ARCHWILIAD

CYNLLUN DATBLYGU LLEOL DIWYGIEDIG

SIR GAERFYRDDIN (2018-2033)

Sesiwn Gwrandawiad 12 – Pobl a Lleoedd Ffyniannus – Dyraniadau Safle (Clystyrau 2, 3 a 6)

Dydd Mawrth 26 Tachwedd 2024 rhwng 10:00 a 17:00

Cam Gweithredu	Ymateb y Cyngor / Newidiadau a gynigir yn sgil Materion a Godwyd	Sylwadau'r Arolygwyr
AP12/1 – Y Cyngor i ddarparu nodyn byr yn egluro bod cost y gwaith adfer yn nyraniad SeC4/h2 wedi cael ei ystyried yn yr Adroddiad Hyfywedd Ariannol.	Mae ymateb y Cyngor wedi'i nodi isod	Cytunwyd.

Pwynt Gweithredu AP12/1

Wrth ystyried gofynion y pwynt gweithredu sy'n ymwneud â thystiolaeth o hyfywedd y safle, cyfeirir at waith a wnaed gan Burrows Hutchinson Ltd (BHL) ar Harbwr Porth Tywyn, yn ogystal â thystiolaeth a baratowyd gan yr ymgynghorwyr eiddo Alder King (Mehefin 2023) sy'n ystyried hyfywedd a gwerth tir ar Asedau Cyd-fenter ar hyd Arfordir Llanelli. Cyhoeddwyd y dystiolaeth hon ar gyfer Cyngor Sir Caerfyrddin, a Llywodraeth Cymru fel rhan o'r Gyd-fenter, sydd wedi cael ei diddymu wedi hynny.

Fel y cyflwynwyd yn Sesiwn Gwrandawiad yr archwiliad, yn hanesyddol mae'r tir yn Harbwr Porth Tywyn (SeC4/h2) wedi cael ei rannu'n dair elfen: Hen safle Grillo a brynwyd gan y Cyngor ym mis Awst 2020, a dau barsel o dir ym mherchnogaeth y Cyngor a elwir yn Safle 5 a 6.

Roedd pris prynu safle Grillo yn adlewyrchu'r gofyniad i ddarparu costau adfer ar y safle ac amcangyfrifwyd y byddai hynny rhwng £1,100,000 a £1,900,000. (ceir tystiolaeth o hyn yn Adroddiad Alder King wrth gyfeirio at safle 6). Yn sesiwn gwrandawiad yr archwiliad, cyflwynodd y Cyngor wybodaeth a oedd wedi digwydd cyn prynu'r safle a oedd yn amcangyfrif y byddai'r costau adfer yn £1,525,000, sydd felly o fewn amrediad canol yr amcangyfrifon hynny. Roedd yr amcangyfrifon hyn yn seiliedig ar fanylion yn ymwneud â samplu, profi a dadansoddi ar y safle, a chynhyrchu dau adroddiad sef Asesiad Risg Meintiol Manwl (DQRA) o Ddyfroedd

Rheoledig a'r Arfarniad Opsiynau Adfer (ROA). Atodir copi o'r ddwy ddogfen isod yn Atodiad 1 a 2 yn y drefn honno.

Wrth ystyried ymhellach y gwaith a wnaed gan Burrows Hutchinson Ltd ar Harbwr Porth Tywyn (gweler dogfennau cyflwyno CSD32 a CSD166a), mae adroddiad Adendwm yr Asesiad Hyfywedd Ariannol Lefel Uchel a'r Crynodeb o'r Arfarniad Hyfywedd Ariannol yn cyfeirio'n benodol at gostau annormal a'r gwaith o baratoi'r safle. Pennwyd y gwerthoedd a fewnbynnwyd ar gyfer y costau annormal yn £4.47 miliwn, sef bron i 6% o GDV cyffredinol y safle ac felly mae'n elfen sylweddol o'r Asesiad Hyfywedd Ariannol.

Mae'r Asesiad Hyfywedd Ariannol yn nodi y dylai fod yn hyfyw i'r safle ddarparu cynllun sy'n cydymffurfio â pholisïau, gan gynnwys y gofyniad ym Mholisi arfaethedig AHOM1 i 25% o'r anheddau newydd fod yn dai fforddiadwy.

Dylid nodi bod y caniatâd cynllunio amlinellol ar gyfer hen safle Grillo, a safleoedd 5 a 6 yn cynnwys amod i ddarparu o leiaf y targed o 20% o gartrefi fforddiadwy. Felly, ceir hyblygrwydd pellach o fewn crynodeb yr Asesiad Hyfywedd Ariannol i ystyried mesurau wrth gefn eraill pe baent yn codi.

Atodiad 1 –
Asesiad Risg Meintiol Manwl (DQRA) o Ddyfroedd Rheoledig

Carmarthenshire County Council

FORMER GRILLO SITE

CONTROLLED WATERS DETAILED QUANTITATIVE RISK ASSESSMENT

70054861-001
SEPTEMBER 2019

PUBLIC

Carmarthenshire County Council

FORMER GRILLO SITE

CONTROLLED WATERS DETAILED QUANTITATIVE RISK ASSESSMENT

TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70054861

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1 INTRODUCTION

WSP Group Ltd has been commissioned by Carmarthenshire County Council to (i) collect up-to-date groundwater quality data and field parameters, (ii) revise the Controlled Waters Detailed Quantitative Risk Assessment (CW DQRA), and (iii) prepare the Remediation Option Appraisal (ROA), for the proposed development located at the former Grillo Zinc-oxide Site at Burry Port Harbour.

1.1 BACKGROUND

It is understood that Carmarthenshire County Council proposes to redevelop the former Grillo zinc-oxide Site to a mixed-use end including residential and commercial developments. The proposed development includes up to 230 homes, 465 m^2 of retail and leisure floorspace (a1, a3 and d1 uses), creation and alteration of existing vehicle and pedestrian accesses, landscaping, public open space, all services and infrastructure, demolition, remediation of the site and associated work. Re-development of the Site was granted outline planning permission (ref: S/30678) in August 2014.

Several phases of investigation have been carried out on the Site and the surrounding area by different consultants over the last fifteen years. The most recent soil and groundwater interpretative contamination assessment report was completed by ESG (August 2017) in response to planning conditions 8(ii) and 8(iii) within the Outline Planning Permission issued to Castleton Estate Limited in August 2014, and comments from Natural Resources Wales (NRW). Within the conclusions from the site assessment, ESG recommended the preparation of:

(i) Updated Controlled Waters DQRA (utilising either ConSim or P20 modelling), and

(ii) Updated remediation option appraisal (with indicative costs), considering the new development proposals.

This report contains the Controlled Waters DQRA, as well as the derivation of preliminary soil remedial target values (PRTV) to reduce future impact onto controlled water receptors through enhanced soil leachability during site development works (breaking hard surface) and future changes in environmental conditions that have the potential to mobilise Potential Contaminants of Concern (PCoC) e.g. in the event of future rising water levels.

1.2 SITE HISTORY

The Site is originally the Pembrey Copper Works constructed in 1849 and undertook copper smelting until 1912 with railway lines in the north and south of the Site. The Site is then briefly occupied by an “ore extraction company" which removed metal bearing flue dust for sale to non-ferrous smelters. During the First World War, Metallic Chemical Ltd was formed to manufacture oxides of nonferrous metals, particularly zinc oxide, but also oxides of lead, copper, iron and barium until 1922. The Site then manufactured zinc oxide under various companies until around 2004 and the former works buildings are demolished in late 2006. The Site has since remained vacant apart from the small boatyard in the south of the Site.

Historically, the surrounding area is predominantly industrial including a Lead and Silver Works, a White Lead Works and Iron Foundry. Between 1964 and 1989 there is a power station to the east of the Site and landfill used by Carmarthen Bay Power between 1980 and 1987 immediately adjacent to the east of the Site.

1.3 PREVIOUS WORKS

The principal ground investigation and assessment reports which have been relied upon include:

- Parsons Brinckerhoff Ltd, 2004, Grillo Zinc oxide (UK) Ltd, The Docks, Burry Port, Phase II Site Investigation and Risk Assessment Report, September 2004.
- GIL, 2008, Grillo Works, Burry Port, Carmarthenshire, Geo-Environmental Site Investigation Report, March 2008.
- Waterman Civils Ltd, 2008, Grillo Works, Burry Port, Soil and Groundwater Quantitative Risk Assessment Report, February 2008.
- Waterman Civils Ltd, 2008, Grillo Works, Burry Port, Remediation Strategy, June 2008.
- ESG, 2011, Burry Port, Ground Contamination and Remediation Strategy, August 2011.
- Waterman Civils Ltd, 2014, Proposed Re-Development of the Former Grillo Zinc-oxide Site at Burry Port, Ground Conditions, July 2014.
- ESG, 2017, Former Grillo Zinc Oxide Site, Burry Port, Interpretative Contamination Assessment, September 2017.

1.4 PREVIOUS CONTROLLED WATERS RISK ASSESSMENT

The general conclusions from the earlier reports regarding controlled waters were that the Burry Port Harbour and Loughor Estuary are the closest off-site receptors. Given the presence of cockle beds, the estuary is the most sensitive receptor. The underlying aquifers are considered as the next most sensitive receptors, with groundwater within the Blown Sands being the more continuous aquifer and presenting a potential source of contamination of the surface water in the harbour and estuary.

During previous assessments it was also concluded that, due to the active use of the harbour by boats, which present an additional potential source of pollutants, the harbour is possibly less sensitive to pollution from the Grillo Site than the estuary; however, it is considered desirable to limit the discharge of potential pollutants to all surface and groundwater receptors.

The review of the available historic data indicated that significant attenuation was occurring on site. Raising ground levels through the development of the site, with installation of high percentage hardstanding, would reduce infiltration of water through contaminated soils. Leachability and mobilisation of metals could further be reduced through soil additives during development (e.g. soil stabilisation), reducing the loading of metals reaching the estuary over time. It was concluded that active groundwater remediation was not necessary. It was recommended that any imported soils should have a pH similar to that on site, of approximately pH 8. The elevated pH will act to reduce the mobilisation of several heavy metals identified as a PCoC at site.

Two key areas of previous uncertainty which are discussed in some of the reports are:

- Differences noted during the various investigations in the Blown Sands hydraulic conductivity (K) values and those applied in the DQRA modelling; and
- Discrepancies in metal soil water partition coefficients applied in DQRA modelling and recorded pH conditions in soil and groundwater.

2 ENVIRONMENTAL SETTING

2.1 GEOGRAPHY

After Waterman (2008)

Burry Port lies in the Gwendraeth valley, with Pembrey Burrows, a large area of burrow and marshland is to the West of the town and to the north of the town is the hill Pembrey Mountain.

The high-water mark of the Loughor Estuary lies approximately 100m south of the Site, and the Outer Harbour is located approximately 40m from the most southwestern corner of the Site. The Loughor Estuary is classified as a "Shellfish Water" under the Surface Waters (Shellfish) (Classification) Regulations 1997. In addition, the cockle beds of Penclawdd lie across the estuary on the north coast of the Gower Peninsula the cockles from which are widely consumed by humans.

Burry Port is currently home to a harbour and in the past, was an export base for the coal mining industry in the Gwendraeth valley. Since the closure of coal mines, the towns economy relied on the power station (which closed in the 1980"s) and "metal bashing" engineering. However, this industry has been relocating and declining in the area recently but is likely to have left significant amounts of contamination within the local groundwater and soils.

The Burry Port Harbour is now part of a redevelopment framework area to the south of the town centre of Burry Port. The newly constructed link road (A484) and harbour serving as a marina for small leisure craft are a first stage of the framework and a planned 11Ha of commercial, residential, amenity and recreation development will take place in the future as published on CW Architects Masterplan.

2.2 GEOLOGY

The geology of the site is shown on BGS Sheet 246 Worms Head 1:50 000 (Solid and Drift Edition). This indicates that the sequence of materials below the Made Ground is Drift Deposits over Carboniferous bedrock; Brithdir Member Sandstone over Upper Coal Measures (including Pennant Measures). Drift Deposits are confirmed to comprise Blown Sands, Alluvium Deposits, and Glacial Sand & Gravels.

2.3 HYDROGEOLOGY

In summary, three groundwater bearing units have been identified beneath the site (**TABLE 2-1**). The two shallow water bodies within Drift Deposits (Blown Sands and Glacial Sand & Gravels) are separated by fine grained (silt and clay-rich) Alluvium Deposits. The Alluvium Deposits are unproductive, several meters thick and act as confining unit to groundwater within the Glacial Sand & Gravels layer. Deeper groundwater is situated within siltstones and sandstones of the Upper Coal Measures.

TABLE 2-1 – AQUIFER CLASSIFICATION

STRATA	DESCRIPTION	AQUIFER CLASSIFICATION
Drift Deposits		
Blown Sands	silty sand	Secondary (A) Aquifer
Glacial Sand and Gravels	glacial sands, gravels and clay	Secondary (A) Aquifer

STRATA	DESCRIPTION	AQUIFER CLASSIFICATION
Bedrock		
Upper Coal Measures	weathered siltstone (encountered in off-site borehole locations).	Secondary (A) Aquifer

There are no current licensed groundwater abstractions within a 1.5 km radius of the site. There are no Source Protection Zones within 500 m of the site.

2.4 HYDROLOGY

The site drainage comprises a combination of surface water drains which discharge into 8 soakaways located around the site and a storm water system which discharges into a storm water pit located in the north-western corner of the site.

The surface water hydrology around the site is dominated by the site's proximity to the sea in Burry Port located around 100 m to the south-west of the site boundary. Hydrology characteristics are summarised below (**TABLE 2-2**).

TABLE 2-2 – HYDROLOGY CHARACTERISTICS

CHARACTERISTIC	OBSERVATIONS
Surface Water Features	The nearest surface water features are Burry Harbour directly adjacent to the site (c.20 m to the west) and the Loughor Estuary (c.100 m to the south).
Surface Water Abstractions	There are no surface water abstraction licences within 1 km of the site.

Flood risk assessment is outside the scope of this report; however, it is understood that as part of the proposed development it is anticipated that site levels are to be raised by a minimum of 500 mm to mitigate against the risk of flooding.

2.5 DESIGNATED ENVIRONMENTALLY SENSITIVE SITES

The site is within 1 km of six Sites of Special Scientific Interest (SSSI) which are all related to the Burry Inlet and Loughor Estuary; the nearest is located around 100 m to the south of the site. There are also three Ramsar sites within 1 km of the study site; these are sites within the Burry Inlet. There are four Special Areas of Conservation within 1 km of the site, three of which relate to the Carmarthen Bay and Estuaries (nearest is 115 m to the south of the site) and the other to Carmarthen Bay Dunes. Three Special Protection Areas are located within 1 km of the site, all of which are areas of the Burry Inlet, with the nearest located 115 m to the south of the site.

3 CONCEPTUAL SITE MODEL

WSP conducted additional field works to collect groundwater quality data that represents the most recent shallow groundwater condition, as pollutant concentrations are likely to change with time due to changing environmental conditions and source term depletion. The field works included:

- One additional round of groundwater quality monitoring and sampling in May 2019 to complement the ESG groundwater quality dataset from 2017, and included well development prior to this;
- Additional hydraulic conductivity field testing within the Blown Sands was completed to support the hydrogeological site model and justify any amendments to the hydrogeological input parameters utilised by Waterman Civils (2008).

WSP 2019 field data is presented within **APPENDIX C**, and analytical data within **APPENDIX E**. The soil and groundwater quality data (2004 to 2019 data set) are screened against generic risk assessment criteria (**APPENDIX G2**).

3.1 GROUND CONDITIONS

Ground conditions identified through multiple phases of site investigation works over the last 15 years are summarised below:

- Reinforced concrete, hardstanding, tarmacadam and buried structures.
- Made Ground, present to depths of between 0.1 and 3.4m, is generally thicker in the central area of the Site. The stratum comprises black, silty, slightly sandy, fine to coarse, angular, ash-based gravel, with many angular cobbles of brick and concrete and varying amounts of slag and coal. A series of culverts/conduits and foundation bases have been identified across the Site with the base of the structures up to 3m below ground level (bgl).
- Blown Sands, present to a depth of up to 8.2m bgl, comprising brown/yellow sand, locally with some rounded, medium to coarse gravel, occasional rounded cobbles and fragments of shell. Average thickness c.5 m.
- Estuarine Alluvium Deposits, present to a depth of 14.7m bgl, comprising initially silty sand with some gravel in places followed by a very soft or soft, wet, grey clay. Average thickness c.5m.
- Glacial Sand and Gravels, base depth not proven <16.45m bgl, comprising grey brown, slightly silty, very sandy, sub-rounded to rounded, sandstone gravel with cobbles. Generally, c.2 to 3 m thickness.

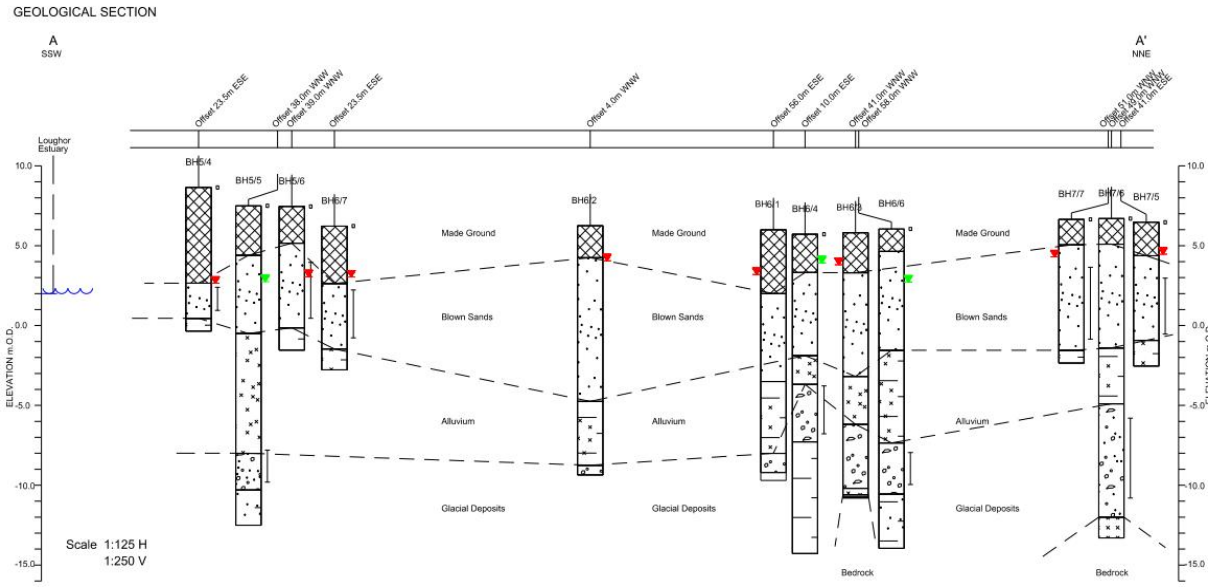
The geological cross section below visualises the geological profile of the Drift Deposits just to the East of the Grillo site (**GRAPH 1**).

3.2 HYDROGEOLOGY

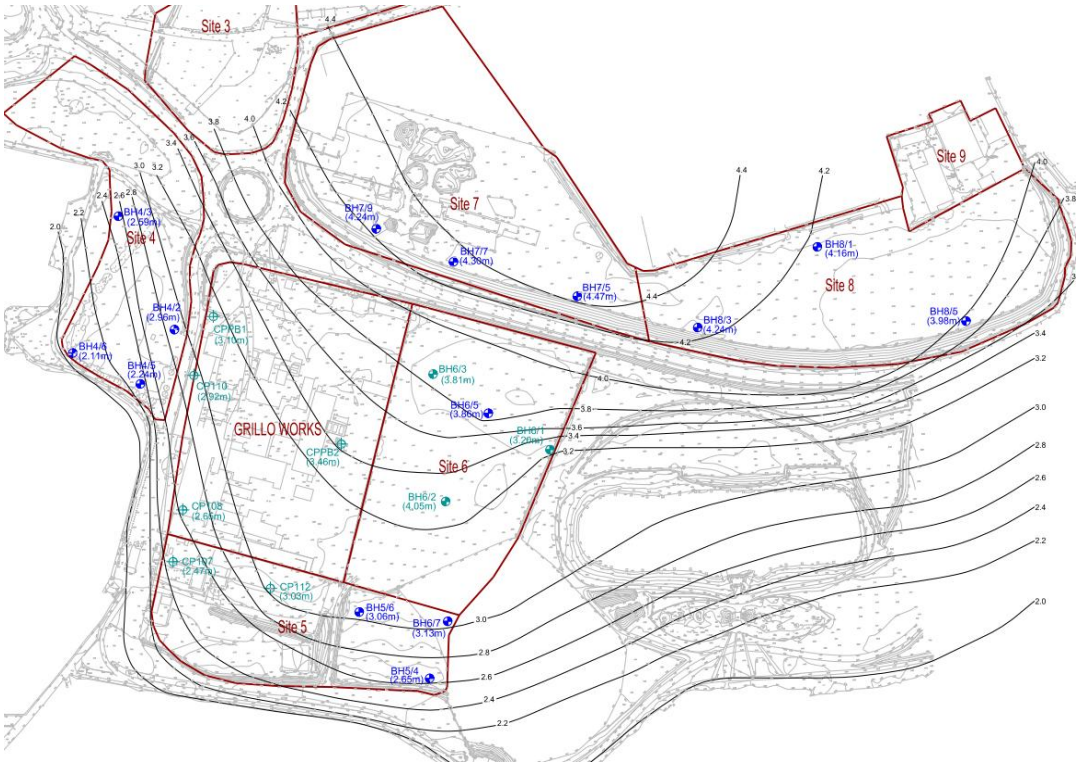
(After Waterman, 2008 and after ESG, 2011)

Groundwater seepages were observed during previous site investigations from approximately 4mbgl in the Blown Sands. Water strikes ranged between 5.1m and 7m in the Blown Sands and 14.6m and 15.6m in the Glacial Sand and Gravel. These are both shallow groundwater bodies with deeper groundwater expected within the Upper Coal Measures. Both water bodies are sub artesian with a medium rate of inflow in the Blown Sands with the water level rising an average of 1.5m 20 minutes after water strike. A fast rate of inflow was recorded with the Glacial Sand and Gravels with the water level rising an average of 8.3m 20 minutes after water strike (Waterman, 2008).

Groundwater flows within the Blown Sands to the southwest towards the Burry Port with a hydraulic gradient of around 0.007 (**GRAPH 2**). Groundwater levels monitored over a tidal cycle, indicate low tidal influence. This may be due to either limited hydraulic connectivity between the groundwater and water levels within the Burry Port, or due to the dampening of tidal variation within the harbour because of recent construction of an impoundment wall and tidal flap gate such that the water levels within the harbour are subject to limited range water level fluctuation.



GRAPH 1: GEOLOGICAL CROSS SECTION THROUGH THE DRIFT DEPOSITS AT BURRY PORT.



GRAPH 2: GROUNDWATER LEVELS IN THE BLOWN SANDS (ESG, 2011).

3.3 CONTAMINATION

Elevated heavy metal (arsenic, cadmium, copper, lead, nickel, selenium, and zinc), PAH and TPH concentrations in soil, soil leachate and groundwater have been historically recorded widespread across the Site. These Potential Contaminants of Concern (PCoC) might pose an unacceptable risk to Human Health, Controlled Waters and Ecological (Loughor Estuary and associated shell fisheries) receptors.

The contaminated groundwater and soils currently pose a potential risk to the underlying Secondary A aquifer (Blown Sands) and nearby surface watercourses (Burry Harbour and Loughor Estuary). Previous DQRA (Waterman, 2008 and ESG 2011, 2016a, 2017) concluded that the actual risk to the Loughor Estuary is low and that whilst some form of remediation to reduce future soil leaching is likely to be beneficial and achievable, groundwater remediation was not proposed as this was considered not to be cost effective.

SOIL QUALITY RESULTS (2004 TO 2017)

Elevated metal soil concentrations are generally associated with shallow soils (Made Ground) (**TABLE 3-1**). Soil samples retrieved from the Blown Sands deposits recorded generally lower metal concentrations (ESG, 2017). Maximum soil concentrations deviate by a factor less than four when comparing the 2004 and 2017 soil data, except for mercury which deviate by a factor of 6.3.

TABLE 3-1 – COMPARISON OF MAXIMUM MEASURED SOIL CONCENTRATIONS

Determinand	PB 2004^ [mg/kg]	ESG, 2017^^ [mg/kg]
Arsenic	2,117.3 (TP12 - 0.7m)	541.1 (WS1 - 0.3m)
Boron	0.7 (TP06G – 0.3m)	2.8 (WS1 – 0.3m)
Cadmium	183.3 (TP26 – 0.3)	92.8 (WS3 - 1.0m)
Chromium (total)	51 (TPA – 0.5m)	43 (WS3 – 0.3m)
Chromium (III)	-	43 (WS3 – 0.3m)
Chromium (VI)	-	<0.1
Copper	9,520 (TP30 – 0.45)	7,890 (WS1 – 0.5m)
Lead	10,900 (TP33 – 0.4)	3,670 (WS3 – 0.3m)
Mercury	9.4 (TP09A – 0.3m)	1.48 (WS4 – 0.5m)
Nickel	1,107 (TPA – 0.5m)	452.5 (WS3 – 0.3m)
Selenium	7.5 (TP06G – 0.3m)	6.2 (WS3 – 0.3m)
Zinc	192,000 (TP05 – 0.55m)	202,000 (WS3 – 0.3m)
Benzo(a)pyrene	292.2 (TP03 – 0.3m)	5.3 (WS1 – 0.5m)

^ based on 33 soil samples analysed for metal concentrations (PB, 2004)
^^ based on 15 soil samples analysed for metal concentrations (ESG, 2017)

Elevated petroleum hydrocarbons (heavy end TPH fractions) in soils are thought to be associated with the former gas tanks located near the site centre. Black heavy oils were observed within trial pits at TP6D (TPH 40,821mg/kg), TP14 (TPH 39,818 mg/kg) and TP22 (TPH 30,902 mg/kg) (PB, 2004).

Elevated Total PAH concentrations in soils were recorded at several locations TP27 (160.9 mg/kg), TP09A (248 mg/kg), TP02 (212.9 mg/kg), and TP03 (4,013.6 mg/kg); however, are unrelated to the black heavy oils (Total PAH concentrations recorded < LOD).

Volatile organic hydrocarbons (VOC), including benzene, ethylbenzene, toluene, xylene, and phenol, were not recorded above the limit of detection (LOD).

Asbestos was recorded in one sample (WS3 ES1) as chrysotile fibres (<0.001%) (ESG, 2017).

SOIL LEACHATE (2005 TO 2017)

Heavy metal and metalloid soil leachate concentrations from shallow soils (Made Ground) exceeded the relevant environmental quality standard (EQS, transitional, coastal) for arsenic, cadmium, chromium (VI), copper, mercury, lead and zinc (ESG, 2017) (**TABLE 3-2**). Arsenic being recorded at EQS with 25 mg/L. Comparison of soil leachate results from previous site investigations indicate that nickel leachate concentrations dropped by one order of magnitude. The average (and maximum) nickel soil leachate concentration is with 2.67 mg/L (and 6 mg/L) below the relevant EQS (8.6 mg/L).

TABLE 3-2 - COMPARISON OF SOIL LEACHATE RESULTS FROM PREVIOUS SITE INVESTIGATIONS

(taken from ESG, 2017)

Contaminant	Churngold 2005 Soil Leachate Concentrations (mg/l)		GIL 2007 Soil Leachate Concentrations (mg/l)		ESG 2017 Soil Leachate Concentrations (mg/l)	
	Range	Average	Range	Average	Range	Average
Arsenic	0.01-0.23	0.037	0.001 – 0.22	0.032	0.002 – 0.025	0.0117
Cadmium	0.0005 - 0.00072	0.000538	0.0002 - 0.009	0.0015	0.0001 - 0.0023	0.00077
Chromium	0.01	0.01	0.001 – 0.01	0.0014	0.009	0.009
Lead	0.05 – 0.1	0.057	0.001 – 0.16	0.0079	0.001 - 0.006	0.0026
Mercury	0.0002	0.0002	0.0002 - 0.003	0.00108	0.0007	0.0007
Nickel	0.02 – 0.096	0.026	0.001 – 0.007	0.00135	0.001 – 0.006	0.00267
Selenium	0.002 -0.0038	0.00216	0.001 – 0.006	0.0014	0.002 -0.01	0.00429
Copper	0.01 – 0.47	0.0713	0.001 – 0.23	0.015	0.007 -0.035	0.0131
Boron	0.05	0.05	Not tested	Not tested	0.05 -0.13	0.09
Zinc	0.01 - 0.68	0.2	0.002 – 0.78	0.075	0.008 - 0.29	0.120

GROUNDWATER QUALITY RESULTS (2004 TO 2019)

Analytical groundwater results indicate that groundwater quality within the Blown Sands has improved over recent years, with selected heavy metal and metalloid dissolved-phase concentrations declined in 2017 and 2019. Cadmium, copper, lead, mercury, and nickel dissolved-phase concentrations have decreased to below the coastal EQS within shallow groundwater, as confirmed in the most recent groundwater monitoring round (May 2019).

Exceedances remain for arsenic, chromium (VI), zinc and the organic compounds benzo(a)pyrene and fluoranthene. Benzo(a)pyrene and fluoranthene are recorded at low concentrations at two well

locations at the north-eastern and south-western site boundary (BH2 and CP108). Both exceedances are minor.

TABLE 3-3 – COMPARISON OF MAXIMUM GROUNDWATER CONCENTRATIONS FROM PREVIOUS SITE INVESTIGATIONS

DETERMINAND	PB 2004[1] [mg/L]	WATERMAN 2007 & 2008[2] [mg/L]	ESG 2017[3] [mg/L]	WSP 2019[4] [mg/L]	EQS (COASTAL WATERS) [mg/L]
Arsenic (diss.)	**795**	**930**	**304**	**601**	25
Boron (diss.)	284	930	320	354	7,000
Cadmium (diss.)	**6**	**37**	**0.3**	0.103	0.2
Chromium (total)	<20	21	-	15.2	-
Chromium (III)	-	-	-	-	-
Chromium (VI)	-	-	**5**	**10.2**	0.6 (Cr VI)
Copper (diss.)	**114**	**348**	**9**	2.21	3.76
Lead (diss.)	**<20**	**58**	<1	0.92	1.3
Mercury (diss.)	<0.01	**0.1**	**0.1**	<0.01	0.07
Nickel (diss.)	**1,393**	**293**	4	1.32	8.6
Selenium^ (diss.)	20	24	33	25.4	see footnote
Zinc (diss.)	**554**	**1,893**	**209**	**80.8**	6.8
Benzo(a)pyrene	**<0.1**	-	**0.147**	**0.0071**	0.00017
Fluoranthene	**<0.1**	-	**0.304**	**0.0159**	0.0063

(1) 12 GW quality samples from Blown Sands (PB, 2004)
(2) 12 GW quality samples in 2008 (Blown Sands and Glacial Sand and Gravels) and 8 GW quality samples in 2007 (Blown Sands) (Waterman, 2008)
(3) 19 GW quality samples (10 wells samples on 08/06 and 9 wells re-sampled on 19/06) (ESG, 2017)
(4) 10 GW quality samples (WSP, 2019)
^ no surface water quality standard; as reference, UK Drinking Water Standards (DWS) for selenium is 10 mg/L

The WSP 2019 groundwater samples taken from the Glacial Sand and Gravels (CP102 and CP105) detected no TPH and PAH concentrations (<LOD) and low concentrations of arsenic, chromium (total), selenium and zinc. Zinc concentrations were recorded with 12.1 and 16.1 mg/L, above the relevant EQS.

GROUNDWATER PH CONDITIONS

Groundwater beneath site is slightly alkaline, with a pH ranging between 7.4 and 7.8 (geomean 7.5). The surface water sample from Burry Port (inner harbour) recorded pH 7.9. Under these slightly alkaline conditions, the soil water partition coefficient for selected heavy metals and metalloids favours partitioning into the soil phase rather than dissolution into the water phase.

The soil water partition coefficient for copper and lead is not a function of pH conditions.

SURFACE WATER QUALITY RESULTS (2019)

The surface water sample taken from Burry Port (inner harbour) recorded no exceedances for metals and metalloids compared to coastal EQS. Arsenic, nickel and zinc were detected above the LOD; however, below the relevant EQS.

3.4 POTENTIAL SOURCE PATHWAY RECEPTOR LINKAGES

POTENTIAL SOURCES

PAH and toxic and phytotoxic metal substances were identified in soils across the Site. Elevated metal and metalloid concentrations are dominantly recorded in shallow soil samples (Made Ground).

Petroleum hydrocarbons were identified within the soils on the site during the Parsons Brinckerhoff and Ground Investigation Limited ground investigations. This contamination is considered to have resulted from leakage of the gas-oil tanks in the north and centre of Site.

PCB contamination may be present from the former electrical substation located in the centre of the Site. However, no evidence of contamination associated with the former electricity substation was found.

The dissolved-phase heavy metal and metalloid groundwater plume beneath the Site within the Blown Sands aquifer act as secondary source with the potential to impact off-site controlled water receptors. Elevated dissolved-phase PAH concentrations are considered to present very localised hotspots in groundwater, and no widespread petroleum hydrocarbon plume.

POTENTIAL OFF-SITE SOURCES

The surrounding area has a long standing industrial history, and the following potential off-site sources have been identified. The land immediately to the East has a history as landfill, coal fired power station and was utilised by the former copper works, and to the North of the Site were the former lead and silver works. About 160 m further to the North a former iron foundry was located.

PATHWAYS

- The potential pathways with respect to controlled waters include lateral and vertical downward migration via the unsaturated and saturated zones within both Made Ground and Blown Sands.

Additional preferential pathways might be associated with:

- The coal shaft to the southeast of the Site,
- Buried culverts and soakaways beneath the Site, and
- The former open well in the east of the Site.

Vertical migration through the Alluvium Deposits is highly unlikely due to its cohesive nature and thickness. However, preferential pathways (i.e. deep buried structures) might connect the Blown Sands and the deeper Glacial Sand & Gravels aquifer which are directly underlain by the Upper Coal Measures.

RECEPTORS

- Blown Sands (Secondary A Aquifer)
- Ecology/Marine Life in the Loughor Estuary (including shellfish and cockle beds)
- Upper Coal Measures (Secondary A Aquifer)

3.5 PRELIMINARY RISK ASSESSMENT

Pollutants consistent with the historical industrial operations on-site (heavy oils, PAH, metals and metalloid), identified in soils (Made Ground and Blown Sands) and shallow groundwater, pose a potential risk to the groundwater aquifer (Secondary A Aquifer) and the Loughor Estuary (including shell fish and cockle beds) to the southwest of the Site.

TABLE 3-4 summarises plausible Controlled Waters source pathway receptor linkages and provides a qualitative risk level based on severity and probability (UK CIRIA 552). Plausible pollutant linkages with risk levels low / moderate or higher are taken forward into the detailed quantitative risk assessment.

TABLE 3-4 – RISK MATRIX BASED ON PLAUSIBLE SOURCE PATHWAY RECEPTOR LINKAGES

Source	Pathway	Receptor	Risk Level (CIRIA 552[1])	Comment
Soils and Groundwater (Made Ground and Blown Sands) containing heavy metals, PAH compounds, and heavy oils (localised)	Leachate from soils (Made Ground) followed by vertical migration to shallow groundwater	Shallow groundwater beneath the site (Blown Sands, Secondary A Aquifer)	Moderate / Low risk	***(Severity-Minor, Probability – High Likelihood).*** Impacted soil and shallow groundwater identified across the site. Confirmed impact within Blown Sands (contaminant linkage complete). Receptor has no known water resource potential (reducing potential severity).
	Vertical migration to shallow groundwater followed by lateral migration and discharge to surface watercourse	Sea (Loughor Estuary)	Moderate / Low risk	***(Severity-Medium, Probability – Low Likelihood).*** Impacted shallow groundwater identified across the site and close to downgradient site boundary. Probability of harm associated with elevated metal and PAH concentrations from the site is considered to be low based on the pollutant attenuation potential prior to reaching surface waters (high soil water partition coefficient) as well as the large Loughor Estuary catchment area.
	Vertical migration and recharge into bedrock aquifer	Deep groundwater beneath the site (Upper Coal Measures, Secondary A Aquifer)	Low risk	***(Severity-Mild, Probability –Low Likelihood).*** No confirmed impact to deep groundwater within Upper Coal Measures. The aquifer is not known to be utilised as portable water resource. Based on the naturally poor water quality of groundwater within the Upper Coal Measures with elevated heavy metal background concentrations (reducing potential severity) the overall risk is low.

(1) D J Rudland, R M Lancefield, and P N Mayell, 2011, Contaminated Land Risk Assessment. A guide to good practice (CIRIA 552).

4 DETAILED QUANTITATIVE RISK ASSESSMENT

The quantitative risk assessment was undertaken in accordance with UK Government guidance issued by the Environmental Agency in connection with Part IIA of the Environmental Protection Act 1990. Risk is quantified using the source-pathway-receptor approach.

In the Generic Quantitative Risk Assessment (GQRA), observed site specific soil and groundwater quality data are screened against GAC. Where a concentration exceeds the GAC, the pollutant is confirmed as a Contaminant of Concern (CoC) and is taken forward into a subsequent DQRA.Heavy end total petroleum hydrocarbons (TPH) were encountered in localised areas within soils during 2004 ground investigation towards the central and northern areas most likely associated with former fuel tank locations. In the groundwater sampling round in May 2019, TPH was present above the laboratory limit of detection (LOD) in a single location (BH3) out of 10 monitoring locations with a concentration of 46µg/l, therefore have not been included within the Controlled Waters DQRA.

The Controlled Waters DQRA derives Site Specific Assessment Criteria (SSAC) for comparison and is based on the Remedial Targets Methodology and Remedial Targets Worksheet v3.2 (EA publication, 2006). The assessment takes into account the geological, hydrogeological, environmental and chemical site conditions. Where available, site-specific fate and transport properties, aquifer properties and contaminant degradation rates are selected.

The purpose of the controlled waters risk assessment is to assess what level of pollutant impact could safely be left in-situ without detriment to a defined sensitive receptor and hence is used to derive clean up levels during the remediation phase or to demonstrate that a certain level of contamination is of no cause of concern.

The assessment has focussed on determining risks from metals and hydrocarbons within site soils and groundwater to the aquifer and to the Estuary (the closest sensitive receptor). The seawater is designated as Shellfish Water (SFW) under the Surface Waters (Shellfish)(Classification) Regulations 1997: Classification of Waters in Wales. Detailed description and supporting information for the controlled waters DQRA is presented in **Appendix G**.

4.1 CONTAMINANTS OF CONCERN

The WSP 2019 groundwater quality data were screened against Coastal Environmental Quality Standards (EQS), also known as Generic Assessment Criteria (GAC). A small number of Contaminants of Concern (CoC) within the Blown Sands aquifer were identified (**TABLE 4-1**).

TABLE 4-1 – GROUNDWATER GENERIC ASSESSMENT CRITERIA SCREENING (2019)

CoC	GAC [mg/L]	Range [mg/L]	Average [mg/L]	No. of Exceedances and Location
Arsenic	25	1.04 to 601	172.8	4 (BH4, BH5, BH6, CP108)
Chromium (VI)	0.6	<3 to 10.2	5.9	10 (all locations) (1)
Zinc	6.8	1.6 to 80.8	27.4	7 (BH2, BH3, BH4, BH6, CP102, CP105, CPPB7)
Benzo(a)pyrene	0.00017	<0.002 to 0.0071	0.0028	10 (all locations) (1)
Fluoranthene	0.0063	<0.005 to 0.159	0.0064	2 (BH2, CP108)

(1) Note that the laboratory limit of detection (LOD) is higher than the relevant GAC.

4.2 LEVEL 3 DETAILED QUANTITATIVE RISK ASSESSMENT

Level 3 SSAC are derived for groundwater using the UK Environment Agency's Remedial Targets Worksheet (v3.2). This allows the quantitative assessment of risks to Controlled Waters from the identified CoC. ConSim was utilised to assess the risks associated with the shallow polluted soils (Made Ground). Preliminary soil Remedial Target Values (RTV) are derived from the ConSim Level 2 soil assessment. A detailed description and supporting information for the water environment assessment is presented in **Appendix G**.

The Level 3 assessment requires the definition of site-specific parameters to determine the potential impact of identified source material at an off-site "compliance point" selected to be protective of the identified water environment receptors.

Each parameter input is determined on the basis of the conditions specific to the site. However, where such information is unavailable, conservative input values are selected. Selection of appropriate values for specific inputs is occasionally derived on the basis of sensitivity testing. However, in all cases the parameter input values are considered suitably site-specific and/or conservative to provide a reasonably conservative risk assessment.

Input parameters, range of values and data references are defined in **Appendix G3 and G4**. Contaminant properties are summarised in Table G.2, whereas site-specific environmental input parameters are presented in Table G.3. The following key input parameters are discussed further:

- Hydraulic conductivity;
- Hydraulic gradient;
- Compliance point;
- Contaminant source;
- Contaminant travel times; and
- Degradation rates.

HYDRAULIC CONDUCTIVITY

Hydraulic conductivity (K) of the Blown Sands has been evaluated through in-situ permeability tests (slug tests) on-site and off-site during multiple phases of site assessments. Hydraulic conductivity ranges between 0.01 and 22.81 m/d with a geometric mean of 0.84 m/d (26 test locations) (**Appendix D**). The range of values is consistent with published hydraulic conductivity for fine to coarse sands (Domenico and Schwartz, 1990).

HYDRAULIC GRADIENT

Groundwater flow configurations indicate a flow direction to the South-west and South with a gradient of around 0.007.

COMPLIANCE POINT

No groundwater abstractions have been confirmed within the direct vicinity of the site. The compliance point adopted in the model is set 50 m hydraulic down gradient from the southern site boundary; between site boundary and the Sea (mean high water level).

CONTAMINANT SOURCE

The shallow subsurface is characterised through a large number of soil samples taken from Made Ground, and groundwater monitoring wells installed into the Blown Sands and Glacial Sand & Gravels.

Groundwater source concentrations are assumed to be in equilibrium with the soil impact, and therefore the most recent groundwater quality data (May 2019) are taken to represent the source concentrations for the CW DQRA. Source concentrations utilised within the Level 3 assessment are summaries in **TABLE 4-2**.

No elevated heavy metal and PAH compound concentrations (above Costal EQS) were detected in groundwater samples taken from the Glacial Sand & Gravels (two water samples taken in 2019) with the exception of low levels of zinc.

TABLE 4-2 – SOURCE CONCENTRATIONS

DETERMINAND	SOIL (AVERAGE) [MG/KG]	GROUNDWATER (AVERAGE) [MG/L]
Arsenic	373.2	0.1728
Chromium (VI)	<2.0 (<LOD)	0.0059
Zinc	41,733.7	0.0274
Benzo(a)pyrene	4.3	0.0000028
Fluoranthene	10.1	0.0000064

The length and width of the groundwater plume (source area beneath site) in the direction of the groundwater flow are estimated through site dimensions with 130m and 200m, respectively. Source concentrations are based on average dissolved-phase concentrations from the most recent groundwater samples (Blown Sands).

RETARDATION AND CONTAMINANT TRAVEL TIMES

In accordance with best practice guidance (UK EA Remedial Targets Methodology), it is considered acceptable for no action to be taken in the case of low flow groundwater systems and/or contaminants which are characterised by a high partition coefficient (e.g. PAH compounds and heavy metals), where the resulting travel-time to the receptor exceeds 1,000 years.

CoC identified as having travel times to the receptor in excess of 1,000 years are deemed as having negligible risk to the identified receptor. Evaluation of travel times between source and receptor are included within the assessment.

BIODEGRADATION

Consistent with UK EA guidance it is acceptable to use published half-life times if groundwater conditions are likely to be receptive to degradation and where site-specific degradation rates could not be derived.

A conservative approach has been taken with no degradation applied in the fate and transport model to heavy metal, metalloids and PAH compounds.

4.3 LEVEL 3 GROUNDWATER RESULTS

Groundwater Level 3 SSAC, protective of controlled waters receptors beyond 50 m from the hydraulic down gradient site boundary, were derived through fate and transport simulations (see **Appendix G4** for the P20 model outputs).

Heavy metals, metalloids, benzo(a)pyrene and fluoranthene groundwater concentrations exceed the L3 screening criteria. However, exceedances are deemed to represent a negligible risk due to travel

times in excess of 1,000 years (with the exception of Chromium VI**)**. Notwithstanding this, the environmental risk is considered relatively low due to the following conservative model assumptions:

- Continuous contamination source;
- Maximum (indefinite) half-live times; and
- POC is set at mid-point between southern site boundary and the estuary.

4.4 MODEL UNCERTAINTIES

Model uncertainties are around source longevity, aquifer properties and natural attenuation along the simulated fluid flow pathway, which influence the spatial extension of the pollutant plume and associated potential environmental risks.

Another key uncertainty is source contribution from natural soil background concentrations, and potentially hydraulic up and cross gradient sources (industrial heritage waste products).

Whilst model uncertainties are highlighted in this section, the developed base case risk model with output presented in **TABLE 4-3** is considered to be suitably representative.

TABLE 4-3 - GROUNDWATER LEVEL 3 SSAC FOR MODEL SETUP WITH POC AT 50M

DETERMINAND	GROUNDWATER			TRAVEL TIME TO RECEPTOR [YEARS]
	AVERAGE 2019 [MG/L]	LEVEL 3 SSAC [MG/L]	NO. AND LOCATION OF EXCEEDANCES	
Arsenic	0.1728	3.44E-02	NA	1,270
Chromium (VI)	0.0059	8.26E-04#	All samples	677
Zinc	0.0274	9.36E-03	NA	3,820
Benzo(a)pyrene	0.0000028	2.34E-07	NA	9,890
Fluoranthene	0.0000064	8.67E-06	NA	2,100

 # Water concentration below laboratory detection limit. LOD for Chromium (VI) <3 ng/L, and benzo(a)pyrene <0.002 ng/L.
Cells shaded red indicate that the average concentration exceeds the calculated SSAC and travel times do not exceed 1,000 years.
Cells shaded grey indicate that travel times are >1,000 years and risk is deemed negligible.

4.5 MODEL SENSITIVITY

Fate and transport simulations through the Blown Sands aquifer are sensitive to the aquifer properties; in particular hydraulic conductivity. Selecting a hydraulic conductivity at the upper end of the observed range would results in exceedances for all metals and metalloids.

5 PRELIMINARY SOIL REMEDIAL TARGETS

Historical industrial operations have resulted in heavy metal and metalloid impacted shallow soils. The heaviest soil impact is recorded between 0.3 and 1.0 m bgl (Made Ground). The soil concentrations of selected metals are visualised in a series of spatial distribution graphs (**Appendix F**). Although, the most recent groundwater quality data indicate that dissolved-phase concentrations (metals, metalloids, and PAHs) have significantly decreased over the last 15 years; the soil leaching potential remains high and depends on infiltration rates and contact time with water. Future demolition works will break hardstanding and the proposed new development with landscaped areas are likely to raise leachate levels. Future changes in environmental conditions with higher seasonal water levels have the potential to enhance leachability as well.

Laboratory derived heavy metal and metalloid soil leachate concentrations from shallow soil samples (Made Ground) exceeded the relevant environmental quality standards (EQS, coastal) for arsenic, cadmium, chromium (VI), copper, mercury, lead and zinc (ESG, 2017).

5.1 SOIL DETAILED QUANTITATIVE RISK ASSESSMENT

Preliminary remedial targets for heavy metals and metalloids are derived using ConSim (Golder Associates, version 2.5), in accordance with the UK Environment Agency methodology (Remedial Targets Methodology, 2006), to support the protection of controlled water receptors under future environmental and development conditions.

ConSim was selected as a suitable soil assessment tool as it can simulate vertical pollutant fate and transport through the unsaturated zone; as well as the model allowed a range of input values (in the form of probability functions) for influential parameters using Monte-Carlo analysis so that natural variations in inputs can be modelled to produce 90th percentile confident limits.

The software utilises probabilistic calculations and iterations, therefore allowing for the adoption of a distribution of input values for model parameters. The results are probabilistic in that they assess a range of permutations which more likely reflect the inherent uncertainty associated with a number of the numerical model input parameter values.

5.2 MODEL SETUP

A Level 2 (ConSim terminology) model was constructed to calculate probabilistic groundwater concentrations derived from shallow soil sources at (i) base of unsaturated zone and (ii) the diluted concentrations within the aquifer beneath site. Two model scenarios are evaluated:

Model A (base case) represents the case during demolition and redevelopment with broken hard surface, high rainwater infiltrations rate (50%), and elevated vertical hydraulic conductivity through the unsaturated zone. The model setup results in enhanced pollutant leachability.

Model B (PRTV) represents the case following remediation measure implementation with reduced soil source concentration (90% reduction through source removal, source stabilisation etc.), reduced rainwater infiltration (5%), and reduced vertical hydraulic conductivity in the unsaturated zone (i.e. preferential pathways like drains, culverts, etc. are removed or blocked). The model setup results in reduced pollutant leachability.

5.3 MODEL SETTINGS

The model has been run with 1001 iterations and the following time slices: 10; 20; 30; 40; 50; 100; and 1,000 years. Metals with high attenuation capacity do not reach steady state conditions after 1,000 years; however, environmental risks are considered low where contaminant breakthrough occurs after 1,000 years.

Model A soil source concentrations are entered as triangular (min, likely, max) probability density function (PDF) based on the observed Grillo soil data set (**TABLE 5-1**).

TABLE 5-1 – SOIL SOURCE CONCENTRATIONS

DETERMINAND	MODEL A SOIL (TRIANGULAR PDF) [MG/KG]	MODEL B SOIL (SINGLE VALUE) [MG/KG]
Arsenic	(4, 373.2, 2261)	37.3
Cadmium	(0.1, 19.9, 183.3)	1.985
Chromium (VI)	(2, 2, 2)	1
Copper	(0.5, 3523.24, 15400)	352.3
Mercury	(0.1, 1.08, 13.19)	0.1
Lead	(1.6, 3247.45, 65560)	324.7
Zinc	(0.5, 41733.7, 202000)	4173.3

ConSim model setup, input parameters and model output are summarised in **Appendix G5**.

5.4 MODEL RESULTS

The results are presented within the context of probability (likelihood). With the given probability (90th confident limit) the plume concentration reaching the receptor at (i) base of unsaturated zone and (ii) diluted aquifer concentration (at time set 100 and 1,000 years) is less than the simulated concentrations provided in **TABLE 5-2** and **TABLE 5-3**. Not exceeding the simulated plume travel times are reported with the 5th percentile confident limit. ConSim model outputs are appended (**Appendix G5**).

TABLE 5-2 – MODEL A PROBABILISTIC PLUME CONCENTRATIONS AT THE BASE OF THE UNSATURATED ZONE AND THE DILUTED AQUIFER

Compound	EQS (coastal) [mg/L]	90th Percentile base of unsat. zone Conc.[mg/L]		90th Percentile diluted aquifer Conc. [mg/L]		5th Percentile Travel Time to base of unsat. zone [years]
		100 yrs	1000 yrs	100 yr	1000 yrs	
Arsenic	0.025	6.505	52.924	3.343	35.461	83.1
Cadmium	0.0002	0	1.306	0	6.858	255.3
Chromium (VI)	0.0006	0.0018	0.125	0.079	0.109	44.3
Copper	0.00376	0	280.71	0	183.93	110.3
Lead	0.0013	123.031	125.0	99.981	109.478	27.8
Mercury	0.00007	0	0	0	0	2735.7
Zinc	0.0068	0	1549.16	0	1004.3	250.1

With a 90th percentile probability it is predicted that **arsenic, chromium (VI),** and **lead** exceed EQS (Coastal) at the base of the unsaturated zone and within the diluted aquifer (**within 100 years**) under Model A conditions (future enhanced leachability). The retarded travel time for lead is predicted with 27.8 years.

With a 90th percentile probability it is predicted that metal and metalloids **do not** exceed EQS (Coastal) at the base of the unsaturated zone and within the diluted aquifer (**within 100 years**) under Model B conditions (remediation). Lead breakthrough is predicted after 287 years.

TABLE 5-3 - MODEL B PROBABILISTIC PLUME CONCENTRATIONS AT THE BASE OF THE UNSATURATED ZONE AND THE DILUTED AQUIFER

Compound	EQS (coastal) [mg/L]	90th Percentile base of unsat. zone Conc.[mg/L]		90th Percentile diluted aquifer Conc. [mg/L]		5th Percentile Travel Time to base of unsat. zone [years]
		100 yrs	1000 yrs	100 yr	1000 yrs	
Arsenic	0.025	0	0.608	0	0.046	860
Cadmium	0.0002	0	0	0	0	2643
Chromium (VI)	0.0006	0	0.054	0	0.016	458
Copper	0.00376	0	0	0	0	1142
Lead	0.0013	0	31.618	0	11.865	287
Mercury	0.00007	0	0	0	0	28314
Zinc	0.0068	0	0	0	0	2589

5.5 SOIL ASSESSMENT CONCLUSIONS

Shallow soils impacted with metals and metalloids have a high leachability. The probability is high that arsenic and lead continue to leach into groundwater at concentrations above the EQS (Coastal) under elevated water infiltration and raised groundwater conditions.

Soil remediation efforts that reduces the soil source term (90% reduction), limit water infiltration, and/or immobilise the pollutants (in-situ) would significantly limit pollutant mass transfer from the unsaturated to the saturated zone. Proposed soil preliminary remediation target values (PRTV) are summarised below (**TABLE 5-4**).

TABLE 5-4 – PROPOSED PRELIMINARY SOIL REMEDIATION TARGET CONCENTRATIONS

DETERMINAND	PRTVS [MG/KG]
Arsenic	37.3
Cadmium	1.985
Chromium (VI)	1
Copper	352.3
Mercury	0.1
Lead	324.7
Zinc	4173.3

6 SUMMARY AND CONCLUSIONS

Burry Port and the surrounding area have a long standing industrial history of metal works. The Grillo site manufactured zinc oxide under various companies until around 2004 and the former works buildings were demolished in late 2006.

Pollutants consistent with the historic industrial operations (heavy oils, PAH compounds, metals and metalloid) have been identified in soils (Made Ground) and shallow groundwater (Blown Sands) beneath the site. Petroleum hydrocarbon impact is considered to have resulted from leakage of former gas-oil tanks. The dissolved-phase plume within the Blown Sands aquifer (Secondary A Aquifer) act as secondary source with the potential to impact off-site controlled water receptors. The Burry Port (inner Harbour) and Loughor Estuary are the closest off-site receptors. Given the presence of cockle beds, the estuary is the most sensitive receptor. The mean high-water mark is about 100 m south from the site boundary.

Pathways with respect to controlled waters include lateral and vertical downward migration via the unsaturated and saturated zones within both Made Ground and Blown Sands. Preferential pathways (i.e. deep buried structures) might connect the Blown Sands and the deeper Glacial Sand & Gravels aquifer which directly overlay the Upper Coal Measures (both Secondary A Aquifer).

The review of the available historic data and comparison with more recent groundwater quality data indicates that significant pollutant attenuation occurs. The 2019 groundwater quality data indicate improved conditions within the Blown Sands aquifer, with arsenic, chromium (VI), zinc, benzo(a)pyrene and fluoranthene the only analytes recorded above EQS (Coastal). Level 3 DQRA simulations predict that these exceedances present a ***low risk*** to off-site receptors (beyond 50m hydraulic down gradient) due to travel times in excess of 1,000 years. The retarded chromium (VI) travel time to the 50m POC is predicted to be 677 years.

The environmental risk is predicted to be ***high*** during the site development phase (breaking hardstanding) and potential future changes in environmental conditions (for example raised groundwater levels). Preliminary soil remediation target levels have been proposed.

Raising ground levels through the development of the site, with installation of a high percentage of hardstanding, would reduce infiltration of water through contaminated soils. Leachability and mobilisation of metals could further be reduced through soil additives during development (e.g. soil stabilisation), reducing the loading of metals reaching the estuary over time. Active groundwater remediation is not considered to be necessary. WSP concurred with the recommendation that any imported soils should have a pH similar to that on site, of approximately pH 8. The slight alkaline pH reduces the mobilisation of several heavy metals identified as PCoC at site.

Appendix A

LIMITATIONS

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

GENERAL

1. WSP UK Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report.

2. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP UK Limited standard Terms and Conditions as included within our proposal to the Client.

3. Project specific appointment documents may be agreed at our discretion and a charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP UK Limited reserves the right to amend the fee should any changes to the appointment terms create an increase risk to WSP UK Limited.

4. The report needs to be considered in the light of the WSP UK Limited proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report and any previous works referenced within the report.

PHASE 1 GEO ENVIRONMENTAL AND PRELIMINARY RISK ASSESSMENTS

Coverage: *This section covers reports with the following titles or combination of titles: phase 1; desk top study; geo environmental assessment; development appraisal; preliminary environmental risk assessment; constraints report; due diligence report; geotechnical development review; environmental statement; environmental chapter; project scope summary report (PSSR), program environmental impact report (PEIR), geotechnical development risk register; and, baseline environmental assessment.*

5. The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. WSP UK Limited cannot be held responsible for any disclosures that are provided post production of our report and will not automatically update our report.

6. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP UK Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

7. It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the site.

8. WSP UK Limited does not warrant work / data undertaken / provided by others.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

INTRUSIVE INVESTIGATION REPORTS

Coverage: *The following report titles (or combination) may cover this category of work: geo environmental site investigation; geotechnical assessment; GIR (Ground Investigation reports); preliminary environmental and geotechnical risk assessment; and, geotechnical risk register.*

9. The investigation has been undertaken to provide information concerning either:

- **i.** The type and degree of contamination present at the site in order to allow a generic quantitative risk assessment to be undertaken; or
- **ii.** Information on the soil properties present at the site to allow for geotechnical development constraints to be considered.

10. The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

11. For contamination purposes, the objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters.

12. For geotechnical investigations the purpose is to broadly consider potential development constraints associated with the physical property of the soils underlying the site within the context of the proposed future or continued use of the site, as stated within the report.

13. The amount of exploratory work, soil property testing and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions.

14. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

15. The inspection, testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. As part of this assessment, WSP UK Limited has used reasonable skill and care to extrapolate conditions between these points based upon assumptions to develop our interpretation and conclusions. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation. Conditions can change between investigation points and these interpretations should be considered indicative.

16. The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values. Specific assumptions associated

with the WSP UK Limited risk assessment process have been outlined within the body or associated appendix of the report.

17. Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

18. Where soil contamination concentrations recorded as part of this investigation are used for commentary on potential waste classification of soils for disposal purposes, these should be classed as indicative only. Due consideration should be given to the variability of contaminant concentrations taken from targeted samples versus bulk excavated soils and the potential variability of contaminant concentrations between sampling locations. Where major waste disposal operations are considered, targeted waste classification investigations should be designed.

19. The results of the asbestos testing are factually reported and interpretation given as to how this relates to the previous use of the site, the types of ground encountered and site conceptualisation. This does not however constitute a formal asbestos assessment. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and / or trace loose asbestos fibres within the soil matrix at the site.

20. If costs have been included in relation to additional site works, and / or site remediation works these must be considered as indicative only and must be confirmed by a qualified quantity surveyor.

EUROCODE 7: GEOTECHNICAL DESIGN

21. On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.

22. In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. The report is likely to represent a Ground Investigation Report (GIR) under the Eurocode 7 guidance.

DETAILED QUANTITATIVE RISK ASSESSMENTS AND REMEDIAL STRATEGY REPORTS

23. These reports build upon previous report versions and associated notes. The scope of the investigation, further testing and monitoring and associated risk assessments were selected on the basis of the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

24. The outputs of the Detailed Quantitative Risk Assessments are based upon WSP UK Limited manipulation of standard risk assessment models. These are our interpretation of the risk assessment criteria.

25. Prior to adoption on site they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP UK Limited. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

GEOTECHNICAL DESIGN REPORT (GDR)

26. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. All the relevant information needs to be provided to allow for a GDR to be produced.

MONITORING (INCLUDING REMEDIATION MONITORING REPORTS)

27. These reports are factual in nature and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of an earthworks or remedial works.

28. The data is presented and will be compared with assessment criteria.

Appendix B

FIGURES AND DRAWINGS

Date Modified: 16/08/2019 14:37

Drawn By: Anna.Irlam

Key

Red Line Site Boundary

ACHDDU

A484

Burry Port Community Primary School

Pembrey Primary School

B4311

Memorial Park

DYFATTY

Pwll Rd

Tanycoed

Bethlehem

Pembrey & Burry Port

Burry Port

Burry Port Lighthouse

River Loughor

0 100 200 300 400 m

Map data ©2019 Imagery ©2019 , Bluesky, Infoterra Ltd & COWI A/S, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies, The GeoInformation Group

wsp

TITLE:

Former Grillo Zinc Oxide Site

FIGURE No:

Figure 1 Site Location Plan

File: Created using iGIS, WSP's Online Mapping System

KEY

SITE BOUNDARY

HISTORICAL STRUCTURE

NOTE:
ALL SITE STRUCTURES HAVE BEEN DEMOLISHED. HISTORICAL STRUCTURE LOCATIONS ARE SHOWN FOR INFORMATION PURPOSES ONLY

KEY TO EXPLORATORY HOLES

CP/BH BOREHOLE (PB 2004)

CP BOREHOLE (WATERMAN 2007)

BH BOREHOLE (ESG 2017)

Rev	Date	Description	By	Chk	App

wsp

3rd Floor, Kings Orchard, 1 Queen St, Bristol, BS2 0HQ, UK
T+ 44 (0) 1179 306 200
wsp.com

Client:
CARMARTHENSHIRE COUNTY COUNCIL

Site/Project:
FORMER GRILLO ZINC OXIDE PLANT, BURRY PORT

Title:
BOREHOLE LOCATION PLAN

Drawn: CEW		Checked: AI	
Designed: AI		Approved:	
Date: 07/08/2019	Scale: 1:700 A2	Sheet:	
Project Number:		Drawing Number:	Revision:
70054861		FIGURE 2	

Login: Watt, Chris
Plot Date: 16/08/2019 14:40:17
File Name: \\uk.wspgroup.com\central data\Projects\700548xx\70054861 - Grillo S73\03 WIP\GRRIZ Dwgs\1-current\70054861-F02.dwg

N

BH1	
Determinand	Concentration (µg/l)
Benzo(a)pyrene	<0.002

CP102	
Determinand	Concentration (µg/l)
Benzo(a)pyrene	<0.002

CPPB7	
Determinand	Concentration (µg/l)
Zinc (diss.filt)	73.4
Benzo(a)pyrene	<0.002

BH2	
Determinand	Concentration (µg/l)
Zinc (diss.filt)	80
Fluoranthene	0.0084
Benzo(a)pyrene	0.0050

BH6	
Determinand	Concentration (µg/l)
Arsenic (diss.filt)	286
Benzo(a)pyrene	<0.002

BH3	
Determinand	Concentration (µg/l)
Zinc (diss.filt)	60.4
Benzo(a)pyrene	<0.002

BH5	
Determinand	Concentration (µg/l)
Arsenic (diss.filt)	601
Benzo(a)pyrene	<0.002

CP108	
Determinand	Concentration (µg/l)
Zinc (diss.filt)	413
Fluoranthene	0.0159
Benzo(a)pyrene	0.0071

CP105	
Determinand	Concentration (µg/l)
Benzo(a)pyrene	<0.002

BH4	
Determinand	Concentration (µg/l)
Arsenic (diss.filt)	399
Benzo(a)pyrene	<0.002

KEY

SITE BOUNDARY

HISTORICAL STRUCTURE

NOTE:
ALL SITE STRUCTURES HAVE BEEN DEMOLISHED. HISTORICAL STRUCTURE LOCATIONS ARE SHOWN FOR INFORMATION PURPOSES ONLY

KEY TO EXPLORATORY HOLES

CP/BH BOREHOLE SAMPLED IN 2019

CP/BH BOREHOLE NOT FOUND OR SAMPLED - ASSUMED DESTROYED

BOREHOLE WITH CONTAMINANTS EXCEEDING GAC

Screening Criteria		
Determinand	GAC (µg/l)	Criteria
Arsenic (diss.filt)	25	EQS Trans 2015
Zinc (diss.filt)	23.21	EQS Trans 2015
Fluoranthene	0.0063	EQS Trans 2015
Benzo(a)pyrene	0.00017*	EQS Trans 2015

* EQS Trans 2015 exceeds the limit of detection (LOD) of <0.002 µg/l.

Rev	Date	Description	By	Chk	App

3rd Floor, Kings Orchard, 1 Queen St, Bristol, BS2 0HQ, UK
T+ 44 (0) 1179 306 200
wsp.com

Client:
CARMARTHENSHIRE COUNTY COUNCIL

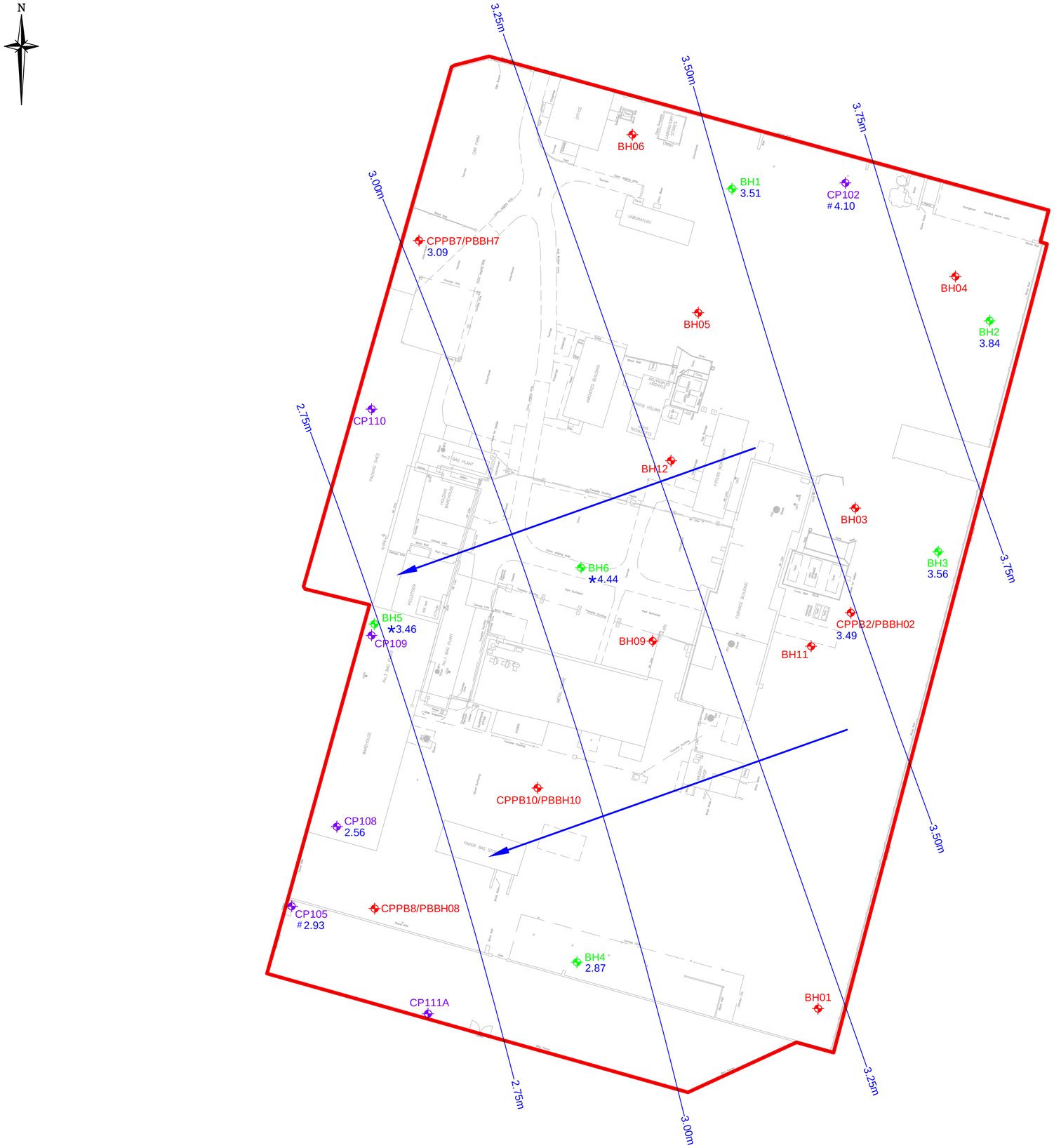
Site/Project:
FORMER GRILLO ZINC OXIDE PLANT, BURRY PORT

Title:
GAC EXCEEDANCE PLAN MAY 2019

Drawn:	CEW	Checked:	AI	
Designed:	AI	Approved:		
Date:	16/08/2019	Scale:	1:700	A2
Sheet:				

Project Number:	Drawing Number:	Revision:
70054861	FIGURE 3	

Login: Watt, Chris
Plot Date: 16/08/2019 15:08:59
File Name: \\uk.wspgroup.com\central data\Projects\70054861 - Grillo S73303 WIP\GRRUZ Dwgs\1-current\70054861-F03.dwg



KEY

SITE BOUNDARY

HISTORICAL STRUCTURE

NOTE:
ALL SITE STRUCTURES HAVE BEEN DEMOLISHED.
HISTORICAL STRUCTURE LOCATIONS ARE SHOWN FOR INFORMATION PURPOSES ONLY

KEY TO EXPLORATORY HOLES

CP/BH	BOREHOLE (PB 2004)
CP	BOREHOLE (WATERMAN 2007)
BH	BOREHOLE (ESG 2017)

KEY TO GROUNDWATER CONFIGURATION

3.84	GROUNDWATER LEVEL (mAOD)
*	GROUNDWATER LEVEL OMITTED FROM CONFIGURATION DUE TO ANOMALOUS GROUNDWATER ELEVATION DATA
#	BOREHOLE NOT SCREENED IN BLOWN SAND DEPOSITS
3.50m	GROUNDWATER CONTOUR (mAOD)
	INFERRED DIRECTION OF GROUNDWATER FLOW

Rev	Date	Description	By	Chk	App

3rd Floor, Kings Orchard, 1 Queen St, Bristol, BS2 0HQ, UK
T+ 44 (0) 1179 306 200
wsp.com

Client:
CARMARTHENSHIRE COUNTY COUNCIL

Site/Project:
FORMER GRILLO ZINC OXIDE PLANT, BURRY PORT

Title:
GROUNDWATER CONFIGURATION FOR BLOWN SAND DEPOSITS (31/5/2019)

Drawn: CEW		Checked: VL	
Designed: JT		Approved: AI	
Date: 12/08/2019	Scale: 1:700	A2	Sheet:
Project Number: 70054861	Drawing Number: FIGURE 4		Revision:

Login: Watt, Chris
Plot Date: 16/08/2019 14:44:33
File Name: \\uk.wspgroup.com\central data\Projects\70054861 - Grillo S73\03 WIP\GRRIZ Dwgs\1-current\70054861-F04.dwg

Appendix C

FIELD PROFORMA

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** BH1				**Depth to Water (m):** 3.06			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 9.195			
Date and Time: 31/05/19, 11:50			**Weather:** Overcast and mild				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
11:55	3.06	Moderate	13.3	45.1	4.6	1107	7.13	-13.3	164.7	Clear, no odour
11:58	3.07	Moderate	13.5	17.6	1.82	1145	7.1	-11.1	163.8	
12:01	3.07	Moderate	13.6	16.1	1.67	1157	7.1	-11.4	161.5	
12:04	3.07	Moderate	13.6	16.1	1.59	1159	7.1	-11.4	159.1	
12:07	3.07	Moderate	13.6	15.9	1.61	1159	7.09	-11.3	157.3	
12:10	3.07	Moderate	13.6	15.7	1.59	1155	7.09	-11.4	149.7	
Borehole Headworks in Competent Condtion?:			Yes		**Comments:**		N/A			
Sampling ID:		BH1		**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative					
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** BH2				**Depth to Water (m):** 2.68			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 3.34			
Date and Time: 31/05/19, 12:23			**Weather:** Overcast and mild				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
12:31	2.68	Moderate	13.5	59.2	6.19	900	7.37	-27.2	111.6	Brown silty water with organic odour initially, purged to clear water with no odour
12:34	2.68	Moderate	13.5	66.1	6.88	766	7.44	-31.0	108.6	
12:37	2.68	Moderate	13.5	69.4	7.25	651	7.45	-31.5	112.8	
12:40	2.68	Moderate	13.5	72.5	7.56	597.3	7.45	-31.6	116.5	
12:43	2.68	Moderate	13.5	73.1	7.61	566.9	7.45	-31.2	119.6	
12:46	2.68	Moderate	13.5	72.9	7.64	565.9	7.44	-31.1	120.4	
Borehole Headworks in Competent Condtion?:			Yes		**Comments:**		N/A			
Sampling ID:		BH2		**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative					
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** BH3				**Depth to Water (m):** 3.11			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 7.04			
Date and Time: 31/05/19, 12:30			**Weather:** Overcast and mild				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
12:34	3.11	Moderate	15.66		5.33	854.90	7.46		102.0	Clear, no odour
12:37	3.11	Moderate	14.58		5.27	896.04	7.38		102.2	
12:40	3.11	Moderate	14.72		4.18	908.03	7.31		103.3	
12:43	3.11	Moderate	14.73		3.48	911.67	7.26		102.6	
12:46	3.11	Moderate	14.77		3.03	917.71	7.25		101.3	
Borehole Headworks in Competent Condtion?:			Yes		**Comments:**		N/A			
Sampling ID:		BH3		**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative					
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** BH4				**Depth to Water (m):** 3.81			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 7.64			
Date and Time: 31/05/19, 10:50			**Weather:** Overcast and drizzly				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
10:55	3.81	Moderate	14.85		7.86	604.05	7.63		156.4	Clear, no odour
10:58	3.81	Moderate	14.21		8.18	602.25	7.61		109.3	
11:01	3.81	Moderate	14.07		8.17	603.63	7.60		104.0	
11:04	3.81	Moderate	14.04		8.11	603.25	7.60		105.3	
11:07	3.81	Moderate	14.04		8.13	604.62	7.60		110.6	
Borehole Headworks in Competent Condtion?:			Yes		**Comments:**		N/A			
Sampling ID:		BH4		**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative					
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** BH5				**Depth to Water (m):** 3.92			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 7.25			
Date and Time: 31/05/19, 10:15			**Weather:** Overcast and mild				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
10:17	3.92	Moderate	15.38		7.6	715.45	7.10		99.9	Clear, no odour
10:20	3.92	Moderate	14.58		7.78	725.59	7.31		106.2	
10:23	3.92	Moderate	14.32		7.92	720.52	7.47		109.1	
10:26	3.92	Moderate	14.22		7.69	722.78	7.42		110.1	
10:29	3.92	Moderate	14.15		7.66	723.13	7.43		110.1	
Borehole Headworks in Competent Condtion?:			Yes		**Comments:**		N/A			
Sampling ID:		BH5		**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative					
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** BH6				**Depth to Water (m):** 3.74			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 7.11			
Date and Time: 31/05/19, 10:06			**Weather:** Overcast, windy and drizzly				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
10:11	3.74	Moderate	17.0	104.0	10.12	2.9	7.46	-32.1	-74.7	Clear, no odour
10:14	3.75	Moderate	16.4	103.7	10.16	2.4	7.36	-26.7	-47.9	
10:17	3.75	Moderate	16.0	102.1	10.07	2.2	7.19	-16.0	-107.1	
10:20	3.75	Moderate	15.9	101.9	10.02	2.3	6.87	1.7	-309.7	
10:23	3.75	Moderate	15.6	99.9	9.94	2.2	6.85	2.0	-305.2	
10:26	3.75	Moderate	15.4	99.7	9.92	2.1	6.86	1.9	-300.1	
Borehole Headworks in Competent Condtion?:			Yes		**Comments:**		N/A			
Sampling ID:		BH6	**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative						
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** CP102				**Depth to Water (m):** 2.74			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 4.69			
Date and Time: 31/05/19, 12:00			**Weather:** Overcast and mild				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
12:00	2.74	Moderate	18.93		4.89	576.47	7.54		138.1	Clear, no odour
12:03	2.74	Moderate	15.14		4.21	644.53	7.42		116.2	
12:06	2.74	Moderate	14.49		2.12	675.81	7.38		-104.5	
12:09	2.74	Moderate	14.35		1.6	689.82	7.38		-86.2	
12:12	2.74	Moderate	14.31		1.97	720.42	7.38		-37.0	
12:15	2.74	Moderate	14.49		1.95	760.42	7.37		23.5	
12:18	2.74	Moderate	14.58		2.07	789.61	7.36		56.3	
Borehole Headworks in Competent Condtion?:			No		**Comments:**		No cover or cap			
Sampling ID:		CP102		**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative					
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** CP105				**Depth to Water (m):** 3.665			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 16.96			
Date and Time: 31/05/19, 13:00			**Weather:** Overcast and mild				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
13:00		Moderate	15.45		0.94	1.163	8.12		96.2	Clear, no odour
13:03		Moderate	14.76		0.41	1.264	7.10		69.9	
13:06		Moderate	14.67		0.35	1.209	7.37		63.2	
13:09		Moderate	14.45		0.32	1.209	7.87		59.5	
13:12		Moderate	14.58		0.30	1.211	7.87		57.3	
13:15		Moderate	14.18		0.09	1.213	7.86		55.1	
Borehole Headworks in Competent Condtion?:			Yes		**Comments:**		N/A			
Sampling ID:		CP105		**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative					
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** CP108				**Depth to Water (m):** 4.10			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 7.17			
Date and Time: 31/05/19, 10:45			**Weather:** Overcast, windy and drizzly				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
10:50	4.10	Moderate	13.4	71.7	7.26	789	7.60	-33.6	159.8	Clear, no odour
10:53	4.10	Moderate	13.0	44.7	4.71	920	7.42	-29.7	161.3	
10:56	4.11	Moderate	13.0	41.6	4.35	943	7.40	-29.3	163.1	
10:59	4.11	Moderate	13.0	41.0	4.31	945	7.40	-28.3	163.3	
11:02	4.11	Moderate	13.1	40.8	4.30	943	7.40	-28.4	163.3	
Borehole Headworks in Competent Condtion?:			No		**Comments:**		No cover			
Sampling ID:		CP108	**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative						
Duplicate ID:		-								

Low Flow Purge and Sample Form										
Project No.: 70054861			**Well No.:** CPPB7				**Depth to Water (m):** 3.59			
Location: Grillo			**Well Diameter:** 50mm				**Depth to Base (m):** 4.41			
Date and Time: 31/05/19, 09:00			**Weather:** Overcast and drizzly				**Datum:** Ground Level			
Time	**Water Level (m)**	**Flow**	**Temperature (°C)**	**DO (%)**	**DO (mg/l)**	**Specific Conductance (µS/cm)**	**pH (s.u.)**	**pH (mV)**	**ORP (mV)**	**Comments**
09:12	3.57	Moderate	13.0	30.1	3.10	686	6.81	2.9	147.2	Clear water with white algea
09:15	3.57	Moderate	13.5	24.9	2.58	655	7.09	-11.4	147.8	
09:18	3.57	Moderate	13.5	21.7	2.24	656	7.12	-13.0	148.7	
09:21	3.57	Moderate	13.6	20.4	2.12	648	7.12	-13.0	149.7	
09:24	3.57	Moderate	13.5	19.6	2.03	644	7.12	-12.9	150.7	
09:27	3.57	Moderate	13.5	19.6	1.92	638	7.13	-13.4	151.4	
Borehole Headworks in Competent Condtion?:			No		**Comments:**		No Cover			
Sampling ID:		CPPB7	**Sample Containers:**	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative						
Duplicate ID:		DUP								

Low Flow Purge and Sample Form		
Project No.: 70054861	**Well No.:** Harbour Sample	**Depth to Water (m):** 3.59
Location: Grillo	**Well Diameter:** 50mm	**Depth to Base (m):** 4.41
Date and Time: 31/05/19, 09.00	**Weather:** Overcast and drizzly	**Datum:** Ground Level

Time	Water Level (m)	Flow	Temperature (°C)	DO (%)	DO (mg/l)	Specific Conductance (µS/cm)	pH (s.u.)	pH (mV)	ORP (mV)	Comments
14:32			17.7	140.4	10.60	46252	8.07	-67.6	204.7	Clear, no odour. Tide coming in
14:35			17.7	103.9	8.32	46175	8.1	-69	192.7	
14:38			17.7	105.1	8.41	46160	8.1	-69.1	184.9	

Borehole Headworks in Competent Condtion?:	No	Comments:	No Cover

Sampling ID:	HARBOUR	Sample Containers:	1 x 250ml glass bottle, 2x 40ml VOC vials, 1x 60ml nitric acid preservative, 1x zinc acetate preservative
Duplicate ID:	-		

Appendix D

HYDRAULIC CONDUCTIVITY SUMMARY

TABLE D-1 – HYDRAULIC CONDUCTIVITY DERIVED FROM IN-SITU PERMEABILITY TESTS (BLOWN SANDS) (SUMMARY FROM MULTIPLE PHASES OF SITE ASSESSMENT)

REPORTED BY	WELL ID	K VALUE [M/S]	K VALUE [M/D]
WSP, 2019	BH1	8.43E-05	7.28
WSP, 2019	BH4	2.72E-05	2.35
WSP, 2019	BH5	3.75E-05	3.24
WSP, 2019	CP102	3.53E-05	3.05
WSP, 2019	CP108	8.41E-05	7.27
WSP, 2019	CPPB7	2.41E-04	20.84
ESG, 2017	BH2	2.64E-04	22.81
ESG, 2017	BH4	1.70E-06	0.15
ESG, 2017	BH5	9.00E-06	0.78
ESG, 2017	BH6	3.60E-06	0.31
ESG, 2017	CP108	2.50E-06	0.22
ESG, 2017	CP110	2.50E-05	2.16
ESG, 2017	CPPB7	3.69E-05	3.19
ESG, 2011	BH4/5	3.60E-06	0.31
ESG, 2011	BH4/6	2.40E-06	0.21
ESG, 2011	BH5/4	1.40E-06	0.12
ESG, 2011	BH5/6	5.50E-07	0.05
ESG, 2011	BH6/5	5.20E-06	0.45
ESG, 2011	BH6/7	6.00E-06	0.52
ESG, 2011	BH8/1	3.50E-06	0.30
ESG, 2011	BH8/3	5.50E-08	0.01
ESG, 2011	BH7/7	4.60E-06	0.40
ESG, 2011	BH7/9	5.20E-06	0.45
ESG, 2011 (re-evaluated GIL, 2007)	G2	3.40E-05	2.94
ESG, 2011 (re-evaluated GIL, 2007)	G2	3.70E-05	3.20
Geomean		**9.73E-06**	**0.84**

Appendix E

LABORATORY CERTIFICATES

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

WSP PB BBC
3rd Floor, Kings Orchard,
1 Queen Street
Bristol
Gloucestershire
BS2 0HQ

Attention: Katherine Prosser

CERTIFICATE OF ANALYSIS

Date of report Generation:	11 June 2019
Customer:	WSP PB BBC
Sample Delivery Group (SDG):	190601-3
Your Reference:	70054861
Location:	Grillo
Report No:	509868

This report has been revised and directly supersedes 509826 in its entirety.

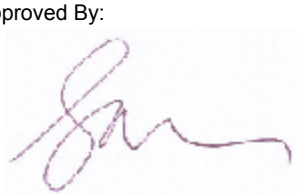
We received 12 samples on Saturday June 01, 2019 and 12 of these samples were scheduled for analysis which was completed on Tuesday June 11, 2019. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Environmental Hawarden (Method codes TM) or ALS Environmental Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.
Incorrect sampling dates and/or sample information will affect the validity of results.

Approved By:



Sonia McWhan

Operations Manager

ALS Life Sciences Limited. ALS Life Sciences Limited registered Office: Units 7 & 8 Hawarden Business Park, Manor Road, Hawarden, Deeside, CH5 3US. Registered in England and Wales No. 4057291.

Version: 2.3 Version Issued: 11/06/2019

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
20061954	BH1	EW	0.00 - 0.00	31/05/2019
20061975	BH2	EW	0.00 - 0.00	31/05/2019
20061980	BH3	EW	0.00 - 0.00	31/05/2019
20061985	BH4	EW	0.00 - 0.00	31/05/2019
20061990	BH5	EW	0.00 - 0.00	31/05/2019
20061995	BH6	EW	0.00 - 0.00	31/05/2019
20062000	CP102	EW	0.00 - 0.00	31/05/2019
20062005	CP105	EW	0.00 - 0.00	31/05/2019
20062010	CP108	EW	0.00 - 0.00	31/05/2019
20061959	CPPB7	EW	0.00 - 0.00	31/05/2019
20061964	DUP	EW	0.00 - 0.00	31/05/2019
20061969	HARBOUR	EW	0.00 - 0.00	31/05/2019

Maximum Sample/Coolbox Temperature (°C) : **17.4**

ISO5667-3 Water quality - Sampling - Part3 -
During Transportation samples shall be stored in a cooling device capable of maintaining a temperature of (5±3)°C.

ALS have data which show that a cool box with 4 frozen icepacks is capable of maintaining pre-chilled samples at a temperature of (5±3)°C for a period of up to 24hrs.

Only received samples which have had analysis scheduled will be shown on the following pages.

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Results Legend

X Test

N No Determination Possible

Sample Types -
S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

Lab Sample No(s)			20061954			20061975			20061980			20061985			20061990			20061995			20062000		
Customer Sample Reference			BH1			BH2			BH3			BH4			BH5			BH6			CP102		
AGS Reference			EW			EW			EW			EW			EW			EW			EW		
Depth (m)			0.00 - 0.00			0.00 - 0.00			0.00 - 0.00			0.00 - 0.00			0.00 - 0.00			0.00 - 0.00			0.00 - 0.00		
Container			0.5l glass bottle (ALE227)	HNO3 Filtered (ALE204)	Vial (ALE297)	0.5l glass bottle (ALE227)	HNO3 Filtered (ALE204)	Vial (ALE297)	0.5l glass bottle (ALE227)	HNO3 Filtered (ALE204)	Vial (ALE297)	0.5l glass bottle (ALE227)	HNO3 Filtered (ALE204)	Vial (ALE297)	0.5l glass bottle (ALE227)	HNO3 Filtered (ALE204)	Vial (ALE297)	0.5l glass bottle (ALE227)	HNO3 Filtered (ALE204)	Vial (ALE297)	0.5l glass bottle (ALE227)	HNO3 Filtered (ALE204)	
Sample Type			GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
Dissolved Metals by ICP-MS	All	NDPs: 0 Tests: 12		X			X			X			X			X			X			X	X
Dissolved Organic/Inorganic Carbon	All	NDPs: 0 Tests: 1																					
EPH CWG (Aliphatic) Filtered GC (W)	All	NDPs: 0 Tests: 11	X			X			X			X			X			X			X		
EPH CWG (Aromatic) Filtered GC (W)	All	NDPs: 0 Tests: 11	X			X			X			X			X			X			X		
GRO by GC-FID (W)	All	NDPs: 0 Tests: 11			X			X			X			X			X			X			
Low Level Hexavalent Chromium (w)	All	NDPs: 0 Tests: 11	X			X			X			X			X			X			X		
Mercury Dissolved	All	NDPs: 0 Tests: 12		X			X			X			X			X			X			X	X
PAH Spec MS - Aqueous (W)	All	NDPs: 0 Tests: 11	X			X			X			X			X			X			X		
pH Value	All	NDPs: 0 Tests: 12	X			X			X			X			X			X			X		
Total Metals by ICP-MS	All	NDPs: 0 Tests: 1																					
TPH CWG Filtered (W)	All	NDPs: 0 Tests: 11	X			X			X			X			X			X			X		

20061969	HARBOUR	EW	0.00 - 0.00	HNO3 Filtered (ALE204)	SW		X						X				
				0.5l glass bottle (ALE227)	SW			X							X		X	
20061964	DUP	EW	0.00 - 0.00	Vial (ALE297)	GW						X							
				HNO3 Filtered (ALE204)	GW		X						X					
				0.5l glass bottle (ALE227)	GW				X	X		X		X	X			X
20061959	CPPB7	EW	0.00 - 0.00	Vial (ALE297)	GW						X							
				HNO3 Filtered (ALE204)	GW		X						X					
				0.5l glass bottle (ALE227)	GW				X	X		X		X	X			X
20062010	CP108	EW	0.00 - 0.00	Vial (ALE297)	GW						X							
				HNO3 Filtered (ALE204)	GW		X						X					
				0.5l glass bottle (ALE227)	GW				X	X		X		X	X			X
20062005	CP105	EW	0.00 - 0.00	Vial (ALE297)	GW						X							
				HNO3 Filtered (ALE204)	GW		X						X					
				0.5l glass bottle (ALE227)	GW				X	X		X		X	X			X
20062000	CP102	EW	0.00 - 0.00	Vial (ALE297)	GW						X							

Validated

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH1	BH2	BH3	BH4	BH5	BH6
Customer Sample Ref.			BH1	BH2	BH3	BH4	BH5	BH6
Depth (m)			0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
Sample Type			Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)
Date Sampled			31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019
Sampled Time			.	.	.	.	.	.
Date Received			01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019
SDG Ref			190601-3	190601-3	190601-3	190601-3	190601-3	190601-3
Lab Sample No.(s)			20061954	20061975	20061980	20061985	20061990	20061995
AGS Reference			EW	EW	EW	EW	EW	EW
Arsenic (diss.filt)	<0.5 µg/l	TM152	1.04 #	16.8 #	1.84 #	399 #	601 #	286 #
Boron (diss.filt)	<10 µg/l	TM152	117 #	25.3 #	104 #	74.7 #	102 #	76.8 #
Cadmium (diss.filt)	<0.08 µg/l	TM152	<0.08 #	<0.08 #	<0.08 #	<0.08 #	<0.08 #	<0.08 #
Chromium (diss.filt)	<1 µg/l	TM152	<1 #	<1 #	15.2 #	8.72 #	9.55 #	1.24 #
Copper (diss.filt)	<0.3 µg/l	TM152	<0.3 #	0.37 #	<0.3 #	<0.3 #	<0.3 #	<0.3 #
Lead (diss.filt)	<0.2 µg/l	TM152	<0.2 #	0.662 #	0.92 #	<0.2 #	<0.2 #	<0.2 #
Manganese (diss.filt)	<3 µg/l	TM152	55.5 #	6.3 #	201 #	18.9 #	<3 #	8.65 #
Nickel (diss.filt)	<0.4 µg/l	TM152	0.662 #	1.32 #	1.31 #	0.527 #	<0.4 #	<0.4 #
Selenium (diss.filt)	<1 µg/l	TM152	5.22 #	3.62 #	6.58 #	25 #	25.4 #	18.1 #
Zinc (diss.filt)	<1 µg/l	TM152	1.64 #	80 #	60.4 #	15.9 #	4.02 #	7.65 #
Iron (Dis.Filt)	<19 µg/l	TM152	33.2 #	<19 #	<19 #	<19 #	<19 #	<19 #
Mercury (diss.filt)	<0.01 µg/l	TM183	<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01 #
pH	<1 pH Units	TM256	7.5 #	7.73 #	7.38 #	7.91 #	7.74 #	7.69 #
Low Level Hexavalent Chromium	<3 µg/l	TM331	7.77	<3	3.43	9.07	9.66	3.07

Validated

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	CP102	CP105	CP108	CPPB7	DUP	HARBOUR
Customer Sample Ref.								
Depth (m)			0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
Sample Type			Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Surface Water (SW)
Date Sampled			31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019
Sampled Time			.	.	.	.	.	.
Date Received			01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019
SDG Ref			190601-3	190601-3	190601-3	190601-3	190601-3	190601-3
Lab Sample No.(s)			20062000	20062005	20062010	20061959	20061964	20061969
AGS Reference			EW	EW	EW	EW	EW	EW
Carbon, Organic (diss.filt)	<3000 µg/l	TM090						<3000
Arsenic (diss.filt)	<0.5 µg/l	TM152	5.08 #	2.97 #	413 #	1.06 #	1.17 #	17.1 #
Boron (diss.filt)	<10 µg/l	TM152	94.8 #	354 #	73.7 #	64.6 #	48.8 #	
Cadmium (diss.filt)	<0.08 µg/l	TM152	<0.08 #	<0.08 #	<0.08 #	0.103 #	<0.08 #	<0.08 #
Chromium (diss.filt)	<1 µg/l	TM152	9.22 #	7.65 #	<1 #	<1 #	<1 #	<1 #
Copper (diss.filt)	<0.3 µg/l	TM152	<0.3 #	<0.3 #	<0.3 #	2.21 #	1.69 #	<0.3 #
Lead (diss.filt)	<0.2 µg/l	TM152	<0.2 #	<0.2 #	<0.2 #	0.742 #	0.475 #	<0.2 #
Manganese (diss.filt)	<3 µg/l	TM152	21 #	103 #	<3 #	3.74 #	<3 #	
Nickel (diss.filt)	<0.4 µg/l	TM152	<0.4 #	<0.4 #	<0.4 #	0.483 #	<0.4 #	1.38 #
Selenium (diss.filt)	<1 µg/l	TM152	3.31 #	<1 #	12.9 #	4.89 #	4.41 #	<1 #
Zinc (diss.filt)	<1 µg/l	TM152	16.1 #	12.1 #	2.54 #	73.4 #	80.8 #	4.99 #
Iron (Dis.Filt)	<19 µg/l	TM152	<19 #	48.6 #	<19 #	87.6 #	<19 #	
Calcium (Tot. Unfilt.)	<57 µg/l	TM152						293000 #
Hardness, Total as CaCO3 unfiltered	<350 µg/l	TM152						3580000
Mercury (diss.filt)	<0.01 µg/l	TM183	<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01
pH	<1 pH Units	TM256	7.68 #	8.04 #	7.73 #	7.83 #	7.53 #	7.91 #
Low Level Hexavalent Chromium	<3 µg/l	TM331	6.44	<3	3.78	10.2	8	

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

PAH Spec MS - Aqueous (W)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	BH1	BH2	BH3	BH4	BH5	BH6
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
			Sample Type	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)
			Date Sampled	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019
			Sampled Time	.	.	.	.	.	.
			Date Received	01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019
			SDG Ref	190601-3	190601-3	190601-3	190601-3	190601-3	190601-3
			Lab Sample No.(s)	20061954	20061975	20061980	20061985	20061990	20061995
			AGS Reference	EW	EW	EW	EW	EW	EW
Naphthalene (aq)	<0.01 µg/l	TM178		<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01 #
Acenaphthene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Acenaphthylene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Fluoranthene (aq)	<0.005 µg/l	TM178		<0.005 #	0.00841 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Anthracene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Phenanthrene (aq)	<0.005 µg/l	TM178		<0.005 #	0.0062 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Fluorene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Chrysene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Pyrene (aq)	<0.005 µg/l	TM178		<0.005 #	0.00752 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Benzo(a)anthracene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Benzo(b)fluoranthene (aq)	<0.005 µg/l	TM178		<0.005 #	0.00796 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Benzo(k)fluoranthene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Benzo(a)pyrene (aq)	<0.002 µg/l	TM178		<0.002 #	0.00497 #	<0.002 #	<0.002 #	<0.002 #	<0.002 #
Dibenzo(a,h)anthracene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Benzo(g,h,i)perylene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Indeno(1,2,3-cd)pyrene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
PAH, Total Detected USEPA 16 (aq)	<0.082 µg/l	TM178		<0.082 #	<0.082 #	<0.082 #	<0.082 #	<0.082 #	<0.082 #

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

PAH Spec MS - Aqueous (W)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	CP102	CP105	CP108	CPPB7	DUP
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
			Sample Type	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)
			Date Sampled	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019
			Sampled Time	.	.	.	.	.
			Date Received	01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019
			SDG Ref	190601-3	190601-3	190601-3	190601-3	190601-3
			Lab Sample No.(s)	20062000	20062005	20062010	20061959	20061964
			AGS Reference	EW	EW	EW	EW	EW
Naphthalene (aq)	<0.01 µg/l	TM178		<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01 #
Acenaphthene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Acenaphthylene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Fluoranthene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	0.0159 #	<0.005 #	<0.005 #
Anthracene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Phenanthrene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	0.00949 #	<0.005 #	<0.005 #
Fluorene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Chrysene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Pyrene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	0.0141 #	<0.005 #	<0.005 #
Benzo(a)anthracene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Benzo(b)fluoranthene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	0.0107 #	<0.005 #	<0.005 #
Benzo(k)fluoranthene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Benzo(a)pyrene (aq)	<0.002 µg/l	TM178		<0.002 #	<0.002 #	0.00712 #	<0.002 #	<0.002 #
Dibenzo(a,h)anthracene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Benzo(g,h,i)perylene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
Indeno(1,2,3-cd)pyrene (aq)	<0.005 µg/l	TM178		<0.005 #	<0.005 #	<0.005 #	<0.005 #	<0.005 #
PAH, Total Detected USEPA 16 (aq)	<0.082 µg/l	TM178		<0.082 #	<0.082 #	<0.082 #	<0.082 #	<0.082 #

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

TPH CWG (W)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	BH1	BH2	BH3	BH4	BH5	BH6
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
			Sample Type	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)
			Date Sampled	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019
			Sampled Time	.	.	.	.	.	.
			Date Received	01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019
			SDG Ref	190601-3	190601-3	190601-3	190601-3	190601-3	190601-3
			Lab Sample No.(s)	20061954	20061975	20061980	20061985	20061990	20061995
			AGS Reference	EW	EW	EW	EW	EW	EW
GRO Surrogate % recovery**	%	TM245		97	97	103	90	98	97
GRO >C5-C12	<50 µg/l	TM245		<50 #	<50 #	<50 #	<50 #	<50 #	<50 #
Methyl tertiary butyl ether (MTBE)	<3 µg/l	TM245		<3	<3	<3	<3	<3	<3
Benzene	<7 µg/l	TM245		<7	<7	<7	<7	<7	<7
Toluene	<4 µg/l	TM245		<4	<4	<4	<4	<4	<4
Ethylbenzene	<5 µg/l	TM245		<5	<5	<5	<5	<5	<5
m,p-Xylene	<8 µg/l	TM245		<8	<8	<8	<8	<8	<8
o-Xylene	<3 µg/l	TM245		<3	<3	<3	<3	<3	<3
Sum of detected Xylenes	<11 µg/l	TM245		<11	<11	<11	<11	<11	<11
Sum of detected BTEX	<28 µg/l	TM245		<28	<28	<28	<28	<28	<28
Aliphatics >C5-C6	<10 µg/l	TM245		<10	<10	<10	<10	<10	<10
Aliphatics >C6-C8	<10 µg/l	TM245		<10	<10	<10	<10	<10	<10
Aliphatics >C8-C10	<10 µg/l	TM245		<10	<10	<10	<10	<10	<10
Aliphatics >C10-C12	<10 µg/l	TM245		<10	<10	<10	<10	<10	<10
Aliphatics >C12-C16 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10	<10
Aliphatics >C16-C21 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10	<10
Aliphatics >C21-C35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10	<10
Total Aliphatics >C12-C35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10	<10
Aromatics >EC5-EC7	<10 µg/l	TM245		<10	<10	<10	<10	<10	<10
Aromatics >EC7-EC8	<10 µg/l	TM245		<10	<10	<10	<10	<10	<10
Aromatics >EC8-EC10	<10 µg/l	TM245		<10	<10	<10	<10	<10	<10
Aromatics >EC10-EC12	<10 µg/l	TM245		<10	<10	<10	<10	<10	<10
Aromatics >EC12-EC16 (diss.filt)	<10 µg/l	TM174		<10	<10	18	<10	<10	<10
Aromatics >EC16-EC21 (diss.filt)	<10 µg/l	TM174		<10	<10	28	<10	<10	<10
Aromatics >EC21-EC35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10	<10
Aromatics >EC16-EC35 (diss.filt)	<10 µg/l	TM174		<10	<10	28	<10	<10	<10
Total Aromatics >EC12-EC35 (diss.filt)	<10 µg/l	TM174		<10	<10	46	<10	<10	<10
Total Aliphatics & Aromatics >C5-35 (diss.filt)	<10 µg/l	TM174		<10	<10	46	<10	<10	<10

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

TPH CWG (W)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+5@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	CP102	CP105	CP108	CPPB7	DUP
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
			Sample Type	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)	Ground Water (GW)
			Date Sampled	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019
			Sampled Time	.	.	.	.	.
			Date Received	01/06/2019	01/06/2019	01/06/2019	01/06/2019	01/06/2019
			SDG Ref	190601-3	190601-3	190601-3	190601-3	190601-3
			Lab Sample No.(s)	20062000	20062005	20062010	20061959	20061964
			AGS Reference	EW	EW	EW	EW	EW
GRO Surrogate % recovery**	%	TM245		100	97	104	95	97
GRO >C5-C12	<50 µg/l	TM245		<50 #	<50 #	<50 #	<50 #	<50 #
Methyl tertiary butyl ether (MTBE)	<3 µg/l	TM245		<3	<3	<3	<3	<3
Benzene	<7 µg/l	TM245		<7	<7	<7	<7	<7
Toluene	<4 µg/l	TM245		<4	<4	<4	<4	<4
Ethylbenzene	<5 µg/l	TM245		<5	<5	<5	<5	<5
m,p-Xylene	<8 µg/l	TM245		<8	<8	<8	<8	<8
o-Xylene	<3 µg/l	TM245		<3	<3	<3	<3	<3
Sum of detected Xylenes	<11 µg/l	TM245		<11	<11	<11	<11	<11
Sum of detected BTEX	<28 µg/l	TM245		<28	<28	<28	<28	<28
Aliphatics >C5-C6	<10 µg/l	TM245		<10	<10	<10	<10	<10
Aliphatics >C6-C8	<10 µg/l	TM245		<10	<10	<10	<10	<10
Aliphatics >C8-C10	<10 µg/l	TM245		<10	<10	<10	<10	<10
Aliphatics >C10-C12	<10 µg/l	TM245		<10	<10	<10	<10	<10
Aliphatics >C12-C16 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Aliphatics >C16-C21 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Aliphatics >C21-C35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Total Aliphatics >C12-C35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Aromatics >EC5-EC7	<10 µg/l	TM245		<10	<10	<10	<10	<10
Aromatics >EC7-EC8	<10 µg/l	TM245		<10	<10	<10	<10	<10
Aromatics >EC8-EC10	<10 µg/l	TM245		<10	<10	<10	<10	<10
Aromatics >EC10-EC12	<10 µg/l	TM245		<10	<10	<10	<10	<10
Aromatics >EC12-EC16 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Aromatics >EC16-EC21 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Aromatics >EC21-EC35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Aromatics >EC16-EC35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Total Aromatics >EC12-EC35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10
Total Aliphatics & Aromatics >C5-35 (diss.filt)	<10 µg/l	TM174		<10	<10	<10	<10	<10

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Table of Results - Appendix

Method No	Reference	Description
TM090	Method 5310, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 415.1 & 9060	Determination of Total Organic Carbon/Total Inorganic Carbon in Water and Waste Water
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS
TM174	Analysis of Petroleum Hydrocarbons in Environmental Media – Total Petroleum Hydrocarbon Criteria	Determination of Speciated Extractable Petroleum Hydrocarbons in Waters by GC-FID
TM178	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS in Waters
TM183	BS EN 23506:2002, (BS 6068-2.74:2002) ISBN 0 580 38924 3	Determination of Trace Level Mercury in Waters and Leachates by PSA Cold Vapour Atomic Fluorescence Spectrometry
TM245	By GC-FID	Determination of GRO by Headspace in waters
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978. ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLpH pH Meter
TM331		Low Level Hexavalent Chromium

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Environmental Hawarden (Method codes TM) or ALS Environmental Aberdeen (Method codes S).

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Test Completion Dates

Lab Sample No(s)	20061954	20061975	20061980	20061985	20061990	20061995	20062000	20062005	20062010	20061959
Customer Sample Ref.	BH1	BH2	BH3	BH4	BH5	BH6	CP102	CP105	CP108	CPPB7
AGS Ref.	EW	EW	EW	EW	EW	EW	EW	EW	EW	EW
Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Dissolved Metals by ICP-MS	10-Jun-2019	10-Jun-2019	10-Jun-2019	10-Jun-2019	10-Jun-2019	10-Jun-2019	10-Jun-2019	10-Jun-2019	10-Jun-2019	10-Jun-2019
EPH CWG (Aliphatic) Filtered GC (W)	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019
EPH CWG (Aromatic) Filtered GC (W)	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019	06-Jun-2019
GRO by GC-FID (W)	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019
Low Level Hexavalent Chromium (w)	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019
Mercury Dissolved	06-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	06-Jun-2019	06-Jun-2019
PAH Spec MS - Aqueous (W)	04-Jun-2019	04-Jun-2019	04-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019
pH Value	04-Jun-2019	05-Jun-2019	04-Jun-2019	03-Jun-2019	05-Jun-2019	05-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	05-Jun-2019
TPH CWG Filtered (W)	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019	07-Jun-2019

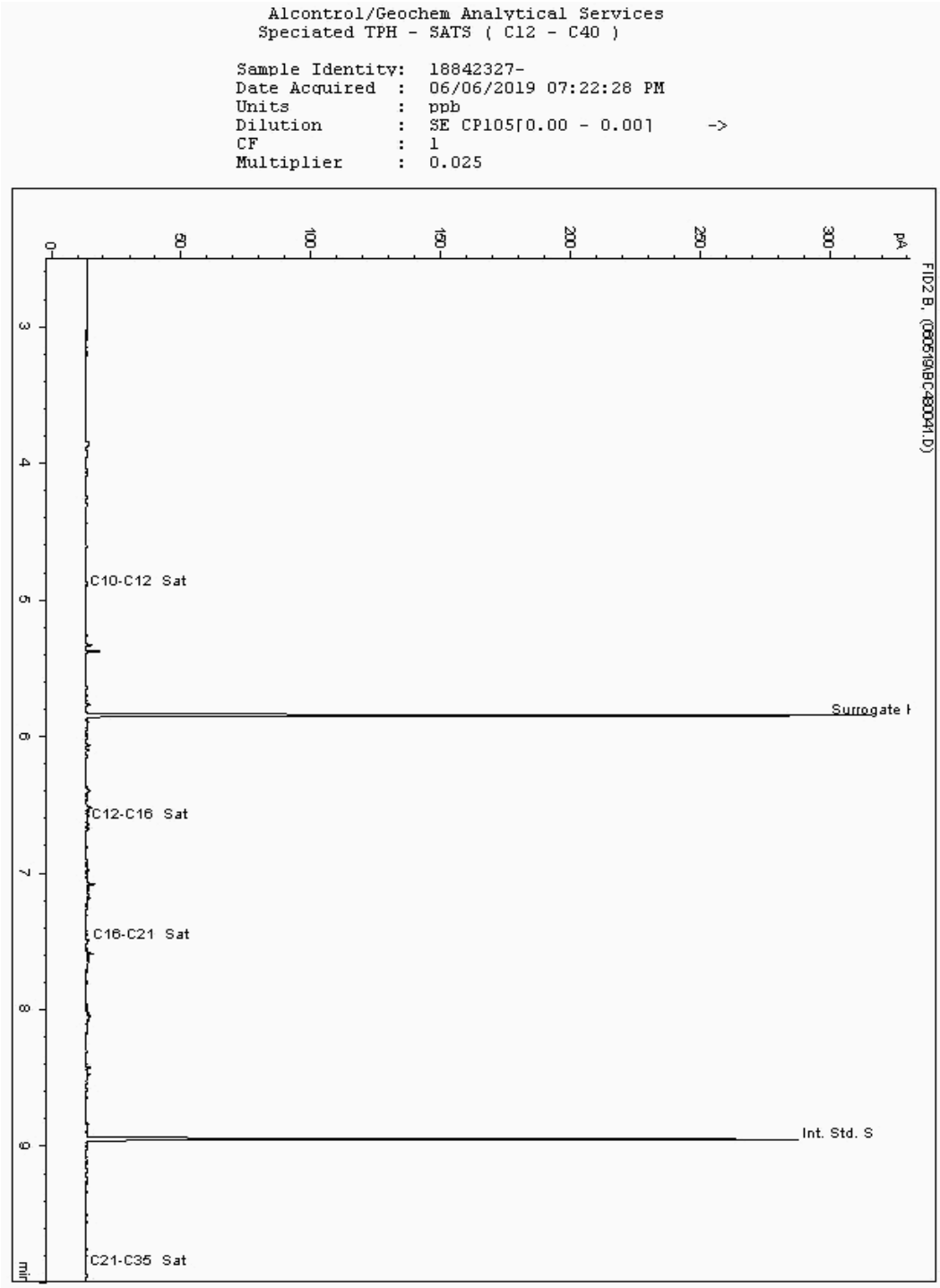
Lab Sample No(s)	20061964	20061969
Customer Sample Ref.	DUP	HARBOUR
AGS Ref.	EW	EW
Depth	0.00 - 0.00	0.00 - 0.00
Type	Ground Water	Surface Water
Dissolved Metals by ICP-MS	11-Jun-2019	10-Jun-2019
Dissolved Organic/Inorganic Carbon		04-Jun-2019
EPH CWG (Aliphatic) Filtered GC (W)	06-Jun-2019	
EPH CWG (Aromatic) Filtered GC (W)	06-Jun-2019	
GRO by GC-FID (W)	07-Jun-2019	
Low Level Hexavalent Chromium (w)	03-Jun-2019	
Mercury Dissolved	07-Jun-2019	07-Jun-2019
PAH Spec MS - Aqueous (W)	07-Jun-2019	
pH Value	05-Jun-2019	03-Jun-2019
Total Metals by ICP-MS		11-Jun-2019
TPH CWG Filtered (W)	07-Jun-2019	

CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20065867 **Depth :** 0.00 - 0.00
Sample ID : CP105



CERTIFICATE OF ANALYSIS

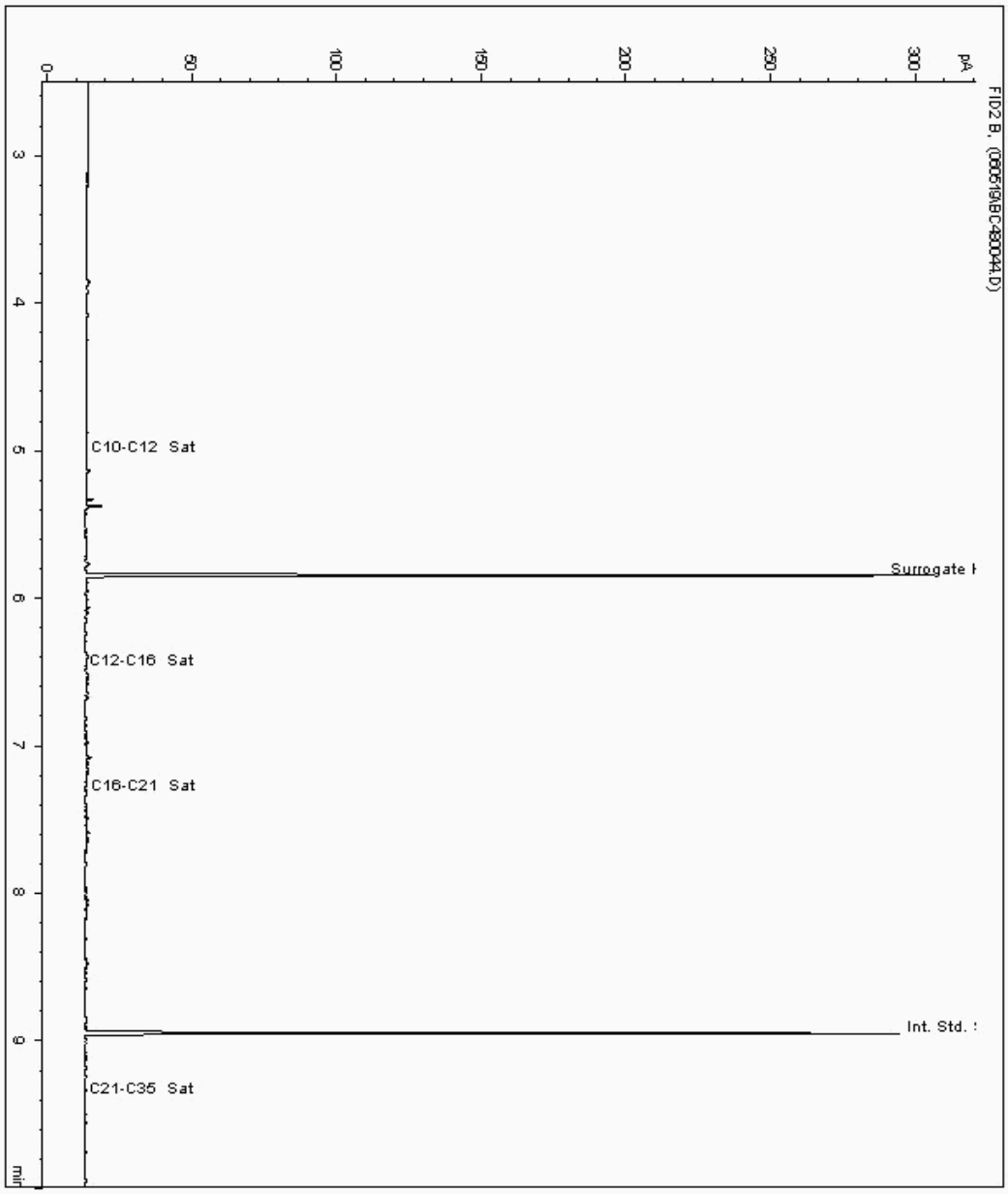
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20065889 **Sample ID :** CP108 **Depth :** 0.00 - 0.00

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842340-
Date Acquired : 06/06/2019 08:31:28 PM
Units : ppb
Dilution : SE CP108[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

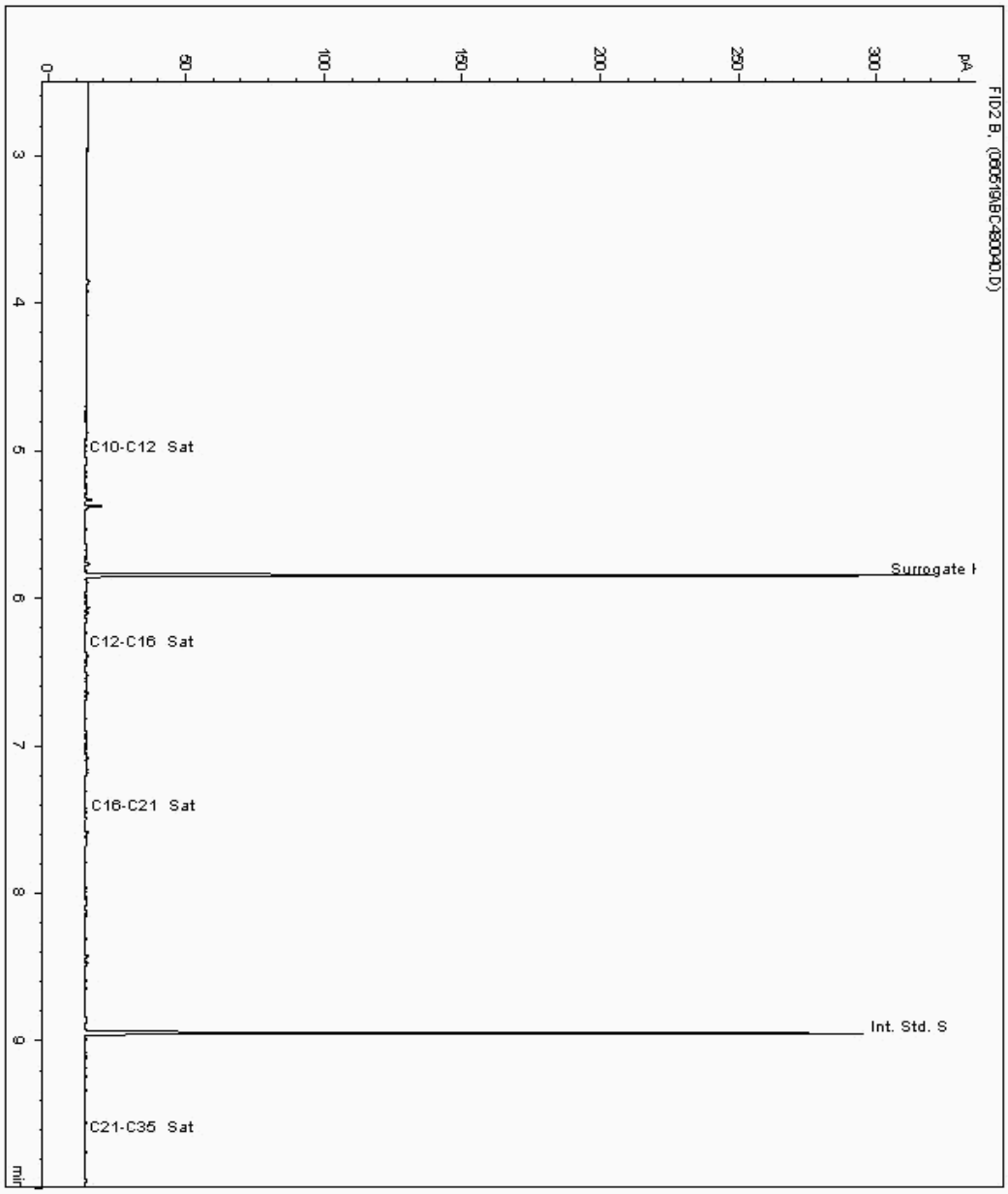
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20065901 **Depth :** 0.00 - 0.00
Sample ID : BH4

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842275-
Date Acquired : 06/06/2019 06:59:06 PM
Units : ppb
Dilution : SE BH4[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025

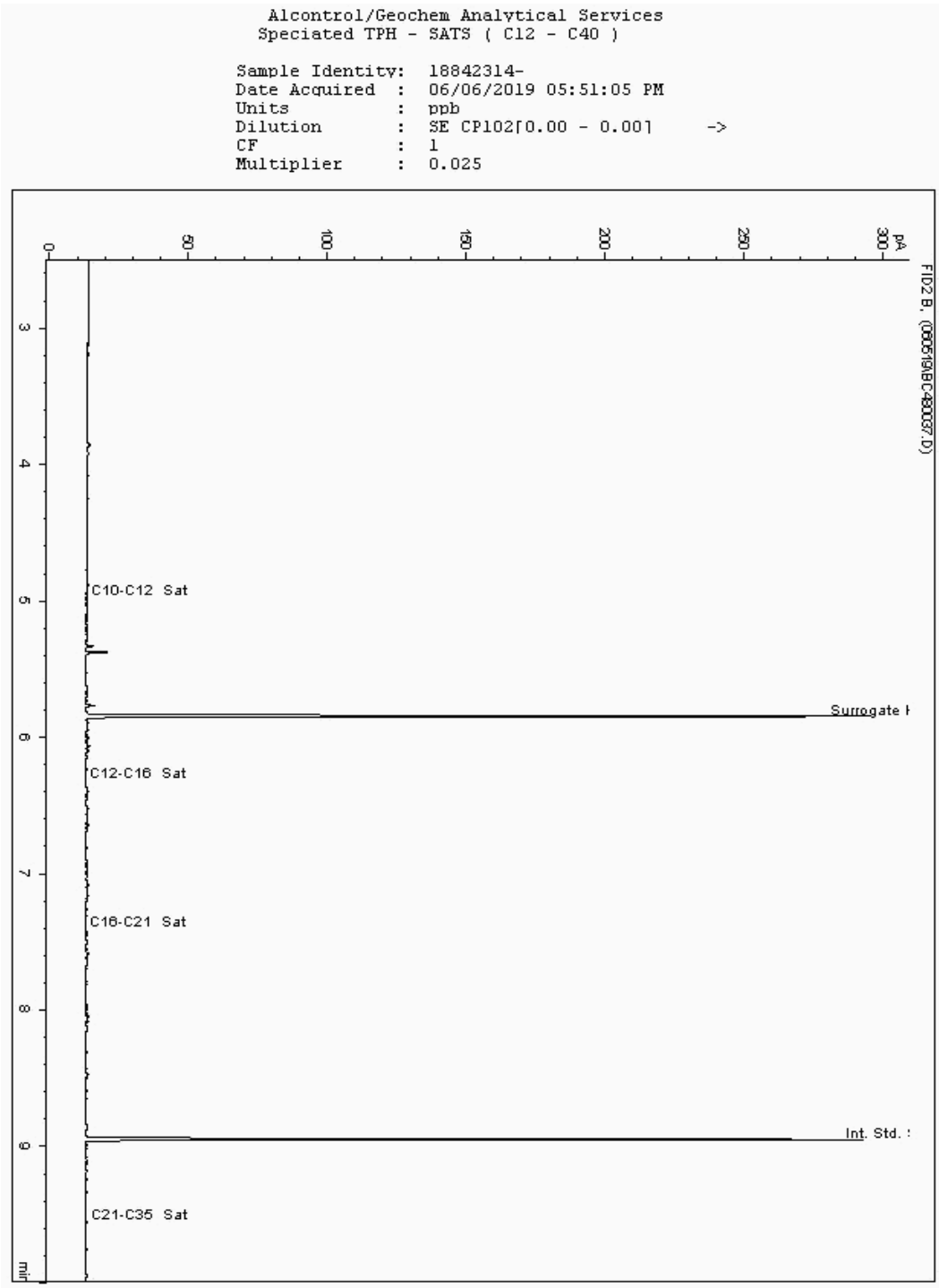


CERTIFICATE OF ANALYSIS

SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20065916 **Sample ID :** CP102 **Depth :** 0.00 - 0.00



CERTIFICATE OF ANALYSIS

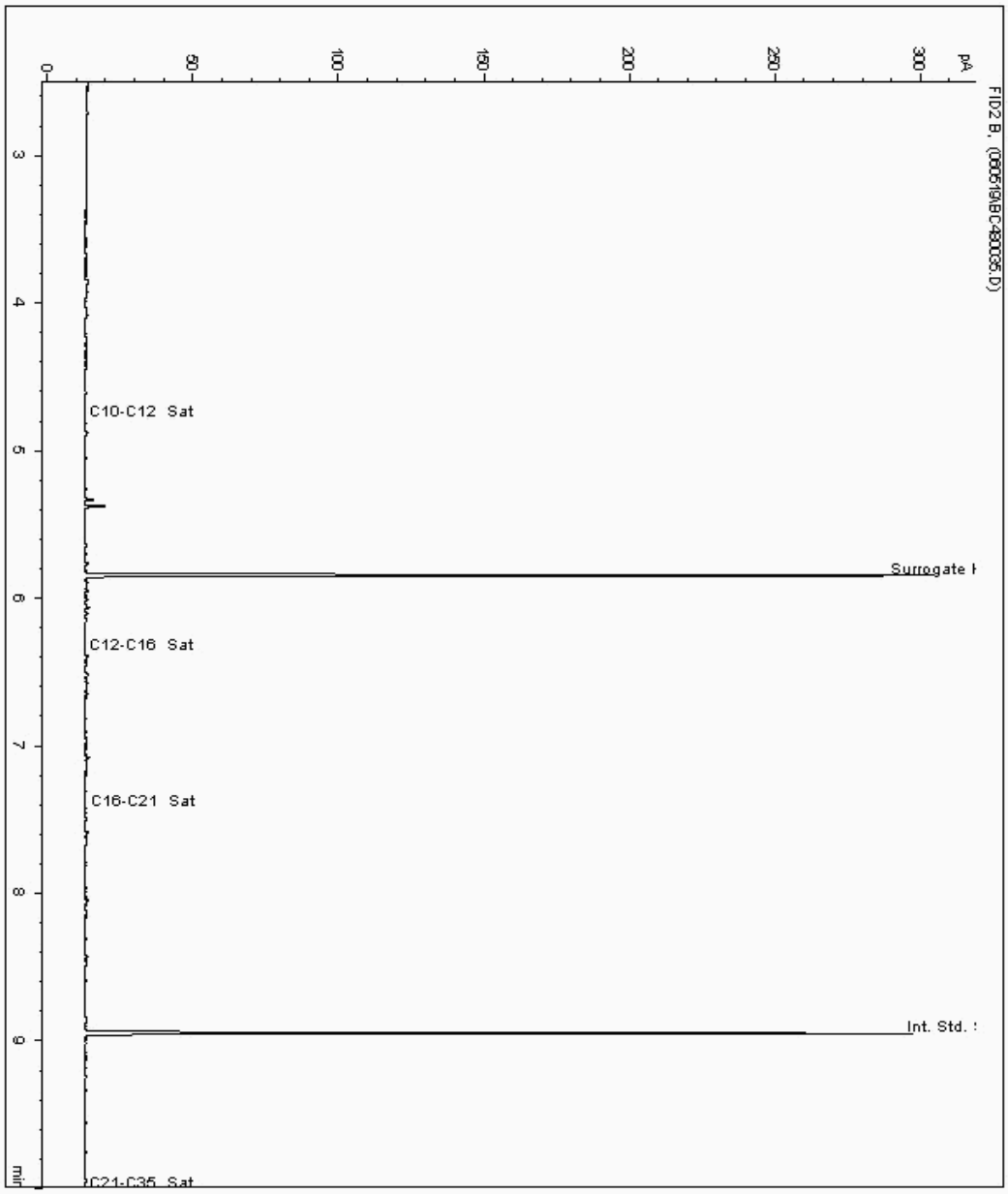
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20065973 **Depth :** 0.00 - 0.00
Sample ID : BH6

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842301-
Date Acquired : 06/06/2019 05:04:57 PM
Units : ppb
Dilution : SE BH6[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

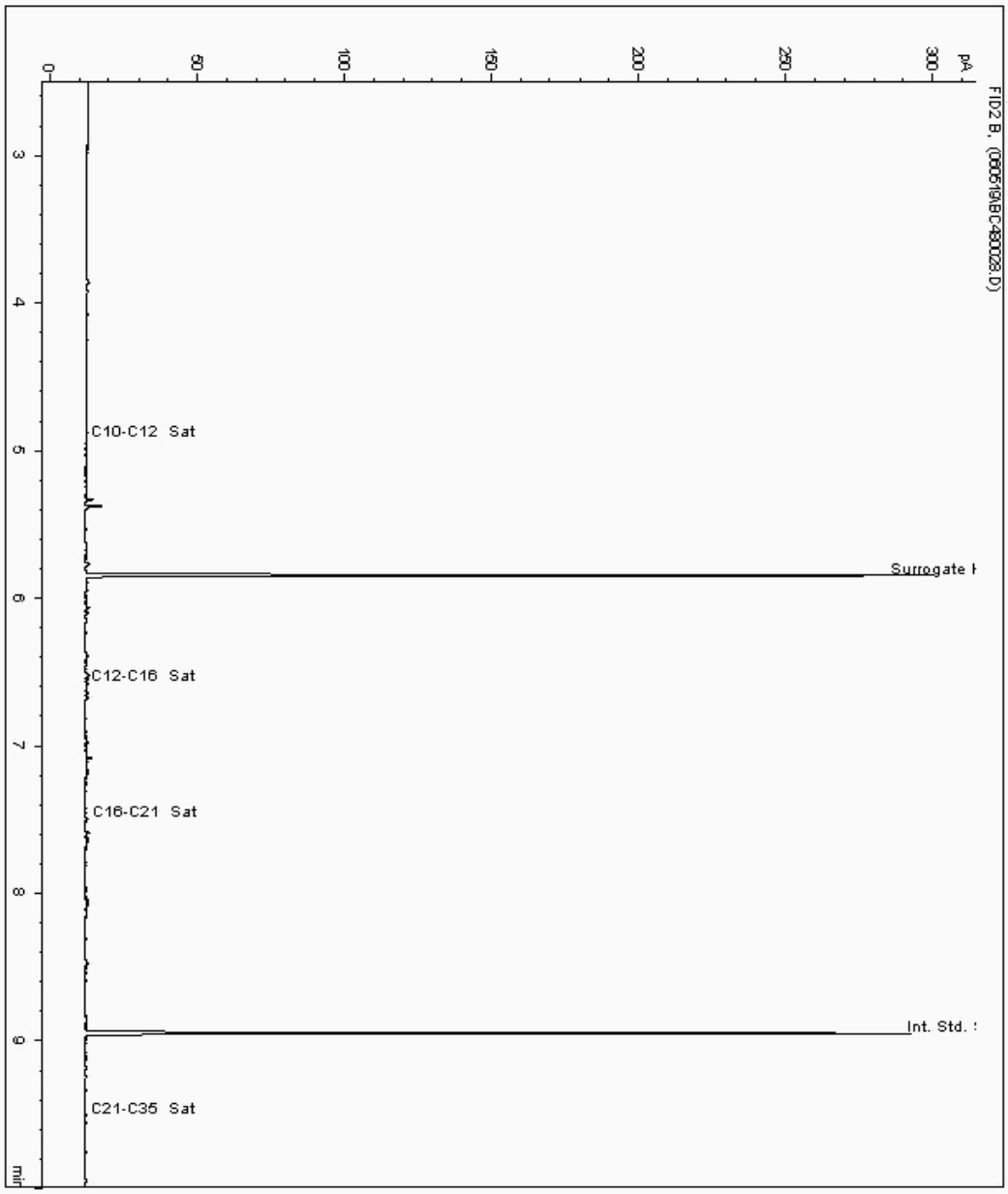
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20066023 **Depth :** 0.00 - 0.00
Sample ID : BH2

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842249-
Date Acquired : 06/06/2019 02:20:35 PM
Units : ppb
Dilution : SE BH2[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

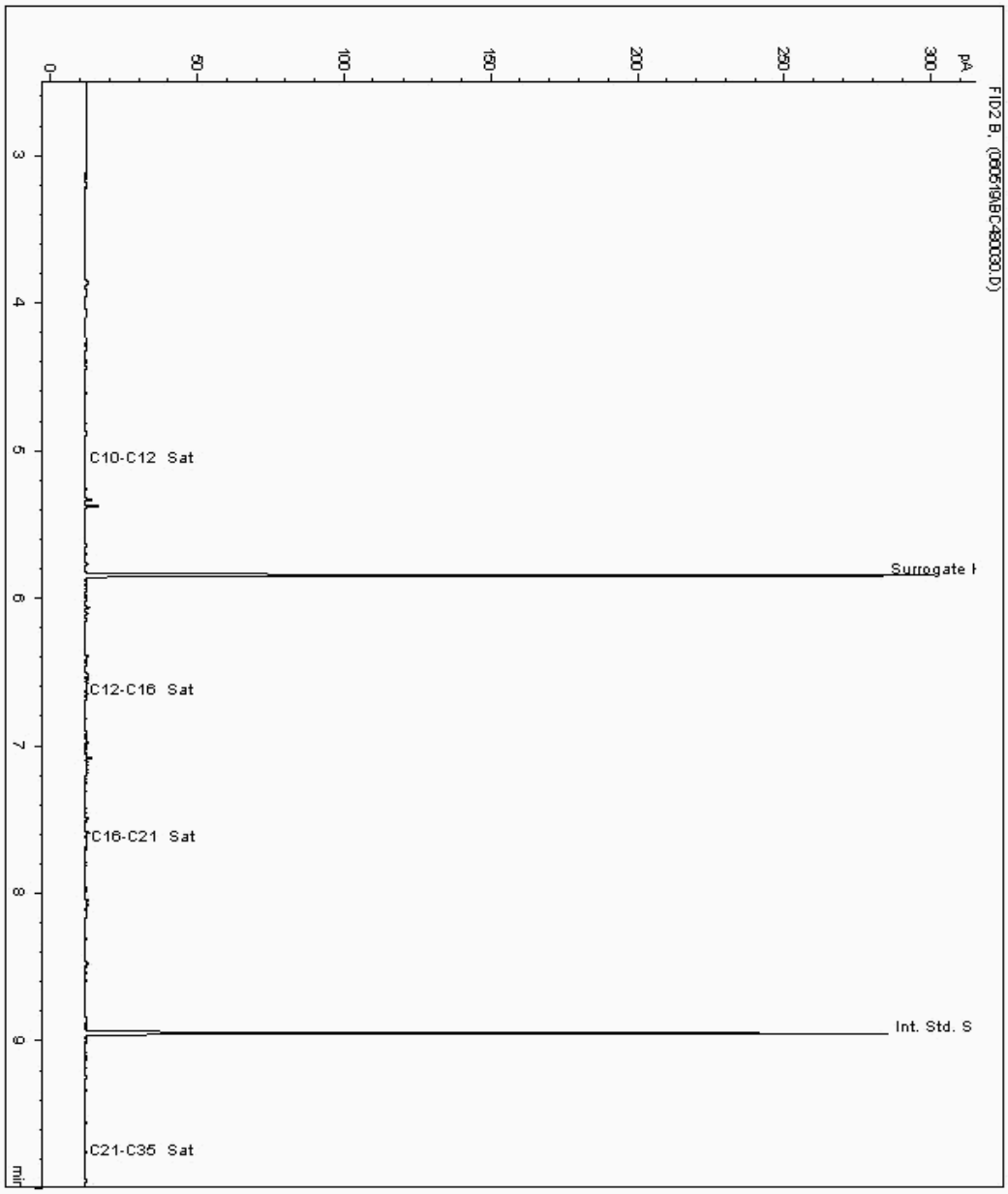
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20066042 **Depth :** 0.00 - 0.00
Sample ID : BH1

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842205-
Date Acquired : 06/06/2019 03:07:34 PM
Units : ppb
Dilution : SE BH1[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

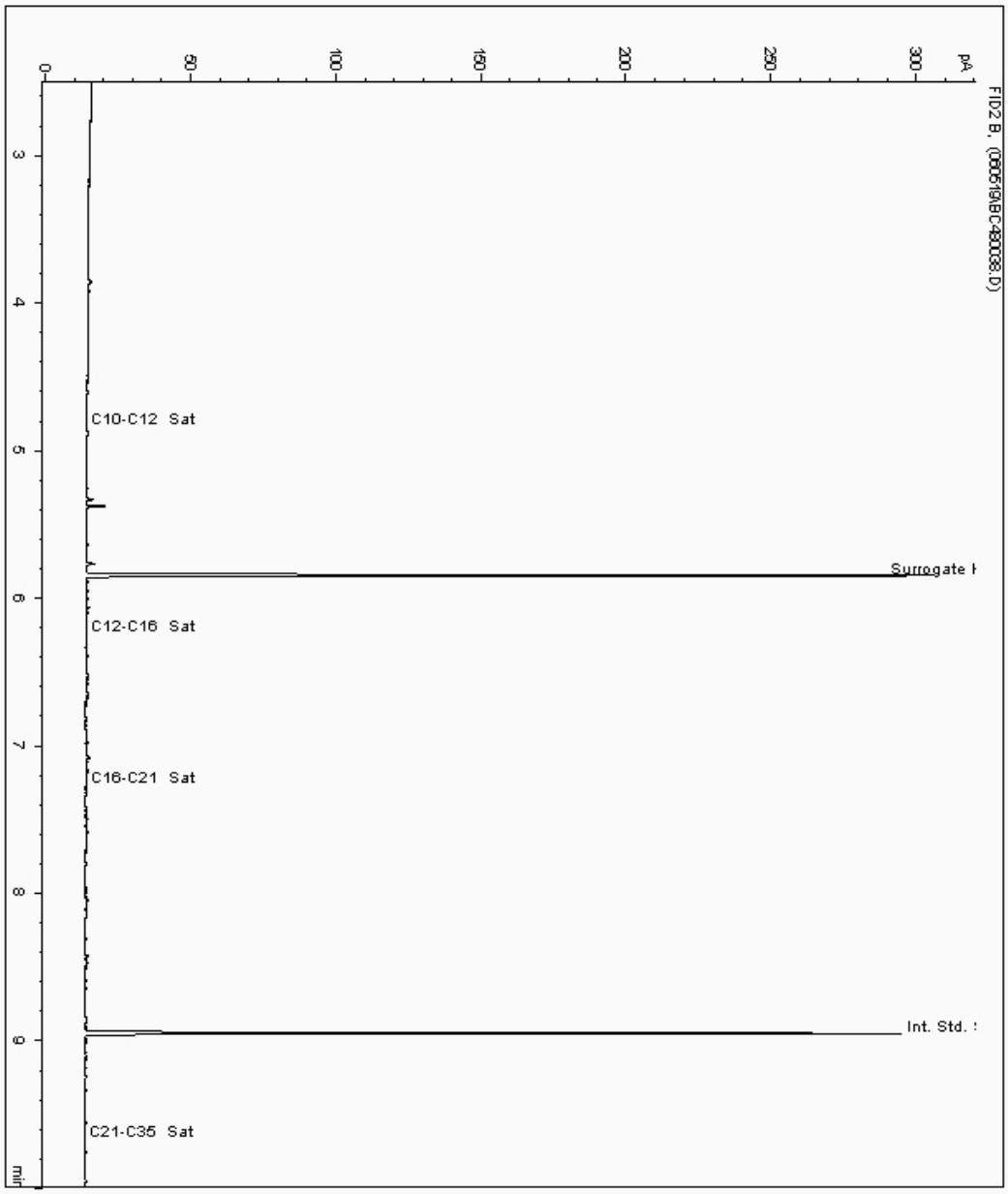
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20066072 **Sample ID :** CPPB7 **Depth :** 0.00 - 0.00

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842218-
Date Acquired : 06/06/2019 06:14:24 PM
Units : ppb
Dilution : SE CPPB7[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

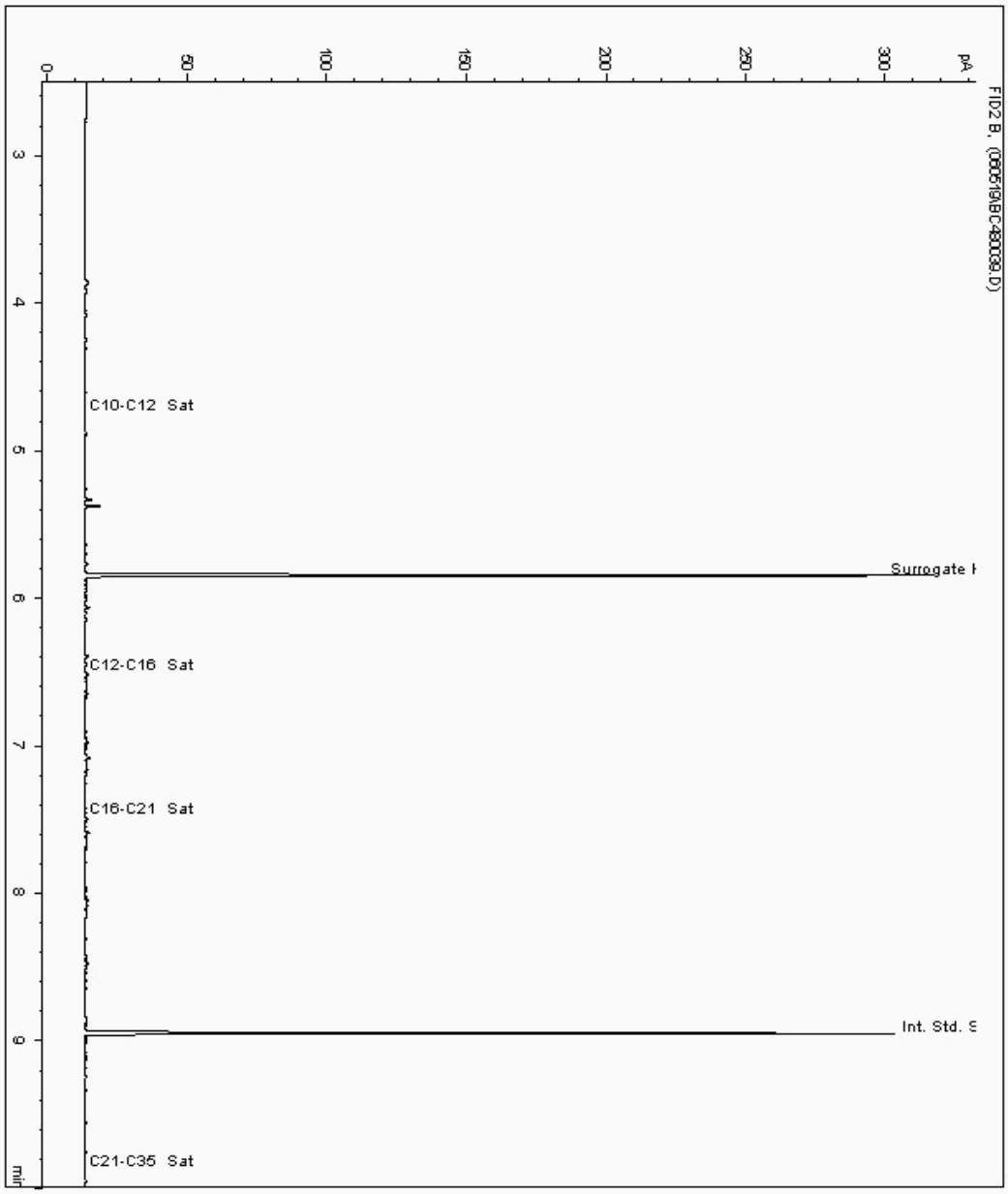
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20066089 **Depth :** 0.00 - 0.00
Sample ID : BH5

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842288-
Date Acquired : 06/06/2019 06:37:28 PM
Units : ppb
Dilution : SE BH5[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

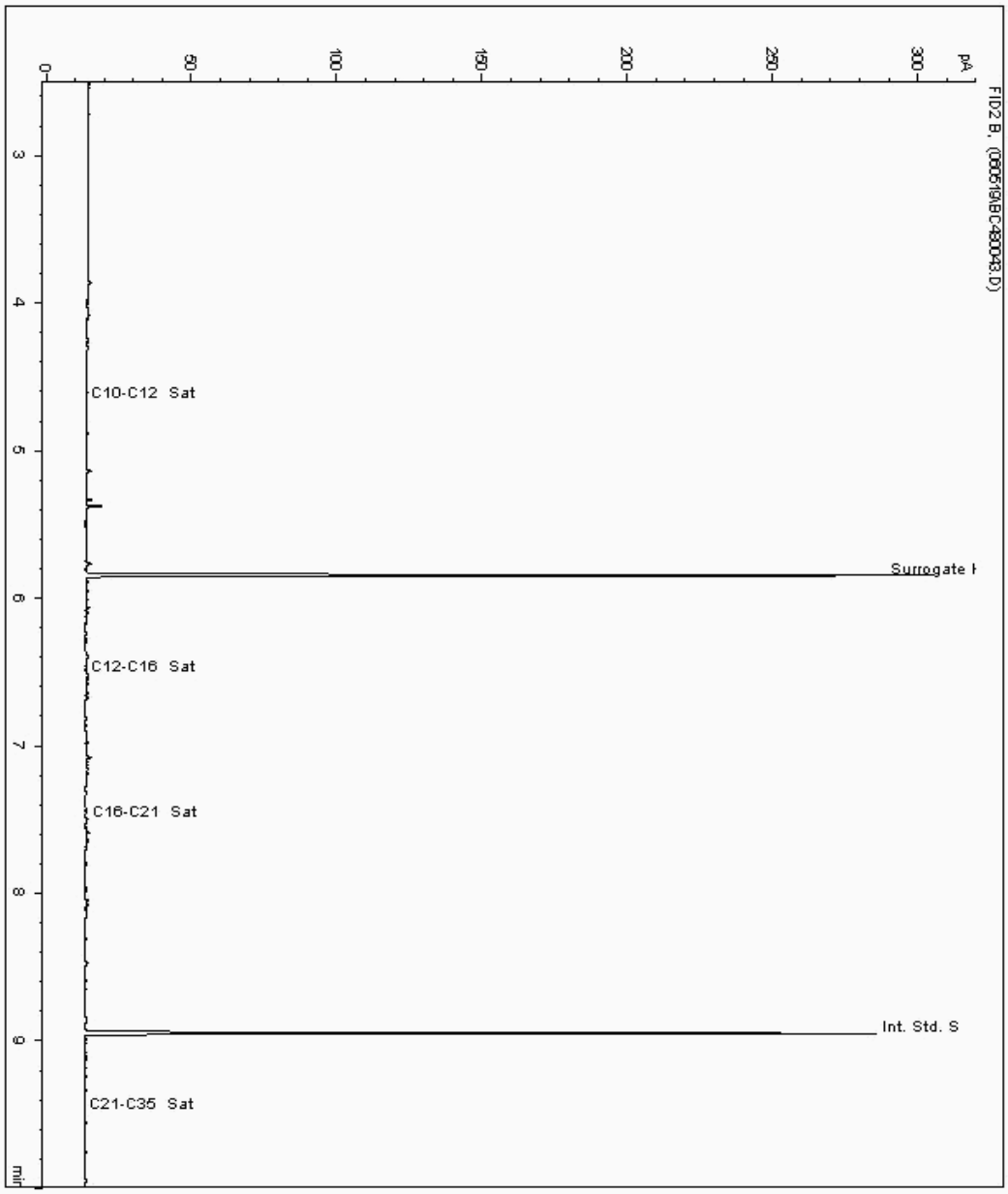
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20066113 **Depth :** 0.00 - 0.00
Sample ID : DUP

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842231-
Date Acquired : 06/06/2019 08:07:56 PM
Units : ppb
Dilution : SE DUP[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

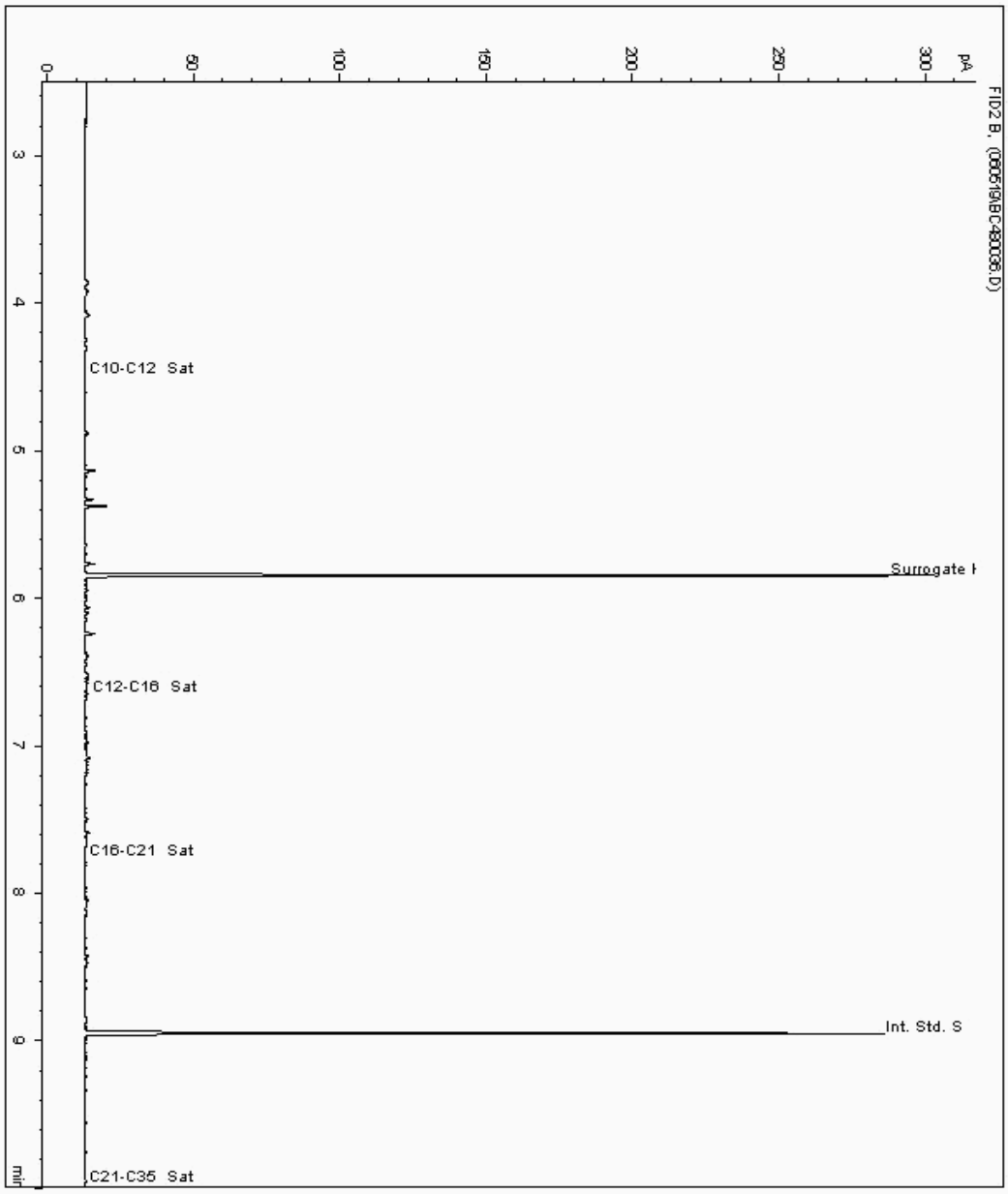
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aliphatic) Filtered GC (W) **Sample No :** 20066126 **Sample ID :** BH3 **Depth :** 0.00 - 0.00

Alcontrol/Geochem Analytical Services
Speciated TPH - SATS (C12 - C40)

Sample Identity: 18842262-
Date Acquired : 06/06/2019 05:28:01 PM
Units : ppb
Dilution : SE BH3[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

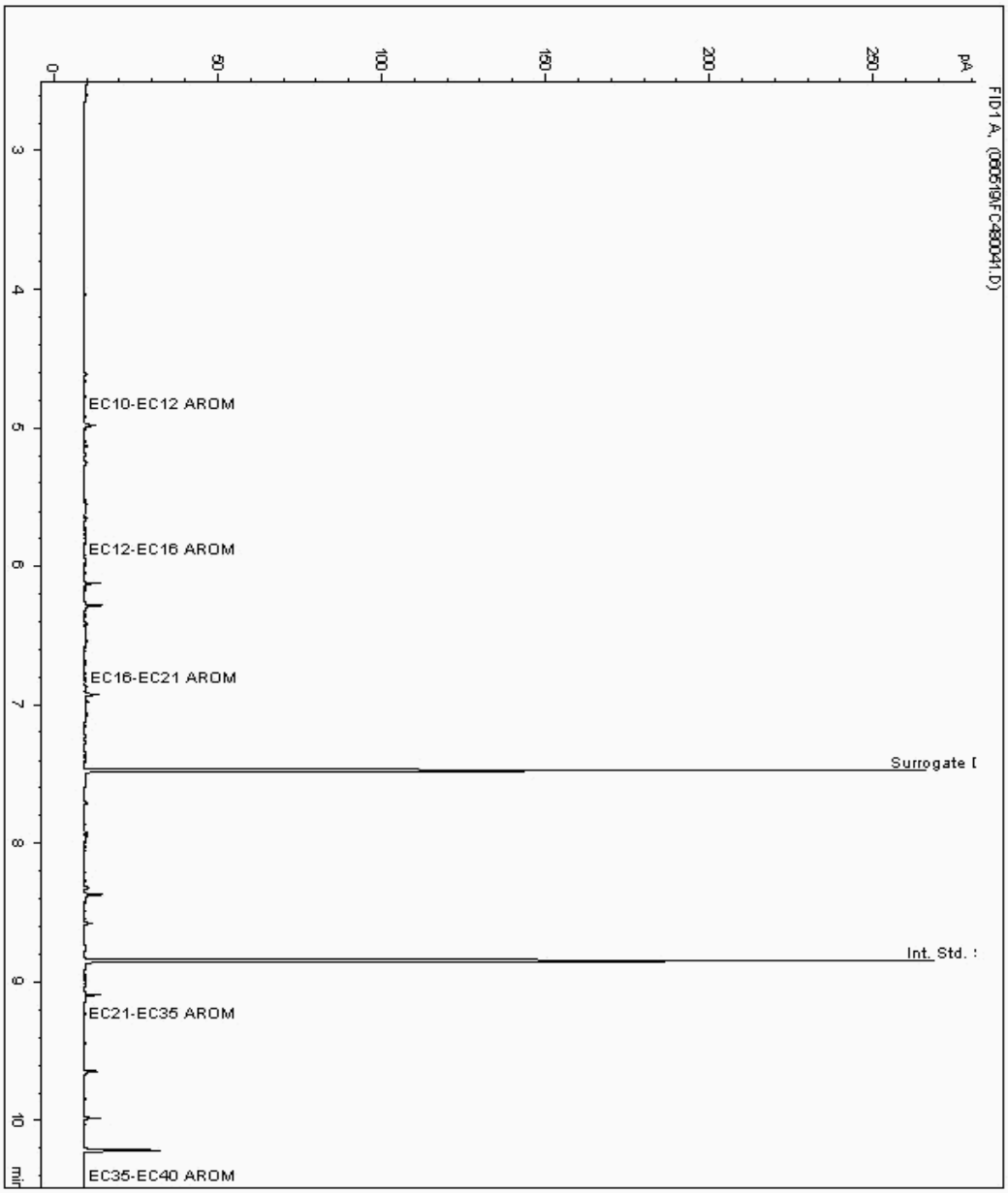
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20065867 **Sample ID :** CP105 **Depth :** 0.00 - 0.00

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842328-
Date Acquired : 06/06/2019 07:22:28 PM
Units : ppb
Dilution : SE CP105[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

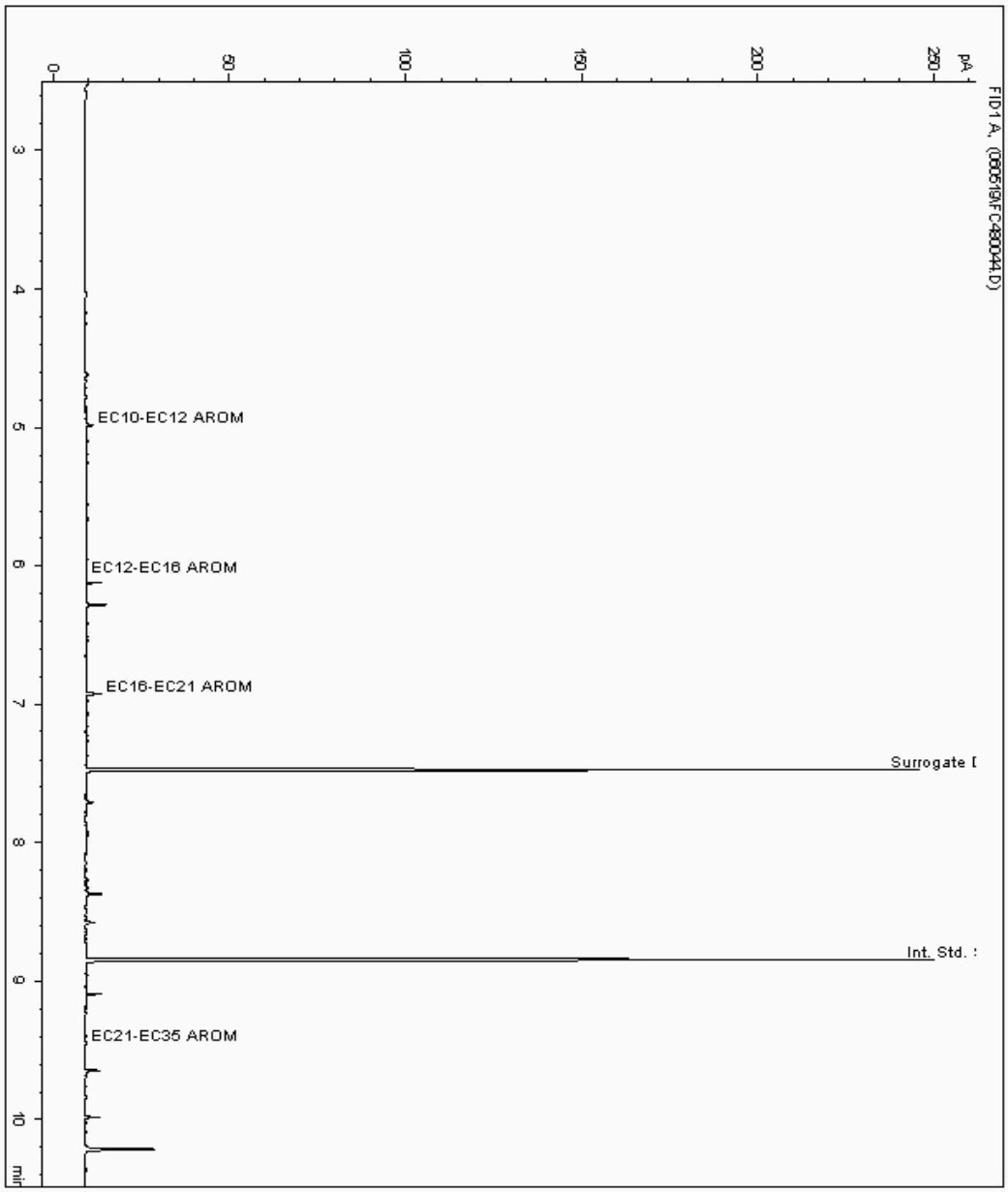
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20065889 **Sample ID :** CP108 **Depth :** 0.00 - 0.00

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842341-
Date Acquired : 06/06/2019 08:31:28 PM
Units : ppb
Dilution : SE CP108[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

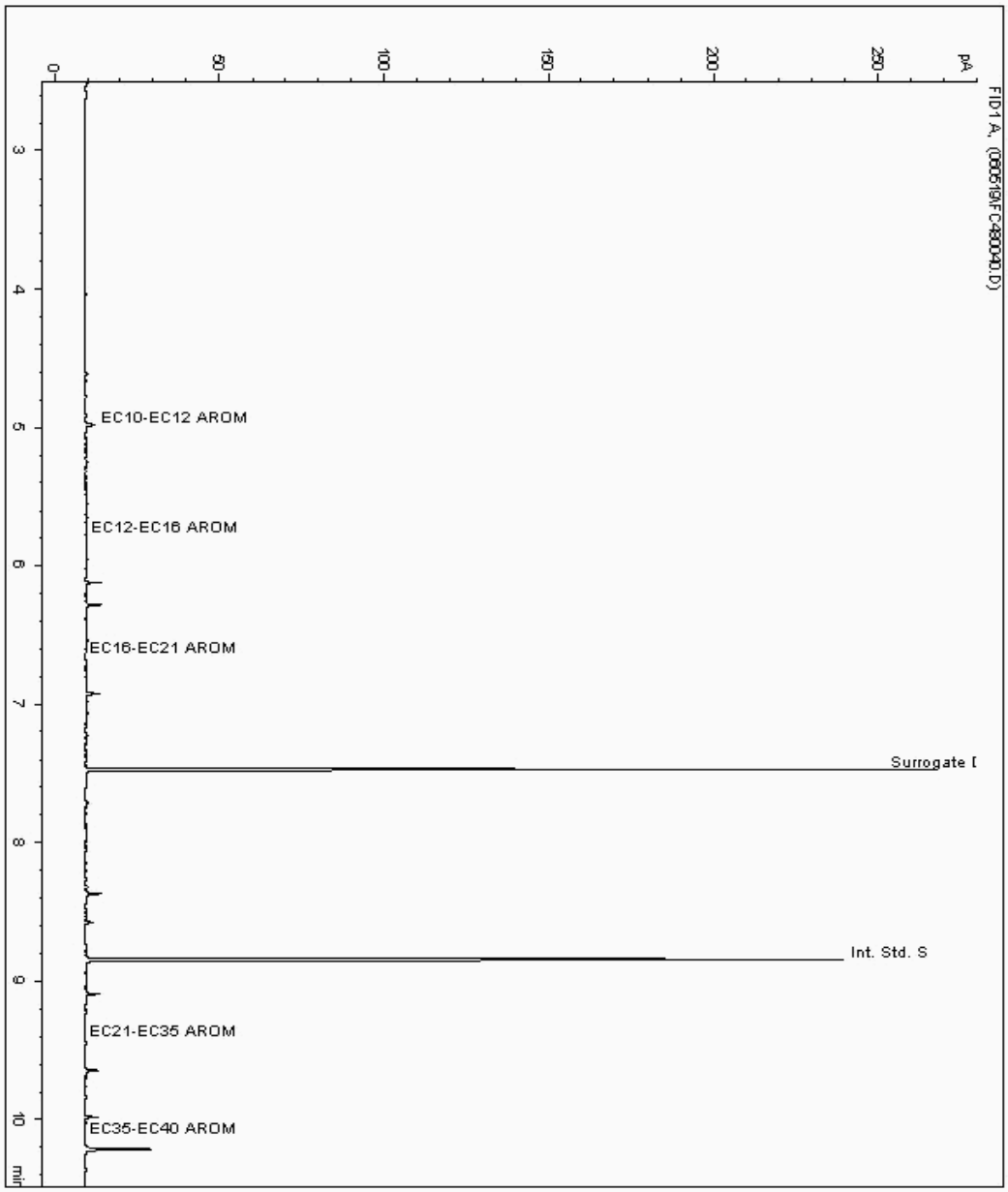
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20065901 **Depth :** 0.00 - 0.00
Sample ID : BH4

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842276-
Date Acquired : 06/06/2019 06:59:06 PM
Units : ppb
Dilution : SE BH4[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

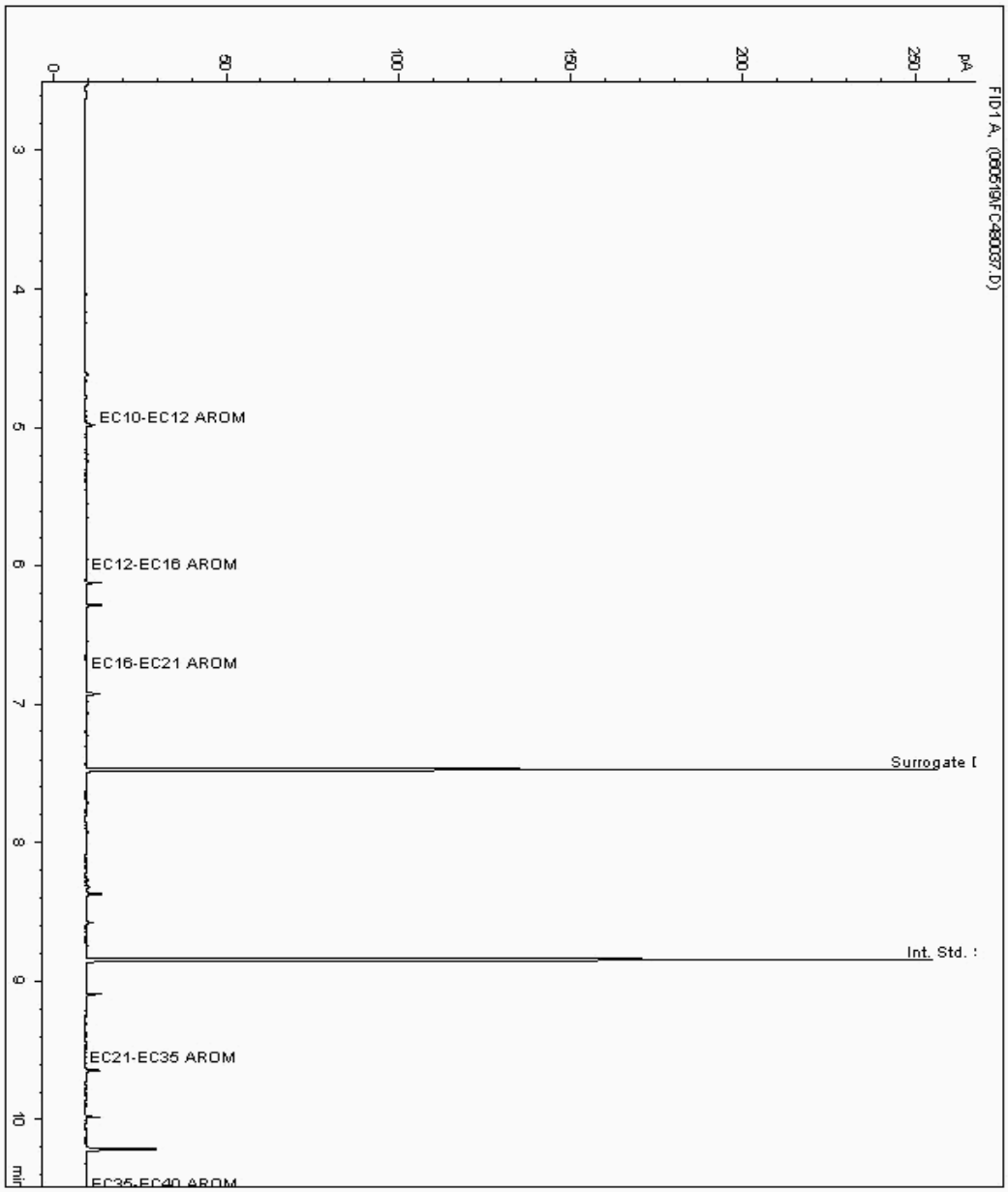
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20065916 **Depth :** 0.00 - 0.00
Sample ID : CP102

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842315-
Date Acquired : 06/06/2019 05:51:05 PM
Units : ppb
Dilution : SE CP102[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

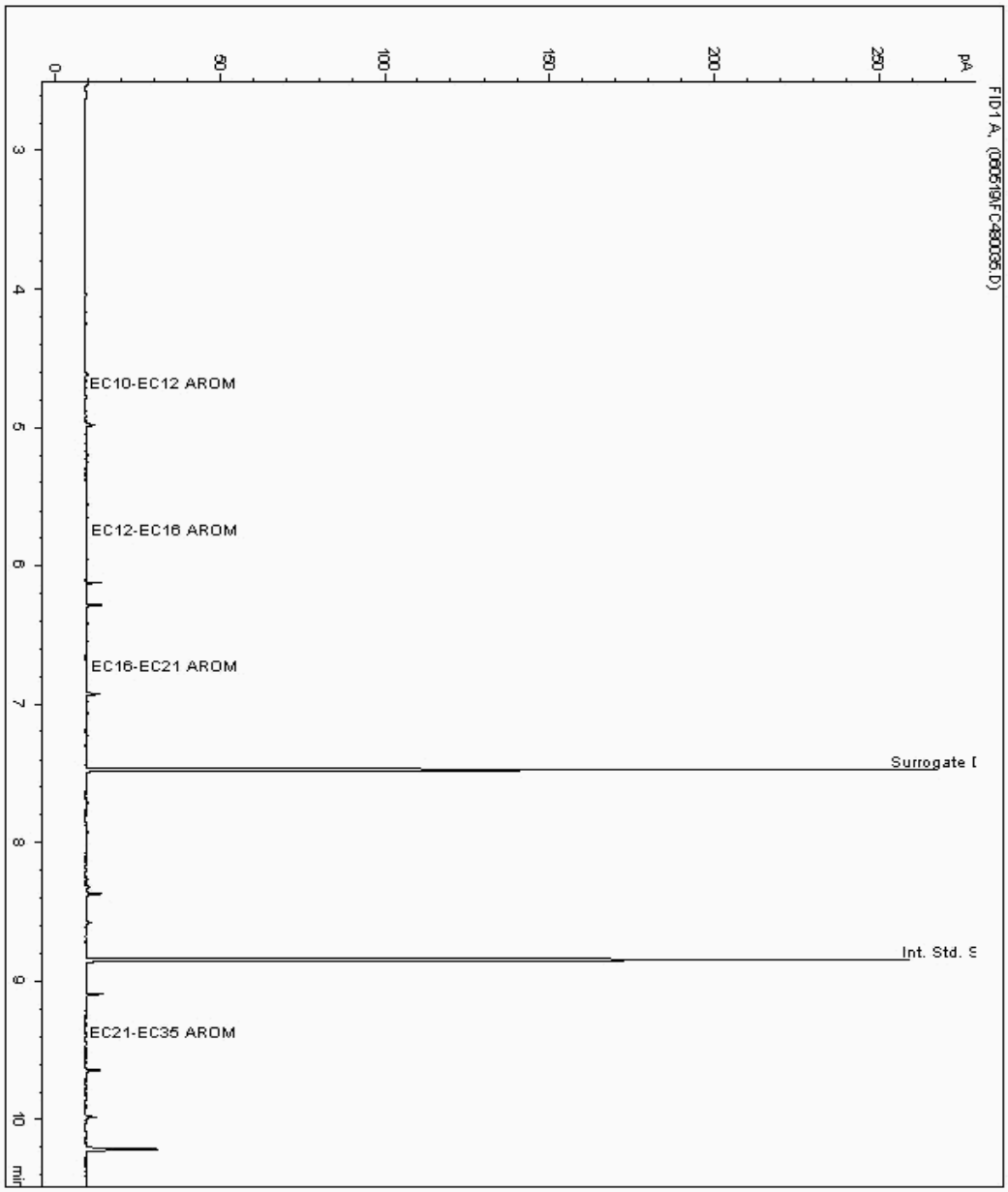
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20065973 **Depth :** 0.00 - 0.00
Sample ID : BH6

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842302-
Date Acquired : 06/06/2019 05:04:57 PM
Units : ppb
Dilution : SE BH6[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

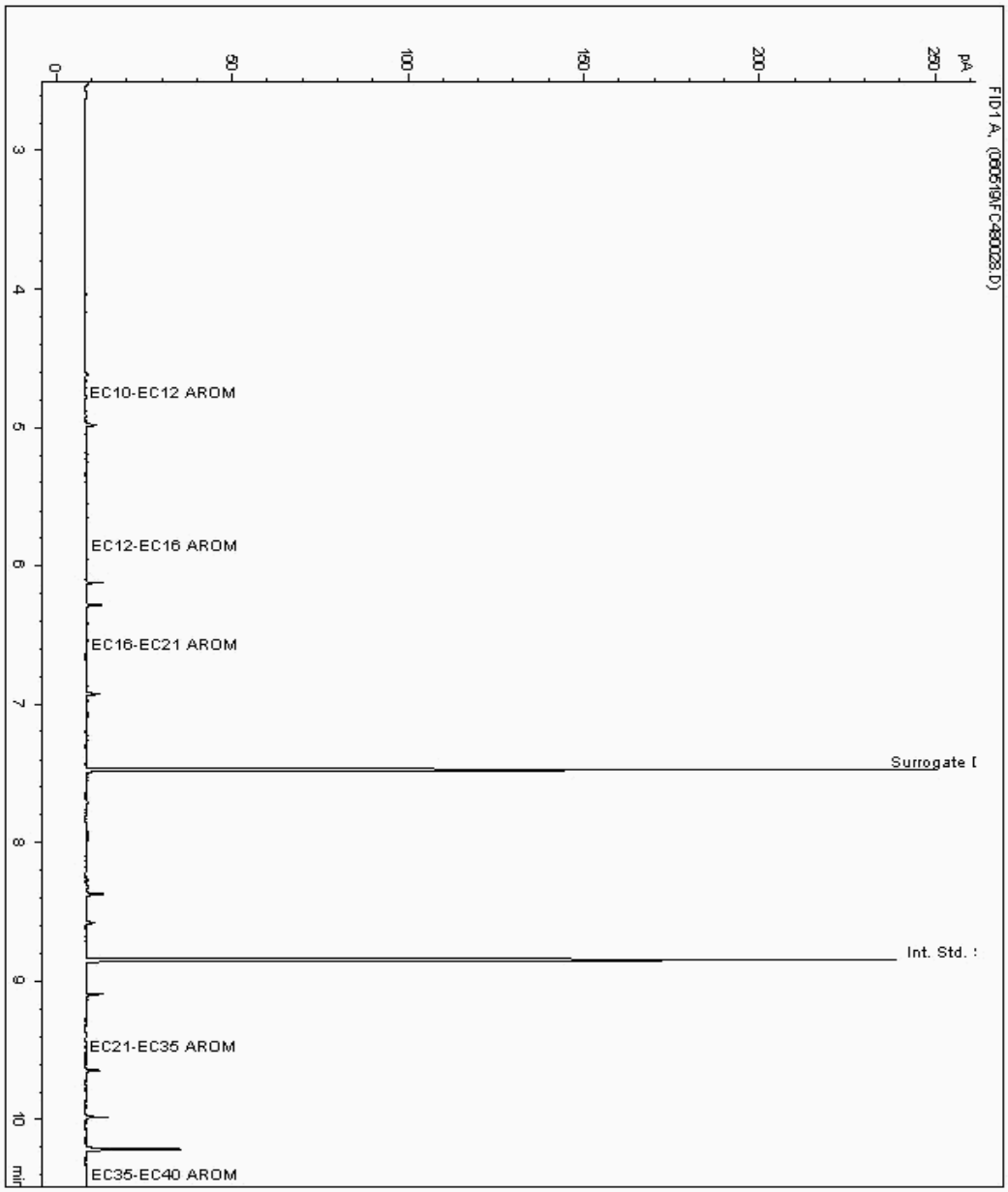
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20066023 **Sample ID :** BH2 **Depth :** 0.00 - 0.00

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842250-
Date Acquired : 06/06/2019 02:20:35 PM
Units : ppb
Dilution : SE BH2[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

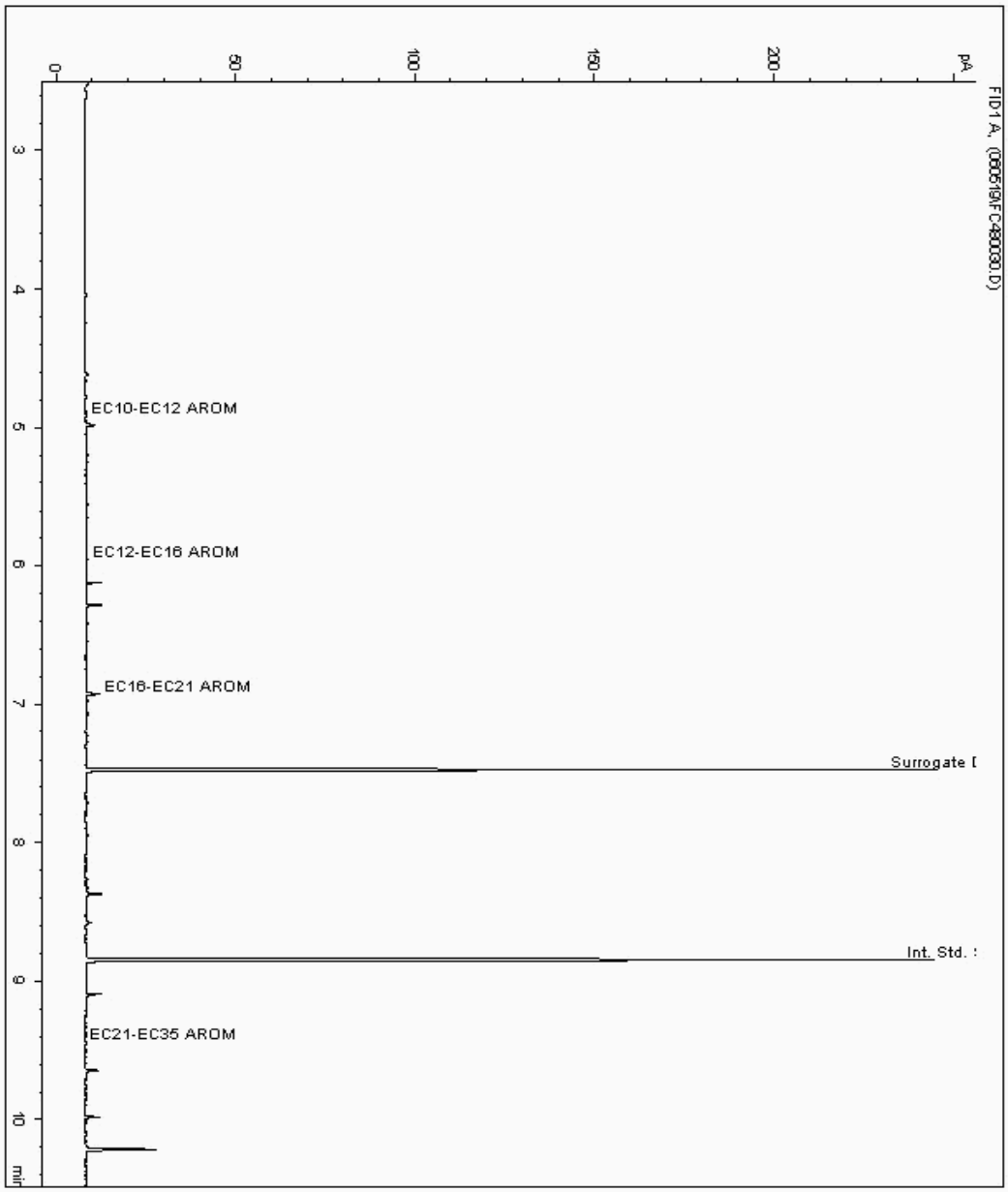
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20066042 **Depth :** 0.00 - 0.00
Sample ID : BH1

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842206-
Date Acquired : 06/06/2019 03:07:34 PM
Units : ppb
Dilution : SE BH1[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

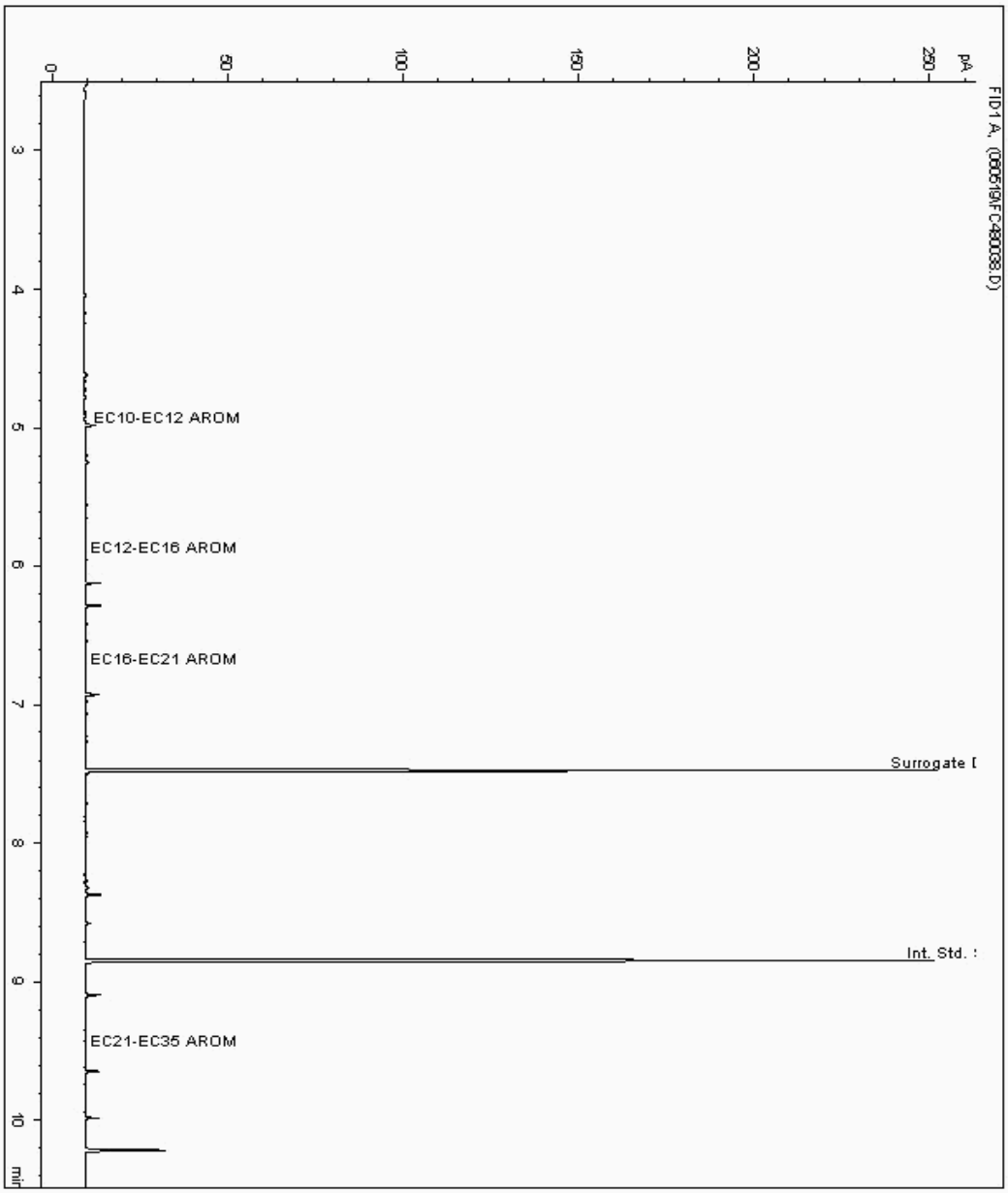
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20066072 **Sample ID :** CPPB7 **Depth :** 0.00 - 0.00

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842219-
Date Acquired : 06/06/2019 06:14:24 PM
Units : ppb
Dilution : SE CPPB7[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

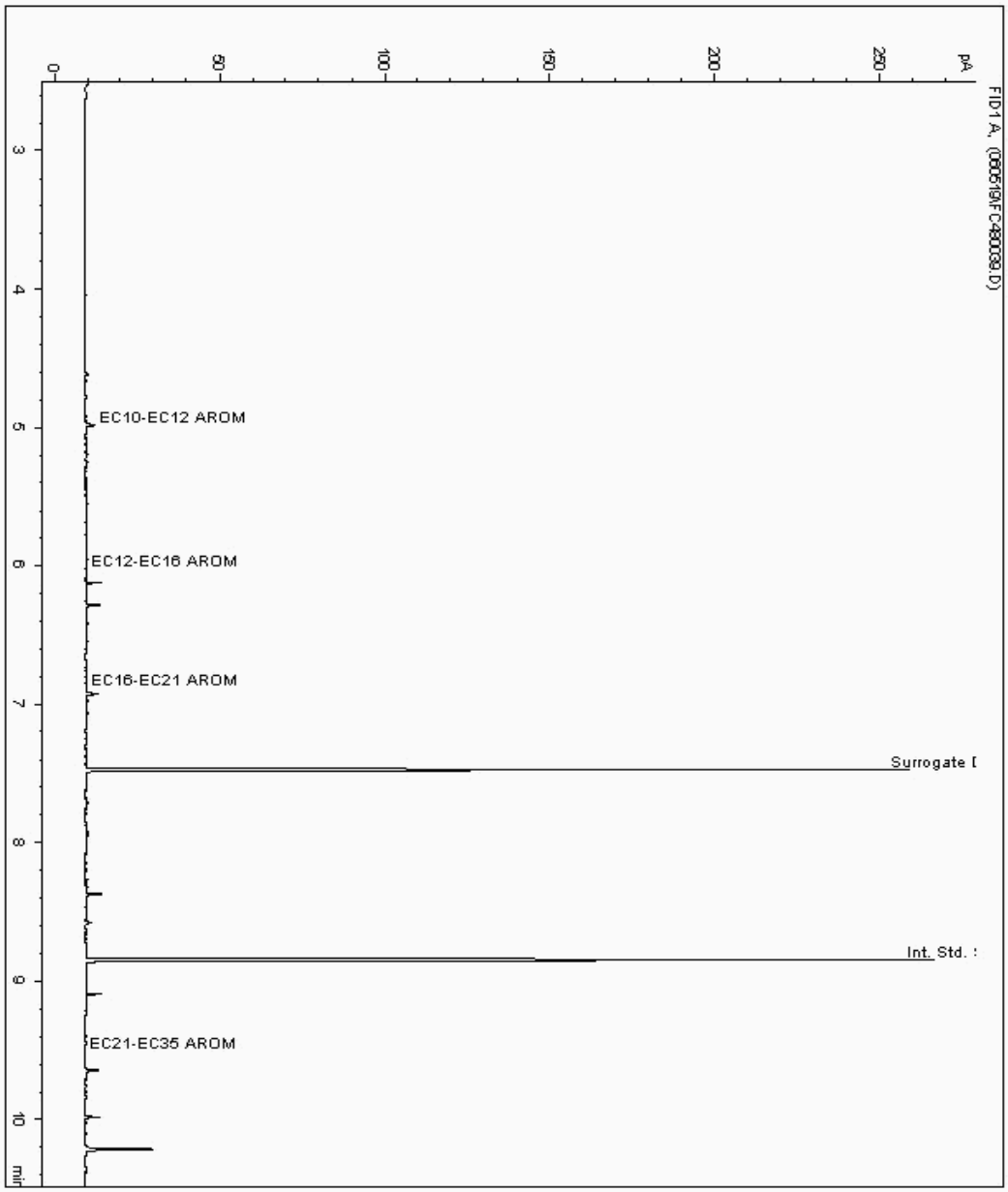
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20066089 **Depth :** 0.00 - 0.00
Sample ID : BH5

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842289-
Date Acquired : 06/06/2019 06:37:28 PM
Units : ppb
Dilution : SE BH5[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

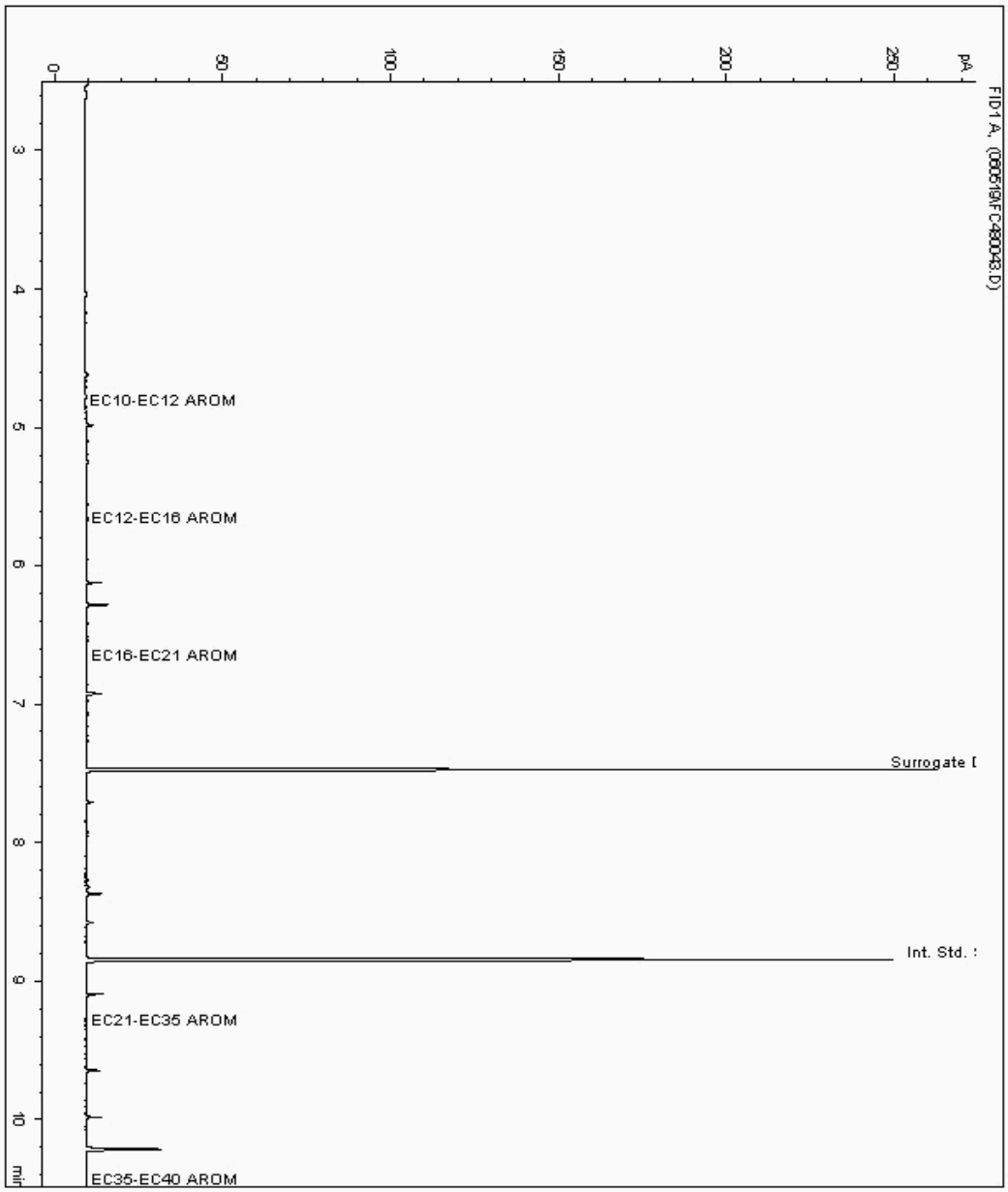
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20066113 **Depth :** 0.00 - 0.00
Sample ID : DUP

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842232-
Date Acquired : 06/06/2019 08:07:57 PM
Units : ppb
Dilution : SE DUP[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

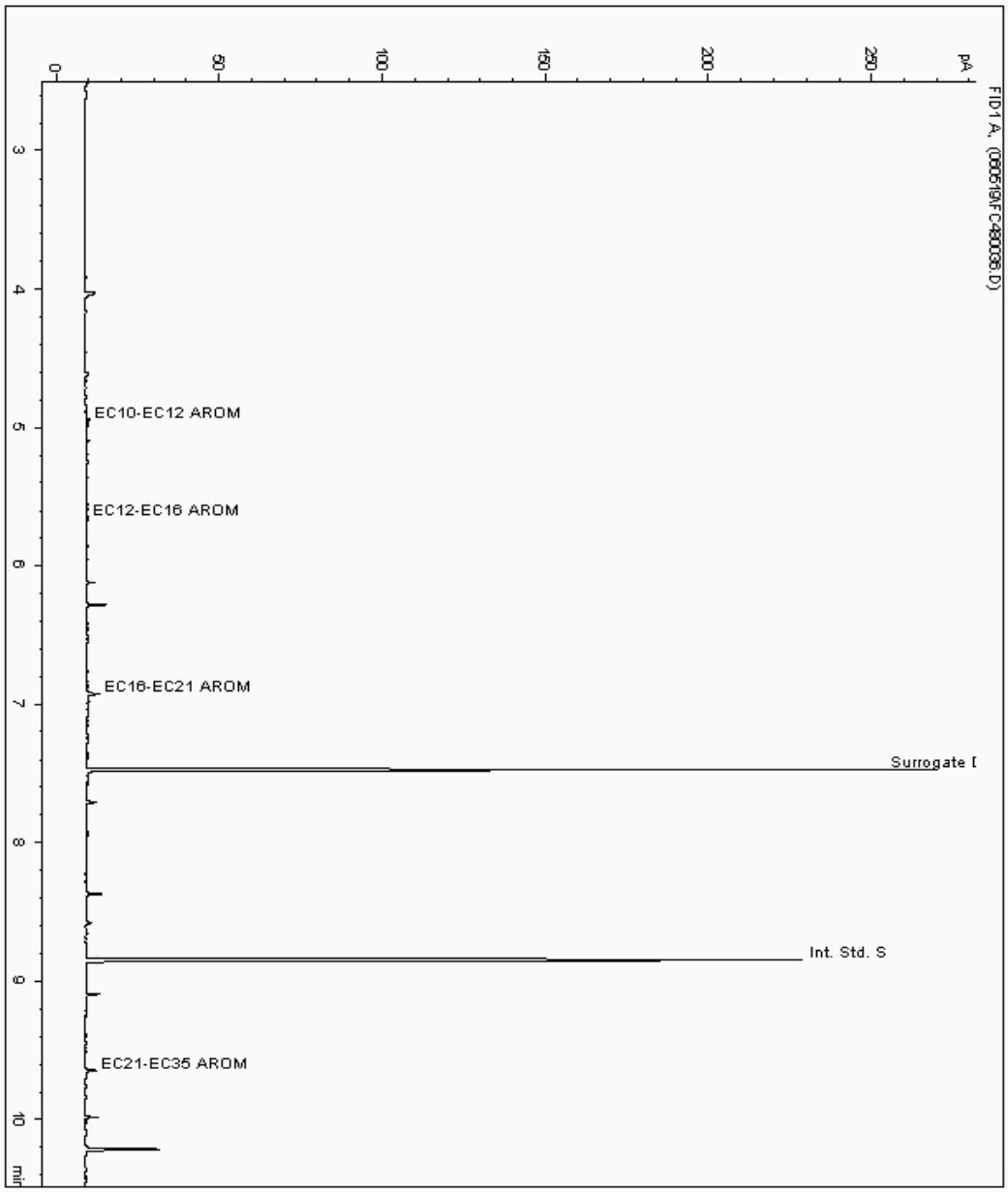
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: EPH CWG (Aromatic) Filtered GC (W) **Sample No :** 20066126 **Depth :** 0.00 - 0.00
Sample ID : BH3

Alcontrol/Geochem Analytical Services
Speciated TPH - AROM (C12 - C40)

Sample Identity: 18842263-
Date Acquired : 06/06/2019 05:28:01 PM
Units : ppb
Dilution : SE BH3[0.00 - 0.00] ->
CF : 1
Multiplier : 0.025



CERTIFICATE OF ANALYSIS

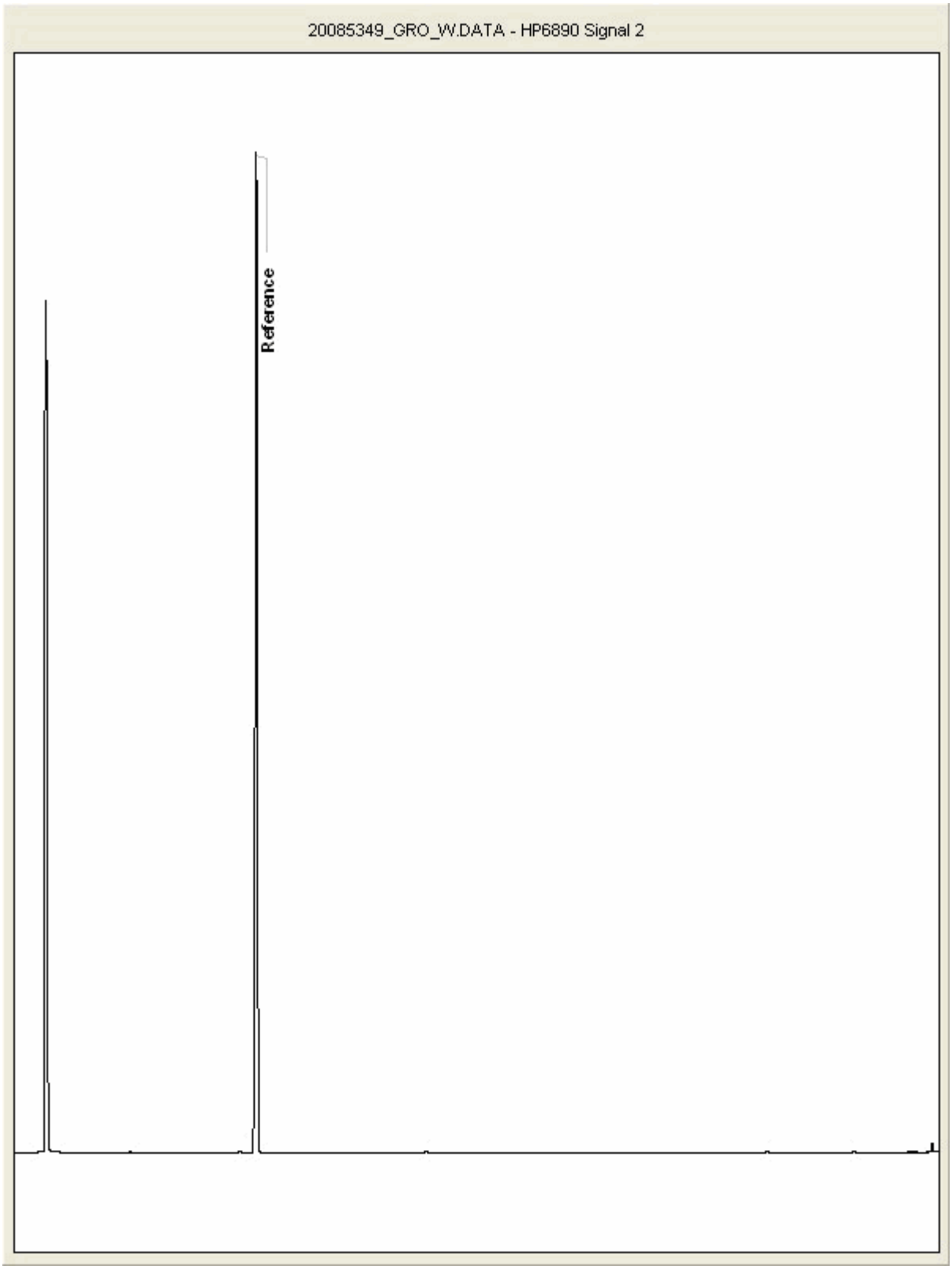
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085349
Sample ID : CP102

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

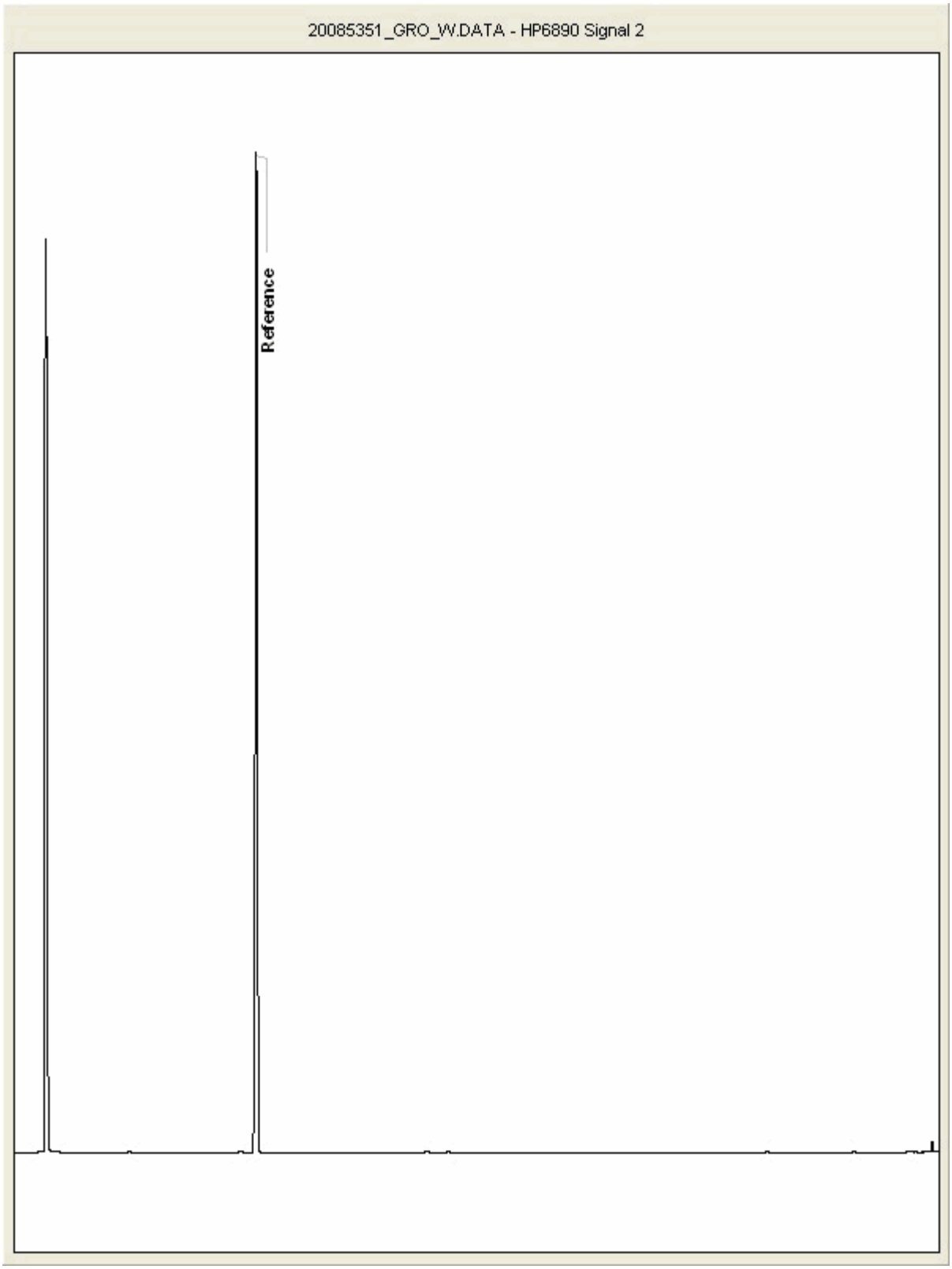
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085351
Sample ID : BH2

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

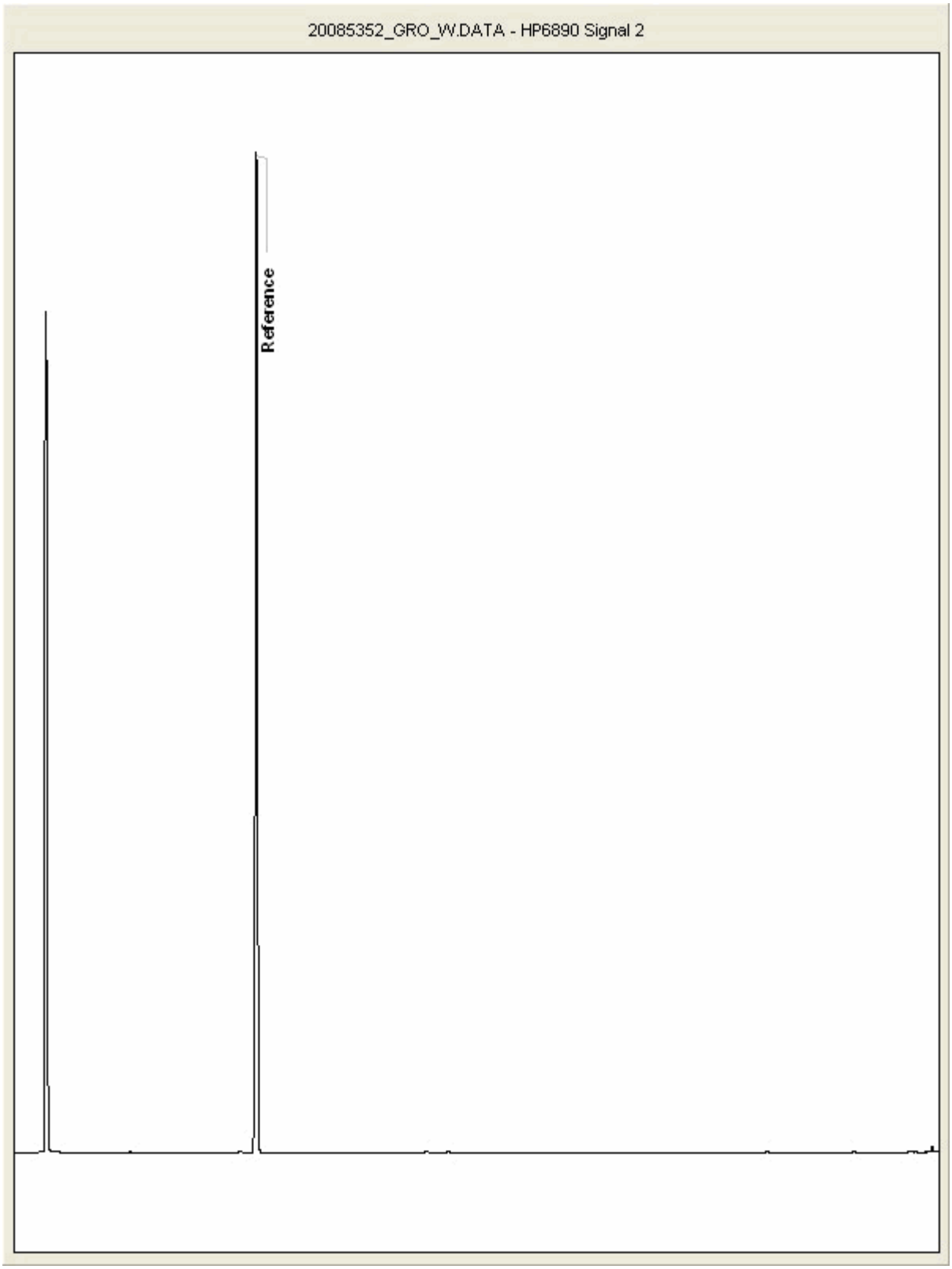
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085352
Sample ID : BH3

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

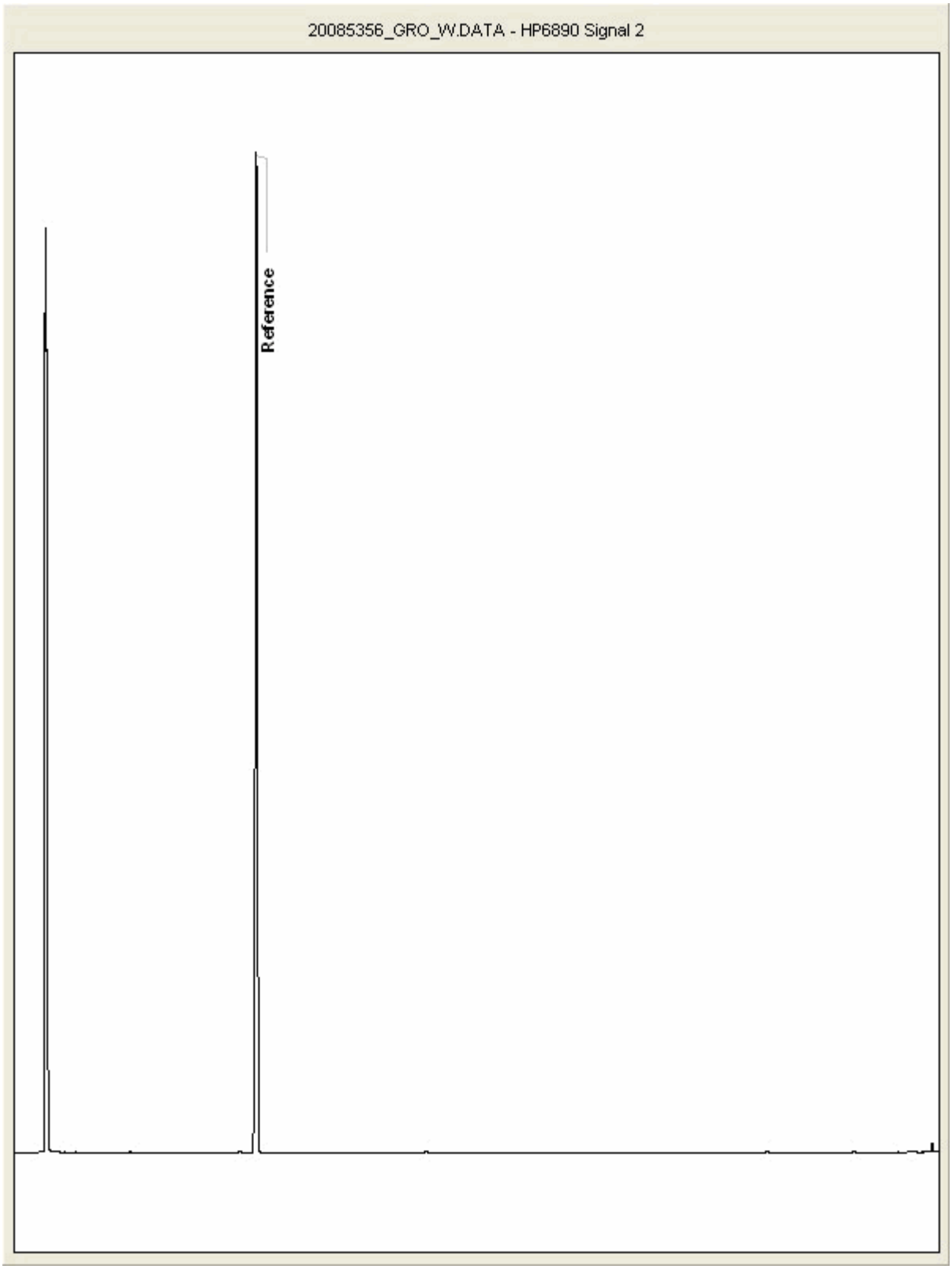
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085356
Sample ID : BH1

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

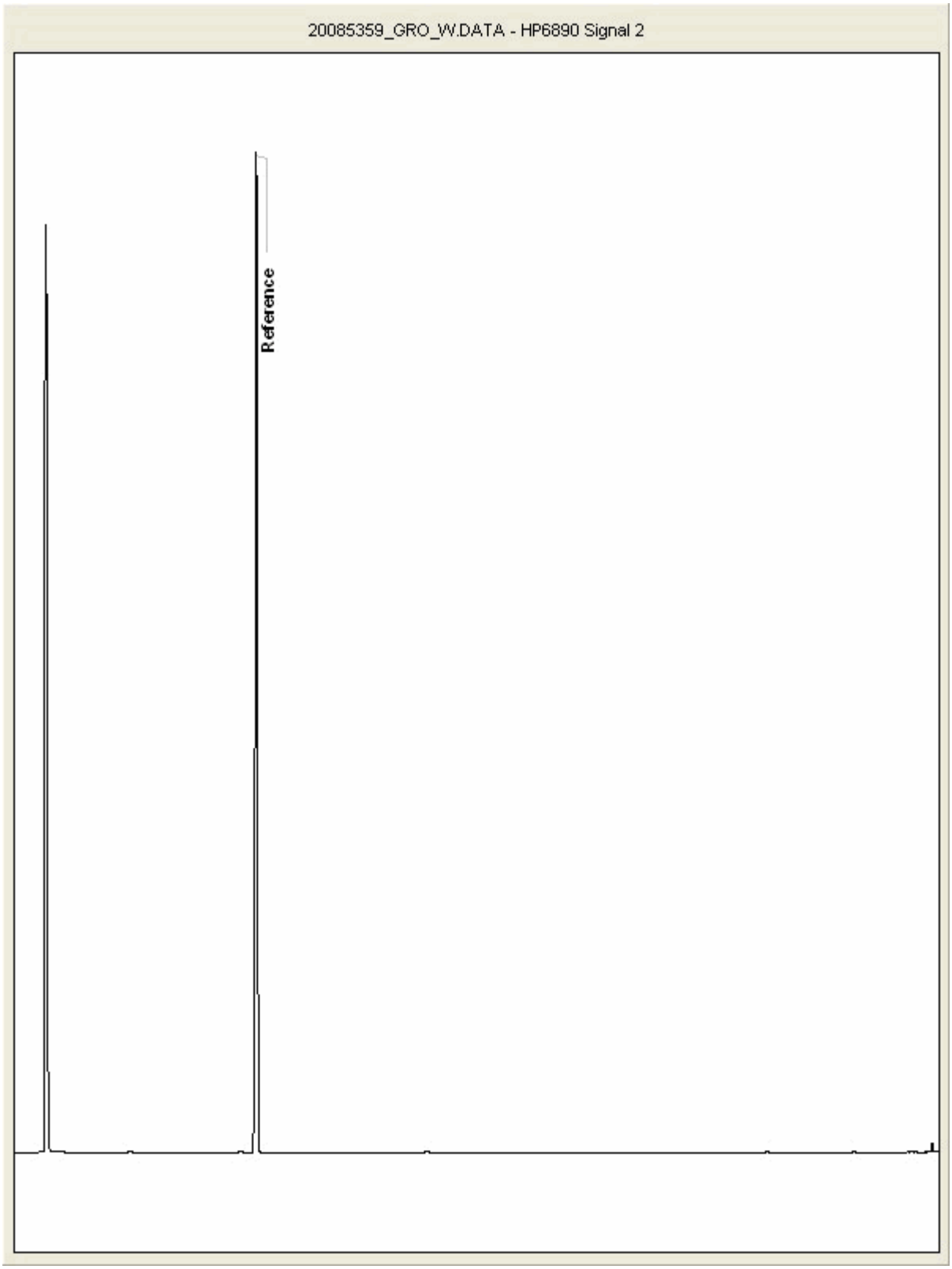
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085359
Sample ID : BH6

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

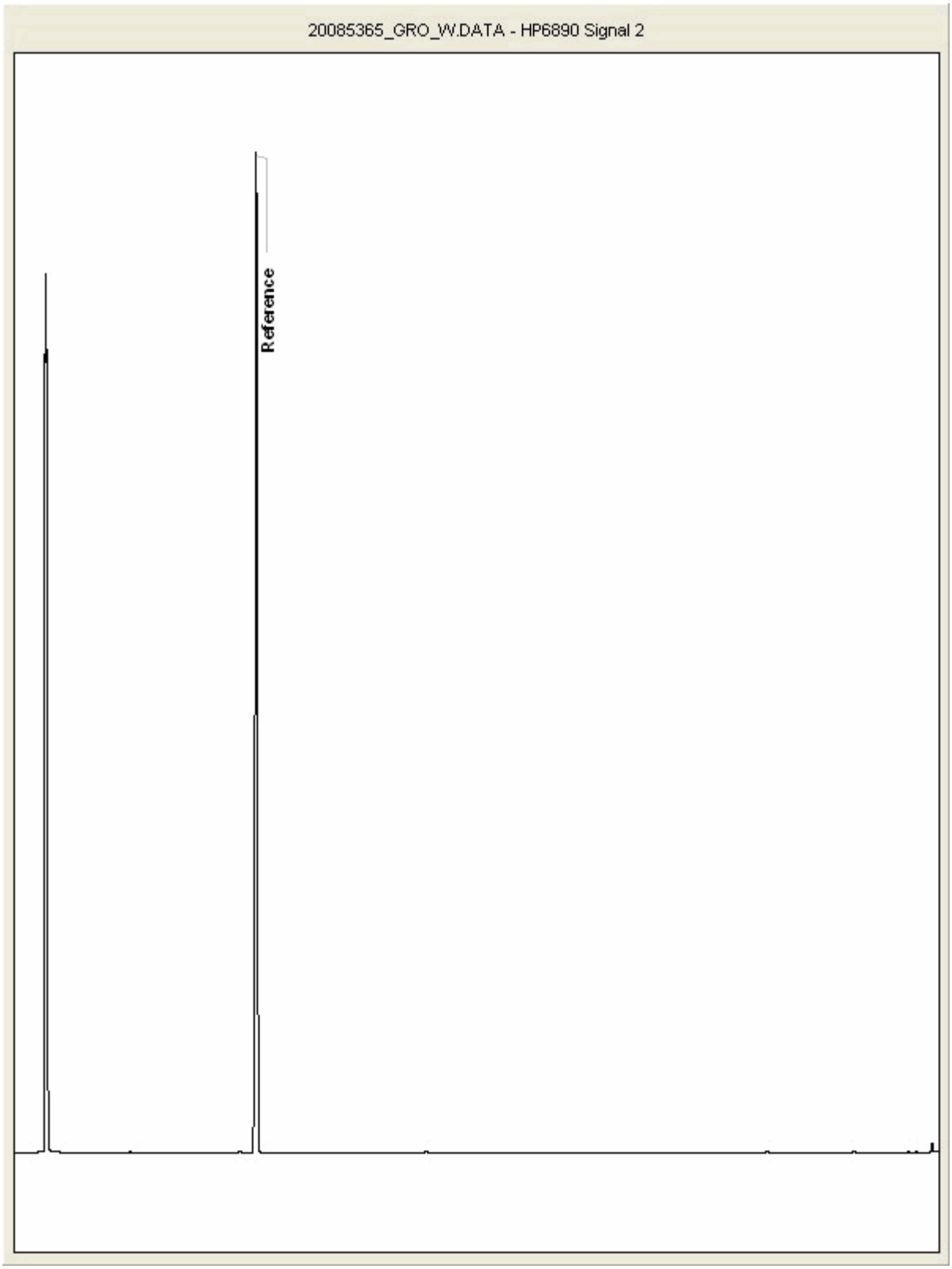
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085365
Sample ID : CP108

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

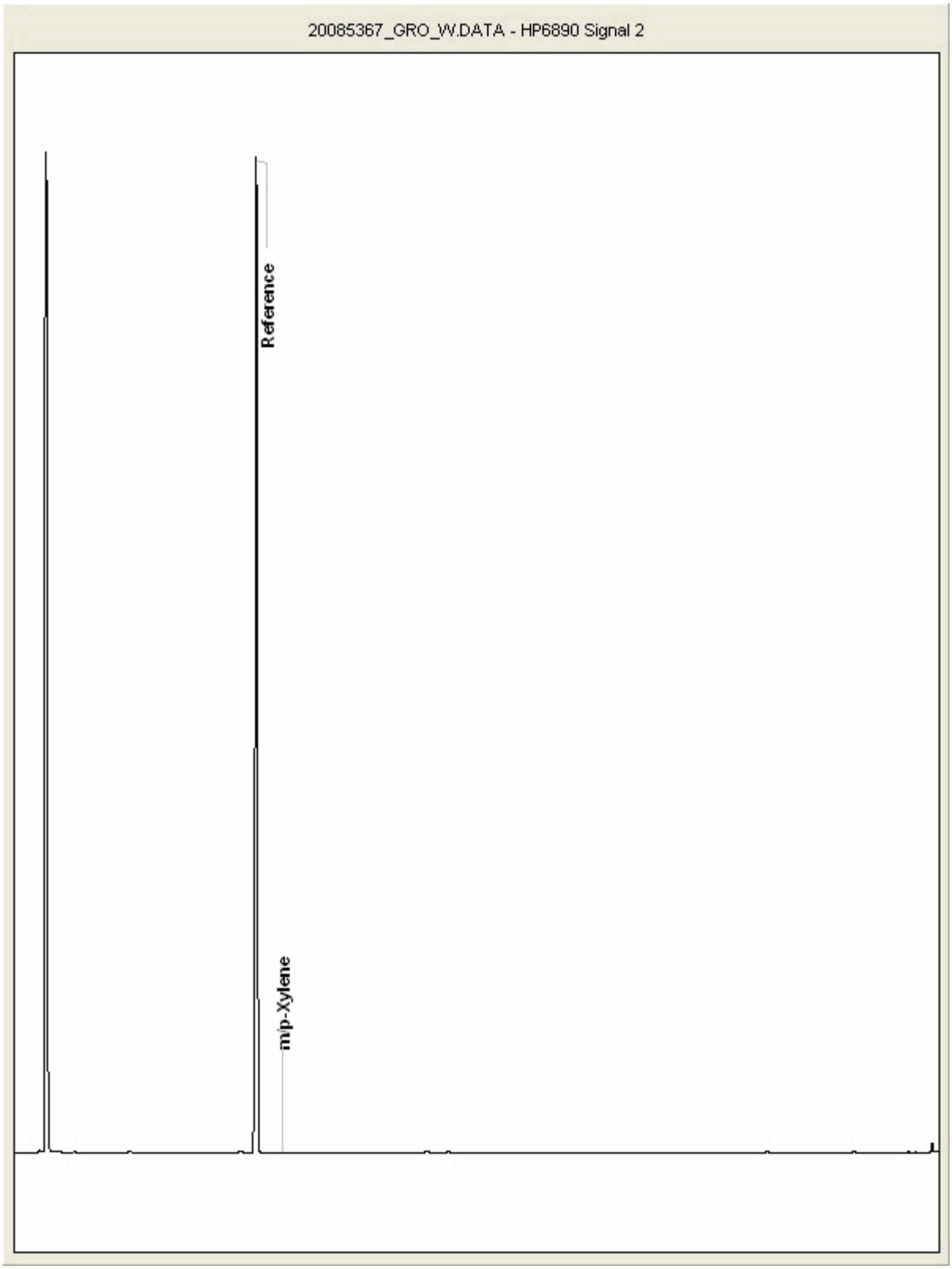
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085367
Sample ID : CP105

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

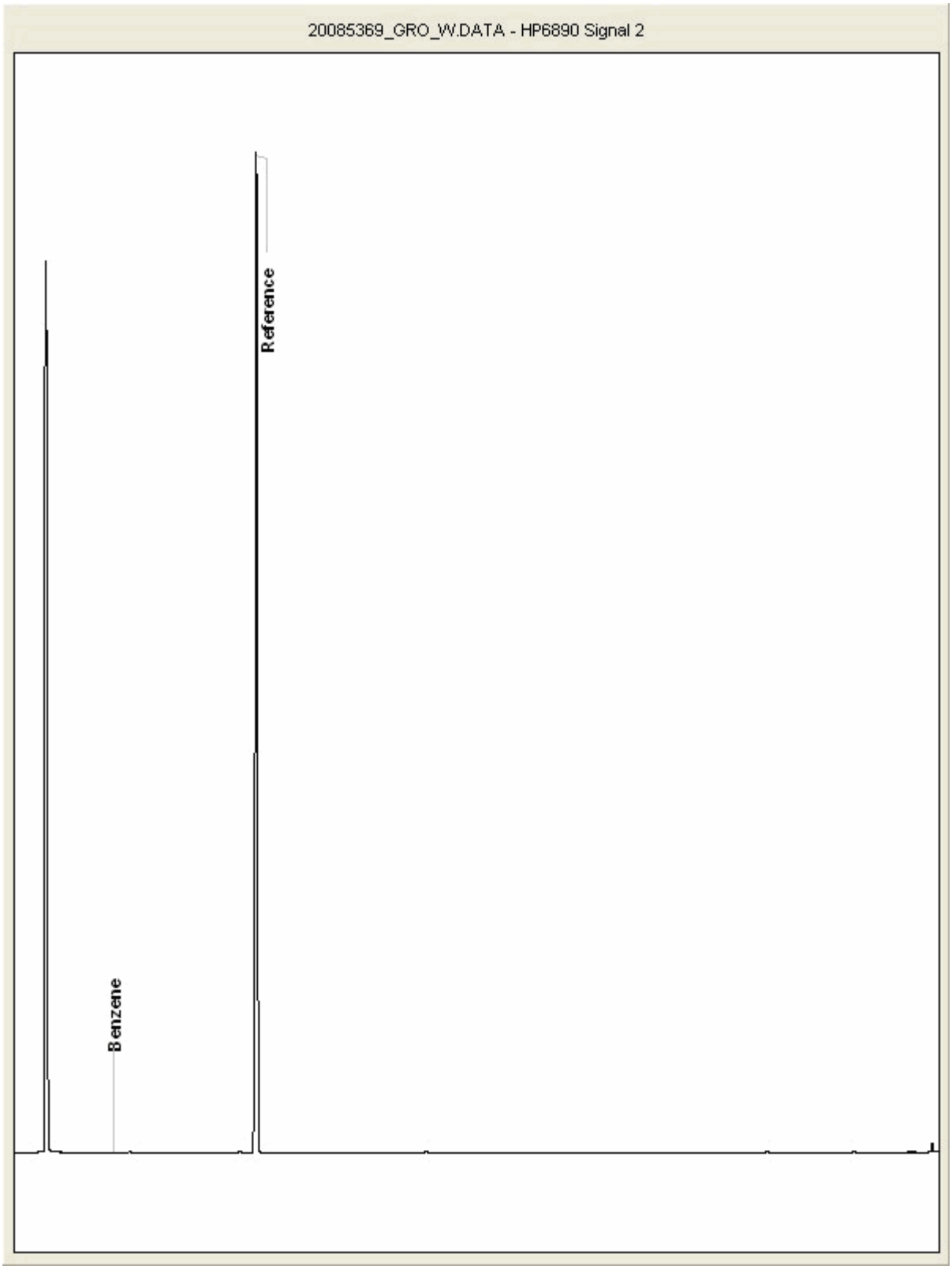
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085369
Sample ID : BH5

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

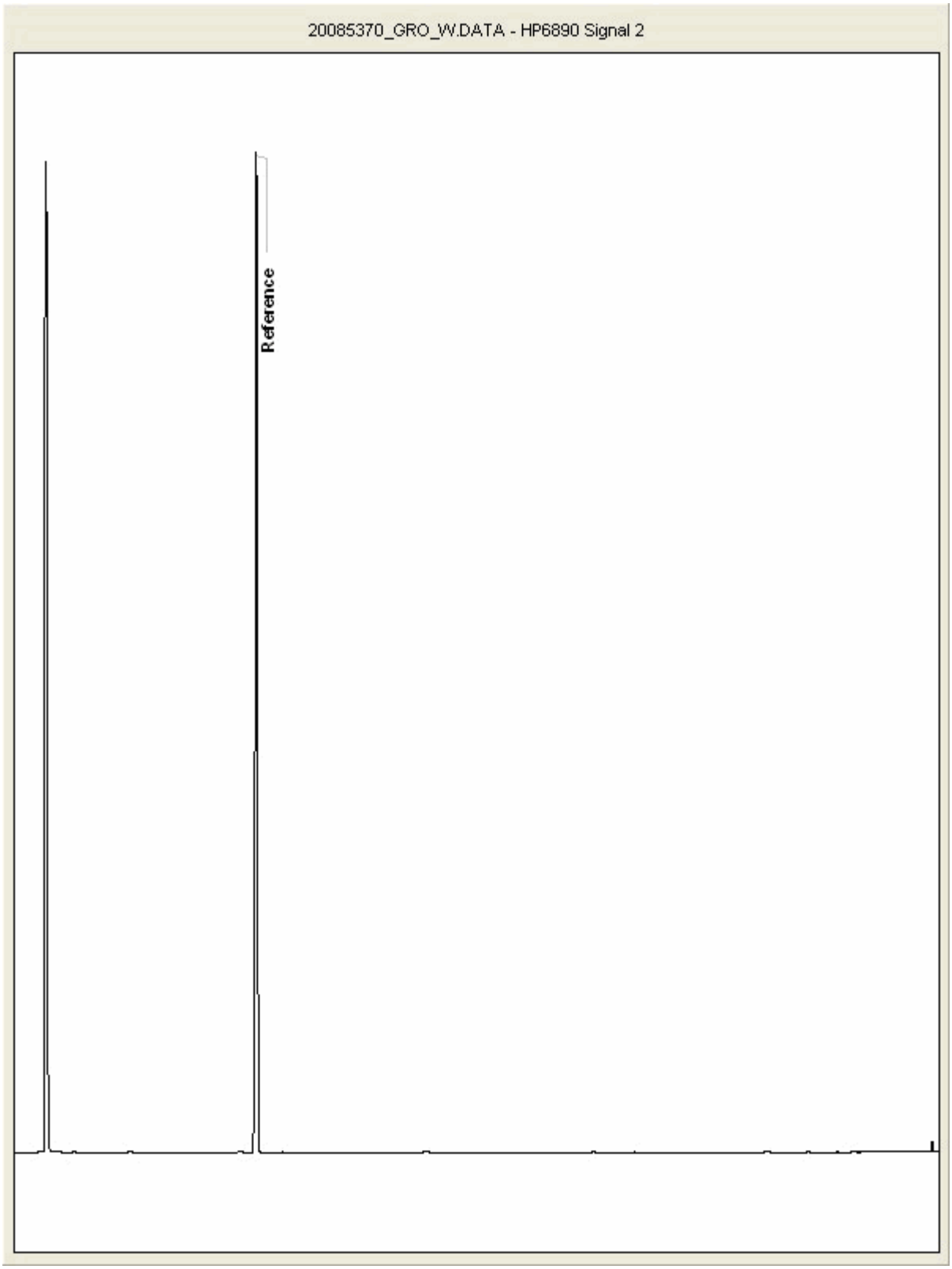
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20085370
Sample ID : BH4

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

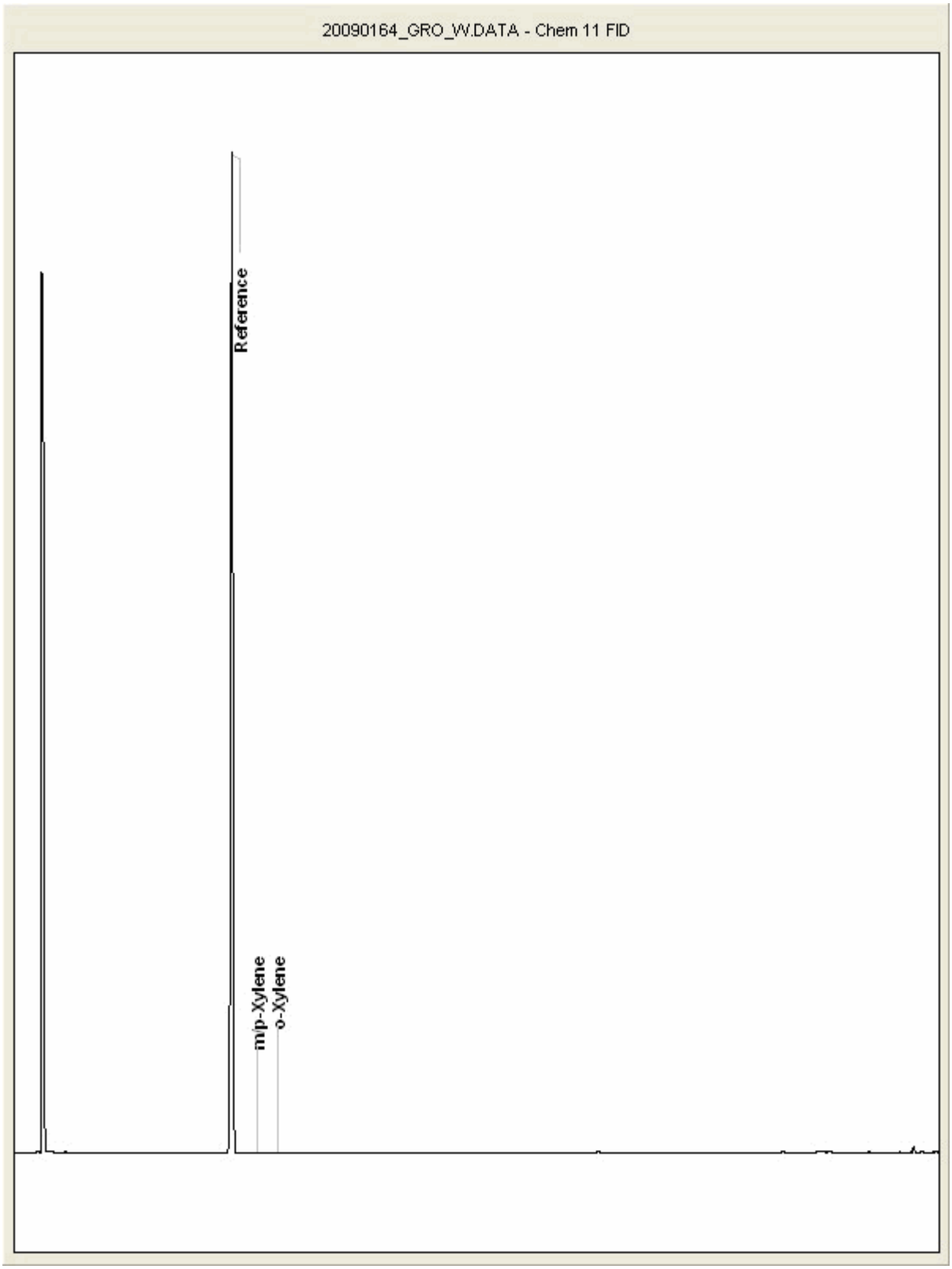
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20090164
Sample ID : CPPB7

Depth : 0.00 - 0.00



CERTIFICATE OF ANALYSIS

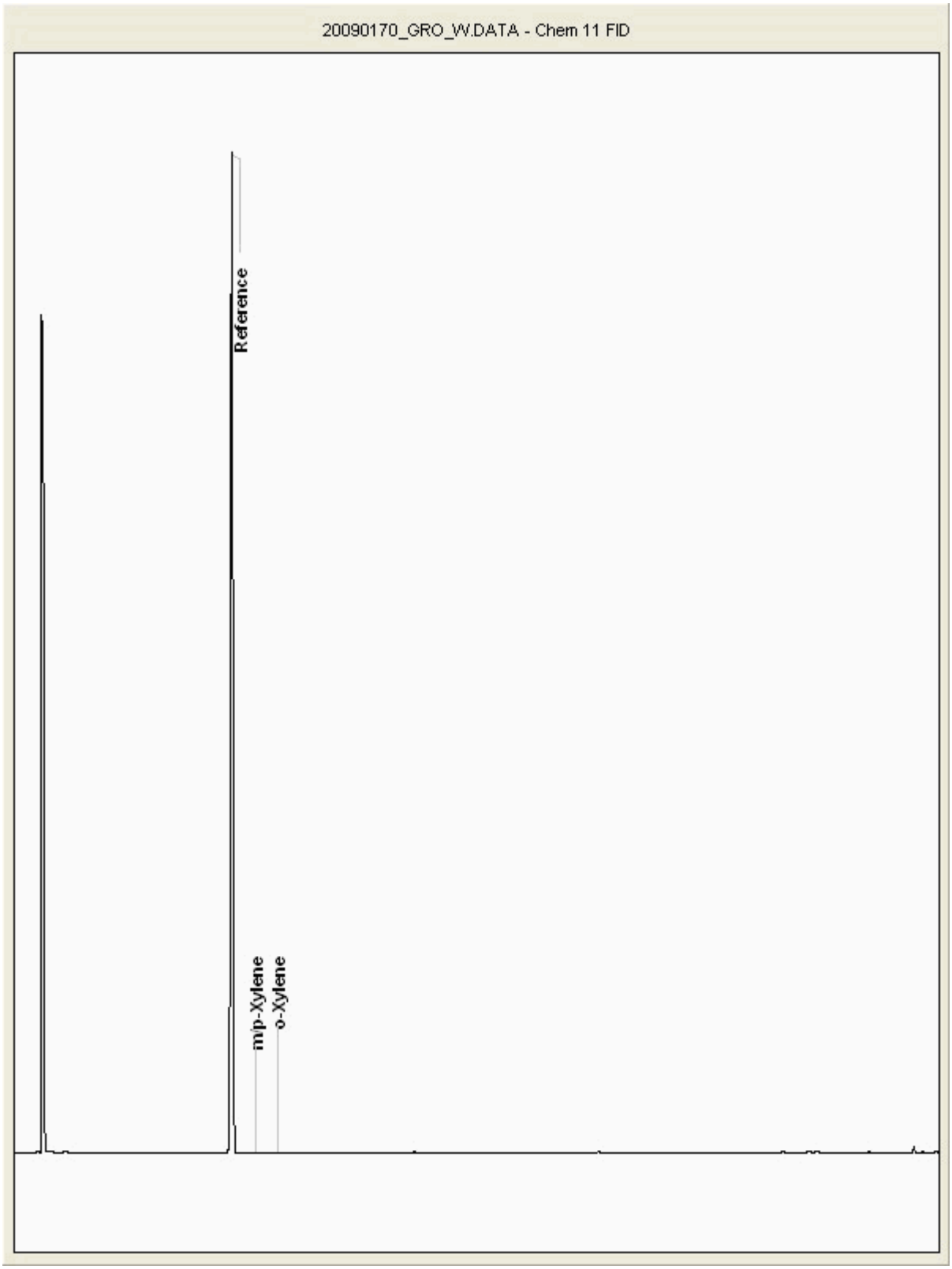
SDG:	190601-3	**Client Reference:**	70054861	**Report Number:**	509868
Location:	Grillo	**Order Number:**	70054861-P01	**Superseded Report:**	509826

Chromatogram

Analysis: GRO by GC-FID (W)

Sample No : 20090170
Sample ID : DUP

Depth : 0.00 - 0.00



Appendix General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as “Not detected”. If no asbestos fibre types are found all will be reported as “Not detected” and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of asbestos present is not determined unless specifically requested.

7. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

9. NDP - No determination possible due to insufficient/unsuitable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals - total metals must be requested separately.

11. Results relate only to the items tested.

12. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

13. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

14. **Product analyses** - Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors employed.

15. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).

16. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

20. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

21. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

22. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

23. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

24. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as “mixed hydrocarbons”. Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

Sample Deviations

If a sample is classed as deviated then the associated results may be compromised.

1	**Container with Headspace provided for volatiles analysis**
2	**Incorrect container received**
3	**Deviation from method**
§	**Sampled on date not provided**
♦	**Sample holding time exceeded in laboratory**
@	**Sample holding time exceeded due to late arrival of instructions or samples**

Asbestos

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

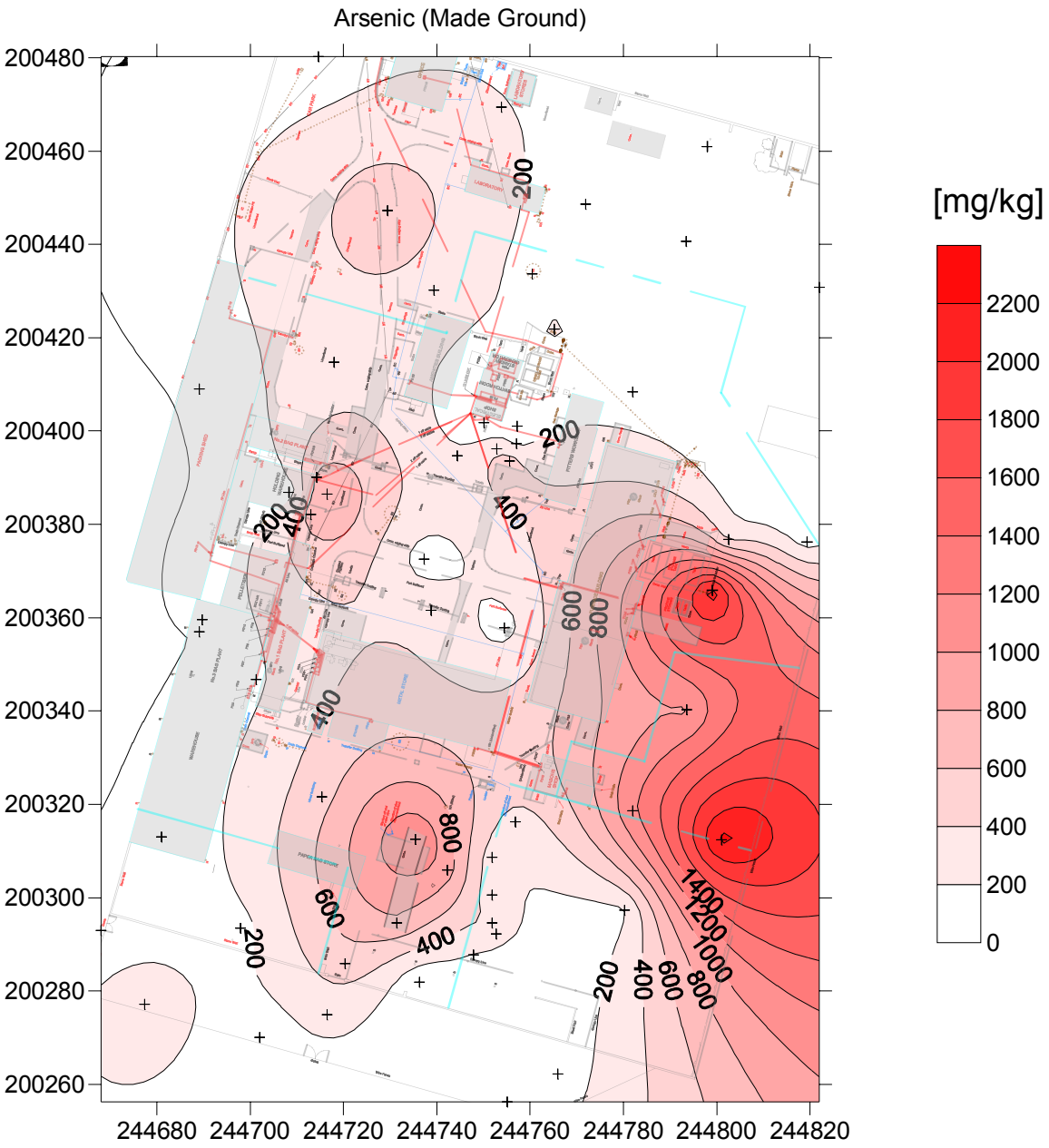
The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

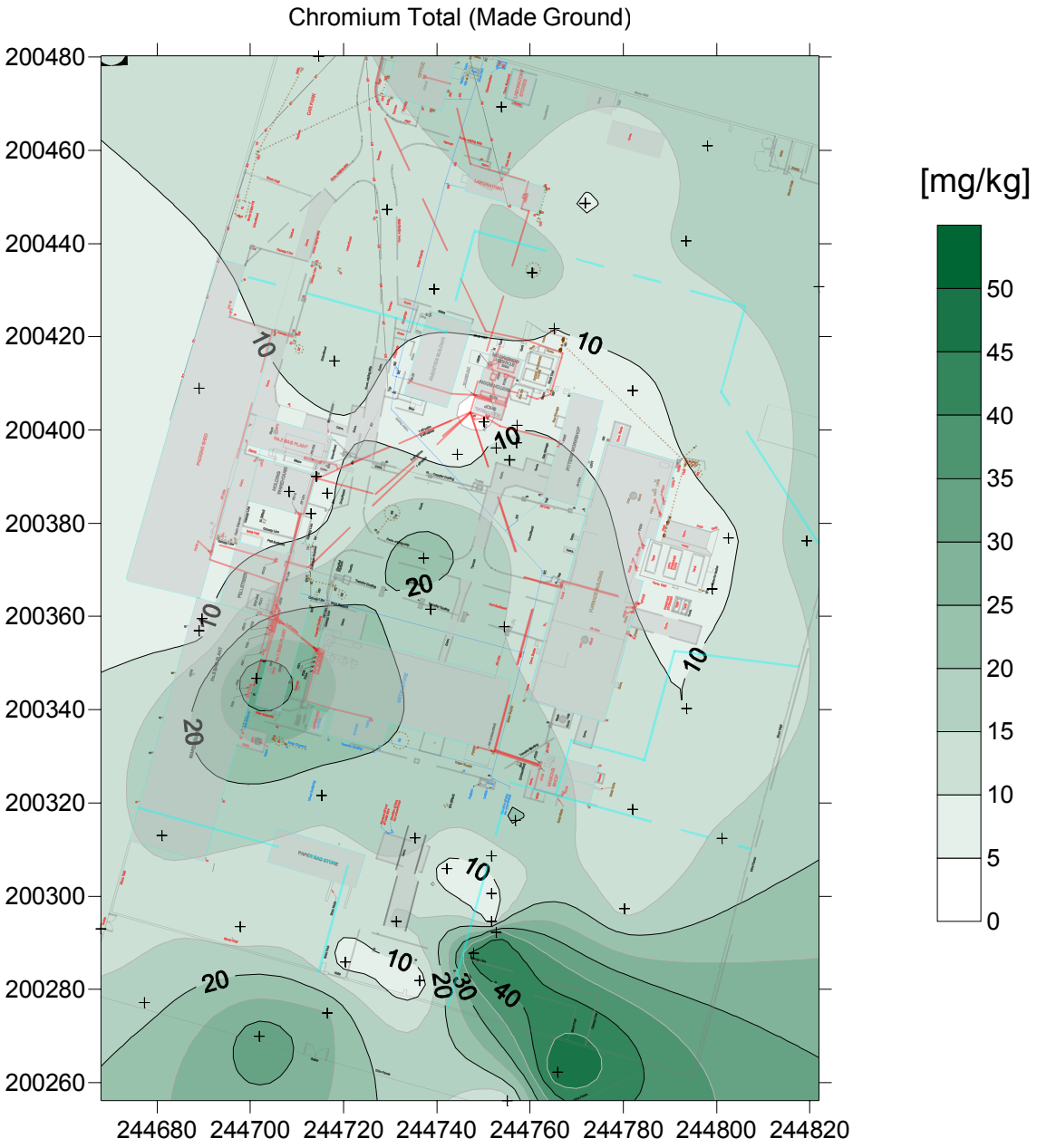
Appendix F

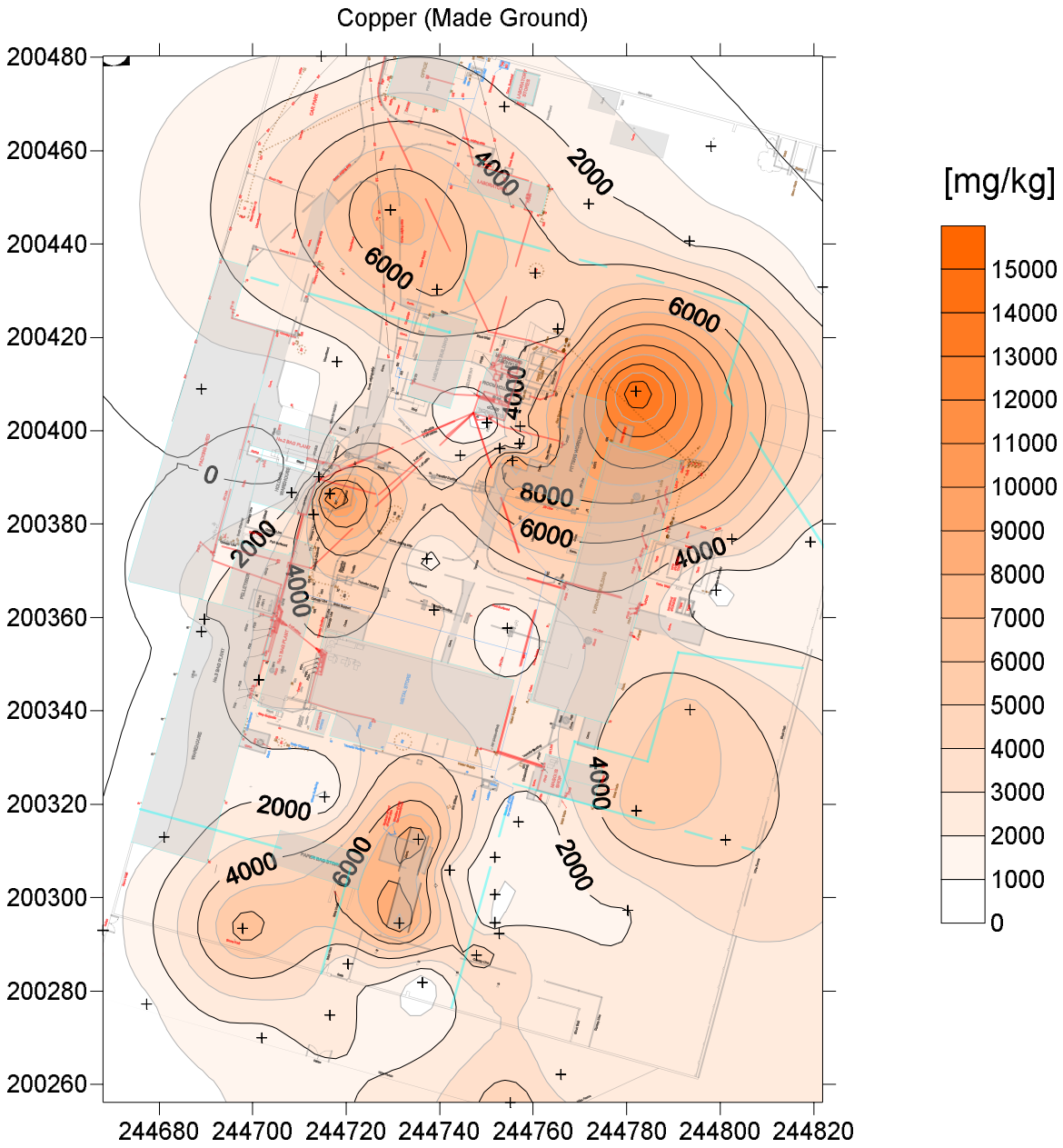
METAL DISTRIBUTION IN SOIL

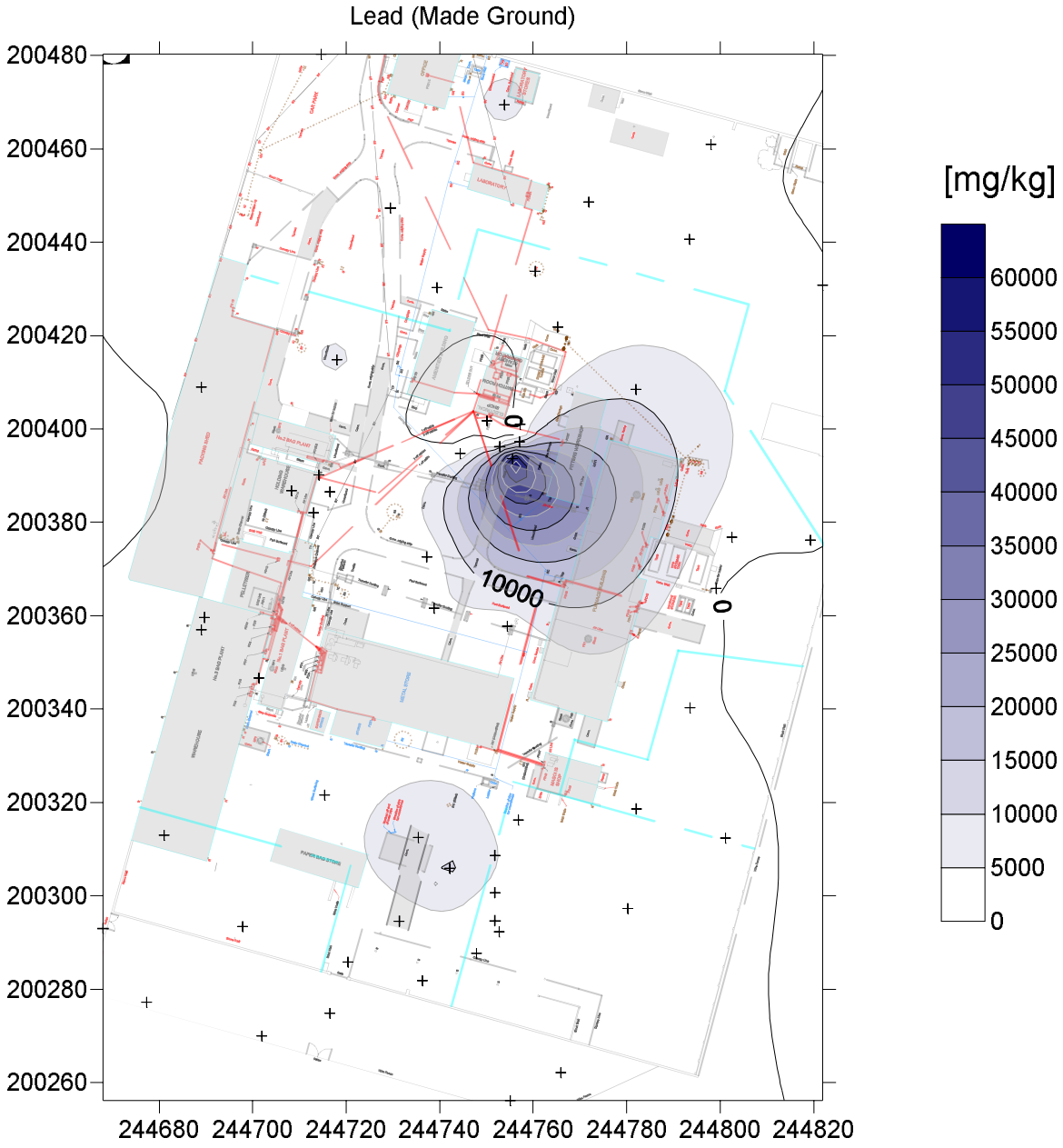
Grillo Shallow Soils

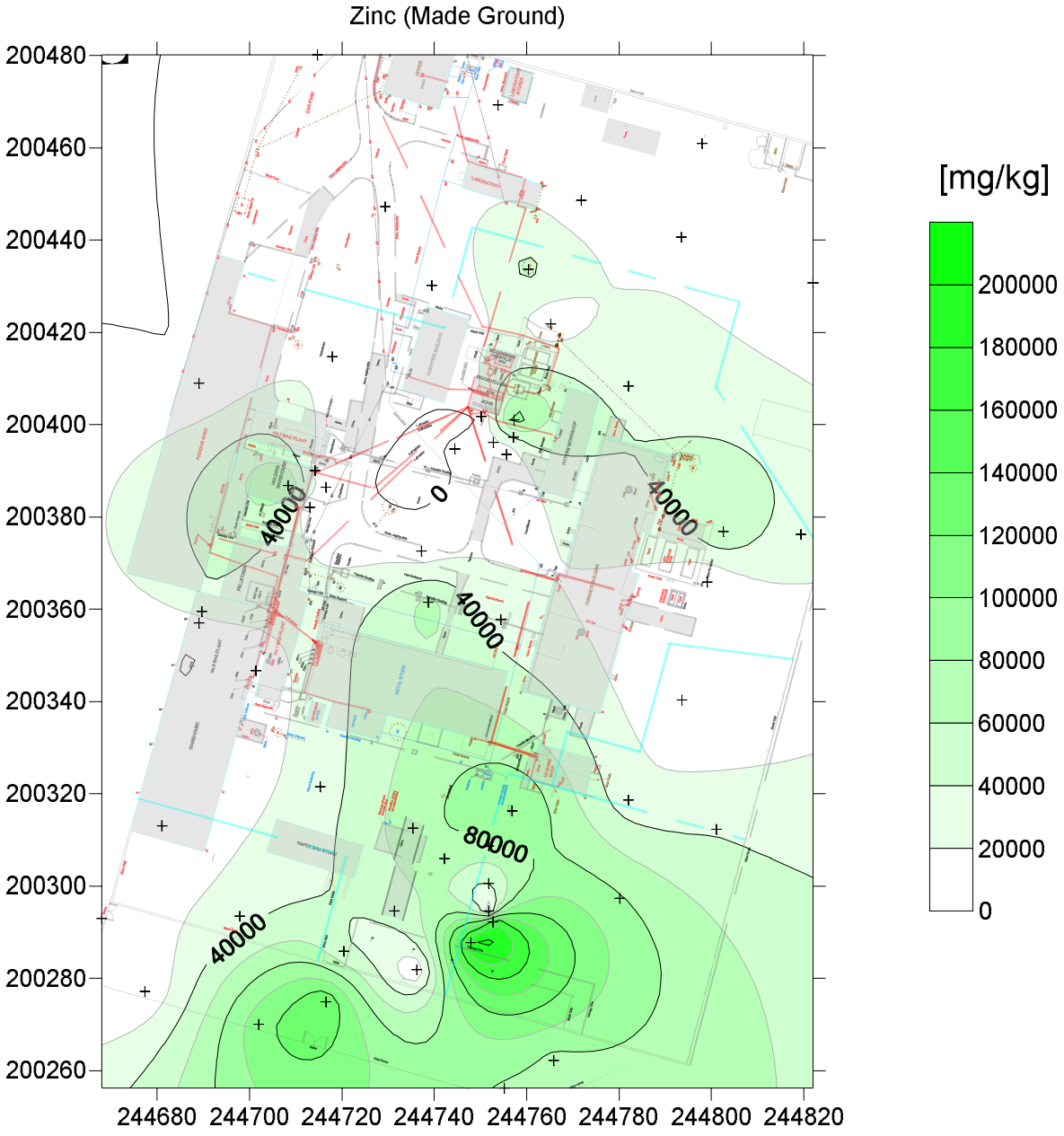
Heavy metal distribution in Made Ground (0.3 to 1.0 m bgl)




Chromium Total (Made Ground)
200480
200460
200440
200420
200400
200380
200360
200340
200320
200300
200280
200260
244680
244700
244720
244740
244760
244780
244800
244820
10
20
30
40
[mg/kg]
50
45
40
35
30
25
20
15
10
5
0


Copper (Made Ground)
200480
200460
200440
200420
200400
200380
200360
200340
200320
200300
200280
200260
244680
244700
244720
244740
244760
244780
244800
244820
0
2000
4000
6000
8000
[mg/kg]
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0


Lead (Made Ground)
200480
200460
200440
200420
200400
200380
200360
200340
200320
200300
200280
200260
244680
244700
244720
244740
244760
244780
244800
244820
10000
0
0
[mg/kg]
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0


Zinc (Made Ground)
200480
200460
200440
200420
200400
200380
200360
200340
200320
200300
200280
200260
244680
244700
244720
244740
244760
244780
244800
244820
0
40000
40000
40000
80000
40000
[mg/kg]
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0

Appendix G

CONTROLLED WATERS RISK ASSESSMENT

Appendix G.1

METHODOLOGY - GUIDANCE

UK APPROACH

THE LEGISLATION

OVERVIEW OF POINTS PERTINENT TO CONTROLLED WATERS RISK ASSESSMENT

The EU Water Framework Directive 2000/60/EC (WFD) is designed to:

- Protect, improve and enhance the status and to prevent further deterioration of aquatic ecosystems and associated wetlands which depend on the aquatic ecosystems.
- Promote the sustainable use of water.
- Reduce and reverse all pollution of water, especially by 'priority' and 'priority hazardous' substances.

River Basin Management (RBM) Plans are part of the WFD strategic framework and are based on detailed analysis of the impacts of human activity on the water environment. They are designed to protect and improve the quality of our water environment and are reviewed and updated every six years. They include improvement measures to progress all ground and surface water bodies to 'Good' status by 2021. The latest system of standards and classification are set out in the 2015 Directions for England and Wales[1] and Scotland[2&3], and also listed for Scotland in WAT-SG-53[4].

The EU Groundwater Daughter Directive 2006/118/EC (GWDD) further protects groundwater. It states that hazardous substances must be prevented from entering groundwater and that non-hazardous substances should be limited from entering groundwater to concentrations that do not cause pollution. The Environmental Quality Standards Directive (EQSD), also known as the Priority Substances Directive 2008/105/EC (PSD) as amended by 2013/39/EU, further protects surface waters and defines Environmental Quality Standards for hazardous and non-hazardous substances in surface waters.

GROUNDWATER BODY CLASSIFICATION

Groundwater bodies are classified on their quantitative and chemical status. The quantitative status is not generally relevant to controlled waters risk assessments. The chemical status requires analytical data collected by the Environment Agency (EA), Natural Resources Wales (NRW) and the Scottish Environment Protection Agency (SEPA) across the water body to be evaluated against five sets of Threshold Values which are used by the regulators to decide if further, specific evaluation is required. They are not used to classify the groundwater bodies' chemical status and the 2014 and 2015 Standards Directions state that they should not be used as part of site-specific investigations.

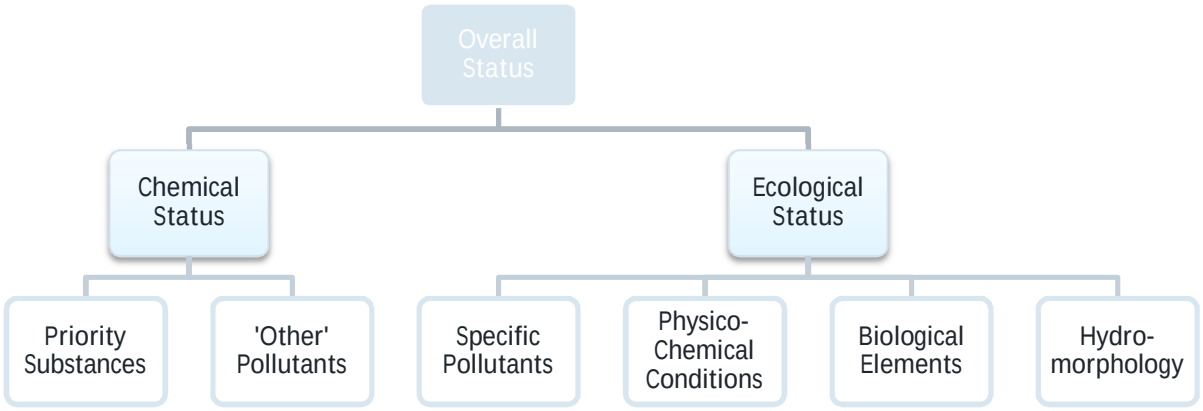
[1] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015
[2] The Scotland River Basin District (Standards) Directions 2014
[3] The Scotland River Basin District (Standards) Amendment Directions 2015
[4] SEPA '*Supporting Guidance (WAT-SG-53): Environmental Quality Standards and Standards for Discharges to Surface Waters'* v6. December 2015

SURFACE WATER BODY CLASSIFICATION

Environmental Quality Standards (EQSs) are used by the EA, NRW and SEPA to characterise, monitor and classify water bodies and to help these regulators establish measures to progress all water bodies to 'Good' status. For surface water bodies the following applies:

- Chemical status is determined on a 'Good' or 'Fail' basis.
- Ecological status is determined on a scale of 'High', 'Good', 'Moderate', 'Poor' and 'Bad'.
- The overall ecological status is determined by the lowest classification of all the parameters that are assessed.
- For an overall 'Good' status both ecological and chemical status must be at least 'Good' (see **Figure 1**).

Figure 1 – Elements of Water Body Status Classification



Priority substances – are defined by the European Commission (EC) and are reviewed every six years to ensure they stay relevant and that EQSs are up to date.

Other pollutants – not priority substances, but defined by the EC and the EQSs are identical to those laid down in legislation applied prior to 13 January 2009.

Specific pollutants - European Union (EU) Member states are required to identify nationally significant pollutants to support the assessment of 'Good' ecological status.

Physico-chemical conditions - includes parameters such as dissolved oxygen, pH, ammonia and phosphate that define the general chemistry of the surface water body and may influence the degree to which an aquatic ecosystem can thrive.

Biological elements – the condition and abundance of fish and invertebrates within the surface water body including the presence of invasive species.

Hydromorphology – includes water flow, sediment composition and the structure of the habitat and its ability to support an aquatic ecosystem.

GUIDANCE ON THE SELECTION OF ASSESSMENT CRITERIA

The Remedial Targets Methodology (RTM)[5] is the framework for controlled waters risk assessment which is used in England and Wales. The equivalent document used for the water environment in Scotland is WAT-PS-10-01[6]. Although the RTM preceded the formal adoption of the WFD in England and Wales, the document was cognisant of the requirements of the forthcoming WFD i.e. no discernible entry of hazardous substances into groundwater bodies, and no new pollution by non-hazardous substances. The methodology for the selection of assessment criteria in both documents states that where a hazardous substance is present in the soil beneath the site but is yet to enter groundwater, no discernible entry of that hazardous substance into groundwater is allowed. This effectively requires the allowable concentration of the contaminant of concern within the groundwater body to be either background or the limit of detection. The EA and SEPA use a published set of Minimum Reporting Values (MRVs) to support the assessment of 'discernible entry'.

With respect to groundwater, where a hazardous substance has already entered the groundwater body to a discernible level, the regulators generally allow appropriate quality standards to be used to quantify the risk to allow pragmatic remedial targets and to take into account the requirements of other legislation such as Part 2A and PPW.

Where non-hazardous pollutants enter groundwater, no new pollution (or substantial risk of pollution) of groundwater is allowable and quality standards are generally an acceptable concentration.

Where the receptor is a surface water body or groundwater-dependent terrestrial ecosystem quality standards are acceptable irrespective of whether the substance is hazardous or non-hazardous.

Both RTM and WAT-PS-10-01 state that any standard used should be relevant to the current or intended use of the aquifer and that they should be 'fit for purpose' in terms of the specific period of time over which they should be measured.

OVERVIEW

WSP follows the RTM approach in England and Wales and the WAT-PS-10-01 approach in Scotland to assess the potential or actual risks to water bodies on sites that it investigates. In deriving a hierarchy of assessment concentrations with which to quantify the risks, WSP uses relevant EU and UK legislation and World Health Organisation (WHO) guidance, considers the background quality of the water resources and takes account of the current and feasible future uses of the resource. In Scotland the assessment concentrations are referred to as '*assessment limits'* and in England as *'target concentrations'*.

For all substances that are detected in groundwater, the quantitative risk assessment is undertaken by comparing the modelled or actual concentration in water to an appropriate published standard

[5] EA *'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination'* 2006.
[6] SEPA *'Position Statement (WAT-PS-10-01): Assigning Groundwater Assessment Criteria for Pollutant Inputs'* v3.0, August 2014.

where one is available; this is the target concentration / assessment limit. The selection of the standards is described in further detail in the following Sections.

Where hazardous substances are either detected in soil leachates or are calculated using theoretical partitioning equations, an evaluation is undertaken to determine if discernible concentrations have entered the groundwater. This information is used to determine the most appropriate target concentration / assessment limit to adopt with which to evaluate the potential risks from the contaminants in the unsaturated zone. Where no published standards are available, WSP determines on a case-by-case basis whether site-specific or chemical-specific targets should be derived through additional research or studies.

WSP seeks to ensure that the best available limit of detections (LOD) are achieved for analysis that it commissions. Where this is the case and the LOD is greater than a published target standard, WSP will not conclude that a potential risk exists to the relevant water body. This is in line with the approach that the EA and SEPA take in determining the classification status of the water bodies.

APPROACH TO HAZARDOUS SUBSTANCES

For sites in England and Wales, WSP evaluates the soil leachate analytical results or theoretical partitioning calculations for hazardous substances as listed on the EA website[7] (updated 13 January 2017). For sites in Scotland, the MRVs provided in Annex 4 of WAT-PS-10-01 are used and these are the same as those produced by the EA. Where an MRV is not available, the limit of detection is used for hazardous substances.

Where groundwater analytical results are also available these are evaluated alongside the unsaturated concentration data to determine if the hazardous substances have entered the groundwater by a discernible amount (taken to be the MRV or limit of detection). If hazardous substances are detected in the groundwater, then the quantitative risk assessment of the soil concentrations continues using published standards appropriate for drinking water (see *'Impact to Drinking Water'* below). If the hazardous substances have not yet entered the groundwater, then the soil concentrations are evaluated using the MRVs/LODs.

IMPACT TO AQUATIC LIFE IN SURFACE WATERS

Although the surface water EQSs are primarily designed to support the EA and SEPA in their programmes of classification and monitoring of the quality of surface water bodies across England, Wales and Scotland under their WFD and EQSD obligations, the EQSs are also commonly used by contaminated land professionals to quantitatively evaluate the potential impact of site-specific ground contamination to surface waters. This approach is also suggested in RTM and WAT-PS-10-01.

The 2014 and 2015 Standards Directions provide EQSs for the assessment of ecological and chemical surface water body status. When quantifying potential impacts to surface waters, WSP's approach is

[7] https://www.gov.uk/government/publications/values-for-groundwater-risk-assessments/hazardous-substances-to-groundwater-minimum-reporting-values

to focus on the chemical status by evaluating the 'priority' and 'other' pollutants that are listed in those Directions. In addition, the 'specific' pollutants, (which are actually part of the evaluation of ecological status), are also assessed. These three classes of pollutants are used by the EA to mark the boundary between a Good status surface water and failing quality. As such, exceedances of these EQSs can be considered to highlight a potential risk that the surface water will not achieve or maintain its 'Good' status, which contravenes the requirements of the WFD. WSP adopts this approach irrespective of whether the EA or SEPA has determined if the surface water body requires an assessment of chemical status or not, so as to ensure that the requirements of the WFD are met for all surface water bodies that it evaluates in the context of ground contamination.

The EQSs are designed to be applied over a specific period of time. WSP selects the annual average or long term mean as the target concentration for each priority substance, specific pollutant and other pollutant. In most cases, the number of groundwater sampling events will be limited and as such, there are limitations to this approach that WSP highlights on a case by case basis.

A number of EQSs do not come into force until 22 December 2018. WSP may use these values because they can be used as an indicator of long term contamination issues that may pose issues for a site in the near future. This is determined on a case-by-case basis.

Maximum Allowable Concentration (MAC) EQSs are designed to assess acute exposure of the aquatic environment to pollutants. As such, WSP does not consider the use of MACs to be appropriate to use as a target concentration in the majority of cases. An exception could be the evaluation of potential ecological risks to a surface water from a one-off catastrophic spill or leak in an emergency response scenario.

WSP does not assess the potential ecological risks posed by physico-chemical quality elements on a regular basis. pH, dissolved oxygen, biological oxygen demand, acid neutralising capacity, phosphorus, temperature and salinity are considered too unstable to be modelled from groundwater to surface water and these parameters are only measured in the receiving surface water body.

Where a published EQS is not available, WSP follows the WAT-PS-10-01 guidance for sites in Scotland and applies non-WFD EQSs. These comprise repealed Dangerous Substances Directive (DSD) substances as well as EQSs from other sources that should be used with caution. For sites in England and Wales, WSP uses the EA's operational environmental quality standards for Environmental Permitting which are essentially the repealed DSD substances that are applied in Scotland. WSP uses the proposed ethylbenzene EQS from R&D Technical Report P2-115/TR4 2002[8] for sites in England and Wales. This is equivalent to the SEPA non-statutory EQS.

[8] EA '*Proposed Environmental Quality Standards for Ethylbenzene in Water*' R&D Technical Report P2-115/TR4. 2002.

With respect to petroleum hydrocarbons, WSP refers to the CL:AIRE 2017 guidance[9] in order to derive alternative assessment criteria. In cases where no equivalent VOC, SVOC or PAH data is available, the following proxy compounds are used:

- Aromatic EC5-EC7 — benzene (EC6.5)
- Aromatic >EC6-EC7 — benzene (EC6.5)
- Aromatic >EC6-EC8 — benzene (EC6.5)
- Aromatic >EC7-EC8 — toluene (EC7.6)
- Aromatic >EC8-EC10 — ethylbenzene (EC8.5)
- Aromatic >EC10-EC12 — naphthalene (EC11.7)
- Aromatic >EC12-EC16 — naphthalene (EC11.7)
- Aromatic >EC16-EC21 — anthracene (EC19.4)
- Aromatic >EC21-EC35 — benzo(a)pyrene (EC31.3)

IMPACT TO DRINKING WATER

ABSTRACTION FOR PUBLIC POTABLE SUPPLY

In line with the RTM and WAT-PS-10-01, WSP uses drinking water quality standards to evaluate the potential risk to aquifers from both the perspective of current abstraction for potable supply and also to evaluate the risk to future resource potential. The sources of drinking water standards are applied by WSP in the following hierarchy with the UK Drinking Water Standards (DWS) as the first tier:

- UK Water Supply (Water Quality) Regulations of England, Wales and Scotland
- EC Drinking Water Directive 1998
- WHO Drinking Water Guidelines 2011
- WHO Petroleum Products in Drinking Water 2008

RTM does not advocate country-specific standards outside the UK.

In Scotland, SEPA's published Resource Protection Values (RPVs) use the published US EPA National Primary Drinking Water Regulations where they are more conservative than the WHO standards. Where no RPV exists, WSP applies the remainder of the WHO standards as a second, non-statutory tier.

ABSTRACTION FOR PRIVATE SUPPLY

The Private Water Supplies Regulations of England, Scotland and Wales prescribe maximum concentrations and values of inorganic and organic constituents as well as radioactivity and bacteria

[9] CL:AIRE '*Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies'* v1.1 March 2017.

for natural waters intended for private supply. The concentrations and values are the same as those for public potable supply.

ABSTRACTION FOR BOTTLED WATER

The Natural Mineral Water, Spring Water and Bottled Drinking Water Regulations of England, Scotland and Wales prescribe maximum concentrations and values of inorganic and organic constituents as well as radioactivity and bacteria for natural waters intended for sale for human consumption.

OTHER RECEPTORS

WSP also considers other less common controlled waters receptors, where applicable, including but not limited to:

- *The Bathing Water Regulations 2013* which provides standards for the classification of the quality of bathing waters at specified locations on the basis of intestinal enterococci and *E. coli* levels.
- *WAT-SG-53, Table 9a: Operational Standards for Aquaculture* which provides the operational water quality standards used by SEPA for regulating the use of chemicals in aquaculture.

Appendix G.2

GQRA TABLES

GENERIC QUANTITATIVE RISK ASSESSMENT

RATIONALE

The risk assessment has been undertaken in general accordance with the United Kingdom approach and guidance issued by the relevant statutory bodies and comprises a Generic Quantitative Risk Assessment (GQRA). Future development plans for the site involve the potential for the construction of residential properties with some commercial/retail premises. As such, soil laboratory test results have been compared to generic assessment criteria (GAC) for a residential with home grown produce end use.

The generic controlled waters risk assessment was conducted in accordance with the principles of the EA 'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination' 2006 (EA 2006) and the 'prevent and limit' approach of the Water Framework Directive (2000/60.EC). Generic controlled waters risk assessments compare directly measured concentrations with standard assessment criteria.

In the event that representative soil or groundwater concentrations at the site exceed their associated GAC for a determinand, it does not automatically mean that a pollutant linkage exists. In the event that exceedances are identified, further evaluation and assessment may be required to establish the extent of any potential environmental liabilities associated with the site. Such an assessment would need to account for sampling uncertainty, analytical uncertainty and hydrological and hydrogeological conditions at the site.

HUMAN HEALTH RISK ASSESSMENT

SELECTION OF ASSESSMENT CRITERIA

The future most sensitive land use for the site is residential with home grown produce. As a result, the dataset has been screened against end-use criteria protective of the future site residents. The sources of the GAC used for the screening of determinands within soils are presented within Appendix G2. GAC have been developed assuming a SOM value of 1%, the most conservative criteria available.

The results of the laboratory analyses from the historic ground investigations carried out on the site have been screened against these GAC, in accordance with best practice. The objective of the assessment is to establish the presence or absence of potential pollutant linkages associated with soils beneath the site.

HUMAN RISK ASSESSMENT RESULTS

Table 1 presents the screening of the available historic soil analytical data. Laboratory certificates of the chemical analysis can be found in appendices of the associated historic ground investigation reports.

Exceedances of the selected GAC within the historic dataset are summarised in Table 1.

Table 1 Soil Exceedances of for Residential (HG vegetables) End-Use

Determinand	GAC (mg/kg)	Measured Maximum Concentration (mg/kg)	Number of Exceedances
Arsenic	32	2,261.3	65
Cadmium	12	183.3	32
Copper	2,490	15,400.0	30

Determinand	GAC (mg/kg)	Measured Maximum Concentration (mg/kg)	Number of Exceedances
Nickel	126	1145.0	16
Lead	134	65560.0	59
Zinc	3,860	202,000.0	50
Naphthalene	2.3	6.0	4
Benzo(a)pyrene	1.6	292.2	10
Aromatic >C12-C16	141	4,704.0	1
Aromatic >C16-C21	249	8,696.0	7
Aromatic >C21-C35	873	11,386.0	6
Aliphatics >C08-C10	27	295.0	2
Aliphatics >C10-C12	132	3,836.0	7
Aliphatics >C12-C16	1,030	10,680.0	6

WATER ENVIRONMENT RISK ASSESSMENT

SELECTION OF ASSESSMENT CRITERIA

Appropriate Water Quality Standards (WQS) are selected based on both a hierarchy of relevance to England and Wales and the receptor. In this case, the controlled water receptors identified in the conceptual site model were the Secondary A Aquifer present in the superficial and bedrock deposits beneath the site and the Loughor Estuary approximately 100m south. The Loughor Estuary is considered to be a transitional water body. The following hierarchies of WQS were considered to be appropriate:

AQUIFERS

- UK Drinking Water Quality Standards (DWS) from The Water Supply (Water Quality) Regulations 2000 (amended 2004)
- World Health Organisation (WHO) Guidelines for Drinking Water Quality, Fourth Edition, Volume 1, (2011)
- World Health Organisation (WHO) Petroleum Products in Drinking Water (2008)

SURFACE WATERS

- Environmental Quality Standards (EQS) for Transitional, Coastal and Territorial Waters from The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015
- Contaminated Land: Applications in Real Environments (CL:AIRE), Guidance on Assessing Petroleum Hydrocarbons using Existing Hydrogeological Risk Assessment Methodologies (2017)

Hardness, pH and dissolved organic carbon within the surface water can affect the bioavailability of copper, manganese, nickel and zinc. Site-specific EQSs may be derived using the WFD-UKTAG metal bioavailability tool (m-BAT). The concentrations of these determinands resulted in the m-BAT tool deriving criteria which was out of range. Therefore it was considered necessary to select the most conservative GAC for the screening assessment.

WATER ENVIRONMENT RISK ASSESSMENT RESULTS

Table 2 presents the screening of the available 2019 WSP analytical data. Laboratory certificates of the chemical analysis are provided in Appendix E.

Exceedances of the selected WQS within the 2019 dataset are summarised in Table 2. No exceedances were detected in the surface water sampled from the harbour. Groundwater exceedances of WQS were identified for arsenic, zinc, fluoranthene and benzo(a)pyrene. These determinands were carried forward to the detailed quantitative risk assessment.

Table 2 Groundwater Exceedances for the Protection of the Water Environment

Determinand	GAC (µg/l)	Standard Reference	Maximum Concentration (µg/l)	Location of Exceedance
Arsenic	25.0	EQS 2015 - Transitional	601	BH4, BH5, BH6, CP108
Chromium VI	0.6	UK DWS	10.2	10 (all locations)
Zinc	23.10	Site specific EQS (derived using m-BAT tool)	80	BH2, BH3 and CPPB7
Fluoranthene	0.0063	EQS 2015 - Transitional	0.0159	BH2, CP108
Benzo(a)pyrene	0.00017	EQS 2015 - Transitional	0.0071	BH1*, BH2, BH3*, BH4*, BH5*, BH6*, CP102*, CP105*, CP108, CPPB7*

*Concentration laboratory limits of detection (LOD). WQS greater than LOD.

Identified exceedances were distributed across the site. Arsenic exceedances, identified in four of the ten wells sampled, were located on the southern half of the site. Boreholes in which the three zinc exceedances were detected are located on the north of the site. Boreholes in which metals exceedances were detected are installed predominately in the Blown Sand deposits. Detected metal concentrations are considered to associated to the historic industrial activities undertaken on the site during the operation of the works.

Fluoranthene and benzo(a)pyrene were detected above LOD in two locations. Detected concentrations exceeded the WQS for both determinands. BH2 and CP108 were located in north-east and south west of the site, respectively. Both wells were screened solely in the Blow Sand deposits.

0.0000	Concentrations >are above laboratory LOD
<0.0000	Concentrations are below laboratory LOD

Sample Date				26/05/2004	26/05/2004	27/05/2004	27/05/2004	28/05/2004	28/05/2004	26/05/2004	26/05/2004	26/05/2004	27/05/2004	24/05/2004	27/05/2004	26/05/2004	27/05/2004	27/05/2004	28/05/2004	27/05/2004	27/05/2004	28/05/2004	26/05/2004	26/05/2004	26/05/2004	28/05/2004
TP/BH				TP16	TP19	TP22	TP22	TP25	TP25	TP13	TP12	TP14	TP22	TP12	TP20	TP13	TP18	TP21	TP27	TP17	TP24	TP29	TP34	TP15	TP35	TPA
Depth (m bgl)				0.85	0.5	2.6	1.7	2.25	0.5	0.3	0.7	1.4	2.5	2.2	0.23	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	1	0.5	0.5
Analyte	**Units**	**Max**	**GAC**																							
Metals																										
Arsenic	mg/kg	2261.3000	32.0000	202.8	144.9				123.4	341.5	2117.3				209.3		109.1	214	311.5	111.8	234.4	327	114.4		79	106.8
Cadmium	mg/kg	183.3000	12.0000	4.1	19.1				57.3	7.3	6.8				4.5		4.5	7.6	3.6	8.3	8	19.7	1.6		10.3	20.6
Chromium	mg/kg	51.0000	1590.0000	16	19				15	9	9				18		9	10	12	9	8	12	17		14	51
Copper	mg/kg	15400.0000	2490.0000	1741	4664				996	4307	496				2173		2341	3372	6390	15400	2545	1111	727		1000	2301
Nickel	mg/kg	1145.0000	126.0000	96	63				49	124	13				76		97	212	59	88	46	43	54		41	1107
Lead	mg/kg	65560.0000	134.0000	428	2166				1683	1173	141				5720		365	1309	2082	8980	1979	5760	187		459	1543
Mercury	mg/kg	13.1900	39.0000	0.6	2.7				0.9	0.6	<0.500				3.5		<0.500	<0.500	0.6	1.3	0.7	2	0.6		0.5	1.2
Selenium	mg/kg	7.5000	258.0000	2.4	3.2				2.3	3.8	1.8				1.3		1.7	1.2	2.4	2.1	1.4	1.1	1		1	1.3
Zinc	mg/kg	202000.0000	3860.0000	17400	46100				27800	59100	451				9500		7750	7990	522	33000	1736	19300	1055		5800	73400
Water Soluble Boron	mg/kg	2.8000	300.0000	<0.500	<0.500				<0.500	<0.500	<0.500				<0.500		<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500		0.5	0.5
Hexavalent Chromium	mg/kg	2.0000	4.5000	<2.000	<2.000				<2.000	<2.000	<2.000				<2.000		<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000		<2.000	<2.000
Silver	mg/kg	40.0000	-		15						3				6		9				40	9	<1.000			
Inorganics																										
Total Cyanide	mg/kg	2.1000	-	<1.000	<1.000				<1.000	<1.000	<1.000				<1.000		<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000		<1.000	<1.000
Free Cyanide	mg/kg	1.0000	15.0000	<1.000	<1.000				<1.000	<1.000	<1.000				<1.000		<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000		<1.000	<1.000
Organics																										
Total Phenols	mg/kg	2.0000	-		<2.000	<2.000				<2.000	<2.000	<2.000	<2.000	<2.000												
Organic Matter	mg/kg	10.6000	-							-	0.8						10.6				3.6					
TOC	%	0.0000	-																							
Polyaromatic Hydrocarbons																										
Naphthalene	mg/kg	6.0000	2.3000	3	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	1.6	<0.500	2.5	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Acenaphthylene	mg/kg	0.6400	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Acenaphthene	mg/kg	57.1000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Fluorene	mg/kg	51.4000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Phenanthrene	mg/kg	679.6000	-	3.9	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	6.8	<0.500	3.7	1.9	34.1	<0.500	<0.500	2.6	<0.500	<0.500	<0.500	<0.500
Anthracene	mg/kg	184.7000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	4.9	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Fluoranthene	mg/kg	696.4000	-	2.5	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	9.9	<0.500	2.3	3.3	30.7	<0.500	<0.500	5.9	<0.500	<0.500	<0.500	<0.500
Pyrene	mg/kg	538.1000	-	1.7	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	11.1	<0.500	1.8	2.1	22.2	<0.500	<0.500	4.2	<0.500	<0.500	<0.500	<0.500
Benzo(a)anthracene	mg/kg	344.5000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	7.5	<0.500	<0.500	<0.500	10.2	<0.500	<0.500	1.6	<0.500	<0.500	<0.500	<0.500
Chrysene	mg/kg	302.0000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	8.6	<0.500	<0.500	<0.500	13.7	<0.500	<0.500	1.7	<0.500	<0.500	<0.500	<0.500
Benzo(b)fluoranthene	mg/kg	373.9000	-	3.1	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	15.9	<0.500	2.9	3	16.7	<0.500	<0.500	3.2	<0.500	<0.500	<0.500	<0.500
Benzo(k)fluoranthene	mg/kg	144.1000	-	1.8	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	6.2	<0.500	1.9	1.9	8.6	<0.500	<0.500	2.7	<0.500	<0.500	<0.500	<0.500
Benzo(a)pyrene	mg/kg	292.2000	1.6000	1	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	11	<0.500	<0.500	<0.500	10.9	<0.500	<0.500	1.7	<0.500	<0.500	<0.500	<0.500
Indeno(1,2,3-cd)pyrene	mg/kg	178.2000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	3.4	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Di-benzo(a,h)anthracene	mg/kg	44.6000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Benzo(ghi)perylene	mg/kg	120.8000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	4.9	<0.500	<0.500	<0.500	6.4	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Coronene	mg/kg	0.5500	-																							
Total PAH	mg/kg	4013.6000	-	17	<0.500	<0.500	<0.500	<0.500	<0.500	-	<0.500	<0.500	<0.500	<0.500	85.3	<0.500	14.2	12.2	160.9	<0.500	<0.500	23.6	<0.500	<0.500	<0.500	<0.500
Petroluem Hydrocarbons																										
Aromatic C5-C7	mg/kg	0.8000	72.0000		<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	0.8	<0.100												
Aromatic >C7-C8	mg/kg	13.2000	130.0000		<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	13.2	1.4	<0.100												
Aromatic >C8-C10	mg/kg	17.0000	34.0000		<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	17	<5.000	<5.000												
Aromatic >C10-C12	mg/kg	25.9000	74.0000		<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000												
Aromatic >C12-C16	mg/kg	4704.0000	141.0000		<5.000	129	14	<5.000	<5.000	<5.000	<5.000	4704	<5.000	<5.000												
Aromatic >C16-C21	mg/kg	8696.0000	249.0000		10	216	78	810	995	41	<5.000	8696	1392	<5.000												
Aromatic >C21-C35	mg/kg	11386.0000	873.0000		47	146	39	130	912	108	<5.000	11386	3428	<5.000												
Total Aromatics (>C8 - C40)	mg/kg		-		57	491	131	940	1907	149	<5.000	24816	4823	<5.000	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic C5-C6	mg/kg	1.2000	42.0000		<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	1.2	<0.100	<0.100												
Aliphatic >C6-C8	mg/kg	20.3000	103.0000		<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	20.3	9.7	<0.100												
Aliphatic >C8-C10	mg/kg	295.0000	27.0000		<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000	<5.000												
Aliphatic >C10-C12	mg/kg	3836.0000	132.0000		<5.000	41	7	136	166	13	<5.000	649	373	<5.000												
Aliphatic >C12-C16	mg/kg	10680.0000	1030.0000		<5.000	255	75	1473	2816	50	<5.000	4935	209	<5.000												
Aliphatic >C16-C21	mg/kg	8774.0000	88400.0000		<5.000	240	107	1431	3319	101	<5.000	4626	8774	<5.000												
Aliphatic >C21-C35	mg/kg	16713.0000	88400.0000		<5.000	68	64	625	1488	88	<5.000	4771	16713	<5.000												
Total Aliphatics (>C8 - C40)	mg/kg	32678.0000	-		<5.000	604	253	3664	7811	252	<5.000	15002	26079	<5.000	-	-	-	-	-	-	-	-	-	-	-	-
Total TPH	mg/kg	40821.0000	-		62	1095	384	4604	9718	401	10	39818	30902	10												
MTBE	mg/kg	24.0000	62.0000																							
Benzene	mg/kg	11.0000	0.0890			<0.100	<0.100	<0.100	<0.100																	
Toluene	mg/kg	11.0000	131.0000			<0.100	<0.100	<0.100	<0.100																	
Ethyl Benzene	mg/kg	11.0000	47.0000			<0.100	<0.100	<0.100	<0.100																	
Xylene	mg/kg	34.0000	57.0000																							
m/p-Xylene	mg/kg	22.0000	57.0000																							
o-Xylene	mg/kg	11.0000	57.0000			<0.100	<0.100	<0.100	<0.100																	

0.0000	Concentrations >are above laboratory LOD
<0.0000	Concentrations are below laboratory LOD

Sample Date				28/05/2004	26/05/2004	21/06/2004	21/05/2004	24/05/2004	24/05/2004	21/05/2004	24/05/2004	21/05/2004	21/05/2004	24/05/2004	21/05/2004	21/05/2004	21/05/2004	21/05/2004	20/05/2004	17/05/2004	17/05/2004	17/05/2004	08/05/2017	08/05/2017	08/05/2017	10/05/2017
TP/BH				TPB	TP34	TP06D	TP06D	TP09C	TP09A	TP06A	TP11	TP02	TP06G	TP07	TP03	TP33	TP01	TP06E	TP26	TP04	TP05	TP30	BH3	BH3	BH3	BH4
Depth (m bgl)				0.5	0.5	0.8	1.2	0.7	0.3	0.3	0.3	0.45	0.3	0.2	0.3	0.4	0.3	0.3	0.3	0.4	0.55	0.45	0.5	1	2	1
Analyte	**Units**	**Max**	**GAC**																							
Metals																										
Arsenic	mg/kg	2261.3000	32.0000	291.3	15.1	279.1		2261.3	1166.8	319.6	970.6	520.9	364.3	164	530	896.9	133.9	268.8	367.9	1206	268	762.9	119	104.9	18.4	10
Cadmium	mg/kg	183.3000	12.0000	86	<0.500	24.6		54.3	25.3	170.8	8.9	50.7	62.1	18.9	29.6	99.1	36.6	83.3	183.3	92.1	56.8	85	13.12	5.6	0.32	<0.200
Chromium	mg/kg	51.0000	1590.0000	26	21	6		16	11	21	10	8	15	13	16	8	12	17	16	17	40	16	17.8	15.4	7.1	6
Copper	mg/kg	15400.0000	2490.0000	2795	33	635		4420	5740	925	5490	2097	6950	1922	752	2572	6740	6660	3427	9150	3378	9520	1530	1150	39	13.7
Nickel	mg/kg	1145.0000	126.0000	288	14	45		79	63	213	58	55	189	144	107	139	179	204	116	134	353	99	120	71.4	7	5.5
Lead	mg/kg	65560.0000	134.0000	4120	17	425		937	4950	2818	601	2315	3425	1016	3384	10900	1280	2531	4345	7500	3738	2743	341.1	134.1	8	4.3
Mercury	mg/kg	13.1900	39.0000	4.1	<0.500	1.1		1.5	9.4	5.4	2.2	2.3	1.6	0.8	3.2	2.3	0.6	3.9	5.7	5.1	1	2.2	<0.500	<0.500	<0.500	<0.500
Selenium	mg/kg	7.5000	258.0000	2.6	<0.500	2.4		3.2	4.8	3.4	2.4	2.3	7.5	1.4	2.2	5.4	1.2	6.3	5.5	5.6	6.1	5.6	1.1	1	<0.500	<0.500
Zinc	mg/kg	202000.0000	3860.0000	139000	52	7470		38100	27400	104000	4020	43900	133000	81800	29700	75600	30900	138000	66900	73500	192000	49300	28500	13300	819	41.8
Water Soluble Boron	mg/kg	2.8000	300.0000	<0.500	<0.500	<0.500		<0.500	<0.500	<0.500	<0.500	<0.500	0.7	<0.500	<0.500	<0.500	<0.500	0.5	<0.500	<0.500	<0.500	<0.500	0.7	0.6	<0.500	<0.500
Hexavalent Chromium	mg/kg	2.0000	4.5000	<2.000	<2.000	<2.000		<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000	<2.000				
Silver	mg/kg	40.0000	-																							
Inorganics																										
Total Cyanide	mg/kg	2.1000	-	<1.000	<1.000	<1.000		<1.000	<1.000	1.3	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	2.1	<1.000	1.4	<1.000				
Free Cyanide	mg/kg	1.0000	15.0000	<1.000	<1.000	<1.000		<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<0.600	<0.600	<0.600	<0.500
Organics																										
Total Phenols	mg/kg	2.0000	-			<2.000	<2.000																<0.600	<0.100	<0.600	<0.500
Organic Matter	mg/kg	10.6000	-																							
TOC	%	0.0000	-																					>25.5		
Polyaromatic Hydrocarbons																										
Naphthalene	mg/kg	6.0000	2.3000	<0.500		<0.500	<0.500	<0.500	1.1	1.8	1.1	<0.500	<0.500	<0.500	6	<0.500	<0.500	<0.500	1.6	<0.500	<0.500	<0.500		<0.100		
Acenaphthylene	mg/kg	0.6400	-	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500		<0.100		
Acenaphthene	mg/kg	57.1000	-	<0.500	-	<0.500	<0.500	<0.500	2	<0.500	<0.500	1.9	<0.500	<0.500	57.1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500		<0.100		
Fluorene	mg/kg	51.4000	-	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	1.5	<0.500	<0.500	51.4	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500		<0.100		
Phenanthrene	mg/kg	679.6000	-	<0.500	-	<0.500	<0.500	<0.500	35.3	4	4.2	39.6	<0.500	2.9	679.6	<0.500	<0.500	<0.500	3.8	14	<0.500	<0.500		0.31		
Anthracene	mg/kg	184.7000	-	<0.500	-	<0.500	<0.500	<0.500	6	<0.500	<0.500	6.9	<0.500	<0.500	184.7	<0.500	<0.500	<0.500	<0.500	3.1	<0.500	<0.500		<0.100		
Fluoranthene	mg/kg	696.4000	-	4.1	-	<0.500	<0.500	<0.500	45.1	7.4	2.9	44.1	<0.500	5.4	696.4	<0.500	<0.500	<0.500	4.2	19.5	<0.500	<0.500		0.23		
Pyrene	mg/kg	538.1000	-	4	-	<0.500	<0.500	<0.500	41.6	8.8	2.4	37.5	<0.500	6.9	538.1	<0.500	<0.500	<0.500	4.2	17.7	<0.500	<0.500		0.18		
Benzo(a)anthracene	mg/kg	344.5000	-	<0.500	-	<0.500	<0.500	<0.500	16.8	2.9	<0.500	12.1	<0.500	1.2	344.5	<0.500	<0.500	<0.500	<0.500	5.7	<0.500	<0.500		0.13		
Chrysene	mg/kg	302.0000	-	<0.500	-	<0.500	<0.500	<0.500	21.9	4.7	<0.500	15	<0.500	1.9	302	<0.500	<0.500	<0.500	<0.500	8.2	<0.500	<0.500		0.17		
Benzo(b)fluoranthene	mg/kg	373.9000	-	2.6	-	<0.500	<0.500	<0.500	26.1	8	<0.500	17.6	<0.500	5.4	373.9	<0.500	<0.500	<0.500	4.7	8.3	<0.500	<0.500		0.13		
Benzo(k)fluoranthene	mg/kg	144.1000	-	1.5	-	<0.500	<0.500	<0.500	13.5	3.3	<0.500	9.1	<0.500	<0.500	144.1	<0.500	<0.500	<0.500	3.3	4.7	<0.500	<0.500		<0.100		
Benzo(a)pyrene	mg/kg	292.2000	1.6000	<0.500		<0.500	<0.500	<0.500	21.2	3.7	<0.500	16.3	<0.500	<0.500	292.2	<0.500	<0.500	<0.500	1.4	6.7	<0.500	<0.500		<0.100		
Indeno(1,2,3-cd)pyrene	mg/kg	178.2000	-	<0.500	-	<0.500	<0.500	<0.500	7.5	2.3	<0.500	5	<0.500	<0.500	178.2	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500		<0.100		
Di-benzo(a,h)anthracene	mg/kg	44.6000	-	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	44.6	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500		<0.100		
Benzo(ghi)perylene	mg/kg	120.8000	-	<0.500	-	<0.500	<0.500	<0.500	9.9	2.9	<0.500	6.3	<0.500	<0.500	120.8	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500		<0.100		
Coronene	mg/kg	0.5500	-																					<0.100		
Total PAH	mg/kg	4013.6000	-	12.2	-	<0.500	<0.500	<0.500	248	49.8	10.6	212.9	<0.500	23.7	4013.6	<0.500	<0.500	<0.500	23.2	87.9	<0.500	<0.500		<2.130		
Petroluem Hydrocarbons																										
Aromatic C5-C7	mg/kg	0.8000	72.0000			<0.100	<0.100																			
Aromatic >C7-C8	mg/kg	13.2000	130.0000			<0.100	<0.100																			
Aromatic >C8-C10	mg/kg	17.0000	34.0000			<5.000	<5.000																	<5.000		
Aromatic >C10-C12	mg/kg	25.9000	74.0000			<5.000	<5.000																	<5.000		
Aromatic >C12-C16	mg/kg	4704.0000	141.0000			<5.000	<5.000																	<5.000		
Aromatic >C16-C21	mg/kg	8696.0000	249.0000			2117	127																	<5.000		
Aromatic >C21-C35	mg/kg	11386.0000	873.0000			6026	701																	<10.590		
Total Aromatics (>C8 - C40)	mg/kg		-	-	-	8143	828																	<24.000		
Aliphatic C5-C6	mg/kg	1.2000	42.0000			<0.100	<0.100																	<0.200		
Aliphatic >C6-C8	mg/kg	20.3000	103.0000			<0.100	<0.100																			
Aliphatic >C8-C10	mg/kg	295.0000	27.0000			295	33																	<4.890		
Aliphatic >C10-C12	mg/kg	3836.0000	132.0000			3836	682																	<4.890		
Aliphatic >C12-C16	mg/kg	10680.0000	1030.0000			10680	1667																	<4.890		
Aliphatic >C16-C21	mg/kg	8774.0000	88400.0000			8002	1218																	<4.890		
Aliphatic >C21-C35	mg/kg	16713.0000	88400.0000			9865	1639																	<10.700		
Total Aliphatics (>C8 - C40)	mg/kg	32678.0000	-	-	-	32678	5238																	<24.400		
Total TPH	mg/kg	40821.0000	-			40821	6066																	48.4		
MTBE	mg/kg	24.0000	62.0000																					<24.000		
Benzene	mg/kg	11.0000	0.0890																					<0.012		
Toluene	mg/kg	11.0000	131.0000																					<0.012		
Ethyl Benzene	mg/kg	11.0000	47.0000																					<0.012		
Xylene	mg/kg	34.0000	57.0000																							
m/p-Xylene	mg/kg	22.0000	57.0000																					<0.012		
o-Xylene	mg/kg	11.0000	57.0000																					<0.012		

0.0000	Concentrations >are above laboratory LOD
<0.0000	Concentrations are below laboratory LOD

Sample Date				11/05/2017	12/05/2017	12/05/2017	04/05/2017	04/05/2017	04/05/2017	04/05/2017	04/05/2017	04/05/2017	04/05/2017	04/05/2017	07/01/2008	09/01/2008	07/01/2008	07/01/2008	07/01/2008	09/01/2008	09/01/2008	07/01/2008	17/01/2008	17/01/2008	07/01/2008	09/01/2008
TP/BH				BH5	BH6	BH6	WS1	WS1	WS2	WS2	WS2	WS3	WS3	WS4	CP102	CP102	CP102	CP102	CP102	CP105	CP105	CP105	CP105	CP107	CP107	CP108	CP108
Depth (m bgl)				1	0.5	2	0.3	0.5	0.3	0.5	1	0.3	1	0.5	0.5	5	10.5	13.9	0.5	3.5	5.6	11.5	3	6	0.5	7
Analyte	**Units**	**Max**	**GAC**																								
Metals																											
Arsenic	mg/kg	2261.3000	32.0000	80.4	93	23	31.5	541.1	137.6	108.8	183.4	189.1	47.2	168	160.1	9.5	6.7	4.1	74.6	7.6	36.6	9.1	325.6	31.9	62.8	36.3
Cadmium	mg/kg	183.3000	12.0000	11.5	11.44	0.63	10.3	14.08	13.03	2.17	3.51	72.3	92.8	6.62	6.11	<0.100	0.14	0.23	9.51	<0.100	<0.100	0.39	0.26	0.12	15.61	<0.100
Chromium	mg/kg	51.0000	1590.0000	8.5	24.6	6	34.2	11.3	11.1	14.4	21	43	8.5	35.5	16.1	4	16.1	10.5	12.4	4.2	4.3	19	18	1.9	16.1	4.6
Copper	mg/kg	15400.0000	2490.0000	2090	1500	94	804	7890	1630	4300	4370	4620	777.1	3730	517.9	6.9	8.2	7.5	474	11	1.7	45.9	754.9	41.6	920.7	2.2
Nickel	mg/kg	1145.0000	126.0000	136	50.3	8	27	234.7	41.3	36.3	30.5	452.5	27.1	78	42.5	3.6	18.6	20	51.6	5.8	3.7	28.7	31.2	5.2	61.7	3.6
Lead	mg/kg	65560.0000	134.0000	568	718.2	32.5	1450	985.4	1480	585.8	2410	3670	256.2	215.5	423.1	3.6	11.6	7.4	705.7	2.6	1.8	38.2	455	15.9	2384	2.2
Mercury	mg/kg	13.1900	39.0000	0.96	<0.500	<0.500	<0.500	<0.500	<0.490	<0.500	<0.510	0.64	<0.500	1.48	0.63	<0.100	<0.100	<0.100	0.53	<0.100	<0.100	<0.100	0.11	<0.100	13.19	<0.100
Selenium	mg/kg	7.5000	258.0000	1.4	2	<0.500	2.1	1.5	1.1	1.1	1.2	6.2	0.9	1.3	<0.500	<0.500	0.7	0.6	<0.500	<0.500	<0.500	0.8	0.5	<0.500	<0.500	<0.500
Zinc	mg/kg	202000.0000	3860.0000	37600	6960	238.9	18000	11000	36100	2090	5540	202000	29200	7920	13660	54.8	300.9	266.8	13140	25.7	15.9	2011	927	178.4	11050	20.4
Water Soluble Boron	mg/kg	2.8000	300.0000			<0.500	2.8	0.7	<0.500	0.9	<0.500	0.7	0.5	1	<0.500	<0.500	1.7	1	0.6	<0.500	<0.500	1.5	1.1	<0.500	1.4	<0.500
Hexavalent Chromium	mg/kg	2.0000	4.5000																								
Silver	mg/kg	40.0000	-																								
Inorganics																											
Total Cyanide	mg/kg	2.1000	-												<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Free Cyanide	mg/kg	1.0000	15.0000	<0.500	<0.600	<0.600	<0.600	<0.600	<0.500	<0.600	<0.600	<0.600	<0.600	<0.600													
Organics																											
Total Phenols	mg/kg	2.0000	-	<0.100	<0.100	<0.600	<0.100	<0.100	<0.500	<0.600	<0.100	<0.600	<0.100	<0.600	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Organic Matter	mg/kg	10.6000	-																								
TOC	%	0.0000	-																								
Polyaromatic Hydrocarbons																											
Naphthalene	mg/kg	6.0000	2.3000	<0.090	0.28		0.21	5.47			<0.100		<0.090	0.09	<0.080	<0.080	<0.080	<0.080	0.08	<0.080	<0.080	<0.080	0.1	<0.080	0.89	<0.080
Acenaphthylene	mg/kg	0.6400	-	<0.090	<0.090		<0.090	0.64			<0.100		<0.090	<0.090	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Acenaphthene	mg/kg	57.1000	-	<0.090	<0.090		<0.090	1.21			<0.100		<0.090	<0.090	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.19	<0.080
Fluorene	mg/kg	51.4000	-	<0.090	<0.090		<0.090	2.12			<0.100		<0.090	<0.090	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.09	<0.080
Phenanthrene	mg/kg	679.6000	-	1.02	0.96		0.97	14.70			0.39		<0.090	0.31	0.41	<0.080	<0.080	<0.080	0.9	<0.080	<0.080	<0.080	0.55	<0.080	2.53	<0.080
Anthracene	mg/kg	184.7000	-	0.15	0.15		0.16	3.30			<0.100		<0.090	<0.090	0.13	<0.080	<0.080	<0.080	0.37	<0.080	<0.080	<0.080	0.14	<0.080	0.75	<0.080
Fluoranthene	mg/kg	696.4000	-	1.38	1.12		1.48	14.40			0.41		<0.090	0.29	0.57	<0.080	<0.080	<0.080	1.87	<0.080	<0.080	<0.080	0.58	<0.080	4.72	<0.080
Pyrene	mg/kg	538.1000	-	0.96	0.93		1.12	11.01			0.39		<0.090	0.20	0.51	<0.080	<0.080	<0.080	1.48	<0.080	<0.080	<0.080	0.46	<0.080	3.86	<0.080
Benzo(a)anthracene	mg/kg	344.5000	-	0.68	0.67		0.80	6.97			0.21		<0.090	0.16	0.21	<0.080	<0.080	<0.080	0.75	<0.080	<0.080	<0.080	0.23	<0.080	1.86	<0.080
Chrysene	mg/kg	302.0000	-	0.80	0.89		1.05	6.67			0.26		<0.090	0.28	0.33	<0.080	<0.080	<0.080	1.04	<0.080	<0.080	<0.080	0.34	<0.080	2.31	<0.080
Benzo(b)fluoranthene	mg/kg	373.9000	-	0.85	1.08		1.07	6.92			0.23		<0.090	0.25	0.13	<0.080	<0.080	<0.080	0.78	<0.080	<0.080	<0.080	0.32	<0.080	1.57	<0.080
Benzo(k)fluoranthene	mg/kg	144.1000	-	0.32	0.40		0.38	2.53			0.10		<0.090	0.09	0.27	<0.080	<0.080	<0.080	0.58	<0.080	<0.080	<0.080	0.18	<0.080	1.27	<0.080
Benzo(a)pyrene	mg/kg	292.2000	1.6000	0.50	0.64		0.62	5.30			0.17		<0.090	0.14	0.22	<0.080	<0.080	<0.080	0.69	<0.080	<0.080	<0.080	0.24	<0.080	1.84	<0.080
Indeno(1,2,3-cd)pyrene	mg/kg	178.2000	-	0.30	0.48		0.42	3.10			0.11		<0.090	0.09	0.11	<0.080	<0.080	<0.080	0.47	<0.080	<0.080	<0.080	0.15	<0.080	1.17	<0.080
Di-benzo(a,h)anthracene	mg/kg	44.6000	-	0.10	0.13		0.14	1.00			<0.100		<0.090	<0.090	<0.080	<0.080	<0.080	<0.080	0.18	<0.080	<0.080	<0.080	<0.080	<0.080	0.39	<0.080
Benzo(ghi)perylene	mg/kg	120.8000	-	0.27	0.39		0.30	2.26			0.10		<0.090	0.10	0.14	<0.080	<0.080	<0.080	0.35	<0.080	<0.080	<0.080	0.14	<0.080	0.97	<0.080
Coronene	mg/kg	0.5500	-	0.10			0.09	0.55			<0.100		<0.090													
Total PAH	mg/kg	4013.6000	-	<7.700	<8.400		<9.040	87.49			<2.930		<1.390	<2.510	<3.430	<1.280	<1.280	<1.280	<9.780	<1.280	<1.280	<1.280	<3.750	<1.280	<24.490	<1.280
Petroluem Hydrocarbons																											
Aromatic C5-C7	mg/kg	0.8000	72.0000																								
Aromatic >C7-C8	mg/kg	13.2000	130.0000																								
Aromatic >C8-C10	mg/kg	17.0000	34.0000	<4.000	5		<5.000				<5.000		<4.000	<5.000						<4.000			<4.000			
Aromatic >C10-C12	mg/kg	25.9000	74.0000	<4.000	<5.000		<5.000				<5.000		<4.000	<5.000						<4.000			<4.000			
Aromatic >C12-C16	mg/kg	4704.0000	141.0000	<4.000	<5.000		7				<5.000		<4.000	4.68						<4.000			<4.000			
Aromatic >C16-C21	mg/kg	8696.0000	249.0000	8.54	10.7		20				<5.000		<4.000	5.57						<4.000			<4.000			
Aromatic >C21-C35	mg/kg	11386.0000	873.0000	38.8	88.8		66.7				<10.440		<9.540	14						<8.760			<8.760			
Total Aromatics (>C8 - C40)	mg/kg		-	53.2	130		99.4				<24.000		<22.000	27.9												
Aliphatic C5-C6	mg/kg	1.2000	42.0000	<0.200	<0.200		<0.200				<0.200		<0.200	<0.200												
Aliphatic >C6-C8	mg/kg	20.3000	103.0000	<0.200	<0.200		<0.200				<0.200		<0.200	<0.200												
Aliphatic >C8-C10	mg/kg	295.0000	27.0000	<4.000	<5.000		<5.000				<5.000		<4.000	<5.000						<4.000			<4.000			
Aliphatic >C10-C12	mg/kg	3836.0000	132.0000	<4.000	<5.000		<5.000				<5.000		<4.000	<5.000						<4.000			<4.000			
Aliphatic >C12-C16	mg/kg	10680.0000	1030.0000	<4.000	<5.000		<5.000				6		5.39	5.87						<4.000			<4.000			
Aliphatic >C16-C21	mg/kg	8774.0000	88400.0000	12.9	7.94		5.87				<5.000		<4.000	<5.000						<4.000			<4.000			
Aliphatic >C21-C35	mg/kg	16713.0000	88400.0000	61.9	70		33				<10.440		<9.540	10.34						<8.760			15.8			
Total Aliphatics (>C8 - C40)	mg/kg	32678.0000	-	80	102		47.2	425			<24.000		<22.000	<23.000												
Total TPH	mg/kg	40821.0000	-	133.2	232		146.6	425			48		44	50.9												
MTBE	mg/kg	24.0000	62.0000	<22.000			<23.000	<22.000			<24.000		<22.000													
Benzene	mg/kg	11.0000	0.0890	<0.011	<0.012		<0.012				<0.012		<0.011	<0.012												
Toluene	mg/kg	11.0000	131.0000	<0.011	<0.012		<0.012	<11.000			<0.012		<0.011	<0.012												
Ethyl Benzene	mg/kg	11.0000	47.0000	<0.011	<0.012		<0.012	<11.000			<0.012		<0.011	<0.012												
Xylene	mg/kg	34.0000	57.0000					<34.000																		
m/p-Xylene	mg/kg	22.0000	57.0000	<0.011	<0.012		<0.012	<22.000			<0.012		<0.011	<0.012												
o-Xylene	mg/kg	11.0000	57.0000	<0.011	<0.012		<0.012	<11.000			<0.012		<0.011	<0.012												

0.0000	Concentrations >are above laboratory LOD
<0.0000	Concentrations are below laboratory LOD

			Sample Date	07/01/2008	07/01/2008	09/01/2008	07/01/2008	07/01/2008	07/01/2008	07/01/2008	09/01/2008	07/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008	07/01/2008	09/01/2008	07/01/2008	09/01/2008	07/01/2008	09/01/2008	07/01/2008	09/01/2008	07/01/2008
			TP/BH	CP108	CP109	CP109	CP109	CP109	CP109	CP110	CP110	CP110	CP111a	CP111a	CP111a	CP111a	CP111a	CP112	CP112	TP101	TP101	TP102	TP102	TP103	TP103	TP104
			Depth (m bgl)	8	0.8	3.5	9.5	11	14.6	1	6.5	8	0.3	3	7	12	17.3	0.5	5	1	3.6	0.1	3	0.1	3	1.3
Analyte	**Units**	**Max**	**GAC**																								
Metals																											
Arsenic	mg/kg	2261.3000	32.0000	11.8	5.8	24.8	7.1	9	5	33.3	6	4.3	71.5	9.2	32.6	10	4	100.1	24.2	11.5	19	123.8	15	365.7	33.4	491.5
Cadmium	mg/kg	183.3000	12.0000	<0.100	1.24	<0.100	0.11	0.15	0.28	0.69	<0.100	<0.100	47.3	<0.100	<0.100	0.63	0.25	15.08	0.1	0.22	<0.100	14.74	0.17	13.53	<0.100	16.76
Chromium	mg/kg	51.0000	1590.0000	6.7	7.2	5.4	15.2	23.6	11.6	8	3.8	4.8	33.2	3.7	2.7	18.1	10.8	11.3	5.2	2.6	4.7	9.4	4.9	12	6.1	10.5
Copper	mg/kg	15400.0000	2490.0000	2	12.2	2.7	7.5	11.3	9.7	642.9	1.6	1.1	1447	3	<0.500	22.1	16.1	4875	35.5	355.7	52.6	6146	106.4	4043	2236	10100
Nickel	mg/kg	1145.0000	126.0000	5.4	9.5	4	16.6	23.8	25.3	15	3.4	4.2	635.8	4.8	3.9	25.4	26.5	1145	5	5.8	5.1	59.4	4.7	48.4	9.1	62.8
Lead	mg/kg	65560.0000	134.0000	4.7	20	2.7	9.4	18.1	11.6	227.4	1.6	2.8	3756	4.5	3.3	38.9	13.7	2309	19.9	36.7	17.6	2378	25.1	1998	20.2	65560
Mercury	mg/kg	13.1900	39.0000	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	0.13	<0.100	<0.100	0.37	<0.100	<0.100	<0.100	<0.100	0.16	0.12	<0.100	<0.100	0.31	<0.100	0.35	<0.100	0.57
Selenium	mg/kg	7.5000	258.0000	0.6	<0.500	<0.500	<0.500	0.7	0.7	<0.500	<0.500	0.5	1	<0.500	1.3	0.7	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	0.9	<0.500	2.7
Zinc	mg/kg	202000.0000	3860.0000	24	1029	32.5	43.4	94.3	227	682	13.3	14.8	113400	90.2	40.1	918.1	674.5	77760	300.7	207.5	40.5	94330	764	16740	75.5	6462
Water Soluble Boron	mg/kg	2.8000	300.0000	<0.500	<0.500	<0.500	<0.500	1.4	1.2	<0.500	<0.500	<0.500	1	<0.500	<0.500	2.6	0.5	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Hexavalent Chromium	mg/kg	2.0000	4.5000																							
Silver	mg/kg	40.0000	-																							
Inorganics																											
Total Cyanide	mg/kg	2.1000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Free Cyanide	mg/kg	1.0000	15.0000																							
Organics																											
Total Phenols	mg/kg	2.0000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Organic Matter	mg/kg	10.6000	-																							
TOC	%	0.0000	-																							
Polyaromatic Hydrocarbons																											
Naphthalene	mg/kg	6.0000	2.3000	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.18	<0.080	<0.080	<0.080	<0.080	0.14	<0.080	<0.080	<0.080	0.12	<0.080	0.12	<0.080	<0.080
Acenaphthylene	mg/kg	0.6400	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Acenaphthene	mg/kg	57.1000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Fluorene	mg/kg	51.4000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Phenanthrene	mg/kg	679.6000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.12	<0.080	<0.080	0.39	<0.080	<0.080	<0.080	<0.080	0.82	<0.080	<0.080	<0.080	0.2	<0.080	0.99	<0.080	0.52
Anthracene	mg/kg	184.7000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.08	<0.080	<0.080	<0.080	<0.080	0.32	<0.080	<0.080	<0.080	<0.080	<0.080	0.29	<0.080	0.15
Fluoranthene	mg/kg	696.4000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.1	<0.080	<0.080	0.36	<0.080	<0.080	<0.080	<0.080	1.26	<0.080	<0.080	<0.080	0.19	<0.080	1.73	<0.080	0.86
Pyrene	mg/kg	538.1000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.36	<0.080	<0.080	<0.080	<0.080	1.04	<0.080	<0.080	<0.080	0.18	<0.080	1.32	<0.080	0.66
Benzo(a)anthracene	mg/kg	344.5000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.15	<0.080	<0.080	<0.080	<0.080	0.41	<0.080	<0.080	<0.080	<0.080	<0.080	0.63	<0.080	0.31
Chrysene	mg/kg	302.0000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.08	<0.080	<0.080	0.22	<0.080	<0.080	<0.080	<0.080	0.59	<0.080	<0.080	<0.080	0.18	<0.080	0.91	<0.080	0.42
Benzo(b)fluoranthene	mg/kg	373.9000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.16	<0.080	<0.080	<0.080	<0.080	0.33	<0.080	<0.080	<0.080	0.08	<0.080	0.46	<0.080	0.26
Benzo(k)fluoranthene	mg/kg	144.1000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.4	<0.080	<0.080	<0.080	0.1	<0.080	0.6	<0.080	0.26
Benzo(a)pyrene	mg/kg	292.2000	1.6000	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.08	<0.080	<0.080	<0.080	<0.080	0.44	<0.080	<0.080	<0.080	<0.080	<0.080	0.58	<0.080	0.24
Indeno(1,2,3-cd)pyrene	mg/kg	178.2000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.26	<0.080	<0.080	<0.080	<0.080	<0.080	0.4	<0.080	0.16
Di-benzo(a,h)anthracene	mg/kg	44.6000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.14	<0.080	<0.080
Benzo(ghi)perylene	mg/kg	120.8000	-	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	0.25	<0.080	<0.080	<0.080	<0.080	<0.080	0.3	<0.080	0.15
Coronene	mg/kg	0.5500	-																							
Total PAH	mg/kg	4013.6000	-	<1.280	<1.280	<1.280	<1.280	<1.280	<1.280	<1.340	<1.280	<1.280	<2.540	<1.280	<1.280	<1.280	<1.280	<6.580	<1.280	<1.280	<1.280	<1.770	<1.280	<8.710	<1.280	<4.390
Petroluem Hydrocarbons																											
Aromatic C5-C7	mg/kg	0.8000	72.0000																							
Aromatic >C7-C8	mg/kg	13.2000	130.0000																							
Aromatic >C8-C10	mg/kg	17.0000	34.0000																							
Aromatic >C10-C12	mg/kg	25.9000	74.0000																							
Aromatic >C12-C16	mg/kg	4704.0000	141.0000																							
Aromatic >C16-C21	mg/kg	8696.0000	249.0000																							
Aromatic >C21-C35	mg/kg	11386.0000	873.0000																							
Total Aromatics (>C8 - C40)	mg/kg		-																							
Aliphatic C5-C6	mg/kg	1.2000	42.0000																							
Aliphatic >C6-C8	mg/kg	20.3000	103.0000																							
Aliphatic >C8-C10	mg/kg	295.0000	27.0000																							
Aliphatic >C10-C12	mg/kg	3836.0000	132.0000																							
Aliphatic >C12-C16	mg/kg	10680.0000	1030.0000																							
Aliphatic >C16-C21	mg/kg	8774.0000	88400.0000																							
Aliphatic >C21-C35	mg/kg	16713.0000	88400.0000																							
Total Aliphatics (>C8 - C40)	mg/kg	32678.0000	-																							
Total TPH	mg/kg	40821.0000																								
MTBE	mg/kg	24.0000	62.0000																							
Benzene	mg/kg	11.0000	0.0890																							
Toluene	mg/kg	11.0000	131.0000																							
Ethyl Benzene	mg/kg	11.0000	47.0000																							
Xylene	mg/kg	34.0000	57.0000																							
m/p-Xylene	mg/kg	22.0000	57.0000																							
o-Xylene	mg/kg	11.0000	57.0000																							

0.0000	Concentrations >are above laboratory LOD
<0.0000	Concentrations are below laboratory LOD

			Sample Date	09/01/2008	07/01/2008	09/01/2008	07/01/2008	09/01/2008	07/01/2008	09/01/2008	07/01/2008	09/01/2008
			TP/BH	TP104	TP105	TP105	TP106	TP106	TP107	TP107	TP108	TP108
			Depth (m bgl)	2.7	1.3	2.1	1.1	3.2	1	3.5	0.35	3.5
Analyte	**Units**	**Max**	**GAC**									
Metals												
Arsenic	mg/kg	2261.3000	32.0000	20.4	652	75.7	750.7	915.9	722	43.4	70.9	108.8
Cadmium	mg/kg	183.3000	12.0000	1.06	8.06	0.16	9.37	7.61	5.98	0.2	36.63	0.33
Chromium	mg/kg	51.0000	1590.0000	4.3	8.9	5.1	9.4	8.7	7.1	5.5	6.8	5.5
Copper	mg/kg	15400.0000	2490.0000	218.2	2385	227.7	12410	5915	5910	117.9	566.6	100.3
Nickel	mg/kg	1145.0000	126.0000	6.1	74.2	5.9	65.7	30.3	55.6	5.9	37.7	8.8
Lead	mg/kg	65560.0000	134.0000	20	647.8	47.5	855.2	795.7	576.5	20.5	536.4	31.4
Mercury	mg/kg	13.1900	39.0000	<0.100	0.47	0.11	0.17	<0.100	0.42	<0.100	0.17	<0.100
Selenium	mg/kg	7.5000	258.0000	<0.500	<0.500	<0.500	1.7	1.7	2.2	<0.500	<0.500	<0.500
Zinc	mg/kg	202000.0000	3860.0000	41.4	10780	117.2	13790	1748	2481	50.7	85130	650.5
Water Soluble Boron	mg/kg	2.8000	300.0000	<0.500	<0.500	<0.500	<0.500	<0.500	0.6	<0.500	<0.500	<0.500
Hexavalent Chromium	mg/kg	2.0000	4.5000									
Silver	mg/kg	40.0000	-									
Inorganics												
Total Cyanide	mg/kg	2.1000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Free Cyanide	mg/kg	1.0000	15.0000									
Organics												
Total Phenols	mg/kg	2.0000	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Organic Matter	mg/kg	10.6000	-									
TOC	%	0.0000	-									
Polyaromatic Hydrocarbons												
Naphthalene	mg/kg	6.0000	2.3000	<0.080	0.18	0.17	<0.080	<0.080	<0.080	<0.080	0.2	<0.080
Acenaphthylene	mg/kg	0.6400	-	<0.080	0.09	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Acenaphthene	mg/kg	57.1000	-	<0.080	0.1	0.24	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Fluorene	mg/kg	51.4000	-	<0.080	0.14	0.3	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Phenanthrene	mg/kg	679.6000	-	<0.080	2.05	0.43	0.21	<0.080	0.14	<0.080	0.4	<0.080
Anthracene	mg/kg	184.7000	-	<0.080	0.61	0.08	0.1	<0.080	<0.080	<0.080	0.13	<0.080
Fluoranthene	mg/kg	696.4000	-	<0.080	2.36	0.16	0.32	<0.080	0.15	<0.080	0.52	<0.080
Pyrene	mg/kg	538.1000	-	<0.080	1.77	0.3	0.27	0.21	0.09	<0.080	0.47	<0.080
Benzo(a)anthracene	mg/kg	344.5000	-	<0.080	0.8	<0.080	0.16	<0.080	<0.080	<0.080	0.19	<0.080
Chrysene	mg/kg	302.0000	-	<0.080	1.17	<0.080	0.23	<0.080	0.13	<0.080	0.34	<0.080
Benzo(b)fluoranthene	mg/kg	373.9000	-	<0.080	0.63	<0.080	0.11	<0.080	<0.080	<0.080	0.16	<0.080
Benzo(k)fluoranthene	mg/kg	144.1000	-	<0.080	0.57	<0.080	0.1	<0.080	<0.080	<0.080	0.2	<0.080
Benzo(a)pyrene	mg/kg	292.2000	1.6000	<0.080	0.63	<0.080	0.15	<0.080	<0.080	<0.080	0.18	<0.080
Indeno(1,2,3-cd)pyrene	mg/kg	178.2000	-	<0.080	0.34	<0.080	<0.080	<0.080	<0.080	<0.080	0.11	<0.080
Di-benzo(a,h)anthracene	mg/kg	44.6000	-	<0.080	0.1	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Benzo(ghi)perylene	mg/kg	120.8000	-	<0.080	0.3	<0.080	<0.080	<0.080	<0.080	<0.080	0.1	<0.080
Coronene	mg/kg	0.5500	-									
Total PAH	mg/kg	4013.6000	-	<1.280	11.84	<2.400	<2.210	<1.410	<1.470	<1.280	<3.320	<1.280
Petroluem Hydrocarbons												
Aromatic C5-C7	mg/kg	0.8000	72.0000									
Aromatic >C7-C8	mg/kg	13.2000	130.0000									
Aromatic >C8-C10	mg/kg	17.0000	34.0000		<4.000	<4.000	<4.000	<4.000	<4.000	<4.000	<4.000	<4.000
Aromatic >C10-C12	mg/kg	25.9000	74.0000		<4.000	25.9	<4.000	9.8	<4.000	<4.000	<4.000	<4.000
Aromatic >C12-C16	mg/kg	4704.0000	141.0000		<4.000	356	<4.000	157	<4.000	4.14	<4.000	<4.000
Aromatic >C16-C21	mg/kg	8696.0000	249.0000		8.45	527	<4.000	327	<4.000	9.3	<4.000	<4.000
Aromatic >C21-C35	mg/kg	11386.0000	873.0000		29.9	223	<8.760	262	<8.760	37.9	<8.760	<8.760
Total Aromatics (>C8 - C40)	mg/kg		-									
Aliphatic C5-C6	mg/kg	1.2000	42.0000									
Aliphatic >C6-C8	mg/kg	20.3000	103.0000									
Aliphatic >C8-C10	mg/kg	295.0000	27.0000		<4.000	21.4	<4.000	<4.000	<4.000	<4.000	<4.000	<4.000
Aliphatic >C10-C12	mg/kg	3836.0000	132.0000		<4.000	176	<4.000	60.7	<4.000	<4.000	<4.000	<4.000
Aliphatic >C12-C16	mg/kg	10680.0000	1030.0000		<4.000	1470	<4.000	624	<4.000	10.9	<4.000	<4.000
Aliphatic >C16-C21	mg/kg	8774.0000	88400.0000		5.79	1590	<4.000	791	<4.000	17.6	<4.000	<4.000
Aliphatic >C21-C35	mg/kg	16713.0000	88400.0000		21.3	527	<8.760	324	<8.760	22.7	16.9	<8.760
Total Aliphatics (>C8 - C40)	mg/kg	32678.0000	-									
Total TPH	mg/kg	40821.0000										
MTBE	mg/kg	24.0000	62.0000									
Benzene	mg/kg	11.0000	0.0890									
Toluene	mg/kg	11.0000	131.0000									
Ethyl Benzene	mg/kg	11.0000	47.0000									
Xylene	mg/kg	34.0000	57.0000									
m/p-Xylene	mg/kg	22.0000	57.0000									
o-Xylene	mg/kg	11.0000	57.0000									

0.0000	Concentrations exceed DWS for the protection of ground water
0.0000	Concentrations exceed EQS for the protection of surface waters
<0.0000	Concentrations are below the laboratory LOD

							Sample ID	BH1	BH2	BH3	BH4	BH5	BH6	CP102	CP105	CP108	CPPB7	DUP
							Sample Date	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019
							Report	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019
Analyte	**Units**	**Max**	**L3 SSAC**	**DWS**	**DWS Ref**	**EQS**	**EQS Ref**	Blown Sands	Blown Sands	Blown Sands	Blown Sands	Blown Sands	Blown Sands	lacial Sand & Grave	lacial Sand & Grave	Blown Sands	Blown Sands	
Inorganics																		
Sulphate	mg/l	0.0000		250.0000	UK DWS	-	-											
Total Phenols	µg/l	<5.000		-	-	7.7000	EQS 2015 - Transitional											
Low Level Total Cyanide	µg/l	<0.900		50.0000	UK DWS	1.0000	EQS 2015 - Transitional											
Low Level Free Cyanide	µg/l	<0.900		-	-	-	-											
Total Cyanide	µg/l	<20.0000		50.0000	UK DWS	1.0000	EQS 2015 - Transitional											
Free Cyanide	µg/l	<20.0000		-	-	-	-											
Cyanide (unspecified)	µg/l	<20.0000		50.0000	UK DWS	1.0000	EQS 2015 - Transitional											
Chloride	mg/l	0.0000		250.0000	UK DWS	-	-											
Nitrate	mg/l	0.0000		50.0000	UK DWS	-	-											
Nitrite	mg/l	<5.000		0.5000	UK DWS	-	-											
Ammoniacal Nitrogen (unspecified)	mg/l	0.0000		0.3890	UK DWS	0.2000	EQS 2015 - Transitional											
BOD	mg/l	<2.000		-	-	-	-											
pH	pH Units	8.0400		6.5 - 10	UK DWS	6.0- 9.0	EQS 2015 - Transitional	7.5000	7.7300	7.3800	7.9100	7.7400	7.6900	7.6800	8.0400	7.7300	7.8300	7.5300
Electrical Conductivity	µS/cm	0.0000		2500.0000	UK DWS	-	-											
Carbonate	mg/l	<20.000		-	-	-	-											
Bicarbonate	mg/l	0.0000		-	-	-	-											
Alkalinity	mg $CaCO_3$/l	0.0000		-	-	-	-											
Total Dissolved Solids	mg/l	0.0000		-	-	-	-											
Ionic Balance	% +/-	-		-	-	-	-											
Metals																		
Low Level Hexavalent Chromium	µg/l	10.2000	0.826	0.6000	UK DWS	-		7.7700	<3.0000	3.4300	9.0700	9.6600	3.0700	6.4400	<3.0000	3.7800	10.2000	8.0000
Hexavalent Chromium (diss)		<20.000		0.6000	UK DWS	-												
Hexavalent Chromium (unspecified)	µg/l	<20.000		0.6000	UK DWS	-												
Hexavalent Chromium (total)	µg/l	<20.000		0.6000	UK DWS	-												
Mercury (diss.filt)	µg/l	<0.0100		1.0000	UK DWS	0.0700	EQS 2015 - Transitional	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Mercury (diss)	µg/l	<0.0100		1.0000	UK DWS	0.0700	EQS 2015 - Transitional											
Mercury (unspecified)	µg/l	<0.0100		1.0000	UK DWS	0.0700	EQS 2015 - Transitional											
Mercury (total)	µg/l	0.0000		1.0000	UK DWS	0.0700	EQS 2015 - Transitional											
Arsenic (diss.filt)	µg/l	601.0000	34.4	10.0000	UK DWS	25.0000	EQS 2015 - Transitional	1.0400	16.8000	1.8400	**399.0000**	**601.0000**	**286.0000**	5.0800	2.9700	**413.0000**	1.0600	1.1700
Arsenic (diss)	µg/l	0.0000		10.0000	UK DWS	25.0000	EQS 2015 - Transitional											
Arsenic (unspecified)	µg/l	0.0000		10.0000	UK DWS	25.0000	EQS 2015 - Transitional											
Arsenic (total)	µg/l	0.0000		10.0000	UK DWS	25.0000	EQS 2015 - Transitional											
Boron (diss.filt)	µg/l	354.0000		1000.0000	UK DWS	-		117.0000	25.3000	104.0000	74.7000	102.0000	76.8000	94.8000	354.0000	73.7000	64.6000	48.8000
Boron (diss)	µg/l	0.0000		1000.0000	UK DWS	-												
Boron (unspecified)	µg/l	0.0000		1000.0000	UK DWS	-												
Boron (total)	µg/l	0.0000		1000.0000	UK DWS	-												
Cadmium (diss.filt)	µg/l	0.1030		5.0000	UK DWS	0.2000	EQS 2015 - Transitional	<0.0800	<0.0800	<0.0800	<0.0800	<0.0800	<0.0800	<0.0800	<0.0800	<0.0800	0.1030	<0.0800
Cadmium (diss)	µg/l	0.0000		5.0000	UK DWS	0.2000	EQS 2015 - Transitional											
Cadmium (unspecified)	µg/l	0.0000		5.0000	UK DWS	0.2000	EQS 2015 - Transitional											
Cadmium (total)	µg/l	0.0000		5.0000	UK DWS	0.2000	EQS 2015 - Transitional											
Chromium (diss.filt)	µg/l	15.2000		50.0000	UK DWS	-		<1.0000	<1.0000	15.2000	8.7200	9.5500	1.2400	9.2200	7.6500	<1.0000	<1.0000	<1.0000
Chromium (diss)	µg/l	<20.000		50.0000	UK DWS	-												
Chromium (unspecified)	µg/l	0.0000		50.0000	UK DWS	-												
Chromium (total)	µg/l	0.0000		50.0000	UK DWS	-												
Copper (diss.filt)	µg/l	2.2100		2000.0000	UK DWS	3.7600	EQS 2015 - Transitional	<0.3000	0.3700	<0.3000	<0.3000	<0.3000	<0.3000	<0.3000	<0.3000	<0.3000	2.2100	1.6900
Copper (diss)	µg/l	0.0000		2000.0000	UK DWS	3.7600	EQS 2015 - Transitional											
Copper (unspecified)	µg/l	0.0000		2000.0000	UK DWS	3.7600	EQS 2015 - Transitional											
Copper (total)	µg/l	0.0000		2000.0000	UK DWS	3.7600	EQS 2015 - Transitional											
Lead (diss.filt)	µg/l	0.9200		10.0000	UK DWS	1.3000	EQS 2015 - Transitional	<0.2000	0.6620	0.9200	<0.2000	<0.2000	<0.2000	<0.2000	<0.2000	<0.2000	0.7420	0.4750
Lead (diss)	µg/l	<20.000		10.0000	UK DWS	1.3000	EQS 2015 - Transitional											
Lead (unspecified)	µg/l	0.0000		10.0000	UK DWS	1.3000	EQS 2015 - Transitional											
Lead (total)	µg/l	0.0000		10.0000	UK DWS	1.3000	EQS 2015 - Transitional											
Manganese (diss.filt)	µg/l	201.0000		50.0000	UK DWS	-		55.5000	6.3000	201.0000	18.9000	<3.0000	8.6500	21.0000	103.0000	<3.0000	3.7400	<3.0000
Nickel (diss.filt)	µg/l	1.3200		20.0000	UK DWS	8.6000	EQS 2015 - Transitional	0.6620	1.3200	1.3100	0.5270	<0.4000	<0.4000	<0.4000	<0.4000	<0.4000	0.4830	<0.4000
Nickel (diss)	µg/l	0.0000		20.0000	UK DWS	8.6000	EQS 2015 - Transitional											
Nickel (unspecified)	µg/l	0.0000		20.0000	UK DWS	8.6000	EQS 2015 - Transitional											
Nickel (total)	µg/l	0.0000		20.0000	UK DWS	8.6000	EQS 2015 - Transitional											
Selenium (diss.filt)	µg/l	25.4000		10.0000	UK DWS	-		5.2200	3.6200	6.5800	25.0000	25.4000	18.1000	3.3100	<1.0000	12.9000	4.8900	4.4100
Selenium (diss)	µg/l	0.0000		10.0000	UK DWS	-												
Selenium (unspecified)	µg/l	0.0000		10.0000	UK DWS	-												
Selenium (total)	µg/l	0.0000		10.0000	UK DWS	-												
Zinc (diss.filt)	µg/l	80.8000	9.36	-	-	6.8000	EQS 2015 - Transitional	1.6400	**80.8000**	**60.4000**	**15.9000**	4.0200	**7.6500**	**16.1000**	**12.1000**	2.5400	**73.4000**	**80.8000**
Zinc (diss)	µg/l	0.0000		-	-	6.8000	EQS 2015 - Transitional											
Zinc (unspecified)	µg/l	0.0000		-	-	6.8000	EQS 2015 - Transitional											
Zinc (total)	µg/l	0.0000		-	-	6.8000	EQS 2015 - Transitional											
Iron (Dis.Filt)	µg/l	87.6000		200.0000	UK DWS	1000.0000	EQS 2015 - Transitional	33.2000	<19.0000	<19.0000	<19.0000	<19.0000	<19.0000	<19.0000	48.6000	<19.0000	87.6000	<19.0000
Iron (unspecified)	µg/l	0.0000		200.0000	UK DWS	1000.0000	EQS 2015 - Transitional											
Silver (diss)	µg/l	<1.0000		-	-	-	-											
Silver (total)	µg/l	<1.0000		-	-	-	-											
Calcium (unspecifed)	mg/l	0.0000		-	-	-	-											
Magnesium (unspecifed)	mg/l	0.0000		-	-	-	-											
Potassium (unspecifed)	mg/l	0.0000		-	-	-	-											
Sodium (unspecifed)	mg/l	0.0000		200.0000	UK DWS	200.0000	EQS 2015 - Transitional											

0.0000	Concentrations exceed DWS for the protection of ground water
0.0000	Concentrations exceed EQS for the protection of surface waters
<0.0000	Concentrations are below the laboratory LOD

							Sample ID	BH1	BH2	BH3	BH4	BH5	BH6	CP102	CP105	CP108	CPPB7	DUP
							Sample Date	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019	31/05/2019
							Report	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019	WSP 2019
Analyte	**Units**	**Max**	**L3 SSAC**	**DWS**	**DWS Ref**	**EQS**	**EQS Ref**	Blown Sands	Blown Sands	Blown Sands	Blown Sands	Blown Sands	Blown Sands	lacial Sand & Grave	lacial Sand & Grave	Blown Sands	Blown Sands	
TPH Criteria Working Group (TPH CWG)																		
GRO >C5-C12	µg/l	<50.0000		-	-	-	-	<50.0000	<50.0000	<50.0000	<50.0000	<50.0000	<50.0000	<50.0000	<50.0000	<50.0000	<50.0000	<50.0000
Methyl tertiary butyl ether (MTBE)	µg/l	<3.0000		15.0000	WHO 2017		-	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000
Benzene	µg/l	<7.0000		1.0000	WHO 2017	8.0000	EQS 2015 - Transitional	<7.0000	<7.0000	<7.0000	<7.0000	<7.0000	<7.0000	<7.0000	<7.0000	<7.0000	<7.0000	<7.0000
Toluene	µg/l	<4.0000		700.0000	WHO 2017	74.0000	EQS 2015 - Transitional	<4.0000	<4.0000	<4.0000	<4.0000	<4.0000	<4.0000	<4.0000	<4.0000	<4.0000	<4.0000	<4.0000
Ethylbenzene	µg/l	<5.0000		300.0000	WHO 2017	20.0000	Proposed EQS	<5.0000	<5.0000	<5.0000	<5.0000	<5.0000	<5.0000	<5.0000	<5.0000	<5.0000	<5.0000	<5.0000
m,p-Xylene	µg/l	<8.0000		500.0000	WHO 2017	50.0000	CL:AIRE 2017 - Coastal	<8.0000	<8.0000	<8.0000	<8.0000	<8.0000	<8.0000	<8.0000	<8.0000	<8.0000	<8.0000	<8.0000
o-Xylene	µg/l	<3.0000		500.0000	WHO 2017	50.0000	CL:AIRE 2017 - Coastal	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000	<3.0000
Sum of detected Xylenes	µg/l	<11.0000		500.0000	WHO 2017	50.0000	CL:AIRE 2017 - Coastal	<11.0000	<11.0000	<11.0000	<11.0000	<11.0000	<11.0000	<11.0000	<11.0000	<11.0000	<11.0000	<11.0000
Sum of detected BTEX	µg/l	<28.0000		-	-	-	-	<28.0000	<28.0000	<28.0000	<28.0000	<28.0000	<28.0000	<28.0000	<28.0000	<28.0000	<28.0000	<28.0000
Aliphatics >C5-C6	µg/l	10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aliphatics >C6-C8	µg/l	10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aliphatics >C8-C10	µg/l	10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aliphatics >C10-C12	µg/l	10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aliphatics >C12-C16 (diss.filt)	µg/l	<10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aliphatics >C12-C16 (unspecified)	µg/l	0.0000		-	-	-	-											
Aliphatics >C16-C21 (diss.filt)	µg/l	<10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aliphatics >C16-C21 (unspecified)	µg/l	0.0000		-	-	-	-											
Aliphatics >C21-C35 (diss.filt)	µg/l	<10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aliphatics >C21-C35 (unspecified)	µg/l	0.0000		-	-	-	-											
Total Aliphatics >C12-C35 (diss.filt)	µg/l	<10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Total Aliphatics >C12-C35 (diss.filt)	µg/l	<100.0000		-	-	-	-											
Aliphatics >C8-C40	µg/l	0.0000		-	-	-	-											
Aromatics >EC5-EC7	µg/l	10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aromatics >EC7-EC8	µg/l	10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aromatics >EC8-EC10	µg/l	10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aromatics >EC10-EC12	µg/l	10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aromatics >EC12-EC16 (diss.filt)	µg/l	18.0000		-	-	-	-	<10.0000	<10.0000	18.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aromatics >EC12-EC16 (unspecified)	µg/l	0.0000		-	-	-	-											
Aromatics >EC16-EC21 (diss.filt)	µg/l	28.0000		-	-	-	-	<10.0000	<10.0000	28.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aromatics >EC16-EC21 (unspecified)	µg/l	0.0000		-	-	-	-											
Aromatics >EC21-EC35 (diss.filt)	µg/l	<10.0000		-	-	-	-	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Aromatics >EC21-EC35 (unspecified)	µg/l	0.0000		-	-	-	-											
Aromatics >EC16-EC35 (diss.filt)	µg/l	28.0000		-	-	-	-	<10.0000	<10.0000	28.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Total Aromatics >EC12-EC35 (diss.filt)	µg/l	46.0000		-	-	-	-	<10.0000	<10.0000	46.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Total Aromatics >EC5-EC35 (unspecified)	µg/l	<100.0000		-	-	-	-											
Aromatics >C8-C40	µg/l	0.0000		-	-	-	-											
Total Aliphatics & Aromatics >C5-35 (diss.filt)	µg/l	46.0000		-	-	-	-	<10.0000	<10.0000	46.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000	<10.0000
Total Aliphatics & Aromatics >C8-40	µg/l	0.0000		-	-	-	-											
Polyaromatic Hydrocarbons (PAHs)																		
Naphthalene (aq)	µg/l	0.0100		-	-	2.0000	EQS 2015 - Transitional	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Acenaphthene (aq)	µg/l	<0.1000		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene (aq)	µg/l	<0.1000		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene (aq)	µg/l	0.0159	0.00867	-	-	0.0063	EQS 2015 - Transitional	<0.0050	0.0084	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0159	<0.0050	<0.0050
Anthracene (aq)	µg/l	0.0050		-	-	0.1000	EQS 2015 - Transitional	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Phenanthrene (aq)	µg/l	0.0095		-	-	-	-	<0.0050	0.0062	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0095	<0.0050	<0.0050
Fluorene (aq)	µg/l	0.0050		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chrysene (aq)	µg/l	0.0050		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Pyrene (aq)	µg/l	0.0141		-	-	-	-	<0.0050	0.0075	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0141	<0.0050	<0.0050
Benzo(a)anthracene (aq)	µg/l	0.0050		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo(b)fluoranthene (aq)	µg/l	0.0107		-	-	-	-	<0.0050	0.0080	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0107	<0.0050	<0.0050
Benzo(k)fluoranthene (aq)	µg/l	0.0050		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo(a)pyrene (aq)	µg/l	0.0071	0.000234	0.001	UK DWS	0.00017	EQS 2015 - Transitional	<0.0050	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0071	<0.0050	<0.0050
Dibenzo(a,h)anthracene (aq)	µg/l	0.0050		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo(g,h,i)perylene (aq)	µg/l	0.0050		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Indeno(1,2,3-cd)pyrene (aq)	µg/l	0.0050		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
PAH, Total Detected USEPA 16 (aq)	µg/l	0.0820		-	-	-	-	<0.0820	<0.0820	<0.0820	<0.0820	<0.0820	<0.0820	<0.0820	<0.0820	<0.0820	<0.0820	<0.0820

				Customer Sample ID	HARBOUR
				Depth	0.00-0.00
Customer:	WSP PB BBC Bristol (7287)			Sample Type	SURFACE_WATER
Client Reference / Location:	Grillo			Sampled Date	31/05/2019
Analysis	**Test**	**Method**	**Units**	**LOD**	
Carbon					
	Carbon, Organic (diss.filt)	TM090	µg/l	<3000	<3000
Inorganics					
	pH	TM256	pH Units	<1	7.91
Filtered (Dissolved) Metals					
	Mercury (diss.filt)	TM183	µg/l	<0.01	<0.01
	Arsenic (diss.filt)	TM152	µg/l	<0.5	17.1
	Cadmium (diss.filt)	TM152	µg/l	<0.08	<0.08
	Chromium (diss.filt)	TM152	µg/l	<1	<1
	Copper (diss.filt)	TM152	µg/l	<0.3	<0.3
	Lead (diss.filt)	TM152	µg/l	<0.2	<0.2
	Nickel (diss.filt)	TM152	µg/l	<0.4	1.38
	Selenium (diss.filt)	TM152	µg/l	<1	<1
	Zinc (diss.filt)	TM152	µg/l	<1	4.99
Unfiltered (Total) Metals					
	Calcium (Tot. Unfilt.)	TM152	µg/l	<2280	293000
	Hardness, Total as CaCO3 unfiltered	TM152	µg/l	<350	3580000

Appendix G.3

P20 MODEL INPUT PARAMETERS

TABLE G-2 – PHYSICAL CHEMICAL AQUIFER PROPERTIES FOR BLOWN SANDS

PROPERTY	RANGE	LIKELY VALUE	UNIT	REFERENCE
Hydraulic gradient	0.006 to 0.008	0.007	-	Site specific[1], GW configurations
Hydraulic conductivity	0.01 to 22.81	0.84	m/day	Site specific[2], geometric mean
Saturated aquifer thickness		5	m	Thickness based on borehole logs
Effective porosity	15 to 35	25	%	Literature values for blown sands.
Bulk density	1.6 to 2.0	1.8	g/cm3	Literature values for sand/silt
Fraction of organic carbon		0.0018	-	Site specific[3]
pH	7.4 to 7.9	7.5	-	Site specific[4]

[1] Observed groundwater configurations during various SI phases (PB, 2004; Waterman, 2008; ESG, 2011; WSP, 2019).
[2] Geometric mean, 26 test locations on-site and off-site (slug tests); (GIL, 2007; Waterman, 2008; ESG, 2011, ESG, 2017; WSP, 2019).
[3] Determined from soil data (Waterman, 2008)
[4] Geometric mean, determined from 20 water samples (PB, 2004 and WSP, 2019)

TABLE G-3 – SOIL WATER PARTITION COEFFICIENT

COMPOUND	K_{OC}	K_D	UNIT	REFERENCE
Arsenic		30.1	L/kg	pH specific K_d for non-organic compounds[1]
Zinc		90.8	L/kg	pH specific K_d for non-organic compounds[1]
Chromium (VI)		16	L/kg	pH specific K_d for non-organic compounds[1]
Benzo(a)pyrene	131,000	235.8	L/kg	K_d derived from K_{oc} x F_{oc}, Koc literature reference[2]
Fluoranthene	27,800	50.04	L/kg	K_d derived from K_{oc} x F_{oc}, Koc literature reference[2]

[1] after RBCA Database (2011), and EPA SSL Guidance: Tech. Background Doc., EPA/540/R-95/128.
[2] TPH Criteria Working Group Series, Volume 3: Selection of Representative TPH Fractions based on Fate and Transport Considerations

Appendix G.4

P20 WORKSHEETS

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Arsenic		from Level 1
Target Concentration	C_T	2.50E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 2 directions**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_o	1.28E-01	mg/l	*WSP 2019 (average)*
Half life for degradation of contaminant in water	$t_{1/2}$	9.00E+99	days	*no degradation*
Calculated decay rate	λ	7.70E-101	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.30E+02	m	*site width (130 m)*
Plume thickness at source	Sy	4.90E+00	m	
Saturated aquifer thickness	da	5.00E+00	m	*thickness of Blown Sands*
Bulk density of aquifer materials	ρ	1.80E+00	g/cm^3	*sand*
Effective porosity of aquifer	n	2.50E-01	fraction	*silt/sand*
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	8.40E-01	m/d	*geometric mean (Blown Sands)*
Distance to compliance point	x	5.00E+01	m	*between site boundary and estuary*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	3.65E+05	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.01E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	2.35E-02	m/d
Retardation factor	Rf	2.18E+02	fraction
Decay rate used	λ	3.54E-103	d^{-1}
Rate of contaminant flow due to retardation	u	1.08E-04	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{ED}	9.29E-02	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	**AF**	**1.38E+00**	

Remedial Targets

Remedial Target		**3.44E-02**	**mg/l**
Domenico - Steady state			
Distance to compliance point		**50**	**m**
Concentration of contaminant at compliance point	**C_{ED}/C_0**	**9.29E-02**	**mg/l**

For comparison with measured groundwater concentration.

Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient — Kd — 3.01E+01 — l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer — foc — fraction

Organic carbon partition coefficient — Koc — l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species — $K_{oc,n}$ — l/kg

Sorption coefficient for ionised species — $K_{oc,i}$ — l/kg

pH value — pH

acid dissociation constant — pKa

Fraction of organic carbon in aquifer — foc — fraction

Soil water partition coefficient — Kd — 3.01E+01 — l/kg

Define dispersivity (click brown cell and use pull down list)

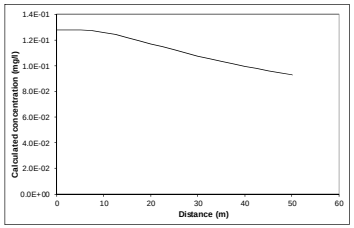
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Gillo Works
Completed by:	VL
Date:	14.08.2019
Version:	x.xx

Calculated concentrations for distance-concentration graph

Domenico - Steady state
From calculation sheet

Distance	Concentration
	mg/l
0	1.3E-01
2.5	1.28E-01
5.0	1.28E-01
7.5	1.27E-01
10.0	1.26E-01
12.5	1.24E-01
15.0	1.22E-01
17.5	1.20E-01
20.0	1.17E-01
22.5	1.15E-01
25.0	1.12E-01
27.5	1.10E-01
30.0	1.08E-01
32.5	1.06E-01
35.0	1.03E-01
37.5	1.01E-01
40.0	9.96E-02
42.5	9.78E-02
45.0	9.61E-02
47.5	9.44E-02
50.0	9.29E-02

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Chromium (VI)		from Level 1
Target Concentration	C_T	6.00E-04	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 2 directions**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

	Variable		Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_o	5.90E-03	mg/l	*WSP 2019 (average)*
Half life for degradation of contaminant in water	$t_{1/2}$	9.00E+99	days	*no degradation*
Calculated decay rate	λ	7.70E-101	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.30E+02	m	*site width (130 m)*
Plume thickness at source	Sy	4.90E+00	m	
Saturated aquifer thickness	da	5.00E+00	m	*thickness of Blown Sands*
Bulk density of aquifer materials	ρ	1.80E+00	g/cm^3	*sand*
Effective porosity of aquifer	n	2.50E-01	fraction	*silt/sand*
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	8.40E-01	m/d	*geometric mean (Blown Sands)*
Distance to compliance point	x	5.00E+01	m	*between site boundary and estuary*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	3.65E+05	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.60E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	2.35E-02	m/d
Retardation factor	Rf	1.16E+02	fraction
Decay rate used	λ	6.63E-103	d^{-1}
Rate of contaminant flow due to retardation	u	2.02E-04	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{ED}	4.29E-03	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	**AF**	**1.38E+00**	

Remedial Targets

Remedial Target		**8.26E-04**	**mg/l**
Domenico - Steady state			
Distance to compliance point		**50**	**m**
Concentration of contaminant at compliance point	**C_{ED}/C_0**	**4.29E-03**	**mg/l**

For comparison with measured groundwater concentration.

Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	1.60E+01	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.60E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

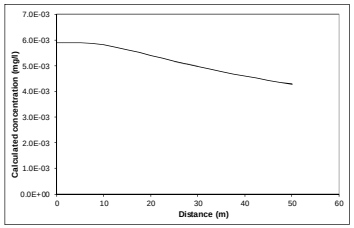
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Gillo Works
Completed by:	VL
Date:	14.08.2019
Version:	x.xx

Calculated concentrations for distance-concentration graph

Domenico - Steady state
From calculation sheet

Distance	Concentration
	mg/l
0	5.9E-03
2.5	5.90E-03
5.0	5.90E-03
7.5	5.87E-03
10.0	5.82E-03
12.5	5.73E-03
15.0	5.63E-03
17.5	5.52E-03
20.0	5.41E-03
22.5	5.30E-03
25.0	5.18E-03
27.5	5.08E-03
30.0	4.97E-03
32.5	4.87E-03
35.0	4.78E-03
37.5	4.69E-03
40.0	4.60E-03
42.5	4.52E-03
45.0	4.44E-03
47.5	4.36E-03
50.0	4.29E-03

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Environment Agency

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Zinc		from Level 1
Target Concentration	C_T	6.80E-03	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 2 directions**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_o	2.74E-02	mg/l	*WSP 2019 (average)*
Half life for degradation of contaminant in water	$t_{1/2}$	9.00E+99	days	*no degradation*
Calculated decay rate	λ	7.70E-101	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.30E+02	m	*site width (130 m)*
Plume thickness at source	Sy	4.90E+00	m	
Saturated aquifer thickness	da	5.00E+00	m	*thickness of Blown Sands*
Bulk density of aquifer materials	ρ	1.80E+00	g/cm^3	*sand*
Effective porosity of aquifer	n	2.50E-01	fraction	*silt/sand*
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	8.40E-01	m/d	*geometric mean (Blown Sands)*
Distance to compliance point	x	5.00E+01	m	*between site boundary and estuary*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	3.65E+05	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	9.08E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	2.35E-02	m/d
Retardation factor	Rf	6.55E+02	fraction
Decay rate used	λ	1.18E-103	d^{-1}
Rate of contaminant flow due to retardation	u	3.59E-05	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{ED}	1.99E-02	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	**AF**	**1.38E+00**	

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	9.08E+01	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	9.08E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

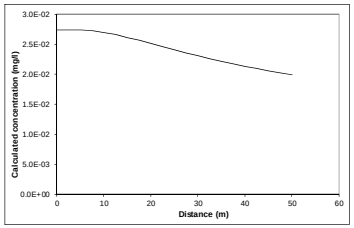
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Gillo Works
Completed by:	VL
Date:	03.06.2019
Version:	x.xx

Calculated concentrations for distance-concentration graph

Domenico - Steady state
From calculation sheet

Distance	Concentration
	mg/l
0	2.7E-02
2.5	2.74E-02
5.0	2.74E-02
7.5	2.73E-02
10.0	2.70E-02
12.5	2.66E-02
15.0	2.62E-02
17.5	2.56E-02
20.0	2.51E-02
22.5	2.46E-02
25.0	2.41E-02
27.5	2.36E-02
30.0	2.31E-02
32.5	2.26E-02
35.0	2.22E-02
37.5	2.18E-02
40.0	2.14E-02
42.5	2.10E-02
45.0	2.06E-02
47.5	2.02E-02
50.0	1.99E-02

Remedial Targets

Remedial Target		**9.36E-03**	**mg/l**
Domenico - Steady state			
Distance to compliance point		**50**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**1.99E-02**	**mg/l**

For comparison with measured groundwater concentration.

Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Benzo(a)pyrene		from Level 1
Target Concentration	C_T	1.70E-07	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state — Equations in HRA publication

Approach for simulating vertical dispersion: Simulate vertical dispersion in 2 directions

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_o	2.80E-06	mg/l	*WSP 2019 (average)*
Half life for degradation of contaminant in water	$t_{1/2}$	9.00E+99	days	*no degradation*
Calculated decay rate	λ	7.70E-101	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.30E+02	m	*site width (130m)*
Plume thickness at source	Sy	4.90E+00	m	
Saturated aquifer thickness	da	5.00E+00	m	*thickness of Blown Sands*
Bulk density of aquifer materials	ρ	1.80E+00	g/cm^3	*sand*
Effective porosity of aquifer	n	2.50E-01	fraction	*silt/sand*
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	8.40E-01	m/d	*geometric mean (Blown Sands)*
Distance to compliance point	x	5.00E+01	m	*between site boundary and estuary*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	3.65E+05	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.36E+02	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	2.35E-02	m/d
Retardation factor	Rf	1.70E+03	fraction
Decay rate used	λ	4.53E-104	d^{-1}
Rate of contaminant flow due to retardation	u	1.38E-05	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{ED}	2.03E-06	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	**AF**	**1.38E+00**	

Remedial Targets

Remedial Target		**2.34E-07**	**mg/l**
Domenico - Steady state			
Distance to compliance point		**50**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**2.03E-06**	**mg/l**

For comparison with measured groundwater concentration.

Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.80E-03	fraction
Organic carbon partition coefficient	Koc	1.31E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	2.36E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

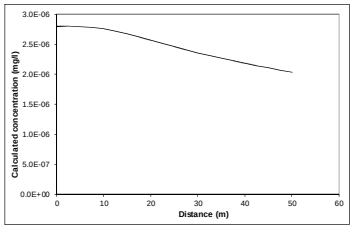
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Gillo Works
Completed by:	VL
Date:	03.06.2019
Version:	x.xx

Calculated concentrations for distance-concentration graph

Domenico - Steady state
From calculation sheet

Distance	Concentration
	mg/l
0	2.8E-06
2.5	2.80E-06
5.0	2.80E-06
7.5	2.79E-06
10.0	2.76E-06
12.5	2.72E-06
15.0	2.67E-06
17.5	2.62E-06
20.0	2.57E-06
22.5	2.51E-06
25.0	2.46E-06
27.5	2.41E-06
30.0	2.36E-06
32.5	2.31E-06
35.0	2.27E-06
37.5	2.22E-06
40.0	2.18E-06
42.5	2.14E-06
45.0	2.11E-06
47.5	2.07E-06
50.0	2.03E-06

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Environment Agency

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Fluoranthene		from Level 1
Target Concentration	C_T	6.30E-06	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state — Equations in HRA publication

Approach for simulating vertical dispersion: Simulate vertical dispersion in 2 directions

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_o	6.40E-06	mg/l	*WSP 2019 (average)*
Half life for degradation of contaminant in water	$t_{1/2}$	9.00E+99	days	*no degradation*
Calculated decay rate	λ	7.70E-101	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.30E+02	m	*site width (130m)*
Plume thickness at source	Sy	4.90E+00	m	
Saturated aquifer thickness	da	5.00E+00	m	*thickness of Blown Sands*
Bulk density of aquifer materials	ρ	1.80E+00	g/cm^3	*sand*
Effective porosity of aquifer	n	2.50E-01	fraction	*silt/sand*
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	8.40E-01	m/d	*geometric mean (Blown Sands)*
Distance to compliance point	x	5.00E+01	m	*between site boundary and estuary*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	3.65E+05	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	5.00E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	2.35E-02	m/d
Retardation factor	Rf	3.61E+02	fraction
Decay rate used	λ	2.13E-103	d^{-1}
Rate of contaminant flow due to retardation	u	6.51E-05	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{ED}	4.65E-06	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	**AF**	**1.38E+00**	

Remedial Targets

Remedial Target		**8.67E-06**	**mg/l**
Domenico - Steady state			
Distance to compliance point		**50**	**m**
Concentration of contaminant at compliance point	**C_{ED}/C_0**	**4.65E-06**	**mg/l**

For comparison with measured groundwater concentration.

Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient — Kd — l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer — foc — 1.80E-03 — fraction

Organic carbon partition coefficient — Koc — 2.78E+04 — l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species — $K_{oc,n}$ — l/kg

Sorption coefficient for ionised species — $K_{oc,i}$ — l/kg

pH value — pH

acid dissociation constant — pKa

Fraction of organic carbon in aquifer — foc — fraction

Soil water partition coefficient — Kd — 5.00E+01 — l/kg

Define dispersivity (click brown cell and use pull down list)

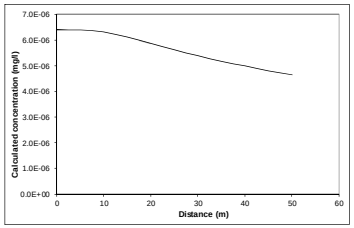
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Gillo Works
Completed by:	VL
Date:	########
Version:	x.xx

Calculated concentrations for distance-concentration graph

Domenico - Steady state
From calculation sheet

Distance	Concentration
	mg/l
0	6.4E-06
2.5	6.40E-06
5.0	6.40E-06
7.5	6.37E-06
10.0	6.31E-06
12.5	6.22E-06
15.0	6.11E-06
17.5	5.99E-06
20.0	5.87E-06
22.5	5.74E-06
25.0	5.62E-06
27.5	5.51E-06
30.0	5.39E-06
32.5	5.29E-06
35.0	5.18E-06
37.5	5.08E-06
40.0	4.99E-06
42.5	4.90E-06
45.0	4.81E-06
47.5	4.73E-06
50.0	4.65E-06

Appendix G.5

CONSIM (MODEL AND RESULTS)

Project: Grillo Soil Assessment

Project Number: 70054861-GR1

Project Details

Title: Grillo Soil Assessment

Project Number: 70054861-GR1

Prepared By: V. Langer

Date: 2019-08-15 17:03:11

Client Name: Camathernshire County Council

Comments:

Consim version 2.05

Simulation Level

Level 2

Simulation Parameters

Iterations 1001

Timeslices:10, 20, 30, 40, 50, 100, 1000

Water Quality Standard

EQS (Saltwater) (* quoted as lower value in range)

Source

site wide
Dry Bulk Density [g/cm³] TRIANGULAR(1.6,1.8,2)
Air Filled Porosity [fraction] UNDEFINED
Water Filled Porosity [fraction] TRIANGULAR(0.05,0.15,0.3)
Thickness [m] UNIFORM(1,2)
Contaminated Land
Constant Source Term

Overall Unsaturated Zone Thickness [m] TRIANGULAR(1,2.5,4)

Infiltration

Infiltration [mm/year] SINGLE(770)

Source Inventory:

Arsenic
Measured as Total Concentration in Soil — Concentration [mg/kg] TRIANGULAR(4,373.24,2261)
Inorganic
Partition Coefficient [ml/g] SINGLE(30.1)
Maximum Solubility [mg/l] SINGLE(441000)

Cadmium
Measured as Total Concentration in Soil — Concentration [mg/kg] TRIANGULAR(0.1,19.85,183.3)
Inorganic
Partition Coefficient [ml/g] SINGLE(92.7)
Maximum Solubility [mg/l] SINGLE(651000)

Chromium
Measured as Total Concentration in Soil — Concentration [mg/kg] SINGLE(2)
Inorganic
Partition Coefficient [ml/g] SINGLE(16)
Maximum Solubility [mg/l] SINGLE(440000)

Copper
Measured as Total Concentration in Soil — Concentration [mg/kg] TRIANGULAR(0.5,3523.24,15400)
Inorganic
Partition Coefficient [ml/g] SINGLE(40)
Maximum Solubility [mg/l] SINGLE(293000)

Lead
Measured as Total Concentration in Soil — Concentration [mg/kg] TRIANGULAR(1.6,3247.45,65560)
Inorganic
Partition Coefficient [ml/g] SINGLE(10)
Maximum Solubility [mg/l] SINGLE(125)

Mercury

Measured as Total Concentration in Soil — Concentration [mg/kg] TRIANGULAR(0.1,1.08,13.19)

Inorganic

Partition Coefficient [ml/g] SINGLE(994.3)

Maximum Solubility [mg/l] SINGLE(48)

Zinc

Measured as Total Concentration in Soil — Concentration [mg/kg] TRIANGULAR(0.5,41733.7,202000)

Inorganic

Partition Coefficient [ml/g] SINGLE(90.8)

Maximum Solubility [mg/l] SINGLE(606000)

Unsaturated Pathway: Made Ground

Active

Porous Medium

Thickness [m] TRIANGULAR(1,2.5,4)

Dry Bulk Density [g/cm³] TRIANGULAR(1.6,1.8,2)

Vertical Dispersivity [m] TRIANGULAR(0.1,0.25,0.4)

Water Filled Porosity [fraction] TRIANGULAR(0.05,0.15,0.35)

Unsaturated Conductivity [m/s] SINGLE(9.73e-005)

Unsaturated Pathway Contaminants

Arsenic

Partition Coefficient [ml/g] SINGLE(30.1)

Cadmium

Partition Coefficient [ml/g] SINGLE(92.7)

Chromium

Partition Coefficient [ml/g] SINGLE(16)

Copper

Partition Coefficient [ml/g] SINGLE(40)

Lead

Partition Coefficient [ml/g] SINGLE(10)

Mercury

Partition Coefficient [ml/g] SINGLE(994.3)

Zinc

Partition Coefficient [ml/g] SINGLE(90.8)

Aquifer Pathway

Thickness [m] UNDEFINED
Dry Bulk Density [g/cm³] UNDEFINED
Mixing Zone Thickness [m] SINGLE(5)
Hydraulic Conductivity [m/s] TRIANGULAR(5.5e-008,9.73e-006,0.000264)
Effective Porosity [fraction] UNDEFINED
Hydraulic Gradient SINGLE(0.007)
Groundwater Flow Direction (degrees), 200.00
Longitudinal Dispersivity [m] UNDEFINED
Lateral Dispersivity [m] UNDEFINED

Contaminant Inventory

Arsenic
Partition Coefficient [ml/g] SINGLE(30.1)

Cadmium
Partition Coefficient [ml/g] SINGLE(92.7)

Chromium
Partition Coefficient [ml/g] SINGLE(16)

Copper
Partition Coefficient [ml/g] SINGLE(40)

Lead
Partition Coefficient [ml/g] SINGLE(10)

Mercury
Partition Coefficient [ml/g] SINGLE(994.3)

Zinc
Partition Coefficient [ml/g] SINGLE(90.8)

site wide Receptor X 244663.289899 Y 200275.001537

Input Correlations

No Correlations

Project: Grillo Soil Assessment

Project Number: 70054861-GR1

site wide - Arsenic

Concentration at Source [mg/l] - 10 years

05% of values less than 7.23443	10% of values less than 9.78728	25% of values less than 15.2003
50% of values less than 27.3074	75% of values less than 39.8974	90% of values less than 52.9241
Minimum 1.03082ɜ than 59.4854	Maximum 73.7387	
Mean 29.0728	SD 16.1178	Variance 259.782

Concentration at Source [mg/l] - 20 years

05% of values less than 7.23443	10% of values less than 9.78728	25% of values less than 15.2003
50% of values less than 27.3074	75% of values less than 39.8974	90% of values less than 52.9241
Minimum 1.03082ɜ than 59.4854	Maximum 73.7387	
Mean 29.0728	SD 16.1178	Variance 259.782

Concentration at Source [mg/l] - 30 years

05% of values less than 7.23443	10% of values less than 9.78728	25% of values less than 15.2003
50% of values less than 27.3074	75% of values less than 39.8974	90% of values less than 52.9241
Minimum 1.03082ɜ than 59.4854	Maximum 73.7387	
Mean 29.0728	SD 16.1178	Variance 259.782

Concentration at Source [mg/l] - 40 years

05% of values less than 7.23443	10% of values less than 9.78728	25% of values less than 15.2003
50% of values less than 27.3074	75% of values less than 39.8974	90% of values less than 52.9241
Minimum 1.03082ɜ than 59.4854	Maximum 73.7387	
Mean 29.0728	SD 16.1178	Variance 259.782

Concentration at Source [mg/l] - 50 years

05% of values less than 7.23443	10% of values less than 9.78728	25% of values less than 15.2003
50% of values less than 27.3074	75% of values less than 39.8974	90% of values less than 52.9241
Minimum 1.03082ɜ than 59.4854	Maximum 73.7387	
Mean 29.0728	SD 16.1178	Variance 259.782

Concentration at Source [mg/l] - 100 years

05% of values less than 7.23443	10% of values less than 9.78728	25% of values less than 15.2003
50% of values less than 27.3074	75% of values less than 39.8974	90% of values less than 52.9241
Minimum 1.03082ɜ than 59.4854	Maximum 73.7387	
Mean 29.0728	SD 16.1178	Variance 259.782

Concentration at Source [mg/l] - 1000 years

05% of values less than 7.23443	10% of values less than 9.78728	25% of values less than 15.2003
50% of values less than 27.3074	75% of values less than 39.8974	90% of values less than 52.9241
Minimum 1.03082ɜ than 59.4854	Maximum 73.7387	
Mean 29.0728	SD 16.1178	Variance 259.782

site wide - Cadmium

Concentration at Source [mg/l] - 10 years

05% of values less than 0.144874	10% of values less than 0.204462	25% of values less than 0.358748
50% of values less than 0.652429	75% of values less than 1.0337	90% of values less than 1.39191
Minimum 0.0170903	an 1.5588	Maximum 1.97515
Mean 0.727889	SD 0.44496	Variance 0.197989

Concentration at Source [mg/l] - 20 years

05% of values less than 0.144874	10% of values less than 0.204462	25% of values less than 0.358748
50% of values less than 0.652429	75% of values less than 1.0337	90% of values less than 1.39191
Minimum 0.0170903	an 1.5588	Maximum 1.97515
Mean 0.727889	SD 0.44496	Variance 0.197989

Concentration at Source [mg/l] - 30 years

05% of values less than 0.144874	10% of values less than 0.204462	25% of values less than 0.358748
50% of values less than 0.652429	75% of values less than 1.0337	90% of values less than 1.39191
Minimum 0.0170903	an 1.5588	Maximum 1.97515
Mean 0.727889	SD 0.44496	Variance 0.197989

Concentration at Source [mg/l] - 40 years

05% of values less than 0.144874	10% of values less than 0.204462	25% of values less than 0.358748
50% of values less than 0.652429	75% of values less than 1.0337	90% of values less than 1.39191
Minimum 0.0170903	an 1.5588	Maximum 1.97515
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Concentration at Source [mg/l] - 50 years

05% of values less than 0.144874	10% of values less than 0.204462	25% of values less than 0.358748
50% of values less than 0.652429	75% of values less than 1.0337	90% of values less than 1.39191
Minimum 0.0170903	an 1.5588	Maximum 1.97515
Mean 0.727889	SD 0.44496	Variance 0.197989

Concentration at Source [mg/l] - 100 years

05% of values less than 0.144874	10% of values less than 0.204462	25% of values less than 0.358748
50% of values less than 0.652429	75% of values less than 1.0337	90% of values less than 1.39191
Minimum 0.0170903	an 1.5588	Maximum 1.97515
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Concentration at Source [mg/l] - 1000 years

05% of values less than 0.144874	10% of values less than 0.204462	25% of values less than 0.358748
50% of values less than 0.652429	75% of values less than 1.0337	90% of values less than 1.39191
Minimum 0.0170903	an 1.5588	Maximum 1.97515
Mean 0.727889	SD 0.44496	Variance 0.197989

site wide - Chromium

Concentration at Source [mg/l] - 10 years

05% of values less than 0.123868	10% of values less than 0.123953	25% of values less than 0.124101
50% of values less than 0.124286	75% of values less than 0.124431	90% of values less than 0.124568
Minimum 0.12359s than 0.124612	Maximum 0.124781	
Mean 0.124268	SD 0.000227649	Variance 5.18238E-008

Concentration at Source [mg/l] - 20 years

05% of values less than 0.123868	10% of values less than 0.123953	25% of values less than 0.124101
50% of values less than 0.124286	75% of values less than 0.124431	90% of values less than 0.124568
Minimum 0.12359s than 0.124612	Maximum 0.124781	
Mean 0.124268	SD 0.000227649	Variance 5.18238E-008

Concentration at Source [mg/l] - 30 years

05% of values less than 0.123868	10% of values less than 0.123953	25% of values less than 0.124101
50% of values less than 0.124286	75% of values less than 0.124431	90% of values less than 0.124568
Minimum 0.12359s than 0.124612	Maximum 0.124781	
Mean 0.124268	SD 0.000227649	Variance 5.18238E-008

Concentration at Source [mg/l] - 40 years

05% of values less than 0.123868	10% of values less than 0.123953	25% of values less than 0.124101
50% of values less than 0.124286	75% of values less than 0.124431	90% of values less than 0.124568
Minimum 0.12359s than 0.124612	Maximum 0.124781	
Mean 0.124268	SD 0.000227649	Variance 5.18238E-008

Concentration at Source [mg/l] - 50 years

05% of values less than 0.123868	10% of values less than 0.123953	25% of values less than 0.124101
50% of values less than 0.124286	75% of values less than 0.124431	90% of values less than 0.124568
Minimum 0.12359s than 0.124612	Maximum 0.124781	
Mean 0.124268	SD 0.000227649	Variance 5.18238E-008

Concentration at Source [mg/l] - 100 years

05% of values less than 0.123868	10% of values less than 0.123953	25% of values less than 0.124101
50% of values less than 0.124286	75% of values less than 0.124431	90% of values less than 0.124568
Minimum 0.12359s than 0.124612	Maximum 0.124781	
Mean 0.124268	SD 0.000227649	Variance 5.18238E-008

Concentration at Source [mg/l] - 1000 years

05% of values less than 0.123868	10% of values less than 0.123953	25% of values less than 0.124101
50% of values less than 0.124286	75% of values less than 0.124431	90% of values less than 0.124568
Minimum 0.12359s than 0.124612	Maximum 0.124781	
Mean 0.124268	SD 0.000227649	Variance 5.18238E-008

site wide - Copper

Concentration at Source [mg/l] - 10 years

05% of values less than 42.019	10% of values less than 59.2563	25% of values less than 97.4705
50% of values less than 148.411	75% of values less than 210.004	90% of values less than 280.735
Minimum 8.1298ss than 315.715	Maximum 381.919	
Mean 159.08	SD 81.68	Variance 6671.63

Concentration at Source [mg/l] - 20 years

05% of values less than 42.019	10% of values less than 59.2563	25% of values less than 97.4705
50% of values less than 148.411	75% of values less than 210.004	90% of values less than 280.735
Minimum 8.1298ss than 315.715	Maximum 381.919	
Mean 159.08	SD 81.68	Variance 6671.63

Concentration at Source [mg/l] - 30 years

05% of values less than 42.019	10% of values less than 59.2563	25% of values less than 97.4705
50% of values less than 148.411	75% of values less than 210.004	90% of values less than 280.735
Minimum 8.1298ss than 315.715	Maximum 381.919	
Mean 159.08	SD 81.68	Variance 6671.63

Concentration at Source [mg/l] - 40 years

05% of values less than 42.019	10% of values less than 59.2563	25% of values less than 97.4705
50% of values less than 148.411	75% of values less than 210.004	90% of values less than 280.735
Minimum 8.1298ss than 315.715	Maximum 381.919	
Mean 159.08	SD 81.68	Variance 6671.63

Concentration at Source [mg/l] - 50 years

05% of values less than 42.019	10% of values less than 59.2563	25% of values less than 97.4705
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Concentration at Source [mg/l] - 100 years

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50% of values less than 148.411	75% of values less than 210.004	90% of values less than 280.735
Minimum 8.1298ss than 315.715	Maximum 381.919	
Mean 159.08	SD 81.68	Variance 6671.63

Concentration at Source [mg/l] - 1000 years

05% of values less than 42.019	10% of values less than 59.2563	25% of values less than 97.4705
50% of values less than 148.411	75% of values less than 210.004	90% of values less than 280.735
Minimum 8.1298ss than 315.715	Maximum 381.919	
Mean 159.08	SD 81.68	Variance 6671.63

site wide - Lead

Concentration at Source [mg/l] - 10 years

05% of values less than 125	10% of values less than 125	25% of values less than 125
50% of values less than 125	75% of values less than 125	90% of values less than 125
Minimum 37.6748ร than 125	Maximum 125	
Mean 124.671	SD 4.26217	Variance 18.1661

Concentration at Source [mg/l] - 20 years

05% of values less than 125	10% of values less than 125	25% of values less than 125
50% of values less than 125	75% of values less than 125	90% of values less than 125
Minimum 37.6748ร than 125	Maximum 125	
Mean 124.671	SD 4.26217	Variance 18.1661

Concentration at Source [mg/l] - 30 years

05% of values less than 125	10% of values less than 125	25% of values less than 125
50% of values less than 125	75% of values less than 125	90% of values less than 125
Minimum 37.6748ร than 125	Maximum 125	
Mean 124.671	SD 4.26217	Variance 18.1661

Concentration at Source [mg/l] - 40 years

05% of values less than 125	10% of values less than 125	25% of values less than 125
50% of values less than 125	75% of values less than 125	90% of values less than 125
Minimum 37.6748ร than 125	Maximum 125	
Mean 124.671	SD 4.26217	Variance 18.1661

Concentration at Source [mg/l] - 50 years

05% of values less than 125	10% of values less than 125	25% of values less than 125
50% of values less than 125	75% of values less than 125	90% of values less than 125
Minimum 37.6748ร than 125	Maximum 125	
Mean 124.671	SD 4.26217	Variance 18.1661

Concentration at Source [mg/l] - 100 years

05% of values less than 125	10% of values less than 125	25% of values less than 125
50% of values less than 125	75% of values less than 125	90% of values less than 125
Minimum 37.6748ร than 125	Maximum 125	
Mean 124.671	SD 4.26217	Variance 18.1661

Concentration at Source [mg/l] - 1000 years

05% of values less than 125	10% of values less than 125	25% of values less than 125
50% of values less than 125	75% of values less than 125	90% of values less than 125
Minimum 37.6748ร than 125	Maximum 125	
Mean 124.671	SD 4.26217	Variance 18.1661

site wide - Mercury

Concentration at Source [mg/l] - 10 years

05% of values less than 0.000971785	10% of values less than 0.00127078	25% of values less than 0.00228948
50% of values less than 0.00401174	75% of values less than 0.0070601	90% of values less than 0.00942438
Minimum 0.000307349	0.0106476	Maximum 0.0131086
Mean 0.00479261	SD 0.00305291	Variance 9.32029E-006

Concentration at Source [mg/l] - 20 years

05% of values less than 0.000971785	10% of values less than 0.00127078	25% of values less than 0.00228948
50% of values less than 0.00401174	75% of values less than 0.0070601	90% of values less than 0.00942438
Minimum 0.000307349	0.0106476	Maximum 0.0131086
Mean 0.00479261	SD 0.00305291	Variance 9.32029E-006

Concentration at Source [mg/l] - 30 years

05% of values less than 0.000971785	10% of values less than 0.00127078	25% of values less than 0.00228948
50% of values less than 0.00401174	75% of values less than 0.0070601	90% of values less than 0.00942438
Minimum 0.000307349	0.0106476	Maximum 0.0131086
Mean 0.00479261	SD 0.00305291	Variance 9.32029E-006

Concentration at Source [mg/l] - 40 years

05% of values less than 0.000971785	10% of values less than 0.00127078	25% of values less than 0.00228948
50% of values less than 0.00401174	75% of values less than 0.0070601	90% of values less than 0.00942438
Minimum 0.000307349	0.0106476	Maximum 0.0131086
Mean 0.00479261	SD 0.00305291	Variance 9.32029E-006

Concentration at Source [mg/l] - 50 years

05% of values less than 0.000971785	10% of values less than 0.00127078	25% of values less than 0.00228948
50% of values less than 0.00401174	75% of values less than 0.0070601	90% of values less than 0.00942438
Minimum 0.000307349	0.0106476	Maximum 0.0131086
Mean 0.00479261	SD 0.00305291	Variance 9.32029E-006

Concentration at Source [mg/l] - 100 years

05% of values less than 0.000971785	10% of values less than 0.00127078	25% of values less than 0.00228948
50% of values less than 0.00401174	75% of values less than 0.0070601	90% of values less than 0.00942438
Minimum 0.000307349	0.0106476	Maximum 0.0131086
Mean 0.00479261	SD 0.00305291	Variance 9.32029E-006

Concentration at Source [mg/l] - 1000 years

05% of values less than 0.000971785	10% of values less than 0.00127078	25% of values less than 0.00228948
50% of values less than 0.00401174	75% of values less than 0.0070601	90% of values less than 0.00942438
Minimum 0.000307349	0.0106476	Maximum 0.0131086
Mean 0.00479261	SD 0.00305291	Variance 9.32029E-006

site wide - Zinc

Concentration at Source [mg/l] - 10 years

05% of values less than 206.564	10% of values less than 293.435	25% of values less than 461.974
50% of values less than 811.061	75% of values less than 1238.73	90% of values less than 1632.26
Minimum 15.7831ɜ than 1811.61	Maximum 2221.19	
Mean 886.427	SD 497.025	Variance 247034

Concentration at Source [mg/l] - 20 years

05% of values less than 206.564	10% of values less than 293.435	25% of values less than 461.974
50% of values less than 811.061	75% of values less than 1238.73	90% of values less than 1632.26
Minimum 15.7831ɜ than 1811.61	Maximum 2221.19	
Mean 886.427	SD 497.025	Variance 247034

Concentration at Source [mg/l] - 30 years

05% of values less than 206.564	10% of values less than 293.435	25% of values less than 461.974
50% of values less than 811.061	75% of values less than 1238.73	90% of values less than 1632.26
Minimum 15.7831ɜ than 1811.61	Maximum 2221.19	
Mean 886.427	SD 497.025	Variance 247034

Concentration at Source [mg/l] - 40 years

05% of values less than 206.564	10% of values less than 293.435	25% of values less than 461.974
50% of values less than 811.061	75% of values less than 1238.73	90% of values less than 1632.26
Minimum 15.7831ɜ than 1811.61	Maximum 2221.19	
Mean 886.427	SD 497.025	Variance 247034

Concentration at Source [mg/l] - 50 years

05% of values less than 206.564	10% of values less than 293.435	25% of values less than 461.974
50% of values less than 811.061	75% of values less than 1238.73	90% of values less than 1632.26
Minimum 15.7831ɜ than 1811.61	Maximum 2221.19	
Mean 886.427	SD 497.025	Variance 247034

Concentration at Source [mg/l] - 100 years

05% of values less than 206.564	10% of values less than 293.435	25% of values less than 461.974
50% of values less than 811.061	75% of values less than 1238.73	90% of values less than 1632.26
Minimum 15.7831ɜ than 1811.61	Maximum 2221.19	
Mean 886.427	SD 497.025	Variance 247034

Concentration at Source [mg/l] - 1000 years

05% of values less than 206.564	10% of values less than 293.435	25% of values less than 461.974
50% of values less than 811.061	75% of values less than 1238.73	90% of values less than 1632.26
Minimum 15.7831ɜ than 1811.61	Maximum 2221.19	
Mean 886.427	SD 497.025	Variance 247034

site wide - Arsenic

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 0.203985	10% of values less than 0.249556	25% of values less than 0.343578
50% of values less than 0.485128	75% of values less than 0.665445	90% of values less than 0.865015
Minimum 0.109902	than 0.974935	Maximum 1.51083
Mean 0.526335	SD 0.241155	Variance 0.0581558

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 83.1174	10% of values less than 97.4341	25% of values less than 124.228
50% of values less than 156.373	75% of values less than 188.891	90% of values less than 216.327
Minimum 53.7025	than 232.064	Maximum 276.595
Mean 156.873	SD 44.755	Variance 2003.01

site wide - Cadmium

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 0.203985	10% of values less than 0.249556	25% of values less than 0.343578
50% of values less than 0.485128	75% of values less than 0.665445	90% of values less than 0.865015
Minimum 0.109902	than 0.974935	Maximum 1.51083
Mean 0.526335	SD 0.241155	Variance 0.0581558

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 255.337	10% of values less than 299.156	25% of values less than 381.313
50% of values less than 480.292	75% of values less than 580.438	90% of values less than 665.072
Minimum 164.951	than 713.635	Maximum 850.418
Mean 482.032	SD 137.523	Variance 18912.7

site wide - Chromium

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 0.203985	10% of values less than 0.249556	25% of values less than 0.343578
50% of values less than 0.485128	75% of values less than 0.665445	90% of values less than 0.865015
Minimum 0.109902than 0.974935	Maximum 1.51083	
Mean 0.526335	SD 0.241155	Variance 0.0581558

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 44.3266	10% of values less than 51.9368	25% of values less than 66.1673
50% of values less than 83.3018	75% of values less than 100.78	90% of values less than 115.252
Minimum 28.645ss than 123.645	Maximum 147.348	
Mean 83.6342	SD 23.8602	Variance 569.307

site wide - Copper

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 0.203985	10% of values less than 0.249556	25% of values less than 0.343578
50% of values less than 0.485128	75% of values less than 0.665445	90% of values less than 0.865015
Minimum 0.109902	than 0.974935	Maximum 1.51083
Mean 0.526335	SD 0.241155	Variance 0.0581558

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 110.353	10% of values less than 129.34	25% of values less than 164.916
50% of values less than 207.694	75% of values less than 250.767	90% of values less than 287.295
Minimum 71.2961	than 308.223	Maximum 367.344
Mean 208.296	SD 59.426	Variance 3531.44

site wide - Lead

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 0.203985	10% of values less than 0.249556	25% of values less than 0.343578
50% of values less than 0.485128	75% of values less than 0.665445	90% of values less than 0.865015
Minimum 0.109902	than 0.974935	Maximum 1.51083
Mean 0.526335	SD 0.241155	Variance 0.0581558

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 27.8199	10% of values less than 32.5996	25% of values less than 41.4982
50% of values less than 52.1779	75% of values less than 63.2248	90% of values less than 72.2413
Minimum 17.9823	than 77.6025	Maximum 92.3488
Mean 52.4687	SD 14.969	Variance 224.072

site wide - Mercury

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 0.203985	10% of values less than 0.249556	25% of values less than 0.343578
50% of values less than 0.485128	75% of values less than 0.665445	90% of values less than 0.865015
Minimum 0.109902	than 0.974935	Maximum 1.51083
Mean 0.526335	SD 0.241155	Variance 0.0581558

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2735.74	10% of values less than 3204.4	25% of values less than 4083.6
50% of values less than 5144.59	75% of values less than 6217.3	90% of values less than 7128.15
Minimum 1767.21	than 7649.5	Maximum 9114.94
Mean 5165.16	SD 1473.63	Variance 2.17158E+006

site wide - Zinc

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 0.203985	10% of values less than 0.249556	25% of values less than 0.343578
50% of values less than 0.485128	75% of values less than 0.665445	90% of values less than 0.865015
Minimum 0.109902 than 0.974935	Maximum 1.51083	
Mean 0.526335	SD 0.241155	Variance 0.0581558

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 250.11	10% of values less than 293.034	25% of values less than 373.511
50% of values less than 470.464	75% of values less than 568.552	90% of values less than 651.452
Minimum 161.574 than 699.019	Maximum 833.002	
Mean 472.163	SD 134.708	Variance 18146.2

site wide - Arsenic

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 6.4047
Minimum 0	es less than 16.9107	Maximum 47.6539
Mean 1.95658	SD 6.3271	Variance 40.0323

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 7.23442	10% of values less than 9.78725	25% of values less than 15.1989
50% of values less than 27.3074	75% of values less than 39.8974	90% of values less than 52.924
Minimum 1.03082	s than 59.4854	Maximum 73.7386
Mean 29.0725	SD 16.1176	Variance 259.776

site wide - Cadmium

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0.133717	10% of values less than 0.187981	25% of values less than 0.334459
50% of values less than 0.618318	75% of values less than 0.960659	90% of values less than 1.3058
Minimum 0.0169229	an 1.47387	Maximum 1.95999
Mean 0.681046	SD 0.419937	Variance 0.176347

site wide - Chromium

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0.0608109
Mean 6.07501E-005	SD 0.00192205	Variance 3.69427E-006

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0.0820757
Mean 0.00226867	SD 0.0121584	Variance 0.000147827

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0.0686217	Maximum 0.0962762
Mean 0.00649549	SD 0.0210295	Variance 0.000442238

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0.0814888	75% of values less than 0.0988251	90% of values less than 0.109913
Minimum 0	es less than 0.114103	Maximum 0.122361
Mean 0.0663131	SD 0.0421078	Variance 0.00177307

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0.123868	10% of values less than 0.123953	25% of values less than 0.124101
50% of values less than 0.124286	75% of values less than 0.124431	90% of values less than 0.124568
Minimum 0.12359	s than 0.124612	Maximum 0.124781
Mean 0.124268	SD 0.000227648	Variance 5.18238E-008

site wide - Copper

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	Maximum 184.893	
Mean 3.05985	SD 18.1691	Variance 330.116

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 42.0171	10% of values less than 59.2554	25% of values less than 97.4705
50% of values less than 148.41	75% of values less than 209.884	90% of values less than 280.71
Minimum 8.12979	Maximum 381.888	
Mean 159.044	SD 81.6603	Variance 6668.4

site wide - Lead

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.0 values less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.0 values less than 0	Maximum 65.8673	
Mean 0.183144	SD 3.3472	Variance 11.2037

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.0 values less than 65.3311	Maximum 94.307	
Mean 4.92927	SD 18.5691	Variance 344.81

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 78.6076
Minimum 0.0 values less than 89.0297	Maximum 109.051	
Mean 17.4972	SD 33.3444	Variance 1111.85

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 79.5125	90% of values less than 97.339
Minimum 0.0 values less than 104.381	Maximum 118.321	
Mean 36.9757	SD 42.7737	Variance 1829.59

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 92.598	10% of values less than 99.7166	25% of values less than 108.349
50% of values less than 115.949	75% of values less than 120.941	90% of values less than 123.031
Minimum 36.9034 values less than 123.836	Maximum 124.97	
Mean 113.11	SD 10.261	Variance 105.288

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 125	10% of values less than 125	25% of values less than 125
50% of values less than 125	75% of values less than 125	90% of values less than 125
Minimum 37.6748 values less than 125	Maximum 125	
Mean 124.671	SD 4.26217	Variance 18.1661

site wide - Mercury

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

site wide - Zinc

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 190.705	10% of values less than 277.602	25% of values less than 441.145
50% of values less than 755.517	75% of values less than 1174.8	90% of values less than 1549.16
Minimum 15.1223	s than 1688.79	Maximum 2204.95
Mean 834.522	SD 471.687	Variance 222489

site wide - Arsenic

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 3.34306
Minimum 0ues less than 10.1641	Maximum 35.815	
Mean 1.20802	SD 4.09293	Variance 16.752

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 4.11385	10% of values less than 5.32029	25% of values less than 8.95905
50% of values less than 16.2441	75% of values less than 24.8663	90% of values less than 35.461
Minimum 0.394278than 42.5015	Maximum 70.4489	
Mean 18.4011	SD 12.0411	Variance 144.988

site wide - Cadmium

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0.0686938	10% of values less than 0.105609	25% of values less than 0.190588
50% of values less than 0.355427	75% of values less than 0.598633	90% of values less than 0.858583
Minimum 0.00838371	n 1.01265	Maximum 1.75653
Mean 0.4293	SD 0.301791	Variance 0.0910776

site wide - Chromium

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0.0212135	
Mean 2.11923E-005	SD 0.000670494	Variance 4.49562E-007

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0.0587122	
Mean 0.0013441	SD 0.00744104	Variance 5.5369E-005

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0.0387508	Maximum 0.0781319	
Mean 0.00394498	SD 0.0132285	Variance 0.000174994

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0.0447247	75% of values less than 0.0625474	90% of values less than 0.0794777
Minimum 0ues less than 0.086595	Maximum 0.109025	
Mean 0.041326	SD 0.0293329	Variance 0.000860417

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0.0471328	10% of values less than 0.0508138	25% of values less than 0.0598883
50% of values less than 0.0765189	75% of values less than 0.0952068	90% of values less than 0.108863
Minimum 0.0422966an 0.113909	Maximum 0.123182	
Mean 0.0780815	SD 0.0211222	Variance 0.000446147

site wide - Copper

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 126.516
Mean 1.73827	SD 10.4249	Variance 108.678

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 23.1286	10% of values less than 32.4103	25% of values less than 56.2504
50% of values less than 87.2401	75% of values less than 132.561	90% of values less than 183.933
Minimum 4.26873	s than 210.055	Maximum 357.15
Mean 100.121	SD 59.697	Variance 3563.73

site wide - Lead

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 32.073
Mean 0.0821758	SD 1.51332	Variance 2.29013

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 35.5224	Maximum 75.1774
Mean 2.96728	SD 11.5439	Variance 133.262

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 50.3387
Minimum 0	es less than 58.8143	Maximum 95.0299
Mean 10.809	SD 21.463	Variance 460.658

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 46.0148	90% of values less than 66.0378
Minimum 0	es less than 74.6014	Maximum 104.001
Mean 22.9782	SD 28.1938	Variance 794.892

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 42.5868	10% of values less than 45.9154	25% of values less than 54.5711
50% of values less than 69.1309	75% of values less than 86.5754	90% of values less than 99.9811
Minimum 16.3075	s than 105.93	Maximum 121.432
Mean 71.0086	SD 20.1506	Variance 406.045

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 47.2676	10% of values less than 50.8474	25% of values less than 60.039
50% of values less than 76.8534	75% of values less than 95.51	90% of values less than 109.478
Minimum 16.6483	s than 114.312	Maximum 123.874
Mean 78.3321	SD 21.3319	Variance 455.051

site wide - Mercury

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

site wide - Zinc

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 111.611	10% of values less than 155.053	25% of values less than 261.179
50% of values less than 449.45	75% of values less than 706.059	90% of values less than 1004.13
Minimum 10.7321s than 1202.71	Maximum 2066.33	
Mean 523.464	SD 338.217	Variance 114391

Project: Grillo Soil Assessment

Project Number: 70054861-GR1

Project Details

Title: Grillo Soil Assessment

Project Number: 70054861-GR1

Prepared By: V. Langer

Date: 2019-08-15 21:23:16

Client Name: Camathernshire County Council

Comments:

Consim version 2.05

Simulation Level

Level 2

Simulation Parameters

Iterations 1001

Timeslices:10, 20, 30, 40, 50, 100, 1000

Water Quality Standard

EQS (Saltwater) (* quoted as lower value in range)

Source

site wide
Dry Bulk Density [g/cm³] TRIANGULAR(1.6,1.8,2)
Air Filled Porosity [fraction] UNDEFINED
Water Filled Porosity [fraction] TRIANGULAR(0.05,0.15,0.3)
Thickness [m] UNIFORM(1,2)
Contaminated Land
Constant Source Term

Overall Unsaturated Zone Thickness [m] TRIANGULAR(1,2.5,4)

Infiltration

Infiltration [mm/year] SINGLE(77)

Source Inventory:

Arsenic

Measured as Total Concentration in Soil — Concentration [mg/kg] SINGLE(37.3)
Inorganic
Partition Coefficient [ml/g] SINGLE(30.1)
Maximum Solubility [mg/l] SINGLE(441000)

Cadmium

Measured as Total Concentration in Soil — Concentration [mg/kg] SINGLE(1.985)
Inorganic
Partition Coefficient [ml/g] SINGLE(92.7)
Maximum Solubility [mg/l] SINGLE(651000)

Chromium

Measured as Total Concentration in Soil — Concentration [mg/kg] SINGLE(1)
Inorganic
Partition Coefficient [ml/g] SINGLE(16)
Maximum Solubility [mg/l] SINGLE(440000)

Copper

Measured as Total Concentration in Soil — Concentration [mg/kg] SINGLE(352.3)
Inorganic
Partition Coefficient [ml/g] SINGLE(40)
Maximum Solubility [mg/l] SINGLE(293000)

Lead

Measured as Total Concentration in Soil — Concentration [mg/kg] SINGLE(324.7)
Inorganic
Partition Coefficient [ml/g] SINGLE(10)
Maximum Solubility [mg/l] SINGLE(125)

Mercury

Measured as Total Concentration in Soil — Concentration [mg/kg] SINGLE(0.1)

Inorganic

Partition Coefficient [ml/g] SINGLE(994.3)

Maximum Solubility [mg/l] SINGLE(48)

Zinc

Measured as Total Concentration in Soil — Concentration [mg/kg] SINGLE(4173.3)

Inorganic

Partition Coefficient [ml/g] SINGLE(90.8)

Maximum Solubility [mg/l] SINGLE(606000)

Unsaturated Pathway: Made Ground

Active

Porous Medium

Thickness [m] TRIANGULAR(1,2.5,4)

Dry Bulk Density [g/cm³] TRIANGULAR(1.6,1.8,2)

Vertical Dispersivity [m] TRIANGULAR(0.1,0.25,0.4)

Water Filled Porosity [fraction] TRIANGULAR(0.05,0.15,0.35)

Unsaturated Conductivity [m/s] SINGLE(9.73e-006)

Unsaturated Pathway Contaminants

Arsenic

Partition Coefficient [ml/g] SINGLE(30.1)

Cadmium

Partition Coefficient [ml/g] SINGLE(92.7)

Chromium

Partition Coefficient [ml/g] SINGLE(16)

Copper

Partition Coefficient [ml/g] SINGLE(40)

Lead

Partition Coefficient [ml/g] SINGLE(10)

Mercury

Partition Coefficient [ml/g] SINGLE(994.3)

Zinc

Partition Coefficient [ml/g] SINGLE(90.8)

Aquifer Pathway

Thickness [m] UNDEFINED
Dry Bulk Density [g/cm³] UNDEFINED
Mixing Zone Thickness [m] SINGLE(5)
Hydraulic Conductivity [m/s] TRIANGULAR(5.5e-008,9.73e-006,0.000264)
Effective Porosity [fraction] UNDEFINED
Hydraulic Gradient SINGLE(0.007)
Groundwater Flow Direction (degrees), 200.00
Longitudinal Dispersivity [m] UNDEFINED
Lateral Dispersivity [m] UNDEFINED

Contaminant Inventory

Arsenic
Partition Coefficient [ml/g] SINGLE(30.1)

Cadmium
Partition Coefficient [ml/g] SINGLE(92.7)

Chromium
Partition Coefficient [ml/g] SINGLE(16)

Copper
Partition Coefficient [ml/g] SINGLE(40)

Lead
Partition Coefficient [ml/g] SINGLE(10)

Mercury
Partition Coefficient [ml/g] SINGLE(994.3)

Zinc
Partition Coefficient [ml/g] SINGLE(90.8)

site wide Receptor X 244663.289899 Y 200275.001537

Input Correlations

No Correlations

Project: Grillo Soil Assessment

Project Number: 70054861-GR1

site wide - Arsenic

Concentration at Source [mg/l] - 10 years

05% of values less than 1.23345	10% of values less than 1.2338	25% of values less than 1.23457
50% of values less than 1.23552	75% of values less than 1.23625	90% of values less than 1.23692
Minimum 1.23204ვ than 1.2373	Maximum 1.23796	
Mean 1.23542	SD 0.00117076	Variance 1.37067E-006

Concentration at Source [mg/l] - 20 years

05% of values less than 1.23345	10% of values less than 1.2338	25% of values less than 1.23457
50% of values less than 1.23552	75% of values less than 1.23625	90% of values less than 1.23692
Minimum 1.23204ვ than 1.2373	Maximum 1.23796	
Mean 1.23542	SD 0.00117076	Variance 1.37067E-006

Concentration at Source [mg/l] - 30 years

05% of values less than 1.23345	10% of values less than 1.2338	25% of values less than 1.23457
50% of values less than 1.23552	75% of values less than 1.23625	90% of values less than 1.23692
Minimum 1.23204ვ than 1.2373	Maximum 1.23796	
Mean 1.23542	SD 0.00117076	Variance 1.37067E-006

Concentration at Source [mg/l] - 40 years

05% of values less than 1.23345	10% of values less than 1.2338	25% of values less than 1.23457
50% of values less than 1.23552	75% of values less than 1.23625	90% of values less than 1.23692
Minimum 1.23204ვ than 1.2373	Maximum 1.23796	
Mean 1.23542	SD 0.00117076	Variance 1.37067E-006

Concentration at Source [mg/l] - 50 years

05% of values less than 1.23345	10% of values less than 1.2338	25% of values less than 1.23457
50% of values less than 1.23552	75% of values less than 1.23625	90% of values less than 1.23692
Minimum 1.23204ვ than 1.2373	Maximum 1.23796	
Mean 1.23542	SD 0.00117076	Variance 1.37067E-006

Concentration at Source [mg/l] - 100 years

05% of values less than 1.23345	10% of values less than 1.2338	25% of values less than 1.23457
50% of values less than 1.23552	75% of values less than 1.23625	90% of values less than 1.23692
Minimum 1.23204ვ than 1.2373	Maximum 1.23796	
Mean 1.23542	SD 0.00117076	Variance 1.37067E-006

Concentration at Source [mg/l] - 1000 years

05% of values less than 1.23345	10% of values less than 1.2338	25% of values less than 1.23457
50% of values less than 1.23552	75% of values less than 1.23625	90% of values less than 1.23692
Minimum 1.23204ვ than 1.2373	Maximum 1.23796	
Mean 1.23542	SD 0.00117076	Variance 1.37067E-006

site wide - Cadmium

Concentration at Source [mg/l] - 10 years

05% of values less than 0.0213808	10% of values less than 0.0213828	25% of values less than 0.0213871
50% of values less than 0.0213924	75% of values less than 0.0213966	90% of values less than 0.0214003
Minimum 0.0213728	an 0.0214025	Maximum 0.0214062
Mean 0.0213919	SD 6.59698E-006	Variance 4.35201E-011

Concentration at Source [mg/l] - 20 years

05% of values less than 0.0213808	10% of values less than 0.0213828	25% of values less than 0.0213871
50% of values less than 0.0213924	75% of values less than 0.0213966	90% of values less than 0.0214003
Minimum 0.0213728	an 0.0214025	Maximum 0.0214062
Mean 0.0213919	SD 6.59698E-006	Variance 4.35201E-011

Concentration at Source [mg/l] - 30 years

05% of values less than 0.0213808	10% of values less than 0.0213828	25% of values less than 0.0213871
50% of values less than 0.0213924	75% of values less than 0.0213966	90% of values less than 0.0214003
Minimum 0.0213728	an 0.0214025	Maximum 0.0214062
Mean 0.0213919	SD 6.59698E-006	Variance 4.35201E-011

Concentration at Source [mg/l] - 40 years

05% of values less than 0.0213808	10% of values less than 0.0213828	25% of values less than 0.0213871
50% of values less than 0.0213924	75% of values less than 0.0213966	90% of values less than 0.0214003
Minimum 0.0213728	an 0.0214025	Maximum 0.0214062
Mean 0.0213919	SD 6.59698E-006	Variance 4.35201E-011

Concentration at Source [mg/l] - 50 years

05% of values less than 0.0213808	10% of values less than 0.0213828	25% of values less than 0.0213871
50% of values less than 0.0213924	75% of values less than 0.0213966	90% of values less than 0.0214003
Minimum 0.0213728	an 0.0214025	Maximum 0.0214062
Mean 0.0213919	SD 6.59698E-006	Variance 4.35201E-011

Concentration at Source [mg/l] - 100 years

05% of values less than 0.0213808	10% of values less than 0.0213828	25% of values less than 0.0213871
50% of values less than 0.0213924	75% of values less than 0.0213966	90% of values less than 0.0214003
Minimum 0.0213728	an 0.0214025	Maximum 0.0214062
Mean 0.0213919	SD 6.59698E-006	Variance 4.35201E-011

Concentration at Source [mg/l] - 1000 years

05% of values less than 0.0213808	10% of values less than 0.0213828	25% of values less than 0.0213871
50% of values less than 0.0213924	75% of values less than 0.0213966	90% of values less than 0.0214003
Minimum 0.0213728	an 0.0214025	Maximum 0.0214062
Mean 0.0213919	SD 6.59698E-006	Variance 4.35201E-011

site wide - Chromium

Concentration at Source [mg/l] - 10 years

05% of values less than 0.061956	10% of values less than 0.0619897	25% of values less than 0.0620619
50% of values less than 0.0621512	75% of values less than 0.0622204	90% of values less than 0.0622839
Minimum 0.0618242	an 0.06232	Maximum 0.0623821
Mean 0.0621425	SD 0.000110469	Variance 1.22033E-008

Concentration at Source [mg/l] - 20 years

05% of values less than 0.061956	10% of values less than 0.0619897	25% of values less than 0.0620619
50% of values less than 0.0621512	75% of values less than 0.0622204	90% of values less than 0.0622839
Minimum 0.0618242	an 0.06232	Maximum 0.0623821
Mean 0.0621425	SD 0.000110469	Variance 1.22033E-008

Concentration at Source [mg/l] - 30 years

05% of values less than 0.061956	10% of values less than 0.0619897	25% of values less than 0.0620619
50% of values less than 0.0621512	75% of values less than 0.0622204	90% of values less than 0.0622839
Minimum 0.0618242	an 0.06232	Maximum 0.0623821
Mean 0.0621425	SD 0.000110469	Variance 1.22033E-008

Concentration at Source [mg/l] - 40 years

05% of values less than 0.061956	10% of values less than 0.0619897	25% of values less than 0.0620619
50% of values less than 0.0621512	75% of values less than 0.0622204	90% of values less than 0.0622839
Minimum 0.0618242	an 0.06232	Maximum 0.0623821
Mean 0.0621425	SD 0.000110469	Variance 1.22033E-008

Concentration at Source [mg/l] - 50 years

05% of values less than 0.061956	10% of values less than 0.0619897	25% of values less than 0.0620619
50% of values less than 0.0621512	75% of values less than 0.0622204	90% of values less than 0.0622839
Minimum 0.0618242	an 0.06232	Maximum 0.0623821
Mean 0.0621425	SD 0.000110469	Variance 1.22033E-008

Concentration at Source [mg/l] - 100 years

05% of values less than 0.061956	10% of values less than 0.0619897	25% of values less than 0.0620619
50% of values less than 0.0621512	75% of values less than 0.0622204	90% of values less than 0.0622839
Minimum 0.0618242	an 0.06232	Maximum 0.0623821
Mean 0.0621425	SD 0.000110469	Variance 1.22033E-008

Concentration at Source [mg/l] - 1000 years

05% of values less than 0.061956	10% of values less than 0.0619897	25% of values less than 0.0620619
50% of values less than 0.0621512	75% of values less than 0.0622204	90% of values less than 0.0622839
Minimum 0.0618242	an 0.06232	Maximum 0.0623821
Mean 0.0621425	SD 0.000110469	Variance 1.22033E-008

site wide - Copper

Concentration at Source [mg/l] - 10 years

05% of values less than 8.77667	10% of values less than 8.77859	25% of values less than 8.7827
50% of values less than 8.78777	75% of values less than 8.7917	90% of values less than 8.79529
Minimum 8.76916s than 8.79734	Maximum 8.80085	
Mean 8.78727	SD 0.00627136	Variance 3.933E-005

Concentration at Source [mg/l] - 20 years

05% of values less than 8.77667	10% of values less than 8.77859	25% of values less than 8.7827
50% of values less than 8.78777	75% of values less than 8.7917	90% of values less than 8.79529
Minimum 8.76916s than 8.79734	Maximum 8.80085	
Mean 8.78727	SD 0.00627136	Variance 3.933E-005

Concentration at Source [mg/l] - 30 years

05% of values less than 8.77667	10% of values less than 8.77859	25% of values less than 8.7827
50% of values less than 8.78777	75% of values less than 8.7917	90% of values less than 8.79529
Minimum 8.76916s than 8.79734	Maximum 8.80085	
Mean 8.78727	SD 0.00627136	Variance 3.933E-005

Concentration at Source [mg/l] - 40 years

05% of values less than 8.77667	10% of values less than 8.77859	25% of values less than 8.7827
50% of values less than 8.78777	75% of values less than 8.7917	90% of values less than 8.79529
Minimum 8.76916s than 8.79734	Maximum 8.80085	
Mean 8.78727	SD 0.00627136	Variance 3.933E-005

Concentration at Source [mg/l] - 50 years

05% of values less than 8.77667	10% of values less than 8.77859	25% of values less than 8.7827
50% of values less than 8.78777	75% of values less than 8.7917	90% of values less than 8.79529
Minimum 8.76916s than 8.79734	Maximum 8.80085	
Mean 8.78727	SD 0.00627136	Variance 3.933E-005

Concentration at Source [mg/l] - 100 years

05% of values less than 8.77667	10% of values less than 8.77859	25% of values less than 8.7827
50% of values less than 8.78777	75% of values less than 8.7917	90% of values less than 8.79529
Minimum 8.76916s than 8.79734	Maximum 8.80085	
Mean 8.78727	SD 0.00627136	Variance 3.933E-005

Concentration at Source [mg/l] - 1000 years

05% of values less than 8.77667	10% of values less than 8.77859	25% of values less than 8.7827
50% of values less than 8.78777	75% of values less than 8.7917	90% of values less than 8.79529
Minimum 8.76916s than 8.79734	Maximum 8.80085	
Mean 8.78727	SD 0.00627136	Variance 3.933E-005

site wide - Lead

Concentration at Source [mg/l] - 10 years

05% of values less than 32.0201	10% of values less than 32.0479	25% of values less than 32.1074
50% of values less than 32.181	75% of values less than 32.2382	90% of values less than 32.2907
Minimum 31.9119s than 32.3206	Maximum 32.3721	
Mean 32.174	SD 0.0911771	Variance 0.00831326

Concentration at Source [mg/l] - 20 years

05% of values less than 32.0201	10% of values less than 32.0479	25% of values less than 32.1074
50% of values less than 32.181	75% of values less than 32.2382	90% of values less than 32.2907
Minimum 31.9119s than 32.3206	Maximum 32.3721	
Mean 32.174	SD 0.0911771	Variance 0.00831326

Concentration at Source [mg/l] - 30 years

05% of values less than 32.0201	10% of values less than 32.0479	25% of values less than 32.1074
50% of values less than 32.181	75% of values less than 32.2382	90% of values less than 32.2907
Minimum 31.9119s than 32.3206	Maximum 32.3721	
Mean 32.174	SD 0.0911771	Variance 0.00831326

Concentration at Source [mg/l] - 40 years

05% of values less than 32.0201	10% of values less than 32.0479	25% of values less than 32.1074
50% of values less than 32.181	75% of values less than 32.2382	90% of values less than 32.2907
Minimum 31.9119s than 32.3206	Maximum 32.3721	
Mean 32.174	SD 0.0911771	Variance 0.00831326

Concentration at Source [mg/l] - 50 years

05% of values less than 32.0201	10% of values less than 32.0479	25% of values less than 32.1074
50% of values less than 32.181	75% of values less than 32.2382	90% of values less than 32.2907
Minimum 31.9119s than 32.3206	Maximum 32.3721	
Mean 32.174	SD 0.0911771	Variance 0.00831326

Concentration at Source [mg/l] - 100 years

05% of values less than 32.0201	10% of values less than 32.0479	25% of values less than 32.1074
50% of values less than 32.181	75% of values less than 32.2382	90% of values less than 32.2907
Minimum 31.9119s than 32.3206	Maximum 32.3721	
Mean 32.174	SD 0.0911771	Variance 0.00831326

Concentration at Source [mg/l] - 1000 years

05% of values less than 32.0201	10% of values less than 32.0479	25% of values less than 32.1074
50% of values less than 32.181	75% of values less than 32.2382	90% of values less than 32.2907
Minimum 31.9119s than 32.3206	Maximum 32.3721	
Mean 32.174	SD 0.0911771	Variance 0.00831326

site wide - Mercury

Concentration at Source [mg/l] - 10 years

05% of values less than 0.000100559	10% of values less than 0.00010056	25% of values less than 0.000100562
50% of values less than 0.000100564	75% of values less than 0.000100566	90% of values less than 0.000100568
Minimum 0.000100556ı 0.000100569	Maximum 0.00010057	
Mean 0.000100564	SD 2.89414E-009	Variance 8.37604E-018

Concentration at Source [mg/l] - 20 years

05% of values less than 0.000100559	10% of values less than 0.00010056	25% of values less than 0.000100562
50% of values less than 0.000100564	75% of values less than 0.000100566	90% of values less than 0.000100568
Minimum 0.000100556ı 0.000100569	Maximum 0.00010057	
Mean 0.000100564	SD 2.89414E-009	Variance 8.37604E-018

Concentration at Source [mg/l] - 30 years

05% of values less than 0.000100559	10% of values less than 0.00010056	25% of values less than 0.000100562
50% of values less than 0.000100564	75% of values less than 0.000100566	90% of values less than 0.000100568
Minimum 0.000100556ı 0.000100569	Maximum 0.00010057	
Mean 0.000100564	SD 2.89414E-009	Variance 8.37604E-018

Concentration at Source [mg/l] - 40 years

05% of values less than 0.000100559	10% of values less than 0.00010056	25% of values less than 0.000100562
50% of values less than 0.000100564	75% of values less than 0.000100566	90% of values less than 0.000100568
Minimum 0.000100556ı 0.000100569	Maximum 0.00010057	
Mean 0.000100564	SD 2.89414E-009	Variance 8.37604E-018

Concentration at Source [mg/l] - 50 years

05% of values less than 0.000100559	10% of values less than 0.00010056	25% of values less than 0.000100562
50% of values less than 0.000100564	75% of values less than 0.000100566	90% of values less than 0.000100568
Minimum 0.000100556ı 0.000100569	Maximum 0.00010057	
Mean 0.000100564	SD 2.89414E-009	Variance 8.37604E-018

Concentration at Source [mg/l] - 100 years

05% of values less than 0.000100559	10% of values less than 0.00010056	25% of values less than 0.000100562
50% of values less than 0.000100564	75% of values less than 0.000100566	90% of values less than 0.000100568
Minimum 0.000100556ı 0.000100569	Maximum 0.00010057	
Mean 0.000100564	SD 2.89414E-009	Variance 8.37604E-018

Concentration at Source [mg/l] - 1000 years

05% of values less than 0.000100559	10% of values less than 0.00010056	25% of values less than 0.000100562
50% of values less than 0.000100564	75% of values less than 0.000100566	90% of values less than 0.000100568
Minimum 0.000100556ı 0.000100569	Maximum 0.00010057	
Mean 0.000100564	SD 2.89414E-009	Variance 8.37604E-018

site wide - Zinc

Concentration at Source [mg/l] - 10 years

05% of values less than 45.8904	10% of values less than 45.8949	25% of values less than 45.9044
50% of values less than 45.916	75% of values less than 45.9251	90% of values less than 45.9334
Minimum 45.8731ɜ than 45.9381	Maximum 45.9462	
Mean 45.9149	SD 0.0144555	Variance 0.000208962

Concentration at Source [mg/l] - 20 years

05% of values less than 45.8904	10% of values less than 45.8949	25% of values less than 45.9044
50% of values less than 45.916	75% of values less than 45.9251	90% of values less than 45.9334
Minimum 45.8731ɜ than 45.9381	Maximum 45.9462	
Mean 45.9149	SD 0.0144555	Variance 0.000208962

Concentration at Source [mg/l] - 30 years

05% of values less than 45.8904	10% of values less than 45.8949	25% of values less than 45.9044
50% of values less than 45.916	75% of values less than 45.9251	90% of values less than 45.9334
Minimum 45.8731ɜ than 45.9381	Maximum 45.9462	
Mean 45.9149	SD 0.0144555	Variance 0.000208962

Concentration at Source [mg/l] - 40 years

05% of values less than 45.8904	10% of values less than 45.8949	25% of values less than 45.9044
50% of values less than 45.916	75% of values less than 45.9251	90% of values less than 45.9334
Minimum 45.8731ɜ than 45.9381	Maximum 45.9462	
Mean 45.9149	SD 0.0144555	Variance 0.000208962

Concentration at Source [mg/l] - 50 years

05% of values less than 45.8904	10% of values less than 45.8949	25% of values less than 45.9044
50% of values less than 45.916	75% of values less than 45.9251	90% of values less than 45.9334
Minimum 45.8731ɜ than 45.9381	Maximum 45.9462	
Mean 45.9149	SD 0.0144555	Variance 0.000208962

Concentration at Source [mg/l] - 100 years

05% of values less than 45.8904	10% of values less than 45.8949	25% of values less than 45.9044
50% of values less than 45.916	75% of values less than 45.9251	90% of values less than 45.9334
Minimum 45.8731ɜ than 45.9381	Maximum 45.9462	
Mean 45.9149	SD 0.0144555	Variance 0.000208962

Concentration at Source [mg/l] - 1000 years

05% of values less than 45.8904	10% of values less than 45.8949	25% of values less than 45.9044
50% of values less than 45.916	75% of values less than 45.9251	90% of values less than 45.9334
Minimum 45.8731ɜ than 45.9381	Maximum 45.9462	
Mean 45.9149	SD 0.0144555	Variance 0.000208962

site wide - Arsenic

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2.18175	10% of values less than 2.61843	25% of values less than 3.57707
50% of values less than 5.09535	75% of values less than 6.8167	90% of values less than 8.65982
Minimum 0.901658	than 9.70146	Maximum 13.9151
Mean 5.37961	SD 2.32895	Variance 5.424

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 860.009	10% of values less than 996.43	25% of values less than 1301.82
50% of values less than 1616.14	75% of values less than 1917.56	90% of values less than 2193.02
Minimum 511.993	than 2341.98	Maximum 2771.27
Mean 1601.18	SD 441.928	Variance 195300

site wide - Cadmium

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2.18175	10% of values less than 2.61843	25% of values less than 3.57707
50% of values less than 5.09535	75% of values less than 6.8167	90% of values less than 8.65982
Minimum 0.901658	than 9.70146	Maximum 13.9151
Mean 5.37961	SD 2.32895	Variance 5.424

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2643.53	10% of values less than 3064.87	25% of values less than 4002.94
50% of values less than 4966.43	75% of values less than 5891.85	90% of values less than 6740.11
Minimum 1571.44	than 7197.45	Maximum 8511.78
Mean 4920.02	SD 1358.12	Variance 1.84448E+006

site wide - Chromium

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2.18175	10% of values less than 2.61843	25% of values less than 3.57707
50% of values less than 5.09535	75% of values less than 6.8167	90% of values less than 8.65982
Minimum 0.901658	than 9.70146	Maximum 13.9151
Mean 5.37961	SD 2.32895	Variance 5.424

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 458.29	10% of values less than 530.535	25% of values less than 693.421
50% of values less than 861.652	75% of values less than 1021.94	90% of values less than 1168.84
Minimum 273.365	than 1248.33	Maximum 1478.28
Mean 853.646	SD 235.569	Variance 55492.6

site wide - Copper

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2.18175	10% of values less than 2.61843	25% of values less than 3.57707
50% of values less than 5.09535	75% of values less than 6.8167	90% of values less than 8.65982
Minimum 0.901658	than 9.70146	Maximum 13.9151
Mean 5.37961	SD 2.32895	Variance 5.424

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 1142.07	10% of values less than 1323.55	25% of values less than 1728.99
50% of values less than 2146.09	75% of values less than 2546.14	90% of values less than 2912.13
Minimum 679.541	than 3109.86	Maximum 3679.11
Mean 2126.04	SD 586.82	Variance 344357

site wide - Lead

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2.18175	10% of values less than 2.61843	25% of values less than 3.57707
50% of values less than 5.09535	75% of values less than 6.8167	90% of values less than 8.65982
Minimum 0.901658than 9.70146	Maximum 13.9151	
Mean 5.37961	SD 2.32895	Variance 5.424

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 287.346	10% of values less than 332.607	25% of values less than 434.528
50% of values less than 540.372	75% of values less than 641.712	90% of values less than 733.016
Minimum 171.82ss than 782.953	Maximum 928.073	
Mean 535.546	SD 147.759	Variance 21832.8

site wide - Mercury

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2.18175	10% of values less than 2.61843	25% of values less than 3.57707
50% of values less than 5.09535	75% of values less than 6.8167	90% of values less than 8.65982
Minimum 0.901658	than 9.70146	Maximum 13.9151
Mean 5.37961	SD 2.32895	Variance 5.424

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 28314.9	10% of values less than 32855.7	25% of values less than 42905.9
50% of values less than 53210	75% of values less than 63097.4	90% of values less than 72229.8
Minimum 16830.1	than 77128.7	Maximum 91189.7
Mean 52719.8	SD 14553.6	Variance 2.11808E+008

site wide - Zinc

Unretarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2.18175	10% of values less than 2.61843	25% of values less than 3.57707
50% of values less than 5.09535	75% of values less than 6.8167	90% of values less than 8.65982
Minimum 0.901658	than 9.70146	Maximum 13.9151
Mean 5.37961	SD 2.32895	Variance 5.424

Retarded Travel Time to Base of Unsaturated Zone Made Ground [years]

05% of values less than 2589.39	10% of values less than 3002.09	25% of values less than 3920.96
50% of values less than 4864.8	75% of values less than 5771.29	90% of values less than 6602.1
Minimum 1539.28	than 7050.08	Maximum 8337.54
Mean 4819.29	SD 1330.31	Variance 1.76972E+006

site wide - Arsenic

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0.588937
Minimum 0	es less than 0.715531	Maximum 1.02335
Mean 0.0742068	SD 0.224208	Variance 0.0502692

site wide - Cadmium

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

site wide - Chromium

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0.0392812	75% of values less than 0.0480317	90% of values less than 0.0545398
Minimum 0	es less than 0.0566048	Maximum 0.0609542
Mean 0.0321751	SD 0.0209361	Variance 0.00043832

site wide - Copper

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 5.97282
Mean 0.126482	SD 0.780062	Variance 0.608497

site wide - Lead

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 23.9949	10% of values less than 25.6477	25% of values less than 27.7168
50% of values less than 29.6898	75% of values less than 30.9798	90% of values less than 31.6413
Minimum 18.9444	s than 31.8252	Maximum 32.1956
Mean 29.0583	SD 2.50132	Variance 6.25658

site wide - Mercury

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

site wide - Zinc

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Concentration at Base of Unsaturated Zone Made Ground [mg/l] - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

site wide - Arsenic

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0.0324334
Minimum 0	es less than 0.0912872	Maximum 0.455344
Mean 0.0121769	SD 0.0448094	Variance 0.00200788

site wide - Cadmium

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

site wide - Chromium

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0.0043587	75% of values less than 0.00804441	90% of values less than 0.0143229
Minimum 0ues less than 0.0193953	Maximum 0.0431487	
Mean 0.0059175	SD 0.00646873	Variance 4.18445E-005

site wide - Copper

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0.es less than 0	Maximum 2.625	
Mean 0.019855	SD 0.149766	Variance 0.0224299

site wide - Lead

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 1.71973	10% of values less than 1.93169	25% of values less than 2.60664
50% of values less than 4.02434	75% of values less than 6.87445	90% of values less than 11.6711
Minimum 1.18797	s than 14.7745	Maximum 27.4903
Mean 5.50657	SD 4.19014	Variance 17.5573

site wide - Mercury

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0	es less than 0	Maximum 0
Mean 0	SD 0	Variance 0

site wide - Zinc

Diluted Concentration [mg/l] Made Ground - 10 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 20 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 30 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 40 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 50 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 100 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Diluted Concentration [mg/l] Made Ground - 1000 years

05% of values less than 0	10% of values less than 0	25% of values less than 0
50% of values less than 0	75% of values less than 0	90% of values less than 0
Minimum 0ues less than 0	Maximum 0	
Mean 0	SD 0	Variance 0

Appendix H

RISK APPRAISAL METHODOLOGY

The identification of potential “pollutant linkages” is a key aspect of the evaluation of potentially contaminated land. An approach based on the UK CIRIA report C552 (Contaminated Land Risk Assessment: A Guide to Good Practice, 2001) has been adopted within this report. For each of the pollutant linkages, an estimate is made of:

- The potential severity of the risk; and
- The likelihood of the risk occurring.

Table H-1 presents the classification of the severity of the risk:

Table H-1: Severity of Risk

Severe	Acute risks to human health; Major pollution of controlled waters (watercourses or groundwater)
Medium	Chronic (long-term) risk to human health; Pollution of sensitive controlled waters (surface waters or aquifers)
Mild	Pollution of non-sensitive water resources.
Minor	Requirement for protective equipment during site works to mitigate health effects; Damage to non-sensitive ecosystems or species

The probability of the risk occurring is classified by criteria given in Table H-2.

Table H-2: Probability of Risk Occurring

High Likelihood	Pollutant linkage may be present, and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor.
Likely	Pollutant linkage may be present, and it is probable that the risk will occur over the long term.
Low Likelihood	Pollutant linkage may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Unlikely	Pollutant linkage may be present but the circumstances under which harm would occur are improbable.

An overall evaluation of the level of risk is gained from a comparison of the severity and probability as presented in Table H-3.

Table H-3: Comparison of Severity and Probability

		Severity			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	Very high risk	High risk	Moderate risk	Moderate / low risk
	Likely	High risk	Moderate risk	Moderate/ low risk	Low risk
	Low Likelihood	Moderate risk	Moderate/ low risk	Low risk	Very low risk
	Unlikely	Moderate / low risk	Low risk	Very low risk	Very low risk

Table H-4 then provides a description of the typical consequences and potential actions required following each risk definition.

Table H-4: Qualitative Risk Assessment - Classification of Consequence

Classification	Definition
Very High Risk	Severe harm to a receptor may already be occurring, or a high likelihood severe harm will arise to a receptor, unless immediate remedial works / mitigation measures are undertaken.
High Risk	Harm is likely to arise to a receptor, and is likely to be severe, unless appropriate remedial actions / mitigation measures are undertaken. Remedial works may be required in the short-term, but likely to be required over the long-term.
Moderate Risk	Possible that harm could arise to a receptor, but low likelihood that such harm would be severe. Harm is likely to be mild. Some remedial works may be required in the long-term.
Moderate / Low Risk	Possible that harm could arise to a receptor, but where a combination of likelihood and consequence results in a risk that is above low, but is not of sufficient concern to be classified as mild. Limited further investigation may be required to clarify the risk. If necessary, remediation works are likely to be limited in extent.
Low Risk	Possible that harm could arise to a receptor. Such harm, at worst, would normally be mild.
Very Low Risk	Low likelihood that harm could arise to a receptor. Such harm is unlikely to be any worse than mild.

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Carmarthenshire County Council

REMEDIATION OPTIONS APPRAISAL

Former Grillo Zinc Oxide Site

70054861
AUGUST 2019

PUBLIC

Carmarthenshire County Council

REMEDIATION OPTIONS APPRAISAL

Former Grillo Zinc Oxide Site

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QUALITY CONTROL

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Signature				
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CONTENTS

TABLES

APPENDICES

1 INTRODUCTION

1.1 TERMS OF REFERENCE

1.1.1. WSP Limited (WSP) was commissioned by Carmarthenshire County Council (CCC), to prepare a remediation options appraisal in relation to soil and groundwater quality at the former Grillo zinc oxide site, Burry Port (hereafter referred to as the 'Site').

1.1.2. The work has been conducted with reference to WSP proposal (ref: 70054861-P01, Grillo Site Redevelopment, Burry Port, dated 24 May 2019).

1.1.3. This work has been conducted in line with current good practice, the steps in this process outlined in the industry best practice document: Environment Agency June 2019 'Land Contamination: Risk Management' which will be replacing CLR11: Environment Agency (EA) document CLR11, Model Procedures for the Management of Land Contamination.

1.2 BACKGROUND

1.2.1. It is understood that Carmarthenshire County Council proposes to redevelop the Site to a mixed end use including residential and commercial developments. The proposed development includes up to 230 homes, 465 m^2 of retail and leisure floorspace (a1, a3 and d1 uses), creation and alteration of existing vehicle and pedestrian accesses, landscaping, public open space, all services and infrastructure, demolition, remediation of the site and associated work. Re-development of the Site was granted outline planning permission (ref: S/30678) in August 2014.

1.2.2. Several phases of investigation have been carried out on the Site and the surrounding area by different consultants over the last fifteen years. The most recent soil and groundwater interpretative contamination assessment report was completed by ESG (August 2017) in response to planning conditions 8(ii) and 8(iii) within the Outline Planning Permission issued to Castleton Estate Limited in August 2014; and comments from Natural Resources Wales (NRW). Within the conclusions of the site assessment, ESG recommended the preparation of:

(i) Updated Controlled Waters DQRA (utilising either ConSim or P20 modelling), and

(ii) Updated remediation option appraisal, considering the new development proposals.

1.2.3. This report contains the remediation options appraisal to evaluate applicable remediation technologies available to mitigate identified contamination risks at this Site. The updated Controlled Waters DQRA has been issued as a separate document (Reference: 70054861-GR1-001) and should be read in conjunction with this report.

1.2.4. The Site was a former zinc oxide plant, which is now disused and demolished to ground level. A programme of detailed site investigation and risk assessment was implemented to established risks to nearby receptors from soil and groundwater impacted with heavy metals and hydrocarbons has been undertaken between 2004 and 2017.

The 2019 Updated Controlled Waters DQRA established that the most sensitive controlled waters receptor was the Loughor Estuary. The 2019 groundwater quality data indicate improved conditions within the Blown Sands aquifer, with arsenic, chromium (VI), zinc, benzo(a)pyrene and fluoranthene the only analytes recorded above EQS (Coastal). Level 3 DQRA simulations predict that these exceedances present a ***low risk*** to off-site receptors (beyond 50m hydraulic down gradient) due to

travel times in excess of 1,000 years. The retarded chromium (VI) travel time to the 50m Point of Compliance (POC) is predicted to be 677 years.

1.2.5. The environmental risk is predicted to be ***increased*** during the site development phase (breaking hardstanding). The enabling works will involve the removal of the site wide hardstanding and therefore, the leaching potential from the soil matrix (unsaturated zone) is likely to increase which has the potential to increased migration of contaminants to the shallow aquifer within the superficial deposits. Therefore, mitigation will be required during works to reduce leaching potential to controlled waters.

1.2.6. The presence of localised hydrocarbons (potentially indicative of saturated soils and light non-aqueous phase liquid (LNAPL)) identified within soils during the ground investigations indicates a potential risk of direct migration to Burry Port Harbour and Loughor Estuary. In accordance with NRW guidance, the identified potential risk associated with potential residual free phase hydrocarbons should be mitigated as far as reasonably practicable.

1.3 OBJECTIVES

1.3.1. This remediation options appraisal evaluates the potential options for mitigating risks associated with heavy metal and localised petroleum hydrocarbon contamination within shallow soils beneath the site.

1.3.2. Based on the outcomes of the options appraisal, a preliminary remediation strategy has been developed to set out how the selected remedial option(s) will be implemented.

1.3.3. The options appraisal assumes a predominantly residential end use with some commercial premises.

1.3.4. The main objectives of the work are as follows:

- To define Site characteristics and set out constraints which may affect the performance of differing remediation options;
- To summarise and present available information regarding the extents and distribution of contamination;
- To conduct an evaluation of the feasible remediation techniques to identify the most appropriate / combination of techniques that will achieve the remediation objectives;
- To identify the most appropriate and cost-effective remediation option based on the evaluation of remedial techniques; and
- To develop a remediation strategy based the outcomes remediation options appraisal.

1.4 REPORT STRUCTURE

1.4.1. This report follows the structure set-out below and is consistent with the recommended sequence detailed in Environment Agency June 2019 ‘Land Contamination: Risk Management’:

- **Section 2 – Site Setting and Assessment:**
  - Establishes key site characteristics and provides a summary of previous reports and assessments. Sets out the remedial objectives of the project.

- **Section 3 – Identification of Feasible Remediation Options:**

The evaluation of remediation options is progressed in a staged process as follows:

- **Stage 1 –** Available techniques (options) are first introduced and assessed with respect to applicability for each relevant contaminant linkage and associated contaminants of concern (CoC);

- **Stage 2 –** The list of remaining techniques from Stage 1 is then qualitatively appraised against site specific characteristics and constraints. Feasible site-specific options are identified for more detailed examination.

¡ **Section 4 – Detailed Evaluation of Options:**
- Presents a detailed evaluation of the identified feasible options. The most appropriate remedial option for the site is identified.

¡ **Section 5 – Preliminary Remediation Strategy:**
- Details the proposed strategy to implement the identified remedial option, which includes consideration of the findings of pilot trials etc.

1.5 PREVIOUS REPORTS

1.5.1. Previous reports and surveys which have been prepared for the site are listed below in Table 1-1:

Table 1-1 Previous Reports

REPORT TITLE	AUTHOR	REFERENCE	DATE
Phase II Site Investigation and Risk Assessment Report	Parsons Brinckerhoff Ltd	FSE96191A	September 2004
Preliminary Remediation Strategy	Waterman Civils	36411-2200-200	October 2007
Soil and Groundwater Quantitative Risk Assessment	Waterman Civils	36411-2200-201	February 2008
Geo-environmental Site Investigation Report	Ground Investigation (Wales) Ltd	542.04	March 2008
Ground Investigation and Remediation at Burry Port (text and figures only)	ESG	30038/GI&RS	August 2011
Ground Investigation and Remediation at Burry Port – Draft Supplementary Letter Report	ESG	LRO/30038/001/HN	November 2011
Proposed Re-Development of the Former Grillo Zinc-oxide Site at Burry Port, Ground Conditions	Waterman Civils	36411-GGC01A	July 2014
Factual Report	ESG	H7043-17	August 2017
Interpretative Contamination Assessment	ESG	R6072-17	September 2017

1.6 LIMITATIONS

1.6.1. WSP has undertaken this report in accordance with the current agreement with CCC under which these services have been performed. The report may be relied upon by CCC as 'the Client', within the meaning given to that phrase in the agreement, and subject to the terms and conditions contained therein.

1.6.2. This report has been completed with regard to generally accepted consulting practices and may not be relied upon by any other party without the explicit written agreement of WSP. No other third-party warranty, expressed or implied, is made as to the professional advice included in this report. This report must be used in this entirety.

1.6.3. Unless WSP has actual knowledge to the contrary, WSP shall assume the correctness and completeness of, and shall have no liability in respect of any inaccuracy, defect or omission in any information or materials provided, anecdotally or otherwise, by the client or any other third party to WSP. WSP does not assume any liability for misrepresentation of information or for items not visible, accessible, present or supplied at the time of the study.

1.6.4. This report is based on the available information at the time of issue. Should further information become available or if specific comments or opinions are expressed by regulators or the client this report may require revision.

2 SITE SETTING AND ASSESSMENT

2.1 SITE REFERENCING INFORMATION

2.1.1. The Site is located at the Former Grillo Zinc Oxide plant, off of the B4311 to the north, and Burry Port Harbour East road to the west, Burry Port, Carmarthenshire. The Site is situated approximately 300 m south of Burry Port town centre. The Site location is shown on Figure 1.

2.1.2. Site referencing information is summarised below in Table 2-1 with more detailed site information provided in the reports listed in Section 1.5.

Table 2-1 – Site Information

SITE NAME	**Former Grillo Zinc Oxide Site**
SITE ADDRESS	South of B4311, Burry Port, Carmarthenshire, Wales SA16 0NH
SITE AREA	2.96 Ha
NATIONAL GRID REFERENCE	244760, 200350
SITE OWNERSHIP	CCC is looking to purchase the Site.
CURRENT SITE USE	The Site currently disused vacant land, demolished to ground level, predominantly comprising concrete slabs of the former zinc oxide plant. A large stockpile comprising demolition rubble is present towards the centre of the Site.
GENERAL ENVIRONMENT	The Site is situated in a historically industrial area with the surrounding plots of land to the north and east also vacant and disused. Burry Port Harbour is located to the west and a boat yard to the south beyond which is the Loughor Estuary.
SITE ACCESS	The Site is accessed via a palisade gate to the north of Site. There is also gated access in the far south of the site from Burry Port Harbour East Road.
NEIGHBOURING LAND USES	Burry Port Harbour is located approximately 20m west. To the south there is a boat yard with the mouth of the River Loughor approximately 100m to the south. The plot of land to the east and north is currently demolished and vacant.
STRUCTURES	The site is vacant and all buildings have been demolished, however there are many foundation slabs and buried structures across the Site including a turntable, backfilled culverts, and two historical disused abstraction wells.
SITE TOPOGRAPHY	The ground level is approximately 6.5 m AOD. The highest point in the centre of the Site, likely associated with the foundation slab, with a gradient falling to the south of the Site.

GROUND COVER	The majority of the Site is covered by concrete hardstanding, from foundation slabs of historical buildings and roadways, etc.
SITE HISTORY (FROM WATERMAN CIVILS, 2008)	In 1849, the Site was developed as Pembrey Copper Works with associated railway lines, undertaking copper smelting until 1912. It was then briefly occupied by an 'ore extraction company', removing metal bearing flue dust for sale to non-ferrous smelters. During World War 1, Metallic Chemical Ltd was formed to manufacture oxides of non-ferrous metals, particularly zinc oxide, but also including oxides of lead, copper, iron and barium until 1922. The Site then manufactured zinc oxide under various companies until circa 2004. In late 2006, the former works buildings were demolished and the Site has remained vacant, except for a boat yard in the south of the Site.
HISTORY OF SURROUNDING LAND	To the north there was historically (circa 1880 - 1908) a lead and silver works and iron foundry. To the east of the Site, Pembrey copper works extended off site with two gasometers in the north and south east. Between 1964 and 1989, a power station was present in this area, with a landfill used by Carmarthen Bay Power between 1980 and 1987 immediately adjacent to the east of the Site. Historical mapping also recorded a large railway present to the north and east of the Site. To the south railway sidings were present until 1991 when the Site was identified as a boat yard. The presence of tipping was also identified in 1908. To the west there was historically (circa 1880 - 1969) a railway engineering shed 120m north west. A wagon repair shop was present from 1969 approximately 30m west of the Site, which was identified as an electrical sub-station from 1991.

2.2 ENVIRONMENTAL SETTING

2.2.1. A summary of the environmental setting is provided below in Table 2-2, full details are provided in the previous reports listed in Section 1.5.

Table 2-2 – Environmental Setting

GEOLOGY	Reinforced concrete hardstanding across the Site. Granular Made Ground has been encountered within all exploratory hole locations excavated across the Site to a maximum depth of 3.4metres below ground level (m bgl). The Made Ground comprised compact and partially fused in places clayey sandy gravel of ash, brick, clinker and slag. Metal, cloth, rope, wire, plastic sheeting, oil drums, and possible asbestos cement sheeting was also encountered within the Made Ground. Underlying the Made Ground, Blow Sands (natural ground) was encountered to a depth of up to 8.2m bgl, comprising a yellowish brown find sand, silty sand or slightly clayey sand. The Blown Sands is underlain by Alluvium to a depth of 14.7m depth, which was described as a variable silty clay, slightly gravelly and slight sandy clayey silt. Below the Alluvium Glacial Deposits were recorded, comprising glacial sands, gravels and clay, the base depth not proven beyond 16.45m bgl. The bedrock underlying the superficial deposits is the weathered Coal Measures (Brithdir Formation) comprising sandstone with conglomerate lenses, thin mudstone /siltstone and seatearth interbeds and mainly thin coals.
HYDROGEOLOGY	The aquifer designations for the Site are as follows: ¡ Superficial deposits – Secondary 'A' Aquifer; and ¡ Bedrock – Secondary 'A' Aquifer. The Site or within 500m does not lie within a source protection zone (SPZ). There are no groundwater or potable water abstraction licenses within 1km of the Site. Groundwater strikes recorded during ground investigations typically ranged between 5.1 to 7.0 m bgl within the Blown Sands, and 14.6 to 15.6m in the Glacial Sand and Gravel. Resting groundwater levels recorded in the May 2019 monitoring round ranged between 2.6 - 4.0m bgl. The Site lies approximately 100m from the limit of the mean high tides on the foreshore at Burry Port, therefore a degree of tidal influence is observed on groundwater levels. The inferred groundwater flow direction within the Blown Sands is to the south west, with localised influence towards the south and south east, based on information from the surrounding sites (ESG, 2011).
HYDROLOGY	Burry Port Harbour is located approximately 20m west of the Site which is in connectivity with the Loughor Estuary, the mouth of which is approximately 125m south of the Site. The Burry Port Inlet (Loughor Estuary) is designated as a shellfish water (for shellfish and cockle beds) under the Surface Waters Regulations 1997, Classification of Waters in Wales. This Estuary is also designated as a Site of Special Scientific Interest (SSSI), Ramsar, Special Protection Area (SPA) and Special Area of Conservation (SAC).

2.3 SITE INVESTIGATION, MONITORING AND ANALYSIS

SITE INVESTIGATION SUMMARY

2.3.1. Numerous phases of site investigation have been undertaken on site since 2004, to investigate and delineate the heavy metal and hydrocarbon contamination across the Site. The works have included excavation of shallow trial pits, deeper boreholes, and the installation of monitoring boreholes, of which ten were available for monitoring in 2019.

2.3.2. Each phase of investigation was supplemented with a subsequent programme of monitoring and permeability testing. The locations of the installed monitoring wells are shown on Figure 2.

2.3.3. Site investigation works and analysis have confirmed a hydrocarbon source in soils and waters, considered to have resulted from leakage of the gas-oil tanks in the centre of the Site. Impact of heavy metals is also identified within the soils and waters across the Site associated with the Site's historical use as a copper works and zinc oxide plant.

2.4 CONTAMINATION

SOIL QUALITY RESULTS (2004 TO 2017)

Elevated metal and metalloid soil concentrations are generally associated with shallow soils within the top 1m of the Made Ground (Table 2-3). Soil samples retrieved from the Blown Sands deposits recorded generally lower metal concentrations (ESG, 2017). Maximum soil concentrations deviate by a factor of less than four when comparing the 2004 and 2017 soil data, except for mercury which deviate by a factor of 6.3.

Table 2-3 – Comparison of Maximum Measured Soil Concentrations

Determinand	PB 2004^ [mg/kg]	ESG, 2017^^ [mg/kg]
Arsenic	2,117.3 (TP12 - 0.7m)	541.1 (WS1 - 0.3m)
Boron	0.7 (TP06G – 0.3m)	2.8 (WS1 – 0.3m)
Cadmium	183.3 (TP26 – 0.3)	92.8 (WS3 - 1.0m)
Chromium (total)	51 (TPA – 0.5m)	43 (WS3 – 0.3m)
Chromium (III)	-	43 (WS3 – 0.3m)
Chromium (VI)	-	<0.1
Copper	9,520 (TP30 – 0.45)	7,890 (WS1 – 0.5m)
Lead	10,900 (TP33 – 0.4)	3,670 (WS3 – 0.3m)
Mercury	9.4 (TP09A – 0.3m)	1.48 (WS4 – 0.5m)
Nickel	1,107 (TPA – 0.5m)	452.5 (WS3 – 0.3m)
Selenium	7.5 (TP06G – 0.3m)	6.2 (WS3 – 0.3m)
Zinc	192,000 (TP05 – 0.55m)	202,000 (WS3 – 0.3m)
Benzo(a)pyrene	292.2 (TP03 – 0.3m)	5.3 (WS1 – 0.5m)

^ based on 33 soil samples analysed for metal concentrations (PB, 2004)

^^ based on 15 soil samples analysed for metal concentrations (ESG, 2017)

Elevated petroleum hydrocarbons (heavy end TPH fractions) in soils are thought to be associated with the former gas-oil tanks located near the Site centre. Black heavy oils were observed within trial pits at TP6D (TPH 40,821mg/kg), TP14 (TPH 39,818 mg/kg) and TP22 (TPH 30,902 mg/kg) (PB, 2004).

Elevated total PAH concentrations in soils were recorded at several locations TP27 (160.9 mg/kg), TP09A (248 mg/kg), TP02 (212.9 mg/kg), and TP03 (4,013.6 mg/kg); however, are unrelated to the black heavy oils (total PAH concentrations recorded < LOD).

Volatile organic hydrocarbons (VOC), including benzene, ethylbenzene, toluene, xylene, and phenol, were not recorded above the limit of detection (LOD).

Asbestos was recorded in one sample (WS3 ES1) as chrysotile fibres (<0.001%) (ESG, 2017).

The distribution of metal contamination across the Site has been plotted visually and are presented in the CW DQRA.

SOIL LEACHATE (2005 TO 2017)

Heavy metal and metalloid soil leachate concentrations from shallow soils (Made Ground) exceeded the relevant environmental quality standard (EQS, transitional, coastal) for arsenic, cadmium, chromium (VI), copper, mercury, lead and zinc (ESG, 2017) (Table 2-4). Arsenic being recorded at EQS with 25 mg/L. Comparison of soil leachate results from previous site investigations indicate that nickel leachate concentrations dropped by one order of magnitude. The average (and maximum) nickel soil leachate concentration is with 2.67 mg/L (and 6 mg/L) below the relevant EQS (8.6 mg/L).

Table 2-4 - Comparison of Soil Leachate Results from Previous GIs

(Taken from ESG, 2017)

Contaminant	Churngold 2005 Soil Leachate Concentrations (mg/l)		GIL 2007 Soil Leachate Concentrations (mg/l)		ESG 2017 Soil Leachate Concentrations (mg/l)	
	Range	Average	Range	Average	Range	Average
Arsenic	0.01-0.23	0.037	0.001 – 0.22	0.032	0.002 – 0.025	0.0117
Cadmium	0.0005 - 0.00072	0.000538	0.0002 - 0.009	0.0015	0.0001 - 0.0023	0.00077
Chromium	0.01	0.01	0.001 – 0.01	0.0014	0.009	0.009
Lead	0.05 – 0.1	0.057	0.001 – 0.16	0.0079	0.001 - 0.006	0.0026
Mercury	0.0002	0.0002	0.0002 - 0.003	0.00108	0.0007	0.0007
Nickel	0.02 – 0.096	0.026	0.001 – 0.007	0.00135	0.001 – 0.006	0.00267
Selenium	0.002 -0.0038	0.00216	0.001 – 0.006	0.0014	0.002 -0.01	0.00429
Copper	0.01 – 0.47	0.0713	0.001 – 0.23	0.015	0.007 -0.035	0.0131
Boron	0.05	0.05	Not tested	Not tested	0.05 -0.13	0.09
Zinc	0.01 - 0.68	0.2	0.002 – 0.78	0.075	0.008 - 0.29	0.120

GROUNDWATER QUALITY RESULTS (2004 TO 2019)

Analytical groundwater results indicate that groundwater quality within the Blown Sands have improved over recent years, with selected heavy metal and metalloid dissolved-phase concentrations declining in 2017 and 2019. Cadmium, copper, lead, mercury, and nickel dissolved-phase concentrations have decreased to below the coastal EQS within shallow groundwater, as confirmed in the most recent groundwater monitoring round (May 2019).

Exceedances remain for arsenic, hexavalent chromium, zinc and the organic compounds benzo(a)pyrene and fluoranthene. Benzo(a)pyrene and fluoranthene are recorded at low concentrations at two well locations at the north-eastern and south-western site boundary (BH2 and CP108). Both exceedances are marginal.

Table 2-5 - Comparison of Maximum Groundwater Concentrations from Previous GIs

DETERMINAND	PB 2004(1) [µg/L]	WATERMAN 2007 & 2008(2) [µg/L]	ESG 2017(3) [µg/L]	WSP 2019(4) [µg/L]	EQS (COASTAL WATERS) [µg/L]
Arsenic (diss.)	**795**	**930**	**304**	**601**	25
Boron (diss.)	284	930	320	354	7,000
Cadmium (diss.)	**6**	**37**	**0.3**	0.103	0.2
Chromium (total)	<20	21	-	15.2	-
Chromium (III)	-	-	-	-	-
Chromium (VI)	-	-	**5**	**10.2**	0.6 (Cr VI)
Copper (diss.)	**114**	**348**	**9**	2.21	3.76
Lead (diss.)	**<20**	**58**	<1	0.92	1.3
Mercury (diss.)	<0.01	**0.1**	**0.1**	<0.01	0.07
Nickel (diss.)	**1,393**	**293**	4	1.32	8.6
Selenium^ (diss.)	20	24	33	25.4	see footnote
Zinc (diss.)	**554**	**1,893**	**209**	**80.8**	6.8
Benzo(a)pyrene	**<0.1**	-	**0.147**	**0.0071**	0.00017
Fluoranthene	**<0.1**	-	**0.304**	**0.0159**	0.0063

(1) 12 GW quality samples from Blown Sands (PB, 2004)
(2) 12 GW quality samples in 2008 (Blown Sands and Glacial Sand and Gravels) and 8 GW quality samples in 2007 (Blown Sands) (Waterman, 2008)
(3) 19 GW quality samples (10 wells samples on 08/06 and 9 wells re-sampled on 19/06) (ESG, 2017)
(4) 10 GW quality samples (WSP, 2019)
^ no surface water quality standard, as reference UK Drinking Water Standards (DWS) for selenium is 10 µg/L

The WSP 2019 groundwater samples recovered from the Glacial Sand and Gravels (CP102 and CP105) detected no TPH and PAH concentrations (<LOD) and low concentrations of arsenic, chromium (total), selenium and zinc. Zinc concentrations were recorded with 12.1 and 16.1 µg/L, above the relevant EQS.

SURFACE WATER QUALITY RESULTS (2019)

A surface water sample taken from Burry Port (inner harbour) in May 2019 recorded no exceedances for metals and metalloids compared to transitional EQS. Arsenic, nickel and zinc were detected above the LOD; however, below the relevant EQS.

CONCLUSIONS

Widespread elevated heavy metal (arsenic, cadmium, chromium VI, copper, lead, nickel, selenium, and zinc), PAH and TPH concentrations in soil, soil leachate and groundwater have historically been recorded.

The previous works indicated contaminated groundwater and soils pose a potential risk to the underlying Secondary A aquifer (Blown Sands) and nearby surface watercourses (Burry Harbour and Loughor Estuary). Previous DQRA (Waterman, 2008 and ESG 2011, 2016a, 2017) concluded that the actual risk to the Loughor Estuary was low and that whilst some form of remediation to reduce future soil leaching was likely to be beneficial and achievable, groundwater remediation was not proposed as it was not considered to be cost effective.

2.5 RISK ASSESSMENT

2.5.1. A Controlled Waters Detailed Quantitative Risk Assessment (CW DQRA) was prepared in August 2019 (Reference: 70054861-GR1-001).

2.5.2. Pollutants consistent with the historic industrial operations (heavy oils, PAH compounds, metals and metalloid) have been identified in soils (Made Ground) and shallow groundwater (Blown Sands) beneath the site. Petroleum hydrocarbon impact is considered to have resulted from leakage of former gas-oil tanks. The dissolved-phase plume within the Blown Sands aquifer (Secondary A Aquifer) act as secondary source with the potential to impact off-site controlled water receptors. The Burry Port (inner Harbour) and Loughor Estuary are the closest off-site receptors. Given the presence of cockle beds, the estuary is the most sensitive receptor. The mean high-water mark is 100m south from the site boundary.

2.5.3. Pathways with respect to controlled waters include lateral and vertical downward migration via the unsaturated and saturated zones within both Made Ground and Blown Sands. Preferential pathways (i.e. deep buried structures) might connect the Blown Sands and the deeper Glacial Sand & Gravels aquifer which directly overlay the Upper Coal Measures (both Secondary A Aquifer).

2.5.4. The review of the available historic data and comparison with more recent groundwater quality data indicates that significant pollutant attenuation occurs. The 2019 groundwater quality data indicate improved conditions within the Blown Sands aquifer, with arsenic, chromium (VI), zinc, benzo(a)pyrene and fluoranthene the only analytes recorded above EQS (Coastal). Level 3 DQRA simulations predict that these exceedances present a low risk to off-site receptors (beyond 50m hydraulic down gradient) due to travel times in excess of 1,000 years. The retarded chromium (VI) travel time to the 50m POC is predicted to be 677 years.

2.5.5. The environmental risk is predicted to be high during the site development phase (breaking hardstanding) and potential future changes in environmental conditions (for example raised groundwater levels).

2.5.6. An Interpretative Contamination Report including Human Health Generic Quantitative Risk Assessment was completed by ESG in 2017 (Reference R6072-17, ESG, September 2017).

2.5.7. Widespread elevated concentrations of heavy metals, and more occasionally PAHs within the shallow Made Ground (0.0 – 1.0m bgl) has been recorded. These concentrations in soils may present an unacceptable risk to human health and areas of landscaping in its proposed end use.

2.5.8. A clean cover system was recommended in areas of proposed gardens and soft landscaping.

2.6 SOURCE – PATHWAY – RECEPTOR LINKAGES AND PRELIMINARY RISK APPRAISAL

POTENTIAL SOURCES

PAH and toxic and phytotoxic metal substances were identified in soils across the Site. Elevated metal and metalloid concentrations are predominantly recorded in shallow soil samples (Made Ground).

Petroleum hydrocarbons were identified within the soils on the Site during the 2004 Parsons Brinckerhoff and 2008 Ground Investigation Limited ground investigations. This contamination is considered to have resulted from leakage of the gas-oil tanks in the north and centre of the Site.

PCB contamination may be present from the former electrical substation located in the centre of the Site. However, no evidence of contamination associated with the former electricity substation was found.

The dissolved-phase heavy metal and metalloid groundwater plume within the Blown Sands aquifer act as secondary source with the potential to impact off-site controlled water receptors. Elevated dissolved-phase PAH concentrations are considered to present very localised hotspots in groundwater, and not a widespread petroleum hydrocarbon plume.

POTENTIAL OFF-SITE SOURCES

The surrounding area has a long standing industrial history, and the following potential off-site sources have been identified. The land immediately to the east has a history as a landfill, coal fired power station and was utilised by the former copper works, and to the north of the Site were the former lead and silver works. About 160 m further to the north a former iron foundry was located.

PATHWAYS

- Direct contact with soil and inhalation of particulate matter and dusts from future site users when exposed to near surface soil contamination;
- The potential pathways with respect to controlled waters include lateral and vertical downward migration via the unsaturated and saturated zones within both Made Ground and Blown Sands.

Additional preferential pathways might be associated with:

- the coal shaft to the southeast of the Site,
- buried culverts and soakaways beneath the Site; and
- the former open abstraction wells on the Site.

Vertical migration through the Alluvium Deposits is highly unlikely due to its cohesive nature and thickness. However, preferential pathways (i.e. deep buried structures, piled foundations, abandoned wells) might connect the Blown Sands and the deeper Glacial Sand & Gravels aquifer which directly overlay the Upper Coal Measures.

RECEPTORS

- Future site users and workers involved during the construction and maintenance phase;
- Blown Sands (Secondary A Aquifer);
- Ecology/Marine Life in the Loughor Estuary (including shellfish and cockle beds); and
- Upper Coal Measures (Secondary A Aquifer).

2.7 PRELIMINARY RISK ASSESSMENT

Contaminants consistent with the historical industrial operations on-site (heavy oils, PAH, metals and metalloid), identified in soils (Made Ground and Blown Sands) and shallow groundwater, pose a potential risk to the groundwater aquifer (Secondary A Aquifer) and the Loughor Estuary (including shell fish and cockle beds) to the south west of the Site.

Table 2-6 summarises plausible source pathway receptor linkages and provides a qualitative risk level based on severity and probability (UK CIRIA 552). Plausible contaminant linkages with risk levels low / moderate or higher are taken forward into the detailed quantitative risk assessment.

Table 2-6 - Risk Matrix Based on Plausible Source Pathway Receptor Linkages

Source	Pathway	Receptor	Risk Level (CIRIA 552[1])	Comment
Soils and Groundwater (Made Ground and Blown Sands) containing heavy metals, PAH compounds, and heavy oils (localised)	Direct contact or inhalation of contaminated soils / dust	Future residential occupants, users and visitors	Low risk	***(Severity-Medium, Probability – Unlikely).*** Impacted soil identified above screening criteria. However, a capping system is proposed to be placed prior to redevelopment reducing the potential risk following development.
		Workers involved in construction or below ground works	Low	***(Severity-Minor, Probability – Likely).*** Impacted soil identified above screening criteria. However, the workers will be following UK best practice procedures, including required PPE reducing severity.
	Leachate from soils (Made Ground) followed by vertical migration to shallow groundwater	Shallow groundwater beneath the site (Blown Sands, Secondary A Aquifer)	Moderate / Low risk	***(Severity-Minor, Probability – High Likelihood).*** Impacted soil and shallow groundwater identified across the Site. Confirmed impact within Blown Sands (contaminant linkage complete). Receptor has no known water resource potential (reducing potential severity).
	Vertical migration to shallow groundwater followed by lateral migration and discharge to surface watercourse	Loughor Estuary	Moderate / Low risk	***(Severity-Medium, Probability – Low Likelihood).*** Impacted shallow groundwater identified across the Site and close to downgradient site boundary. Probability of harm associated with elevated metal and PAH concentrations from the Site is considered to be low based on the contaminant attenuation potential prior to reaching surface waters (high soil water partition coefficient) as

Source	Pathway	Receptor	Risk Level (CIRIA 552[1])	Comment
				well as the large Loughor Estuary catchment area.
	Vertical migration and recharge into bedrock aquifer	Deep groundwater beneath the site (Upper Coal Measures, Secondary A Aquifer)	Low risk	***(Severity-Mild, Probability –Low Likelihood).*** No confirmed impact to deep groundwater within Upper Coal Measures. The aquifer is not known to be utilised as portable water resource. Based on the naturally poor water quality of groundwater within the Upper Coal Measures with elevated heavy metal background concentrations (reducing potential severity) the overall risk is low.

(1) D J Rudland, R M Lancefield, and P N Mayell, 2011, Contaminated Land Risk Assessment. A guide to good practice (CIRIA 552).

2.8 REMEDIATION OBJECTIVE

2.8.1. Based on the findings of the existing contaminant linkage assessments, the 2019 Updated Controlled Waters DQRA and NRW guidance for addressing impacts from heavy metals and likely residual hydrocarbon risks, the key objectives of the remediation works are:

- Objective 1 - Break the pathway associated with potential direct contact or inhalation risks associated with shallow soil contamination;
- Objective 2 - Removal or fixation of heavy metal contamination within the Made Ground to prevent an increase in leaching to shallow groundwater; and
- Objective 3 - Removal of any residual free-phase hydrocarbons as far as is reasonably practicable, if encountered during the redevelopment works.

2.8.2. Key aims include:

- To avoid increasing the heavy metals and dissolved phase hydrocarbons concentrations within groundwater below the Site;
- To avoid impacts on the Loughor Estuary and associated ecological receptors; and
- Prior to development, site elevation levels need to be increased by a minimum of 600mm, therefore minimal disposal of materials off-site is preferred. Limit the volume of imported material to the Site. This will form part of the capping layer required for the protection of human health, if suitable for reuse.

3 IDENTIFICATION OF FEASIBLE REMEDIATION OPTIONS

3.1 STAGE 1 - PRELIMINARY EVALUATION OF POTENTIAL REMEDIATION OPTIONS

3.1.1. The preliminary assessment of remediation options considers the general applicability of widely used remedial techniques to remove, reduce or control the identified potential contaminant linkages, such that the Site is suitable for the intended residential with gardens and associated commercial end-use. The preliminary assessment considers applicability of the techniques to the identified contaminant sources and remediation objectives.

3.1.2. The ground investigation information indicates that heavy metal contamination is present within Made Ground soils and this may be leaching to shallow groundwater within the Blown Sands (superficial deposits). Petroleum hydrocarbon contamination within the shallow soils has been recorded in previous ground investigations, in occasional localised locations that may be indicative of saturated soils or free phase contamination. Asbestos has also been identified within the Made Ground during the ESG GI, therefore there is potential that asbestos may also exist within the Made Ground elsewhere on Site.

3.1.3. The applicability of different remediation techniques is determined on the basis of the ability to address the risks associated with heavy metal contamination and potentially asbestos containing materials in the unsaturated zone, with a secondary technique to deal with the likely presence of petroleum hydrocarbon contamination that may be encountered during the ground works.

3.1.4. An initial evaluation of groups of available remediation techniques specific to the identified sources at the Site are summarised in Table 3.1.

Table 3-1 - Applicability of Remediation Techniques

REMEDIATION OPTION		Application of Technique		
	Source:	**1**	**2**	**3**
	Applicable Contaminants:	**Metals**	**Poly-cyclic aromatic hydrocarbons**	**Petroleum Hydrocarbons**
	Media:	**Soil**	**Soil**	**Soil**
Civil Engineering Methods				
Containment – Cover systems		P	P	O
Excavation and disposal		P	P	P
Containment – Impermeable barriers		O	O	O
Biological Methods				
Bio-piles / windrow turning		O	O	P

REMEDIATION OPTION		Application of Technique		
	Source:	1	2	3
	Applicable Contaminants:	Metals	Poly-cyclic aromatic hydrocarbons	Petroleum Hydrocarbons
	Media:	Soil	Soil	Soil
Physical Methods				
Soil Flushing/Washing		P	P	P
Surfactant Flushing		O	O	P
Stabilisation and Solidification Methods				
Binders (e.g., cement)		P	P	P
Vitrification		P	P	P
Thermal Methods				
Thermal desorption		O	O	P

[P] Generally applicable to contaminant type / media.

[O] Generally, not suitable for contaminant type / media.

3.2 SITE CONSTRAINTS AND DEVELOPMENT REQUIREMENTS

3.2.1. Prior to the assessment of the applicable techniques identified above, site-specific factors and constraints have been identified that could affect the selection of feasible options, as detailed below in Table 3-2.

Table 3-2 – Site Constraints

SITE SETTING	The Site is located in a predominately historical industrial area, which is now mostly vacant land proposed for redevelopment to predominantly residential end use with some commercial/retail use. The redevelopment proposal will introduce new sensitive receptors close to the Site, including a new school approximately 250m to the east-north east. Noise, dust and odour considerations will be required for implementation of remediation options. The Site contains a significant degree of hardstanding with a large number of foundation slabs and likely buried structures (abnormals).
ENVIRONMENTAL SETTING	Naturally occurring geology and groundwater comprises of blown sands and a shallow groundwater table. Groundwater levels fluctuate across the Site and are responsive to tidal and seasonal conditions. However, resting groundwater ranged from 2.6 – 4.0m bgl in the May 2019 monitoring round.

	The Burry Port Harbour is located approximately 20 m west of the Site. The close proximity of this sensitive receptor should be taken into consideration when evaluating in-situ remedial options.
SITE ACCESS AND RESTRICTIONS	The Site is accessed from the north off of the B4311 via a palisade gate to the north of Site. Access to the Site is suitable for vehicular access, however, the gates opening width is currently restricted and will require fixing before large vehicles can gain access.
SITE STRUCTURES	Two disused abstraction wells are present on site. One was observed in the walkover in 2019 along the western boundary. A second was encountered during the PB, 2004 ground investigation (GI) in the eastern edge of TP12A as a brick lined well with timber cap / cover exposed at 1m bgl. The base of the well feature is considered likely to be in the region of 3m bgl (but possibly deeper and it has been infilled. The well diameter was 1m and no water was present. Significant thicknesses of concrete foundations and other buried abnormal features have also been identified within the Made Ground from the sites' previous development. A railway turntable exposed in TP1 (PB, 2004 GI) at 0.15 – 0.8m. Other structures identified predominantly in the central and southern site area, include foundation bases and a series of culverts / conduits. With the exception of the well feature, all structures were apparently backfilled with loose brick debris / demolition material, with occasional voids noted. The apexes to all culverts / conduits typically lay below 0.5m of grey, occasionally ashy gravelly (of clinker or slag) sand (PB, 2004). Towards the north of the Site, the remains of a wall and brick floor was encountered in TP19 at 1.1m (PB, 2004). Although fuel storage tanks were observed above ground (prior to decommissioning and removal), there is potential for historical underground storage tanks (USTs) to be present due to the historical land use at the site. These structures to 2m depth will need to be removed, with the material being crushed and sorted for reuse on site, if confirmed as acceptable (both chemically and geotechnically).
SERVICES	Utility services at the Site have not been provided. At this stage it is considered prudent to assume services are live under the Site. Western Power Distribution hold the electricity mapping. There is a high voltage (11kv) cable entering the Site from the north, going towards the centre of the Site in a south easterly direction. There is another 11kv cable entering the Site from the west and linking up with the other cable. All other cables are mapped as being outside of the Grillo site boundary. Wales and West Utilities have provided the gas mapping. No apparatus is mapped on site. BT Openreach mapping present across the Site show overhead lines to the west of the Site going north to south, and also from the Site access in the north west across the centre of the Site, exiting at the eastern boundary. During the 2019 monitoring round, no overhead cables were observed, therefore it is assumed that BT cables could be underground if they exist. There is no water or sewer utilities on site. The water mains ends at the Site entrance to the north. The foul sewer runs up the road to the west of the Site.

	There are a number of buried culverts and drainage across the Site. These were encountered during the PB GI in 2004. They are backfilled with Made Ground fill material but will require grubbing out during the enabling works. Although fuel storage tanks were above ground (prior to decommissioning and removal), there is potential for historical underground storage tanks (USTs) to be present, including fuel lines. Safe excavation methods with appropriate stand-offs would need to be applied, for both in-situ and ex-situ options.
EXISTING BOREHOLES	There are 10 existing monitoring wells installed across the Site that were monitored and sampled as part of the May 2019 round as shown on Figure 2. These may need to be retained for monitoring purposes during and for a period following remediation
DEVELOPMENT LEVELS	As part of the proposed development, there will be a requirement to raise development platform levels to support drainage and flood mitigation. At this stage, a minimum of 600m of cover material will be required across the site.
ECOLOGY	The Site has limited vegetation cover and no ecological constraints have been identified, however this requires confirmation from an ecologist.
PROJECT TIMESCALES	The project timescales for completion of the remediation works have not yet been confirmed.
LICENSES / PERMISSIONS AND REGULATORY ISSUES	¡ Reserved Matters Planning permission has been obtained with associated planning conditions which include the requirement of investigation, assessment and remediation at the Site which include the necessary approval from the regulators; ¡ Remediation will need to be carried out under consultation with Natural Resources Wales and the Local Authority; ¡ An Environmental Permit (EP) may be required for treatment activities as applicable; ¡ Trade effluent consent will be required from the local provider for any discharges to foul sewer; and ¡ Removal or reuse of any materials will need to be undertaken under a site-specific materials management plan and relevant waste exemption together with Environmental Permit conditions.
RELEVANT STAKEHOLDERS	The following relevant stakeholders have been identified: ¡ Carmarthenshire County Council; ¡ Natural Resources Wales; ¡ Utilities / services owners; ¡ Neighbouring users adjacent to the site and public footpaths; ¡ Users of the harbour, fishing of the cockle beds and shellfish within Burry Port Inlet
SITE MANAGEMENT AND PR ISSUES	A public relations management strategy may be required for the remediation works due to the proximity of the works to the public footpath and harbour.

3.3 STAGE 2 – EVALUATION OF SHORTLISTED TECHNIQUES

3.3.1. Short-listed techniques from the preliminary assessment of remediation options are qualitatively appraised with consideration of the site-specific characteristics, constraints and objectives as detailed below in Table 3.3. Previous experience on similar sites and technical literature have been used to reject remediation options due to the timescales involved in application, economic considerations, and due to site constraints.

Table 3-3 – Evaluation of Applicable Remediation Techniques

Group of Techniques	Remediation Option	Applicable Remediation Objective	Comments of Feasibility and Evaluation[1]	Considered for Further Evaluation?
Enabling Works	Significant enabling works will be required to move the Site forward for redevelopment from both a geotechnical and remediation perspective. This will comprise the excavation and grubbing out of foundations and other buried structures, followed by sorting and crushing the materials for reuse on site (following verification testing). The Site is currently vacant therefore there should be sufficient space for the treatment of materials on site providing a coordinated plan can be developed. During the enabling phase, the importation of material to raise site levels will also take place to support the installation of infrastructure and support flood mitigation measures. For the purpose of this assessment, it is assumed that enabling works, in particular the importation of additional fill material to raise levels, will provide a pathway 'break' to remove the pollutant linkage associated with direct contact and dust inhalation pathways identified within the previous iterations of risk assessment. This overlaps with the remediation technique outlined in Table 3-1 under '**Containment – Cover Systems'**. Other techniques within the ROA will focus on the remediation objectives to address the controlled waters risks and betterment requirements identified and outlined previously.			Not during the Remediation Options Analysis but will require consideration during Remediation Strategy.
Ex-Situ: **Civil Engineering Methods**	Excavation and off-site disposal	2 and 3	Excavation and off-site removal is a robust and straightforward process that directly removes the source of contamination from the site and breaks the pathway associated with ongoing leaching of heavy metal and hydrocarbon contamination. However, off-site disposal is expensive and unsustainable and requires the importation of material to restore site levels. Such an approach is not consistent with the waste hierarchy within the Waste (England and Wales) Regulations 2011.	Yes

[1] Defra, 2010 Contaminated Land Remediation

Group of Techniques	Remediation Option	Applicable Remediation Objective	Comments of Feasibility and Evaluation[1]	Considered for Further Evaluation?
			Furthermore, in the case of this site, it is likely that a significant majority of material would be classified as hazardous and based upon preliminary Waste Acceptance Criteria outlined within the 2017 ESG report, further pre-treatment of WAC will be required. Soil treatment facilities could potentially be used as an alternative to landfill, although costs are still comparatively high compared to other options. In addition, transport and haulage costs to appropriate disposal sites and the cost of imported material will be expensive, along with the environmental and logistical impact on the local community. Where localised removal of materials is required (for example localised hydrocarbon contamination), excavation and off-site disposal to a treatment centre for recovery could be a viable option.	
Ex-Situ: **Chemical Methods**	Bio-remediation / Windrows	3	Biologically augmented remediation of hydrocarbon contamination is a well-established technique for supporting the remediation of hydrocarbon impacted soils and enabling the re-use of the materials once treated. The technique uses naturally occurring microbes within the soil to breakdown hydrocarbons through respiration processes in doing so, metabolising contaminants and released degradation by-products such as carbon dioxide, methane and water. Depending on the condition of the soil, ameliorants such as fertilisers and bulking agents can be applied to enhance of accelerate microbial activity. However, the effectiveness of bio-remediation can be constrained by a number of factors and in the case of the Grillo site, these can be summarised as follows: ¡ Relatively small volume of hydrocarbon contaminated soils identified does not offer economy of scale when compared to alternative solutions. ¡ Elevated concentrations (up to 40,000mg/kg) will require considerable improvement to reach likely remediation standards. ¡ Heavy metal contamination ubiquitous within site soils may inhibit microbial population and activity.	Yes

Group of Techniques	Remediation Option	Applicable Remediation Objective	Comments of Feasibility and Evaluation[1]	Considered for Further Evaluation?
			¡ Enabling and setup requirements are unlikely to be cost-effective based on the scale of material requiring treatment. Based on the information available, it is likely that hydrocarbon contamination encountered during the redevelopment of the site will be in the form of hotspots or localised contamination within discrete areas of the site. These are not likely to be sufficient enough in volume to warrant further consideration.	
Ex-Situ: Physical Methods	Soil Flushing/Washing	1, 2 & 3	Soil flushing and washing is a physical process designed to remove contamination that is bound to fine soil / material matrix and interconnected pore spaces to remove mobile or leachable contaminants from the soil and facilitate the re-use. The overall objective is to reduce the loading of contamination and reduce the volume of contaminated material through separating 'uncontaminated' components within the soil matrix. The process is relatively intensive and requires a multiple stage process and generally treats material on a batch basis. During the washing process, additives can be used to accelerate or promote the separation process and water is used as a flushing media to mobilise and separate out the fine particles from coarse particles. Subsequent processing of material is then required to address the eluate and effluent together with the fines generated from the washing process. In the case of the Grillo site, this would require the establishment and operation of a water treatment plant to reduce metal loading (ion-exchange or pH adjustment and precipitation) within the effluent and secondary treatment or off-site disposal of the fines fraction, the volume of which is not currently known and would require detailed characterisation of soil particle sizes and distribution.	Yes
Ex or In-Situ: Physical Methods	Surfactant Flushing	3	The use of surfactants in soil remediation is broadly similar to the approach taken within soil-washing or flushing and is typically applied during ex-situ treatment of soils.	No

Group of Techniques	Remediation Option	Applicable Remediation Objective	Comments of Feasibility and Evaluation[1]	Considered for Further Evaluation?
			A chemical surfactant or additive is applied to mobilise recalcitrant or soil-bound contamination from the soil matrix. This technique is typically used to reduce the sorption capacity of the hydrocarbon and mobilise hydrocarbons into solution. This is normally achieved via reduction in the interfacial tension between soil bound contamination and the soil matrix itself. The resulting eluate/flush is then formed of a solubilised effluent that is then treated via secondary mechanisms. Surfactant flushing can be effective in situations where access to capillary surfaces within the soil matrix is difficult or to mobilise more viscous soil-bound contamination. Similar to soil-washing, a multi-stage process is required to enable flushing and processing of the effluent which then needs supplementary treatment or disposal. It is unlikely that the volume of hydrocarbon contamination at the Grillo site will warrant the setup and operational costs associated with a surfactant flushing technique and it therefore not considered to be a viable option to take forward.	
In-Situ or Ex-Situ: **Physical Methods**	Stabilisation / Solidification	1, 2 and 3	This technique involves mixing or augering of a reagent (binder) with the soil matrix to react and form a stable more homogenised mass that will reduce the mobility and leachability of contaminants from the soil source. The fixation of the contaminants will restrict on-going leaching of contaminants from shallow soils to underlying groundwater and reduce the general permeability of treated soils. Common reagents (binders) used are cements, lime, pozzolans and organophilic clays. The technique can be applied using in-situ augering or mixing or ex-situ mixing, treatment and reinstatement. Depending on the extent of enabling works and grubbing out required at the Grillo site, the use of in-situ or ex-situ techniques will need to be determined. The technique can be used to reduce leachability of heavy metal and inorganic contamination together with reducing the mobility of organic contamination within	Yes

Group of Techniques	Remediation Option	Applicable Remediation Objective	Comments of Feasibility and Evaluation[1]	Considered for Further Evaluation?
			the soil matrix. Stabilisation/solidification techniques can often be used to address hydrocarbon contamination but at the Grillo site, heavier chain aliphatic and aromatic hydrocarbons are less suitable for stabilisation based treatment compared to shorter chain hydrocarbons. Limited off-site disposal would be anticipated via this route and is therefore likely to be more sustainable and have less impact that other options. However, there is a requirement to establish a treatment/preparation plant together with the import and use of the stabilisation chemicals/binders and reagents. A pilot or bench study will be required to determine the appropriate specification for the stabilisation or solidification to be implemented.	
In-Situ or Ex-Situ: **Physical Methods**	Vitrification	1, 2, & 3	This uses an electrical current, or other heat source to melt excavated soil material to an extremely high temperature in a contained unit. Organic compounds are vaporised. It then cools to form a glassy solid that immobilises inorganic compounds which is chemically stable and leach-resistant. For sites where there are multiple or difficult contaminants this can be an efficient technique. Soils with a high moisture content can be problematic and require careful control due to volatilisation. The plant setup is expensive and is an energy intensive technique	No

3.3.2. Following the preliminary assessment of remediation options, the identified feasible were taken forward for detailed evaluation. The detailed evaluation of options is presented in Section 4.

4 DETAILED EVALUATION OF OPTIONS

4.1 REQUIRED WORKS FOR REDEVELOPING BROWNFIELD SITES

ENABLING GROUND WORKS

4.1.1. There is a certain level of activity that will be required to support any redevelopment of a former industrial site and those activities can be independent or complimentary to whatever the preferred solution is to deal with contamination issues and environmental risk.

4.1.2. In the case of the Grillo site, the full scope of enabling has not yet been determined but is anticipated to include the following activities:

- Disconnection and removal of redundant services including high-voltage supplies and substations;
- Decommissioning former abstraction wells;
- Breaking out of hardstanding and remnant slabs;
- Grubbing out of all buried structures including foundations and hard-spots;
- Crushing and sorting of generated material for recycling; and
- Verification testing for suitability for reuse.

4.1.3. The detail of the works required to facilitate enabling will be set-out within a detailed remediation or reclamation strategy that will be developed in due course.

4.2 EVALUATION OF OPTIONS

4.2.1. Detailed evaluation criteria were used to assess the ability of each feasible combination of options, to meet specific remediation and technical objectives. A variety of methods were used to assess comparative costs associated with each remediation option. These include recent previous experience, technical literature and information from specialist remediation contractors.

4.2.2. The detailed evaluation criteria and evaluation for the selected options are detailed below in Table 4.1.

Table 4.1: Site-Specific Evaluation Criteria and Qualitative Evaluation

Method	Removing of pathway	Timeframe	Safety	Longevity	Waste generation	Sustainability	Site restrictions	Verification	Cost	Feasibility (sum)	Advantages	Disadvantages	Comments
Enabling works	Not scored as part of evaluation										This will remove obstructions in the ground preventing redevelopment. Facilitates the recycling and re-use of aggregates and materials within construction Provides a clear site for remediation activities	Breaking through the hardstanding will create a direct pathway for infiltration and increase leaching potential to shallow groundwater, however this will be a temporary situation prior to the remediation phase. Locally, enabling works can result in significant plant movement, noise and vibration due to breaking out and other reclamation activities. Appropriate mitigation will be required to protect sensitive receptors. Not all material will be able to be re-used or recycled so there is the potential for disposal off site being required.	Enabling will be required to support redevelopment of the Grillo site. This is part of the activities to reclaim the Site for remediation and subsequent repurposing.

Method	Removing of pathway	Timeframe	Safety	Longevity	Waste generation	Sustainability	Site restrictions	Verification	Cost	Feasibility (sum)	Advantages	Disadvantages	Comments
Excavation, treatment off-site and / or disposal	5	5	2	5	1	1	2	4	1	26	Certainty in addressing and removing the risks at the subject site. Comparatively simple implementation and low-tech approach. Could be carried out in combination with enabling works.	Significant waste generation destined for off-site disposal. Very high costs for transport, treatment and disposal. Unsustainable and whole lifecycle impact shifting treatment and burden to landfill or treatment centre site. Requirement to import recycled or quarried material to reinstate levels.	Off-site disposal for whole-sale ground contamination results in significant environmental impact and cost. Landfill tax and financial implications of material movement and logistical difficulties in export/import balance make implementation more difficult. Could be considered for small scale material that is deemed unsuitable for other treatment techniques.
Bio-Remediation/ Windrows	4	3	3	3	5	4	2	4	3	31	Established technique for addressing hydrocarbon contamination. Sustainable and enables the re-use of material on the subject site. Avoids the need to import off-site material.	Initial setup favours larger volumes for treatment. Heavy metal contamination may impinge effectiveness of biological remediation. Slightly longer programme due to treatment process and verification.	Bioremediation is typically used as an alternative to off-site disposal where elevated levels of hydrocarbon contamination are identified. There is a certain amount of preparation and setup required to create a treatment bed/compound and this is balanced against the volume

Method	Removing of pathway	Timeframe	Safety	Longevity	Waste generation	Sustainability	Site restrictions	Verification	Cost	Feasibility (sum)	Advantages	Disadvantages	Comments
											Relatively small footprint required for treatment (space and plant).	Gross contamination cannot be treated and contingency required for off-site disposal of untreatable material.	of material requiring treatment. In the case of the Grillo site, whilst bioremediation could be considered for addressing the area of identified contamination, the efficacy cannot be confirmed, based on: ¡ Presence of heavy metal contamination that could inhibit biological activity. ¡ Potentially small volume of material not justifying setup cost. ¡ Programme delay and uncertainty for limited benefit.

Method	Removing of pathway	Timeframe	Safety	Longevity	Waste generation	Sustainability	Site restrictions	Verification	Cost	Feasibility (sum)	Advantages	Disadvantages	Comments
Soil Flushing/Soil Washing	5	3	3	4	4	3	2	4	3	31	Facilitates the recycling of material through a relatively simple process. Removes contaminated material and fines where majority of contaminant mass may exist Simple verification process for treated material	Requires significant setup and infrastructure. Secondary and tertiary treatment of eluent and sludges through sequential process. Off-site disposal for untreatable material. No option to carry out in-situ treatment so double handling costs and programme delay likely.	Soil flushing or washing could be considered at the site as a potential option for addressing the source-term for heavy metal contamination. However, further detailed information on soil properties and particle size distribution would be required to assess efficacy. The initial setup cost and potentially longer programme does reduce its feasibility together with unknown additional secondary and tertiary treatment requirements.
Stabilisation / Solidification	4	4	3	3	5	3	3	4	3	32	Stabilisation will restrict future leaching to pore-water and groundwater. Due to bulking, stabilisation method may result in an overall increase in volume of material, which is an advantage at this site (less imported material required).	Contaminants not destroyed or removed, simply immobilised. Reagent delivery and effective mixing can be difficult to achieve and requires thorough soil screening process at enabling stage.	Stabilisation is considered to be a viable option at the site but the implementation will require further detailed assessment of soil properties and completion of appropriate pilot or bench studies to assess amendment and reagent quantities and

Method	Removing of pathway	Timeframe	Safety	Longevity	Waste generation	Sustainability	Site restrictions	Verification	Cost	Feasibility (sum)	Advantages	Disadvantages	Comments
											Potential to consider in-situ or ex-situ application to give project flexibility Process equipment occupies relatively small footprint (particularly in-situ). Physical properties of soil are often improved by treatment (increased strength, lower permeability).	Very little long-term leachate data available to confirm stability of treatment under variable conditions.	develop a final specification for the application of stabilisation. There is inherent cost uncertainty depending on the quantities of raw materials required to meet the remediation requirements. Technique can plausibly be used to address heavy metal and organic contamination identified at the site and reduce the contingency for off-site disposal.

Scores for evaluation factors (1 to 5) based on professional judgement:
1 – Low; 2 - Low to Moderate; 3 – Moderate; 4 – Moderate to High; 5 - High

4.2.3. Timescales across both option disposal and stabilisation are broadly similar, however, stabilisation will be the more commercially viable and sustainable option.

4.3 RECOMMENDED REMEDIATION OPTION AND JUSTIFICATION FOR SELECTION

4.3.1. Based on the appraisal carried out, it is considered that some form of soil stabilisation or solidification will be the most appropriate solution to meet the remediation objectives outlined for the site. This is on the basis that:

- A programme of enabling works will be required to facilitate reclamation of the site and remediation efforts will focus upon addressing the identified pollutant linkages;
- A clean cover layer is required to facilitate development and this will be used to address contaminant linkages associated with direct contact and inhalation risks.

4.3.2. Excavation and off-site disposal is ruled out on the basis of being unsustainable from an environmental and cost perspective. Consideration for its use can be given to small volumes of otherwise untreatable material. in these circumstances, the waste hierarchy should be adopted and material diverted to soil treatment / recycling facilities and away from landfill, where conditions allow.

4.3.3. Soil washing or flushing could be considered as a reserve measure or alternative, however, there remains uncertainty about the efficacy of the process and this would still require the disposal of a certain proportion of untreatable material that would likely be classified as hazardous. The additional treatment processes add operational and programme risk and is unlikely to offer a more commercially advantageous outcome compared to stabilisation.

4.3.4. In the case of hydrocarbon contamination, if identified during earthworks there may be a requirement to carry out localised treatment or recovery of NAPL within isolated areas of the site. These are not anticipated to be significant in scale and enabling works may confirm not present.

5 CONCLUSIONS AND NEXT STEPS

5.1 CONCLUSIONS

5.1.1. Following the remediation options appraisal, the most appropriate technology for preventing future leaching of contaminants from the unsaturated zone to groundwater was considered to be a form of soil stabilisation / solidification.

5.1.2. Bench scale testing will be required and a pilot trial would also be beneficial to confirm the efficacy and application of this remediation option. Based on the results of this testing, the proposed remediation objective is to adopt a betterment approach to address the leaching of metals and PAHs into groundwater from the unsaturated source material as far as reasonably practicable.

5.1.3. The enabling ground works will be required prior to the proposed remediation works. The enabling works will involve the breaking out of hardstanding, grubbing out of all foundation slabs and buried structures, then crushing and sorting for recycled aggregate. This material will be tested to confirm suitability for reuse both chemically and geotechnically.

5.1.4. The remediation effort will target hotspots of contamination within the unsaturated zone, as per the zoning completed in the DQRA. In these areas, the excavation will be extended and material treated either in-situ or ex-situ for stabilisation to fixate the contaminants (arsenic, chromium VI, zinc, benzo(a)pyrene and fluoranthene).

5.1.5. During excavation works (enabling works or remedial works) groundwater is likely to be encountered from approximately 2.6m bgl, although water levels will fluctuate due to tidal variation. Residual petroleum hydrocarbons may to be encountered in localised areas across the Site. As part of the enabling ground works, a temporary water treatment system (hydraulic management, particle separation and oil-water separation) will be required to address groundwater encountered during the excavation works and separate NAPL in the event it is encountered.

5.2 NEXT STEPS

5.2.1. It is anticipated that the remediation will comprise the following principal elements:

- Bench scale testing to investigate whether stabilisation will be successful for treating the contaminated unsaturated soil matrix and confirm the proof of concept;
- Discussions with NRW to confirm whether a pilot trial should be undertaken;
- Enabling ground works including the protection of boundary monitoring wells and the decommissioning of all other wells including disused water wells from the Site's historic use;
- Set up of water treatment system as part of the enabling works;
- Pilot trial if required;
- Treatment of hotspots of contamination via stabilisation / solidification (subject to bench/pilot trial);
- Reuse of sorted material from enabling works to backfill back to ground level;
- Validation testing of recycled and treated materials;
- Laying of a no-dig membrane;
- Importing of material to raise levels for flood alleviation and protection of human health.

Appendix A

DRAWINGS

Date Modified: 16/08/2019 14:37

Drawn By: Anna.Irlam

Key

Red Line Site Boundary

ACHDDU

A484

Burry Port Community Primary School

Pembrey Primary School

B4311

Memorial Park

DYFATTY

Pwll Rd

Tanycoed

Bethlehem

Pembrey & Burry Port

Burry Port

Burry Port Lighthouse

River Loughor

0 100 200 300 400 m

Map data ©2019 Imagery ©2019 , Bluesky, Infoterra Ltd & COWI A/S, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies, The GeoInformation Group

wsp

TITLE:

Former Grillo Zinc Oxide Site

FIGURE No:

Figure 1 Site Location Plan

File: Created using iGIS, WSP's Online Mapping System

KEY

SITE BOUNDARY

HISTORICAL STRUCTURE

NOTE:
ALL SITE STRUCTURES HAVE BEEN DEMOLISHED. HISTORICAL STRUCTURE LOCATIONS ARE SHOWN FOR INFORMATION PURPOSES ONLY

KEY TO EXPLORATORY HOLES

CP/BH BOREHOLE (PB 2004)

CP BOREHOLE (WATERMAN 2007)

BH BOREHOLE (ESG 2017)

Rev	Date	Description	By	Chk	App

wsp

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Client:
CARMARTHENSHIRE COUNTY COUNCIL

Site/Project:
FORMER GRILLO ZINC OXIDE PLANT, BURRY PORT

Title:
BOREHOLE LOCATION PLAN

Drawn: CEW		Checked: AI	
Designed: AI		Approved:	
Date: 07/08/2019	Scale: 1:700 A2	Sheet:	
Project Number:		Drawing Number:	Revision:
70054861		FIGURE 2	

Login: Watt, Chris
Plot Date: 16/08/2019 14:40:17
File Name: \\uk.wspgroup.com\central data\Projects\700548xx\70054861 - Grillo S73\03 WIP\GRRIZ Dwgs\1-current\70054861-F02.dwg

Appendix B

LIMITATIONS

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

GENERAL

1. WSP UK Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report.

2. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP UK Limited standard Terms and Conditions as included within our proposal to the Client.

3. Project specific appointment documents may be agreed at our discretion and a charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP UK Limited reserves the right to amend the fee should any changes to the appointment terms create an increase risk to WSP UK Limited.

4. The report needs to be considered in the light of the WSP UK Limited proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report and any previous works referenced within the report.

PHASE 1 GEO ENVIRONMENTAL AND PRELIMINARY RISK ASSESSMENTS

Coverage: *This section covers reports with the following titles or combination of titles: phase 1; desk top study; geo environmental assessment; development appraisal; preliminary environmental risk assessment; constraints report; due diligence report; geotechnical development review; environmental statement; environmental chapter; project scope summary report (PSSR), program environmental impact report (PEIR), geotechnical development risk register; and, baseline environmental assessment.*

5. The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. WSP UK Limited cannot be held responsible for any disclosures that are provided post production of our report and will not automatically update our report.

6. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP UK Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

7. It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the site.

8. WSP UK Limited does not warrant work / data undertaken / provided by others.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

INTRUSIVE INVESTIGATION REPORTS

Coverage: *The following report titles (or combination) may cover this category of work: geo environmental site investigation; geotechnical assessment; GIR (Ground Investigation reports); preliminary environmental and geotechnical risk assessment; and, geotechnical risk register.*

9. The investigation has been undertaken to provide information concerning either:

- **i.** The type and degree of contamination present at the site in order to allow a generic quantitative risk assessment to be undertaken; or
- **ii.** Information on the soil properties present at the site to allow for geotechnical development constraints to be considered.

10. The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

11. For contamination purposes, the objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters.

12. For geotechnical investigations the purpose is to broadly consider potential development constraints associated with the physical property of the soils underlying the site within the context of the proposed future or continued use of the site, as stated within the report.

13. The amount of exploratory work, soil property testing and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions.

14. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

15. The inspection, testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. As part of this assessment, WSP UK Limited has used reasonable skill and care to extrapolate conditions between these points based upon assumptions to develop our interpretation and conclusions. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation. Conditions can change between investigation points and these interpretations should be considered indicative.

16. The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values. Specific assumptions associated

with the WSP UK Limited risk assessment process have been outlined within the body or associated appendix of the report.

17. Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

18. Where soil contamination concentrations recorded as part of this investigation are used for commentary on potential waste classification of soils for disposal purposes, these should be classed as indicative only. Due consideration should be given to the variability of contaminant concentrations taken from targeted samples versus bulk excavated soils and the potential variability of contaminant concentrations between sampling locations. Where major waste disposal operations are considered, targeted waste classification investigations should be designed.

19. The results of the asbestos testing are factually reported and interpretation given as to how this relates to the previous use of the site, the types of ground encountered and site conceptualisation. This does not however constitute a formal asbestos assessment. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and / or trace loose asbestos fibres within the soil matrix at the site.

20. If costs have been included in relation to additional site works, and / or site remediation works these must be considered as indicative only and must be confirmed by a qualified quantity surveyor.

EUROCODE 7: GEOTECHNICAL DESIGN

21. On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.

22. In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. The report is likely to represent a Ground Investigation Report (GIR) under the Eurocode 7 guidance.

DETAILED QUANTITATIVE RISK ASSESSMENTS AND REMEDIAL STRATEGY REPORTS

23. These reports build upon previous report versions and associated notes. The scope of the investigation, further testing and monitoring and associated risk assessments were selected on the basis of the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

24. The outputs of the Detailed Quantitative Risk Assessments are based upon WSP UK Limited manipulation of standard risk assessment models. These are our interpretation of the risk assessment criteria.

25. Prior to adoption on site they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP UK Limited. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

GEOTECHNICAL DESIGN REPORT (GDR)

26. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. All the relevant information needs to be provided to allow for a GDR to be produced.

MONITORING (INCLUDING REMEDIATION MONITORING REPORTS)

27. These reports are factual in nature and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of an earthworks or remedial works.

28. The data is presented and will be compared with assessment criteria.

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