. Discontinuities are randomly orientated extremely closely spaced planar rough tight with light grey clay infill (<2mm). 6.30-7.00m: Chemical dissolution voids (<20mm).	6.30	60.21	
		D	6.80						(0.70)		
7		C	7.00 - 8.50	C*667		100%		Medium strong thinly laminated reddish light brown MUDSTONE. Discontinuities are sub-vertical very closely to closely spaced planar rough tight with black staining and occasional light brown clay infill (<2mm).	7.00	59.51	7
		SPT C	7.00 - 7.15			25%					
		B	7.50 - 7.70		C	7%					
		D	7.80								
8											8

EQUIPMENT: Hand digging tools. Comacchio MC205 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.25m. Dynamic sampling using 113mm sample barrel: 0.25-2.10m. Waterflush rotary coring using T6-116 coring barrel: 2.10-10.00m.
CASING: 140mm diameter to 2.00m.
GROUNDWATER: None encountered prior to use of water flush.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 1.00-10.00m. Plain 50mm ID HDPE pipe with a bentonite pellet seal: 0.20-1.00m Flush 150mm steel cover set in concrete: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 0.5ppm; 0.50m - 0.3ppm and 1.00m - 0.3ppm. Installation completed on 19/06/20.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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Borehole No. **BH03**

Sheet 2 of 2

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189128 N 209363	Hole Type DS+RC
Location: Pembrokeshire		Level: 66.51mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 18/06/2020 End: 18/06/2020	Logged By MM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
9		C SPT C B D	8.50 - 10.00 8.50 - 8.64 9.00 - 9.20 9.30	C*750	C C	100% 16% 13%		Medium strong thinly laminated reddish light brown MUDSTONE. Discontinuities are sub-vertical very closely to closely spaced planar rough tight with black staining and occasional light brown clay infill (<2mm). *(continued from previous sheet)* 9.40-9.80m: 1No sub-vertical discontinuities planar smooth tight with black staining.	(3.00)		
10		SPT C	10.00 - 10.10	C*857				Borehole completed at 10.00m	10.00	56.51	

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
18/06/2020 17:15	10.00	2.00	1.65

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Borehole No. **BH04**

Sheet 1 of 2

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189043 N 209323	Hole Type DS+RC
Location: Pembrokeshire		Level: 65.03mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 25/06/2020 End: 26/06/2020	Logged By MM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.05		C			MADE GROUND: Dark grey TARMACADAM.	0.05	64.98	
		C	0.00 - 0.25					MADE GROUND: Yellowish brown CONCRETE.	0.25	64.78	
		B	0.05 - 0.25					Reddish brown slightly sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone.			
		B	0.25 - 0.55								
		ES	0.25	C 48							
		B	0.55 - 1.40								
		ES	0.55								
1		SPT C	0.55 - 1.00						(1.60)		1
		D	1.00								
		ES									
		C	1.40 - 2.50	C 50		100%		1.40-1.85m: Very Dense.			
		SPT C	1.40 - 1.85			0%					
						0%			1.85	63.18	
2					C			Weak thinly laminated reddish brown MUDSTONE. Discontinuities are sub-horizontal and sub-vertical intersecting extremely closely spaced planar rough locally infilled (<10mm) with brown clay and locally stained black.			2
		C	2.50 - 3.50	C*188		100%					
		SPT C	2.50 - 2.80			0%					
						0%					
3					C				(2.65)		3
		C	3.50 - 4.50	C*428		100%					
		SPT C	3.50 - 3.72			0%					
						0%		3.75-3.95m: Reddish brown mottled green.			
4					C			4.00-4.20m: 1no discontinuities vertical planar rough locally infilled (<5mm) with brown clay and black staining.			4
		C	4.50 - 5.50	C*462		100%		Medium strong thinly laminated reddish brown SANDSTONE with weak thinly laminated (<5mm) sub bed. Interbed discontinuaties sub-vertical are extremely closely to very closely spaced planar rough partly open with brown and white clay infill and black staining (<5mm).	4.50	60.53	
		SPT C	4.50 - 4.70			5%					
						0%					
5					C						5
		C	5.50 - 7.00	C*546		100%					
		SPT C	5.50 - 5.68			16%		5.65-6.35m: 1no vertical discontinuities undulating rough infilled (<5mm) with brown clay and localy stained black.	(2.50)		
						11%					
6					C			6.10-6.20m: Extremely weak thinly laminated mudstone. Discontinuities are randomly orientated extremely closely spaced planar striated with orangish brown infill.			6
		C	7.00 - 8.50	C**		100%		Very strong thinly laminated light reddish grey SANDSTONE. Discontinuities are sub-vertical closely to very closely spaced planar smooth locally infilled (<5mm) with light grey and green clay.	7.00	58.03	
		SPT C	7.00 - 7.09			22%					
						19%					
7					C						7
									(1.60)		
8											8

EQUIPMENT: Hand digging tools. Comacchio MC205 track mounted rig.
METHOD: 300mm concrete cored: 0.00-0.25m. Hand dug inspection pit: 0.25-0.55m. Dry drilled using 140mm casing: 0.55-1.40m. Waterflush rotary coring using T6-116 coring barrel: 1.40-10.00m.
CASING: 140mm diameter to 1.40m.
GROUNDWATER: None encountered prior to use of water flush to advance casing to 1.40m.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 1.00-10.00m. Plain 50mm ID HDPE pipe with a bentonite pellet seal: 0.20-1.00m Flush 150mm steel cover set in concrete: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.25m - 6.1ppm; 0.55m - 5.9ppm and 1.00m - 5.3ppm. Installation completed on 26/06/20.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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Borehole No. **BH04**

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189043 N 209323	Hole Type DS+RC
Location: Pembrokeshire		Level: 65.03mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 25/06/2020 End: 26/06/2020	Logged By MM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
9		C SPT C	8.50 - 10.00 8.50 - 8.55	C**	C C	100% 19% 16%		Very strong thinly laminated light reddish grey SANDSTONE. Discontinuities are sub-vertical closely to very closely spaced planar smooth locally infilled (<5mm) with light grey and green clay. *(continued from previous sheet)* 8.20-8.50m: Medium strong. Strong thinly laminated reddish brown MUDSTONE. Discontinuities are sub-vertical extremely closely to very closely spaced planar rough locally infilled (<5mm) with brown clay and locally with black staining.	8.60 (1.40)	56.43	
10		SPT C	10.00 - 10.04	C**				Borehole completed at 10.00m	10.00	55.03	
11											
12											
13											
14											
15											
16											
17											

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
25/06/2020 17:00	10.00	1.40	3.10

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Borehole No. **BH05**

Sheet 1 of 2

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189080 N 209332	Hole Type DS+RC
Location: Pembrokeshire		Level: 65.82mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 19/06/2020 End: 23/06/2020	Logged By MM/TH

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B B ES SPT C	0.00 - 0.10 0.10 0.10 - 0.40 0.20 0.40 - 0.85	C 26				MADE GROUND: Greenish light grey sandy silty angular to sub angular fine to coarse GRAVEL of igneous material. 0.10m: Geo-textile membrane (<2mm). Light reddish brown sandy clayey angular to sub angular fine to coarse GRAVEL of mudstone. 0.40-0.85m: Medium dense.	0.10	65.72	
1		B ES D SPT C	1.00 - 1.20 1.00 1.30 1.40 - 1.85	C 25				1.40-1.85m: Medium dense.	(2.40)		1
2		B D	2.00 - 2.20 2.30								2
		C SPT C	2.50 - 3.50 2.50 - 2.88	C*130	C	100% 0% 0%		Weak locally very weak purplish reddish brown MUDSTONE. Discontinuities are sub-horizontal to sub-vertical intersecting extremely closely to very closely spaced with light yellowish brown and black staining locally infill (<20mm) with reddish brown clay. 2.50-2.70m: Recovered non intact.	2.50	63.32	
3		C SPT C	3.50 - 4.50 3.50 - 3.88	C*130	C	100% 13% 13%			(1.50)		3
4		C SPT C	4.50 - 5.50 4.50 - 4.70	C*462	C	100% % 56%		Weak purplish reddish brown MUDSTONE. Discontinuities sub-horizontal and sub-vertical locally intersecting very closely to closely spaced with yellowish brown and black staining locally infill (<5mm) with reddish brown clay. 4.50-4.70m: Drill disturbed. 4.80-5.30m: Discontinuities are sub-vertical and closely spaced.	4.00	61.82	4
5		C SPT C	5.50 - 7.00 5.50 - 5.65	C*500	C	130% % 33%		Weak purplish and reddish brown MUDSTONE. Discontinuities are horizontal and sub-vertical locally intersecting closely to medium spaced with yellowish brown and black staining. 5.50-5.75m: Recovered non intact.	5.30	60.52	
6									(0.90)		6
								Weak locally very weak purplish reddish brown MUDSTONE. Discontinuities are sub-horizontal to sub-vertical intersecting extremely closely to very closely spaced with light yellowish brown and black staining local infill (<5mm) with reddish brown clay.	6.20	59.62	
7		C SPT C	7.00 - 8.40 7.00 - 7.29	C*182	C	90% % 0%					7
8											8

EQUIPMENT: Hand digging tools. Comacchio MC205 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.40m. Dynamic sampling using 113mm sample barrel: 0.40-2.50m. Waterflush rotary coring using T6-116 coring barrel: 2.50-10.00m.
CASING: 140mm diameter to 3.50m.
GROUNDWATER: None encountered prior to use of water flush.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 1.00-10.00m. Plain 50mm ID HDPE pipe with a bentonite pellet seal: 0.20-1.00m Flush 150mm steel cover set in concrete: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 5.4ppm; 0.50-0.60m - 5.6ppm and 0.80-0.90m - 5.8ppm. Dynamic sampling to recover dropped core 8.80-9.30m.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
19/06/2020 13:00	2.50	2.50	
23/06/2020 15:00	2.50	2.50	
23/06/2020 16:00	3.50	3.50	0.60
24/06/2020 08:00	3.50	3.50	0.60

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Borehole No. **BH05**

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189080 N 209332	Hole Type DS+RC
Location: Pembrokeshire		Level: 65.82mAOD	Scale 1 : 50.00
Client: Stantec		Dates: Start: 19/06/2020 End: 23/06/2020	Logged By MM/TH

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
9		C SPT C	8.40 - 9.30 8.40 - 8.65	C*316	C	40% % 0%		Weak locally very weak purplish reddish brown MUDSTONE. Discontinuities are sub-horizontal to sub-vertical intersecting extremely closely to very closely spaced with light yellowish brown and black staining local infill (<5mm) with reddish brown clay. *(continued from previous sheet)* 8.40-9.30m: Recovered non intact. 8.80-9.30m: Core dropped and recovered by dynamic sampling. Recovered as gravel SAND of MUDSTONE. Gravel is angular fine to coarse of mudstone.	(3.80)		
		C	9.30 - 10.00		C	70% % 0%					
10		SPT C	10.00 - 10.12	C*546				Borehole completed at 10.00m	10.00	55.82	
11											
12											
13											
14											
15											
16											
17											

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
24/06/2020 17:00	10.00	3.50	

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Borehole No. **WS01**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 188944 N 209419	Hole Type WLS
Location: Pembrokeshire		Level: 66.89mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 24/06/2020 End: 24/06/2020	Logged By MM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.30				MADE GROUND: Grass over reddish brown gravelly slightly sandy CLAY. Gravel is angular to sub-angular fine to coarse of mudstone and siliceous material with occasional rootlets (<3mm).	(0.30) 0.30	66.59	
		B ES	0.30 - 0.60 0.30				Firm reddish brown slightly gravelly slightly sandy CLAY with occasional mudstone lithorelics. Gravel is angular to sub-angular fine to coarse of mudstone lithorelicts.			
		B ES	0.60 - 1.00 0.60					(1.00)		
1		B ES SPT B	1.00 - 1.30 1.00 1.00 - 1.45 1.30 - 2.00	S 15			Reddish brown sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone with occasional mudstone lithorelics.	1.30	65.59	1
2		B SPT	2.00 - 2.50 2.00 - 2.45	S 57			2.00-2.45m: Very dense.	(1.20)		2
		SPT C	2.50 - 2.71	C*222			2.50m: Dry. Borehole completed at 2.50m	2.50	64.39	
3										3
4										4
5										5
6										6

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm and 86mm sample barrels: 1.00-2.50m.
CASING: None used.
GROUNDWATER: Non encountered.
BACKFILL: Upon compleation borehole backfilled with bentonite pellets: 0.20-2.50m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.30m - 1.9ppm; 0.60m - 1.1ppm and 1.00m - 0.1ppm. Boerhole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
24/06/2020 13:30	2.50		

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Borehole No. **WS02**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 188984 N 209398	Hole Type WLS
Location: Pembrokeshire		Level: 66.58mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 24/06/2020 End: 24/06/2020	Logged By MM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.20				MADE GROUND: Light grey slightly sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone and limestone with occasional rootlets (<3mm).	(0.55)		
		B ES	0.20 - 0.55 0.20					0.55	66.03	
		B ES	0.55 - 0.90 0.55				Soft light brown reddish slightly sandy gravelly CLAY with occasional mudstone lithorelics. Gravel is angular to sub-angular fine to coarse of mudstone.	(0.35)		
1		B ES SPT	0.90 - 1.90 1.00 1.00 - 1.45	S 28			Medium dense reddish brown very sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone with occasional mudstone lithorelics.	0.90	65.68	1
								(1.00)		
2		B SPT C	1.90 - 2.80 2.00 - 2.45	C 85			Reddish brown very sandy very clayey angular to sub-angular fine to medium GRAVEL of mudstone with frequent lithorelics.	1.90	64.68	2
								(0.90)		
		SPT C	2.80 - 2.96	C*316			2.80m: Dry. Borehole completed at 2.80m	2.80	63.78	
3										3
4										4
5										5
6										6

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.55m. Continuous disturbed sampling using 101mm, 86mm and 76mm sample barrels: 0.55-2.80m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Upon compleation borehole backfilled with bentonite pellets: 0.20-2.80m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 1.2ppm; 0.55m - 6.4ppm and 1.00m - 2.1ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
24/06/2020 13:30	2.80		

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Borehole No. **WS03**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189047 N 209367	Hole Type WLS
Location: Pembrokeshire		Level: 66.75mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 24/06/2020 End: 24/06/2020	Logged By MM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.05				MADE GROUND: Light grey slightly sandy silty angular to sub-angular fine to coarse GRAVEL of igneous material.	0.05	66.70	
		B	0.05 - 0.20				MADE GROUND: Light grey CONCRETE.	0.20	66.55	
		B	0.20 - 0.50				Light brown reddish very sandy very clayey angular to sub-angular fine to coarse GRAVEL of mudstone with occasional lithorelics.			
		ES	0.20							
		B	0.50 - 1.30							
		ES	0.50							
1		ES	1.00	S 37				(1.80)		
		SPT	1.00 - 1.45							
		B	1.30 - 2.00							
2		SPT C	2.00 - 2.30	C*194			2.00m: Dry	2.00	64.75	
							Borehole completed at 2.00m			
3										
4										
5										
6										

EQUIPMENT: Hydralic breaker: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hydralic braker with a range of chisels 0.00-0.20m: Hand dug inspection pit: 0.20-0.50m. Continuous disturbed sampling using 101mm and 86mm sample barrels: 0.50-2.00m.
CASING: None used.
GROUNDWATER: Non encountered.
BACKFILL: Upon conpleation borehole backfilled with bentonite pellets: 0.20-2.00m; compacted arisings: 0.10-0.20m and Concrete: 0.00-0.10m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 21.8ppm; 0.50m - 22.6ppm and 1.00m - 85.5ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
24/06/2020 13:30	2.00		

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Borehole No. **WS04**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189047 N 209392	Hole Type WLS
Location: Pembrokeshire		Level: 67.04mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 24/06/2020 End: 24/06/2020	Logged By MM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.10				MADE GROUND: Black TARMACADAM.	0.10	66.94	
		B	0.10 - 0.70				MADE GROUND: Light grey sandy clayey angular to sub-angular fine to coarse GRAVEL of limestone and mudstone.			
		ES	0.20					(0.60)		
		ES	0.50							
		B	0.70 - 1.00				Light brown reddish slightly sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone and sandstone.	0.70	66.34	
1		B	1.00	S 34			1.00-1.45m: Dense.			1
		ES	1.00 - 1.45							
		SPT						(1.20)		
		SPT C	1.90 - 2.26	C*122			1.90m: Dry.	1.90	65.14	
2							Borehole completed at 1.90m			2
3										3
4										4
5										5
6										6

EQUIPMENT: Hydralic breaker: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hydralic breaker with a range of chisels: 0.00-0.10m Hand dug inspection pit: 0.10-0.35m. Continuous disturbed sampling using 101mm and 86mm sample barrels: 0.35-1.90m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Upon compleation borehole backfilled with bentonite pellets: 0.20-1.90m; compacted arisings: 0.10-0.20m and concrete 0.00-0.10m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 8.7ppm; 0.50m - 9.5ppm and 1.00m - 15ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
24/06/2020 13:30	1.90		

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Borehole No. **WS05**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189013 N 209354	Hole Type WLS
Location: Pembrokeshire		Level: 65.34mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 23/06/2020 End: 23/06/2020	Logged By TH/MM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.20				MADE GROUND: Grey and brown very sandy clayey angular to sub-angular fine to coarse GRAVEL of igneous material and mudstone with low cobble content and rare roots and rootlets (<2mm). Cobbles are sub-angular of mudstone.	0.20	65.14	
		B	0.20 - 0.30				Reddish brown very sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone.	0.30	65.04	
		ES	0.20				Light brown slightly sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone lithorelicts (probably weathered mudstone).			
		B	0.30 - 1.00							
		ES	0.30							
		ES	0.50							
1		B	1.00 - 1.80	C 62			1.00-1.45m: Very dense.	(1.50)		1
		SPT C	1.00 - 1.45							
		B	1.80 - 2.30				Light brown sandy silty angular to sub-angular angular fine to coarse GRAVEL of mudstone with occasional mudstone lithorelics.	1.80	63.54	
2		SPT C	2.00 - 2.45	C 56			2.00-2.45m: Very dense.	(0.50)		2
		B	2.30 - 3.00				Light brown sandy silty angular to sub-angular fine to coarse GRAVEL of sandstone with occasional siltstone lithorelics.	2.30	63.04	
								(0.70)		
3		SPT C	3.00 - 3.31	C*140			3.00m: Dry. Borehole completed at 3.00m	3.00	62.34	3
4										4
5										5
6										6

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.30m. Continuous disturbed sampling using 101mm, 86mm and 76mm sample barrels: 0.30-3.00m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Upon compleation borehole backfilled with bentonite pellets: 0.20-3.00m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 0.0ppm, 0.30m - 0.0ppm and 0.50m - 13.9ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
23/06/2020 15:30	3.00		

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Borehole No. **WS06**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 188989 N 209301	Hole Type WLS
Location: Pembrokeshire		Level: 63.27mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 23/06/2020 End: 23/06/2020	Logged By TH

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B ES	0.00 - 0.30 0.00				MADE GROUND: Grey and brown very sandy clayey angular to sub-angular fine to coarse GRAVEL of igneous material and mudstone with low cobble content and rare roots and rootlets (<2mm). Cobbles are sub-angular of mudstone.	(0.30) 0.30	62.97	
		B ES B ES B	0.40 - 0.60 0.40 0.60 - 0.80 0.60 0.80 - 1.00				Reddish brown very sandy very clayey angular to sub-angular fine to coarse GRAVEL of mudstone.	(0.30) 0.60	62.67	
							Stiff friable reddish brown slightly gravelly slightly sandy CLAY. Gravel is angular to sub-angular fine to coarse of mudstone.	0.80	62.47	
1		SPT C	1.00 - 1.43	C*103			Reddish brown very sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone.	1.00	62.27	
							1.00m: Dry. Borehole completed at 1.00m			
2										
3										
4										
5										
6										

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.80m. Continuous disturbed sampling using 101mm sample barrels: 0.80-1.00m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Upon compleation borehole backfilled with bentonite pellets: 0.20-1.00m and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.30m - 0.0ppm; 0.60m - 0.0ppm and 0.80m - 0.2ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
23/06/2020 08:00	1.00		

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Borehole No. **WS07**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189055 N 209283	Hole Type WLS
Location: Pembrokeshire		Level: 63.63mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 23/06/2020 End: 24/06/2020	Logged By TH/MM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.15				MADE GROUND: Grey and greenish grey very sandy clayey angular to sub-angular fine to coarse GRAVEL of igneous material with rare roots and rootlets (<2mm).			
		B	0.15 - 0.40				0.15m: Geo-textile membrane (<2mm).	0.15	63.48	
		ES	0.15				Brown very sandy clayey angular to sub-rounded fine to coarse GRAVEL of sandstone and mudstone.	0.40	63.23	
		B	0.40 - 1.00				Stiff light reddish brown slightly gravelly slightly sandy CLAY with occasional mudstone lithorelics. Gravel is angular to sub-angular fine to coarse mudstone.			
		ES	0.40							
		ES	0.50							
1		B	1.00 - 2.00	S 21						1
		SPT	1.00 - 1.45							
2		B	2.00 - 3.00	S 17				(3.25)		2
		SPT	2.00 - 2.45							
3		B	3.00 - 3.65	C 29						3
		SPT C	3.00 - 3.45				3.50-3.70m: Occasional light grey silt lenses (<3mm).			
		B	3.65 - 4.00				Very stiff light grey slightly gravelly slightly sandy SILT. Gravel is angular fine to coarse of sandstone.	3.65	59.98	
								(0.35)		
4		SPT C	4.00 - 4.13	C*429			4.00m: Dry. Borehole completed at 4.00m	4.00	59.63	4
5										5
6										6

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.40m. Continuous disturbed sampling using 101mm, 86mm, 76mm and 66mm sample barrels: 0.40-4.00m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Upon compleation borehole backfilled with bentonite pellets: 0.20-4.00m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.15m - 2.1ppm; 0.40m - 0.0ppm and 0.50m - 42.8ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
23/06/2020 16:00	0.40		
24/06/2020 07:00	0.40		
24/06/2020 13:30	4.00		

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Borehole No. **WS08**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189099 N 209308	Hole Type WLS
Location: Pembrokeshire		Level: 65.89mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 23/06/2020 End: 23/06/2020	Logged By TH

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B ES	0.00 - 0.20				MADE GROUND: Grey and greenish grey very sandy clayey angular to sub-angular fine to coarse GRAVEL of igneous material with rare roots and rootlets (<2mm).	0.20	65.69	
		B ES	0.20 - 0.50				Reddish brown very sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone. 0.20-0.50m: Groundwater seepage.	(0.30) 0.50	65.39	
		ES	0.70 - 0.90				Brown very sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone, sandstone and siltstone.	0.70	65.19	
		D	0.90 - 1.00				Stiff reddish brown slightly sandy silty CLAY.	(0.30)		
1		SPT	1.00 - 1.45	S 25			Stiff friable slightly gravelly sandy silty CLAY. Gravel is sub-angular fine to medium of mudstone and sandstone.	1.00	64.89	1
		D	1.50 - 1.60					(0.65)		
		B	1.65 - 2.50				Brown and reddish brown slightly gravelly very clayey SAND. Gravel is sub-angular to sub-rounded fine to coarse of mudstone and sandstone.	1.65	64.24	
2		SPT	2.00 - 2.45	S 28			2.00-2.45m: Medium dense.	(0.85)		2
		B	2.50 - 3.00				Reddish brown very sandy slightly clayey angular fine to coarse GRAVEL of mudstone.	2.50	63.39	
								(0.50)		
3		SPT C	3.00 - 3.41	C*118			3.00m: Dry. Borehole completed at 3.00m	3.00	62.89	3
4										4
5										5
6										6

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.50m. Continuous disturbed sampling using 101mm, 86mm and 76mm sample barrels: 0.50-3.00m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Borehole backfilled with bentonite pellets: 0.20-3.00m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 3.4ppm; 0.50m - 5.1ppm and 0.90m - 1.7ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
23/06/2020 12:00	3.00		

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Borehole No. **WS09**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189139 N 209304	Hole Type WLS
Location: Pembrokeshire		Level: 66.34mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 23/06/2020 End: 23/06/2020	Logged By TH

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B ES	0.00 - 0.20				MADE GROUND: Grey and greenish grey very sandy clayey angular to sub-angular fine to coarse GRAVEL of igneous material with rare roots and rootlets (<2mm). 0.20m: Geo-textile membrane (<2mm). 0.18m: Groundwater seepage.	0.20	66.14	
		B ES	0.50 - 0.80				Reddish brown sandy very clayey angular to sub-angular fine to coarse GRAVEL of mudstone.	(0.90)		
1		SPT	1.00 - 1.45	S 15				1.10	65.24	1
							Light brown slightly gravelly silty SAND. Gravel is sub-angular to sub-rounded fine to coarse of sandstone.	1.30	65.04	
		B	1.60 - 3.00				Reddish brown very sandy very clayey angular to sub-angular fine to coarse GRAVEL of mudstone.			
2		SPT	2.00 - 2.45	S 27			2.00-2.45m: Medium dense.	(1.70)		2
3		SPT C	3.00 - 3.18	C*316			3.00m: Dry. Borehole completed at 3.00m	3.00	63.34	3
4										4
5										5
6										6

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.80m. Continuous disturbed sampling using 101mm, 86mm and 76mm sample barrels: 0.80-3.00m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Borehole backfilled with bentonite pellets: 0.20-3.00m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 0.0ppm and 0.80m - 0.2ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
23/06/2020 13:20	3.00		

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Borehole No. **WS10**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189155 N 209333	Hole Type WLS
Location: Pembrokeshire		Level: 66.52mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 23/06/2020 End: 23/06/2020	Logged By TH

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.10				MADE GROUND: Grey and greenish grey very sandy clayey angular to sub-angular fine to coarse GRAVEL of igneous material with rare roots and rootlets (<2mm).	0.10	66.42	
		ES	0.10 - 0.40				0.10m: Geo-textile membrane (<2mm).	(0.30)		
		B					Reddish brown sandy very clayey angular to sub-angular fine to coarse GRAVEL of mudstone.	0.40	66.12	
		ES					Very stiff friable brown slightly gravelly sandy silty CLAY with frequent mudstone lithorelicts. Gravel is sub-angular to sub-rounded fine to medium of mudstone.	(0.70)		
		B	0.40 - 0.55				0.90-1.00m: Tending to very sandy very clayey angular to sub-angular fine to medium gravel of mudstone.	1.10	65.42	
		ES					Dense light brown very sandy clayey angular to sub-angular fine to coarse GRAVEL of mudstone.	(1.40)		
		D	0.80 - 0.90							
1		SPT	1.00 - 1.45	S 47						1
		B	1.10 - 2.50							
2		SPT	2.00 - 2.45	S 77			2.00-2.45m: Very dense.			2
		SPT C	2.50 - 2.68	C*300			2.50m: Dry. Borehole completed at 2.50m	2.50	64.02	
3										3
4										4
5										5
6										6

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.55m. Continuous disturbed sampling using 101mm, 86mm and 76mm sample barrels: 0.55-2.50m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Upon completion borehole backfilled with bentonite pellets: 0.20-3.00m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.10m - 2.0ppm; 0.40m - 3.4ppm and 0.55m - 3.6ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
23/06/2020 10:15	2.50		

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Borehole No. **WS11**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189207 N 209316	Hole Type WLS
Location: Pembrokeshire		Level: 65.98mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 23/06/2020 End: 23/06/2020	Logged By TH

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B ES	0.00 - 0.20				MADE GROUND: Grey and greenish grey very sandy clayey angular to sub-angular fine to coarse GRAVEL of igneous material with rare roots and rootlets (<2mm). 0.20m: Geo-textile membrane (<2mm). 0.18m: Groundwater seepage.	0.20	65.78	
		B ES B	0.50 - 0.70 0.70 - 1.70				Reddish brown sandy very clayey angular to sub-angular fine to coarse GRAVEL of mudstone.	(1.50)		
1		SPT	1.00 - 1.45	S 35			1.00-1.45m: Dense.			
		ES	1.50 - 1.70							
		SPT C	1.70 - 1.81	C*600			Borehole completed at 1.70m	1.70	64.28	
2										
3										
4										
5										
6										

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.70m. Continuous disturbed sampling using 101mm and 86mm sample barrels: 0.70-1.70m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Upon compleation borehole backfilled with bentonite pellets: 0.20-1.70m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 3.0ppm; 0.50m - 2.3ppm and 1.50m - 3.7ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
23/06/2020 09:10	1.70		

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Borehole No. **WS12**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189172 N 209290	Hole Type WLS
Location: Pembrokeshire		Level: 66.45mAOD	Scale 1 : 37.50
Client: Stantec		Dates: Start: 22/06/2020 End: 22/06/2020	Logged By TH

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B ES	0.00 - 0.20				MADE GROUND: Grey and greenish grey very sandy clayey angular to sub-angular fine to coarse GRAVEL of igneous material with rare roots and rootlets (<2mm). 0.20m: Geo-textile membrane (<2mm).	0.20	66.25	
		B D ES	0.50 - 0.60				Stiff friable reddish brown slightly gravelly slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium of mudstone.	(0.70)		
1		B ES D SPT	0.80 - 0.90 0.90 - 1.00 1.00 - 1.45	S 24			Stiff friable brown slightly sandy gravelly CLAY. Gravel is sub-angular to sub-rounded fine to medium of sandstone, mudstone and siltstone.	0.90 (0.40)	65.55	1
		B	1.30 - 2.00				Reddish brown very sandy clayey sub-angular to sub-rounded fine to coarse GRAVEL of mudstone.	1.30 (0.70)	65.15	
2		SPT C	2.00 - 2.28	C*171			2.00m: Dry. Borehole completed at 2.00m	2.00	64.45	2
3										3
4										4
5										5
6										6

EQUIPMENT: Hand digging tools. Terrier 2002 track mounted rig.
METHOD: Hand dug inspection pit: 0.00-0.80m. Continuous disturbed sampling using 101mm sample barrels: 0.80-2.00m.
CASING: None used.
GROUNDWATER: None encountered.
BACKFILL: Upon compleation borehole backfilled with bentonite pellets: 0.20-2.00m; and compacted arisings: 0.00-0.20m.
REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 5.4ppm; 0.50m - 5.6ppm and 0.80m - 5.8ppm. Borehole terminated due to refusal.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
22/06/2020 17:00	2.00		

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TRIAL PIT LOG

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Pit No **TP01**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 188945 N 209368 Level: 66.08mAOD	Date 17/06/2020
Location: Pembrokeshire		Dimensions: 2.80m Depth 1.70m 0.70m	Scale 1 : 25
Client: Stantec			Logged By MM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.20		TOPSOIL: Grass over firm friable reddish brown slightly gravelly slightly sandy CLAY with frequent rootlets (<3mm). Gravel is angular to sub-angular fine to coarse of mudstone.	(0.40)		
		ES	0.20					
		B	0.40 - 0.50		Extremely weak thinly laminated reddish brown MUDSTONE recovered as slightly sandy silty clayey tabular angular fine to coarse gravel.	0.40	65.68	
		B	0.50 - 1.00		0.60-1.50m: Occasional tabular angular cobbles of mudstone.			
		ES	0.50		0.80-1.70m: Very weak.			
1		B	1.00 - 1.70			(1.30)		1
		ES	1.00					
					1.70m: Dry.	1.70	64.38	
					Trial pit completed at 1.70m			
2								2
3								3
4								4

EQUIPMENT: JCB 3CX Mechanical Excavator.

METHOD: Trial pits excavated using 0.60m bucket.

GROUNDWATER: None encountered.

STABILITY: Trial pit generally stable.

BACKFILL: Trial pit backfilled with arisings and compacted with excavator bucket.

REMARKS: PID readings undertaken on all environmental samples. Results: 0.20m - 0.1ppm; 0.50m - 0.0ppm and 1.00m - 0.0ppm. Soakaway testing undertaken - see separate sheet.

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Pit No **TP02**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189078 N 209375 Level: 66.74mAOD	Date 17/06/2020
Location: Pembrokeshire		Dimensions: 2.80m Depth 2.20m 0.70m	Scale 1 : 25
Client: Stantec			Logged By MM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
		D ES B ES B B ES	0.10 0.15 - 0.25 0.15 0.25 - 0.50 0.50 - 1.50 0.50		MADE GROUND: Light grey matrix supported CONCRETE. 0.05m: 1no 10mm diameter reinforced bar mesh.			
					0.15m: 1no plastic sheeting (approximately 1mm).	0.15	66.59	
					MADE GROUND: Light grey slightly sandy silty angular to sub-angular fine to coarse GRAVEL of mudstone with medium cobble content. Cobbles are sub-angular of mudstone.	0.25	66.49	
					Very soft friable light reddish brown slightly gravelly slightly sandy silty CLAY with Rare black flecks (<10mm). Gravel is sub-angular to sub-rounded fine to coarse of mudstone.	(1.25)		
1								1
					Extremely weak thinly laminated reddish brown MUDSTONE recovered as slightly sandy silty clayey angular tabular fine to coarse gravel of mudstone with low cobble content. Cobbles are sub-angular of mudstone.	1.50	65.24	
						(0.70)		
2								2
					Trial pit completed at 2.20m	2.20	64.54	
3								3
4								4

EQUIPMENT: JCB 3CX Mechanical Excavator.

METHOD: Trial pits excavated using 0.60m bucket.

GROUNDWATER: None encountered.

STABILITY: Trial pit generally stable.

BACKFILL: Trial pit backfilled with arisings and compacted with excavator bucket.

REMARKS: PID readings undertaken on all environmental samples. Results: 0.10m - 0.2ppm; 0.15m - 0.4ppm and 0.50m - 0.4ppm. Soakaway testing undertaken - see separate sheet.

CC TP LOG C6725.GPJ CCGI GINT STD AGS 4_0.GDT 31/7/20 MA

CC GROUND INVESTIGATIONS LTD

TRIAL PIT LOG

Telephone: 01452 739165 , Fax: 01452 739220 , Email: info@ccground.co.uk

Pit No **TP03**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: **C6725**	Co-ords: E 189094 N 209252 Level: 63.66mAOD	Date 18/06/2020
Location: Pembrokeshire		Dimensions: 1.60m, Depth 1.65m, 0.60m	Scale 1 : 25
Client: Stantec			Logged By MM

(m)	Water Levels	Samples & In Situ Testing: No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
		B	0.00 - 0.15		MADE GROUND: Light grey sandy silty angular to sub-angular fine to coarse GRAVEL of igneous material.			
		ES	0.10					
		B	0.15 - 0.50		Extremely weak reddish brown mudstone recovered as friable gravelly slightly sandy silty CLAY. Gravel is angular to sub-angular fine to coarse mudstone. 0.15m: Woven geo-textile.	0.15	63.51	
		D	0.20					
		B	0.50 - 1.00		0.60-0.90m: Reddish brown mottled light brown friable clay.			
		ES	0.50					
		D	0.80			(1.50)		
1		B	1.00 - 1.65					1
		ES	1.00					
		D	1.30					
					Trial pit completed at 1.65m	1.65	62.01	
2								2
3								3
4								4

EQUIPMENT: JCB 3CX Mechanical Excavator.

METHOD: Trial pits excavated using 0.60m bucket.

GROUNDWATER: None encountered.

STABILITY: Trial pit generally stable.

BACKFILL: Trial pit backfilled with arisings and compacted with excavator bucket.

REMARKS: PID readings undertaken on all environmental samples. Results: 0.10m - 0.0ppm; 0.50m - 0.0ppm and 1.00m - 0.0ppm. Soakaway testing undertaken - see separate sheet.

CC TP LOG C6725.GPJ CCGI GINT STD AGS 4_0.GDT 31/7/20 MA

CC GROUND INVESTIGATIONS LTD

SOAKAWAY TEST

Telephone: 01452 739165, Fax: 01452 739220, Email: info@ccground.co.uk

Pit No **TP01**

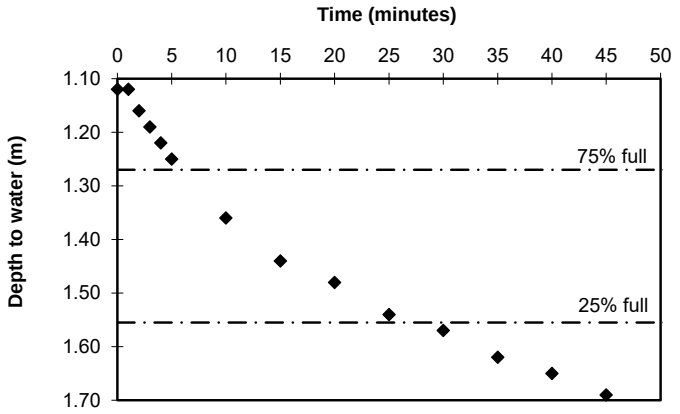
Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: C6725	Co-ords: E 188905.63 N 209394.60 Level: 66.55 mAOD	Date 17/06/2020
Location: Pembrokeshire			Logged By SF
Client: Wardell Armstrong LLP			Checked By MA

TEST 1:

LENGTH	2.70	m
BREADTH	0.60	m
DEPTH	1.70	m
WATER LEVEL	Dry	m
FILL LEVEL	1.12	m
v_{p75-25}	0.47	m^3
a_{p50}	3.534	m^2
t_{p75-25}	21	min

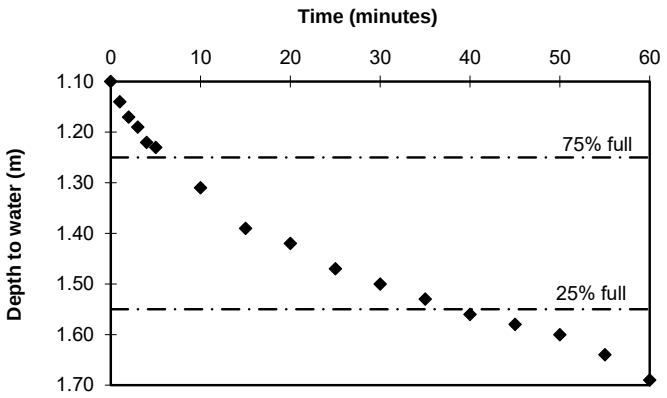
soil infiltration rate, *f* **1.06×10^{-4} ms^{-1}**



TEST 2

LENGTH	2.70	m
BREADTH	0.60	m
DEPTH	1.70	m
WATER LEVEL	Dry	m
FILL LEVEL	1.10	m
v_{p75-25}	0.49	m^3
a_{p50}	3.600	m^2
t_{p75-25}	32	min

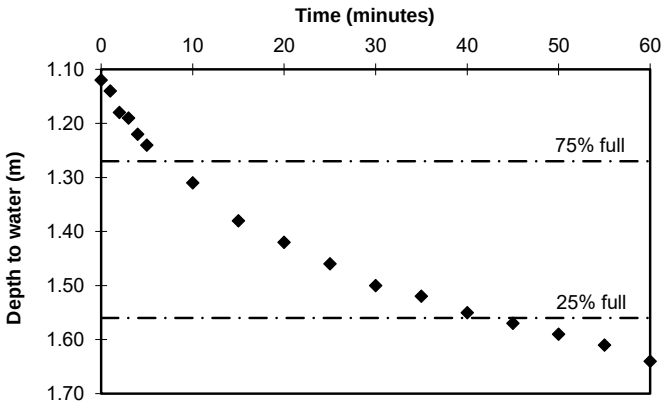
soil infiltration rate, *f* **7.14×10^{-5} ms^{-1}**



TEST 3

LENGTH	2.70	m
BREADTH	0.60	m
DEPTH	1.70	m
WATER LEVEL	Dry	m
FILL LEVEL	1.12	m
v_{p75-25}	0.47	m^3
a_{p50}	3.534	m^2
t_{p75-25}	36	min

soil infiltration rate, *f* **6.24×10^{-5} ms^{-1}**



REMARKS:

Carried out in general accordance with BRE 365 (2016).

CC GROUND INVESTIGATIONS LTD

SOAKAWAY TEST

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Pit No **TP02**

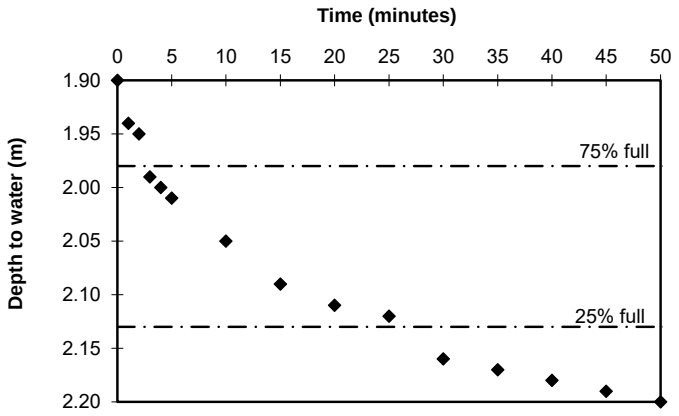
Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: C6725	Co-ords: E 188992.52 N 209414.71 Level: 66.99 mAOD	Date 17/06/2020
Location: Pembrokeshire			Logged By SF
Client: Wardell Armstrong LLP			Checked By MA

TEST 1:

LENGTH	2.60	m
BREADTH	0.60	m
DEPTH	2.20	m
WATER LEVEL	Dry	m
FILL LEVEL	1.90	m
v_{p75-25}	0.23	m^3
a_{p50}	2.520	m^2
t_{p75-25}	23	min

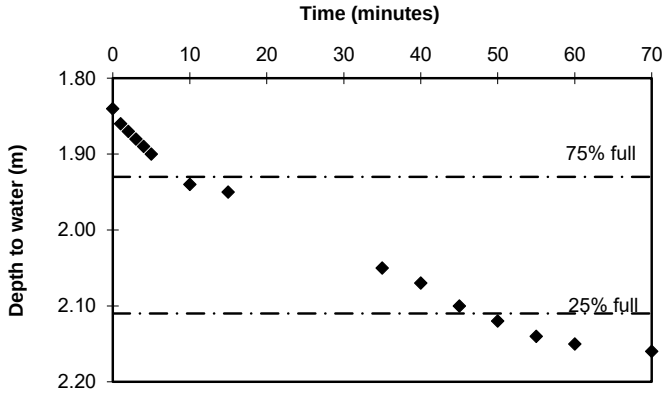
soil infiltration rate, *f* **6.66×10^{-5} ms^{-1}**



TEST 2

LENGTH	2.60	m
BREADTH	0.60	m
DEPTH	2.20	m
WATER LEVEL	Dry	m
FILL LEVEL	1.84	m
v_{p75-25}	0.28	m^3
a_{p50}	2.712	m^2
t_{p75-25}	39	min

soil infiltration rate, *f* **4.48×10^{-5} ms^{-1}**

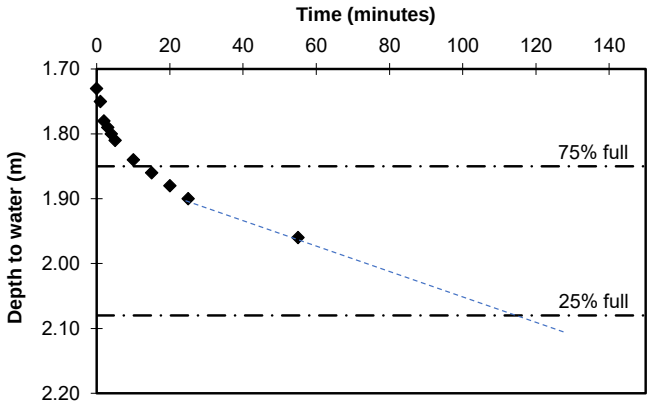


TEST 3

LENGTH	2.60	m
BREADTH	0.60	m
DEPTH	2.20	m
WATER LEVEL	Dry	m
FILL LEVEL	1.73	m
v_{p75-25}	0.37	m^3
a_{p50}	3.064	m^2
t_{p75-25}	105	min

soil infiltration rate, *f* **1.91×10^{-5} ms^{-1}**

Calculated by extrapolating timeline



REMARKS:

Carried out in general accordance with BRE 365 (2016).

CC GROUND INVESTIGATIONS LTD

SOAKAWAY TEST

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Pit No **TP03**

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: C6725	Co-ords: E 189128.28 N 209363.27 Level: 66.51 mAOD	Date 18/06/2020
Location: Pembrokeshire			Logged By SF
Client: Wardell Armstrong LLP			Checked By MA

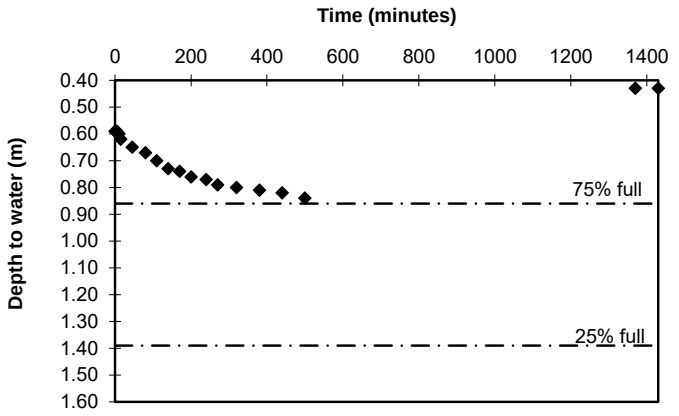
TEST 1:

LENGTH	1.60	m
BREADTH	0.60	m
DEPTH	1.65	m
WATER LEVEL	Dry	m
FILL LEVEL	0.59	m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

Insufficient soakaway to calculate infiltration rate.

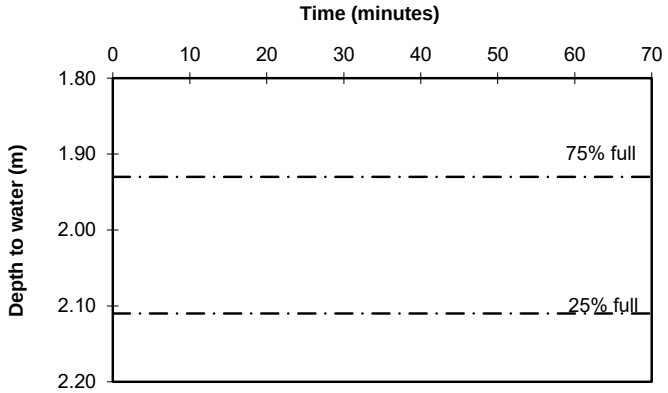
Surface water ingress noted overnight.



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

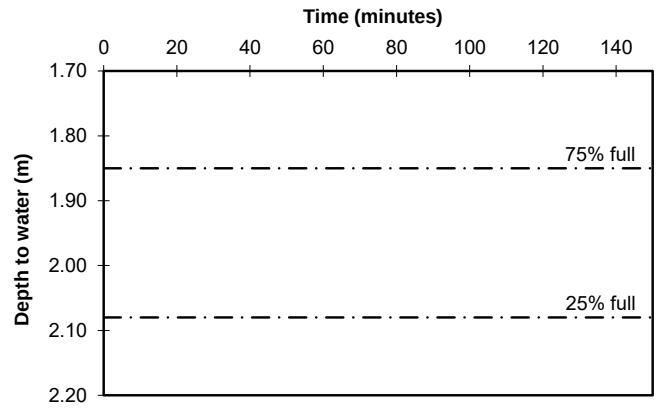
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



REMARKS:

Carried out in general accordance with BRE 365 (2016).

Appendix C Soil Laboratory Analysis Certificates

Oliver Belson
Stantec
3rd Floor, 50-60 Station Rd,
Cambridge CB1 2JH

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Herts,
WD18 8YS

t: 01923 225404
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e: reception@i2analytical.com

Analytical Report Number : 20-16008

Project / Site name:	Milford Haven Refinery	**Samples received on:**	22/06/2020
Your job number:		**Sample instructed/ Analysis started on:**	23/06/2020
Your order number:	32797	**Analysis completed by:**	22/07/2020
Report Issue Number:	1	**Report issued on:**	22/07/2020
Samples Analysed:	11 soil samples		

Signed:

Joanna Wawrzeczko
Technical Reviewer (Reporting Team)

For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

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

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543778	1543779	1543780	1543781	1543782
Sample Reference				BH01	BH01	BH02	BH02	BH03
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	0.40	0.20	0.50	0.10
Date Sampled				16/06/2020	16/06/2020	17/06/2020	17/06/2020	18/06/2020
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	8.9	8.6	4.1	4.8	1.8
Total mass of sample received	kg	0.001	NONE	0.60	0.90	0.80	0.80	1.0
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	-	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	6.2	6.2	6.5	6.7	8.9
Total Cyanide	mg/kg	1	MCERTS	< 1	-	< 1	-	< 1
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	0.011	-	0.0081	-
Organic Matter	%	0.1	MCERTS	3.2	3.3	1.8	0.4	0.3
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	-	< 0.80	-	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	8.3	7.5	6.2	3.6	1.1
Barium (aqua regia extractable)	mg/kg	1	MCERTS	61	57	97	66	7.1
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	0.80	0.72	1.2	1.1	0.21
Boron (water soluble)	mg/kg	0.2	MCERTS	0.2	0.4	< 0.2	< 0.2	< 0.2
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	28	24	24	33	18
Copper (aqua regia extractable)	mg/kg	1	MCERTS	24	22	28	64	58
Lead (aqua regia extractable)	mg/kg	1	MCERTS	28	25	18	10	2.2
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	26	22	25	45	17
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	37	34	39	38	80
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	63	57	83	73	67
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10

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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543778	1543779	1543780	1543781	1543782
Sample Reference				BH01	BH01	BH02	BH02	BH03
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	0.40	0.20	0.50	0.10
Date Sampled				16/06/2020	16/06/2020	17/06/2020	17/06/2020	18/06/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
Chloroethane	µg/kg	1	NONE	< 1.0	-	-	-	-
Bromomethane	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
Vinyl Chloride	µg/kg	1	NONE	< 1.0	-	-	-	-
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	-	-	-	-
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	-	-	-	-
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Trichloromethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	-	-	-	-
Benzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Trichloroethene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Dibromomethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
Toluene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
Tetrachloroethene	µg/kg	1	NONE	< 1.0	-	-	-	-
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Styrene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Tribromomethane	µg/kg	1	NONE	< 1.0	-	-	-	-
o-Xylene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Bromobenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Butylbenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	-	-	-	-
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	-	-	-	-

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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543778	1543779	1543780	1543781	1543782
Sample Reference				BH01	BH01	BH02	BH02	BH03
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	0.40	0.20	0.50	0.10
Date Sampled				16/06/2020	16/06/2020	17/06/2020	17/06/2020	18/06/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1	-	-	-	-
Phenol	mg/kg	0.2	ISO 17025	< 0.2	-	-	-	-
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
4-Methylphenol	mg/kg	0.2	NONE	< 0.2	-	-	-	-
Isophorone	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1	-	-	-	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	-	-	-	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
2-Methylnaphthalene	mg/kg	0.1	NONE	< 0.1	-	-	-	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Dibenzofuran	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	-	-	-	-
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Fluorene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Anthracene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Carbazole	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Anthraquinone	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Pyrene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	-	-	-	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Chrysene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-

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Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543783	1543784	1543785	1543786	1543787
Sample Reference				BH03	TP01	TP01	TP02	TP02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	0.20	0.50	0.10	0.15
Date Sampled				18/06/2020	17/06/2020	17/06/2020	17/06/2020	17/06/2020
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	6.1	7.5	3.0	2.1	1.7
Total mass of sample received	kg	0.001	NONE	0.80	0.60	1.0	1.1	0.90
Asbestos in Soil	Type	N/A	ISO 17025	-	Not-detected	-	Not-detected	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.9	7.9	8.4	12.0	8.2
Total Cyanide	mg/kg	1	MCERTS	-	< 1	-	< 1	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.020	0.015	-	-	0.030
Organic Matter	%	0.1	MCERTS	0.2	2.9	0.4	< 0.1	< 0.1
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Fluoranthene	mg/kg	0.05	MCERTS	-	0.40	-	< 0.05	-
Pyrene	mg/kg	0.05	MCERTS	-	0.36	-	< 0.05	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	0.25	-	< 0.05	-
Chrysene	mg/kg	0.05	MCERTS	-	0.22	-	< 0.05	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	-
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	1.23	-	< 0.80	-
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	5.0	6.8	4.1	6.0	5.4
Barium (aqua regia extractable)	mg/kg	1	MCERTS	32	52	32	43	250
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	1.1	0.69	1.0	0.28	0.99
Boron (water soluble)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	0.3	0.3
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	32	26	38	13	24
Copper (aqua regia extractable)	mg/kg	1	MCERTS	27	20	13	12	21
Lead (aqua regia extractable)	mg/kg	1	MCERTS	11	24	15	4.6	5.1
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	41	24	53	7.6	25
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	42	35	33	16	32
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	74	59	84	24	81
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10

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Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543783	1543784	1543785	1543786	1543787
Sample Reference				BH03	TP01	TP01	TP02	TP02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	0.20	0.50	0.10	0.15
Date Sampled				18/06/2020	17/06/2020	17/06/2020	17/06/2020	17/06/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
Chloroethane	µg/kg	1	NONE	-	-	-	-	< 1.0
Bromomethane	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
Vinyl Chloride	µg/kg	1	NONE	-	-	-	-	< 1.0
Trichlorofluoromethane	µg/kg	1	NONE	-	-	-	-	< 1.0
1,1-Dichloroethene	µg/kg	1	NONE	-	-	-	-	< 1.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,1-Dichloroethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
2,2-Dichloropropane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Trichloromethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,2-Dichloroethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,1-Dichloropropene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Trans-1,2-dichloroethene	µg/kg	1	NONE	-	-	-	-	< 1.0
Benzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Tetrachloromethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,2-Dichloropropane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Trichloroethene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Dibromomethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Bromodichloromethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
Toluene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,3-Dichloropropane	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
Dibromochloromethane	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
Tetrachloroethene	µg/kg	1	NONE	-	-	-	-	< 1.0
1,2-Dibromoethane	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
Chlorobenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
p & m-Xylene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Styrene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Tribromomethane	µg/kg	1	NONE	-	-	-	-	< 1.0
o-Xylene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Isopropylbenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Bromobenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
n-Propylbenzene	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
2-Chlorotoluene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
4-Chlorotoluene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
tert-Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
sec-Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
p-Isopropyltoluene	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-	-	-	-	< 1.0
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
Hexachlorobutadiene	µg/kg	1	MCERTS	-	-	-	-	< 1.0
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-	-	-	-	< 1.0

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Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543783	1543784	1543785	1543786	1543787
Sample Reference				BH03	TP01	TP01	TP02	TP02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	0.20	0.50	0.10	0.15
Date Sampled				18/06/2020	17/06/2020	17/06/2020	17/06/2020	17/06/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-	-	-	-	< 0.1
Phenol	mg/kg	0.2	ISO 17025	-	-	-	-	< 0.2
2-Chlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	< 0.1
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	-	-	-	< 0.1
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	-	-	-	< 0.1
2-Methylphenol	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
Hexachloroethane	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Nitrobenzene	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
4-Methylphenol	mg/kg	0.2	NONE	-	-	-	-	< 0.2
Isophorone	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
2-Nitrophenol	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
Naphthalene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
4-Chloroaniline	mg/kg	0.1	NONE	-	-	-	-	< 0.1
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	-	-	-	< 0.1
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	-	-	-	< 0.1
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	< 0.1
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
2-Methylnaphthalene	mg/kg	0.1	NONE	-	-	-	-	< 0.1
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	-	-	-	< 0.1
Dimethylphthalate	mg/kg	0.1	MCERTS	-	-	-	-	< 0.1
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	-	-	-	< 0.1
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
Dibenzofuran	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	-	-	-	< 0.3
Diethyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
4-Nitroaniline	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
Fluorene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Azobenzene	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
Phenanthrene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Anthracene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Carbazole	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	< 0.2
Anthraquinone	mg/kg	0.3	MCERTS	-	-	-	-	< 0.3
Fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Pyrene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	-	-	-	< 0.3
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Chrysene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-	-	< 0.05

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Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543788				
Sample Reference				TP03				
Sample Number				None Supplied				
Depth (m)				0.10				
Date Sampled				18/06/2020				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1				
Moisture Content	%	N/A	NONE	2.9				
Total mass of sample received	kg	0.001	NONE	1.1				
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected				
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.9				
Total Cyanide	mg/kg	1	MCERTS	< 1				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.012				
Organic Matter	%	0.1	MCERTS	0.4				
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05				
Fluorene	mg/kg	0.05	MCERTS	< 0.05				
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05				
Anthracene	mg/kg	0.05	MCERTS	< 0.05				
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Pyrene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Chrysene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05				
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05				
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05				
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80				
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	1.5				
Barium (aqua regia extractable)	mg/kg	1	MCERTS	21				
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	0.34				
Boron (water soluble)	mg/kg	0.2	MCERTS	0.3				
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2				
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	23				
Copper (aqua regia extractable)	mg/kg	1	MCERTS	38				
Lead (aqua regia extractable)	mg/kg	1	MCERTS	2.0				
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3				
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	20				
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0				
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	120				
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	74				
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	< 10				

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Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543788				
Sample Reference				TP03				
Sample Number				None Supplied				
Depth (m)				0.10				
Date Sampled				18/06/2020				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	-				
Chloroethane	µg/kg	1	NONE	-				
Bromomethane	µg/kg	1	ISO 17025	-				
Vinyl Chloride	µg/kg	1	NONE	-				
Trichlorofluoromethane	µg/kg	1	NONE	-				
1,1-Dichloroethene	µg/kg	1	NONE	-				
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-				
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-				
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-				
1,1-Dichloroethane	µg/kg	1	MCERTS	-				
2,2-Dichloropropane	µg/kg	1	MCERTS	-				
Trichloromethane	µg/kg	1	MCERTS	-				
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-				
1,2-Dichloroethane	µg/kg	1	MCERTS	-				
1,1-Dichloropropene	µg/kg	1	MCERTS	-				
Trans-1,2-dichloroethene	µg/kg	1	NONE	-				
Benzene	µg/kg	1	MCERTS	-				
Tetrachloromethane	µg/kg	1	MCERTS	-				
1,2-Dichloropropane	µg/kg	1	MCERTS	-				
Trichloroethene	µg/kg	1	MCERTS	-				
Dibromomethane	µg/kg	1	MCERTS	-				
Bromodichloromethane	µg/kg	1	MCERTS	-				
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-				
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-				
Toluene	µg/kg	1	MCERTS	-				
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-				
1,3-Dichloropropane	µg/kg	1	ISO 17025	-				
Dibromochloromethane	µg/kg	1	ISO 17025	-				
Tetrachloroethene	µg/kg	1	NONE	-				
1,2-Dibromoethane	µg/kg	1	ISO 17025	-				
Chlorobenzene	µg/kg	1	MCERTS	-				
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-				
Ethylbenzene	µg/kg	1	MCERTS	-				
p & m-Xylene	µg/kg	1	MCERTS	-				
Styrene	µg/kg	1	MCERTS	-				
Tribromomethane	µg/kg	1	NONE	-				
o-Xylene	µg/kg	1	MCERTS	-				
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-				
Isopropylbenzene	µg/kg	1	MCERTS	-				
Bromobenzene	µg/kg	1	MCERTS	-				
n-Propylbenzene	µg/kg	1	ISO 17025	-				
2-Chlorotoluene	µg/kg	1	MCERTS	-				
4-Chlorotoluene	µg/kg	1	MCERTS	-				
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-				
tert-Butylbenzene	µg/kg	1	MCERTS	-				
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-				
sec-Butylbenzene	µg/kg	1	MCERTS	-				
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-				
p-Isopropyltoluene	µg/kg	1	ISO 17025	-				
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-				
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-				
Butylbenzene	µg/kg	1	MCERTS	-				
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-				
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-				
Hexachlorobutadiene	µg/kg	1	MCERTS	-				
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-				

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Analytical Report Number: 20-16008

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1543788				
Sample Reference				TP03				
Sample Number				None Supplied				
Depth (m)				0.10				
Date Sampled				18/06/2020				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-				
Phenol	mg/kg	0.2	ISO 17025	-				
2-Chlorophenol	mg/kg	0.1	MCERTS	-				
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-				
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-				
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-				
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-				
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-				
2-Methylphenol	mg/kg	0.3	MCERTS	-				
Hexachloroethane	mg/kg	0.05	MCERTS	-				
Nitrobenzene	mg/kg	0.3	MCERTS	-				
4-Methylphenol	mg/kg	0.2	NONE	-				
Isophorone	mg/kg	0.2	MCERTS	-				
2-Nitrophenol	mg/kg	0.3	MCERTS	-				
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-				
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-				
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-				
Naphthalene	mg/kg	0.05	MCERTS	-				
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-				
4-Chloroaniline	mg/kg	0.1	NONE	-				
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-				
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-				
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-				
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-				
2-Methylnaphthalene	mg/kg	0.1	NONE	-				
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-				
Dimethylphthalate	mg/kg	0.1	MCERTS	-				
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-				
Acenaphthylene	mg/kg	0.05	MCERTS	-				
Acenaphthene	mg/kg	0.05	MCERTS	-				
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-				
Dibenzofuran	mg/kg	0.2	MCERTS	-				
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-				
Diethyl phthalate	mg/kg	0.2	MCERTS	-				
4-Nitroaniline	mg/kg	0.2	MCERTS	-				
Fluorene	mg/kg	0.05	MCERTS	-				
Azobenzene	mg/kg	0.3	MCERTS	-				
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-				
Hexachlorobenzene	mg/kg	0.3	MCERTS	-				
Phenanthrene	mg/kg	0.05	MCERTS	-				
Anthracene	mg/kg	0.05	MCERTS	-				
Carbazole	mg/kg	0.3	MCERTS	-				
Dibutyl phthalate	mg/kg	0.2	MCERTS	-				
Anthraquinone	mg/kg	0.3	MCERTS	-				
Fluoranthene	mg/kg	0.05	MCERTS	-				
Pyrene	mg/kg	0.05	MCERTS	-				
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-				
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-				
Chrysene	mg/kg	0.05	MCERTS	-				
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-				
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-				
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-				
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-				
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-				
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-				

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Analytical Report Number : 20-16008

Project / Site name: Milford Haven Refinery

* 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 *
1543778	BH01	None Supplied	0.20	Brown loam and sand with gravel and vegetation.
1543779	BH01	None Supplied	0.40	Brown loam and sand with gravel and vegetation.
1543780	BH02	None Supplied	0.20	Brown loam and sand with gravel and vegetation.
1543781	BH02	None Supplied	0.50	Brown loam and sand with gravel and vegetation.
1543782	BH03	None Supplied	0.10	Brown clay and sand with gravel.
1543783	BH03	None Supplied	0.20	Brown loam and clay with gravel and vegetation.
1543784	TP01	None Supplied	0.20	Brown loam and sand with gravel and vegetation.
1543785	TP01	None Supplied	0.50	Non Soil**
1543786	TP02	None Supplied	0.10	Grey rubble.**
1543787	TP02	None Supplied	0.15	Brown loam and sand with gravel and stones.
1543788	TP03	None Supplied	0.10	Brown loam and sand with gravel and vegetation.

**Non MCERTS Matrix,

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Analytical Report Number : 20-16008

Project / Site name: Milford Haven Refinery

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
D.O. for Gravimetric Quant if Screen/ID positive	Dependent option for Gravimetric Quant if Screen/ID positive scheduled.	In house asbestos methods A001 & A006.	A006-PL	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-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 (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS

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 30oC.

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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH01		S	20-16008	1543778	c	Total cyanide in soil	L080-PL	c
BH02		S	20-16008	1543780	c	Total cyanide in soil	L080-PL	c
BH03		S	20-16008	1543782	c	Total cyanide in soil	L080-PL	c
TP01		S	20-16008	1543784	c	Total cyanide in soil	L080-PL	c
TP02		S	20-16008	1543786	c	Total cyanide in soil	L080-PL	c
TP03		S	20-16008	1543788	c	Total cyanide in soil	L080-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

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Analytical Report Number : 20-16942

Project / Site name:	Milford Haven Refinery	**Samples received on:**	26/06/2020
Your job number:	C6725	**Sample instructed/ Analysis started on:**	29/06/2020
Your order number:	32797	**Analysis completed by:**	22/07/2020
Report Issue Number:	1	**Report issued on:**	23/07/2020
Samples Analysed:	9 soil samples		

Signed: Karolina Marek

Karolina Marek
PL Head of Reporting Team

For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

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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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

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Analytical Report Number: 20-16942

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548580	1548581	1548582	1548583	1548584
Sample Reference				BH03	WS02	WS03	WS04	WS01
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	0.20	0.20	0.20	0.30
Date Sampled				18/06/2020	24/06/2020	24/06/2020	24/06/2020	24/06/2020
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	4.0	4.0	1.5	4.0	8.2
Total mass of sample received	kg	0.001	NONE	1.3	2.0	2.0	2.0	2.0
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.7	6.7	11.5	9.1	7.7
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.011	0.0095	0.075	0.084	0.014
Organic Matter	%	0.1	MCERTS	0.6	0.3	< 0.1	1.1	2.1
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	3.9	2.8	3.9	5.4
Barium (aqua regia extractable)	mg/kg	1	MCERTS	8.6	22	30	60	130
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	0.33	0.45	0.37	0.44	0.78
Boron (water soluble)	mg/kg	0.2	MCERTS	0.5	0.3	1.1	0.7	0.6
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	21	34	40	25	31
Copper (aqua regia extractable)	mg/kg	1	MCERTS	35	54	40	24	14
Lead (aqua regia extractable)	mg/kg	1	MCERTS	3.2	3.2	2.4	3.2	15
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	16	19	21	15	30
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	100	110	60	40	36
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	82	68	41	43	65
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10

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Analytical Report Number: 20-16942

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548580	1548581	1548582	1548583	1548584
Sample Reference				BH03	WS02	WS03	WS04	WS01
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	0.20	0.20	0.20	0.30
Date Sampled				18/06/2020	24/06/2020	24/06/2020	24/06/2020	24/06/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	-	-	-	-	-
Chloroethane	µg/kg	1	NONE	-	-	-	-	-
Bromomethane	µg/kg	1	ISO 17025	-	-	-	-	-
Vinyl Chloride	µg/kg	1	NONE	-	-	-	-	-
Trichlorofluoromethane	µg/kg	1	NONE	-	-	-	-	-
1,1-Dichloroethene	µg/kg	1	NONE	-	-	-	-	-
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-	-	-	-	-
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-	-	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	-	-
1,1-Dichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
2,2-Dichloropropane	µg/kg	1	MCERTS	-	-	-	-	-
Trichloromethane	µg/kg	1	MCERTS	-	-	-	-	-
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,1-Dichloropropene	µg/kg	1	MCERTS	-	-	-	-	-
Trans-1,2-dichloroethene	µg/kg	1	NONE	-	-	-	-	-
Benzene	µg/kg	1	MCERTS	-	-	-	-	-
Tetrachloromethane	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dichloropropane	µg/kg	1	MCERTS	-	-	-	-	-
Trichloroethene	µg/kg	1	MCERTS	-	-	-	-	-
Dibromomethane	µg/kg	1	MCERTS	-	-	-	-	-
Bromodichloromethane	µg/kg	1	MCERTS	-	-	-	-	-
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	-	-	-
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	-	-	-
Toluene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,3-Dichloropropane	µg/kg	1	ISO 17025	-	-	-	-	-
Dibromochloromethane	µg/kg	1	ISO 17025	-	-	-	-	-
Tetrachloroethene	µg/kg	1	NONE	-	-	-	-	-
1,2-Dibromoethane	µg/kg	1	ISO 17025	-	-	-	-	-
Chlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
p & m-Xylene	µg/kg	1	MCERTS	-	-	-	-	-
Styrene	µg/kg	1	MCERTS	-	-	-	-	-
Tribromomethane	µg/kg	1	NONE	-	-	-	-	-
o-Xylene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	-	-	-
Isopropylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
Bromobenzene	µg/kg	1	MCERTS	-	-	-	-	-
n-Propylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
2-Chlorotoluene	µg/kg	1	MCERTS	-	-	-	-	-
4-Chlorotoluene	µg/kg	1	MCERTS	-	-	-	-	-
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
tert-Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
sec-Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-	-	-	-	-
p-Isopropyltoluene	µg/kg	1	ISO 17025	-	-	-	-	-
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-	-	-	-	-
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
Hexachlorobutadiene	µg/kg	1	MCERTS	-	-	-	-	-
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-	-	-	-	-

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Analytical Report Number: 20-16942

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548580	1548581	1548582	1548583	1548584
Sample Reference				BH03	WS02	WS03	WS04	WS01
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	0.20	0.20	0.20	0.30
Date Sampled				18/06/2020	24/06/2020	24/06/2020	24/06/2020	24/06/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-	-	-	-	-
Phenol	mg/kg	0.2	ISO 17025	-	-	-	-	-
2-Chlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	-	-	-	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	-	-	-	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	-	-	-	-
2-Methylphenol	mg/kg	0.3	MCERTS	-	-	-	-	-
Hexachloroethane	mg/kg	0.05	MCERTS	-	-	-	-	-
Nitrobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
4-Methylphenol	mg/kg	0.2	NONE	-	-	-	-	-
Isophorone	mg/kg	0.2	MCERTS	-	-	-	-	-
2-Nitrophenol	mg/kg	0.3	MCERTS	-	-	-	-	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	-	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	-	-	-	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Naphthalene	mg/kg	0.05	MCERTS	-	-	-	-	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	-	-	-	-
4-Chloroaniline	mg/kg	0.1	NONE	-	-	-	-	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	-	-	-	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	-	-	-	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	-	-	-	-
2-Methylnaphthalene	mg/kg	0.1	NONE	-	-	-	-	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	-	-	-	-
Dimethylphthalate	mg/kg	0.1	MCERTS	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	-	-	-	-
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	-	-	-
Acenaphthene	mg/kg	0.05	MCERTS	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	-	-	-	-
Dibenzofuran	mg/kg	0.2	MCERTS	-	-	-	-	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	-	-	-	-
Diethyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	-
4-Nitroaniline	mg/kg	0.2	MCERTS	-	-	-	-	-
Fluorene	mg/kg	0.05	MCERTS	-	-	-	-	-
Azobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	-	-	-	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Phenanthrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Carbazole	mg/kg	0.3	MCERTS	-	-	-	-	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	-
Anthraquinone	mg/kg	0.3	MCERTS	-	-	-	-	-
Fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Chrysene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-	-	-

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Analytical Report Number: 20-16942

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548585	1548586	1548587	1548588	
Sample Reference				WS05	WS08	WS10	WS11	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.50	0.20	0.10	0.00	
Date Sampled				24/06/2020	23/06/2020	23/06/2020	23/06/2020	
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	3.7	7.1	7.8	4.0	
Total mass of sample received	kg	0.001	NONE	2.0	1.8	1.9	1.9	
Asbestos in Soil	Type	N/A	ISO 17025	-	Not-detected	Not-detected	Not-detected	
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.6	7.4	7.6	7.7	
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.021	0.030	0.015	0.018	
Organic Matter	%	0.1	MCERTS	< 0.1	0.8	0.7	0.4	
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	< 0.80	< 0.80	< 0.80	
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	3.4	4.6	4.7	1.0	
Barium (aqua regia extractable)	mg/kg	1	MCERTS	30	46	49	17	
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	0.99	0.89	1.1	0.34	
Boron (water soluble)	mg/kg	0.2	MCERTS	< 0.2	0.4	0.4	0.3	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	27	33	31	40	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	12	21	18	54	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	10	11	7.9	2.1	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	38	41	38	22	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	28	38	38	130	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	58	67	69	76	
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	

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Analytical Report Number: 20-16942

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548585	1548586	1548587	1548588	
Sample Reference				WS05	WS08	WS10	WS11	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.50	0.20	0.10	0.00	
Date Sampled				24/06/2020	23/06/2020	23/06/2020	23/06/2020	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	-	-	< 1.0	-	
Chloroethane	µg/kg	1	NONE	-	-	< 1.0	-	
Bromomethane	µg/kg	1	ISO 17025	-	-	< 1.0	-	
Vinyl Chloride	µg/kg	1	NONE	-	-	< 1.0	-	
Trichlorofluoromethane	µg/kg	1	NONE	-	-	< 1.0	-	
1,1-Dichloroethene	µg/kg	1	NONE	-	-	< 1.0	-	
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-	-	< 1.0	-	
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-	-	< 1.0	-	
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,1-Dichloroethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
2,2-Dichloropropane	µg/kg	1	MCERTS	-	-	< 1.0	-	
Trichloromethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,2-Dichloroethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,1-Dichloropropene	µg/kg	1	MCERTS	-	-	< 1.0	-	
Trans-1,2-dichloroethene	µg/kg	1	NONE	-	-	< 1.0	-	
Benzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
Tetrachloromethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,2-Dichloropropane	µg/kg	1	MCERTS	-	-	< 1.0	-	
Trichloroethene	µg/kg	1	MCERTS	-	-	< 1.0	-	
Dibromomethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
Bromodichloromethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	< 1.0	-	
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	< 1.0	-	
Toluene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,3-Dichloropropane	µg/kg	1	ISO 17025	-	-	< 1.0	-	
Dibromochloromethane	µg/kg	1	ISO 17025	-	-	< 1.0	-	
Tetrachloroethene	µg/kg	1	NONE	-	-	< 1.0	-	
1,2-Dibromoethane	µg/kg	1	ISO 17025	-	-	< 1.0	-	
Chlorobenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
Ethylbenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
p & m-Xylene	µg/kg	1	MCERTS	-	-	< 1.0	-	
Styrene	µg/kg	1	MCERTS	-	-	< 1.0	-	
Tribromomethane	µg/kg	1	NONE	-	-	< 1.0	-	
o-Xylene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	< 1.0	-	
Isopropylbenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
Bromobenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
n-Propylbenzene	µg/kg	1	ISO 17025	-	-	< 1.0	-	
2-Chlorotoluene	µg/kg	1	MCERTS	-	-	< 1.0	-	
4-Chlorotoluene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	< 1.0	-	
tert-Butylbenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	< 1.0	-	
sec-Butylbenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-	-	< 1.0	-	
p-Isopropyltoluene	µg/kg	1	ISO 17025	-	-	< 1.0	-	
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
Butylbenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-	-	< 1.0	-	
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-	-	< 1.0	-	
Hexachlorobutadiene	µg/kg	1	MCERTS	-	-	< 1.0	-	
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-	-	< 1.0	-	

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Analytical Report Number: 20-16942

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548585	1548586	1548587	1548588	
Sample Reference				WS05	WS08	WS10	WS11	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.50	0.20	0.10	0.00	
Date Sampled				24/06/2020	23/06/2020	23/06/2020	23/06/2020	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-	-	< 0.1	-	
Phenol	mg/kg	0.2	ISO 17025	-	-	< 0.2	-	
2-Chlorophenol	mg/kg	0.1	MCERTS	-	-	< 0.1	-	
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	-	< 0.1	-	
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	-	< 0.1	-	
2-Methylphenol	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
Hexachloroethane	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Nitrobenzene	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
4-Methylphenol	mg/kg	0.2	NONE	-	-	< 0.2	-	
Isophorone	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
2-Nitrophenol	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
Naphthalene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
4-Chloroaniline	mg/kg	0.1	NONE	-	-	< 0.1	-	
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	-	< 0.1	-	
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	-	< 0.1	-	
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	-	< 0.1	-	
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
2-Methylnaphthalene	mg/kg	0.1	NONE	-	-	< 0.1	-	
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	-	< 0.1	-	
Dimethylphthalate	mg/kg	0.1	MCERTS	-	-	< 0.1	-	
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	-	< 0.1	-	
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Acenaphthene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
Dibenzofuran	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	-	< 0.3	-	
Diethyl phthalate	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
4-Nitroaniline	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
Fluorene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Azobenzene	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
Phenanthrene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Anthracene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Carbazole	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	-	< 0.2	-	
Anthraquinone	mg/kg	0.3	MCERTS	-	-	< 0.3	-	
Fluoranthene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Pyrene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	-	< 0.3	-	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Chrysene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	< 0.05	-	

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Analytical Report Number : 20-16942

Project / Site name: Milford Haven Refinery

* 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 *
1548580	BH03	None Supplied	0.10	Brown sand with gravel.
1548581	WS02	None Supplied	0.20	Brown loam and clay with gravel and vegetation.
1548582	WS03	None Supplied	0.20	Grey gravel.**
1548583	WS04	None Supplied	0.20	Grey sand with gravel.
1548584	WS01	None Supplied	0.30	Grey loam and clay with gravel and vegetation.
1548585	WS05	None Supplied	0.50	Grey sand with gravel.
1548586	WS08	None Supplied	0.20	Brown sand with gravel.
1548587	WS10	None Supplied	0.10	Brown sand with gravel.
1548588	WS11	None Supplied	0.00	Brown clay with gravel.

** Non MCERTS matrix

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Analytical Report Number : 20-16942

Project / Site name: Milford Haven Refinery

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
D.O. for Gravimetric Quant if Screen/ID positive	Dependent option for Gravimetric Quant if Screen/ID positive scheduled.	In house asbestos methods A001 & A006.	A006-PL	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-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 (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS

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 30oC.

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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH03		S	20-16942	1548580	c	Total cyanide in soil	L080-PL	c
WS01		S	20-16942	1548584	c	Total cyanide in soil	L080-PL	c
WS02		S	20-16942	1548581	c	Total cyanide in soil	L080-PL	c
WS03		S	20-16942	1548582	c	Total cyanide in soil	L080-PL	c
WS04		S	20-16942	1548583	c	Total cyanide in soil	L080-PL	c
WS05		S	20-16942	1548585	c	Total cyanide in soil	L080-PL	c
WS08		S	20-16942	1548586	c	Total cyanide in soil	L080-PL	c
WS10		S	20-16942	1548587	c	Total cyanide in soil	L080-PL	c
WS11		S	20-16942	1548588	c	Total cyanide in soil	L080-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

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Analytical Report Number : 20-16959

Project / Site name:	Milford Haven Refinery	**Samples received on:**	25/06/2020
Your job number:	C6725 PC 472443502	**Sample instructed/ Analysis started on:**	29/06/2020
Your order number:	32797	**Analysis completed by:**	22/07/2020
Report Issue Number:	1	**Report issued on:**	23/07/2020
Samples Analysed:	8 soil samples		

Signed: Karolina Marek

Karolina Marek
PL Head of Reporting Team

For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

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

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 20-16959

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548660	1548661	1548662	1548663	1548664
Sample Reference				BH05	BH05	WS12	WS10	WS10
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	0.20	0.00-0.20	0.00-0.10	0.10-0.40
Date Sampled				19/06/2020	19/06/2020	22/06/2020	23/06/2020	23/06/2020
Time Taken				None Supplied	None Supplied	1530	1000	1000
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	-	< 0.1	< 0.1	-	< 0.1
Moisture Content	%	N/A	NONE	-	12	3.5	-	7.9
Total mass of sample received	kg	0.001	NONE	-	1.3	1.9	-	1.9
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	Not-detected	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	8.2	-	-	7.7
Total Cyanide	mg/kg	1	MCERTS	-	< 1	-	-	< 1
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	0.014	-	-	0.014
Organic Matter	%	0.1	MCERTS	-	0.5	-	-	0.7
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	< 0.80	-	-	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	4.3	< 1.0	-	4.1
Barium (aqua regia extractable)	mg/kg	1	MCERTS	-	46	16	-	42
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	-	0.89	0.30	-	1.0
Boron (water soluble)	mg/kg	0.2	MCERTS	-	0.3	< 0.2	-	0.2
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	-	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	35	28	-	27
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	13	57	-	17
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	9.9	1.7	-	13
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	-	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	38	18	-	35
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	< 1.0	< 1.0	-	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	-	40	150	-	34
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	57	77	-	67
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	-	< 10	-	-	< 10

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Analytical Report Number: 20-16959

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548660	1548661	1548662	1548663	1548664
Sample Reference				BH05	BH05	WS12	WS10	WS10
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	0.20	0.00-0.20	0.00-0.10	0.10-0.40
Date Sampled				19/06/2020	19/06/2020	22/06/2020	23/06/2020	23/06/2020
Time Taken				None Supplied	None Supplied	1530	1000	1000
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Chloroethane	µg/kg	1	NONE	-	< 1.0	-	-	-
Bromomethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Vinyl Chloride	µg/kg	1	NONE	-	< 1.0	-	-	-
Trichlorofluoromethane	µg/kg	1	NONE	-	< 1.0	-	-	-
1,1-Dichloroethene	µg/kg	1	NONE	-	< 1.0	-	-	-
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1-Dichloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
2,2-Dichloropropane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Trichloromethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2-Dichloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1-Dichloropropene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Trans-1,2-dichloroethene	µg/kg	1	NONE	-	< 1.0	-	-	-
Benzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Tetrachloromethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2-Dichloropropane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Trichloroethene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Dibromomethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Bromodichloromethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Toluene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,3-Dichloropropane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Dibromochloromethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Tetrachloroethene	µg/kg	1	NONE	-	< 1.0	-	-	-
1,2-Dibromoethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Chlorobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
p & m-Xylene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Styrene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Tribromomethane	µg/kg	1	NONE	-	< 1.0	-	-	-
o-Xylene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Isopropylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Bromobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
n-Propylbenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
2-Chlorotoluene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
4-Chlorotoluene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
tert-Butylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
sec-Butylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
p-Isopropyltoluene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Butylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Hexachlorobutadiene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-

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Analytical Report Number: 20-16959

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548660	1548661	1548662	1548663	1548664
Sample Reference				BH05	BH05	WS12	WS10	WS10
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	0.20	0.00-0.20	0.00-0.10	0.10-0.40
Date Sampled				19/06/2020	19/06/2020	22/06/2020	23/06/2020	23/06/2020
Time Taken				None Supplied	None Supplied	1530	1000	1000
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-	< 0.1	-	-	-
Phenol	mg/kg	0.2	ISO 17025	-	< 0.2	-	-	-
2-Chlorophenol	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
2-Methylphenol	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Hexachloroethane	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Nitrobenzene	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
4-Methylphenol	mg/kg	0.2	NONE	-	< 0.2	-	-	-
Isophorone	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
2-Nitrophenol	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
4-Chloroaniline	mg/kg	0.1	NONE	-	< 0.1	-	-	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	< 0.1	-	-	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
2-Methylnaphthalene	mg/kg	0.1	NONE	-	< 0.1	-	-	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
Dimethylphthalate	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Dibenzofuran	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	< 0.3	-	-	-
Diethyl phthalate	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
4-Nitroaniline	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Azobenzene	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Carbazole	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Anthraquinone	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	< 0.3	-	-	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-

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Analytical Report Number: 20-16959

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548665	1548666	1548667		
Sample Reference				WS08	WS05	WS07		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.00-0.20	0.00-0.20	0.00-0.15		
Date Sampled				23/06/2020	23/06/2020	23/06/2020		
Time Taken				1100	1345	1530		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1		
Moisture Content	%	N/A	NONE	4.9	3.4	4.0		
Total mass of sample received	kg	0.001	NONE	1.9	2.0	2.0		
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected		
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.4	7.6	7.7		
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	-		
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.011	0.029	0.022		
Organic Matter	%	0.1	MCERTS	0.6	0.7	0.9		
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80		
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	4.2	5.6	3.8		
Barium (aqua regia extractable)	mg/kg	1	MCERTS	19	180	52		
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	0.35	0.94	0.70		
Boron (water soluble)	mg/kg	0.2	MCERTS	< 0.2	0.5	0.5		
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2		
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	44	27	25		
Copper (aqua regia extractable)	mg/kg	1	MCERTS	62	27	39		
Lead (aqua regia extractable)	mg/kg	1	MCERTS	3.5	9.3	6.0		
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3		
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	23	28	21		
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	98	45	110		
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	65	87	72		
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	< 10		

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Analytical Report Number: 20-16959

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548665	1548666	1548667		
Sample Reference				WS08	WS05	WS07		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.00-0.20	0.00-0.20	0.00-0.15		
Date Sampled				23/06/2020	23/06/2020	23/06/2020		
Time Taken				1100	1345	1530		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0	-		
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0	-		
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0	-		
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	-		
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	-		
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0	-		
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0	-		
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0	-		
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-		

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Analytical Report Number: 20-16959

Project / Site name: Milford Haven Refinery
Your Order No: 32797

Lab Sample Number				1548665	1548666	1548667		
Sample Reference				WS08	WS05	WS07		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.00-0.20	0.00-0.20	0.00-0.15		
Date Sampled				23/06/2020	23/06/2020	23/06/2020		
Time Taken				1100	1345	1530		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1	< 0.1	-		
Phenol	mg/kg	0.2	ISO 17025	< 0.2	< 0.2	-		
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	-		
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	-		
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	< 0.1	-		
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
4-Methylphenol	mg/kg	0.2	NONE	< 0.2	< 0.2	-		
Isophorone	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1	< 0.1	-		
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	-		
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	< 0.1	-		
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	-		
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
2-Methylnaphthalene	mg/kg	0.1	NONE	< 0.1	< 0.1	-		
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	-		
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	< 0.1	-		
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	-		
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
Dibenzofuran	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	-		
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Carbazole	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-		
Anthraquinone	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-		
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	-		
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-		

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Analytical Report Number : 20-16959

Project / Site name: Milford Haven Refinery

* 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 *
1548660	BH05	None Supplied	0.10	-
1548661	BH05	None Supplied	0.20	Brown clay.
1548662	WS12	None Supplied	0.00-0.20	Brown sand with gravel and vegetation.
1548663	WS10	None Supplied	0.00-0.10	-
1548664	WS10	None Supplied	0.10-0.40	Brown sand with gravel.
1548665	WS08	None Supplied	0.00-0.20	Brown sand with gravel and vegetation.
1548666	WS05	None Supplied	0.00-0.20	Brown sand with gravel and vegetation.
1548667	WS07	None Supplied	0.00-0.15	Brown loam and clay with gravel and vegetation.

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Analytical Report Number : 20-16959

Project / Site name: Milford Haven Refinery

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
D.O. for Gravimetric Quant if Screen/ID positive	Dependent option for Gravimetric Quant if Screen/ID positive scheduled.	In house asbestos methods A001 & A006.	A006-PL	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-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 (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS

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 30oC.

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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH05		S	20-16959	1548661	c	Total cyanide in soil	L080-PL	c
WS05		S	20-16959	1548666	c	Total cyanide in soil	L080-PL	c
WS08		S	20-16959	1548665	c	Total cyanide in soil	L080-PL	c
WS10		S	20-16959	1548664	c	Total cyanide in soil	L080-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Oliver Belson
Stantec
3rd Floor, 50-60 Station Rd,
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e:

i2 Analytical Ltd.
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Analytical Report Number : 20-17753

Project / Site name:	Pembs New WTS - Puma Energy	**Samples received on:**	06/07/2020
Your job number:	47244 3502	**Sample instructed/ Analysis started on:**	07/07/2020
Your order number:		**Analysis completed by:**	20/07/2020
Report Issue Number:	1	**Report issued on:**	20/07/2020
Samples Analysed:	5 water samples		

Signed: A. Czerwińska

Agnieszka Czerwińska

Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

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

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

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Analytical Report Number: 20-17753

Project / Site name: Pembs New WTS - Puma Energy

Lab Sample Number				1552913	1552914	1552915	1552916	1552917
Sample Reference				BH01	BH02	BH03	BH04	BH05
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				7.36	5.76	7.99	4.54	7.70
Date Sampled				02/07/2020	02/07/2020	02/07/2020	02/07/2020	02/07/2020
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	7.5	6.1	7.4	6.4	6.0
Dissolved Organic Carbon (DOC)	mg/l	0.1	NONE	2.91	1.69	5.28	1.76	1.41
Total Phenols								
Total Phenols (monohydric)	µg/l	10	ISO 17025	< 10	< 10	< 10	< 10	< 10
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	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total PAH								
Total EPA-16 PAHs	µg/l	0.16	ISO 17025	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16
Heavy Metals / Metalloids								
Arsenic (dissolved)	µg/l	0.15	ISO 17025	0.63	0.21	2.30	0.31	0.23
Boron (dissolved)	µg/l	10	ISO 17025	20	22	24	20	21
Cadmium (dissolved)	µg/l	0.02	ISO 17025	< 0.02	0.03	0.36	0.03	0.16
Chromium (dissolved)	µg/l	0.2	ISO 17025	< 0.2	< 0.2	5.0	< 0.2	< 0.2
Copper (dissolved)	µg/l	0.5	ISO 17025	2.8	1.8	1.8	2.8	13
Lead (dissolved)	µg/l	0.2	ISO 17025	< 0.2	< 0.2	62	< 0.2	< 0.2
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel (dissolved)	µg/l	0.5	ISO 17025	0.8	5.4	4.9	3.6	28
Selenium (dissolved)	µg/l	0.6	ISO 17025	1.0	1.4	2.1	3.9	< 0.6
Zinc (dissolved)	µg/l	0.5	ISO 17025	1.1	2.2	2.8	2.7	8.8
Monoaromatics & Oxygenates								
Benzene	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
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	< 1.0	< 1.0
o-xylene	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

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Analytical Report Number: 20-17753

Project / Site name: Pembs New WTS - Puma Energy

Lab Sample Number				1552913	1552914	1552915	1552916	1552917
Sample Reference				BH01	BH02	BH03	BH04	BH05
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				7.36	5.76	7.99	4.54	7.70
Date Sampled				02/07/2020	02/07/2020	02/07/2020	02/07/2020	02/07/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
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	< 10	< 10
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 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	< 10	< 10

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Analytical Report Number: 20-17753

Project / Site name: Pembs New WTS - Puma Energy

Lab Sample Number				1552913	1552914	1552915	1552916	1552917
Sample Reference				BH01	BH02	BH03	BH04	BH05
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				7.36	5.76	7.99	4.54	7.70
Date Sampled				02/07/2020	02/07/2020	02/07/2020	02/07/2020	02/07/2020
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	< 1.0	< 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	< 1.0	< 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	< 1.0	< 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

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

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Analytical Report Number : 20-17753

Project / Site name: Pembs New WTS - Puma Energy

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Boron in water	Determination of boron in water 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 (Monoaromatics)	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
Dissolved Organic Carbon in water	Determination of dissolved inorganic 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	NONE
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on USEPA Method 6020 & 200.8 "for the determination of trace elements in water by ICP-MS.	L012-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
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In house method.	L099-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. Accredited matrices: SW PW GW	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	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 30oC.

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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH01		W	20-17753	1552913	c	pH at 20oC in water (automated)	L099-PL	c
BH02		W	20-17753	1552914	c	pH at 20oC in water (automated)	L099-PL	c
BH03		W	20-17753	1552915	c	pH at 20oC in water (automated)	L099-PL	c
BH04		W	20-17753	1552916	c	pH at 20oC in water (automated)	L099-PL	c
BH05		W	20-17753	1552917	c	pH at 20oC in water (automated)	L099-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Appendix D Monitoring Data

CC Ground Investigations Ltd

GAS AND WATER MONITORING RECORD

Telephone: 01452 739 165 , Fax: 01452 739 220 , Email: info@CCGround.co.uk

Borehole No.

BH01

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: C6725	Co-ords: E N Level: mAD	Date 17/07/2020
Location: Milford Haven Refinery, SA73 3UP			Logged By SF
Client: Stantec UK Ltd			Checked By MA

Date & Time	Methane (CH_4) (%)	Carbon Dioxide (CO_2) (%)	Oxygen (O_2) (%)	Carbon Monoxide (CO) (ppm)	Hydrogen Sulphide (H_2S) (ppm)	LEL (%)	Flow (L/hr)	Temp (C°)	Baro Pressure (mb)	Water Level (m)	Install Depths (m)
Visit 1											
29/06/2020 12:00									1010		
30/06/2020 12:00									1005		
01/07/2020 12:00									1006		
02/07/2020 09:05								18	1006		
02/07/2020 09:06							0.0				
02/07/2020 09:07							0.0				
02/07/2020 09:08							0.0				
02/07/2020 09:09							0.0				
02/07/2020 09:10							0.0				
02/07/2020 09:11	0.1	2.0	17.9	0	0	2%					
02/07/2020 09:12	0.2	2.1	17.7	0	0	4%					
02/07/2020 09:13	0.1	2.3	17.6	0	0	2%					
02/07/2020 09:14	0.1	2.4	17.4	0	0	2%					
02/07/2020 09:15	0.1	2.5	17.4	0	0	2%					
02/07/2020 09:16										4.59	7.86
Visit 2											
07/07/2020 12:00									1019		
08/07/2020 12:00									1015		
09/07/2020 12:00									1013		
10/07/2020 10:30								20	1014		
10/07/2020 10:31							0.0				
10/07/2020 10:32							0.0				
10/07/2020 10:33							0.0				
10/07/2020 10:34							0.0				
10/07/2020 10:35							0.0				
10/07/2020 10:36	0.1	2.8	18.3	0	0	2%					
10/07/2020 10:37	0.1	2.8	18.1	0	0	2%					
10/07/2020 10:38	0.0	2.8	18.0	0	0	0%					
10/07/2020 10:39	0.0	2.8	18.0	0	0	0%					
10/07/2020 10:40	0.0	2.8	17.9	0	0	0%					
10/07/2020 10:41										3.73	7.86
Visit 3											
14/07/2020 12:00									1020		
15/07/2020 12:00									1018		
16/07/2020 12:00									1023		
17/07/2020 10:00								18	1015		
17/07/2020 10:01							0.0				
17/07/2020 10:02							0.0				
17/07/2020 10:03							0.0				
17/07/2020 10:04							0.0				
17/07/2020 10:05							0.0				
17/07/2020 10:06	0.0	3.2	16.8	1	0	0%					
17/07/2020 10:07	0.0	3.2	16.8	1	0	0%					
17/07/2020 10:08	0.0	3.3	16.7	1	0	0%					
17/07/2020 10:09	0.0	3.3	16.7	1	0	0%					
17/07/2020 10:10	0.0	3.3	16.6	0	0	0%					
17/07/2020 10:11										4.1	7.86

EQUIPMENT: Soil Instruments GA5000 Portable Gas Analyser. Geotechnical Instruments Dipmeter.
INSTALLATION TYPE: 50mm ID HDPE gas monitoring standpipe. See corresponding borehole log for details.
METHOD: Gas flow measured using internal flow meter for 5 minutes. Ground gas monitored using 5 gas analyser for 5 minutes in accordance with CIRIA 665 (2007).
REMARKS: LEL value calculated only. Full set of samples obtained using dedicated bailer on completion of visit 2. Boreholes purged 10 x Well Volumes where required on visit 1.

CC Ground Investigations Ltd

GAS AND WATER MONITORING RECORD

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Borehole No.

BH02

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: C6725	Co-ords: E N Level: mAD	Date 17/07/2020
Location: Milford Haven Refinery, SA73 3UP			Logged By SF
Client: Stantec UK Ltd			Checked By MA

Date & Time	Methane (CH_4) (%)	Carbon Dioxide (CO_2) (%)	Oxygen (O_2) (%)	Carbon Monoxide (CO) (ppm)	Hydrogen Sulphide (H_2S) (ppm)	LEL (%)	Flow (L/hr)	Temp (C°)	Baro Pressure (mb)	Water Level (m)	Install Depths (m)
Visit 1											
29/06/2020 12:00									1010		
30/06/2020 12:00									1005		
01/07/2020 12:00									1006		
02/07/2020 11:30								19	1006		
02/07/2020 11:31							0.0				
02/07/2020 11:32							0.0				
02/07/2020 11:33							0.0				
02/07/2020 11:34							0.0				
02/07/2020 11:35							0.0				
02/07/2020 11:36	0.0	1.3	18.2	1	0	0%					
02/07/2020 11:37	0.0	1.5	17.7	1	0	0%					
02/07/2020 11:38	0.0	1.6	17.5	1	0	0%					
02/07/2020 11:39	0.0	1.5	17.4	1	0	0%					
02/07/2020 11:40	0.0	1.4	17.5	1	0	0%					
02/07/2020 11:41										5.19	9.81
Visit 2											
07/07/2020 12:00									1019		
08/07/2020 12:00									1015		
09/07/2020 12:00									1013		
10/07/2020 10:50								20	1014		
10/07/2020 10:51							0.0				
10/07/2020 10:52							0.0				
10/07/2020 10:53							0.0				
10/07/2020 10:54							0.0				
10/07/2020 10:55							0.0				
10/07/2020 10:56	0.0	0.9	13.3	0	0	0%					
10/07/2020 10:57	0.0	0.9	12.7	0	0	0%					
10/07/2020 10:58	0.0	0.9	12.7	0	0	0%					
10/07/2020 10:59	0.0	0.9	12.7	0	0	0%					
10/07/2020 11:00	0.0	1.0	12.6	0	0	0%					
10/07/2020 11:01										3.96	9.81
Visit 3											
14/07/2020 12:00									1020		
15/07/2020 12:00									1018		
16/07/2020 12:00									1023		
17/07/2020 10:20								18	1015		
17/07/2020 10:21							-0.1				
17/07/2020 10:22							-0.1				
17/07/2020 10:23							-0.1				
17/07/2020 10:24							-0.1				
17/07/2020 10:25							-0.1				
17/07/2020 10:26	0.0	2.3	12.3	1	0	0%					
17/07/2020 10:27	0.0	2.3	12.2	0	0	0%					
17/07/2020 10:28	0.0	2.1	12.9	0	0	0%					
17/07/2020 10:29	0.0	1.6	15.1	0	0	0%					
17/07/2020 10:30	0.0	1.5	15.7	0	0	0%					
17/07/2020 10:31										4.37	9.81

EQUIPMENT: Soil Instruments GA5000 Portable Gas Analyser. Geotechnical Instruments Dipmeter.
INSTALLATION TYPE: 50mm ID HDPE gas monitoring standpipe. See corresponding borehole log for details.
METHOD: Gas flow measured using internal flow meter for 5 minutes. Ground gas monitored using 5 gas analyser for 5 minutes in accordance with CIRIA 665 (2007).
REMARKS: LEL value calculated only. Full set of samples obtained using dedicated bailer on completion of visit 2. Boreholes purged 10 x Well Volumes where required on visit 1.

CC Ground Investigations Ltd

GAS AND WATER MONITORING RECORD

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Borehole No.

BH03

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: C6725	Co-ords: E N Level: mAD	Date 17/07/2020
Location: Milford Haven Refinery, SA73 3UP			Logged By SF
Client: Stantec UK Ltd			Checked By MA

Date & Time	Methane (CH_4) (%)	Carbon Dioxide (CO_2) (%)	Oxygen (O_2) (%)	Carbon Monoxide (CO) (ppm)	Hydrogen Sulphide (H_2S) (ppm)	LEL (%)	Flow (L/hr)	Temp (C°)	Baro Pressure (mb)	Water Level (m)	Install Depths (m)
Visit 1											
29/06/2020 12:00									1010		
30/06/2020 12:00									1005		
01/07/2020 12:00									1006		
02/07/2020 12:15								21	1007		
02/07/2020 12:16							0.0				
02/07/2020 12:17							0.0				
02/07/2020 12:18							0.0				
02/07/2020 12:19							0.0				
02/07/2020 12:20							0.0				
02/07/2020 12:21	0.0	0.1	20.9	2	0	0%					
02/07/2020 12:22	0.0	0.1	20.7	2	0	0%					
02/07/2020 12:23	0.0	0.2	20.7	2	0	0%					
02/07/2020 12:24	0.0	0.2	20.6	2	0	0%					
02/07/2020 12:25	0.0	0.2	20.6	2	0	0%					
02/07/2020 12:26										4.75	8.82
Visit 2											
07/07/2020 12:00									1019		
08/07/2020 12:00									1015		
09/07/2020 12:00									1013		
10/07/2020 11:10								20	1014		
10/07/2020 11:11							-0.0				
10/07/2020 11:12							0.0				
10/07/2020 11:13							0.0				
10/07/2020 11:14							0.0				
10/07/2020 11:15							0.0				
10/07/2020 11:16	0.0	1.3	17.2	0	0	0%					
10/07/2020 11:17	0.0	1.3	17.2	0	0	0%					
10/07/2020 11:18	0.0	1.3	17.2	0	0	0%					
10/07/2020 11:19	0.0	1.4	17.2	0	0	0%					
10/07/2020 11:20	0.0	1.4	17.2	0	0	0%					
10/07/2020 11:21										2.96	8.82
Visit 3											
14/07/2020 12:00									1020		
15/07/2020 12:00									1018		
16/07/2020 12:00									1023		
17/07/2020 10:45								18	1015		
17/07/2020 10:46							0.0				
17/07/2020 10:47							0.0				
17/07/2020 10:48							0.0				
17/07/2020 10:49							0.0				
17/07/2020 10:50							0.0				
17/07/2020 10:51	0.0	1.6	17.2	0	0	0%					
17/07/2020 10:52	0.0	1.7	17.0	0	0	0%					
17/07/2020 10:53	0.0	1.7	17.0	0	0	0%					
17/07/2020 10:54	0.0	1.7	17.0	0	0	0%					
17/07/2020 10:55	0.0	1.8	17.1	0	0	0%					
17/07/2020 10:56										3.65	8.82

EQUIPMENT: Soil Instruments GA5000 Portable Gas Analyser. Geotechnical Instruments Dipmeter.
INSTALLATION TYPE: 50mm ID HDPE gas monitoring standpipe. See corresponding borehole log for details.
METHOD: Gas flow measured using internal flow meter for 5 minutes. Ground gas monitored using 5 gas analyser for 5 minutes in accordance with CIRIA 665 (2007).
REMARKS: LEL value calculated only. Full set of samples obtained using dedicated bailer on completion of visit 2. Boreholes purged 10 x Well Volumes where required on visit 1.

CC Ground Investigations Ltd

GAS AND WATER MONITORING RECORD

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Borehole No.

BH04

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: C6725	Co-ords: E N Level: mAD	Date 17/07/2020
Location: Milford Haven Refinery, SA73 3UP			Logged By SF
Client: Stantec UK Ltd			Checked By MA

Date & Time	Methane (CH_4) (%)	Carbon Dioxide (CO_2) (%)	Oxygen (O_2) (%)	Carbon Monoxide (CO) (ppm)	Hydrogen Sulphide (H_2S) (ppm)	LEL (%)	Flow (L/hr)	Temp (C°)	Baro Pressure (mb)	Water Level (m)	Install Depths (m)
Visit 1											
29/06/2020 12:00									1010		
30/06/2020 12:00									1005		
01/07/2020 12:00									1006		
02/07/2020 13:00								21	1007		
02/07/2020 13:01							0.0				
02/07/2020 13:02							0.0				
02/07/2020 13:03							0.0				
02/07/2020 13:04							0.0				
02/07/2020 13:05							0.0				
02/07/2020 13:06	0.0	0.1	21.1	4	0	0%					
02/07/2020 13:07	0.0	0.1	21.1	4	0	0%					
02/07/2020 13:08	0.0	0.1	21.2	4	0	0%					
02/07/2020 13:09	0.0	0.1	21.2	3	0	0%					
02/07/2020 13:10	0.0	0.1	21.2	3	0	0%					
02/07/2020 13:11										4.02	9.67
Visit 2											
07/07/2020 12:00									1019		
08/07/2020 12:00									1015		
09/07/2020 12:00									1013		
10/07/2020 11:25								20	1014		
10/07/2020 11:26							0.1				
10/07/2020 11:27							0.1				
10/07/2020 11:28							0.0				
10/07/2020 11:29							0.0				
10/07/2020 11:30							0.0				
10/07/2020 11:31	0.0	0.1	21.3	0	0	0%					
10/07/2020 11:32	0.0	0.2	21.3	0	0	0%					
10/07/2020 11:33	0.0	0.2	21.3	0	0	0%					
10/07/2020 11:34	0.0	0.2	21.3	0	0	0%					
10/07/2020 11:35	0.0	0.2	21.3	0	0	0%					
10/07/2020 11:36										2.95	9.67
Visit 3											
14/07/2020 12:00									1020		
15/07/2020 12:00									1018		
16/07/2020 12:00									1023		
17/07/2020 11:05								18	1015		
17/07/2020 11:06							0.0				
17/07/2020 11:07							0.0				
17/07/2020 11:08							0.0				
17/07/2020 11:09							0.0				
17/07/2020 11:10							0.0				
17/07/2020 11:11	0.0	1.3	19.0	1	0	0%					
17/07/2020 11:12	0.0	1.3	19.0	1	0	0%					
17/07/2020 11:13	0.0	1.4	19.0	1	0	0%					
17/07/2020 11:14	0.0	1.5	19.0	1	0	0%					
17/07/2020 11:15	0.0	1.7	18.9	1	0	0%					
17/07/2020 11:16										3.44	9.67

EQUIPMENT: Soil Instruments GA5000 Portable Gas Analyser. Geotechnical Instruments Dipmeter.
INSTALLATION TYPE: 50mm ID HDPE gas monitoring standpipe. See corresponding borehole log for details.
METHOD: Gas flow measured using internal flow meter for 5 minutes. Ground gas monitored using 5 gas analyser for 5 minutes in accordance with CIRIA 665 (2007).
REMARKS: LEL value calculated only. Full set of samples obtained using dedicated bailer on completion of visit 2. Boreholes purged 10 x Well Volumes where required on visit 1.

CC Ground Investigations Ltd

GAS AND WATER MONITORING RECORD

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Borehole No.

BH05

Sheet 1 of 1

Project Name: Milford Haven Refinery	Project No: C6725	Co-ords: E N Level: mAD	Date 17/07/2020
Location: Milford Haven Refinery, SA73 3UP			Logged By SF
Client: Stantec UK Ltd			Checked By MA

Date & Time	Methane (CH_4) (%)	Carbon Dioxide (CO_2) (%)	Oxygen (O_2) (%)	Carbon Monoxide (CO) (ppm)	Hydrogen Sulphide (H_2S) (ppm)	LEL (%)	Flow (L/hr)	Temp (C°)	Baro Pressure (mb)	Water Level (m)	Install Depths (m)
Visit 1											
29/06/2020 12:00									1010		
30/06/2020 12:00									1005		
01/07/2020 12:00									1006		
02/07/2020 13:45								21	1008		
02/07/2020 13:46							-0.1				
02/07/2020 13:47							-0.1				
02/07/2020 13:48							0.0				
02/07/2020 13:49							0.0				
02/07/2020 13:50							0.0				
02/07/2020 13:51	0.0	0.3	21.8	2	0	0%					
02/07/2020 13:52	0.0	0.5	21.7	2	0	0%					
02/07/2020 13:53	0.0	0.8	21.6	2	0	0%					
02/07/2020 13:54	0.0	1.1	21.5	3	0	0%					
02/07/2020 13:55	0.0	1.1	21.5	3	0	0%					
02/07/2020 13:56										6.04	9.78
Visit 2											
07/07/2020 12:00									1019		
08/07/2020 12:00									1015		
09/07/2020 12:00									1013		
10/07/2020 11:50								20	1016		
10/07/2020 11:51							0.0				
10/07/2020 11:52							-0.1				
10/07/2020 11:53							0.0				
10/07/2020 11:54							0.0				
10/07/2020 11:55							0.0				
10/07/2020 11:56	0.0	2.6	16.5	2	0	0%					
10/07/2020 11:57	0.0	2.6	16.3	2	0	0%					
10/07/2020 11:58	0.0	2.7	16.2	2	0	0%					
10/07/2020 11:59	0.0	2.7	16.2	3	0	0%					
10/07/2020 12:00	0.0	2.7	16.2	3	0	0%					
10/07/2020 12:01										5.23	9.78
Visit 3											
14/07/2020 12:00									1020		
15/07/2020 12:00									1018		
16/07/2020 12:00									1023		
17/07/2020 11:25								18	1015		
17/07/2020 11:26							0.0				
17/07/2020 11:27							0.0				
17/07/2020 11:28							0.0				
17/07/2020 11:29							0.0				
17/07/2020 11:30							0.0				
17/07/2020 11:31	0.0	3.3	15.6	2	0	0%					
17/07/2020 11:32	0.0	3.3	5.5	2	0	0%					
17/07/2020 11:33	0.0	3.5	15.4	2	0	0%					
17/07/2020 11:34	0.0	3.6	15.4	2	0	0%					
17/07/2020 11:35	0.0	3.6	15.4	2	0	0%					
17/07/2020 11:36										5.27	9.78

EQUIPMENT: Soil Instruments GA5000 Portable Gas Analyser. Geotechnical Instruments Dipmeter.
INSTALLATION TYPE: 50mm ID HDPE gas monitoring standpipe. See corresponding borehole log for details.
METHOD: Gas flow measured using internal flow meter for 5 minutes. Ground gas monitored using 5 gas analyser for 5 minutes in accordance with CIRIA 665 (2007).
REMARKS: LEL value calculated only. Full set of samples obtained using dedicated bailer on completion of visit 2. Boreholes purged 10 x Well Volumes where required on visit 1.

Appendix E Methodology

Stantec Guide: Methodology for Assessment of Land Contamination (Wales)

1 INTRODUCTION

This document defines the approach adopted by Stantec in relation to the assessment of land contamination in Wales. The aim is for the approach to (i) be systematic and objective, (ii) provide for the assessment of uncertainty and (iii) provide a rational, consistent, transparent framework.

When preparing our methodology, we have made reference to various technical guidance documents and legislation referenced in Section 7 of which the principal documents are (i) Contaminated Land Statutory Guidance for Wales (Welsh Government 2012), (ii) online guidance Land Contamination: Risk Management (LC:RM) accessed from GOV.UK which is expected to replace Contaminated Land Research (CLR) Report 11: Model Procedures for the Management of Contamination (EA 2004). It should be noted that LCRM is currently due to be revised following consultation and CLR 11 is archived, (iii) Contaminated land risk assessment: A guide to good practice (C552) (CIRIA 2001) (iv) Planning Policy Wales (PPW, 2018) (v) BS 10175 Investigation of potentially contaminated sites - Code of Practice (BSI 2017) (vi) The series of British Standards on Soil Quality BS 18400; and (vii) Development of Land Affected by Contamination: A Guide for Developers (WLCWG, 2017).

2 DEALING WITH LAND CONTAMINATION

Government policy on land contamination aims to prevent new contaminated land from being created and promotes a risk-based approach to addressing historical contamination. For historical contamination, regulatory intervention is held in reserve for land that meets the legal definition and cannot be dealt with through any other means, including through planning. Land is only considered to be "*contaminated land*" in the legal sense if it poses an unacceptable risk.

Part 2A of the Environmental Protection Act 1990 is a piece of primary legislation introduced to deal with the historic legacy of contaminated land. It was inserted into the Environmental Protection Act (1990) by section 57 of the Environment Act (1995) and later came into force in Wales on the 1st of July 2001. It places a statutory duty, on local authorities (as principle regulators), to inspect their areas in order to identify contaminated land. This is done in accordance with the local authorities published inspection strategy.
Part 2A provides a risk-based approach to the identification and remediation of land where contamination poses an unacceptable risk to human health or the environment.

The Model Procedures for the Management of Land Contamination (CLR 11), were developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. The process involves identifying, making decisions on, and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK. The approach, concepts and principles for land contamination management promoted by LC:RM (and its predecessor CLR 11) are applied to the determination of planning applications. The guidance given in LC:RM follows the same principles.

Other legislative regimes may also provide a means of dealing with land contamination issues, such as the regimes for waste, water, environmental permitting, and environmental damage. Further, the law of statutory nuisance may result in contaminants being unacceptable to third parties whilst not attracting action under Part 2A or other environmental legislation.

2.1 Part 2A

Contaminated Land Statutory Guidance for Wales 2012 refers to The Contaminated Land (Wales) Regulations 2006 but is noted that The Contaminated Land (Wales) (Amendment) Regulations 2012 is also published.

The statutory definition of Contaminated Land is "*land which appears to the Local Authority in whose area it is situated to be in such a condition that, by reason of substances in, on or under the land that significant harm is being caused, or there is a significant possibility that such significant harm (SPOSH) could be caused, or significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution (SPOSP) being caused*".

Harm is defined as "*harm to the health of living organisms or other interference with the ecological systems of which they form part, and in the case of man, includes harm to his property*".

Part 2A provides a means of dealing with unacceptable risks posed by land contamination to human health and the environment, and under the guidance enforcing authorities should seek to find and deal with such land. It states that "*under Part 2A the starting point should be that land is not contaminated land unless there is reason to consider otherwise. Only land where unacceptable risks are clearly identified, after a risk assessment has been undertaken in accordance with the Guidance, should be considered as meeting the Part 2A definition of contaminated land"*. Further, the guidance makes it clear that *"regulatory decisions should be based on what is reasonably likely, not what is hypothetically possible".*

The overarching objectives of the Government's policy on contaminated land and the Part 2A regime are:

"(a) To identify and remove unacceptable risks to human health and the environment.
(a) To seek to ensure that contaminated land is made suitable for its current use.

(b) To ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development".

The enforcing authority may need to decide whether and how to act in situations where decisions are not straight forward, and where there is uncertainty. "*In so doing, the authority should use its judgement to strike a reasonable balance between: (a) dealing with risks raised by contaminants in land and the benefits of remediating land to remove or reduce those risks; and (b) the potential impacts of regulatory intervention including financial costs to whoever will pay for remediation, health and environmental impacts of taking action, property blight, and burdens on affected people".*

The authority is required to "*take a precautionary approach to the risks raised by contamination, whilst avoiding a disproportionate approach given the circumstances of each case".* The aim is "*that the regime produces net benefits, taking account of local circumstances*".

The guidance recognises that *"normal levels of contaminants in soils should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise".* Normal levels are quoted as:

"a) natural presence of contaminants' such as from underlying geology *'that have not been shown to pose an unacceptable risk to health and the environment*

b) …low level diffuse pollution, and common human activity…"

Similarly the guidance states that significant pollution or significant possibility of significant pollution of controlled waters is required for land to be considered contaminated and the "*fact that substances are merely entering water*" or "*where discharge from land is not discernible at a location immediately downstream"* does not constitute contaminated land.

To help achieve a more targeted approach to identifying and managing contaminated land in relation to the risk (or possibility) of harm to human health, the revised Statutory Guidance presented a new four category system for considering land under Part 2A, ranging from Category 4, where there is no risk that land poses a significant possibility of significant harm (SPOSH), or the level of risk is low, to Category 1, where the risk that land poses a significant possibility of significant harm (SPOSH) is unacceptably high.

For land that cannot be readily placed into Categories 1 or 4 further assessment is required. If there is sufficient concern that the risks could cause significant harm or have the significant possibility of significant harm the land is to be placed into Category 2. If the concern is not met land is considered Category 3.

The technical guidance clearly states that the currently published Soil Guidance Values (SGV's) and Generic Assessment Criteria (GAC's) represent *"cautious estimates of level of contaminants in soils"* which should be considered *"no risk to health or, at most, a minimal risk"*. These values do not represent the boundary between categories 3 and 4 and "*should be considered to be comfortably within Category 4".*

At the end of 2013 technical guidance in support of Defra's revised Statutory Guidance (SG) was published and then revised in 2014 (CL: AIRE 2014) which provided:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

For controlled waters, the revised Statutory Guidance states that the following types of pollution should be considered to constitute significant pollution of controlled waters:

"(a) Pollution equivalent to "environmental damage" to surface water or groundwater as defined by The Environmental Damage (Prevention and Remediation) Regulations 2009, but which cannot be dealt with under those Regulations.

(b) Inputs resulting in deterioration of the quality of water abstracted, or intended to be used in the future, for human consumption such that additional treatment would be required to enable that use.

(c) A breach of a statutory surface water Environment Quality Standard, either directly or via a groundwater pathway.

(d) Input of a substance into groundwater resulting in a significant and sustained upward trend in concentration of contaminants (as defined in Article 2(3) of the Groundwater Daughter Directive (2006/118/EC)".

The guidance also states that, in some circumstances, significant concentrations at a compliance point (in groundwater or surface water) may constitute pollution of controlled waters.

As with SPOSH for human health, the revised Statutory Guidance presents a four-category system for Significant Pollution of controlled waters. Category 1 covers land where there is a strong and compelling case for SPOSP, for example where

significant pollution would almost certainly occur if no action was taken to avoid it. Category 4 covers land where there is no risk or the risk is low, for example, where the land contamination is having no discernible impact on groundwater or surface water quality. Category 2 is for land where the risks posed to controlled waters are not high enough to consider the land as Category 1 but nonetheless are of sufficient concern to constitute SPOSP, Category 3 is for land where the risks posed to controlled waters are higher than low but not of sufficient concern to constitute SPOSP.

2.2 Planning Policy

Planning Policy Wales (PPW) (PPW Edition 10 December 2018) sets out the land use planning policies of the Welsh Government. It is supplemented by a series of Technical Advice Notes (TANs), Welsh Government Circulars, and policy clarification letters, which together with PPW provide the national planning policy framework for Wales. Of these Welsh Office Circular 22/87, Development of Contaminated Land is relevant.

PPW contains the following relevant to ground conditions:

Previously Developed Land (para 3.51 – 3.53) – promotes development on previously developed (also referred to as brownfield) land in preference to greenfield sites where it is suitable for development.

The Best and Most Versatile Agricultural Land (para 3.54 – 3.55) defines what agricultural land should be conserved as a finite resource for the future.

Land Contamination (para 6.9.16 – 6.9.21) includes the following:

The onus will remain with the developer to ensure that the development of the site will remove any unacceptable risks.

Where land contamination issues arise, the planning authority will require evidence of a detailed investigation and risk assessment prior to the determination of the application to enable beneficial use of land, unless it can already be established that remedial measures can be employed.

Where it is known that acceptable remedial measures can overcome contamination, planning permission may be granted subject to conditions specifying the necessary measures and the need for their implementation, including provision for remediating any unexpected contamination which may arise during construction. If contamination cannot be overcome satisfactorily, the authority may refuse planning permission.

Physical Ground Conditions and Land Instability (para 6.9.22 – 6.9.28) – identifies the need to identify instability and specifically

Land stability should be addressed and appropriate mitigation measures secured to protect both existing assets and proposed development itself

Any planning application in coal mining consultation areas may need to be accompanied by a coal mining risk assessment report

It is noted that Appendix A (Causes of Instability) and Appendix B (Sources of Information) of PPG14, 'Development on Unstable Land', 1990, remain in force in Wales until superseded by a Technical Advice Note

Sustainable Drainage Systems (SuDS) and Development (para 6.6.17 – 6.6.19) require new developments of more than one dwelling or where the area covered by construction work equals or exceeds 100 square metres also require approval from the SuDS Approval Body (SAB) and development proposals should not result in the mobilisation of contaminants which may have an impact over a wider area.

De-risking Development (para 6.9.12 – 6.9.15) the planning system should "*ensure that development is suitable and that the physical, geo-technical, chemical and other relevant constraints on the land, including the anticipated impacts which climate change may have, are taken into account at all stages of the planning process".*

2.3 Building Regulations

Approved Documents provide guidance on addressing the requirements contained in the Building Regulations 2010 and are accessed from https://gov.wales/building-regulations-approved-documents. Part C is resistance to contaminants and moisture.

Although environmental protection, planning and Building Regulations have different purposes their aims are similar and the processes for assessing the effects of pollutants and contaminants are also similar including the use of risk assessment and the identification of Pollutant Linkages.

3 APPROACH

As with CLR11 the guidance given in LC:RM presents three stages of risk management: -

(a) Stage 1 - Risk Assessment.

(b) Stage 2 - Options Appraisal.

(c) Stage 3 - Remediation.

Each stage has three tiers. The three tiers of Stage 1 Risk Assessment are: -

- Tier 1 - Preliminary Risk Assessment (PRA) - first tier of RA that develops the outline conceptual model (CM) and establishes whether there are any potentially unacceptable risks.

- Tier 2 - Generic Quantitative Risk Assessment (GQRA) - carried out using generic assessment criteria and assumptions to estimate risk.

- Tier 3 - Detailed Quantitative Risk Assessment (DQRA) - carried out using detailed site-specific information to generate Site Specific Assessment Criteria (SSAC) as risk evaluation criteria.

For each tier of a Stage 1 - Risk Assessment you must:

1. Identify the hazard - establish contaminant sources.

2. Assess the hazard - use a source-pathway-receptor (S-P-R) pollutant linkage approach to find out if there is the potential for unacceptable risk.

3. Estimate the risk - predict what degree of harm or pollution might result and how likely it is to occur.

4. Evaluate the risk - decide whether a risk is unacceptable.

A Stantec Preliminary Investigation report normally comprises a desk study, walkover site reconnaissance and preliminary risk assessment (PRA). The project specific proposal defines the actual scope of work which might include review of ground investigation data in which case the report includes a GQRA.

Risk estimation involves identifying the magnitude of the potential consequence (taking into account both the potential severity of the hazard and the sensitivity of the receptor) and the magnitude of the likelihood i.e. the probability (taking into account the presence of the hazard and the receptor and the integrity of the pathway). This approach is promoted in current guidance such as R&D 66 (NHBC 2008).

For a PRA, Stantec's approach is that if a pollution linkage is identified then it represents a potentially unacceptable risk which either (1) remediation / direct risk management or (2) progression to further tiers of risk assessment (GQRA and GQRA) requiring additional data collection and enabling refinement of the CM using the site specific data.

4 IDENTIFICATION OF POLLUTANT LINKAGES AND DEVELOPMENT OF A CONCEPTUAL MODEL (CM)

For all Tiers of a Stage 1 Risk Assessment, the underlying principle to ground condition assessment is the identification of *pollutant linkages* in order to evaluate whether the presence of a source of contamination could potentially lead to harmful consequences. A pollutant linkage consists of the following three elements: -

- A source/hazard – a substance or situation which has the potential to cause harm or pollution;
- A pathway – a means by which the hazard moves along / generates exposure; and
- A receptor/target – an entity which is vulnerable to the potential adverse effects of the hazard.

The *Conceptual Model* identifies the types and locations of potential contaminant sources/hazards and potential receptors and potential migration/transportation pathway(s). The CM is refined through progression to further tiers of risk assessment (GQRA and GQRA) requiring additional data collection.

4.1 Hazard Identification

A hazard is a substance or situation that has the potential to cause harm. Hazards may be chemical, biological or physical.

In a PRA the potential for hazards to be present is determined from consideration of the previous or ongoing activities on or near to the site in accordance with the criteria presented in **Table 1**.

Based on the land use information Contaminants of Potential Concern (COPC) are identified. The COPC direct the scope of the collection of site-specific data and the analytical testing selected for subsequent Tiers.

At Tier 2 the site-specific data is evaluated using appropriate published assessment criteria (refer to Stantec document entitled Rationale for the Selection of Evaluation Criteria for a Generic Quantitative Risk Assessment (GQRA)). In general, published criteria have been developed using highly conservative assumptions and therefore if the screening criterion is not exceeded (and if enough samples from appropriate locations have been analysed) then the COPC is eliminated as a potential Hazard. It should be noted that exceedance does not necessarily indicate that a site is contaminated and/or unsuitable for use only that the COPC is retained as a potential Hazard. Published criteria are generated using models based on numerous and complex assumptions. Whether or not these assumptions are appropriate or sufficiently protective requires confirmation on a project by project basis. Manipulation of the default assumptions would normally form part of a Tier 3 Detailed Quantitative Risk Assessment (DQRA).

When reviewing or assessing site specific data Stantec utilise published guidance on comparing contamination data with a critical concentration (CL:AIRE/CIEH 2008) which presents a structured process for employing statistical techniques for data assessment purposes.

4.2 Receptor and Pathway Identification

For all Tiers the potential receptors (for both on site and adjoining land) that will be considered are:

- Human Health – including current and future occupiers, construction and future maintenance workers, and neighbouring properties/third parties;
- Ecological Systems; [1]
- Controlled Waters [2] – Under section 78A(9) of Part 2A the term "pollution of controlled waters" means the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter. The term "controlled waters" in relation to Wales has the same meaning as in Part 3 of the Water Resources Act 1991, except that "ground waters" does not include waters contained in underground strata but above the saturation zone.
- Property - Animal or Crop (including timber; produce grown domestically, or on allotments, for consumption; livestock; other owned or domesticated animals; wild animals which are the subject of shooting or fishing rights); and
- Property - Buildings (any structure or erection, and any part of a building including any part below ground level, but does not include plant or machinery comprised in a building, or buried services such as sewers, water pipes or electricity cables including archaeological sites and ancient monuments).

If a receptor is taken forward for further assessment it will be classified in terms of its sensitivity, the criteria for which are presented in **Table 2**. Table 2 has been generated using descriptions of environmental receptor importance/value given in various guidance documents including R&D 66 (NHBC 2008), EA 2017 and Transport Analysis Guidance (based on DETR 2000). Human health and buildings classifications have been generated by Stantec using the attribute description for each class. Surface water sensitivity is classified using the Water Framework Directive (WFD) status for the River Basin obtained from: https://environment.data.gov.uk/catchment-planning/

The exposure pathway and modes of transport that will be considered are presented in **Table 3**.

4.3 Note regarding Ecological Systems

The Environment Agency (EA) has developed an ecological risk assessment framework which aims to provide a structured approach for assessing the risks to ecology from chemical contaminants in soils (EA 2008). In circumstances where contaminants in water represent a potential risk to aquatic ecosystems then risk assessors will need to consider this separately.

The framework consists of a three-tiered process: -

- Tier 1 is a screening step where the site soils chemical data is compared to a soil screening value (SSV)
- Tier 2 uses various tools (including surveys and biological testing) to gather evidence for any harm to the ecological receptors
- Tier 3 seeks to attribute the harm to the chemical contamination

Tier 1 is preceded by a desk study to collate information about the site and the nature of the contamination to assess whether pollutant linkages are feasible. The framework presents ten steps for ecological desk studies and development of a conceptual model as follows.

1. Establish Regulatory Context
2. Collate and Assess Documentary Information
3. Summarise Documentary Information
4. Identify Contaminants of Potential Concern
5. Identify Likely Fate Transport of Contaminants
6. Identify Potential Receptors of Concern
7. Identify Potential Pathways of Concern
8. Create a Conceptual Model
9. Identify Assessment and Measurement Endpoints
10. Identify Gaps and Uncertainties

The information in a standard PRA report covers Steps 1 to 4 inclusive. Step 5 considers fate and transport of contaminants and it should be noted

[1] International or nationally designated sites (as defined in the statutory guidance (Defra Circular 04/12)) "*in the local area*" will be identified as potential ecological receptors. A search radius of 1, 2 or 5km will be utilised depending on the site-specific circumstances (see also pathway identification). The Environment Agency has published an ecological risk assessment framework (EA 2008) which promotes (as opposed to statutorily enforces) consideration of additional receptors to include locally protected sites and protected or notable species. These additional potential receptors will only be considered if a Phase 1 habitat survey, undertaken in accordance with guidance (JNCC 1993), is commissioned and the data provided to Stantec. It should be noted that without such a survey a Land Contamination risk assessment may conclude that the identification of potential ecological receptors is inconclusive (refer to Stantec Specification for a Preliminary Investigation (Desk Study and Site Reconnaissance).

[2] The definition of "pollution of controlled water" was amended by the introduction of Section 86 of the Water Act 2003. For the purposes of Part 2A groundwater does not include waters above the saturated zone and our assessment does not therefore address perched water other than where development causes a pathway to develop.

that our standard report adopts a simplified approach considering only transport mechanisms. A simplified approach has also been adopted in respect of Steps 6 and 7 receptors (a detailed review of the ecological attributes has not been undertaken) and pathways (a food chain assessment has not been undertaken). Step 9 is outside the scope of our standard PRA report.

It should be noted that the PRA report will present an assessment for ecological systems (where identified as a receptor for a land contamination assessment) considering the viability of the mode of transport given the site-specific circumstances and not specific pathways. The PRA may conclude that the risk to potential ecological receptors is inconclusive.

4.4 Note regarding Controlled Waters

Controlled waters are rivers, estuaries, coastal waters, lakes and groundwaters, but not perched waters.

The EU Water Framework Directive (WFD) 2000/60/EC provides for the protection of sub-surface, surface, coastal and territorial waters through a framework of river basin management. The EU Updated Water Framework Standards Directive 2014/101/EU amended the EU WFD to update the international standards therein; it entered into force on 20 November 2014 with the requirements for its provisions to be transposed in Member State law by 20 May 2016. Other EU Directives in the European water management framework include:

- the EU Priority Substances Directive 2013/39/EU;
- EU Groundwater Pollutants Threshold Values Directive 2014/80/EU amending the EU Groundwater Directive 2006/118/EC; and
- EU Biological Monitoring Directive 2014/101/EU.

The Ground Water Daughter Directive (GWDD) was enacted by the Groundwater Regulations (2009), which were subsumed by the Environmental Permitting Regulations (2010) which provide essential clarification including on the four objectives specifically for groundwater quality in the WFD: -

Achieve ‘Good’ groundwater chemical status by 2015, commonly referred to as ‘status objective’;
Achieve Drinking Water Protected Area Objectives;
Implement measures to reverse any significant and sustained upward trend in groundwater quality, referred to as ‘trend objective’; and

Prevent or limit the inputs of pollutants into groundwater, commonly referred to as ‘prevent or limit’ objectives

Section 86 of the Water Act 2003 Contaminated land: pollution of controlled waters amends the Environmental Protection Act 1990 so that pollution of controlled waters must now be "significant" to meet the definition of statutory contaminated land.

The Water Framework Directive (WFD) requires the preparation, implementation and review of River Basin Management Plans (RBMP) on a six-year cycle. River basins are made up of lakes, rivers, groundwaters, estuaries and coastal waters, together with the land they drain. River Basin Districts (RBD) and the WFD Waterbodies that they comprise are important spatial management units, regularly used in catchment management studies. River Basin Management Plans (RBMP) have been developed for the 11 River Basin Districts in England and Wales.
These were released by Defra in 2009 (Defra 2009) and updated in 2015.

These RBMP’s establish the current status of waters within the catchments of the respective Districts and the current status of adjoining waters identified. As part of a Tier 2 risk assessment water quality data is screened against the WFD assessment criteria. Comparison with the RBMP’s current status of waters for the catchment under consideration would form part of a Tier 3 assessment.

5 RISK ESTIMATION

Risk estimation classifies what degree of harm might result to a receptor (defined as consequence) and how likely it is that such harm might arise (probability).
At Tier 1 the consequence classification is generated by multiplying the hazard classification score and the receptor sensitivity score. This approach follows that presented in the republished R&D 66 (NHBC 2008).

The criteria for classifying probability are set out in **Table 4** and have been taken directly from Table 6.4 CIRIA C552 (CIRIA 2001). Probability considers the integrity of the exposure pathway.

The consequence classifications detailed in **Table 5** have been adapted from Table 6.3 presented in C552 and R&D 66 (Annex 4 Table A4.3).

The Tier 1 risk classification is estimated for each pollutant linkage using the matrix given in **Table 6** which is taken directly from C552 (Table 6.5).

Subsequent Tiers refine the CM through retention or elimination of potential hazards and pollutant linkages.

6 RISK EVALUATION

Evaluation criteria are the parameters used to judge whether harm or pollution needs further

assessment or is unacceptable. The evaluation criteria used will depend on:

- the reasons for doing the RA and the regulatory context such as Part 2A or planning;
- the CM and pollutant linkages present;
- any criteria set by regulators;
- any advisory requirements such as from Public Health Wales;
- the degree of confidence and precaution required;
- the level of confidence required to judge whether a risk is unacceptable;
- how you've used or developed more detailed assessment criteria in the later tiers of RA;
- the availability of robust scientific data;
- how much is known - for example, about the pathway mechanism and how the contaminants affect receptors; and
- any practical reasons such as being able to measure or predict against the criteria.

In order to put the Tier 1 risk classification into context the likely actions are described in **Table 7** which is taken directly from Table 6.6 of C552 (CIRIA 2001).

REFERENCES

BSI 2017 BS 10175:2011+A2:2017 Investigation of potentially contaminated sites - Code of Practice

BSI 2019 BS 8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

CIRIA 2001: Contaminated land risk assessment – a guide to good practice C552.

CIRIA 2008: Assessing risks posed by hazardous ground gases to buildings C655

CL: AIRE/CIEH 2008 Guidance on Comparing Soil Contamination Data with a Critical Concentration. Published by Contaminated Land: Applications in Real Environments (CL: AIRE) and the Chartered Institute of Environmental Health (CIEH)

CL: AIRE 2013 SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Final Project Report published by Contaminated Land: Applications in Real Environments (CL: AIRE) 20th December 2013

DCLG 2010 Building Regulations 2010 Approved Document C Site preparation and resistance to contaminants and moisture.

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DEFRA, 2013 Environmental Damage (Prevention and Remediation) Regulations 2009: Guidance for England and Wales

Defra '2009 Water for Life and Livelihoods. River Basin Management Plan. (11 Districts: Anglia, Dee, Humber, Northumbria, Northwest, Severn, Solway and Tweed, Southeast, Thames, Western Wales) December 2009

EA 2004: Contaminated Land Research (CLR) Report 11: The Model Procedures for the Management of Land Contamination CRL 11 by the Environment Agency (EA).

EA 2008 Ecological Risk Assessment Science Report Series SC070009 published by the Environment Agency (EA).

EA 2017 New groundwater vulnerability mapping methodology in England and Wales Report – SC040016/R Environment Agency (EA) September 2017

JNCC 1993 Handbook for Phase 1 Habitat Survey – A Technical for Environmental Audit prepared by the Joint Nature Conservancy Council (JNCC)

NHBC/EA/CIEH 2008: R&D Publication 66 Guidance for the safe development of housing on land affected by contamination.

Welsh Government 1987 Development of Contaminated Land (circular 22/87) Guidance on the identification, assessment and development of contaminated land August 1987.

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Welsh Government, 2012 Environmental Protection Act 1990, Guidance Document: Contaminated Land Statutory Guidance: 2012

Welsh Government, 2018 Planning Policy Wales Edition 10, December 2018.

WLCWG, 2017. Development of Land Affected by Contamination: A Guide For Developers, Welsh Contaminated Land Group, May 2017.

Stantec Methodology for Assessment of Land Contamination (Wales)

Table 1: Criteria for Classifying Hazards / Potential for Generating Contamination

Classification/Score	Potential for generating contamination/gas based on land use
Very Low 1	Land Use: Residential, retail or office use, agriculture Contamination: Limited. Gas generation potential: Soils with low organic content
Low 2	Land Use: Recent small scale industrial and light industry Contamination: locally slightly elevated concentrations. Gas generation potential: Soils with high organic content (limited thickness)
Moderate 3	Land Use: Railway yards, collieries, scrap yards, engineering works. Contamination: Possible widespread slightly elevated concentrations and locally elevated concentrations. Gas generation potential: Dock silt and substantial thickness of organic alluvium/peat
High 4	Land Use: Heavy industry, non-hazardous landfills. Contamination: Possible widespread elevated concentrations. Gas generation potential: Shallow mine workings Pre 1960s landfill
Very High 5	Land Use: Hazardous waste landfills, gas works, chemical works, Contamination: Likely widespread elevated concentrations. Gas generation potential: Landfill post 1960

"Greenfield" is land which has not been developed and there has been no use of agrochemicals

Table 2: Criteria for Classifying Receptor Sensitivity/Value

Classification	Definition
Very Low 1	Receptor of limited importance • Groundwater: Unproductive strata (Strata with negligible significance for water supply or river baseflow) (previously Non-aquifer), Secondary B (water-bearing parts of non-aquifers), Secondary undifferentiated (previously minor or non-aquifer, but information insufficient to classify as secondary A or B) • Surface water: WFD Surface Water status Bad • Ecology: No local designation • Buildings: Replaceable • Human health: Unoccupied/limited access
Low 2	Receptor of local or county importance with potential for replacement • Groundwater: Secondary A aquifer • Surface water: WFD Surface Water status Poor • Ecology: local habitat resources • Buildings: Local value • Human health: Minimum score 4 where human health identified as potential receptor
Moderate 3	Receptor of local or county importance with potential for replacement • Groundwater: Principal aquifer • Surface water: WFD Surface Water status Moderate • Ecology: County wildlife sites, Areas of Outstanding Natural Beauty (AONB) • Buildings: Area of Historic Character • Human health: Minimum score 4 where human health identified as potential receptor
High 4	Receptor of county or regional importance with limited potential for replacement • Groundwater: Source Protection Zone 2 or 3 • Surface water: WFD Surface Water status Good • Ecology: SSSI, National or Marine Nature Reserve (NNR or MNR) • Buildings: Conservation Area • Human health: Minimum score 4 where human health identified as potential receptor
Very High 5	Receptor of national or international importance • Groundwater: Source Protection Zone (SPZ) 1 • Surface water: WFD Surface Water status High • Ecology: Special Areas of Conservation (SAC and candidates), Special Protection Areas (SPA and potentials) or wetlands of international importance (RAMSAR) • Buildings: World Heritage site • Human health: Residential, open spaces and uses where children are present

Table 3: Exposure Pathway and Modes of Transport

Receptor	Pathway	Mode of transport
Human health	Ingestion	Fruit or vegetable leaf or roots
		Contaminated water
		Soil/dust indoors
		Soil/dust outdoors
	Inhalation	Particles (dust / soil) – outdoor
		Particles (dust / soil) - indoor
		Vapours – outdoor - migration via natural or anthropogenic pathways
		Vapours - indoor - migration via natural or anthropogenic pathways
	Dermal absorption	Direct contact with soil
		Direct contact with waters (swimming / showering)
		Irradiation
Groundwater	Leaching	Gravity / permeation
	Migration	Natural – groundwater as pathway Anthropogenic (e.g. boreholes, culverts, pipelines etc.)
Surface Water	Direct	Runoff or discharges from pipes
	Indirect	Recharge from groundwater
	Indirect	Deposition of windblown dust
Buildings	Direct contact	Sulphate attack on concrete, hydrocarbon corrosion of plastics
	Gas ingress	Migration via natural or anthropogenic paths
Ecological systems	See Notes	Runoff/discharge to surface water body
	See Notes	Windblown dust
	See Notes	Groundwater migration
	See Notes	At point of contaminant source
Animal and crop	Direct	Windblown or flood deposited particles / dust / sediments
	Indirect	Plants via root up take or irrigation. Animals through watering
	Inhalation	By livestock / fish - gas / vapour / particulates / dust
	Ingestion	Consumption of vegetation / water / soil by animals

Table 4: Classification of Probability

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

Table 5: Classification of Consequence (score = magnitude of hazard and sensitivity of receptor)

Classification / Score	Examples
Severe **17-25** **(3 out of 25 outcomes)**	Human health effect - exposure likely to result in "significant harm" as defined in the Defra (2012) Part 2A Statutory Guidance [1]. Controlled water effect - short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Equivalent to EA Category 1 incident (persistent and/or extensive effects on water quality leading to closure of potable abstraction point or loss of amenity, agriculture or commercial value. Major fish kill. Ecological effect - short-term exposure likely to result in a substantial adverse effect. Catastrophic damage to crops, buildings or property
Medium **10-16** **(7 out of 25 outcomes)**	Human health effect - exposure could result in "significant harm" [1]. Controlled water effect - equivalent to EA Category 2 incident requiring notification of abstractor Ecological effect - short-term exposure may result in a substantial adverse effect. Damage to crops, buildings or property
Mild **5-9** **(7 out of 25 outcomes)**	Human health effect - exposure may result in "significant harm" [1]. Controlled water effect - equivalent to EA Category 3 incident (short lived and/or minimal effects on water quality). Ecological effect - unlikely to result in a substantial adverse effect. Minor damage to crops, buildings or property. Damage to building rendering it unsafe to occupy (for example foundation damage resulting in instability).
Minor **1-4** **(8 out of 25 outcomes)**	No measurable effect on humans. Protective equipment is not required during site works. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects to crops, buildings or property. The loss of plants in a landscaping scheme. Discolouration of concrete.

[1] Significant harm includes death, disease, serious injury, genetic mutation, birth defects or impairment of reproductive function. The local authority may also consider other health effects to constitute significant harm such as physical injury; gastrointestinal disturbances; respiratory tract effects; cardio-vascular effects; central nervous system effects; skin ailments; effects on organs such as the liver or kidneys; or a wide range of other health impacts. Whether or not these would constitute significant harm would depend on the seriousness of harm including impact on health, quality of life and scale of impact.

Table 6: Classification of Risk (Combination of Consequence Table 5 and Probability Table 4)

	Consequence			
Probability	***Severe***	***Medium***	***Mild***	***Minor***
High likelihood	Very high	High	Moderate	Low
Likely	High	Moderate	Moderate/	Low
Low likelihood	Moderate	Moderate	Low	Very low
Unlikely	Low	Low	Very low	Very low

Table 7: Description of Risks and Likely Action Required

Risk Classification	Description
Very high risk	There is a high 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. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation is likely to be required in the short term.
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 undertaken already) is required and remedial works 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 relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer-term.
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 low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Appendix F Rationale for Generic Assessment Criteria

Stantec Guide: Generic Quantitative Risk Assessment - Evaluation Criteria (England)

1 INTRODUCTION

The aim of this document is to present an explanation for the selection of the evaluation criteria routinely used by Stantec UK Ltd when undertaking a land contamination Tier 2 Generic Quantitative Risk Assessment (GQRA).

A GQRA uses published criteria to screen the site-specific contamination testing data and identify potential hazards to specific receptors. Generic criteria are typically conservative in derivation and exceedance does not indicate that a site is statutorily contaminated and/or unsuitable for use in the planning context. These criteria are used to identify situations where further assessment and/or action may be required. This document is divided into general introductory text and sections on soils, waters and gases.

2 GENERAL NOTES

This document should be read in conjunction with another entitled "Stantec Methodology for Assessment of Land Contamination" which summarises the legislative regime and our approach to ground contamination and risk assessment.

Any Stantec interpretation of contamination test results is based on a scientific and engineering appraisal. The perceptions of, for example, banks, insurers, lay people etc are not taken into account.

Any tables included in this document are produced for ease of reference to the criteria, they do not in any way replace the documents of origin (which are fully referenced) and which should be read to ensure appropriate use and interpretation of the data.

Generic criteria provide an aid to decision-making, but they do not replace the need for sound professional judgement in risk assessment (EA, 2006). The criteria are based on numerous and complex assumptions. The appropriateness of these assumptions in a site-specific context requires confirmation on a project by project basis. Our interpretative report will comment on the appropriateness of the routine criteria for project objectives or ground conditions. In some cases the published criteria whilst typically conservative may in some circumstances not be suitable for the site being assessed, either because they do not address the identified pollutant linkages or because they may not be sufficiently precautionary in the context of the site. Under these circumstances it may be necessary to recommend deriving site-specific assessment criteria. Any deviation from the routine criteria and/or selection of criteria for parameters not covered in this document will be described in the report text.

3 CRITERIA FOR EVALUATING SOIL RESULTS

3.1 Potential Harm to Human Health

The criteria used by Stantec UK Ltd to assess the potential for harm to human health are:-

- Category 4 Screening Levels (C4SLs) (DEFRA, 2014).
- Suitable 4 Use Levels (S4ULs) (Nathanail *et al*, 2015).
- CL:AIRE/EIC/AGS Generic Assessment Criteria (GAC) (CL:AIRE, 2010).
- Soil Guideline Values (SGVs) (EA, 2009a).

These criteria have been generated using the Contaminated Land Exposure Assessment model (CLEA) and supporting technical guidance (EA, 2009b, 2009c, 2009d, 2009e). The CLEA model uses generic assumptions about the fate and transport of chemicals in the environment and a generic conceptual model for site conditions and human behaviour to estimate child and adult exposures to soil contaminants for those potentially living, working, and/or playing on contaminated sites over long time periods (EA, 2009c).

The S4ULs, SGVs and GACs are all based on use of minimal/tolerable risk Health Criteria Values (HCVs) as the toxicological benchmark whereas the C4SL are based on use of a "low level of toxicological concern" (LLTC) as the toxicological benchmark. The LLTC represents a slightly higher level of risk than the HCV.

An update to the software (1.071) was published on 04/09/2015 (the handbook (EA 2009f) referring to version 1.05 is still valid). The update includes the library data sets from the DEFRA research project SP1010 (Development of Category 4 Screening Levels for assessment of land affected by contamination).

The CLEA model uses ten exposure pathways (Ingestion (outdoor soil, indoor dust, homegrown vegetables and soil attached to homegrown vegetables), Dermal Contact (outdoor soil and indoor dust) and Inhalation (outdoor dust, indoor dust, outdoor vapours and indoor vapours)). There are exposure pathways not included in the CLEA model such as the permeation of organics into plastic water supply pipes.

The presence and/or significance of each of the potential exposure pathways is dependent on the land use being considered. The model uses standard land use scenarios as follows:-

Residential – habitation of a dwelling up to two storeys high with various default material and design parameters, access to either private or nearby community open space with soil track back

to form indoor dust. Assumes ingestion of homegrown produce.

Allotments – the model has default parameters for use and consumption of vegetables but not animals or their products (eggs).

Industrial/Commercial – assumes office or light physical work in a permanent three storey structure with breaks taken outside and that the site is NOT covered in hardstanding.

Public Open Space – two public open space (POS) scenarios are considered: POS_{resi} is shared communal space within a residential development where tracking back of soil into the home is assumed to occur. POS_{park} is intended for a public park sufficiently distant from housing (i.e. not adjacent to housing) such that tracking back of soil into the home is negligible. Note that the POS assessment criteria may not be appropriate for assessing sports fields.

The assessment criteria generated using CLEA can be used as a conservative starting point for evaluating long-term risks to human health from chemicals in soil.

It is important to note that the model does not assess all the potential exposure scenarios, for example risk to workers in excavations (short term exposure) or diffusion of contaminants through drinking water pipes.

Recent guidance (DEFRA 2012) introduces a four stage classification system where Category 1 sites are clearly contaminated land and Category 4 sites are definitely not contaminated land as defined by EPA 1990. Outside of these categories further specific risk assessment is required to determine if the site should fall into Category 2 (contaminated land) or Category 3 (not contaminated land). Category 4 screening values are considered to be more pragmatic than the current published SGV/GAC criteria but still strongly precautionary with the aim of allowing rapid identification of sites where the risk is above minimal but still low/acceptable.

Category 4 Screening Levels (C4SLs)

At the end of 2013, technical guidance in support of DEFRA's revised Statutory Guidance (SG) was published and then revised in 2014 (CL:AIRE 2014) which provided:

- A methodology for deriving C4SLs for the standard land-uses and two new public open space scenarios using the updated assumptions relating to the modelling of human exposure to soil contaminants; and
- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

Following issue of an Erratum in December 2014, a Policy Companion Document was published (DEFRA 2014).

A letter from Lord de Mauley dated 3rd September 2014 provides more explicit direction to local authorities on the use of the C4SL in a planning context. The letter identifies four key points:

1) that the screening values were developed expressly with the planning regime in mind

2) their use is recommended in DCLG's planning guidance

3) soil concentrations below a C4SL limit are considered to be 'definitely not contaminated' under Part IIA of the 1990 Environmental Protection Act and pose at most a 'low level of toxicological concern' and,

4) exceedance of a C4SL screening value does not mean that land is definitely contaminated land, just that further investigation may be warranted.

Stantec use the C4SLs as the Tier 2 soil screening criteria protective of human health for substances with C4SL available. Table 1 summarises the C4SL (DEFRA 2014) for each of the six substances.

Note that, with the exception of benzene, the DEFRA published C4SL are not dependent on soil organic matter content (SOM) ("*Given that BaP is non volatile and that empirical soil to plant concentration factors have been used, soil organic matter content has a negligible influence on the C4SLs for this chemical*"). The DEFRA published C4SL for benzene is based on an SOM of 6%. Stantec have used the CLEA model (v1.071) to derive C4SL for benzene for 1% and 2.5% SOM which are also shown in Table 1.

Note that an industry led project to derive C4SL for a further 20 substances has commenced (CL:AIRE, 2018). The project is being project managed by CL:AIRE and is funded by the Soil and Groundwater Technology Association (SAGTA), the Society of Brownfield Briefing (SoBRA) and others. A dedicated steering group, made up of representatives from SAGTA, DEFRA, Welsh Government, Public Health England, Environment Agency, Natural Resources Wales, Food Standards Agency, Homes England and further Land Forum representatives, has been set up to oversee the project. The new C4SL will be added to this document as they are published.

Suitable 4 Use Levels (S4ULs)

In July 2009, Generic Assessment Criteria (GACs) for 82 substances were published (LQM and CIEH, 2009) using the then current version of the CLEA software v1.04 and replaced those generated in

2006 using the original version of the model CLEA UK *beta*. In 2015 S4ULs were published by LQM/CIEH (Nathanail *et al*, 2015) to replace the second edition GACs. Table 2 summarises the S4ULs which are reproduced with permission; Publication Number S4UL3202.

Soil Guideline Values (SGVs) and Generic Assessment Criteria (GAC)

In 2009, Soil Guideline Values (SGVs) were published by the Environment Agency for arsenic, cadmium, mercury, nickel, selenium, benzene, toluene, ethyl benzene, xylenes, phenol and dioxins, furans and dioxin-like PCBs. These were derived using the CLEA model for residential, allotments and commercial land-uses.

These SGVs have now largely been superseded by the C4SLs and the S4ULs, with the exception of the SGVs for dioxins, furans and dioxin-like PCBs which are shown in Table 3.

In January 2010, Generic Assessment Criteria (GAC) derived using CLEA were published by CL:AIRE for 35 substances. These GAC are listed in Table 4.

Note that the SGVs for dioxins, furans and dioxin like PCBs and CL:AIRE GAC were derived using an older version of CLEA (v1.06) than used to derive the S4UL and C4SL (v1.07). This older version used slightly more conservative values for some exposure parameters and therefore the derived SGVs/GAC are still considered suitably precautionary for use as screening criteria.

Note on Mercury, Chromium and Arsenic

The analytical testing routinely undertaken by Stantec determines total concentration, however, the toxicity depends on the form of the contaminant.

If a source of Mercury, Chromium or Arsenic is identified or the total concentration exceeds the relevant worst case speciated criteria it will be desirable/necessary to undertake additional speciated testing and further assessment.

Note on Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs) are a family of hundreds of different congeners whose chemical structures contain two or more fused aromatic rings. Whilst it is recognised that there is an ongoing debate on the most appropriate method to assess health effects of PAH mixtures, in 2010 the Health Protection Agency recommended the use of benzo[a]pyrene (BaP) as a surrogate marker approach in the assessment of carcinogenic risks posed by PAHs in soils (HPA, 2010).

In most cases, BaP is chosen as the surrogate marker (SM) due to its ubiquitous nature and the vast amount of data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food. The SM approach estimates the carcinogenic toxicity of a mixture of PAHs in an environmental matrix by using toxicity data for a PAH mixture for which the composition is known.

Exposure to the SM is assumed to represent exposure to all PAHs in that matrix therefore the toxicity of the SM represents the toxicity of the mixture. The SM approach relies on a number of assumptions (HPA, 2010).

- The SM (BaP) must be present in all the samples.
- The profile of the different PAH relative to BaP should be similar in all samples.
- The PAH profile in the soil samples should be sufficiently similar to that used in the pivotal toxicity study on which HBGV was based i.e. the Culp study (Culp et al. (1998)).

In order to justify the use of a surrogate marker assessment criterion (C4SL for benzo(a)pyrene and S4UL coal tar) the LQM PAH Profiling Tool is used by Stantec to assess the similarity of the PAH profile in a soil sample to that of the toxicity study. The spreadsheet calculates the relative proportions of the genotoxic PAHs and plots them relative to the composition of the two coal mixtures used by Culp et al. Provided that the relative proportions are within an order of magnitude of those from the Culp Study (as suggested by HPA) Stantec will use the C4SL for benzo(a)pyrene as a surrogate marker for the carcinogenic PAHs, i.e. benzo(a)pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(ah)anthracene, indeno(123-cd)pyrene and benzo(ghi)perylene. For projects where this approach is appropriate the results will be assessed using the Coal Tar criterion (BAP C4SL) and the criteria for non-carcinogenic PAHs (S4ULs), i.e. naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene and pyrene.

Note on Total Petroleum Hydrocarbons

The S4UL for Total Petroleum Hydrocarbon (TPH) fractions are based on ‘threshold’ health effects. In accordance with Environment Agency guidance (EA, 2005) and the S4UL report (Nathanail *et al*, 2015) the potential for additivity of toxicological effects between fractions should be considered. Practically, to address this issue the hazard quotient (HQ) for each fraction should be calculated by dividing the measured concentration of the fraction by the GAC. The HQs are then added to form a hazard index (HI) for that sample. An HI greater than 1 indicates an exceedance.

Note on Dioxins, Furans and Dioxin-like PCBs

The SGVs for dioxins, furans and dioxin-like PCBs are based on an assumed congener profile for urban soils. The total measured concentration of dioxin, furan and dioxin-like PCB congeners listed in the SGV report (EA, 2009a) should be compared with the SGVs to make an initial assessment of risk. A more accurate assessment can be made using the Environment Agency's site specific worksheet for dioxins, furans and dioxin like PCBs available from https://www.claire.co.uk/useful-government-legislation-and-guidance-by-country/77-risk-assessment-info-ra/199-dioxins-site-specific-worksheets.

Note on Asbestos

Asbestos in soil and made ground is currently under review by a number of bodies. There are no current published guidance values for asbestos in soil other than the waste classification values given in the EA's Technical Guidance WM3, Hazardous Waste – Interpretation of the definition and classification of hazard waste (EA, 2015). This guidance is only appropriate for soils that are being discarded as waste.

Testing for asbestos will be carried out on selected samples of made ground encountered during investigation, initially samples will be subjected to an asbestos screen and, if asbestos is found to be present, subjected to quantification depending on the project specific requirements. The reader is directed to the report text for guidance on the approach adopted in respect to any asbestos found to be present.

Further guidance is also available in publication C733, Asbestos in soil and made ground: a guide to understanding and managing risks (CIRIA 2014).

Note on Soil Saturation Concentration

The soil saturation concentration is the concentration of an organic constituent in soil at which either the pore water or soil vapour has theoretically become saturated with the substance, i.e. the substance concentration has reached its maximum aqueous solubility or vapour pressure. The soil saturation concentration is related to the properties of the substance as well as the properties of the soil (including soil organic matter content).

The soil saturation concentrations are shown in Table 2 in brackets where exceeded by the assessment criteria and in Table 4 for all substances. Measured concentrations in excess of the soil saturation concentration have various potential implications as discussed below.

Firstly, where measured concentrations exceed the soil saturation concentration, the risk from vapour inhalation and/or consumption of produce may be limited. The CLEA model calculates the soil saturation concentration but it does not limit exposure where this concentration is exceeded. This adds an additional level of conservatism for CLEA derived assessment criteria where these exceed the calculated soil saturation concentration. Secondly, the soil saturation concentration is sometimes used to flag the potential presence of non-aqueous phase liquid (NAPL, a.k.a. free phase) in soil. The presence of NAPL is an important consideration in the Tier 2 assessment because, where present, the risks from NAPL may need to be considered separately. Theoretically, where a measured concentration exceeds the soil saturation concentration NAPL could be present. However, using theoretical saturation values is not always reliable for the following reasons: The soil saturation concentration is based on the aqueous solubility and vapour pressure of a pure substance and not a mixture, of which NAPLs are often comprised; and

The soil saturation concentration does not account for the sorption capacity of the soil. As a result, exceedance of the soil saturation concentration does not necessarily imply that NAPL is present. This is particularly the case for longer chain hydrocarbons such as PAHs which have low solubility and vapour pressure and hence a low soil saturation concentration but that are strongly sorbed to soil.

The measured concentrations will be compared to the soil saturation concentrations shown in Tables 2 and 4. Where exceeded Stantec will use additional lines of evidence (such as visual evidence and concentration of total TPH) to determine whether or not NAPL is likely to be present. If the presence of NAPL is deemed plausible the implications will be considered in the risk assessment.

3.2 Potential Harm to the Built Environment

Land contamination can pose risks to buildings, building materials and services (BBM&S) in a number of ways. Volatile contaminants and gases can accumulate and cause explosion or fire. Foundations and buried services can be damaged by corrosive substances and contaminants such as steel slags can create unstable ground conditions through expansion causing structural damage.

Stantec use the following primary guidance to assess the significance of soil chemistry with respect to its potential to harm the built environment.

i) Approved Document C - Site Preparation and Resistance to Contaminants and Moisture. (DCLG, 2013);
ii) Concrete in aggressive ground SD1 (BRE 2005);
iii) Guidance for the selection of water supply pipes to be used in brownfield sites (UK WIR 2011);
iv) Protocols published by agreement between

Water UK and the Home Builders Federation providing supplementary guidance which includes the Risk Assessment for Water Pipes (the 'RA') (Water UK 2014).

v) Performance of Building Materials in Contaminated Land report BR255 (BRE 1994).
vi) Risks of Contaminated Land to Buildings, Building Materials and Services. A Literature Review - Technical Report P331 (EA, 2000).
vii) Guidance on assessing and managing risks to buildings from land contamination - Technical Report P5 035/TR/01 (EA, 2001).

3.3 Potential to Harm Ecosystems, Animals, Crops etc

The criteria routinely used by Stantec as Tier 2 screening values to assess the potential of soil chemistry to harm ecosystems are taken from the following guidance and are summarised in Table 5.

i) Derivation and Use of Soil Screening Values for assessing ecological risks (EA, 2017a);
ii) The Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing (ICRCL 70/90, 1990);
iii) Sewage sludge on farmland: code of practice for England, Wales and Northern Ireland (DEFRA, 2018); and
iv) BS 3882:2015 Specification for topsoil and requirements for use (BSI, 2015).

Unless stated in the report the assessment is solely for phytotoxic parameters and additional assessment is required to determine suitability as a growing medium.

4 CRITERIA FOR EVALUATING LIQUID RESULTS

4.1 Potential Harm to Human Health via Ingestion

The Tier 2 water screening values routinely adopted by Stantec for assessing the potential for harm to human health via ingestion (presented as Table 6) are taken from Statutory Instrument (S.I.) The Water Supply (Water Quality) Regulations (S.I. 2016/614).

It should be noted that some of the prescribed concentrations listed in the Water Supply Regulations have been set for reasons other than their potential to cause harm to human health. The concentrations of iron and manganese are controlled because they may taint potable water with an undesirable taste, odour or colour or may potentially deposit precipitates in water supply pipes.

4.2 Potential Harm to Human Health via Inhalation of Vapours

The Tier 2 water screening values adopted by Stantec for assessing the potential for chronic human health risk from the inhalation of vapours from volatile contaminants in groundwater are presented in Table 7. These generic assessment criteria have been taken from a report published by the Society of Brownfield Risk Assessment (SoBRA) (SoBRA, 2017). The methodology adopted in their generation is considered compatible with the UK approach to deriving GAC and adopts a precautionary approach. As with all published GAC the suitability for use on the site being assessed has to be decided by the assessor based on a thorough understanding of the methodology and assumptions used in their derivation. Note, that the SoBRA groundwater vapour GAC are not intended for assessing risks to ground workers from short-term exposure.

Note that Table 7 shows the theoretical maximum aqueous solubility for each contaminant and indicates the GAC that exceed solubility. Measured concentrations in excess of solubility may be an indication that NAPL is present. As for the assessment of soils, if the presence of NAPL is deemed plausible the implications will be considered in the risk assessment.

4.3 Potential to Harm Controlled Waters

When assessing ground condition data and the potential to harm Controlled Waters Stantec uses the approach presented in the groundwater protection position statements published 14.03.17 (EA, 2017b) which describe the Environment Agency's approach to managing and protecting groundwater. They update and replace Groundwater Protection: principles and practice (GP3). Controlled Waters are rivers, estuaries, coastal waters, lakes and groundwaters. Water in the unsaturated zone is not groundwater but does come within the scope of the term "ground waters" as used and defined in the Water Resources Act 1991. It will continue to be a technical decision for the Environment Agency to determine what is groundwater in certain circumstances for the purposes of the Regulations. As discussed in our Methodology for Assessment of Land Contamination perched water is not considered a receptor in Stantec assessments.

The EU Water Framework Directive (WFD) 2000/60/EC provides for the protection of sub-surface, surface, coastal and territorial waters through a framework of river basin management.

The EU Updated Water Framework Standards Directive 2014/101/EU amended the EU WFD to update the international standards therein; it entered into force on 20 November 2014 with the requirement for its provisions to be transposed in Member State law by 20 May 2016.

Member States are required under the EU WFD to update their river basin management plans every six years. The first river basin management plans for England and Wales, Scotland and Northern Ireland were published in December 2009, and these were updated in 2015.

Other EU Directives in the European water management framework include:

- the EU Priority Substances Directive 2013/39/EU;
- EU Groundwater Pollutants Threshold Values Directive 2014/80/EU amending the EU Groundwater Daughter Directive (GWDD) 2006/118/EC; and
- the EU Biological Monitoring Directive 2014/101/EU.

The Priority Substances Directive set environmental quality standards (EQS) for the substances in surface waters (river, lake, transitional and coastal) and confirmed their designation as priority or priority hazardous substances (PS), the latter being a subset of particular concern. Environmental Quality Standards for PS are determined at the European level and apply to all Member States. Member States identify and develop standards for 'Specific Pollutants'. Specific Pollutants (SP) are defined as substances that can have a harmful effect on biological quality.

The Water Framework Directive (Standards and Classification) Directions (England and Wales) (DEFRA, 2015) were issued to the Environment Agency as an associated document of the Water Environment (WFD) (England and Wales) Regulations 2015 (S.I. 2015/1623) and provide directions for the classification of surface water and groundwater bodies. Schedule 3 parts 2 and 3 relate to surface water standards for specific pollutants in fresh or salt water bodies and priority substances in inland (rivers, lakes and related modified/artificial bodies) or other surface waters respectively. Although Schedule 5 presents threshold values for groundwater the Direction specifically excludes their use as part of site-specific investigations.

Table 6 presents the criteria routinely used by Stantec as Tier 2 screening values. This table only presents a selection of the more commonly analysed parameters and the source documents should be consulted for other chemicals. For screening groundwater the criteria selected are the standards for surface water and/or human consumption as appropriate together with the following:-

For a **hazardous substance** Stantec adopts the approach that, if the concentration in a discharge to groundwater is less than the Minimum Reporting Value (MRV), the input is regarded as automatically meeting the Article 2 (b) 'de-minimus' requirement of exemption 6 (3) (b) of the GWDD. Stantec has selected hazardous substances from the latest list published by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG, 2018). MRV is the lowest concentration of a substance that can be routinely determined with a known degree of confidence, and may not be equivalent to limit of detection. MRVs have been identified from DEFRA's guidance on Hazardous Substances to Groundwater: Minimum Reporting Values (DEFRA, 2017), and are shown in Table 6.

Note that for land contamination assessments, where hazardous substances have already entered groundwater, remediation targets would typically be based on achieving appropriate water quality standards (e.g. drinking water standard or EQS) at a compliance point rather than an MRV. For this reason, when assessing measured groundwater or soil leachate concentrations, the values for human consumption, fresh water and salt water shown in Table 6 (whichever is appropriate for the context of the site) will be used as the Tier 2 assessment criteria rather than MRV. For hazardous substances with no water quality standard the laboratory method detection limit will be used as the assessment criteria.

For **non-hazardous substances** the GWDD requires that inputs be limited to avoid deterioration. UKTAG guidance equates deterioration with pollution. Non-hazardous substances are all substances not classified as hazardous. For Stantec assessments the values for human consumption, fresh water and salt water shown in Table 6 (whichever is appropriate for the context of the site) are used as the assessment criteria for non-hazardous substances.

Note on Copper, Lead, Manganese, Nickel and Zinc

$EQS_{bioavailable}$ have been developed for UK Specific Pollutants copper, zinc and manganese and the EU priority substances lead and nickel. An EQS is the concentration of a chemical in the environment below which there is not expected to be an adverse effect on the specific endpoint being considered, e.g. the protection of aquatic life.

It is very difficult to measure the bioavailable concentration of a metal directly. The UK has developed simplified Metal Bioavailability Assessment Tool (M-BAT) for copper, zinc, nickel and manganese which uses local water chemistry data, specifically pH, dissolved organic carbon (DOC) (mg/L) and Calcium (Ca) (mg/L).

Where the recorded total dissolved concentration exceeds the screening criteria for these parameters ($EQS_{bioavailable}$) further assessment will be undertaken using the tools downloaded from http://www.wfduk.org/resources/rivers-lakes-metal-bioavailability-assessment-tool-m-bat

The models calculate a risk characterisation ratio (RCR) and where this is greater than 1 this indicates the bioavailable concentration is above the EQS and the parameter is then identified as a potential hazard. The report will discuss this identified hazard noting that the pH, calcium and, in particular, the dissolved organic carbon (DOC) in groundwater may be quite different to the receiving water (e.g. due to the presence to leaf litter or organic sediments dissolving in the water).

5 CRITERIA FOR EVALUATING GAS RESULTS

Stantec use the following primary guidance on gas monitoring methods and investigation, the assessment of risk posed by soil gases (including Volatile Organic Compounds (VOCs)) and mitigation measures/risk reduction during site development.

i) BS 8576:2013 – Guidance on Ground Gas Investigations: Permanent gases and Volatile Organic Compounds (VOCs) (BSI, 2013);
ii) TB18 Continuous Ground-Gas Monitoring and the Lines of Evidence Approach to Risk Assessment CL:AIRE Technical Bulletin TB18 (CL:AIRE 2019)
iii) RB17 A pragmatic approach to Ground Gas Risk Assessment. CL:AIRE Research Bulletin RB17 (Card et al, 2012);
iv) The VOCs Handbook. C682 (CIRIA, 2009).
v) Assessing risks posed by hazardous gases to buildings C665 (CIRIA, 2007);
vi) Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present. (NHBC, 2007); and
vii) BS 8485:2015+A1:2019- Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (BSI, 2019).

Gas and borehole flow data are used to obtain the gas screening value (GSV) for methane and carbon dioxide. The GSV is used to establish the characteristic situation and to make recommendations for gas protection measures for buildings if required.

Radon

Stantec use the following primary guidance to assess the significance of the radon content of soil gas.

i) Radon: guidance on protective measures for new dwellings. Report BR211 (BRE, 2015); and
ii) Indicative Atlas of Radon in England and Wales (HPA & BGS, 2007).

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Table 1: Category 4 Screening Levels (C4SL)

	Allotments	Residential (with home-grown produce)	Residential (without home-grown produce)	Commercial	Public Open Space 1	Public Open Space 2
Arsenic	49	37	40	640	79	170
Benzene - 1% SOM* - 2.5% SOM* - 6% SOM	 0.039 0.081 0.18	 0.20 0.41 0.87	 0.89 1.6 3.3	 27 50 98	 140 140 140	 190 210 230
Benzo(a)pyrene (as a surrogate marker for carcinogenic PAHs)	5.7	5.0	5.3	77	10	21
Cadmium	3.9	22	150	410	220	880
Chromium VI	170	21	21	49	21	250
Lead	80	200	310	2300	630	1300

Units mg/kg dry weight

Values taken from SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document (Department for Environment, Food and Rural Affairs December 2014), unless stated otherwise
Public Open Space 1 – for grassed area adjacent to residential housing
Public Open Space 2 - Park Type Public Open Space Scenario
Based on a sandy loam as defined in SR3 (Environment Agency, 2009b)
Note that, with the exception of benzene, these C4SL are not SOM dependent
* - Stantec derived C4SL using CLEA v1.071

Table 2: Suitable 4 Use Levels (S4UL)

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Metals						
Arsenic (**Inorganic**)[a, b, c]	43	37	40	640	79	170
Beryllium [a, b, d, e]	35	1.7	1.7	12	2.2	63
Boron [a, b, d]	45	290	11000	240000	21000	46000
Cadmium (**pH6-8**) [a, b, d, f]	1.9	11	85	190	120	560
Chromium (trivalent) [a, b, d, g]	18000	910	910	8600	1500	33000
Chromium (hexavalent) [a, b, c]	1.8[h]	6[i]	6[i]	33[i]	7.7[i]	220[i]
Copper [a, b, c]	520	2400	7100	68000	12000	44000
Mercury (elemental) [a, b, c, j]	21	1.2	1.2	58[vap] (25.8)	16	30[vap] (25.8)
Mercury (inorganic) [a, b, c]	19	40	56	1100	120	240
Methylmercury [a, b, c]	6	11	15	320	40	68
Nickel [a, b, c]	53[k]	130[e]	180[e]	980[e]	230[e]	800[k]
Selenium [a, b, c]	88	250	430	12000	1100	1800
Vanadium [a, b, c, i, j]	91	410	1200	9000	2000	5000
Zinc [a, b, c]	620	3700	40000	730000	81000	170000
BTEX Compounds (SOM 1%/ 2.5%/ 6%)						
Benzene [a, b, l, m]	0.017/0.034/ 0.075	0.087/0.17/ 0.37	0.38/0.7/1.4	27 / 47 / 90	72 / 72 / 73	90 / 100 / 110
Toluene [a, b, l, m]	22 / 51 / 120	130 / 290 / 660	880[vap] (869) /1900/3900	56000[vap] (869) / 110000[vap] (1920)/ 180000[vap] (4360)	56000 / 56000 / 56000	87000[vap](869)/ 95000[vap](1920)/ 100000[vap](4360)
Ethylbenzene [a, b, l, m]	16 / 39 / 91	47 / 110 / 260	83 / 190 / 440	5700[vap] (518) / 13000[vap] (1220) / 27000[vap] (2840)	24000 / 24000 / 25000	17000[vap] (518) / 22000[vap](1220) / 27000[vap] (2840)
O – Xylene [a, b, l, m, n]	28 / 67 / 160	60 / 140 / 330	88 / 210 / 480	6600[sol] (478) / 15000[sol] (1120) / 33000[sol] (2620)	41000 / 42000 / 43000	17000[sol] (478) / 24000[sol] (1120) / 33000[sol] (2620)
M – Xylene [a, b, l, m, n]	31 / 74 / 170	59 / 140 / 320	82 / 190 / 450	6200[vap] (625) / 14000[vap] (1470) / 31000[vap] (3460)	41000 / 42000 / 43000	17000[vap] (625) / 24000[vap](1470) / 32000[vap] (3460)
P – Xylene [a, b, l, m, n]	29 / 69 / 160	56 / 130 / 310	79 / 180 / 430	5900[sol] (576) / 14000[sol] (1350) / 30000[sol] (3170)	41000 / 42000 / 43000	17000[sol] (576) / 23000[sol] (1350) / 31000[sol] (3170)
Total xylenes [t]	28 / 67 / 160	56 / 130 / 310	79 / 180 / 430	5900[sol] (576) / 14000[sol] (1350) / 30000[sol] (3170)	41000 / 42000 / 43000	17000[sol] (576) / 23000[sol] (1350) / 31000[sol] (3170)
Polycyclic Aromatic Hydrocarbons (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
Acenaphthene	34 / 85 / 200	210 / 510 / 1100	3000[sol](57.0)/ 4700[sol] (141)/ 6000[sol] (336)	84000[sol] (57.0)/ 97000[sol] (141)/ 100000	15000 / 15000 / 15000	29000/ 30000/ 30000
Acenaphthylene	28 / 69 / 160	170 / 420 / 920	2900[sol](86.1)/ 4600[sol] (212)/ 6000[sol] (506)	83000[sol] (86.1)/ 97000[sol] (212)/ 100000	15000 / 15000 / 15000	29000 / 30000 / 30000
Anthracene	380 / 950 / 2200	2400 / 5400 / 11000	31000[sol](1.17) /35000/ 37000	520000/ 540000/ 540000	74000 / 74000 / 74000	150000 / 150000 / 150000
Benzo(a)anthracene	2.9 / 6.5 / 13	7.2 / 11 / 13	11 / 14 / 15	170 / 170 / 180	29 / 29 / 29	49 / 56 / 62
Benzo(a)pyrene (Bap) [u]	0.97 / 2.0 / 3.5	2.2 / 2.7 / 3.0	3.2 / 3.2 / 3.2	35 / 35 / 36	5.7 / 5.7 / 5.7	11 / 12 / 13
Benzo(b)fluoranthene	0.99 / 2.1 / 3.9	2.6 / 3.3 / 3.7	3.9 / 4.0 / 4.0	44 / 44 / 45	7.1 / 7.2 / 7.2	13 / 15 / 16

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Benzo(g,h,i)perylene	290 / 470 / 640	320 / 340 / 350	360 / 360 / 360	3900 / 4000 / 4000	640 / 640 / 640	1400 / 1500 / 1600
Benzo(k)fluoranthene	37 / 75 / 130	77 / 93 / 100	110 / 110 / 110	1200 / 1200 /1200	190 / 190 / 190	370 / 410 / 440
Chrysene	4.1 / 9.4 / 19	15 / 22 / 27	30 / 31 / 32	350 / 350 / 350	57 / 57 / 57	93 / 110 / 120
Dibenzo(ah)anthracene	0.14 / 0.27 / 0.43	0.24 / 0.28 / 0.3	0.31 / 0.32 / 0.32	3.5 / 3.6 / 3.6	0.57 / 0.57 / 0.58	1.1 / 1.3 / 1.4
Fluoranthene	52 / 130 / 290	280 / 560 / 890	1500 / 1600 / 1600	23000 / 23000 / 23000	3100 / 3100 / 3100	6300 / 6300 / 6400
Fluorene	27 / 67 / 160	170 / 400 / 860	2800[sol] (30.9) /3800[sol] (76.5) /4500[sol] (183)	63000[sol] (30.9) / 68000 / 71000	9900 / 9900 / 9900	20000 / 20000 / 20000
Indeno(1,2,3-cd)pyrene	9.5 / 21 / 39	27 / 36 / 41	45 / 46 / 46	500 / 510 / 510	82 / 82 / 82	150 / 170 / 180
Naphthalene [q]	4.1 / 10 / 24	2.3 / 5.6 / 13	2.3 / 5.6 / 13	190[sol] (76.4) / 460[sol] (183) / 1100[sol] (432)	4900/ 4900/ 4900	1200[sol] (76.4) / 1900[sol] (183) / 3000
Phenanthrene	15 / 38 / 90	95 / 220 / 440	1300[sol](36.0) / 1500 / 1500	22000 / 22000 / 23000	3100 / 3100 / 3100	6200 / 6200 / 6300
Pyrene	110 / 270 / 620	620 / 1200 / 2000	3700 / 3800 / 3800	54000 / 54000 / 54000	7400 / 7400 / 7400	15000 / 15000 / 15000
Coal Tar (Bap as surrogate marker) [u]	0.32 / 0.67 / 1.2	0.79 / 0.98 / 1.1	1.2 / 1.2 / 1.2	15 / 15 / 15	2.2 / 2.2 / 2.2	4.4 / 4.7 / 4.8
Explosives [a, b, l, p]						
2, 4, 6 Trinitrotoluene	0.24 / 0.58 / 1.40	1.6 / 3.7 / 8.0	65 / 66 / 66	1000 / 1000 / 1000	130 / 130 / 130	260 / 270 / 270
RDX (Royal Demolition Explosive $C_3H_6N_6O_6$)	17 / 38 / 85	120 / 250 / 540	13000 / 13000 / 13000	210000 / 210000 / 210000	26000 / 26000 / 27000	49000[sol] (18.7) / 51000 / 53000
HMX (High Melting Explosive $C_4H_8N_8O_8$)	0.86 / 1.9 / 3.9	5.7 / 13 / 26	6700 / 6700 / 6700	110000 / 110000 / 110000	13000 / 13000 / 13000	23000[vap] (0.35) /23000[vap] (0.39) /24000[vap] (0.48)
Petroleum Hydrocarbons (SOM 1%/ 2.5%/ 6%) [a, b, l, m]						
Aliphatic EC 5-6	730 / 1700 / 3900	42 / 78 / 160	42 / 78 / 160	3200[sol] (304) / 5900[sol] (558) / 12000[sol] (1150)	570000[sol](304) 590000 / 600000	95000[sol] (304) / 130000[sol] (558)/ 180000[sol](1150)
Aliphatic EC >6-8	2300 / 5600 / 13000	100 / 230 / 530	100 / 230 / 530	7800[sol] (144) / 17000[sol] (322) / 40000[sol] (736)	600000 / 610000 / 620000	150000[sol] (144) 220000[sol] (322)/ 320000[sol] (736)
Aliphatic EC >8-10	320 / 770 / 1700	27 / 65 / 150	27 / 65 / 150	2000[sol] (78) / 4800[vap] (190) / 11000[vap] (451)	13000 / 13000 / 13000	14000[sol] (78) / 18000[vap] (190) / 21000[vap] (451)
Aliphatic EC >10-12	2200 / 4400 / 7300	130v[ap] (48) / 330[vap] (118) / 760[vap] (283)	130v[ap] (48) / 330[vap] (118) / 770[vap] (283)	9700[sol] (48) / 23000[vap] (118) / 47000[vap] (283)	13000 / 13000 / 13000	21000[sol] (48) / 23000[vap] (118) / 24000[vap] (283)
Aliphatic EC >12-16	11000 / 13000 / 13000	1100[sol] (24) / 2400[sol] (59) / 4300[sol] (142)	1100[sol] (24) / 2400[sol] (59) / 4400[sol] (142)	59000[sol] (24) / 82000[sol] (59) / 90000[sol] (142)	13000 / 13000 / 13000	25000[sol] (24) / 25000[sol] (59) / 26000[sol] (142)
Aliphatic EC >16-35 °	260000 / 270000 / 270000	65000[sol](8.48 92000[sol] (21) 110000	65000[sol] (8.48 92000[sol] (21) 110000	1600000 / 1700000 / 1800000	250000 / 250000 / 250000	450000 / 480000 / 490000
Aliphatic EC >35-44 °	260000 / 270000 / 270000	65000[sol](8.48 92000[sol] (21) / 110000	65000[sol](8.48 92000[sol] (21) 110000	1600000 / 1700000 / 1800000	250000 / 250000 / 250000	450000 / 480000 / 490000
Aromatic EC 5-7 (benzene)	13 / 27 / 57	70 / 140 / 300	370 / 690 / 1400	26000[sol] (1220) / 46000[sol] (2260) / 86000[sol] (4710)	56000 / 56000 / 56000	76000[sol] (1220) /84000[sol](2260)/ 92000[sol] (4710)
Aromatic EC >7-8 (toluene)	22 / 51 / 120	130 / 290 / 660	860 / 1800 / 3900	56000[vap] (869)/ 110000[sol] (1920)/ 180000[vap] (4360)	56000 / 56000 / 56000	87000[vap](869) / 95000[sol] (1920)/ 100000[vap](4360)
Aromatic EC >8-10	8.6 / 21 / 51	34 / 83 / 190	47 / 110 / 270	3500[vap] (613) / 8100[vap] (1500) / 17000[vap] (3580)	5000 / 5000 / 5000	7200[vap](613) / 8500[vap] (1500) / 9300[vap] (3580)
Aromatic EC >10-12	13 / 31 / 74	74 / 180 / 380	250 / 590 / 1200	16000[sol] (364) / 28000[sol] (899) / 34000[sol] (2150)	5000 / 5000 / 5000	9200[sol] (364) / 9700[sol] (899) / 10000
Aromatic EC >12-16	23 / 57 / 130	140 / 330 / 660	1800 / 2300[sol] (419) / 2500	36000[sol] (169) / 37000 / 38000	5100 / 5100 / 5000	10000 / 10000 / 10000
Aromatic EC >16-21 °	46 / 110 / 260	260 / 540 / 930	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7600 / 7700 / 7800
Aromatic EC >21-35 °	370 / 820 / 1600	1100 / 1500 / 1700	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Aromatic EC >35-44 °	370 / 820 / 1600	1100 / 1500 / 1700	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Aliphatic+Aromatic EC >44-70 °	1200 / 2100 / 3000	1600 / 1800 / 1900	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Chloroalkanes & Chloroalkenes (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
1,2-Dichloroethane	0.0046 / 0.0083 / 0.016	0.0071 / 0.011 / 0.019	0.0092 / 0.013 / 0.023	0.67 / 0.97 / 1.7	29 / 29 / 29	21 / 24 / 28

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
1,1,1 Trichloroethane (TCA)	48 / 110 / 240	8.8 / 18 / 39	9.0 / 18 / 40	660 / 1300 / 3000	140000 / 140000 / 140000	57000[vap](1425) 76000[vap](2915)/ 100000[vap](6392)
1,1,1,2 Tetrachloroethane	0.79 / 1.9 / 4.4	1.2 / 2.8 / 6.4	1.5 / 3.5 / 8.2	110 / 250 / 560	1400 / 1400 / 1400	1500 / 1800 / 2100
1,1,2,2 Tetrachloroethane	0.41 / 0.89 / 2.0	1.6 / 3.4 / 7.5	3.9 / 8.0 / 17	270 / 550 / 1100	1400 / 1400 / 1400	1800 / 2100 / 2300
Tetrachloroethene (PCE)	0.65 / 1.5 / 3.6	0.18 / 0.39 / 0.90	0.18 / 0.4 / 0.92	19 / 42 / 95	1400 / 1400 / 1400	810[sol](424)/1100[sol] (951)/1500
Tetrachloromethane (Carbon Tetrachloride)	0.45 / 1.0 / 2.4	0.026 / 0.056 / 0.13	0.026 / 0.056 / 0.13	2.9 / 6.3 / 14	890 / 920 / 950	190 / 270 / 400
Trichloroethene (TCE)	0.041 / 0.091 / 0.21	0.016 / 0.034 / 0.075	0.017 / 0.036 / 0.080	1.2 / 2.6 / 5.7	120 / 120 / 120	70 / 91 / 120
Trichloromethane (Chloroform)	0.42 / 0.83 / 1.7	0.91 / 1.7 / 3.4	1.2 / 2.1 / 4.2	99 / 170 / 350	2500 / 2500 / 2500	2600 / 2800 / 3100
Chloroethene (Vinyl Chloride)	0.00055/ 0.001/ 0.0018	0.00064 / 0.00087/ 0.0014	0.00077 / 0.001 / 0.0015	0.059 / 0.077 / 0.12	3.5 / 3.5 / 3.5	4.8 / 5.0 / 5.4
Phenol & Chlorophenols [a, b, l, p]						
Phenol	23 / 42 / 83	120 / 200 / 380	440 / 690 / 1200	440[dir] (26000) / 690[dir] (30000) / 1300[dir] (34000)	440[dir] (10000)/ 690[dir](10000) 1300[dir](10000)	440[dir] (7600) / 690[dir] (8300) / 1300[dir] (93000)
Chlorophenols (excluding PCP) [r]	0.13[s] / 0.3 / 0.7	0.87[s] / 2.0 / 4.5	94 / 150 / 210	3500 / 4000 / 4300	620 / 620 / 620	1100 / 1100 / 1100
Pentachlorophenol (PCP)	0.03 / 0.08 / 0.19	0.22/ 0.52 / 1.2	27[vap] (16.4) / 29 / 31	400 / 400 / 400	60 / 60 / 60	110 / 120 / 120
Other [a, b, l, p]						
Carbon Disulphide	4.8 / 10 / 23	0.14 / 0.29 / 0.62	0.14 / 0.29 / 0.62	11 / 22 / 47	11000 / 11000 / 12000	1300 / 1900 / 2700
Hexachlorobutadiene (HCBD)	0.25 / 0.61 / 1.4	0.29 / 0.7 / 1.6	0.32 / 0.78 / 1.8	31 / 66 / 120	25 / 25 / 25	48 / 50 / 51
Pesticides (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
Aldrin	3.2 / 6.1 / 9.6	5.7/ 6.6 /7.1	7.3 / 7.4 / 7.5	170 / 170 / 170	18 / 18 / 18	30 / 31 / 31
Atrazine	0.5 / 1.2 / 2.7	3.3 / 7.6 / 17.4	610 / 620 / 620	9300 / 9400 / 9400	1200 / 1200 / 1200	2300 / 2400 / 2400
Dichlorvos	0.0049 / 0.010 / 0.022	0.032 / 0.066 / 0.14	6.4 / 6.5 / 6.6	140 / 140 / 140	16 / 16 / 16	26 / 26 / 27
Dieldrin	0.17/0.41/0.96	0.97/ 2 / 3.5	7.0 / 7.3 / 7.4	170 / 170 / 170	18 / 18 / 18	30 / 30 / 31
Alpha - Endosulfan	1.2 / 2.9 / 6.8	7.4 / 18 / 41	160[vap] (0.003)/ 280[vap] (0.007)/ 410[vap] (0.016)	5600[vap] (0.003) / 7400[vap] (0.007) / 8400[vap] (0.016)	1200 / 1200 / 1200	2400 / 2400 / 2500
Beta - Endosulfan	1.1 / 2.7 / 6.4	7.0 / 17 / 39	190[vap](0.00007) /320[vap](0.0002) /440[vap](0.0004)	6300[vap](0.00007) /7800[vap](0.0002) / 8700	1200 / 1200 / 1200	2400 / 2400 / 2500
Alpha-Hexachlorocyclohexane	0.035/0.087/ 0.21	0.23/0.55 / 1.2	6.9 / 9.2 / 11	170 / 180 / 180	24 / 24 / 24	47 / 48 / 48
Beta - Hexachlorocyclohexane	0.013 / 0.032 / 0.077	0.085 / 0.2 / 0.46	3.7 / 3.8 / 3.8	65 / 65 / 65	8.1 / 8.1 / 8.1	15 / 15 / 16
Gamma – Hexachlorocyclohexane	0.0092 / 0.023 / 0.054	0.06 / 0.14 / 0.33	2.9 / 3.3 / 3.5	67 / 69 / 70	8.2 / 8.2 / 8.2	14 / 15 / 15
Chlorobenzenes [a, b, l, p]						
Chlorobenzene	5.9 / 14 / 32	0.46 / 1.0 / 2.4	0.46 / 1.0 / 2.4	56 / 130 / 290	11000 / 13000 / 14000	1300[sol](675)/ 2000[sol](1520)/ 2900
1,2-dichlorobenzene (1,2-DCB)	94 / 230 / 540	23 / 55 / 130	24 / 57 / 130	2000[sol] (571) / 4800[sol] (1370) / 11000[sol] (3240)	90000 / 95000 / 98000	24000[sol] (571) / 36000[sol] (1370) /51000[sol] (3240)
1,3-dichlorobenzene (1,3-DCB)	0.25 / 0.6 / 1.5	0.4 / 1.0 / 2.3	0.44 /1.1 / 2.5	30 / 73 / 170	300 / 300 / 300	390 / 440 / 470
1-4-dichlorobenzene (1,4-DCB)	15[i] / 37[i] / 88 [i]	61[q] / 150[q] /350 [q]	61[q] / 150[q] / 350[q]	4400[vap,q] (224) / 10000[vap,q] (540) / 25000[vap,q] (1280)	17000[i] / 17000[i] / 17000[i]	36000[vap,i] (224) 36000[vap, i](540)/ 36000[vap,i](1280)
1,2,3-Trichlorobenzene	4.7 / 12 / 28	1.5 / 3.6 / 8.6	1.5 / 3.7 / 8.8	102 / 250 / 590	1800 / 1800 / 1800	770[vap] (134) / 1100[vap] (330) / 1600[vap] (789)
1,2,4- Trichlorobenzene	55 / 140 / 320	2.6 / 6.4 / 15	2.6 / 6.4 / 15	220 / 530 / 1300	15000 / 17000 / 19000	1700[vap] (318) / 2600[vap] (786) / 4000[vap] (1880)
1,3,5- Trichlorobenzene	4.7 / 12 / 28	0.33 / 0.81 / 1.9	0.33 / 0.81 / 1.9	23 / 55 / 130	1700 / 1700 / 1800	380[vap] (36.7) / 580[vap] (90.8) / 860[vap] (217)
1,2,3,4-Tetrachlorobenzene	4.4 / 11 / 26	15 / 36 / 78	24 / 56 / 120	1700[vap] (122) / 3080[vap] (304) / 4400[vap] (728)	830 / 830 / 830	1500[vap] (122) / 1600 / 1600
1,2,3,5- Tetrachlorobenzene	0.38 / 0.90 / 2.2	0.66 / 1.6 / 3.7	0.75 / 1.9 / 4.3	49[vap] (39.4) / 120[vap] (98.1) / 240[vap] (235)	78 / 79 / 79	110[vap] (39.4) / 120 / 130
1,2,4,5- Tetrachlorobenzene	0.06 / 0.16 / 0.37	0.33 / 0.77 / 1.6	0.73 / 1.7 / 3.5	42[sol] (19.7) / 72[sol] (49.1) / 96	13 / 13 / 13	25 / 26 / 26

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Pentachlorobenzene (P_ECB)	1.2 / 3.1 / 7.0	5.8 / 12 / 22	19 / 30 / 38	640^{sol} (43.0) / 770^{sol} (107) / 830	100 / 100 / 100	190 / 190 / 190
Hexachlorobenzene (HCB)	0.47 / 1.1 / 2.5	1.8^{vap} (0.20) / 3.3^{vap} (0.5) / 4.9	4.1^{vap} (0.20) / 5.7^{vap} (0.5) / 6.7^{vap} (1.2)	110^{vap} (0.20) / 120 / 120	16 / 16 / 16	30 / 30 / 30

Units are mg/kg Dry Weight

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R_WHP Residential with homegrown produce
$R_{WO}HP$ Residential without homegrown produce
POSresi public open spaces near residential housing
POSpark public open space for recreational use but not dedicated sports pitches
SOM Soil Organic Matter – ***the S4UL for all organic compounds will vary according to SOM***

a Based on a sandy loam soil as defined in SR3 (Environment Agency, 2009b) and 6% soil organic matter (SOM)
b Figures rounded to two significant figures
c Based only on a comparison of oral and dermal soil exposure with oral Index Dose
d The background ADE is limited to being no larger than the contribution from the relevant soil ADE
e Based on comparison of inhalation exposure with inhalation TDI only
f Based on a lifetime exposure via the oral, dermal and inhalation pathways
g Based on localised effects comparing inhalation exposure with inhalation ID only
h Based on comparison of inhalation exposure with inhalation ID
i Based on comparison of oral and dermal exposure with oral TDI
j Based on comparison of oral, dermal and inhalation exposure with inhalation TDI
k Based on comparison of all exposure pathways with oral TDI
l S4ULs assume that free phase contamination is not present
m S4ULs based on a sub-surface soil to indoor air correction factor of 10
n The HCV applied is based on the intake of total Xylene and therefore exposure should not consider an isomer in isolation
o Oral, dermal and inhalation exposure compared with oral HCV
p S4ULs based on a sub-surface soil to indoor air correction factor of 1
q Based on a comparison of inhalation exposure with the inhalation TDI for localised effects
r Based on 2,4-dichlorophenol unless otherwise stated
s Based on 2,3,4,6-tetrachlorophenol
t Based on lowest GAC for all three xylene isomers
u Measured concentrations of benzo(a)pyrene should be compared to the S4UL for benzo(a)pyrene as a single compound and to the S4UL for benzo(a)pyrene as a surrogate marker of genotoxic PAHs.
vap S4UL presented exceeded the vapour saturation limit, which is presented in brackets
sol S4UL presented exceeds the solubility saturation limit, which is presented in brackets
dir S4ULs based on a threshold protective of direct skin contact, guideline in brackets based on the health effects following long term exposure provided for illustration only

Table 3: Soil Guideline Values (SGVs) for dioxins, furans and dioxin like PCBs

Determinand	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial
Sum of PCDDs, PCDFs and dioxin-like PCBs	0.008	0.008	0.008	0.24

Units are mg/kg Dry Weight

Table 4: EIC/AGS/CL:AIRE Generic Assessment Criteria (GAC)

	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial	Soil Saturation Concentration
Metals					
Antimony	ND	ND	550	7500	NA
Barium	ND	ND	1300	22000	NA
Molybdenum	ND	ND	670	17000	NA
Organics (SOM 1%/ 2.5%/ 6%)					
1,1,2 Trichloroethane	0.28 / 0.61 / 1.4	0.6 / 1.2 / 2.7	0.88 / 1.8 / 3.9	94 / 190 / 400	4030 / 8210 / 18000
1,1-Dichloroethane	9.2 / 17 / 35	2.4 / 3.9 / 7.4	2.5 / 4.1 / 7.7	280 / 450 / 850	1830 / 2960 / 5600
1,1-Dichloroethene	2.8 / 5.6 / 12	0.23 / 0.4 / 0.82	0.23 / 0.41 / 0.82	26 / 46 / 92	2230 / 3940 / 7940
1,2,4-Trimethylbenzene	0.38 / 0.93 / 2.2	0.35 / 0.85 / 2	0.41 / 0.99 / 2.3	42 / 99 / 220	557 / 1360 / 3250
1,2-Dichloropropane	0.62 / 1.2 / 2.6	0.024 / 0.042 / 0.084	0.024 / 0.042 / 0.085	3.3 / 5.9 / 12	1190 / 2110 / 4240
2,4-Dimethylphenol	3.1 / 7.2 / 17	19 / 43 / 97	210 / 410 / 730	16000 / 24000 / 30000	1380 / 3140 / 7240
2,4-Dinitrotoluene	0.22 / 0.49 / 1.1	1.5 / 3.2 / 7.2	170 / 170 / 170	3700 / 3700 / 3800	141 / 299 / 669
2,6-Dinitrotoluene	0.12 / 0.27 / 0.61	0.78 / 1.7 / 3.9	78 / 84 / 87	1900 / 1900 / 1900	287 / 622 / 1400
2-Chloronaphthalene	40 / 98 / 230	3.7 / 9.2 / 22	3.8 / 9.3 / 22	390 / 960 / 2200	114 / 280 / 669
Biphenyl	14 / 35 / 83	66 / 160 / 360	220 / 500 / 980	18000 / 33000 / 48000	34.4 / 84.3 / 201
Bis (2-ethylhexyl) phthalate	47 / 120 / 280	280 / 610 / 1100	2700 / 2800 / 2800	85000 / 86000 / 86000	8.68 / 21.6 / 51.7

	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial	Soil Saturation Concentration
Bromobenzene	3.2 / 7.6 / 18	0.87 / 2 / 4.7	0.91 / 2.1 / 4.9	97 / 220 / 520	853 / 1970 / 4580
Bromodichloromethane	0.016 / 0.032 / 0.068	0.016 / 0.03 / 0.061	0.019 / 0.034 / 0.07	2.1 / 3.7 / 7.6	1790 / 3220 / 6570
Bromoform	0.95 / 2.1 / 4.6	2.8 / 5.9 / 13	5.2 / 11 / 23	760 / 1500 / 3100	2690 / 5480 / 12000
Butyl benzyl phthalate	220 / 550 / 1300	1400 / 3300 / 7200	42000 / 44000 / 44000	940000 / 940000 / 950000	26.3 / 64.7 / 154
Chloroethane	110 / 200 / 380	8.3 / 11 / 18	8.4 / 11 / 18	960 / 1300 / 2100	2610 / 3540 / 5710
Chloromethane	0.066 / 0.13 / 0.23	0.0083 / 0.0098 / 0.013	0.0085 / 0.0099 / 0.013	1 / 1.2 / 1.6	1910 / 2240 / 2990
Cis 1,2 Dichloroethene	0.26 / 0.5 / 1	0.11 / 0.19 / 0.37	0.12 / 0.2 / 0.39	14 / 24 / 47	3940 / 6610 / 12900
Dichloromethane	0.1 / 0.19 / 0.34	0.58 / 0.98 / 1.7	2.1 / 2.8 / 4.5	270 / 360 / 560	7270 / 9680 / 15300
Diethyl Phthalate	19 / 41 / 94	120 / 260 / 570	1800 / 3500 / 6300	150000 / 220000 / 290000	13.7 / 29.1 / 65
Di-n-butyl phthalate	2 / 5 / 12	13 / 31 / 67	450 / 450 / 450	15000 / 15000 / 15000	4.65 / 11.4 / 27.3
Di-n-octyl phthalate	940 / 2100 / 3900	2300 / 2800 / 3100	3400 / 3400 / 3400	89000 / 89000 / 89000	32.6 / 81.5 / 196
Hexachloroethane	0.27 / 0.67 / 1.6	0.2 / 0.48 / 1.1	0.22 / 0.54 / 1.3	22 / 53 / 120	8.17 / 20.1 / 48.1
Isopropylbenzene	32 / 79 / 190	11 / 27 / 64	12 / 28 / 67	1400 / 3300 / 7700	390 / 950 / 2250
Methyl tert-butyl ether (MTBE)	23 / 44 / 90	49 / 84 / 160	73 / 120 / 220	7900 / 13000 / 24000	20400 / 33100 / 62700
Propylbenzene	34 / 83 / 200	34 / 82 / 190	40 / 97 / 230	4100 / 9700 / 21000	402 / 981 / 2330
Styrene	1.6 / 3.7 / 8.7	8.1 / 19 / 43	35 / 78 / 170	3300 / 6500 / 11000	626 / 1440 / 3350
Total Cresols (2-, 3- and 4-methylphenol)	12 / 27 / 63	80 / 180 / 400	3700 / 5400 / 6900	160000 / 180000 / 180000	15000 / 32500 / 73300
Trans 1,2 Dichloroethene	0.93 / 1.9 / 4	0.19 / 0.34 / 0.7	0.19 / 0.35 / 0.71	22 / 40 / 81	3420 / 6170 / 12600
Tributyl tin oxide	0.042 / 0.1 / 0.24	0.25 / 0.59 / 1.3	1.4 / 3.1 / 5.7	130 / 180 / 200	41.3 / 101 / 241

Units are mg/kg Dry Weight

Table 5: Tier 2 Criteria for the Assessment of Soils – Protection of Flora and Fauna

Parameter	ICRCL 70/90 [a]		SSVs [b]	Code of Practice for Agricultural Use of Sewage Sludge [c]	BS 3882:2015 Specification for topsoil and requirements for use
	Maximum				Phytotoxic contaminants
	Livestock	Crop Growth			
	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW
Antimony			37		
Arsenic	500	1000		50	
Cadmium	30	50	0.6	3	
Chromium				400	
Cobalt			4.2		
Copper	500	250	35.1	80/ 100/ 135/ 200 [d]	<100/<135/<200 [e]
Fluoride	1000			500	
Lead	1000			300	
Mercury				1	
Molybdenum			5.1	4	
Nickel			28.2	50/ 60/ 75/ 110 [d]	<60/<75/<110 [e]
Selenium				3	
Silver			0.3		
Vanadium			2.0		
Zinc	3000	1000	35.6	200/200/200/300 [d]	<200/<200/<300 [e]
Benzo(a)pyrene			0.15		
Bis(2-ethylhexyl) phthalate			13		
Hexachlorobenzene			0.002		
Pentachlorobenzene					
Pentachlorophenol			0.6		
Perfluorooctanoic acid			0.022		
Perfluorooctane sulfonate			0.014		
Polychlorinated alkanes medium chain			11.9		
Tetrachloroethene					
Toluene					
Triclosan			0.13		

Parameter	ICRCL 70/90 [a]		SSVs [b]	Code of Practice for Agricultural Use of Sewage Sludge [c]	BS 3882:2015 Specification for topsoil and requirements for use
	Maximum				Phytotoxic contaminants
	Livestock	Crop Growth			
	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW
Tris(2-chloroethyl)phosphate			1.1		
Tris(2-chloro-1-methylethyl) phosphate			1.8		

a. Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) 70/90 Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing 1st edition 1990.
b. Soil screening values for assessing ecological risks, EA 2017a Report – ShARE id26
c. Maximum permissible concentration of potentially toxic elements for Arable land from the Sewage sludge in agriculture: code of practice.. There are also criteria for Grassland which are higher than for Arable.
d. Where four values are presented, concentrations are for soils with pH values 5.0-5.5/ 5.5-6.0/ 6.0-7.0/ >7.0 (and the soils contain more than 5% calcium carbonate)
e. Where three values are presented, concentrations are for soils with pH values <6.0/ 6.0-7.0/ >7.0

Table 6: Tier 2 Criteria for Screening Liquids

	Screening Concentration (mg/l)			
	Minimum Reporting Value	Human Consumption	Fresh Water/Inland	Salt Water/Other
Arsenic SP	-	0.01	0.05 (2)	0.025 (2)
Boron	-	1	-	-
Cadmium PS	0.0001	0.005	≤0.00008, 0.00008, 0.00009, 0.00015, 0.00025 (14)	0.0002
Chromium (total)	-	0.05	-	-
Chromium (III) SP	-	-	0.0047	-
Chromium (VI) SP	-	-	0.0034	0.0006
Copper SP	-	2	0.001 bioavailable	0.00376 bioavailable
Iron SP	-	0.2	1	1
Lead PS	-	0.01	0.0012 bioavailable	0.0013 bioavailable
Mercury compounds PS	0.00001	0.001	0.00007 max	0.00007 max
Manganese SP	-	0.05	0.123 bioavailable	-
Nickel PS	-	0.02	0.004 bioavailable	0.0086 bioavailable
Selenium	-	0.01	-	-
Zinc SP	-	5(3)	0.0109bioavailable(13)	0.0068bioavailable (13)
Chlorinated Compounds				
C10-13 chloroalkanes PS short chain chlorinated paraffins	-	-	0.0004	0.0004
Dichloromethane PS	-	-	0.02	0.02
1,2-Dichloroethane PS	0.001	0.003	0.01	0.01
Trichloroethene PS	0.0001	0.01(5)	0.01	0.01
1,1,1-Trichloroethane	0.0001	-	-	-
1,1,2-Trichloroethane	0.0001	-	-	-
Trichloromethanes PS	-	0.1(1)	0.0025	0.0025
1, 2, 4-Trichlorobenzene	0.00001			
Tetrachloroethene PS	0.0001	0.01(5)	0.01	0.01
Tetrachloromethane PS	0.0001	0.003	0.012	0.012
Tetrachloroethane SP	-		0.140	
Vinyl chloride	-	0.0005	-	-
Trichlorobenzene (TCB) PS	-	-	0.0004	0.0004
Chloroform	0.0001			
Chloronitrotoluenes(CNT)(11)	0.001	-	-	-
Hexachlorobutadiene PS	0.000005	-	0.0006 max	0.0006 max
Hexachlorocyclohexanes (HCH) PS	0.000001	-	0.00002	0.000002
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	-	-	-	-

	Screening Concentration (mg/l)			
	Minimum Reporting Value	Human Consumption	Fresh Water/Inland	Salt Water/Other
Acenaphthylene	-	-	-	-
Anthracene PS	-	-	0.0001	0.0001
Benzo(a)anthracene	-	-	-	-
Benzo(b)fluoranthene PS	-	0.0001 (10)	0.000017 max (12)	0.000017 max (12)
Benzo(a)pyrene PS	-	0.00001	0.00000017	0.00000017
Benzo(k)fluoranthene PS	-	0.0001 (10)	0.000017 max (12)	0.000017 max (12)
Benzo(g,h,i)perylene PS	-	0.0001 (10)	0.0000082 max (12)	0.00000082 max (12)
Indeno(1,2,3-cd)pyrene PS	-	0.0001 (10)	- (12)	- (12)
Chrysene		-	-	-
Dibenzo(a,h)anthracene		-	-	-
Fluoranthene PS	-	-	0.0000063	0.0000063
Fluorene	-	-	-	-
Phenanthrene	-	-	-	-
Pyrene	-	-	-	-
Naphthalene PS	-	-	0.002	0.002
Polycyclic Aromatic Hydrocarbons		0.0001(10)		
Petroleum hydrocarbons				
Total petroleum hydrocarbons	-	0.01(3)	-	-
Benzene PS	0.001	0.001	0.01	0.008
Toluene SP	0.004	0.7(9)	0.074	0.074
Ethylbenzene	-	0.3(9)	-	-
Xylenes	0.003(4)	0.5(9)		
Methyl tert-butyl ether (MTBE)	-	0.015(7)	-	-
Pesticides and Herbicides				
Alachlor PS	-	-	0.0003	0.0003
Aldrin PS	0.000003	0.00003	0.00001(8)	0.000005(8)
Dieldrin PS	0.000003	0.00003		
Endrin PS	0.000003	0.0006(9)		
Isodrin	0.000003	-	-	-
2,4 dichlorophenol SP	0.0001	-	0.0042	0.00042
2,4 D ester SP	0.0001	-	0.0003	0.0003
op and pp DDT (each) PS		0.001(6)	0.000025 (6)	0.000025 (6)
op and pp DDE (each)				
op and pp TDE (each)				
Dimethoate SP	0.00001	-	0.00048	0.00048
Endosulfan PS	0.000005	-	0.000005	0.0000005
Hexachlorobenzene PS	0.000001		0.00005 max	0.00005 max
Permethrin SP		-	0.000001	0.0000002
Atrazine PS	0.00003	-	0.0006	0.0006
Simazine PS	0.00003	-	0.001	0.001
Linuron SP		-	0.0005	0.0005
Mecoprop SP		-	0.018	0.018
Trifluralin PS	0.00001	-	0.00003	0.00003
Total pesticides		0.0005		
Miscellaneous				
Ammoniacal nitrogen (as NH4+)	-	0.5	0.26 16 0.39 17	-
Ammoniacal nitrogen (as N)	-	0.39	0.2 16 0.3 17	-
Unionised Ammonia (NH3) SP	-	-	-	0.021
Chloride	-	250		
Chlorine SP			0.002	0.01 max
Cyanide SP (hydrogen cyanide)	-	0.05	0.001	0.001
Nitrate (as NO_3)	-	50	-	-
Nitrite (as NO_2)	-	0.1	-	-
Phenol SP	-	0.5 (3)	0.0077	0.0077
Pentachlorophenol PS	0.0001	-	0.0004	0.0004
PCBs (individual congeners)	0.000001	-	-	-
Sodium	-	200	-	-
Sulphate	-	250		-

	Screening Concentration (mg/l)			
	Minimum Reporting Value	Human Consumption	Fresh Water/Inland	Salt Water/Other
Tributyl and triphenyl tin compounds (each) PS	0.000001	-	0.0000002	0.0000002
Di(2-ethylhexyl)-phthalate PS	-	-	0.0013	0.0013

Substances highlighted in yellow are hazardous substances, PS = Priority Substances, SP = Specific Pollutants, '-' screening concentration is not available, 'max' – maximum allowable concentration used where no annual average provided

Notes:

1. Concentration for trihalomethanes is the sum of chloroform, bromoform, dibromochloromethane and bromodichloromethane.
2. Concentration is the dissolved fraction of a water sample obtained by filtration through a 0.45um filter.
3. Concentration is taken from Statutory Instrument 1989 No. 1147. The Water Supply (Water Quality) Regulations 1989, as amended.
4. Concentration for xylenes is 0.003mg/l each for o-xylene and m/p xylene.
5. Concentration is the Sum of TCE and PCE.
6. Concentration is for Total DDT. Para DDT on its own has a target concentration of 0.00001mg/l.
7. Concentration for MTBE is taken from Environment Agency guidance, dated 2006.
8. Concentration is the sum of aldrin, dieldrin, endrin.
9. Concentration is taken from WHO (2004) guidelines for drinking-water quality.
10. Sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene
11. Concentration is for 2,6-CNT, 4,2-CNT, 4,3-CNT, 2,4-CNT, 2,5-CNT
12. BAP can be considered as a marker of the other PAHs for comparison with the annual average
13. Concentration plus ambient background concentration (dissolved)
14. For cadmium and its compounds the EQS depends on the hardness of the water (Class 1: < 40 mg CaCO3/l, Class 2: 40 to < 50 mg CaCO3/l, Class 3: 50 to < 100 mg CaCO3/l, Class 4: 100 to < 200 mg CaCO3/l and Class 5: ≥ 200 mg CaCO3/l).
15. Manufactured and used in industrial applications, such as flame retardants and plasticisers, as additives in metal working fluids, in sealants, paints, adhesives, textiles, leather fat and coatings. Persistent, bioaccumulate and toxic to aquatic life (carcinogen in rat studies). Candidate Persistent Organic Pollutant (POP).
16. Acceptable 90th percentile concentration for a freshwater lake/river with "High" chemical quality standard and alkalinity (as mg/l CaCO3) < 50 mg/L or alkalinity < 200 mg/L where river elevation > 80 m above Ordnance Datum (mAOD). See the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 for further details.
17. Acceptable 90th percentile concentration for a freshwater lake/river with "High" chemical quality standard and alkalinity (as mg/l CaCO3) ≥ 50 mg/L where river elevation < 80 m mAOD or > 200 mg/l where river elevation > 80 mAOD. See the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 for further details.

Table 7: Tier 2 Criteria for Screening Groundwater Vapour Generation Hazard

Chemical	CAS	GAC_{gwvap}(µg/l)[1,2]		Aqueous Solubility (µg/l)
		Residential	Commercial	
Petroleum Hydrocarbons				
1,2,4-Trimethylbenzene	95-63-6	24	2,200	559,000
Benzene [3]	71-43-2	210	20,000	1,780,000
Ethylbenzene [3]	100-41-4	10,000	*960,000 (sol)*	180,000
Isopropylbenzene	98-82-8	850	*86,000 (sol)*	56,000
Propylbenzene	103-65-1	2,700	*240,000 (sol)*	54,100
Styrene	100-42-5	8,800	*810,000 (sol)*	290,000
Toluene [3]	108-88-3	230,000	*21,000,000 (sol)*	590,000
TPH Aliphatic EC5-EC6 [3]		1,900	*190,000 (sol)*	35,900
TPH Aliphatic >EC6-EC8 [3]		1,500	*150,000 (sol)*	5,370
TPH Aliphatic >EC8-EC10 [3]		57	*5,700 (sol)*	427
TPH Aliphatic >EC10-EC12 [3]		37	*3,600 (sol)*	34
TPH Aromatic >EC5-EC7 [2,3]		210,000	*20,000,000 (sol)*	1,780,000
TPH Aromatic >EC7-EC8 [3]		220,000	*21,000,000 (sol)*	590,000
TPH Aromatic >EC8-EC10 [3]		1,900	*190,000 (sol)*	64,600
TPH Aromatic >EC10-EC12 [3]		6,800	*660,000 (sol)*	24,500
TPH Aromatic >EC12-EC16 [3]		39,000	*3,700,000 (sol)*	5,750
meta-Xylene [3,5]	108-38-3	9,500	*940,000 (sol)*	200,000
ortho-Xylene [3,5]	95-47-6	12,000	*1,100,000 (sol)*	173,000
para-Xylene [3,5]	106-42-3	9,900	*980,000 (sol)*	200,000
Polycyclic Aromatic Hydrocarbons (PAH)				
Acenaphthene	83-32-9	*170,000 (sol)*	*15,000,000 (sol)*	4,110

Chemical	CAS	GAC_{gwvap}(µg/l)[1,2]		Aqueous Solubility (µg/l)
		Residential	Commercial	
Acenaphthylene	208-96-8	*220,000 (sol)*	*20,000,000 (sol)*	7,950
Fluorene	86-73-7	*210,000 (sol)*	*18,000,000 (sol)*	1,860
Naphthalene	91-20-3	220	*23,000 (sol)*	19,000
Pesticides				
Aldrin	309-00-2	*47 (sol)*	*3,700 (sol)*	20
alpha-Endosulfan	959-98-8	*7,400 (sol)*	*590,000 (sol)*	530
beta-Endosulfan	33213-65-9	*7,500 (sol)*	*600,000 (sol)*	280
Halogenated Organics				
1,1,1,2-Tetrachloroethane	79-34-5	240	22,000	1,110,000
1,1,1-Trichloroethane	71-55-6	3,000	290,000	1,300,000
1,1,2,2-Tetrachloroethane	79-35-4	1,600	150,000	2,930,000
1,1,2-Trichloroethane	79-00-5	520	49,000	4,491,000
1,1-Dichloroethane	75-34-3	2,700	260,000	3,666,000
1,1-Dichloroethene	75-35-4	160	1,6000	3,100,000
1,2,3,4-Tetrachlorobenzene	634-66-2	240	*31,000 (sol)*	7,800
1,2,3,5-Tetrachlorobenzene	634-90-2	7.0	*600*	3,500
1,2,3-Trichlorobenzene	87-61-7	35	3,100	21,000
1,2,4,5-Tetrachlorobenzene	95-94-3	8.1	*700 (sol)*	600
1,2,4-Trichlorobenzene	120-82-1	68	7,200	41,400
1,2-Dichlorobenzene	95-50-1	2,000	*220,000 (sol)*	133,000
1,2-Dichloroethane	107-06-2	8.9	850	8,680,000
1,2-Dichloropropane	78-87-5	22	2,600	2,050,000
1,3,5-Trichlorobenzene	108-70-3	7.4	660	6,000
1,3-Dichlorobenzene	541-73-1	31	2,800	103,000
1,4-Dichlorobenzene	106-46-7	5,000	*460,000 (sol)*	51,200
Bromobenzene	108-86-1	220	20,000	388,040
Bromodichloromethane	75-27-4	17	1,600	3,000,000
Bromoform (Tribromomethane)	75-25-2	3,100	400,000	3,000,000
Chlorobenzene	108-90-7	98	15,000	387,000
Chloroethane	75-00-3	10,000	1,000,000	5,742,000
Chloroethene (Vinyl Chloride)	75-01-4	0.62	63	2,760,000
Chloromethane	74-87-3	14	1,400	5,350,000
cis-1,2-Dichloroethene	156-59-2	130	13,000	7,550,000
Dichloromethane	75-09-2	3,300	370,000	20,080,000
Hexachlorobenzene	118-74-1	*16 (sol)*	*1,400 (sol)*	10
Hexachlorobutadiene	87-68-3	1.7	230	4,800
Hexachloroethane	67-72-1	8.5	740	49,900
Pentachlorobenzene	608-93-5	140	*12,000 (sol)*	500
Tetrachloroethene	127-18-4	34	4,600	225,000
Tetrachloromethane (Carbon Tetrachloride)	56-23-5	5.3	770	846,000
trans-1,2-Dichloroethene	156-60-5	160	16,000	5,250,000
Trichloroethene	79-01-6	5.7	530	1,370,000
Trichloromethane (Chloroform)	67-66-3	790	85,000	8,950,000
Others (organic and inorganic)				
2-Chloronaphthalene	91-58-7	160	*14,000 (sol)*	11,700
Biphenyl (Lemonene)	92-52-4	*15,000 (sol)*	*1,300,000 (sol)*	4,060
Carbon Disulphide	75-15-0	56	5,600	2,100,000
Mercury, elemental	7439-97-6	1.1	*95 (sol)*	56
Methyl tertiary butyl ether (MTBE)	1634-04-4	83,000	7,800,000	48,000,000

Notes

1. GAC in *italics* with (sol) exceed aqueous solubility.
2. GAC rounded to two significant figures.
3. The GAC for these petroleum hydrocarbon contaminants have been calculated using a sub-surface soil to indoor air correction factor of 10 in line with the physical-chemical data sources.
4. The GAC for TPH fractions do not account for genotoxic mutagenic effects. Concentrations of TPH Aromatic >EC5-EC7 should therefore also be compared with the GAC for benzene to ensure that such effects are also assessed.
5. The Health Criteria Value used for each xylene isomer was for total xylene. If site specific additivity assessments are not completed, as a conservative measure the sum of isomer concentrations should be compared to the lowest xylene GAC (as is the case for soil GAC).