

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment
Report Annex D

CL-27 Elver Pill Reen and Green
Moor Landfill Land Contamination
Assessment Report

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1 Introduction

1.1 Background

- 1.1.1** This report relates to an area of land potentially affected by contamination (CL-27) known as the 'Elver Pill Reen and Green Moor Landfill' and hereinafter referred to as the Site.
- 1.1.2** The Site is located between chainage 16,400 and 17,900 (See Figure 1) and covers an area of historical landfill and infilling of the Elver Pill Reen.

1.2 Reporting Context

- 1.2.1** The Site has been assessed as part of investigations and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the 'Scheme'). This report informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the chapter on Geology and Soils.
- 1.2.2** In 2014, a Preliminary Sources Study Report (2014 PSSR) was prepared as an initial land contamination appraisal (Ove Arup & Partners, 2014) as part of DMRB Stage 2 Assessments for this Scheme. This identified a number of individual areas that may have been affected by contamination as a result of historical activities at the Site. In addition, this report draws upon the 2015 Supplementary Ground Investigation Works undertaken on behalf of the Welsh Government (Geotechnical Engineering, 2015). This report relates to the area defined on the Site Location Plan Figure 1.
- 1.2.3** The overarching rationale and approach for the assessment of areas of land along the Scheme with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

- 1.3.1** The key objectives of this report are as follows:
- Undertake a risk assessment of the Site and determine whether potential risks to human health or controlled waters could exist based upon the Scheme.
 - Identify the need for further assessment and investigation in order to refine potential land contamination risks and inform the need for remediation/mitigation.
 - To provide information to support the Ground Investigation Report (GIR) and Geotechnical Design Report (GDR) required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

- 1.4.1** The remainder of this report is structured as follows:

- Section 2: Site Location and Description – This section summarises the Site description.
- Section 3: The Scheme – This section details the alignment of the new section of motorway and associated features at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and historical land photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and any relevant environmental information presented in the 2014 PSSR.
- Section 6: Scope of Ground Investigations Work – This section describes the previous and supplementary ground investigation data available for the Site.
- Section 7: Ground Conditions – This section describes the main findings of the intrusive site investigations including the ground conditions encountered and significant visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contamination linkages and presents the human health and controlled waters screening assessments.
- Section 9: Refined Conceptual Site Model – This section presents the CSM for the Site and identifies potential contaminant linkages, based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations - This section provides conclusions concerning the likelihood of land contaminant associated with the Site affecting the Scheme and requirements for remediation / mitigation.
- Section 11: References – This section summarises the key documents referred to in this report.
- Section 12: Glossary – This section provides a summary of the terms used in this report.

2 Site Location and Description

- 2.1.1** The Site is located to the east of the Llanwern Steel Works former lagoon areas (CL-26 report, Annex D of Appendix 11.1 of the ES) and south of the steel works itself. It is centred at National Grid Reference ST386 854 and covers an area of approximately 1 km².
- 2.1.2** The Site is located within a low lying area comprising fields intersected by reens and drainage ditches. Corus Reed bed No. 2 is situated to the north of the Site. Much of the Site is generally used for agriculture.
- 2.1.3** It is understood parts of the Site have historically been used as a landfill for steel works waste comprising slag, clinker, stone and ash. The landfilling activities relate to three areas:
- An area of a historical landfill area called 'Llanwern Steelworks Land Adjacent to 1-3 Blast Furnace'; According to the Natural Resources Wales (NRW) records, this historical landfill covers the entire Site area.
 - Areas of known in-filling in the vicinity of the Elver Pill Reen (later referred to as the 'Elver Pill Reen site'), The Elver Pill Reen site is an area surrounding and to the west of the reen and was identified as a potential contaminant source due to the presence of slag fill used to create roadways. The Site includes two main tracks, the eastern track is 'L'-shaped and the western track traverses north-south parallel to the Elver Pill Reen on its eastern side as shown on Figure 1.
 - Green Moor Lane landfill (later referred to as the 'Green Moor Lane site'). The Green Moor Lane site comprises three small (750-1,600 m² each) locations of buried steel works waste of slag, clinker, stone and ash to the east of the Elver Pill Reen site.
- 2.1.4** A site walkover was planned to be undertaken in January 2014, however no access could be gained.
- 2.1.5** A walkover survey in 2015 identified that the Site comprises a number of fields, ditches and reens and is largely in agricultural use as semi-improved grassland and scrub. Photographs are provided in Appendix 7.

3 The Scheme

- 3.1.1** The proposed new section of motorway would cross the Site centrally from east to west. The approximate chainage is 16,400 to 17,900. Refer to Figure 1 for the Site location in relation to the Scheme.
- 3.1.2** The current Scheme design crosses the Site on an earth embankment some 2 m to 3 m high. A proposed new overbridge to accommodate North Row road also cuts through the eastern part of the Site.
- 3.1.3** The alignment would transect the western Elver Pill Reen track and encroach on the northern end of the existing eastern track. The road construction would also cross the Green Moor landfill areas.
- 3.1.4** An area of permanent land take is proposed in the north eastern corner of the Site which includes a water treatment area, an attenuation pond and associated landscaping.

4 Site History

- 4.1.1** The 2014 PSSR historical searches have been based on Ordnance Survey plans, literature reviews, information provided by Natural Resources Wales (NRW) (formally Environment Agency Wales) and Newport City Council and interpretation of aerial photography.
- 4.1.2** This is supplemented by a review of historical maps obtained in 2015 from Welsh Government. Relevant extracts are presented in Appendix 8.
- 4.1.3** A summary of the Site's history is presented in Table 1 below.

Table 1: Site History Summary

1995 Feature ID / Date	Use / Observation	Source of Information
1843 - 1893	The Site comprises a number of fields traversed by reens and drainage ditches. Middle Road and Middle Road Reen run northeast-southwest through the centre of Site. The Elver Pill Reen runs north-south in the west of Site and Newcut Reen runs northwest-southeast through the centre of Site. A road runs along the southern and eastern boundary. Prides Bridge is located in the northwest corner.	1:10,560 Historical Mapping
1891 - 1912	No significant change.	1:10,560 Historical Mapping
1904 - 1939	No significant change.	1:10,560 Historical Mapping
1964 – 1965	A cattle shelter is present in the south.	1:10,560 Historical Mapping
1969	<u>A steelworks including settling ponds</u> beyond the Site to the north.	Aerial Photography
1970 - 1973	Two overhead wires and associated masts are located running northeast-southwest along the Site southern boundary. The cattle shelter is no longer present.	1: 10,000 Historical Mapping
1979	No significant change	Aerial Photography
1985 - 1996	A pond / area of <u>infilling</u> is located in the southwest corner of Site. A <u>pipeline</u> (assumed associated with the steelworks, above or below ground status unknown) runs along the western boundary of the Site.	1 : 10,000 Historical Mapping
1991	<u>Landfill activity observed</u> on the Site including <u>stockpiling of material / construction of a bund</u> along the southern and eastern boundary of the Site. Tracks observed in the western area of the Site. Area of <u>disturbed ground with ponding water</u> in the south western corner. Evidence of <u>stockpiling</u> adjacent to a track along the western boundary.	Aerial Photography

1995 Feature ID / Date	Use / Observation	Source of Information
1998	Three settling ponds are located in the north western area of the Site. A further <u>track</u> is located along the northern boundary. Areas of bare ground and <u>stockpiling</u> observed in discrete areas across the Site.	Aerial Photography
2006	One of the three settling ponds appears <u>infilled</u> and vegetated. Further <u>ponds / areas of disturbed ground</u> identified in the south western area of the Site. An area of bare ground with stockpiles is located along the northern boundary. Areas of bare ground with white material observed adjacent to track south of the settling ponds (described as a 'white spill' in the 1995 PSSR, however this is not captured in the 1998 image).	Aerial Photography
2009 - 2010	No significant change	Aerial Photography
2014	The northernmost settling pond appears infilled / covered by patchy vegetation. White material partially overgrown.	Aerial Photography

*Notes. Potential sources of contamination are underlined. Those within temporary and permanent land take are shown in bold.

- 4.1.4** The sources of information presented above supplement those used in the 2014 PSSR. Relevant extract of the photographs are presented in Appendix 8.
- 4.1.5** Consultation with Newport City Council and NRW has revealed that a large area encompassing Elver Pill Reen and Green Moor Lane sites was a licensed landfill (Reference: 6935/0026) and bounded to the north by Llanwern Works East, Queensway and to the south by Rush Wall road.
- 4.1.6** The Site commenced to accept waste in 1981. The tip was licensed to accept 49 tonnes of sludge per day before the licence was revoked in 1984. It is understood that only the north west corner of the licensed area has been used for sludge disposal and this includes Reedbed No 2, part of the Llanwern Steelworks former lagoon site (CL- 26).
- 4.1.7** Evidence of large scale landfilling across the entire Site is not present from the historical maps and aerial photographs.
- 4.1.8** Historically, the Site was used as bombing decoy site during World War II which is described in detail within the 2014 PSSR (Ove Arup 2014) and the Explosive Ordnance Threat Assessment Report (Bactec, 2014). The risk from unexploded ordnance at the Site is categorised as medium risk (Bactec, 2014).

5 Environmental Setting

5.1 Geology

5.1.1 The British Geological Survey (BGS) geological maps show relatively impermeable Tidal Flat Deposits underlying the Site and bands of peat are likely to be present within these.

5.1.2 The BGS geological records show bedrock beneath the Site is that of the Mercia Mudstone Group comprising weathered mottled and often fractured mudstones.

5.2 Hydrology

5.2.1 A number of drainage ditches traverse the Site. Middle Road Reen runs northeast-southwest through the Site centre, Elver Pill Reen runs north-south in the west and a number of settling ponds are present in the west of Site as shown in Figure 1.

5.3 Hydrogeology

5.3.1 NRW classifies the Mercia Mudstone Group as a Secondary B Aquifer. The Tidal Flat Deposits are classified as non productive (negligibly permeable) strata.

5.3.2 The Site does not lie within a groundwater source protection zone.

5.3.3 Groundwater is anticipated to be present between the interface of the bedrock strata and Tidal Flat Deposits. Further, perched water may be encountered at shallow depth within any fill material above the Tidal Flat Deposits.

5.4 Environmental Information

5.4.1 NRW reports the following information within the study area:

- No pollutant incidents, abstraction licences or discharge consents within the Site or within 300 m of the Site.
- One historic landfill site has been recorded within the Site boundary.

Table 2: Historic Landfills within Site Boundary

Landfill Name	Location	Material Type	Date Waste First and Last Received
Llanwern Steelworks Land Adjacent to 1-3 Blast Furnace, Corus, Llanwern Works	Over whole Site	Industrial waste and liquid sludge	16/11/1981 20/06/1984

- Three authorised landfills are recorded within 300 m of the Site.

Table 3: Authorised Landfills within 300 m of Site

Landfill Name	Operator's Name	Location	Licence Type	Licence Status
Llanwern Landfill: South Side of Queensway	Corus Strip Products PPC	Adjacent to the west of the Site	Industrial Waste Landfill	Modified
South Side of Queensway Llanwern Landfill	Tata Steel UK Limited	Adjacent to the west of the Site	Waste landfilling; >10 T/D with capacity >25,000T excluding inert waste	Effective
Llanwern Works East	Corus Strip Products	Adjacent to the north eastern Site boundary	Industrial Waste Landfill	Issued

5.4.2 The Site lies within the Gwent Levels – Whitson and Redwick and Llandeenny Site of Special Scientific Interest.

5.4.3 Residual levels of potential contamination associated with the historical landfilling may be present.

6 Scope of Investigations

6.1 General

6.1.1 Five intrusive ground investigations have been undertaken at the Site since 1997 and these have been summarised in the following sections.

6.2 Scope of Works

6.2.1 The various intrusive ground investigations undertaken within the Site area are summarised in Table 4 and are shown on Figure 1.

Table 4: Ground Investigation Summary

Date	Contractor	Site Location	Boreholes	Trial Pits	Sampling
1997	Norwest Holst	South	BHK2, BHK3, BHK4, BHK5, BHL1, BHL2	-	Soil
2000	Exploration Associates	South	-	CH51, CH52, CH52A, CH53, CH53A, CH54, CH54A	Soil and leachate
2002	Enviros	Unknown	RBBH3 , RBBH4, RBBH5	-	Soil & groundwater
2008	Norwest Holst	Central area	SBHK01CP, SBHK02CP, SBHK03CP, SBHK04CP, SBHL01CP, SBHL02CP, SBHL02RC	STPK01, STPK02, STPL01	Soil, leachate & groundwater
2015	Geotechnical Engineering	South	BH526, BH527, BH528, BH529, BH530	TP510, TP11, TP12, TP13	Soil

6.2.2 The construction details of all boreholes installed with monitoring wells on the Site are summarised in Table 5 below and shown on Figure 1.

Table 5: Summary of Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (m bGL)	Base of Slotted Well Casing / Gravel Pack (m bGL)	Targeted Geology
SBHK01CP	50	13.5	4.8	6.8	Tidal Flat Deposits
SBHK02CP	50	13.7	7.2	11.2	Tidal Flat Deposits
SBHK03CP	50	11.5	4.9	5.9	Tidal Flat Deposits
SBHK04CP	50	12.2	10.2	12.2	TFD / Mercia Mudstone Group
SBHL02CP	19	20.3	14.8	15.4	Mercia Mudstone
BH527	35	19.1	4.9	9	Tidal Flat Deposits
	50		12.9	19	Mercia Mudstone
BH528	35	17	6	7	Peat / TFD
	50		11.8	17	Mercia Mudstone
BH530	35	21	5	8	Peat / TFD
	50		12	21	Mercia Mudstone

6.3 Surface Water Quality Monitoring

6.3.1 Surface water quality monitoring has been undertaken at a number of locations surrounding the Site which are shown in Figure 1. Sampling has also been undertaken during 2015 (Geotechnical Engineering, 2015) and by RPS (Appendix 16.2 of the ES) as part of the supplementary works commissioned by Welsh Government.

6.3.2 Further sampling has previously been undertaken between 2007 and 2008 as part of the Titan surface water sampling regime (Titan, 2008).

6.3.3 These surface water monitoring locations are shown in Table 6.

Table 6: Surface water monitoring locations

Surface Water Location ID	Location Description	Comments
R14	Located Elver Pill Reen approximately 50 m south of the Site.	Flow was noted as slack to slow
R15	Located on Greenmoor Triangle approximately 50m north of the Site.	Flow was noted as slack to slow
R16	Located on Windmill Reen on the southern Site boundary.	Flow was noted as slack to slow
17.1	Located on 100 Perches Reen approximately 150 m north of the Site.	Slow slow noted, little vegetation
17.2	Located on Middle Road Reen Diversion on the southern Site boundary.	Shallow with significant vegetation
17.3	Located Elver Pill Reen approximately 50m south of the Site.	Low to no flow, duck weed on surface of water
SW506	Located on field drain on the western boundary of the Site.	-
SW507	Located on Middle Road Reen Diversion on the eastern boundary of the Site.	-
SW508	Located on Middle Road Reen Diversion on the north eastern boundary of the Site.	-

6.4 Field Testing

6.4.1 Monitoring of VOCs was undertaken on soil samples at locations STPK01, STPK02, SBHK02CP and SBHK04CP (Norwest Holst, 2008), and BH526, BH527, BH528, BH529, BH530, TP510, TP511, TP512 and TP513 (Geotechnical Engineering 2015).

6.5 Groundwater Monitoring

6.5.1 The groundwater sampling, groundwater monitoring and ground gas monitoring rounds are shown in Table 7.

Table 7: Summary of Monitoring Rounds

Location Ref.	Number of Rounds (Date of Sampling)	Monitoring Details	Notes
RBBH003	6 no. 1st March 2002, 21st March 2002, 17th April 2002, 5th November 2002, 28th November 2002, 14th January 2003	Groundwater - sampling	
RBBH004	5 no. 21st March 2002, 17th April 2002, 5th November 2002, 28th November 2002, 14th January 2003	Groundwater - sampling	
RBBH005	0 no. recorded	Groundwater - sampling	
SBHK01CP	6 no. 1st February 2008, 25th February 2008, 6th March 2008, 19th March 2008, 3rd April 2008,	Groundwater - levels and sampling	

Location Ref.	Number of Rounds (Date of Sampling)	Monitoring Details	Notes
	17th April 2008.		
SBHK02CP	6 no. 1st February 2008, 25th February 2008, 6th March 2008, 19th March 2008, 3rd April 2008, 17th April 2008.	Groundwater - levels and sampling	
SBHK03CP	6 no. 1st February 2008, 25th February 2008, 6th March 2008, 19th March 2008, 3rd April 2008, 17th April 2008.	Groundwater - levels and sampling	
SBHK04CP	6 no. 1st February 2008, 25th February 2008, 6th March 2008, 19th March 2008, 3rd April 2008, 17th April 2008.	Groundwater - levels and sampling	
SBHL02CP	6 no. 1st February 2008, 25th February 2008, 6th March 2008, 19th March 2008, 3rd April 2008, 17th April 2008.	Groundwater -levels	
BH527 (35 mm)	4 no. 20th March 2015, 27th March 2015, 13th April 2015, 8th May 2015	Groundwater - levels and sampling	Dual installations. Gas monitoring in 35 mm shallow installations only.
BH527 (50 mm)		Soil Gas	
BH528 (35 mm)	4 no. 20th March 2015, 27th March 2015, 13th April 2015, 8th May 2015	Groundwater - levels and sampling	
BH528 (50 mm)		Soil Gas	
BH530 (35 mm)	4 no. 30th March 2015, 14th April 2015, 21st April 2015, 11th May 2015	Groundwater - levels and sampling	
BH530 (35 mm)		Soil Gas	

6.6 Laboratory Chemical Testing

6.6.1 A summary of all laboratory analysis undertaken on soil, groundwater, leachate and surface water is summarised in Table 8 and Table 9 below.

Table 8: Summary of Previous Investigation Sampling - Intrusive Exploratory Locations

Site Investigation Date	No. of Soil Samples	No. of Leachate Samples	No. of Water Samples	Suites of Testing
1997	4	0	0	Metals, pH, sulphate, cyanide, PAH screening, phenols, mineral oil
2000	6	2	0	Metals, pH, sulphate, cyanide, PAH screening, TPH, oil, phenol, PCBs
2002	3	0	9	Metals, pH, phenol, sulphate, cyanide, asbestos, TOC, TPH and PAH speciated, PCBs, BTEX, SVOCs

Site Investigation Date	No. of Soil Samples	No. of Leachate Samples	No. of Water Samples	Suites of Testing
2008	10	6	8	Metals, pH, sulphate, asbestos, cyanide, phenol, MTBE, BTEX, TPH, PAH
2015	14	4	18	Metals, PAH, TPH, asbestos, pH, cyanide, organic matter, sulphate, sulphur, VOCs, SVOCs, nitrate, BTEX, phenols, PCBs

Table 9: Summary of Previous Investigation Sampling - Surface Water

Site Investigation date	No. of water sample locations / number of rounds	Suites of testing
2007/2008	3 locations / 4 rounds	Metals, inorganics, quality
2015	3 locations / three rounds	Inorganics, PAH, TPH, BTEX, VOCs, Phenols, quality
2015	3 locations / 1 round	Inorganics, PAH, TPH, BTEX, quality

Soil Analysis

6.6.2 The following sections summarise the laboratory analytical results for soil samples collected during the various intrusive investigation phases. The available data set has been tabulated and is presented in Appendix 3 with the supporting laboratory certificates available in the relevant original ground investigation reports (See Table 4).

6.6.3 To inform the conceptual ground model, the analytical data from the Made Ground has been segregated from those of the natural soils (Tidal Flat Deposits specifically).

6.6.4 For the purpose of meeting the requirements of Volume 4, Section 1, Part 2 of the DMRB (HD22/08 – Managing Geotechnical Risk – 2008 (Highway Agency, 2008), the historical data used to support the PSSR and the additional 2015 information (Geotechnical Engineering, 2015) have been differentiated in the following sections.

6.6.5 The available information has been summarised in Table 10.

Table 10: Summary of Analytical Soil Data

Formation Unit	Number of Soil Analysis per Analytical Suite - 2015 data/ All GI data							
	Metals & Inorganics	Asbestos	PAH	TPH	Phenol	BTEX	VOCs	SVOCs
Made Ground	7 / 22	7 / 11	7 / 15	7 / 15	0 / 15	3 / 7	3 / 3	1 / 1
Natural Soils	7 / 15	1 / 7	7 / 15	4 / 12	0 / 8	3 / 9	3 / 3	1 / 1

Soil Leaching Analysis

6.6.6 Similarly to the soils data, the soil leachate results have been considered for the Made Ground and natural soils separately. The available information is presented in Appendix 6 and summarised in Table 11.

Table 11: Summary of Soil Leaching Analytical Data

Formation Unit	Number of Soil Leachate Analysis per Analytical Suite - 2015 data / All GI data							
	Metals & inorganics	PAH	TPH	Phenol	BTEX	VOCs	SVOCs	PCBs
Made Ground	3 / 9	3 / 3	3 / 3	3 / 3	3 / 3	0 / 0	0 / 0	0 / 0
Natural Soils	1 / 3	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1

Groundwater Analysis

6.6.7 The following section summarises the laboratory analytical results for groundwater samples collected during the various intrusive investigation phases. The available data set has been tabulated and is presented in Appendix 4 with supporting laboratory certificates available in the relevant original ground investigation reports.

6.6.8 The available data relates to groundwater samples taken from wells installed within the groundwater of the Tidal Flat Deposits and/or Mercia Mudstone and is summarised in Table 12.

Table 12: Summary of Analytical Groundwater Data

Groundwater Unit	Number of Groundwater Analysis per Analytical Suite (number of well locations) – 2015 data / All GI data								
	Metals & Inorganics	PAH	TPH	PCB	BTEX	VOC	SVOC	Non Metal Inorganics	Phenols
Perched (Made Ground)	0 (0) / 7 (5)*	0 (0) / 7 (5)*	0 (0) / 7 (5)*	0 (0) / 1 (2)*	0 (0) / 4 (2)	0 (0) / 0 (0)	0 (0) / 0 (0)	0 (0) / 7 (5)*	0 (0) / 5 (5)*
Perched (Tidal Flat Deposits)	9 (3) / 13 (5)	9 (3) / 13 (5)	9 (3) / 13 (5)	6 (2) / 6 (2)	9 (3) / 13 (5)	9 (3) / 9 (3)	9 (3) / 13 (5)	9 (3) / 13 (5)	9 (3) / 13 (5)
Groundwater (Mercia Mudstone)	9 (3) / 9 (3)	9 (3) / 9 (3)	9 (3) / 9 (3)	6 (2) / 6 (2)	9 (3) / 9 (3)	9 (3) / 9 (3)	9 (3) / 9 (3)	9 (3) / 9 (3)	9 (3) / 9 (3)
Undifferentiated	0 (0) / 9 (3)	0 (0) / 3 (3)	0 (0) / 3 (3)	0 (0) / 0 (0)	0 (0) / 0 (0)	0 (0) / 0 (0)	0 (0) / 0 (0)	0 (0) / 9 (3)	0 (0) / 0 (0)

* Some samples relate to grab samples obtained within trial pits during 2000 ground investigation.

Surface water Analysis

6.6.9 The following section summarises the laboratory analytical results for surface water samples collected during the various intrusive investigation phases. The available data set has been tabulated in a table format and is presented in

Appendix 5 with supporting laboratory certificates available in the relevant original ground investigation reports.

Table 13: Summary of Analytical Surface Water Data

Surface Water System	Number of Water Analysis per Analytical Suite (number of locations) – 2015 data / All GI data				
	Metals & Inorganics	Water Quality Parameters	Polycyclic Aromatic Hydrocarbons	Total Petroleum Hydrocarbon	BTEX
Elver Pill Reen	5 (2) / 1 (2)	5 (2) / 1 (2)	1 (1) / 0 (1)	5 (2) / 1 (2)	1 (1) / 0 (1)
Greenmoor Triangle	4 (1) / 0 (1)	4 (1) / 0 (1)	0 (1) / 0 (1)	4 (1) / 0 (1)	0 (1) / 0 (1)
Windmill Reen	4 (1) / 0 (1)	4 (1) / 0 (1)	0 (1) / 0 (1)	4 (1) / 0 (1)	0 (1) / 0 (1)
Middle Road Reen Diversion	6 (3) / 3 (3)	6 (3) / 3 (3)	6 (3) / 3 (3)	6 (3) / 3 (3)	6 (3) / 3 (3)
100 Perches Reen	1 (1) / 1 (1)	1 (1) / 1 (1)	1 (1) / 1 (1)	1 (1) / 1 (1)	1 (1) / 1 (1)

6.7 Gap Analysis of Available Data

6.7.1 The investigation data available for the Site is considered reasonable as there has been sampling along the length of the new section of motorway. However, no investigation data is available within the Green Moor landfill (three areas of tipping) and within the proposed water treatment area. The latter are located adjacent to the Llanwern Works East Landfill and Llanwern Steelworks main operation areas.

7 Ground Conditions

7.1 Geology

7.1.1 The geological logs for all available exploratory holes on the Site are provided in Appendix 1. The observed geological sequence is consistent with that discussed in the 2014 PSSR report and is summarised in the following sections. Information from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) has also been used.

Topsoil

7.1.2 Topsoil was encountered at nine locations across the Site. It was generally at ground level above the superficial deposits and ranged between 0.05 to 0.3 m thickness. One exception was in CH52A where the topsoil was encountered at 1.1 m bGL below the Made Ground.

Made Ground

7.1.3 Made Ground was encountered in eighteen exploratory locations at ground level at thicknesses ranging between 0.8 – 3.2 m. It is considered the majority of Made Ground relates to construction material for the existing access roads which cross the Site and is generally at 1 m above surrounding ground levels. Made Ground was also identified in the ponded area in the north west of Site. It commonly comprised a grey / black coarse material comprising slag, ash and occasionally bricks.

7.1.4 Made ground was not identified in seventeen locations on the Site, the majority of which were located in the south and east.

7.1.5 The investigation data has not identified Made Ground which may be associated with landfilling. However, it is noted that no exploratory hole has targeted the Green Moor Landfill areas.

Superficial Deposits

7.1.6 Unconsolidated superficial deposits were encountered beneath the Made Ground or topsoil in all locations. These comprised Tidal Flat Deposits, generally firm bluish grey clays becoming soft or very soft with occasional gravel.

7.1.7 The deposits included one or two layers of peat beneath the Site with an upper layer encountered at typically 4.6 - 6 m bGL and a second layer at typically 5.25 - 8 m bGL. The horizontal continuity of these layers remains unproven. The thickness of the peat layers was variable between 0.1 - 2.8 m.

7.1.8 Sand and gravel material considered to represent Glaciofluvial Deposits was found to be generally absent beneath the Site, although some boreholes proved the base of the Tidal Flat Deposits to include a coarse fraction. A discrete pocket of the Glaciofluvial Deposits (identified as River Terrace Deposits in the borehole log) was found in SBHL01CP at a depth of 8.5 m bGL with a thickness of 1.9 m.

Solid Geology

7.1.9 Below the Superficial Deposits, the Mercia Mudstone Group was encountered at a depth of between 8.1 and 11.2 m bGL. The Mercia Mudstone Group was typically described as very stiff weathered reddish brown clay.

7.1.10 Borehole BHL2 in the Mercia Mudstone Group encountered siltstone formation below 10.5 m bGL to an unknown thickness (0.5 m proven).

Geological Sequence Summary

7.1.11 The general geological sequence identified during the previous ground investigations are summarised in Table 14 below.

Table 14: Summary of Geological Sequence

Unit	Description	Thickness Range (m)	Basal Depth m bGL)
Topsoil	-	0.05 - 0.3	0.05 - 1.2
Made Ground (associated with road construction)	Predominantly coarse to including ash, clinker, brick and slag.	0.5 - 3.2	0.5 - 3.2 (road generally 1m raised above surrounding ground level)
Superficial Deposits (Tidal Flat Deposits)	Silty clay, organic in places with at least one defined peat layer	7.45 - 11.2	8.1 - 11.2
Superficial Deposits (Glaciofluvial Deposits) – Discrete pockets	Gravel (SBHL01 only)	Generally absent – 1.9 m at SBHL01	10.4
Mercia Mudstone Group (Mudstone)	Very stiff clays becoming weak completely fractured Mudstone	unproven (>0.5)	unproven

7.1.12 The conceptual ground model included within the 2014 PSSR report has been amended in light of the 2015 information and is included within Figure 2.

7.2 Visual and Olfactory Evidence of Contamination

7.2.1 A summary of visual and olfactory evidence of potential contamination encountered during the previous ground investigations is summarised in Table 15.

Table 15: Visual and Olfactory Evidence of Contamination Summary

Location ID	Depth (m bGL)	Strata	Evidence of Potential Contamination
Most exploratory locations in the west	GL to 0.5 - 3.2	Made Ground	Ash, clinker, brick and slag.

7.2.2 No visual or olfactory evidence of hydrocarbon contamination was identified during any of the previous ground investigations. The PID meter recorded generally zero or low levels of VOCs with greatest concentrations recorded within BH529 within the Tidal Flat Deposits in which frequent rootlets were identified (15 to 24 ppm). In the absence of any significant source of contamination, the levels identified are considered to be naturally occurring.

7.3 Gas Monitoring

7.3.1 The ground gas monitoring dataset collected during each of the three monitoring rounds in 2015 is summarised on the summary field data sheets provided in Appendix 2. The maximum concentrations (minimum for oxygen) are presented in Table 16.

Table 16: Summary of Gas Monitoring Data

Location ID	Flow (l/hr)	VOCs (ppm)	CH ₄ (%/vol)	Peak LEL (%)	CO ₂ (%/ vol)	O ₂ (%/vol)	CO (ppm)	H ₂ S (ppm)
	Max	Max	Max	Max	Max	Min	Max	Max
BH527 35mm	1.3	3.2	3.4	61	0.0	19.6	0	0
BH528 35mm	0.4	0.4	31	>100	8.1	11.8	5	0
BH530 35mm	0.0	1.1	14.8	>100	5.3	15.0	10	0

7.4 Groundwater

Groundwater Encountered During Investigation

7.4.1 Groundwater strikes were encountered during the drilling of most boreholes and are detailed on the geological logs provided in Appendix 1. These are summarised in Table 17.

Table 17: Summary of Groundwater Level Data during Drilling

Location	Strike Depth (m bGL)	Geological Formation	Level after 20 Minutes (m bGL)
BHK2	6.8	Tidal Flat Deposits	6.8
	10.75	Mercia Mudstone	9.5
BHK3	10.8	Mercia Mudstone	7.1
BHK4	1.1	Made Ground	1
BHK5	9.2	Mercia Mudstone	5.4
BHL1	1.68	Tidal Flat Deposits	1.68
	6.1	Tidal Flat Deposits	5.8
	10.4	Mercia Mudstone	8.8
BHL2	10.4	Mercia Mudstone	9.05

Location	Strike Depth (m bGL)	Geological Formation	Level after 20 Minutes (m bGL)
CH51	0.8	Made Ground	not recorded
CH52A	0.8	Made Ground	not recorded
CH53	1.5	Tidal Flat Deposits	not recorded
CH54	1.6	Tidal Flat Deposits	not recorded
RBBH3	0.7	Made Ground	0.7
RBBH5	1.5	Made Ground	1.3
SBHK02CP	1	Made Ground	0.8
SBHL01CP	8.5	Tidal Flat Deposits	5.2
SBHL02CP	10.8	Mercia Mudstone	10.8
SBHL02RC	12	Mercia Mudstone	not recorded
STPK01	0.89	Tidal Flat Deposits	not recorded
STPK02	1.12	Made Ground	not recorded
STPL01	1.39	Tidal Flat Deposits	not recorded
BH526	2.5	Tidal Flat Deposits	2.1
BH528	0.25	Tidal Flat Deposits	0.20
BH529	0.9	Tidal Flat Deposits	0.52
TP510	1.05	Made Ground	not recorded
	3.8	Tidal Flat Deposits	not recorded
TP511	1.05	Made Ground	not recorded
TP512	1.5	Tidal Flat Deposits	not recorded
TP513	2.9	Tidal Flat Deposits	not recorded

7.4.2 Groundwater was not recorded in any other boreholes and trial pits during the previous investigations.

Groundwater Levels During Monitoring Rounds

Table 18: Summary of Groundwater Level Data

Location	Installation #1	Depth of Response Zone (m bGL) and Geological Formation	No. Measurements	Min Depth (m bGL)	Max Depth (m bGL)
SBHK01C P	50 mm	4.8 - 6.8 TFD	6	0.70	1.06
SBHK02C P	50 mm	7.2 - 11.2 TFD	6	1.33	1.48
SBHK03C P	50 mm	4.9 - 5.9 TFD	6	0.87	1.07
SBHK04C P	50 mm	10.2 - 12.2 TFD / MMG	6	1.45	1.67
SBHL02R C	19 mm	14.8 - 15.4 MMG	6	2.27	2.45
BH527	35 mm (S)	4.9 - 9 TFD	4	0.67	2.74

Location	Installation #1	Depth of Response Zone (m bGL) and Geological Formation	No. Measurements	Min Depth (m bGL)	Max Depth (m bGL)
	50 mm (D)	12.9 - 19 MMG	4	1.71	3.10
BH528	35 mm (S)	6 - 7 Peat / TFD	4	0.49	1.63
	50 mm (D)	11.8 - 17 MMG	4	1.28	2.90
BH530	35 mm (S)	5 - 8 Peat / TFD	4	1.52	2.62
	50 mm (D)	12 - 21 MMG	4	2.00	3.49

^{#1} S denotes a shallow installation and D denotes deep installation;

Groundwater Summary

- 7.4.3** A perched water body was typically encountered within the Made Ground during the investigations between 0.7 and 1.3 m bGL.
- 7.4.4** The main groundwater body is within the granular Mercia Mudstone Group, which is confined by the intervening Tidal Flat Deposits representing an aquitard limiting vertical groundwater flow.
- 7.4.5** Perched groundwater is observed within the upper Tidal Flat Deposits associated with limited zones of permeability associated with more granular lithologies and peat. This 'groundwater' is regarded as 'pore water' which does not contribute to advective flow within these strata.

8 Contamination Assessment

8.1 Introduction

8.1.1 The following sections provide details of the assessment of land contamination at the Site.

8.1.2 The outline Conceptual Site Model (CSM) presented within the 2014 PSSR has been reviewed and updated based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and the Scheme. The main alteration to the 2014 PSSR model are summarised below:

- Addition of gas dataset from borehole monitoring wells on Site.
- Proposed use of band drains to accelerate surcharging of soft soils during construction. These are anticipated to be vertical drains installed in a close grid pattern through the Made Ground and underlying Tidal Flat Deposits and into the Glaciofluvial Deposits.
- Piled foundations proposed for the bridge / link road junction.
- Inclusion of a defined peat horizon.
- Update of the source/pathway/receptor linkages.

8.2 Preliminary Risk Assessments

Potential Sources

8.2.1 The potential sources of contamination and associated contaminants which may be present within the Site are detailed below:

- Made Ground used for road construction across the Site.
- Waste material associated with landfill activity (Green Moor Landfill) – details not known in the absence of intrusive investigation data although extent anticipated to be limited based on historical mapping and aerial photographs.
- There is the possibility of ground gas generation from infilled ground and the presence of ground gas generated by natural organic rich soils beneath the Site.
- The quality of surface water drainage, perched water and the deep aquifer within the Glaciofluvial Deposits and Mercia Mudstone may influence or impact the quality of the others. Surface water, perched groundwater and aquifer could therefore be regarded as a source of possible contaminants as well as receptors. The waters associated with the Glaciofluvial deposits, Mercia Mudstone and Tidal Flat Deposits are saline whereas the surface water is not.

8.2.2 The north-west corner of the Site includes the Reedbed No.2 of the Llanwern Steelworks which receives all surface waters from the factory and lagoons prior to being discharged within the estuary.

8.2.3 The Site is also surrounded by three potential sources of contamination:

- To the north of the Site beyond Queen's Way (A4810) is Llanwern Steelworks.

- At the north eastern end of the Site is the Llanwern Works East Landfill which accepted industrial waste.
- To the west of the Site lies Llanwern Lagoon 26. The information related to the lagoon is discussed in more detail in the Land Contamination Assessment Report CL-26 Lagoons (Annex D of Appendix 11.1 of the ES). Whilst Lagoon 26 is a permitted landfill, previous ground investigation proved minimal waste to be present, comprising mainly slag material with brick and concrete inclusions to typically 1-3 m in thickness. The soil contamination was associated with high pH and discrete areas of heavy metals (arsenic and nickel). Groundwater quality is considered to be similar to the overall baseline seen in this general area of the Gwent Levels as defined within the Baseline Water Environment Report (RPS, 2015).

8.2.4 In addition to the above sources, the quality of surface waters, perched groundwater and the deeper aquifer within the Glaciofluvial Deposits and Mercia Mudstone bodies may influence or impact the quality of the others (for instance the groundwater within the Glaciofluvial Deposits and Mercia Mudstone is saline whilst the surface water is not). Surface water, perched groundwater and deeper aquifer are therefore regarded as a source of possible contaminants as well as receptors.

Potential Receptors

8.2.5 The following potential receptors have been identified:

Construction

- Construction workers during Site development works.
- General public and workers adjacent to construction works.
- Groundwater within the Glaciofluvial Deposits / Mercia Mudstone.
- Onsite and nearby surface waters including the reens and existing surface water ditches within the Site and bordering the surrounding fields. This land drainage is part of the Gwent Levels SSSI wider network of reens and ditches, which extends to the south of the Scheme.

Operational

- Maintenance workers.
- General public end users.
- Groundwater within the Glaciofluvial Deposits and/or Mercia Mudstone.
- The Gwent Levels SSSI surface water network of ditches and reens.

Potential Pathways

- Dermal contact, ingestion, inhalation pathways possible during development and maintenance works.
- Inhalation pathways for general public future end users.
- Contaminated surface water run-off into existing / new drainage system.
- Leaching of contaminants from Made Ground to perched water.

- Vertical migration of perched water within the Made Ground and/or leachate from the Made Ground into Tidal Flat Deposits and/or Mercia Mudstone aquifer due to band drain / pile installation.
- Lateral migration of perched water within the Made Ground to land drainage (surface waters).
- Leaching of contaminants from the Made Ground to shallow groundwater and then migration to land drainage (surface waters).
- Vertical or lateral migration of ground gas associated with Made Ground and peat and organic soils.

8.3 Risk Evaluation

8.3.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the new data described herein, the following risk evaluation has been reconsidered:

- Proposed 2–3 m motorway embankment and overlying hardstanding (carriage way) is to be constructed at the Site which is to cover most of the motorway corridor reducing pathways from any contamination in shallow soils left *in situ*.
- Tidal Flat Deposits are classified as non-productive and overlie an underlying secondary B aquifer associated with the Mercia Mudstone.
- The low permeability Tidal Flat Deposits (of over 10 m thickness) separates the various onsite and offsite Made Ground and deeper aquifer. Main groundwater body identified as being confined by the Tidal Flat Deposits.
- Perched groundwater within the Tidal Flat Deposits is not considered a water resource due to its anticipated low vertical hydraulic continuity with the aquifer beneath, low permeability and low storage capacity.
- Hardstanding cover which is proposed in some areas of the new motorway corridor is likely to limit infiltration thus reducing leaching.
- Creation of new drainage system may increase leaching of any contaminants from the Made Ground with associated increase in the risk for migration into surface waters.
- Piled and band drain foundations may create pathways to groundwater at depth. Pathways may allow increase in the influx of water within the Made Ground, given the recorded sub-artesian pressures.
- Motorway users will be within open environment with no proposed structures or other confined spaces.
- Risk of increase flux of gas emission due to induced consolidation of the Made Ground and peat from the proposed surcharge loading. However, potential receptors are limited, primarily associated to accumulation in confined spaces (such as underground services).
- Waters within the Tidal Flat Deposits and deeper aquifer of the Mercia Mudstone are saline whereas surface water is not.

8.4 Human Health Risk Assessment

8.4.1 The rationale and approach for the human health (Tier 2) screening assessment is detailed in the Land Contamination Preliminary Assessment Report (Appendix 11.1 of the ES). Soil chemical results and the findings of the generic tier 2 human health risk assessment are presented in Appendix 3. All exceedances to the relevant criteria are summarised in Table 19 below.

Table 19: Summary of Human Health Soil Screening Exceedances

Determinant	Units	Range	Screening Criteria	No. Samples Exceeding Screening Criteria (Total Number of Results)	Locations of Exceedances
Chromium	mg/kg	32 - 1,800	33	33 (37)	BHK3 (x2), BHK4 (x2), CH51, CH52A (x2), CH53A (x2), CH54A, RBBH3, RBBH4, RBBH5, SBHK03CP (x2), SBHK02CP, SBHK04CP (x2), STPK01 (x2), STPK02 (x2), BH526 (x3), BH527 (x2), BH528, BH530 (x2), TP510 (x3)
pH	pH units	7.1 - 12.9	6 - 9	20 (37)	BHK4 (x2), CH51, CH52A, CH53A, CH54A, RBBH3, RBBH4, RBBH5, SBHK03CP, SBHK02CP, STPK02, BH526 (x3), BH527 (x2), TP510 (x3)
PAH	mg/kg	<10 - 82	3.5	4 (6)	CH51, CH52A (x2), CH53A

8.4.2 Elevated alkaline soil conditions have been identified in over half of the samples, mainly within the Made Ground material but also in three samples of the Tidal Flat Deposit material.

8.4.3 Although exceedances to chromium are widespread in both Made Ground and natural soils, the criterion relates to the hexavalent. The majority of the results are considered to be within normal background data range (<95 mg/kg) and therefore are not considered to represent a contaminant of concern (RPS, 2015a). However, nineteen locations including a distinct cluster around TP510, STPK02 and SBHK03, exceed this background range with maximum of up to 1,800 mg/kg. It is likely that the elevated chromium concentrations are related to the slag used to construct access roads. Further sampling and analysis is needed to determine whether the elevated levels relate to hexavalent chromium.

8.4.4 PAHs are identified in exceedances over half of the samples analysed without speciation. In this instance the criterion for total PAH has been taken considering

the most stringent PAH compound (Dibenzo(ah)anthracene) and the elevated PAHs are mainly associated with Made Ground used for road construction.

8.4.5 All phenols, BTEX, VOCs and SVOCs were at levels below the laboratory limit of detection. PAHs and TPH were identified at low levels at both locations, however, this is considered unlikely to pose a risk to human health.

8.4.6 No other exceedances of the applied assessment criteria have been identified and no asbestos fibres were detected visually or in samples analysed in the laboratory.

8.5 Controlled Waters Screening Assessment

8.5.1 The rationale and approach for the controlled waters (Tier 1) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES) and the groundwater chemical results are presented in Appendix 4. All exceedances to the relevant generic criteria are summarised in Table 20, 21 and 22 for soil leachate, groundwater and surface water, respectively.

8.5.2 Where an EQS is dependent on water hardness i.e. some heavy metals, the hardness of the surface water receptor should normally be used. The Groundwater Baseline Report (Appendix 16.2 of the ES) indicates surface water to be generally moderately hard with hardness concentrations within a range of 100 to 150 mg/l as calcium carbonate. Therefore EQSs within this water hardness range have been used for screening purposes.

Soil Leaching Results

8.5.3 Twelve soil samples were subjected to leaching analysis. The majority of the soil leaching results were all below the applied screening criteria, with the exception of the contaminants in Table 20.

Table 20: Controlled Waters screening exceedances – soil leaching

Determinant	Units	Range	EQS	DWS	No. Exceeded EQS Screening Criteria (Total Number of Results)	Location (Formation)	No. Exceeded DWS Screening Criteria (Total Number of Results)	Location (Formation)
Arsenic	µg/l	<1 - 27	50	10	0 (10)	-	3 (10)	SBHK03CP, BH526, TP510 (All Made Ground)
Boron	µg/l	<10 - 1,200	2,000	1,000	0 (10)	-	1 (10)	SBHK03CP (Made Ground)
Copper	µg/l	<1 - 14	10	2,000	2 (10)	STPK01, BH526 (Both Made Ground)	0 (10)	-

Determinant	Units	Range	EQS	DWS	No. Exceeded EQS Screening Criteria (Total Number of Results)	Location (Formation)	No. Exceeded DWS Screening Criteria (Total Number of Results)	Location (Formation)
Nickel	µg/l	<1 - 20	4	20	5 (10)	SBHK03CP, STPK01, STPK02, BH526 (all Made Ground), SBHK04CP (Tidal Flat Deposits)	0 (10)	-
Lead	µg/l	<1 - 1,500	1.2	10	5 (10)	SBHK02CP, SBHK03CP, STPK01, STPK02 (All Made Ground), SBHK04CP (Tidal Flat Deposits)	3 (10)	SBHK02CP, SBHK03CP (Made Ground), SBHK04CP (Tidal Flat Deposits)
Antimony	µg/l	<5 - 8		5	-	-	1 (6)	SBHK03CP (Made Ground)
pH	pH Units	10.9 - 11.8	6 - 9	6.5 - 10	2 (2)	CH51, CH53A (Made Ground)	2 (2)	CH51, CH53A (Made Ground)

8.5.4 The leaching analysis in some samples of Made Ground indicates that arsenic, copper, nickel and lead are leachable such that concentrations would exceed EQS's. Similarly pH in leachate is alkaline (10.9-11.8). The leachable concentrations are generally associated with slag materials in the Made Ground used to construct the roadways. However, it is noticeable that although potential leachate could be generated, surface water sampling has not identified similar concentrations or pH levels and the roadways constructed from slag do not appear to currently be impacting surface water quality. This indicates there is no currently active pathway from the Made Ground to surface waters.

8.5.5 The laboratory detection levels for cadmium, mercury, cyanide, some PAH, VOC and SVOC compounds are higher than applied screening criteria. This is considered unlikely to pose a risk to controlled waters.

Groundwater Results

8.5.6 The groundwater results assessment includes data from three grab samples taken from within the Made Ground during the 2000 investigation, three monitoring rounds at boreholes RBBH3, RBBH4 and RBBH5 in 2002, two monitoring rounds at boreholes SBHK01, SBHK02, SBHK03 and SBHK04 in 2008 and three monitoring rounds from boreholes BH527, BH528 and BH530 in 2015. These groundwater samples were taken from the aquifer body within the

Mercia Mudstone and from perched groundwater within the Tidal Flat Deposits. Samples were also collated from other monitoring wells but results were not differentiated between each groundwater body and are presented as 'undifferentiated'.

8.5.7 The summary of the exceedances of the applied assessment criteria is presented in Table 21 and discussed below.

Table 21: Groundwater screening exceedances

Determinant	Units	Range	EQS	DWS	No. exceeded Screening Criteria (Total Number of Results) against EQS	Location of Exceedances	No. Exceeded Screening Criteria (Total Number of Results) against DWS	Location of Exceedances
Perched Water (Made Ground)								
Nickel	µg/l	2 - 5	4	20	1 (3)	CH52	0 (3)	-
Cyanide	µg/l	<0.025 - 0.09	0.001	0.05	1 (3)	CH51	1 (3)	CH51
pH	pH Units	7.5 - 11.9	6-9	6.5-10	2 (3)	CH51, CH52A	2 (3)	CH51, CH52A
Benzo(a)pyrene	µg/l	<0.05 - 0.06	0.00017	0.01	1 (3)	CH52A	1 (3)	CH52A
Benzo(b)fluoranthene	µg/l	<0.05 - 0.07	0.017	0.1	1 (3)	CH52A	0 (3)	-
Fluoranthene	µg/l	<0.05 - 0.16	0.0063	-	1 (3)	CH52A	0 (3)	-
Groundwater (Tidal Flat Deposits)								
Arsenic	µg/l	<1 - 40	50	10	0 (17)	-	13 (17)	SBHK01, SBHK02, SBHK03, SBHK04, BH527, BH528), BH530
Boron	µg/l	<20 - 1,900	2,000	1,000	0 (9)	-	5 (9)	BH527, BH528, BH530
Chromium	µg/l	<1 - 110	-	50	-	-	4 (17)	BH527, BH528, BH530
Copper	µg/l	<1 - 41	10	2,000	6 (17)	SBHK04, BH527, BH528, BH530	0 (17)	-

Determinant	Units	Range	EQS	DWS	No. exceeded Screening Criteria (Total Number of Results) against EQS	Location of Exceedances	No. Exceeded Screening Criteria (Total Number of Results) against DWS	Location of Exceedances
Iron	µg/l	<50 - 3,000	1,000	200	1 (8)	SBHK01	4 (8)	SBHK01, SBHK02, SBHK03
Lead	µg/l	<1 - 4.8	1.2	10	3 (17)	SBHK01, SBHK02, SBHK04	0 (17)	-
Manganese	µg/l	560 - 1,800	30	50	8 (8)	SBHK01, SBHK02, SBHK03, SBHK04	8 (8)	SBHK01, SBHK02, SBHK03, SBHK04
Nickel	µg/l	<1 - 20	4	20	10 (17)	SBHK01, SBHK02, SBHK03, SBHK04, BH527, BH528, BH530	0 (17)	-
Selenium	µg/l	<1 - 60	-	10	-	-	10 (17)	SBHK01, SBHK02, SBHK03, SBHK04, BH527, BH528, BH530
Cadmium	µg/l	<0.08 - 8.8	0.15	5	8 (17)	SBHK01, SBHK02, SBHK03, SBHK04, BH527, BH530	2 (17)	SBHK01
Mercury	µg/l	<0.5 - 1.2	0.07	1	5 (17)	BH527, BH528, BH530	1 (17)	BH527
Zinc	µg/l	<1 - 4,800	75	-	8 (17)	SBHK01, SBHK02, SBHK03, SBHK04	-	-
BOD	mg/l	<1 - 12	5	-	3 (8)	SBHK01, SBHK03	-	-
Sodium	mg/l	590 - 3,500	-	200	-	-	8 (8)	SBHK01, SBHK02, SBHK03, SBHK04

Determinant	Units	Range	EQS	DWS	No. exceeded Screening Criteria (Total Number of Results) against EQS	Location of Exceedances	No. Exceeded Screening Criteria (Total Number of Results) against DWS	Location of Exceedances
Sulphate	mg/l	71 - 550	400	250	3 (8)	SBHK03, SBHK04	5 (8)	SBHK02, SBHK03, SBHK04
Chloride	mg/l	330 - 5,300	250	250	16 (17)	SBHK01, SBHK02, SBHK03, SBHK04, BH527, BH528, BH530	16 (17)	SBHK01, SBHK02, SBHK03, SBHK04, BH527, BH528, BH530
Ammoniacal Nitrogen	mg/l	<0.01 - 35	0.6	-	16 (17)	SBHK01, SBHK02, SBHK03, SBHK04, BH527, BH528,	-	-
Total Ammonium	mg/l	6.8 - 35	-	0.5	-	-	4 (4)	SBHK01, SBHK02, SBHK03, SBHK04
Aquifer (Mercia Mudstone)								
Arsenic	µg/l	15 - 120	50	10	3 (9)	BH528, BH530	9 (9)	BH527, BH528, BH530
Boron	µg/l	390 - 1,500	2,000	1,000	0 (9)	-	4 (9)	BH527, BH528
Chromium	µg/l	22 - 240	-	50	-	-	5 (9)	BH527, BH528, BH530
Copper	µg/l	9.9 - 110	10	2,000	8 (9)	BH527, BH528, BH530	0 (9)	-
Nickel	µg/l	<1 - 5.9	4	20	4 (9)	BH528, BH530	0 (9)	--
Selenium	µg/l	7.8 - 180	-	10	-	-	7 (9)	BH527, BH528, BH530
Mercury	µg/l	<0.5 - 1.3	0.07	1	4 (9)	BH527, BH528, BH530	2 (9)	BH527, BH528

Determinant	Units	Range	EQS	DWS	No. exceeded Screening Criteria (Total Number of Results) against EQS	Location of Exceedances	No. Exceeded Screening Criteria (Total Number of Results) against DWS	Location of Exceedances
Chloride	mg/l	1,500 - 4,800	250	250	9 (9)	BH527, BH528, BH530	9 (9)	BH527, BH528, BH530
Ammoniacal Nitrogen	mg/l	2.6 - 12	0.6	-	9 (9)	BH527, BH528, BH530	-	-
pH	pH units	7.3 - 9.1	6 - 9	6.5 - 10	1 (9)	BH527	0 (9)	-
Undifferentiated (Perched groundwater: Tidal Flat Deposits / Aquifer: Mercia Mudstone)								
Iron	µg/l	<10 - 640	1,000	200	0 (9)	-	3 (9)	RBBH4
Lead	µg/l	<1 - 3	1.2	10	3 (9)	RBBH4, RBBH5	0 (9)	-
Nickel	µg/l	3 - 10	4	20	5 (9)	RBBH3, RBBH4, RBBH5	0 (9)	-
Sodium	mg/l	112 - 268	-	200	-	-	2 (3)	RBBH3
Sulphate	mg/l	106 - 347	400	250	0 (9)	-	3 (9)	RBBH3
Ammoniacal Nitrogen	mg/l	0.2 - 7.2	0.6	-	8 (9)	RBBH3, RBBH4, RBBH5	-	-
Cyanide	µg/l	<0.05 - 0.4	0.001	0.05	3 (9)	RBBH4	3 (9)	RBBH4
pH	pH units	7.4 - 12.7	6 - 9	6.5 - 10	4 (9)	RBBH4, RBBH5	3 (9)	RBBH5

- 8.5.8** The review of the water chemical testing results indicated that the perched water within the Made Ground at the Site (based on three samples) has discrete areas of elevated levels of nickel, cyanide and some PAH compounds including benzo[a]pyrene, benzo[b]fluoranthene and fluoranthene (all found at CH52A). In addition to these exceedances of the screening criteria, elevated levels of TPH were identified, with a maximum concentration of 5,700 µg/l found at location CH51. Both CH51 and CH52A are associated with high pH. These two locations are located about 150 m south of the new section of motorway and associated land take and are not expected to be disturbed during construction of the Scheme.
- 8.5.9** The groundwater within the Tidal Flat Deposits is identified to have elevated levels of metals (arsenic, boron, chromium, copper, iron, lead, manganese, nickel, selenium, cadmium, mercury and zinc) and inorganics above screening criteria. TPH was generally below the laboratory limit of detection, however two boreholes BH527 and BH530 were identified to have concentrations of 1,900 µg/l and 23 µg/l, respectively. For both boreholes, the results were associated with the first round, with the subsequent two monitoring rounds giving concentrations below laboratory limit of detection. All PAH, VOCs, SVOCs, phthalates, phenols, organics and PCB results were found below limit of detection.
- 8.5.10** The groundwater within the Mercia Mudstone beneath the Site has elevated levels of metals (arsenic, boron, chromium, copper, nickel, selenium and mercury) and inorganics. All PAH, VOCs, SVOCs, phthalates, phenols, organics and PCB results were found below the limit of detection. Total Petroleum Hydrocarbons (TPH) was also found below the limit of detection with the exception of BH530 where the first round gave a concentration of 100 µg/l (subsequent two gave non-detects).
- 8.5.11** The chemical analysis results for the undifferentiated waters within the Tidal Flat Deposits or the Mercia Mudstone indicate elevated levels of metals (iron, lead and nickel) and inorganics and are of similar quality to that of the groundwater within the Tidal Flat Deposits. It is noted the laboratory detection levels for some metals, PAH compounds, VOCs and SVOCs are higher than applied screening criteria. This is not considered to pose a risk to controlled waters, given the low concentrations.
- 8.5.12** Presence of high chloride concentrations indicates saline conditions exist within the perched and deep aquifers.

Surface Water

- 8.5.13** A total of nine surface water samples have been collected from the reens surrounding the Site. These have been collected from between 2007 – 2008, and most recently in 2015 (Appendix 16.2 of the ES and Geotechnical Engineering, 2015) as part of RPS sampling regime and included within the supplementary works commissioned by Welsh Government.
- 8.5.14** The full results are presented in the Baseline Water Quality Monitoring Report (Appendix 16.2 of the ES).

Table 22: Summary Surface Water Screening Exceedances

Parameter	Unit	No. Analyses	No. Analyses Above LOD	Minimum Concentration	Maximum Concentration	Location & Round with Max. Concentration	EQS	No. Analyses Exceeding EQS	DWS	No. Analyses Exceeding DWS	CCW Trigger Level	No. Analyses Exceeding CCW Trigger Level
Lead	ug/l	23	6	0.049	7	R15 / E3	1.2	2	10	0	250	0
Nickel	ug/l	23	10	1	4.2	2 / SW506	4	2	20	0	100	0
Cadmium	ug/l	23	7	0	2.9	2 / SW506	0.15	5	5	0	5	0
Zinc	ug/l	12	12	6	310	R15 / E4	75	2	-	-	1,000	0
BOD	mg/l	15	10	1	15.7	17.3 / Q1	5	3	-	-	18	0
Phosphorus	mg/l	3	3	229	1200	17.2 / Q1	120	3	-	-	-	-
Chloride	mg/l	20	20	21	785	17.3 / Q1	250	2	250	2	300	2
Ammoniacal Nitrogen	mg/l	23	20	0.04	1.2	SW507 / 3	0.6	1	-	-	1	1
pH	pH units	20	20	7.3	8.9	SW506 / 2	6-9	0	6.5-10	0	6.8-8.5	7
Dissolved Oxygen	%	12	12	10.5	98.2	R15 / E3	60	7	-	-	-	-
Nitrate as N	mg/l	12	7	0.9	3.6	E1 / R15	-	-	50	0	1	6
Nitrate as NO3	mg/l	15	9	1.3	15.9	E1 / R15	-	-	50	0	1	9
Nitrite as N	mg/l	12	1	< LOD	0.2	E4 / R16	-	-	0.15	1	1	0
TON	mg/l	15	8	0.9	9.43	Q1 / 17.1	-	-	50	0	2	4
Phosphate	mg/l	12	10	0.1	1.2	E3 / R14	-	-	-	-	1	3

8.5.15 The water quality within Elver Pill Reen and Middle Road Reen Diversion are generally similar, both of which recorded exceedances above the EQS for phosphorous and single occurrences of heavy metal exceedances such as cadmium and nickel.

8.5.16 Nitrates and Total Oxidised Nitrogen exceeded their respective CCW trigger levels on a number of occasions primarily at Elver Pill Reen, 100 Perches Reen, Windmill Reen and Greenmoor Triangle.

8.5.17 TPH was recorded below its laboratory limit of detection throughout all sampling regimes, as were BTEX organics.

8.6 Ground Gas Risk Assessment

8.6.1 The ground gas data available relates to three boreholes, (BH527, BH528 and BH530), drilled during the 2015 investigation with response zones within the Tidal Flat Deposits and including peat horizons (4.9 - 9 m bGL, 6 - 7 m bGL and 5 - 8 m bGL respectively). Of the 4 no monitoring rounds available, the below observations have been made:

- No monitoring was undertaken during low barometric pressure (less than 1000 mb), with the lowest conditions being 1001 mb. As such worst case atmospheric conditions for potential ground gas generation may have not been monitored.
- Gas flow was generally recorded absent, with the exception of the first round in BH527 which recorded a peak flow of 1.3 l/hr and the first round in BH528 which recorded a flow of 0.4 l/hr before rapidly stabilising to zero.
- Methane has been recorded up to 3.41 % on the third round in BH527, up to 31% in the third round in BH528 and absent for the other three monitoring rounds in these boreholes. In BH530 methane was absent in the first round and recorded up to 14.8% in the other three monitoring rounds. When encountered, methane concentrations were seen to reduce through the first minute's reading intervals, indicating a limited amount of gas is present within the soils. The concentrations are above the screening criterion of 1 %.
- Carbon dioxide is absent in BH527, identified at up to 8.1 % in BH528 and up to 5.3 % in BH530. These concentrations are above the screening criteria of 5 %.
- Trace of Volatile Organic Compounds of up to 3.2 ppm has been recorded.
- Hydrogen sulphide was not detected throughout the monitoring.
- Carbon monoxide was recorded at a maximum of 10 ppm in the second monitoring round at BH530. These concentrations are below the screening criteria of 30 ppm.
- Oxygen has been recorded to be at ambient concentrations of between 19.6 - 20.4 % in BH527. In BH530 it is recorded at lower concentrations during the second round at concentrations of 15 - 15.6 % and within BH528 during the third round at concentrations of 11.8 and 12.1 %.
- Ground gas data from the Made Ground has not been collected.

8.6.2 The available data identifies elevated methane concentration and raised carbon dioxide that are higher than the screening criteria with ambient or depleted

oxygen conditions and these are considered representative of peat deposits with low gas generation potential.

- 8.6.3** A gas risk assessment has been undertaken and is set out in the Land Contamination Assessment Report Appendix 11.1 of the ES).

8.7 Summary

- 8.7.1** Made Ground has been shown to have elevated chromium concentrations above background range with maximum of up to 1,900 mg/kg. The elevated concentrations generally relate to the slag material used in the construction of roads at the Site. This material could represent a potential human health risk to future site workers and remediation may be necessary. Further sampling and analysis of these soils is recommended to determine if the chromium detected is the more toxic hexavalent form and whether remediation is needed.
- 8.7.2** Elevated alkaline soil conditions have been identified in over half of the samples, mainly within the Made Ground material but also in three samples of the Tidal Flat Deposit material. However, the pH in nearby surface water receptors is not noted to be elevated.
- 8.7.3** Made Ground tested at the Site was identified to have leachable contaminants with exceedances of arsenic, boron, copper, nickel, lead, antimony and pH. The natural soils were identified to have limited leachability with marginal exceedances of nickel and lead limited to one sample out of three. Similar elevated levels of these metals were not observed in surface water samples.
- 8.7.4** Perched water within the Made Ground has high levels of metals, pH and PAHs. Elevated TPH concentrations are also identified within the perched water. However, the area where perched groundwater within Made Ground has been identified is not going to be affected by the Scheme.
- 8.7.5** Both the perched groundwater within the Tidal Flat Deposits and the aquifer have been identified to have elevated metals and inorganics contaminants when compared to the Environment Quality Standards or the Drinking Water Standards. Localised and sporadic presence of TPH contamination is identified. The pore waters within the Tidal Flat Deposits and groundwater within the Mercia Mudstone is saline. These groundwater qualities are considered to be within the baseline of this area within the Gwent levels as defined within the Baseline Water Environment Report (RPS, 2015).
- 8.7.6** Surface waters at the boundary of the Site are generally of good quality and are comparable to the baseline surface water quality (Appendix 16.2 of the ES).
- 8.7.7** Elevated concentrations of methane along with depleted oxygen levels identified are likely attributed to the presence of organic material including peat and are consistent with the expected gas regime given the types of natural soils present beneath the Site.

9 Refined Conceptual Site Model

- 9.1.1** The results of the Supplementary Ground Investigation have enabled the original CSM presented in the 2014 PSSR to be updated. The assessment is based on the Scheme during its construction and operation phases.
- 9.1.2** A CSM to represent general ground conditions, overall Scheme layout and relevant source-pathway-receptors (each of which having a specific alpha-numerical symbol attached) is presented in Figure 2.

Table 23: Conceptual Site Model

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
<p>On Site Metals, inorganics and organic contaminants associated with slag and industrial rubble from the nearby steel works in particular. Sludge and industrial waste within the Green Moor Land Landfill. Road construction material (slag) in particular</p> <p>Off site Llanwern Lagoon26 (CL-26); Llanwern Works East Landfill; Llanwern steelworks main operation</p>	Construction Stage					
	Construction Workers (B)	Direct dermal (1)	Likely	Moderate	Moderate	<p>Construction workers will possibly be exposed to Made Ground materials during Site construction works; however exposure duration will be short term only. Prior to construction, a specific risk assessment will be required in line with CDM and H&S guidance. This will enable safe methods of work and appropriate level of PPE to be put in place. As such all risks will be duly considered and suitably mitigated to protect construction workers.</p> <p>The contamination status is not foreseen to represent abnormal constraints to construction workers' health and safety over and above those typical of a brownfield site. A construction mat will be placed over the length and width of the proposed embankment to enable piling and band drain installation as well as general construction. This will break dermal, ingestion and inhalation pathways once placed.</p> <p>Made Ground comprising ash and slag used to make up the existing access roads will require removal to facilitate construction. The materials may be appropriate for reuse within the Scheme subject to meeting suitability for re-use criteria.</p> <p>Gap in the data has been identified and further investigations are required to delineate any potential contamination associated with the known areas of tipping associated with Green Moor Lane Landfill and along the new route of North Row and the proposed Water Treatment Area.</p>
		Ingestion (3)	Likely	Moderate	Moderate	
		Inhalation of soil dust (2)	Likely	Moderate	Moderate	
		Inhalation of ground gas / VOCs / hydrocarbon vapours (2)	Unlikely	Moderate	Low	
	General public/site neighbours during construction works (C)	Dermal contact with soil dust(1)	Unlikely	Moderate	Low	<p>During construction period there is the possibility of inhalation/ ingestion of soil dust. Dust suppression measures will be required during construction works. Potential contamination sources extend well beyond the land take.</p> <p>A construction mat will be placed over the length and width</p>
		Ingestion of soil dust (3)	Unlikely	Moderate	Low	
		Inhalation of soil dust (2)	Unlikely	Moderate	Low	

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
		Inhalation of soil gas or vapours (2)	Unlikely	Moderate	Low	of the proposed embankment to enable piling and band drain installation as well as general construction. This will break dermal, ingestion and inhalation pathways once placed. Gap in the data has been identified and further investigations are required to delineate any potential contamination and confirm the risks.
	Surface water (land drainage, reens), part of Gwent Levels SSSI (C)	Saturated flow within perched water and groundwaters (4)	Low likelihood	Moderate	Moderate to Low	Leachable organics and inorganics identified within the Made Ground. Surface waters at the boundary of the Site are generally of good quality. The quality of perched groundwater may become impacted by contamination during the construction works, particularly in the area where excavation is undertaken (new drains and piling). Made Ground comprising ash and slag used to make up the existing access roads will require removal to facilitate construction. The materials may be appropriate for re-use within the Scheme subject to meeting suitability for re-use criteria. Perched groundwater is likely to have very low flow and may be absent seasonally. Perched water within the Made Ground has elevated metals and organics, albeit in an area not to be affected by the Scheme. Application of appropriate surface water run-off control measures will be required.
		Contaminated surface water run-off (5)	Likely	Moderate	Moderate	
	Deep groundwater within Mercia Mudstone(Da)	Vertical migration (4)	Low likelihood	Moderate	Moderate to low	Displacement of potentially impacted made ground possible during piling, however this is subject to selected piling technique. Furthermore, Made Ground comprising ash and slag used to make up the existing access roads will require removal to facilitate construction. The materials may be appropriate for reuse within the Scheme subject to meeting suitability for re-use criteria. A thick mantle of predominantly very low permeability Tidal Flat Deposits overlie the Mercia Mudstone aquifer,

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
						reducing risk of downward migration. Groundwater (aquifer) quality identified to be impacted by metal and inorganic contaminants of concern and of same quality as the Tidal Flat Deposit perched groundwater. Groundwater characterised with saline intrusion. Perched groundwater in Made Ground has been impacted with hydrocarbons in CH52A. This is anticipated to be discrete feature rather than widespread across the Site and is also not going to be affected by the Scheme. A piling risk assessment will be required to mitigate risks from piling and band drain installation to controlled waters. Gap in the data has been identified and further investigations are required to delineate any potential contamination and confirm the risks.
Groundwater – Aquifer from the Glaciofluvial Deposits and/or Mercia Mudstone	Surface water (land drainage) (E)	Piles and band drains (4)	Unlikely	High	Moderate to Low	Groundwater (aquifer) is saline. The hydrostatic pressure of the aquifer is likely to be near base of Made Ground and band drains and piles could create potential vertical pathways connecting aquifer with surface water. Controls and a piling risk assessment are required to mitigate the risks.
Peat and organic soils	Construction Workers (B)	Inhalation of soil gas / explosion (2)	Low likelihood	High	Moderate	High methane concentrations associated with peat / organic clays but with low or absent flux. Gas flux likely to increase during surcharge loading.
	Off site users during construction works (C)	Inhalation of soil gas/ explosion (2)	Unlikely	High	Moderate to low	New pathways to be created with band drain. Construction to be largely within open space. Any earthworks within confined space would require specific risk assessment, control measures and PPE. Gas control measures would be needed during piling and band drain installation. Risks to offsite general public during construction considered very low as no enclosed spaces or buildings within public access and low permeability of Tidal Flat Deposits will inhibit migration. Gap in the data has been identified and further investigations are required to assess any potential gas and confirm the risks.

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
						Piling and band drain installations could result in explosive risks during operations and risk assessment and gas mitigation measures will be needed.
<p>On Site Metals, inorganic and organic contaminants associated with slag and industrial rubble from the nearby steel works.</p> <p>Sludge and industrial waste within the Green Moor Land Landfill.</p> <p>Ground gas Off site</p> <p>Llanwern Lagoon26 (CL-26);</p> <p>Llanwern Works East Landfill;</p> <p>Llanwern steelworks main operation</p>	Operational					
	Maintenance Workers (B)	Direct dermal (1)	Low likelihood	Low	Very low	<p>Made Ground to be largely encapsulated by the embankment or removed and therefore the exposure to contamination will be limited outside the motorway embankment along existing tracks albeit outside the permanent land take.</p> <p>Areas outside the motorway hardstanding will receive topsoil and / or subsoil cover for planting further reducing pathways.</p> <p>Exposure duration will be short term only. Site specific risk assessment will be required in line with health and safety legislation. This will enable safe methodology and appropriate level of PPE to be put in place. As such all risks will be duly considered and suitably mitigated for instance during future excavations required during maintenance.</p> <p>Current data set identifies limited exceedances above the selected generic screening criteria.</p> <p>Existing contamination levels are not foreseen to represent abnormal constraints to maintenance workers' health and safety over and above those typical of a brown field site redevelopment.</p> <p>Surcharge of superficial soils may temporary increase gas flux.</p> <p>Maintenance works to be largely within open space. Any works within confined space would require specific risk assessment, control measures and PPE to meet legislative requirements.</p> <p>Gap in the data has been identified and further investigations are required to delineate any potential contamination and confirm the risks associated with potential waste deposition in the three areas at Green Moor Lane Landfill.</p>
		Ingestion (3)	Low likelihood	Low	Very low	
		Inhalation of soil dust (2)	Low likelihood	Low	Very low	
		Inhalation of soil gas or vapours (2)	Low likelihood	Low	Very low	

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Future Motorway users (A) and other off site users (C)	Dermal contact with soil dust (1)	Unlikely	Low	Very low	<p>Potential contamination sources in soil are limited to the existing roadways constructed from ash and slag and the Made Ground is to be largely encapsulated by the embankment. Exposure duration will be short term only for Motorway users.</p> <p>The human health screening criteria is considered conservative when considering exposure and pathway mechanisms to future Site users.</p> <p>Limited potential for lateral gas migration given the presence of low permeability Tidal Flat Deposits to shallow depth. Off-site receptors adjacent to proposed earthworks at the link road but some 450 m from the main motorway section and this is not considered at risk. Gap in the data has been identified and further investigations are required to delineate any potential contamination and confirm the risks associated with potential waste deposition in the three areas at Green Moor Lane Landfill.</p>
		Ingestion of soil dust (3)	Unlikely	Low	Very low	
		Inhalation of soil dust (2)	Unlikely	Low	Very low	
		Inhalation of soil gas or vapours (2)	Unlikely	Low	Very low	
	Deep groundwater within Mercia Mudstone(Da)	Vertical migration (4)	Low likelihood	Moderate	Moderate to Low	<p>Leaching of contaminants from the Made Ground materials used to construct existing roadways could migrate via piling and band drains; however the Made Ground comprising ash and slag will require removal to facilitate construction. The materials may be appropriate for reuse within the Scheme subject to meeting suitability for reuse criteria.</p> <p>Thick mantle of predominantly very low permeability Tidal Flat Deposits overlying aquifer, reducing risk of downward migration.</p> <p>Groundwater (aquifer) quality already identified to be impacted by metal and inorganic contaminants of same quality than the perched groundwater. Groundwater characterized with saline intrusion.</p> <p>Water in Made Ground impacted with hydrocarbons (CH52A). This is anticipated to be discrete feature rather than widespread across the Site and is also not going to be affected by the Scheme.</p>

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
						Piling risk assessment will be required to mitigate risks from piling and band drain installation to controlled waters. Gap in the data has been identified and further investigations are required to delineate any potential contamination and confirm the risks associated with potential waste deposition in the three areas at Green Moor Lane Landfill.
	Surface water (land drainage) (E)	Leaching / migration of contaminants to surface waters (4)	Likely	Moderate	Moderate	Leachable organics and inorganics identified within the Made Ground. Made Ground comprising ash and slag used to make up the existing access roads will require removal to facilitate construction. The materials may be appropriate for reuse within the Scheme subject to meeting suitability for re-use criteria. Perched groundwater is likely to have very low flow and may be absent seasonally. Perched water within the Made Ground has elevated metals and organics, albeit in an area not to be affected by the Scheme. Application of appropriate surface water run-off control measures will be required.
Groundwater – Aquifer from the Glaciofluvial Deposits and/or Mercia Mudstone	Surface water (land drainage) (E)	Piles (4)	Likely	High	High	Groundwater (aquifer) is saline. The hydrostatic pressure of the aquifer is near base of Made Ground and band drains and piles could create potential vertical pathways connecting aquifer with surface water. Controls and a piling risk assessment are required to mitigate these risks.
Peat and organic soils	Maintenance Workers (B)	Inhalation of soil gas / explosion (2)	Unlikely	High	Moderate to Low	Although elevated methane concentrations are known within the natural soils of the Tidal Flat Deposits, the low permeability soils will result in limited gas generation post construction. Risks to maintenance workers low but entry into any confined spaces will need to adhere to health and safety legislation requirements. Pathways along piles likely to “heal” with increase in soil contact along pile shaft preventing gas migration. However

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
						band drains could still allow localised gas migration. Gap in the data has been identified and further investigations are required to assess any potential gas and confirm the risks.
	Future motorway users (A) and off-site users (C)	Inhalation of soil gas / explosion (2)	Unlikely	High	Moderate to Low	Ground gas data from the peat horizons within the superficial deposits identify concentrations of methane, carbon dioxide and trace VOCs. New pathways to be created with piles and band drains. Limited potential for lateral gas migration given the presence of low permeability Tidal Flat Deposits to shallow depth. Motorway to be built on raised embankment providing a further barrier to migration gases. Pathways along piles likely to “heal” with increase in soil contact along pile shaft preventing gas migration. However band drains could still allow localised gas migration. Gap in the data has been identified and further investigations are required to assess any potential gas and confirm the risks.

10 Conclusions and Recommendations

10.1 Conclusions

- 10.1.1** Ground investigations have been undertaken at the Site to assess risks from land contamination associated with the construction and operation of the Scheme including human health and controlled waters risks.
- 10.1.2** Widespread gross contamination associated with the Site's historical use has not been identified. The risk assessment has identified that some residual risks to human health and controlled waters could exist and control measures are required to facilitate the construction and ongoing operation of the Scheme.
- 10.1.3** The laboratory testing results from previous ground investigations confirm the on site observations and field testing, and indicate that the materials encountered within the Site are at tolerable levels of risk to human health both during construction and operational phases. Materials are also likely to be suitable for reuse subject to provision of reuse criteria under a Material Management Plan.
- 10.1.4** Contaminated materials appear to be confined to existing tracks that cross the Site that have been constructed from slag and ash materials. There are three areas of suspected tipping that have not been intrusively investigated that require additional assessment.
- 10.1.5** During the construction phase, specific mitigation measures will be required to prevent inhalation pathways of dust to off site and work force receptors, although such measures would be no more than typically expected on a construction site.
- 10.1.6** Impacted perched groundwaters likely to be in continuity with land drainage will require suitable water management strategy to prevent potential impact to surface waters from contaminant run-offs.
- 10.1.7** During the operational phase, the embankment will cover part of the Site which will significantly limit the infiltration of rainwater through the soils and potentially leaching any soil contaminants into the groundwater. However, perched groundwater may be within the Made Ground materials and could remain beneath the embankment.
- 10.1.8** Surface waters at the boundary of the Site are generally of good quality with limited evidence of impact on quality that can be associated with the Site. The surface water quality appears similar to that seen elsewhere across the Gwent Levels.
- 10.1.9** Adoption of band drain and piles may provide new pathways which may lead to groundwater within the Tidal Flat Deposits and possibly any water bodies within the Made Ground to enter the currently confined aquifer within the Glaciofluvial Deposits and Mercia Mudstone.
- 10.1.10** The deep aquifer is identified to be impacted with metals, organic and inorganic contaminants which may reduce surface water quality if the band drain pathways allow direct or indirect linkage. Further consideration and a piling risk assessment will be undertaken to mitigate the potential impact of the band drains to allow specific mitigation measures to be implemented.

- 10.1.11** Post construction, the embankment itself and topsoil and subsoil cover along the motorway corridor will break potential human health pathways to end-users and maintenance workers. However, topsoil materials placed at the surface will need to be checked for contamination.

10.2 Recommendations

- 10.2.1** Given the identified gap in the data, in particular associated with potentially contaminated land use (landfills and steelworks) an additional ground investigation works is required to verify risk levels described in this report. Upon completion this report shall be reviewed and updated accordingly once the findings of the additional investigation are made available. The additional investigation will include the following:

- Trial pits and boreholes to collect soil samples including targeting the three suspected areas of tipping.
- Installation of groundwater monitoring wells to collect groundwater samples and gas monitoring.

- 10.2.2** Upon review and assessment of the additional ground investigation information, any contamination identified that could cause an unacceptable risk to the identified receptors will require appropriate remedial mitigation measures to be implemented. These measures would be identified within a remedial strategy for the Scheme. The remediation strategy is anticipated to include but is not limited to the below:

- Addressing uncertain human health risk and controlled waters risk identified by the proposed additional ground investigation.
- Risk assessment of piles / band drains and associated construction works creating pathways enabling contaminants migration.
- Dealing with unexpected contamination.
- Verification sampling strategy to confirm suitability for soils for retention / re-use.
- Control measures to prevent risks to construction workers and the general public during construction.
- Verification of imported topsoils for suitability of use.

- 10.2.3** The remediation strategy should include a remediation options appraisal, remediation implementation plan and remediation verification plan. The remediation strategy should be supported by a Scheme wide Material Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

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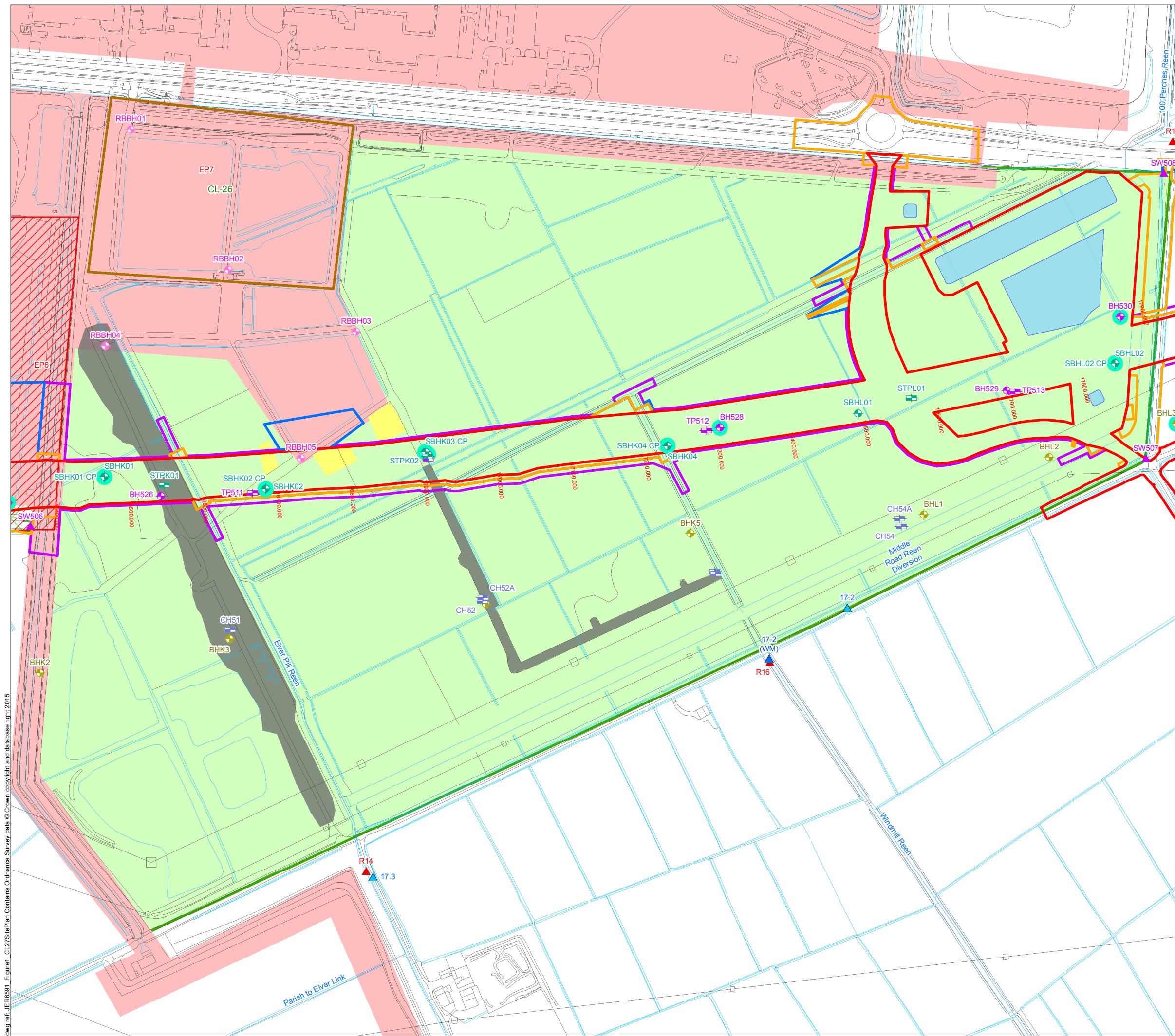
12 Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection
mAOD	Metres Above Ordnance Datum

mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O ₂	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures

dwg ref: JER6591_Figure1_CL27SitePlan Contains Ordnance Survey data © Crown copyright and database right 2015



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Proposed Water Treatment Area (WTA)
- Potential Area of Land Contamination based on 2014 PSSR
- Other Potential Area of Land Contamination
- Reedbed No. 2
- Green Moor Landfill
- Elver Pill Reen Infill

Permit Boundaries

- Main Installation
- Non-Hazardous Landfill

Investigation Locations

2015 (RPS)

- Surface Water Monitoring Location - Q2
- Surface Water Monitoring Location - Q1

2015 (Geotechnical Engineering)

- Borehole
- Trial Pit
- Surface Water Monitoring Location

2008-2009 (Titan Surveys)

- Surface Water Monitoring Location

2007 (Norwest Holst)

- Borehole
- Trial Pit

2002 (Exploration Associates)

- Borehole

2000 (Exploration Associates)

- Trial Pit

1997 (Norwest Holst)

- Borehole

- Monitoring Well Installation

NEWPORT

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Welsh Government

Appendix 11.1 Annex D CL-27

Site Plan for CL-27

Figure: 1	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Scale: A3 @ 1:5,000

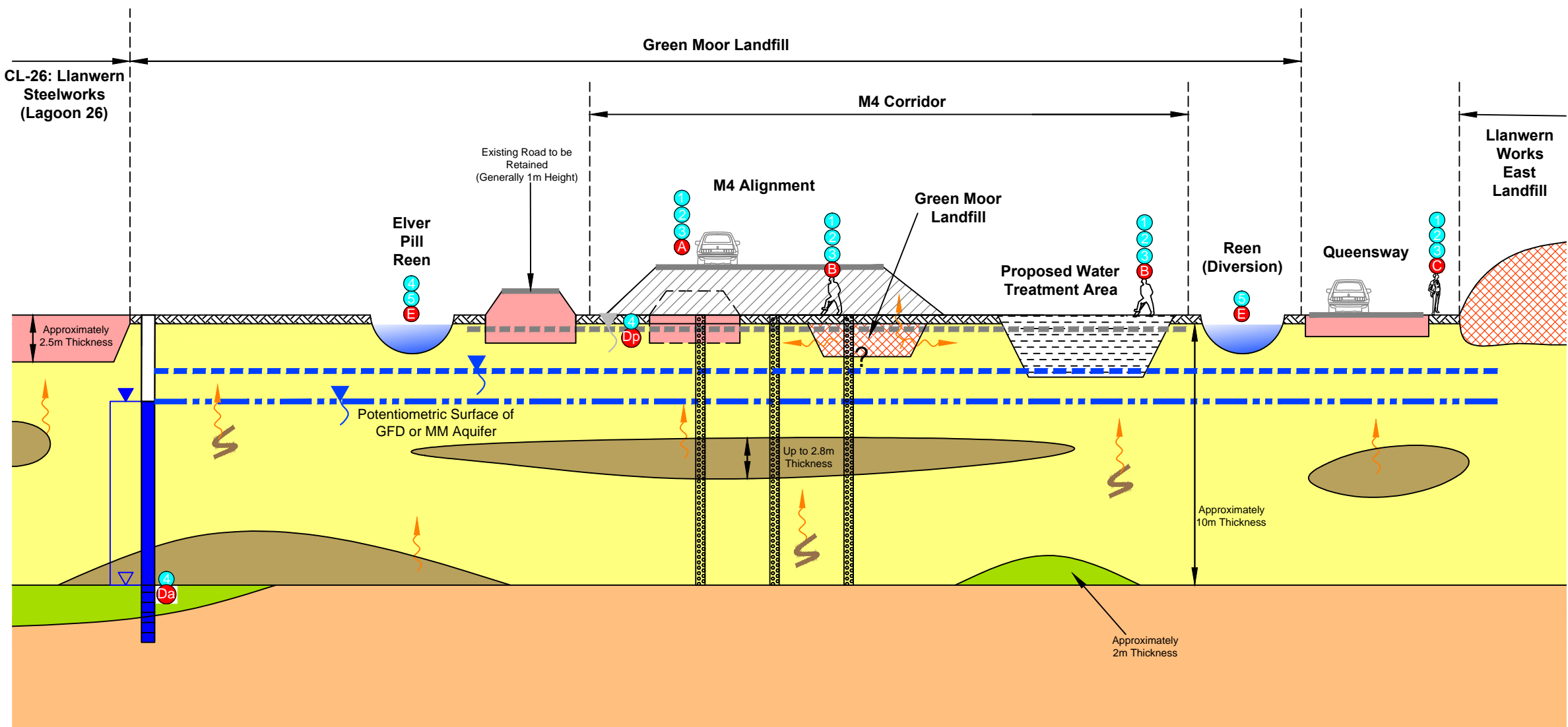
0 80 160m

N

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dwg ref: JER6591_Figure1_CL27SitePlan

CL- 27 Green Moor Landfill



Legend

- Topsoil
- Waste Material (Green Moor Landfill)
- Made Ground - MG
- Tidal Flat Deposits - TFD
- Organic Matter within TFD
- Peat
- Glaciofluvial Deposits - GFD
- Mercia Mudstone - MM
- Proposed Embankment
- Proposed Cutting
- Proposed Band Drain
- No Information Available
- Perched Water (MG)
- Perched Groundwater (TFD)
- Groundwater (GFD and MM)
- Water Strike
- Rest Water Level
- Gas Migration Pathway

Potential Receptors

- Humans On-Site (M4 User)
- Humans On-Site (Construction/Maintenance)
- Humans Off-Site (Site Neighbours)
- Groundwater (Aquifer)
- Surface Water

Potential Pathways

- Dermal Contact
- Inhalation
- Ingestion
- Leaching / Migration
- Surface Run Off

Potential Sources of Contamination

Possible contamination present on site associated with :

On-Site

- Green Moor landfill comprising sludge & industrial waste
- Fill material from adjacent steel works
- Ground gas originating from the natural organic rich soils / infill material

Off-Site

- Llanwern Steelworks (Lagoon 26)
- Llanwern Steelworks (Main Operation)
- Llanwern Works East Landfill

NOTE
Drawing refined from PSSR Drawing Reference
M4-OA-17-00DR-Z-XX-0149 (February 2014)



Appendix 11.1 Annex D CL-27

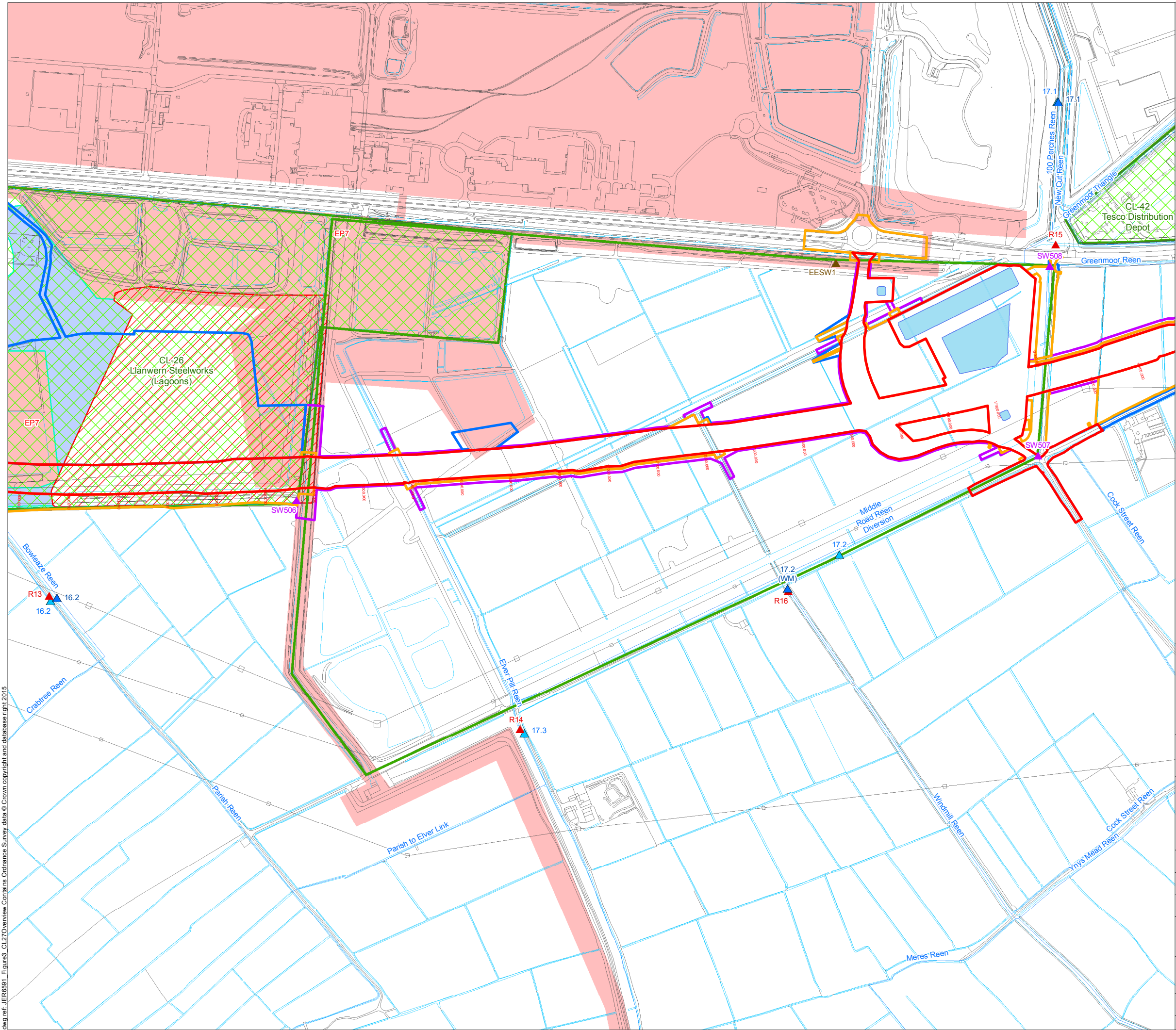
Conceptual Site Model for CL-27

Figure: 2	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Not to Scale

Ground conditions based
on available information

dwg ref: JER6591_Figure2_CL27ConceptualSiteModel



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Proposed Water Treatment Area (WTA)
- Potential Area of Land Contamination based on 2014 PSSR
- Other Potential Area of Land Contamination

Permit Boundaries

- EP7 Tata Steel Strip products UK (Llanwern Steelworks), EPR/BS3905IP - Active Permissions
- EP5 Llanwern South Side of Queensway Landfill, EPR/HP3899FC - Working Towards a State of Closure
- EP6 South Side Queensway Non-hazardous Landfill, EPR/GP3331SV - Active Permissions

Surface Water Monitoring Locations

- ▲ 2015 (RPS) - Q2
- ▲ 2015 (RPS) - Q1
- ▲ 2015 (Geotechnical Engineering)
- ▲ 2008-2009 (Titan Surveys)
- ▲ 2006 (Enviros)



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Welsh Government

Appendix 11.1 Annex D CL-27

Overview Site Plan for CL-27 with Permit Boundaries

Figure: 3	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Scale: A3 @ 1:7,500
0 125 250 m



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dwg ref: JER6591_Figure3_CL27Overview

Appendices

A1 Appendix 1

Exploratory Records



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK2

Header

Contract No.	F10895	Method	Cable Percussion	Coordinates	338344.8 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon	Ground Level	185347.3 N
Client	Welsh Office	Driller	A.M	Orientation	Vertical
Consultant	Ove Arup and Partners	Logged by	T.R	Date Started	16/10/1997
				Date Completed	16/10/1997

PROGRESS						DRILLING DETAILS			
Date	Time	Hole depth	Casing depth	Water depth	Remarks	Hardbore from depth	Hardbore to depth	Chiselling hours	Remarks
16/10/1997	1800	11.25	8.60	6.80		10.80	11.25	1.00	

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
150	11.25	150	8.00	16/10/1997	1500	6.80	6.80	20.0	seepage	5.85	5.85
				16/10/1997	1700	10.75	9.50	15.0	fast	8.00	0.00

GENERAL NOTES		SPT DETAILS		
1. Borehole complete at 11.25m, grouted to ground level.		Depth	Type	Incremental blow count/penetration in mm
		2.00	S	N=7 (1,1,1,2,2,2)
		4.00	S	N=3 (0,1,1,0,1,1)
		8.15	S	N=20 (3,4,5,4,5,6)
		9.15	S	N=42 (4,7,8,10,10,14)
		10.55	S	37/150mm
		11.10	S	80/150mm*
		* Seating blows only.		

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes, chiselling time in hours.

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK2

Sheet 1 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	338344.8 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185347.3 N
Client	Welsh Office	Driller	A.M	Ground Level	7.30m AOD
Consultant	Ove Arup and Partners	Logged by	T.R	Orientation	Vertical
				Date Started	16/10/1997
				Date Completed	16/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Installation
TOPSOIL		0.30	7.00	B 0.30 - 0.90			
Soft brown mottled grey CLAY with occasional partings of light brown fine sand and rootlets. (Estuarine Alluvium)				D 0.95 - 1.45	(7)		
				U 1.00			
				D 1.45			
				D 2.00	S7	S 2.00	2.45
				B 2.45 - 3.00			
		3.00	4.30	D 3.05 - 3.55	(6)		
				U 3.10			
				D 3.55			
				D 4.00	S0	S 4.00	4.23
				B 4.45 - 5.00			
				D 5.10 - 5.60	(6)		
				U 5.15			
				D 5.60			
		5.90	1.40	B 5.90 - 6.00	(7)		
				U 6.00 - 6.45			
		6.45	0.85	D 6.45			
				D 7.20			
				U 7.50 - 7.95	(10)		
				D 7.95			
		8.10	-0.80	D 8.15	S20	S 8.15	8.60
				B 8.60 - 9.10			
				D 9.15 - 9.60	S42	S 9.15	9.60
				B 9.60 - 10.75			

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK2

Sheet 2 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	338344.8 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185347.3 N
Client	Welsh Office	Driller	A.M	Ground Level	7.30m AOD
		Logged by	T.R	Orientation	Vertical
				Date Started	16/10/1997
Consultant	Ove Arup and Partners			Date Completed	16/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Install- ation
Bluish green grey completely weathered MUDSTONE, very weak. (Mercia Mudstone Group)				D 10.55	S37/150mm	S 10.55 10.85	
---at 10.80m reddish brown moderately to highly weathered weak		11.25	-3.95		S80/150mm*	S 11.10 11.25	
Cable Percussion boring complete at 11.25 m.							

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water
strikes. See legend sheet for key to symbols.

Form NH CP LOG

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK3

Header

Contract No.	F10895	Method	Cable Percussion	Coordinates	338602.4 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon	Ground Level	185393.9 N
Client	Welsh Office	Driller	A.M	Orientation	Vertical
Consultant	Ove Arup and Partners	Logged by	M.B	Date Started	17/10/1997
				Date Completed	17/10/1997

PROGRESS						DRILLING DETAILS			
Date	Time	Hole depth	Casing depth	Water depth	Remarks	Hardbore from depth	Hardbore to depth	Chiselling hours	Remarks
17/10/1997	1800	11.20	9.50	7.10		0.70 1.45 10.85	0.95 1.75 11.20	0.25 0.25 1.00	

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
150	11.20	150	9.50	17/10/1997	0000	10.80	7.10	15.0	fast	9.50	0.00

GENERAL NOTES		SPT DETAILS		
<ol style="list-style-type: none">Borehole complete at 11.20m.Backfilled with grout from 11.20m.		Depth	Type	Incremental blow count/penetration in mm
		1.00	C	N=43 (4,5,7,10,10,16)
		1.80	S	N=6 (2,2,1,2,2,1)
		4.00	S	N=2 (1,0,1,0,1,0)
		6.80	S	N=13 (1,1,3,3,4,3)
		10.20	S	N=81 (8,8,12,16,22,31)
		11.05	S	80/150mm*
* Seating blows only.				

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes, chiselling time in hours.

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK3

Sheet 1 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	338602.4 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185393.9 N
Client	Welsh Office	Driller	A.M	Ground Level	6.00m AOD
		Logged by	M.B	Orientation	Vertical
				Date Started	17/10/1997
Consultant	Ove Arup and Partners			Date Completed	17/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Install- ation
MADE GROUND: Reddish brown sandy gravelly clay with some gravel sized black clayey ash sand and occasional cobbles and boulders.		0.95	5.05	B 0.00 - 0.95			
MADE GROUND: Reddish brown very sandy clay with much angular to sub-angular siliceous clinker and occasional cobbles and boulders.		1.80	4.20	B 1.00 - 1.80	C43	C 1.00	1.45
Soft becoming very soft brown mottled grey slightly sandy CLAY locally very silty. (Estuarine Alluvium)				D 1.80 - 2.25	S6	S 1.80	2.25
---at 1.80m very silty							
				D 4.00	S2	S 4.00	4.45
				B 4.50 - 5.00			
				D 5.30			
				B 5.40 - 5.90	(4)		
				U 5.40 - 5.85			
---at 5.95m becoming grey mottled black slightly organic clay				D 5.95 - 6.45	(11)		
				U 6.00			
---at 6.00m very silty		6.45	-0.45	D 6.45			
				D 6.80	S13	S 6.80	7.25
Spongy dark brown slightly sandy clayey fibrous PEAT. (Peat)		7.40	-1.40				
Soft dark grey slightly sandy CLAY. (Estuarine Alluvium)				D 7.80			
				U 8.10 - 8.55	(11)		
				D 8.55			
---at 8.70m becoming grey mottled black slightly organic clay				D 8.70 - 9.20			
				U 8.75			
		9.25	-3.25	D 9.20			
Light grey mottled blue completely weathered slightly sandy MUDSTONE, very weak. (Mercia Mudstone Group)				U 9.40 - 9.80	(48)		
				D 9.80			

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK4

Header

Contract No.	F10895	Method	Cable Percussion	Coordinates	338949.9 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon	Ground Level	185441.6 N
Client	Welsh Office	Driller	LM	Orientation	5.50m AOD
Consultant	Ove Arup and Partners	Logged by	T.R	Date Started	16/10/1997
				Date Completed	17/10/1997

PROGRESS						DRILLING DETAILS			
Date	Time	Hole depth	Casing depth	Water depth	Remarks	Hardbore from depth	Hardbore to depth	Chiselling hours	Remarks
16/10/1997	1800	10.00	10.00	Dry		1.25	1.50	1.00	
17/10/1997	0800	10.00	10.00	8.20		10.80	11.05	1.00	
17/10/1997	1000	11.05	10.80	8.20					

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
150	11.05	150	10.80	16/10/1997	0000	1.10	1.00	15.0	slight	1.00	3.00

GENERAL NOTES					SPT DETAILS		
					Depth	Type	Incremental blow count/penetration in mm
					1.00	C	67/115mm (10,11,17,50)
					2.00	C	N=18 (6,7,7,8,2,1)
					3.50	S	N=3 (1,0,1,0,1,1)
					6.00	S	N=7 (1,2,2,1,3,1)
					9.40	S	N=30 (4,6,7,7,8,8)
					10.50	S	80/150mm (14,19,30,50)
					11.05	S	50/20mm*
					* Seating blows only.		

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes, chiselling time in hours.

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK4

Sheet 1 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	338949.9 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185441.6 N
Client	Welsh Office	Driller	IM	Ground Level	5.50m AOD
Consultant	Ove Arup and Partners	Logged by	T.R	Orientation	Vertical
				Date Started	16/10/1997
				Date Completed	17/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Installation
MADE GROUND: Dark brown black sandy fine to coarse angular to subangular ash, clinker and silicious gravel.				B 0.00 - 0.50			
				D 1.00	C67/115mm	C 1.00	
				W 1.00			1.27
				D 2.00	C18	C 2.00	
		2.30	3.20				2.45
MADE GROUND: Very soft to soft greyish blue silty slightly organic clay with occasional gravel size pockets of black fine to coarse ash sand and fine to coarse subangular to subrounded clinker and silicious gravel.				D 2.50	(6)		
				U 2.60 - 3.05			
				D 3.05			
		3.20	2.30	D 3.30			
				D 3.50	S3	S 3.50	
							3.95
Very soft light greyish blue slightly organic CLAY. (Estuarine Alluvium)				B 4.00 - 4.50			
				U 4.50 - 4.95	(8)		
		4.60	0.90				
Spongy dark brownish black fibrous PEAT. (Peat)				D 4.95			
---from 5.50m with occasional gravel to cobble size pockets of light grey very organic clay				D 5.50			
---from 6.00m becoming spongy to firm				D 6.00	S7	S 6.00	
				B 6.50 - 7.00			6.45
				D 7.40	(3)		
		7.40	-1.90	U 7.50 - 7.95			
Very soft to soft light greyish blue organic CLAY. (Estuarine Alluvium)				D 7.95			
---from 7.95 to 8.50m very organic				D 8.50			
				D 9.10			
		9.10	-3.60	D 9.40	S30	S 9.40	
							9.85
Blue greenish grey completely weathered silty MUDSTONE, very weak. (Mercia Mudstone)				B 10.00 - 10.50			
		10.00	-4.50				

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK4

Sheet 2 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	338949.9 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185441.6 N
Client	Welsh Office	Driller	I.M	Ground Level	5.50m AOD
Consultant	Ove Arup and Partners	Logged by	T.R	Orientation	Vertical
				Date Started	16/10/1997
				Date Completed	17/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Install- ation
Blue greenish grey completely weathered silty MUDSTONE, very weak. (Mercia Mudstone)		10.00	-4.50	B 10.00 - 10.50			
Red brown mottled grey green highly to completely weathered silty MUDSTONE very weak to weak. (Mercia Mudstone Group)		10.80	-5.30	D 10.50	S80/150mm	S 10.50	
		11.05	-5.55	D 11.05	S50/20mm*	S 11.05	
Brown highly weathered silty MUDSTONE, weak. (Mercia Mudstone Group)						11.07	
Cable Percussion boring complete at 11.05 m.							

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form NH CP LOG

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK5

Header

Contract No.	F10895	Method	Cable Percussion	Coordinates	339228.1 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon	Ground Level	185536.9 N
Client	Welsh Office	Driller	IM	Orientation	Vertical
Consultant	Ove Arup and Partners	Logged by	T.R	Date Started	17/10/1997
				Date Completed	17/10/1997

PROGRESS						DRILLING DETAILS			
Date	Time	Hole depth	Casing depth	Water depth	Remarks	Hardbore from depth	Hardbore to depth	Chiselling hours	Remarks
17/10/1997	1800	11.55	11.30	Dry		11.30	11.55	1.00	

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
150	11.55	150	11.30	17/10/1997	1600	9.20	5.40	15.0	fast	9.00	11.30

GENERAL NOTES						SPT DETAILS		
						Depth	Type	Incremental blow count/penetration in mm
						2.00	S	N=7 (2,1,3,1,2,1)
						4.00	S	1/450mm*
						11.50	S	50/50mm*

* Seating blows only.

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes, chiselling time in hours.

Form CP HEADER

Version 2.00

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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK5

Sheet 1 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	339228.1 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185536.9 N
Client	Welsh Office	Driller	I.M	Ground Level	5.20m AOD
Consultant	Ove Arup and Partners	Logged by	T.R	Orientation	Vertical
				Date Started	17/10/1997
				Date Completed	17/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Installation
TOPSOIL		0.30	4.90	B 0.30 - 1.00			
Firm greyish brown occasionally thinly laminated CLAY. (Estuarine Alluvium)				U 1.00 - 1.45	(10)		
				D 1.45			
				D 1.80			
---at 2.00m becoming soft				D 2.00	S7	S 2.00	2.45
		2.40	2.80	B 2.50 - 3.00			
Very soft grey very silty CLAY. (Estuarine Alluvium)				U 3.00 - 3.45	(4)		
				D 3.45			
				D 3.80			
				D 4.00 - 4.60	S1/450mm*	S 4.00	4.45
				B 4.60 - 5.00			
		5.30	-0.10	D 5.40			
Firm dark brownish black fibrous PEAT with gravel to cobble size pockets of grey organic clay. (Peat)				W 5.40 - 6.05	(7)		
				U 5.60			
				D 6.05			
				B 6.50 - 7.10			
		7.10	-1.90	D 7.20			
Very soft grey organic CLAY with gravel to cobble size pockets of dark brown slightly clayey peat. (Estuarine Alluvium)				U 7.40 - 7.85	(8)		
				D 7.85			
				D 8.50			
		8.90	-3.70	D 8.90			
Soft to firm reddish brown sandy very clayey SILT with gravel size pockets of sandy clay and occasional fine to medium angular to subrounded gravel. (Mercia Mudstone Group)				U 9.20 - 9.65	(20)		
				D 9.65			

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH CP LOG
Version	2.00
Revised	19/12/1996



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHK5

Sheet 2 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	339228.1 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185536.9 N
Client	Welsh Office	Driller	I.M	Ground Level	5.20m AOD
Consultant	Ove Arup and Partners	Logged by	T.R	Orientation	Vertical
				Date Started	17/10/1997
				Date Completed	17/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Installation
Soft to firm reddish brown sandy very clayey SILT with gravel size pockets of sandy clay and occasional fine to medium angular to subrounded gravel. (Mercia Mudstone Group)		10.30	-5.10	D 10.30 B 10.50 - 11.30 D 10.50			
Blue greenish grey completely weathered silty MUDSTONE, very weak. (Mercia Mudstone Group)		11.55	-6.35	D 11.50	S50/50mm*	S 11.50 11.55	
---from 11.30m becoming moderately to highly weathered							
Cable Percussion boring complete at 11.55 m.							

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH CP LOG
Version	2.00
Revised	19/12/1996



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHL1

Header

Contract No.	F10895	Method	Cable Percussion	Coordinates	339545.0 E
Project	M4 Relief Road Magor to Castleton Stage 2				185562.1 N
Client	Welsh Office	Drilling Rig	Pilcon	Ground Level	5.00m AOD
		Driller	A.M	Orientation	Vertical
		Logged by	M.B	Date Started	18/10/1997
Consultant	Ove Arup and Partners			Date Completed	18/10/1997

PROGRESS						DRILLING DETAILS			
Date	Time	Hole depth	Casing depth	Water depth	Remarks	Hardbore from depth	Hardbore to depth	Chiselling hours	Remarks
18/10/1997	1600	10.91	9.30	8.80		10.40	10.70	1.00	

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
150	10.91	150	9.30	18/10/1997	0000	1.68	1.68	0.00	slight	1.50	NR
				18/10/1997	0000	6.10	5.80	15.0	slow	6.00	NR
				18/10/1997	0000	10.40	8.80	15.0	fast	8.85	NR

GENERAL NOTES				SPT DETAILS		
<ol style="list-style-type: none"> Borehole complete at 10.93m. Backfilled with bentonite/grout from 10.93m. 				Depth	Type	Incremental blow count/penetration in mm
				1.95	S	0/450mm*
				4.00	S	0/450mm*
				6.20	S	N=7 (1,1,2,2,1,2)
				9.00	S	N=22 (3,4,4,6,5,7)
				10.70	S	50/75mm (17,34,50)

* Seating blows only.

NB All depths in metres, all diameters in millimetres, water strike rise time in minutes, chiselling time in hours.

Form CP HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHL1

Sheet 1 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	339545.0 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185562.1 N
Client	Welsh Office	Driller	A.M	Ground Level	5.00m AOD
Consultant	Ove Arup and Partners	Logged by	M.B	Orientation	Vertical
				Date Started	18/10/1997
				Date Completed	18/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Installation
Firm to stiff grey mottled brown slightly sandy CLAY with occasional rootlets. (Estuarine Alluvium)				B 0.50 - 0.90			
				D 0.95			
				U 1.05 - 1.50	(12)		
				D 1.50			
		1.68	3.32				
Very soft grey slightly sandy CLAY. (Estuarine Alluvium)				D 1.95	S0/450mm*	S 1.95	
--from 1.95 to 3.00m slightly organic							2.40
				B 2.60 - 3.00			
				D 3.05			
				D 3.10			
				D 3.55			
				D 4.00	S0/450mm*	S 4.00	
							4.45
				B 4.55 - 5.00			
				D 5.05 - 5.55	(5)		
				U 5.10			
		5.63	-0.63	D 5.55			
Firm black slightly sandy fibrous PEAT. (Peat)				B 5.70 - 6.10	NR		
				U 5.70 - 6.10			
		6.10	-1.10				
Soft dark grey mottled black slightly organic very sandy CLAY. (Estuarine Alluvium)				B 6.20 - 7.15	S7	S 6.20	
				D 6.20			6.65
		7.15	-2.15	D 7.20			
Very soft dark grey mottled black sandy CLAY with occasional thin beds of firm black fibrous peat. (Estuarine Alluvium)				U 7.30 - 7.75	(9)		
		7.75	-2.75	D 7.75			
Soft dark grey slightly organic sandy CLAY with occasional sub-angular gravel and cobbles. (Estuarine Alluvium)				U 8.10 - 8.55	NR		
				B 8.55 - 8.80			
		8.80	-3.80				
Grey mottled pale blue highly weathered sandy MUDSTONE, weak to moderately weak. (Mercia Mudstone Group)				D 9.00	S22	S 9.00	
							9.45
				B 9.45 - 10.00			

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH CP LOG
Version	2.00
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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHL1

Sheet 2 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	339545.0 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185562.1 N
Client	Welsh Office	Driller	A.M	Ground Level	5.00m AOD
		Logged by	M.B	Orientation	Vertical
				Date Started	18/10/1997
Consultant	Ove Arup and Partners			Date Completed	18/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Installation
Grey mottled pale blue highly weathered sandy MUDSTONE, weak to moderately weak. (Mercia Mudstone Group)		10.40	-5.40	W 10.40 W 10.40 D 10.70	S50/75mm	S 10.70	
Brown mottled grey highly weathered sandy MUDSTONE, moderately weak to moderately strong. (Mercia Mudstone Group)		10.93	-5.93			10.93	
Cable Percussion boring complete at 10.93 m.							

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH CP LOG
Version	2.00
Revised	19/12/1996



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHL2

Header

Contract No.	F10895	Method	Cable Percussion	Coordinates	339715.5 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon	Ground Level	185640.1 N
Client	Welsh Office	Driller	LM	Orientation	6.10m AOD
Consultant	Ove Arup and Partners	Logged by	T.R	Date Started	18/10/1997
				Date Completed	18/10/1997

PROGRESS						DRILLING DETAILS			
Date	Time	Hole depth	Casing depth	Water depth	Remarks	Hardbore from depth	Hardbore to depth	Chiselling hours	Remarks
18/10/1997	1800	11.00	9.20	8.60		10.50	10.80	1.00	

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
150	11.00	150	9.20	18/10/1997	1600	10.40	9.05	20.0	slow	9.20	NR

GENERAL NOTES		SPT DETAILS		
<ol style="list-style-type: none">Borehole complete at 11.00m.Borehole backfilled with bentonite/cement grout.		Depth	Type	Incremental blow count/penetration in mm
		2.10	S	N=3 (1,0,0,1,1,1)
		4.00	S	N=1 (1,0,1,0,0,0)
		7.20	S	N=3(1,0,1,1,1,0)
		9.20	S	N=25 (2,4,5,6,7,7)
		10.80	S	50/60mm (19,36,50)
* Seating blows only.				

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes, chiselling time in hours.

Form CP HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHL2

Sheet 1 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	339715.5 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185640.1 N
Client	Welsh Office	Driller	I.M	Ground Level	6.10m AOD
Consultant	Ove Arup and Partners	Logged by	T.R	Orientation	Vertical
				Date Started	18/10/1997
				Date Completed	18/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Installation
TOPSOIL		0.20	5.90				
Soft to firm becoming soft brownish grey occasionally thinly laminated CLAY with occasional rootlets. (Estuarine Alluvium)				B 0.50 - 1.00 D 0.50			
---at 1.00m becoming soft very silty				U 1.00 - 1.45	(10)		
				D 1.45			
				D 1.70			
		2.10	4.00	D 2.10	S3	S 2.10	
Very soft bluish grey very silty CLAY. (Estuarine Alluvium)				B 2.55 - 3.00		2.55	
				U 3.00 - 3.45	(2)		
				D 3.45			
				D 3.70			
				D 4.00	S1	S 4.00	
				B 4.50 - 5.00		4.45	
				U 5.00 - 5.45	(3)		
		5.60	0.50	D 5.45			
Firm dark brownish black slightly sandy fibrous PEAT. (Peat)				D 5.60			
---from 5.70m with gravel to cobble size pockets of brownish green slightly sandy clayey very organic silt				U 5.70 - 6.15	(20)		
				D 6.15 - 6.80			
				B 6.20			
		6.80	-0.70				
Very soft grey sandy CLAY. (Estuarine Alluvium)				D 7.00			
				D 7.20	S3	S 7.20	
				B 7.65 - 8.00		7.65	
				U 8.30 - 8.75	(7)		
---from 8.30m with occasional firm black slightly sandy fibrous peat				D 8.95			
				W 9.05			
				W 9.05			
				D 9.20	S25	S 9.20	
		9.20	-3.10			9.65	
Greenish blue completely weathered silty MUDSTONE, very weak. (Mercia Mudstone Group)				B 9.70 - 10.50			

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH CP LOG
Version	2.00
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Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHL2

Sheet 2 of 2

Contract No.	F10895	Method	Cable Percussion	Coordinates	339715.5 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		185640.1 N
Client	Welsh Office	Driller	I.M	Ground Level	6.10m AOD
		Logged by	T.R	Orientation	Vertical
				Date Started	18/10/1997
Consultant	Ove Arup and Partners			Date Completed	18/10/1997

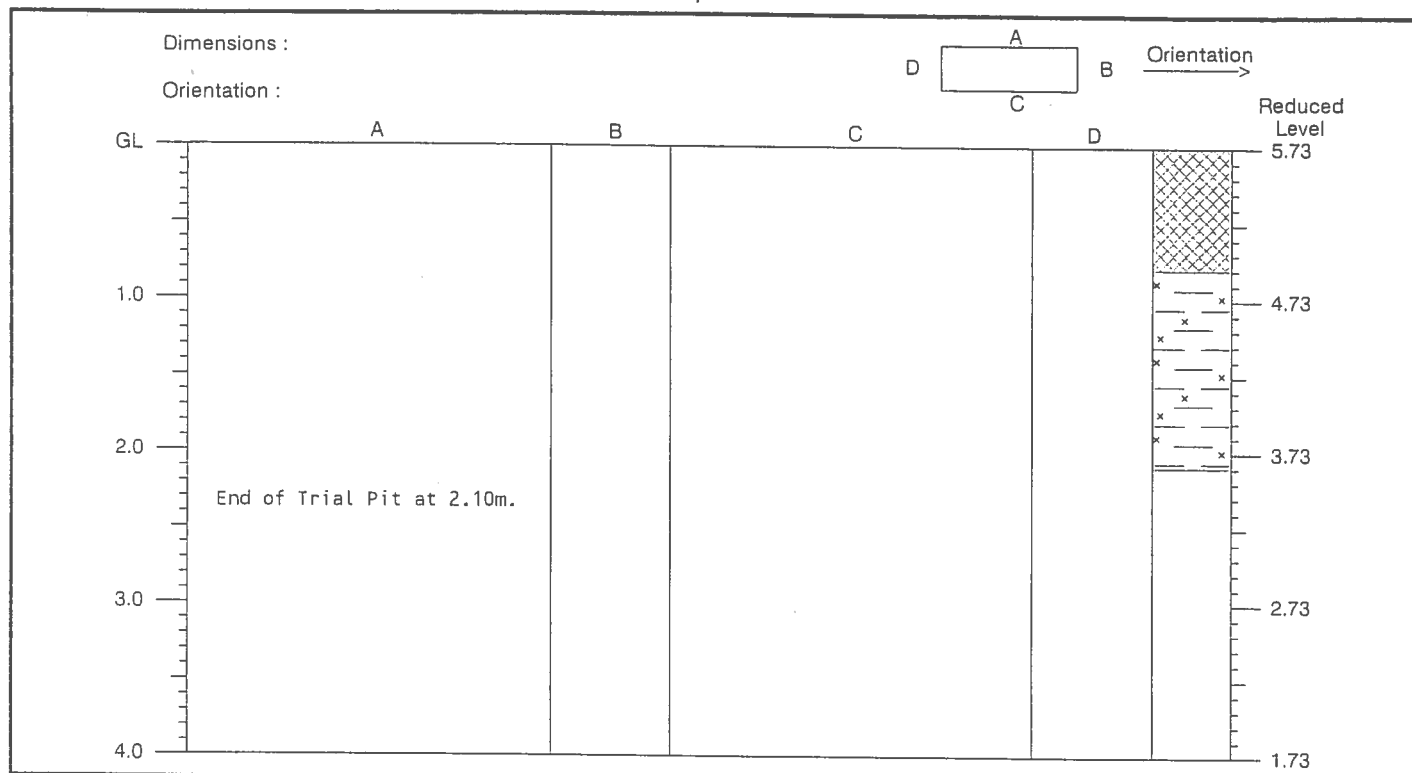
Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Install- ation
Greenish blue completely weathered silty MUDSTONE, very weak. (Mercia Mudstone Group)		10.50	-4.40	D 10.50			
Light greyish green moderately weathered slightly sandy SILTSTONE moderately weak. (Mercia Mudstone Group)		11.00	-4.90		S50/60mm	S 10.80 11.01	
Cable Percussion boring complete at 11.00 m.							

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water
strikes. See legend sheet for key to symbols.

Form NH CP LOG

Version 2.00

Revised 19/12/1996




Strata			Samples and Tests		
Depth (m)	No.	Description	Depth (m)	Type	Results
0.00-0.80	1	MADE GROUND: Loose brown sandy slightly silty sub-angular to sub-rounded fine to coarse gravel and cobbles of slag, ash and brick.	0.00-0.50	BTO	
0.80-2.10	2	Firm to stiff blue grey mottled green grey and brown very silty organic CLAY with much root material.from 1.90m becoming soft to firm.	0.80-1.10	BTO	
			1.10-1.90	BTO	
			2.10-0.80	W	
Date of Excavation 03/02/00 Equipment JCB 3CX Stability Stable			Groundwater No. Struck Behaviour 1 0.80 medium inflow		
			Ground Level 5.73 m OD Coordinates 338603.12 mE 185406.50 mN Logged by DC Checked by AF		

Remarks

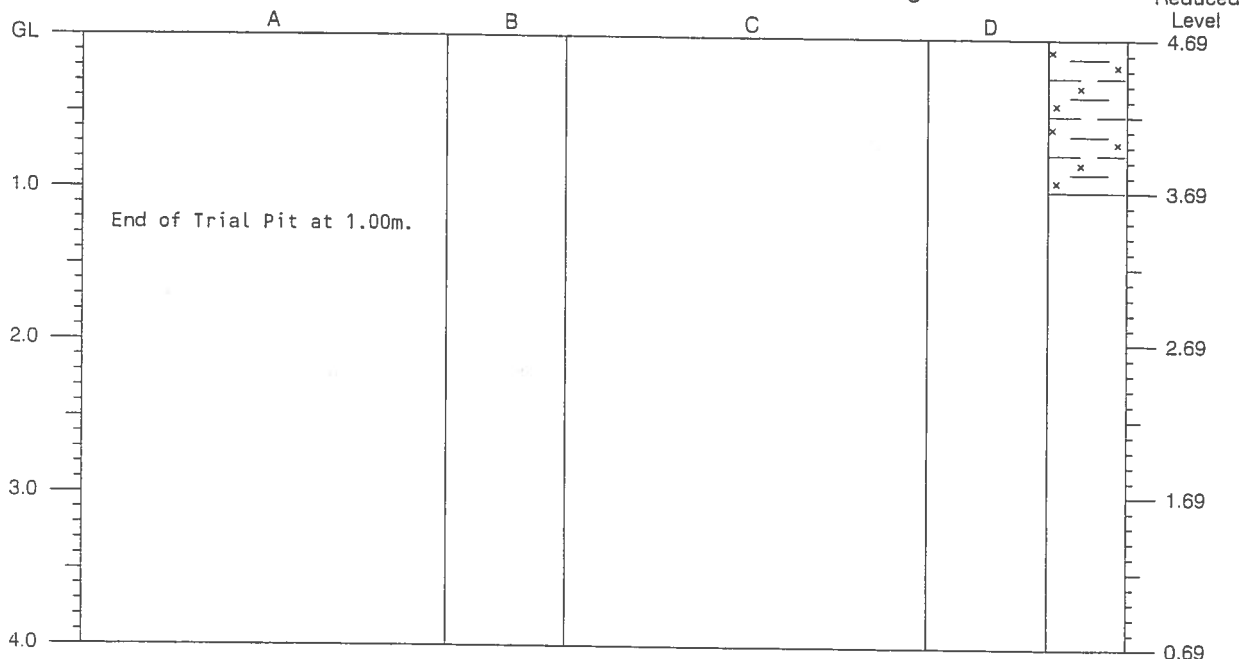
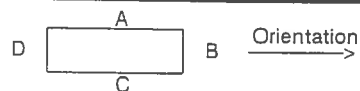
See key sheet and appendices for explanations.

Form 2/0

Trial Pit Record		Project M4 Relief Road - Stage 2. Preliminary Chemical Investigation Ove Arup & Partners	Contract	150006
 Exploration Associates			Trial Pit	CH51

Dimensions :

Orientation :



Strata

Samples and Tests

Depth (m)	No.	Description	Depth (m)	Type	Results
0.00-1.00	1	Soft to firm grey mottled brown and dark grey very silty organic CLAY with much root material.	0.50-1.00	BTO	
			0.00	W	

Date of Excavation 03/02/00

Equipment JCB 3CX

Stability Stable

Groundwater

No. Struck Behaviour

Surface groundwater present

Ground Level 4.69 m OD

Coordinates 338945.93 mE
185445.65 mNLogged by DC
Checked by AF

Remarks Pit stopped at 1.00m (surface water filled trial pit).

See key sheet
and appendices
for explanations.

Form 2/0

Trial Pit Record

Project

M4 Relief Road - Stage 2. Preliminary
Chemical Investigation
Ove Arup & Partners

Contract 150006

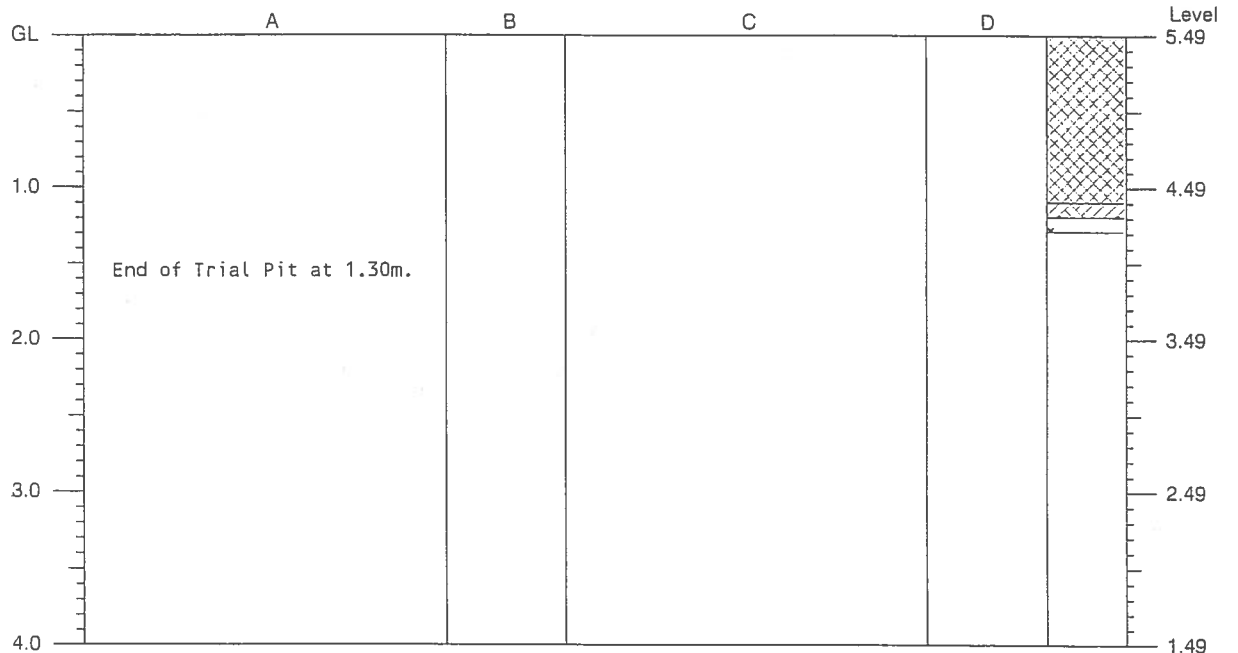
Trial Pit CH52



Exploration Associates

Dimensions : 1.80 x 1.00

Orientation : S



Strata

Samples and Tests

Depth (m)	No.	Description	Depth (m)	Type	Results
0.00-1.10	1	MADE GROUND: Moderately compact grey sandy slightly silty sub-angular to sub-rounded fine to coarse gravel and cobbles of slag,ash,siltstone and limestone	0.30 0.80	BTO W	
1.10-1.20	2	TOPSOIL			
1.20-1.30	3	Firm to stiff grey brown very silty CLAY with much root material	1.20	BTO	

Date of Excavation 16/02/00
Equipment JCB 3CX
Stability Stable

Groundwater
No. Struck Behaviour
1 0.80 Fast

Ground Level 5.49 m OD
Coordinates 338946.51 mE
185449.82 mN

Logged by DC
Checked by AF

Remarks

See key sheet
and appendices
for explanations.

Form 2/0

Trial Pit Record

Project

M4 Relief Road - Stage 2. Preliminary
Chemical Investigation
Ove Arup & Partners

Contract 150006

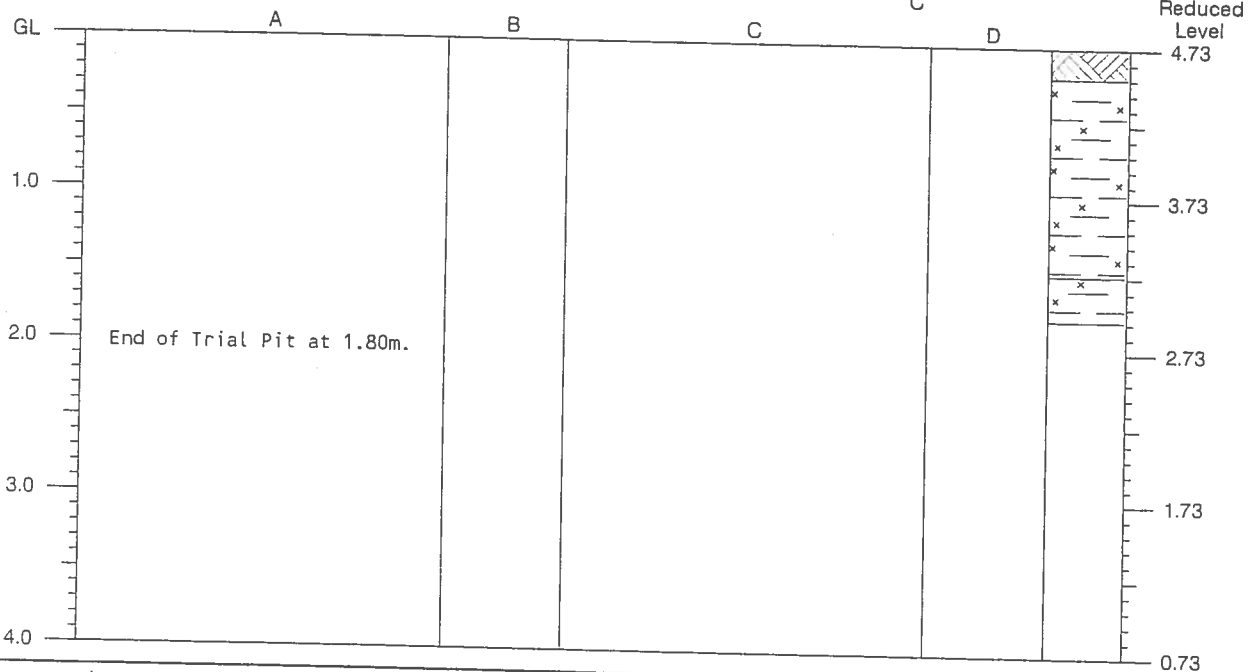
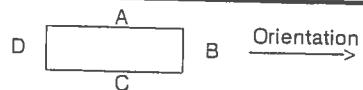
Trial Pit CH52A



Exploration Associates

Dimensions :

Orientation :



Strata

Samples and Tests

Depth (m)	No.	Description	Depth (m)	Type	Results
0.00-0.20	1	Brown very silty clayey TOPSOIL.			
0.20-1.50	2	Firm to stiff grey mottled brown very silty CLAY with much root material.	0.40-0.50	BTO	
1.50-1.80	3	Soft to firm blue grey mottled brown and dark grey very silty CLAY with much organic and root material.	1.50-1.80	W BTO	

Date of Excavation 03/02/00
Equipment JCB 3CX
Stability Stable

Groundwater
No. Struck Behaviour
1 1.50 medium flow

Ground Level 4.73 m OD
Coordinates 339261.29 mE
185485.43 mN

Logged by DC
Checked by AF

Remarks Water sample taken in rear adjacent to CH53 known as "size No. 9 rear sample".

See key sheet
and appendices
for explanations.

Form 2/0

Trial Pit Record

Project

Contract 150006

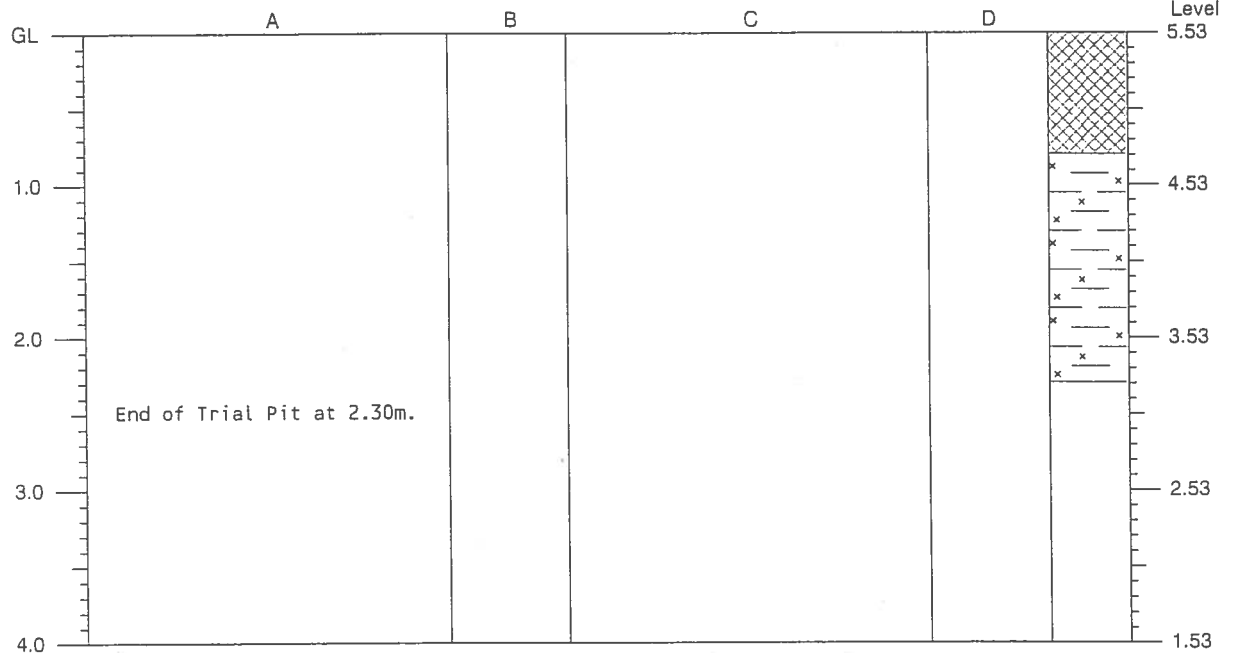
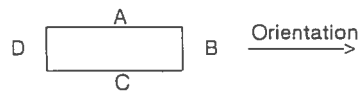
 Exploration Associates

M4 Relief Road - Stage 2. Preliminary
Chemical Investigation
Ove Arup & Partners

Trial Pit CH53

Dimensions : 1.90 x 1.10

Orientation : W



Strata

Samples and Tests

Depth (m)	No.	Description	Depth (m)	Type	Results
0.00-0.80	1	MADE GROUND: Loose grey sandy slightly silty sub-angular to sub-rounded fine to coarse gravel and cobbles of slag,ash,brick,siltstone and limestone	0.40	BTO	
0.80-2.30	2	Firm to stiff grey brown very silty CLAY with much root materialfrom 1.60m becoming soft to firm	1.10	BTO	

Date of Excavation 16/02/00
Equipment JCB 3CX
Stability Stable

Groundwater
No. Struck Behaviour
Not encountered during excavation

Ground Level 5.53 m OD
Coordinates 339262.37 mE
185482.23 mN

Logged by DC
Checked by AF

Remarks

See key sheet
and appendices
for explanations.

Form 2/0

Trial Pit Record

Project

M4 Relief Road - Stage 2. Preliminary
Chemical Investigation
Ove Arup & Partners

Contract

150006

Trial Pit

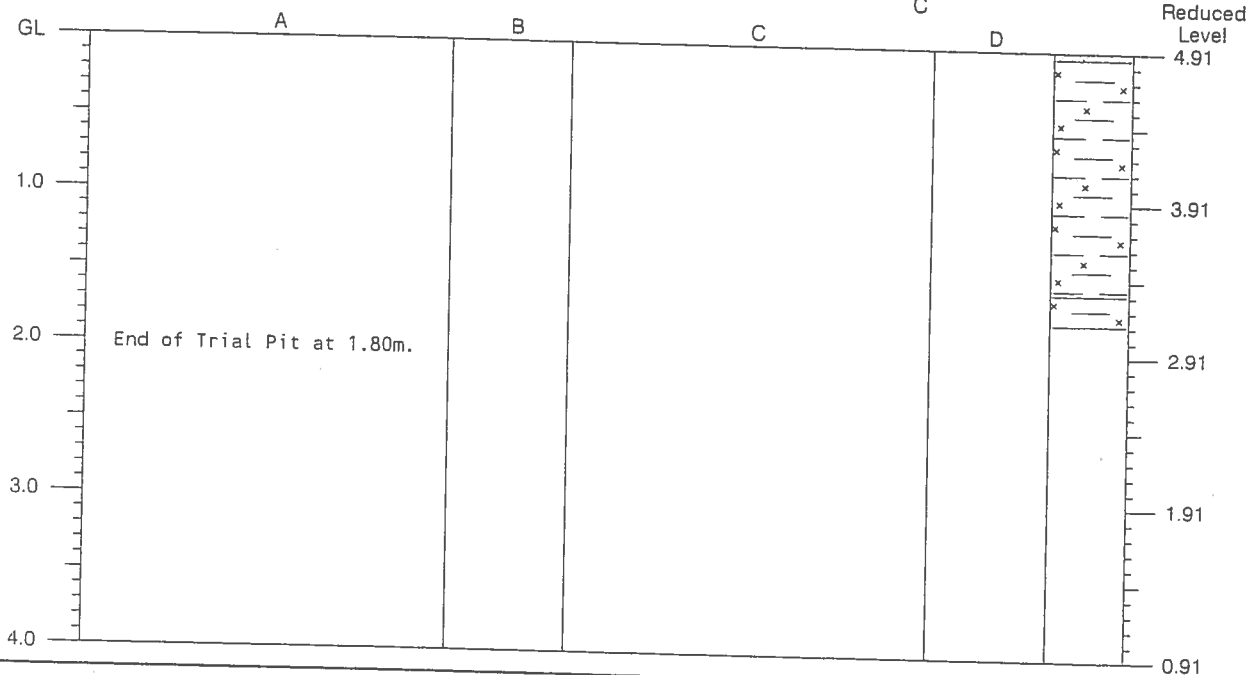
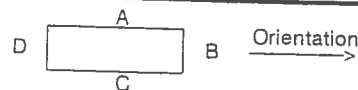
CH53A



Exploration Associates

Dimensions :

Orientation :



Strata

Depth (m)	No.	Description	Samples and Tests		
			Depth (m)	Type	Results
0.00-0.05	1	Brown very silty clayey TOPSOIL.			
0.05-1.60	2	Firm to stiff brown and grey very silty organic CLAY with much root material.from 1.10m becoming soft to firm.	0.05-0.50	BTO	
1.60-1.80	3	Soft to firm grey mottled brown and dark grey very silty organic CLAY with much root material.	1.60-1.80	BTO	

Date of Excavation 03/02/00

Equipment JCB 3CX

Stability Stable

Groundwater

No. Struck Behaviour
1 1.60 slight water seepage

Ground Level 4.91 m OD
Coordinates 339514.60 mE
185546.01 mN

Logged by DC
Checked by AF

Remarks

See key sheet
and appendices
for explanations.

Form 2/0

Trial Pit Record

Project

M4 Relief Road - Stage 2. Preliminary
Chemical Investigation
Ove Arup & Partners

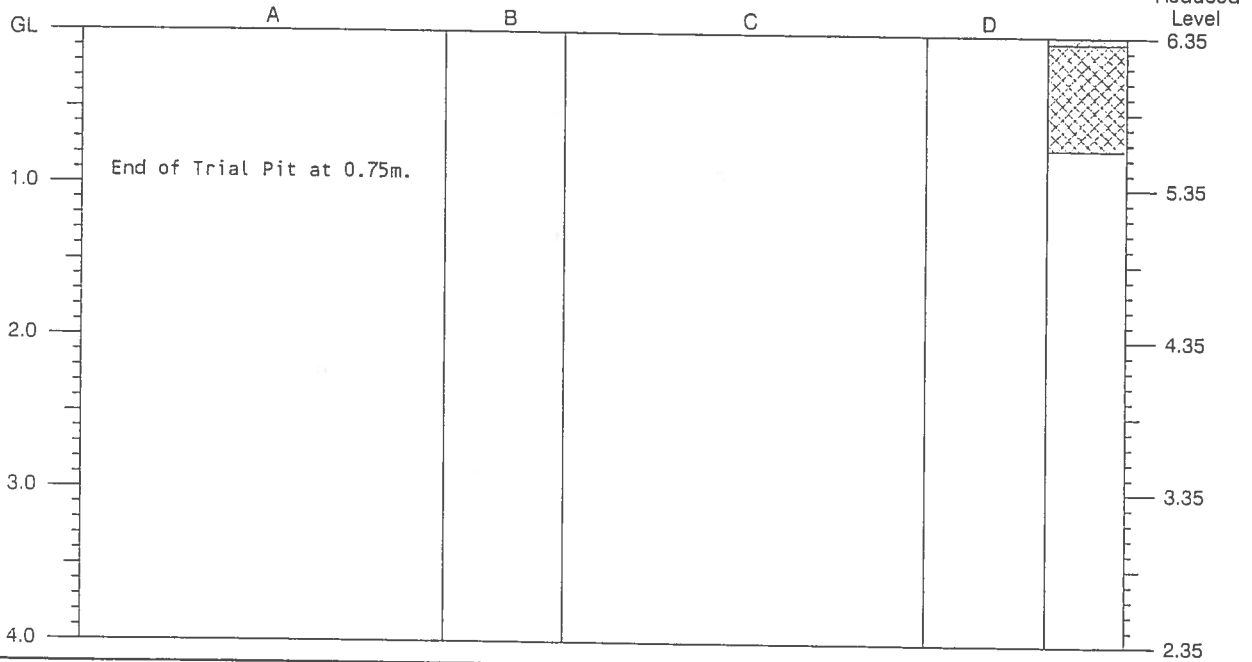
Contract 150006

Trial Pit CH54

 Exploration Associates

Dimensions : 0.50 x 0.50

Orientation : N/A



Strata

Samples and Tests

Depth (m)	No.	Description	Depth (m)	Type	Results
0.00-0.05	1	Brown clayey very silty TOPSOIL			
0.05-0.75	2	MADE GROUND: Firm to stiff grey brown very silty CLAY with occasional to some root material	0.40	BTO	

Date of Excavation 16/02/00
Equipment Hand Dug
Stability Stable

Groundwater
No. Struck Behaviour
Not encountered during excavation

Ground Level 6.35 m OD
Coordinates 339512.35 mE
185556.72 mN

Logged by DC
Checked by AF

Remarks CH54A Excavated by hand due to unsuitable access for the JCB 3CX

See key sheet
and appendices
for explanations.

Form 2/0

Trial Pit Record

Project

Contract 150006

 **Exploration Associates**

M4 Relief Road - Stage 2. Preliminary
Chemical Investigation
Ove Arup & Partners

Trial Pit CH54A

Borehole Log



Exploration Associates

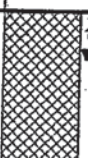
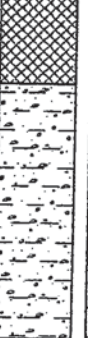


Drilled by NF
Logged by JN
Checked by

Equipment and Methods
Cable Percussion 150 mm diameter from 0.00m to 7.00m.

Ground Level + 4.59 m OD
National Grid E 338486.07
Coordinates N 186080.47

Samples and Tests

Strata

Depth	Type & No.	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)	Legend
1.00	ES1		30/01/2002		MADE GROUND: Black and grey sandy GRAVEL. Gravel is angular and subangular fine to coarse of slag and limestone.	(1.50)	
2.50	ES2				Soft to firm grey slightly gravelly CLAY. Gravel is angular and fine. Driller reports sandy clay.	1.50 +3.09 (1.70)	
					Very soft PEAT (DRILLERS DESCRIPTION).	3.20 +1.39 (3.80pen)	
7.00		KRH	30/01/2002 7.00		EXPLORATORY HOLE ENDS AT 7.00 m.	7.00 -2.41	

Groundwater
No. Struck Behaviour
1 0.30m Seepage

Remarks
Chiselling : 1.10m to 1.50m 90minutes
Hole backfill : 0.00m to 0.30m Concrete (c), 0.30m to 1.00m Bentonite (b). Surface protection : Stop Cock Cover
Standpipe installed, 50mm diameter, response zone from 1.00m to 7.00m.

Notes : For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.
Scale 1 : 50

Project ENVIRONMENTAL INVESTIGATION AT LLANWERN
Project no. STEELWORKS
Carried out for 152002
Corus plc

Borehole
RBBH1
Sheet 1 of 1

Borehole Log



Exploration Associates

Drilled by IH
Logged by LM
Checked by

Equipment and Methods
Cable Percussion 150 mm diameter from 0.00m to 7.00m.

Ground Level + 5.22 m OD
National Grid E 338597.19
Coordinates N 185909.39

Samples and Tests

Strata

Depth	Type & No.	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)	Legend
0.90	ES1		29/01/2002		MADE GROUND : Dark grey SAND AND GRAVEL. Gravel is angular to subrounded fine and medium of slag.	(1.50)	c
2.50	ES2				Soft to firm grey mottled brown sandy CLAY.	1.50 +3.72 (2.70)	b
4.50	ES3				Black spongy pseudofibrous PEAT with frequent soft light grey SILT pockets.	4.20 +1.02 (1.90)	
6.80 7.00	ES4	xRH	29/01/2002 0.00		Soft dark grey SILT.	6.10 -0.88 (0.90pen)	
					EXPLORATORY HOLE ENDS AT 7.00 m.	7.00 -1.78	

Groundwater
Not encountered during drilling.

Remarks
Hole backfill : 0.00m to 0.50m Concrete (c), 0.50m to 2.00m Bentonite (b). Surface protection : Stop Cock Cover
Standpipe installed, 50mm diameter, response zone from 2.00m to 7.00m.

Notes : For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.
Scale 1 : 50

Project ENVIRONMENTAL INVESTIGATION AT LLANWERN
Project no. STEELWORKS
Carried out for 152002
Corus plc

Borehole
RBBH2
Sheet 1 of 1

Borehole Log



Exploration Associates

Drilled by GW Logged by LM Checked by		Equipment and Methods Inspection Pit from 0.00m to 1.20m. Cable Percussion 150 mm diameter from 1.20m to 7.00m.				Ground Level + 4.64 m OD National Grid E 338770.81 Coordinates N 185836.90	
Samples and Tests				Strata			
Depth	Type & No.	Records	Date Casing Time Water	Description	Depth, Level (Thickness)	Legend	
0.50	ES1		29/01/2002	MADE GROUND : Dark grey SAND AND GRAVEL. Gravel is angular to rounded fine to coarse of Slag.	(0.70)		
1.00	ES2				0.70 +3.94		
				Soft to firm grey mottled orange brown slightly sandy CLAY.	(4.70)		
5.50	ES3		29/01/2002 7.00	Soft light grey mottled dark grey and brown SILT with black spongy pseudofibrous PEAT pockets.	5.40 -0.76 (1.60pen)		
				EXPLORATORY HOLE ENDS AT 7.00 m.	7.00 -2.36		
Groundwater No. Struck Behaviour 1 0.70m Rising to 0.70m after 20 mins. Sealed 1.00. Slow inflow				Remarks Hole backfill : 0.00m to 0.30m Concrete (c), 0.30m to 0.90m Bentonite (b). Surface protection : Stop Cock Cover Standpipe installed, 50mm diameter, response zone from 0.90m to 7.00m.			
Notes : For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column. Scale 1 : 50				Project ENVIRONMENTAL INVESTIGATION AT LLANWERN Project no. 152002 Carried out for Corus plc		Borehole RBBH3 Sheet 1 of 1	

Borehole Log



Exploration Associates

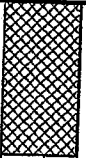
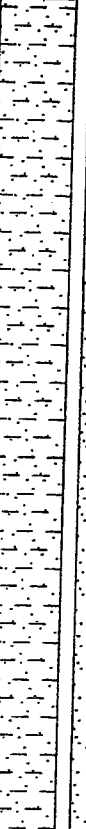



Drilled by GW
Logged by JN
Checked by

Equipment and Methods
Cable Percussion 150 mm diameter from 0.00m to 7.00m.

Ground Level + 5.05 m OD
National Grid E 338433.74
Coordinates N 185791.62

Samples and Tests

Strata

Depth	Type & No.	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)	Legend
0.50	ES1		30/01/2002		MADE GROUND: Grey brown very sandy GRAVEL. Gravel is angular and subangular fine and medium of slag.	(1.00)	
1.20	ES2					1.00 +4.05	
					Firm grey mottled orange brown slightly sandy CLAY.	(5.60)	
6.70	ES3		30/01/2002 0.00	dry	PEAT (DRILLERS DESCRIPTION).	6.60 -1.55 (0.40pen)	
					EXPLORATORY HOLE ENDS AT 7.00 m.	7.00 -1.95	

Groundwater
Not encountered during drilling.

Remarks

Chiselling : 0.00m to 1.00m 180minutes
Hole backfill : 0.00m to 0.30m Concrete (c), 0.30m to 0.90m Bentonite (b). Surface protection : Stop Cock Cover
Standpipe installed, 50mm diameter, response zone from 0.90m to 7.00m.

Notes : For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.
Scale 1 : 50

Project
Project no.
Carried out for

ENVIRONMENTAL INVESTIGATION AT LLANWERN
STEELWORKS
152002
Corus plc

Borehole
RBBH4
Sheet 1 of 1








Borehole Log



Exploration Associates

Drilled by GW Logged by LM Checked by		Equipment and Methods Inspection Pit from 0.00m to 1.00m. Cable Percussion 150 mm diameter from 1.00m to 7.00m.				Ground Level National Grid Coordinates	
Samples and Tests					Strata		
Depth	Type & No.	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)	Legend
0.50	ES1		29/01/2002		MADE GROUND: Dark grey SAND AND GRAVEL. Gravel is subangular and subrounded fine and medium of slag.	(1.50)	
1.70	ES2				Soft to firm grey mottled orange brown slightly sandy CLAY with rare pockets of decaying plant matter.	1.50	
6.80 7.00	ES3	KRH	29/01/2002 7.00		Soft dark grey SILT with frequent brown spongy pseudofibrous PEAT pockets.	6.70 (0.30pen)	
					EXPLORATORY HOLE ENDS AT 7.00 m.	7.00	
Groundwater No. Struck Behaviour 1 1.50m Rising to 1.30m after 20 mins. Sealed 2.00. Slow inflow					Remarks Chiselling: 1.00m to 1.50m 90minutes Hole backfill: 0.00m to 0.30m Concrete (c), 0.30m to 0.90m Bentonite (b). Surface protection: Stop Cock Cover Standpipe installed, 50mm diameter, response zone from 0.90m to 7.00m.		
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column. Scale 1:50					Project ENVIRONMENTAL INVESTIGATION AT LLANWERN Project no. 152002 Carried out for Corus plc		Borehole RBBH5 Sheet 1 of 1


<div>RPS</div>		BOREHOLE LOG						Borehole No. SBHK01 CP				
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 06/12/2007 - 07/12/2007			Sheet 1 of 2					
Project No: JER6591-Temp		Easting: 338433		Drilling Method:			Hole Type: CP					
Location:		Northing: 185614		Dando		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client:		Ground Level (mAOD): 5.26		Logged By: DH		200	12.50	1:50				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
		0.50 - 1.00	B1	N=8 (1,1/1,2,2,3)	1.50	(1.50)	3.76		Firm grey mottled orangish brown slightly gravelly CLAY with occasional rootlets. Gravekl is angular fine of mudstone. (Estuarine Alluvium) (TFD)	1		
		1.00	W1									
		1.00	W001									
		1.50	D3	N=4 (1,0/1,1,1,1)	4.70	(3.20)	0.56		Very soft to soft grey silty CLAY (Organic odour). (Estuarine Alluvium) (TFD)	2		
		1.50	SPT(S)									
		2.00 - 2.50	D4									
		3.00	ES006	Blows=6	4.70	(3.20)	0.56		Very soft to soft grey silty CLAY (Organic odour). (Estuarine Alluvium) (TFD)	3		
		3.00 - 3.45	U6									
		3.00	U006									
		3.50	D7	N=7 (1,1/2,1,2,2)	6.80	(2.10)	-1.54		Very soft to soft grey silty CLAY (Organic odour). (Estuarine Alluvium) (TFD)	4		
3.50 - 3.95	D8											
3.50	SPT(S)											
4.70	D9	Blows=10	6.80	(2.10)	-1.54		Very soft to soft grey silty CLAY (Organic odour). (Estuarine Alluvium) (TFD)	5				
5.00 - 5.45	U10											
5.50 - 5.95	D12											
5.50	D11	N=2 (1,0/0,1,0,1)	9.00	(1.00)	-3.74		Very soft to soft grey silty CLAY (Organic odour). (Estuarine Alluvium) (TFD)	6				
5.50	SPT(S)											
6.00 - 6.50	B13											
6.80	D14	Blows=5	9.00	(1.00)	-3.74		Very soft to soft grey silty CLAY (Organic odour). (Estuarine Alluvium) (TFD)	7				
6.80	W1											
6.80	W001											
7.00 - 7.45	U15	N=2 (1,0/0,1,0,1)	9.00	(1.00)	-3.74		Very soft to soft grey silty CLAY (Organic odour). (Estuarine Alluvium) (TFD)	8				
7.50	D16											
7.50 - 7.95	D17											
7.50	SPT(S)	Blows=12	9.00	(1.00)	-3.74		Very soft to soft grey silty CLAY (Organic odour). (Estuarine Alluvium) (TFD)	9				
8.00 - 8.50	B18											
9.00 - 9.45	U19											
9.50	D20	Continued on next sheet	10.00	-4.74				10				
9.50	D021											
9.50 - 9.95	D21											
10.00 - 10.50	B22											
Remarks 1. Cable Percussive boring terminated at 13.50m. 2. 50mm standpipe installed, slotted from 4.80m to 6.80m.						Groundwater			Chiselling			<div>AGS</div>
						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)	Base Depth (m)	
									01:00	12.90	13.20	



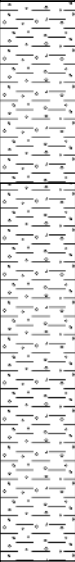

		<h1>BOREHOLE LOG</h1>						Borehole No. SBHK01 CP		
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 06/12/2007 - 07/12/2007				Sheet 2 of 2		
Project No: JER6591-Temp		Easting: 338433		Drilling Method:				Hole Type: CP		
Location:		Northing: 185614		Dando		Casing Diameter (mm)	Casing Depth (m)	Scale:		
Client:		Ground Level (mAOD): 5.26		Logged By: DH		200	12.50	1:50		
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results						
		10.50 10.50 - 10.90	U023 U23	Blows=100	10.40	(0.40)	-5.14		Soft to firm greenish grey slightly sandy gravelly CLAY with occasional cobbles. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and limestone. Cobbles are subangular of limestone. (Estuarine Alluvium ?) (TFD)	
		11.00 11.00 - 11.40 11.00	D24 D25 SPT(S)	50 (6,8/50 for 200mm)					Very stiff very high strength reddish brown slightly gravelly CLAY. Gravel is angular fine to medium (Weathered Mudstone). (Mercia Mudstone Group) (MMG)	11
		11.50 - 12.00	B26			(3.10)				12
		12.50 - 12.90 12.50	D27 SPT(S)	50 (9,13/50 for 190mm)						13
		13.20 - 13.50 13.20	D28 SPT(S)	50 (8,15/50 for 170mm)						14
									End of Borehole at 13.50m	15
										16
										17
										18
										19
										20
Remarks				Groundwater			Chiselling			
1. Cable Percussive boring terminated at 13.50m. 2. 50mm standpipe installed, slotted from 4.80m to 6.80m.				Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)	Base Depth (m)	
							01:00	12.90	13.20	

Project Name:	M4 CaN (Temp)	Co-ordinates:	Date(s): 11/12/2007 - 12/12/2007			Hole Type:
Project No:	JER6591-Temp	Easting: 338651	Drilling Method:			CP
Location:		Northing: 185597	Dando	Casing Diameter (mm) 200	Casing Depth (m) 12.00	Scale:
Client:		Ground Level (mAOD): 5.53	Logged By: DH			1:50

Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale	
		Depth (m)	Type	Results							
<div><div></div><div><div></div><div></div></div></div>					0.00		5.53		MADE GROUND: Slag, stone. (Driller's description) (MG)	1	
		0.30	ES1			(0.50)					
		0.50 - 1.00	B2			0.50		5.03		MADE GROUND: Black and grey sandy gravel. Sand sized fragments are coarse. Gravel sized fragments are angular to subangular fine to coarse of ash and clinker. (MG)	2
		1.00	ES003								
		1.00 - 1.45	D4								
		1.00	L003								
		1.00	ES3								
		1.00 - 2.00	B5			(2.00)					
		1.00	SPT(S)	N=20 (3,3/3,4,6,7)							
		1.33	W1								
		1.33	W001								
		2.00	ES6								
		2.00 - 2.45	D7								
		2.00	SPT(S)	N=21 (2,3/4,5,6,6)							
		2.50 - 2.95	U9	Blows=9		2.50		3.03		Very soft extremely low strength grey silty CLAY. (Estuarine Alluvium) (TFD)	3
		2.50	D8								
		3.00	ES011								
		3.00 - 3.45	D12								
		3.00	D10								
		3.00	ES11								
		3.00	L011								
		3.00	SPT(S)	N=3 (1,0/1,1,0,1)							
		3.50 - 4.00	B13								
		3.50	B013								
		4.00	ES14								
		4.50	U015								
		4.50	ES015								
4.50 - 4.95	U15	Blows=6		(4.50)							
5.00 - 5.45	D18										
5.00 - 5.45	D16										
5.00	ES17										
5.00	SPT(S)	N=3 (1,0/1,0,1,1)									
6.00	D19										
6.50 - 6.95	U20	Blows=7						Spongy black pseudofibrous PEAT. (Peat) (PEAT)	7		
7.00 - 7.45	D22			7.00		-1.47					
7.00	SPT(S)	N=6 (1,1/1,2,1,2)									
7.50 - 8.00	B23				(0.90)			Very soft grey slightly gravelly silty CLAY. Gravel is subangular to well rounded of mudstone, sandstone and siltstone. (Estuarine Alluvium) (TFD)	8		
				7.90		-2.37					
8.50 - 8.95	U24							Stiff blueish grey mottled greyish brown slightly gravelly CLAY with closely to very closely spaced fine to coarse gravel sized lenses of light brown fibrous peat. Gravel is angular to subangular fine to medium of mudstone. (Estuarine Alluvium) (TFD)	9		
8.50	U024				(1.20)						
9.00	D25										
9.00 - 9.45	D26			9.10		-3.57					
9.00	SPT(S)	N=14 (1,2/3,3,4,4)									
10.00 - 10.45	U27	Blows=21							Continued on next sheet	10	

Remarks	Groundwater			Chiselling		
	Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)	Base Depth (m)
	1.00	0.00	0.80	01:00	13.00	13.40
1. Cable Percussive boring complete at 13.70m. 2. Insitu permeability testing carried out from 12.00m to 13.70m. 3. 50mm standpipe installed, slotted from 7.20m to 11.20m.						



		<h1>BOREHOLE LOG</h1>						Borehole No. SBHK02 CP				
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 11/12/2007 - 12/12/2007				Sheet 2 of 2				
Project No: JER6591-Temp		Easting: 338651		Drilling Method:				Hole Type: CP				
Location:		Northing: 185597		Dando		Casing Diameter (mm) 200	Casing Depth (m) 12.00	Scale: 1:50				
Client:		Ground Level (mAOD): 5.53		Logged By: DH								
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
		10.50	D28			(2.10)			Very stiff reddish brown slightly gravelly CLAY. Gravel is subangular fine to coarse of mudstone siltstone and sandstone (Weathered Mudstone). (Mercia Mudstone Group) (MMG)	11		
		11.20	W001		11.20	-5.67				12		
		11.20	W1									
		11.30	D29									
		11.50 - 11.75	B30									
		11.80 - 12.20	D31									
		11.80	SPT(S)	50 (10,15/50 for 155mm)								
		12.50	D32			(2.50)						
		12.80 - 13.10	D33									
		12.80	SPT(S)	50 (26 for 135mm/50 for 115mm)						13		
		13.20	D34									
	13.40 - 13.70	D35										
	13.40	SPT(S)	50 (25 for 125mm/50 for 85mm)						14			
								End of Borehole at 13.70m	15			
									16			
									17			
									18			
									19			
									20			
Remarks						Groundwater		Chiselling				
1. Cable Percussive boring complete at 13.70m. 2. Insitu permeability testing carried out from 12.00m to 13.70m. 3. 50mm standpipe installed, slotted from 7.20m to 11.20m.						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)		Top Depth (m)	Base Depth (m)
						1.00	0.00	0.80	01:00		13.00	13.40


<div>RPS</div>		BOREHOLE LOG						Borehole No. SBHK03 CP			
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 18/12/2007 - 20/12/2007				Sheet 1 of 2			
Project No: JER6591-Temp		Easting: 338868		Drilling Method:				Hole Type: CP			
Location:		Northing: 185648		Dando		Casing Diameter (mm)	Casing Depth (m)	Scale:			
Client:		Ground Level (mAOD): 5.83		Logged By: PH		200	11.00	1:50			
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale	
		Depth (m)	Type	Results							
		0.30	ES1		0.00	(1.20)	5.83		MADE GROUND: Very compact slag. (Driller's description) (MG)		
		0.89	W1								
		0.89	W001							1	
		1.00	ES2		1.20		4.63		Firm grey mottled greyish brown slightly sandy slightly gravelly CLAY. Gravel is angular fine of mudstone. (Estuarine Alluvium) (TFD)		
		1.00	L002			(0.70)					
		1.00	ES002								
		1.20	D3								
		1.20 - 1.65	U4	Blows=14					---from 1.46m soft		
		1.70	D005		1.90		3.93		Soft grey silty CLAY with rare pieces of organic material. (Estuarine Alluvium) (TFD)	2	
		1.70	D5								
		1.70	D6								
		1.70	SPT(S)	N=8 (2,2/3,2,2,1)							
		2.00	ES007								
		2.00	ES7								
		2.50	D008								
		2.50	D8								
		3.00 - 3.45	U10	Blows=5						3	
		3.00	ES9			(2.60)					
		3.50	D12								
		3.50	D11								
		3.50	D011								
		3.50	SPT(S)	N=2 (1,0/1,0,1,0)						4	
		4.00	ES13								
					4.50	(0.40)	1.33		Interbedded extremely closely spaced very thin laminations of soft grey silty CLAY and plastic black amorphous PEAT. (Estuarine Alluvium with peat bands) (TFDP)		
		5.00 - 5.45	U16		4.90		0.93		Spongy black pseudofibrous PEAT. (Peat) (PEAT)	5	
		5.00	U016								
		5.00	ES015			(1.00)					
		5.00	ES15								
		5.50	D017								
		5.50	D18								
		5.50	D17		5.90		-0.07		Extremely low strength grey SILT. (Estuarine Alluvium) (TFD)	6	
		5.50	SPT(S)	N=10 (1,2/2,3,3,2)							
		5.90	W001								
		5.90	W1								
		6.00	D19								
		7.00 - 7.45	U21	Blows=3						7	
		7.00	U021			(2.60)					
		7.00	ES021								
		7.00	D020								
		7.00	D20						---from 7.50m coarse gravel sized pockets of fine sand		
		7.50	D022								
		7.50	D23								
		7.50	D22							8	
		7.50	SPT(S)	N=1 (1,0/0,1,0,0)							
		8.50	D24		8.50		-2.67		Soft grey silty CLAY with medium to coarse gravel sized lenses of peat. (Estuarine Aluvium) (TFD)	9	
		8.50	D024			(1.00)					
		9.00 - 9.45	U25	Blows=11							
		9.50	D026		9.50		-3.67		Firm grey slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is subangular fine to coarse of sandstone. (Estuarine Alluvium)	10	
		9.50	D26			(0.50)					
		9.50	D27								
		9.50	SPT(S)	N=12 (2,2/3,3,3,3)							
		10.00	D028		10.00		-4.17				
		10.00	D28						Continued on next sheet		
Remarks 1. Cable Percussive boring from GL to 11.50m. 2. 50mm standpipe installed, slotted from 4.90m to 5.90m.						Groundwater			Chiselling		
						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)	Base Depth (m)
									02:30 01:00 01:00	0.00 1.00 11.20	1.00 1.20 11.50
						<div>AGS</div>					




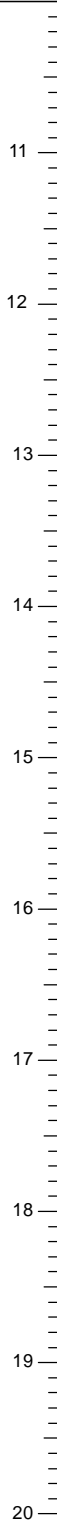
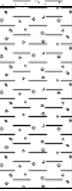



Project Name:	M4 CaN (Temp)	Co-ordinates:	Date(s): 08/12/2007 - 10/12/2007			Hole Type:
Project No:	JER6591-Temp	Easting: 339197	Drilling Method:			CP
Location:		Northing: 185656	Dando	Casing Diameter (mm) 200	Casing Depth (m) 11.00	Scale:
Client:		Ground Level (mAOD): 5.55	Logged By: DH			1:50




Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale			
		Depth (m)	Type	Results									
					0.00		5.55		Firm to stiff grey mottled orangish brown CLAY. (Estuarine Alluvium) (TFD)	1 2 3 4 5 6 7 8 9 10			
		0.30	ES1	Blows=12									
		0.30	L001										
		0.30	ES001										
		1.00	U4	Blows=12									
		1.00	ES2										
		1.00	ES002										
		1.00	D3	N=12 (1,2/3,3,3,3)									
		1.50	D6										
		1.50	D5										
		1.50	SPT(S)										
		2.00	D7										
		2.00	ES8										
							(5.00)						
		3.00	D9	Blows=11									
		3.00	ES10										
		3.00	U11										
		3.50	D12	N=7 (1,2/1,2,2,2)									
		3.50	SPT(S)										
		4.00	D14										
		4.00	ES15										
		5.00	ES017	Blows=12		5.00	0.55						
		5.00	D16										
		5.00	ES17										
		5.00 - 5.45	U18			(0.90)							
		5.50	D20										
		5.50	D19	N=12 (2,2/2,3,3,4)									
		5.50	SPT(S)										
		6.00	D21		5.90	-0.35							
					(1.40)								
7.00 - 7.45	U23	Blows=14											
7.00	D22												
				7.30	-1.75								
7.50	D25	N=3 (1,0/1,0,1,1)											
7.50	D24												
7.50	SPT(S)												
8.00	D26			(2.20)									
8.87	W1	Blows=11											
8.87	W001												
9.00 - 9.45	U28												
9.00	ES028												
9.00	D27												
9.00	U028	N=26 (3,3/6,6,7,7)		9.50	-3.95								
9.50	D30												
9.50	D29												
9.50	SPT(S)												
9.50													
								Continued on next sheet					

Remarks 1. Cable Percussive boring complete at 12.20m. 2. 50mm standpipe installed, slotted from 10.20m to 12.20m.	Groundwater			Chiselling		
	Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)	Base Depth (m)
				01:00	12.00	12.20





		<h1>BOREHOLE LOG</h1>						Borehole No. SBHK04 CP				
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 08/12/2007 - 10/12/2007				Sheet 2 of 2				
Project No: JER6591-Temp		Easting: 339197		Drilling Method:				Hole Type: CP				
Location:		Northing: 185656		Dando		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client:		Ground Level (mAOD): 5.55		Logged By: DH		200	11.00	1:50				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
									---from 10.00m becomes slightly gravelly. Gravel is subangular to subrounded fine to medium of sandstone and mudstone			
	11.00	U033			11.00	(1.50)	-5.45					
	11.00	D32										
	11.00 - 11.45	U33	Blows=96						11			
	11.50	D34										
	11.50	D35				(1.20)						
	11.50	SPT(S)	50 (7,11/50 for 160mm)						Very stiff medium strength reddish brown slightly gravelly CLAY. Gravel is angular fine to medium of mudstone (Weathered Mudstone). (Mercia Mudstone Group) (MMG)			
								---from 12.00m becomes very stiff	12			
								End of Borehole at 12.20m				
										13		
										14		
										15		
										16		
										17		
										18		
										19		
										20		
Remarks						Groundwater			Chiselling			
1. Cable Percussive boring complete at 12.20m. 2. 50mm standpipe installed, slotted from 10.20m to 12.20m.						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)		Base Depth (m)
									01:00	12.00		12.20



<div>RPS</div>		BOREHOLE LOG						Borehole No. SBHL01 CP		
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 11/12/2007 - 12/12/2007			Sheet 1 of 2			
Project No: JER6591-Temp		Easting: 339456		Drilling Method:			Hole Type: CP			
Location:		Northing: 185700		Dando		Casing Diameter (mm)	Casing Depth (m)	Scale:		
Client:		Ground Level (mAOD): 4.93		Logged By: DH		200	10.50	1:50		
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results						
					0.00		4.93		Firm grey mottled orangish brown silty CLAY with occasional rootlets. (Estuarine Alluvium) (TFD)	
		1.00 - 1.45	U2 D1 U002 ES002 D4 D3 SPT(S)	Blows=16 N=12 (2,2/2,3,3,4)		(2.00)				1
					2.00		2.93		Very soft grey locally mottled orangish brown slightly gravelly CLAY. Gravel is angular fine of mudstone. (Estuarine Alluvium) (TFD)	2
		2.50	D5							
		3.00 - 3.45	U6	Blows=7						3
		3.50 3.50 3.50	D7 D8 SPT(S)	N=1 (1,0/0,1,0,0)		(3.31)				4
		4.50	D9							
		5.00 - 5.45	U10	Blows=14						5
		5.50 5.50	D12 SPT(S)	N=15 (2,2/3,3,4,5)	5.31		-0.38		Spongy black fibrous PEAT. (Peat) (PEAT)	6
						(1.19)				
		6.50	D13		6.50		-1.57		Spongy dark brown amorphous PEAT with coarse gravel sized pockets of soft grey silty clay. (Peat) (PEAT)	
						(0.60)				
		7.00 7.00	U14 ES014	Blows=12	7.10		-2.17		Firm grey silty organic CLAY. (Estuarine Aluvium) (TFD)	
		7.50 7.50 7.50	D15 D16 SPT(S)	N=14 (2,3/4,3,3,4)		(1.40)				8
		8.50 8.50	W17 SPT(C)	N=44 (7,9/9,11,12,12)	8.50		-3.57		Dense grey slightly sandy subangular to rounded fine to coarse GRAVEL of mudstone, siltstone, sandstone and limestone with medium cobble content. Sand is fine to coarse. Cobbles are subrounded of sandstone and siltstone. (Fluvial Alluvium) (FLUV)	9
		9.00 9.00 - 9.50	B018 B18			(1.90)				
		10.00	D19							10
Continued on next sheet										
Remarks 1. Cable Percussive boring complete at 11.50m. 2. Borehole grouted upon completion.					Groundwater			Chiselling		
					Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)	Base Depth (m)
					8.50	8.50	5.20	00:50 01:00	9.10 11.20	9.30 11.50
<div>AGS</div>										






		<h1>BOREHOLE LOG</h1>						Borehole No. SBHL01 CP				
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 11/12/2007 - 12/12/2007				Sheet 2 of 2				
Project No: JER6591-Temp		Easting: 339456		Drilling Method:				Hole Type: CP				
Location:		Northing: 185700		Dando		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client:		Ground Level (mAOD): 4.93		Logged By: DH		200	10.50	1:50				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
		10.50	U021	Blows=11	10.40	(1.10)	-5.47		Very stiff high strength greenish grey slightly gravelly CLAY. Gravel is angular fine to medium of mudstone (Weathered Mudstone). (Mercia Mudstone Group) (MMG)	11		
		10.50	D20									
		10.50	U21									
		11.00	D23									
		11.00	D22									
		11.00	SPT(S)	50 (25 for 95mm/50 for 25mm)								
		11.50	D24									
		11.50	SPT(S)	50 (25 for 10mm/50 for 15mm)					End of Borehole at 11.50m	12		
										13		
										14		
										15		
										16		
										17		
										18		
										19		
										20		
Remarks						Groundwater			Chiselling			
1. Cable Percussive boring complete at 11.50m. 2. Borehole grouted upon completion.						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)		Base Depth (m)
						8.50	8.50	5.20	00:50 01:00	9.10 11.20		9.30 11.50



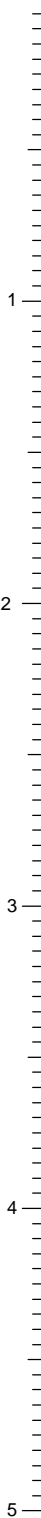



<div>RPS</div>		BOREHOLE LOG						Borehole No. SBHL02 CP				
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 06/12/2007 - 07/12/2007			Hole Type:					
Project No: JER6591-Temp		Easting: 339805		Drilling Method:			CP					
Location:		Northing: 185767		Dando		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client:		Ground Level (mAOD): 6.52		Logged By: DH		200	12.00	1:50				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
		0.00					6.52		Soft to firm low strength grey mottled orangish brown slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse of mudstone. (Estuarine Alluvium) (TFD)			
		1.00 - 1.45	U2	Blows=14						1		
		1.00	D1									
		1.50	D3									
		1.50	D4									
		1.50	SPT(S)	N=6 (1,2/2,2,1,1)					---from 1.50m to 2.00m soft	2		
		2.00	D5			(4.10)						
		2.00	ES005									
		3.00	D6							3		
		3.00 - 3.45	U7	Blows=12								
		3.00	U007									
		3.50	D8									
		3.50	D9									
		3.50	SPT(S)	N=5 (2,2/1,2,1,1)						4		
		4.00	D10		4.10		2.42		Soft to very soft grey CLAY with very closely to closely spaced gravel sized pockets of black amorphous peat. (Estuarine Alluvium) (TFD)			
		5.00	U12	Blows=5						5		
		5.00	D11			(2.40)						
		5.50	D14									
		5.50	D13									
		5.50	SPT(S)	N=1 (1,0/0,1,0,0)						6		
		6.00	D15									
		6.50 - 7.00	B16		6.50		0.02		Spongy black psuedofibrous PEAT. (Peat) (PEAT)	7		
		6.50	B016									
		7.00	D17	Blows=12		(1.40)						
		7.00 - 7.45	U18									
		7.00	U018									
		7.00	ES018									
		7.00	ES017									
		7.00	D19									
		7.50 - 7.95	D20	N=14 (2,2/3,5,3,3)	7.90		-1.38		Soft grey CLAY with occasional coarse gravel sized pockets of brown and black psuedofibrous locally fibrous peat. (Estuarine Alluvium) (TFD)	8		
		7.50	SPT(S)			(1.40)						
		7.50	ES021									
		8.00	D21									
		8.00										
		9.00 - 9.45	U23	Blows=10						9		
		9.00	D22		9.30		-2.78		Very stiff greenish grey slightly gravelly CLAY. Gravel is angular fine to coarse of mudstone (Weathered Mudstone). (Mercia Mudstone Group) (MMG)			
		9.50	D25									
		9.50	D24									
		9.50	SPT(S)	N=23 (3,4/4,6,6,7)								
		10.00	D26							10		
Continued on next sheet												
Remarks 1. Cable Percussive boring complete at 12.60m. 2. Borehole grouted upon completion.						Groundwater			Chiselling		<div>AGS</div>	
						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)	Top Depth (m)		Base Depth (m)
						10.80	10.50	10.80	01:00	12:10		12:50

		<h1>BOREHOLE LOG</h1>						Borehole No. SBHL02 CP				
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 06/12/2007 - 07/12/2007				Sheet 2 of 2				
Project No: JER6591-Temp		Easting: 339805		Drilling Method:				Hole Type: CP				
Location:		Northing: 185767		Dando		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client:		Ground Level (mAOD): 6.52		Logged By: DH		200	12.00	1:50				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
		11.00 - 11.45 11.00 11.00	U28 U028 D27	Blows=71		(3.30)				11		
		11.50 - 11.90 11.50 11.50	D30 D29 SPT(S)	50 (8,15/50 for 170mm)						12		
		12.00	D31									
		12.50 12.50	D32 SPT(S)	50 (25 for 20mm/50 for 45mm)					End of Borehole at 12.60m	13		
										14		
										15		
										16		
										17		
										18		
										19		
										20		
Remarks						Groundwater		Chiselling				
1. Cable Percussive boring complete at 12.60m. 2. Borehole grouted upon completion.						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Duration (Mins)		Top Depth (m)	Base Depth (m)
						10.80	10.50	10.80	01:00		12.10	12.50

<div>RPS</div>		ROTARY BOREHOLE LOG						Borehole No. SBHL02 RC			
								Sheet 2 of 3			
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 11/12/2007 - 12/12/2007				Hole Type:			
Project No: JER6591-Temp		Easting: 339806		Drilling Method:				RC			
Location:		Northing: 185767		Dando Tractor		Casing Diameter (mm) 121		Casing Depth (m) 11.20			
Client:		Ground Level (mAOD): 6.53		Logged By: DH				Scale: 1:50			
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale	
		Depth (m)	Type & Fl	Results & Coring							
		11.20 - 12.20			11.20		-4.67		Zone of core loss. MARL/LIMESTONE. (Driller's description) (NR)	11	
		12.20 - 13.20	C1		12.20	(1.00)	-5.67		Extremely weak to weak reddish brown locally mottled greenish grey locally greenish grey MUDSTONE. Recovered as non intact core (angular to subangular medium to coarse gravel sized fragments). (Mercia Mudstone Group) (MMG)	12	
		12.20	C007								
		12.20	C7								
		12.20	C001								
		12.20	SPT(S)	100 (25 for 0mm/100 for 0mm)		(1.55)			---from 12.54m to 13.20m assumed zone of core loss	13	
		12.20 - 13.20		RQD: 0 TCR: 34 SCR: 0							
		13.20 - 14.00		RQD: 0 TCR: 100 SCR: 28	13.75	-7.22			Very weak to weak reddish brown locally mottled greenish grey locally greenish grey MUDSTONE. Discontinuities: 1) 0 -10 deg extremely closely to medium spaced undulating rough to smooth. 2) 60 - 90 deg medium to widely spaced undulating rough and smooth. (Mercia Mudstone Group) (MMG)	14	
		14.00 - 14.90	C2								
		14.00	C002								
		14.00	SPT(S)	100 (25 for 75mm/100 for 75mm)					---from 13.94m to 13.95m recovered as non intact core (angular fine to coarse gravel sized fragments)		
		14.00 - 14.90		RQD: 0 TCR: 74 SCR: 47					---from 14.00m to 14.10m recovered as non intact core (angular medium to coarse gravel sized fragments)	15	
		14.10	ES008						---from 14.38m to 14.42m recovered as non intact core (angular medium to coarse gravel sized fragments)		
		14.10	C8						---from 14.50m to 14.58m recovered as non intact core (angular fine to coarse gravel sized fragments)		
		14.90 - 16.00		RQD: 14 TCR: 86 SCR: 43					---from 14.63m to 14.67m recovered as non intact core (angular fine to coarse gravel sized fragments)		
		15.00	C009						---from 14.67m to 14.90m assumed zone of core loss	16	
		15.00	C9						---from 15.18m to 16.59m 1 No medium bed of greenish grey mudstone		
		16.00 - 18.00	C3						---from 15.19m to 15.26m recovered as non intact core (angular fine to coarse gravel sized fragments)		
16.00	C003					---from 15.30m to 15.36m recovered as non intact core (angular fine to medium gravel sized fragments)					
16.00 - 18.00		RQD: 21 TCR: 95 SCR: 60		(6.55)		---from 15.57m to 15.73m recovered as non intact core (angular fine to medium gravel sized fragments)	17				
17.00	C10					---from 15.85m to 16.00m assumed zone of core loss					
17.00	ES010					---from 16.00m to 16.20m recovered as non intact core (angular fine to coarse gravel sized fragments)					
						---from 16.40m to 16.59m recovered as non intact core (angular fine to coarse gravel sized fragments)					
						---from 16.76m to 16.87m recovered as non intact core (angular fine to coarse gravel sized fragments)	18				
18.00 - 20.30	C4					---from 17.10m to 17.18m recovered as non intact core (angular fine to coarse gravel sized fragments)					
18.00	C004					---from 17.50m to 17.63m recovered as non intact core (angular fine to coarse gravel sized fragments)					
18.00 - 20.30		RQD: 19 TCR: 100 SCR: 63				---from 17.85m to 17.90m recovered as non intact core (angular fine to coarse gravel sized fragments)					
						---from 17.90m to 18.00m assumed zone of core loss	19				
						---from 18.00m to 18.70m 1 No thick bed of greenish grey mudstone					
						---from 18.44m to 18.55m recovered as non intact core (angular fine to coarse gravel sized fragments)					
						---from 18.84m to 19.00m recovered as non intact core (angular medium to coarse gravel sized fragments)					
						---from 19.13m to 19.20m recovered as non intact core	20				
Continued on next sheet											
Remarks 1. Rotary Openhole drilling from GL to 11.20m. 2. Rotary Coring from 11.20m to 20.30m. 3. 19mm piezometer installed, tip at 15.20m, with response zone from 14.80m to 15.40. 4. 0.00*indicates openhole drilling.						Groundwater		Drilling Progress		<div>AGS</div>	
						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Depth		Remarks
						12.00	11.20		14.90 14.90 20.30		Start of Shift End of Shift End of Hole

		ROTARY BOREHOLE LOG						Borehole No. SBHL02 RC Sheet 3 of 3		
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 11/12/2007 - 12/12/2007				Hole Type: RC		
Project No: JER6591-Temp		Easting: 339806		Drilling Method:						
Location:		Northing: 185767		Dando Tractor		Casing Diameter (mm) 121	Casing Depth (m) 11.20	Scale: 1:50		
Client:		Ground Level (mAOD): 6.53		Logged By: DH						
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale
		Depth (m)	Type & Fl	Results & Coring					---from 19.13m to 19.20m recovered as non intact core (angular fine to coarse gravel sized fragments) ---from 19.50m to 19.89m recovered as non intact core (angular fine to coarse gravel sized fragments) ---from 19.61m to 19.89m 1 no thin bed of greenish grey mudstone ---from 20.00m to 20.10m recovered as non intact core (angular fine to coarse gravel sized fragments) End of Borehole at 20.30m	21
										22
										23
										24
										25
										26
										27
										28
										29
										30
Remarks						Groundwater			Drilling Progress	
1. Rotary Openhole drilling from GL to 11.20m. 2. Rotary Coring from 11.20m to 20.30m. 3. 19mm piezometer installed, tip at 15.20m, with response zone from 14.80m to 15.40. 4. 0.00*indicates openhole drilling.						Strike Depth (m)	Casing Depth (m)	Level After 20 Mins (m)	Depth	Remarks
						12.00	11.20		14.90	Start of Shift
									14.90	End of Shift
								20.30	End of Hole	
										

		<h1>TRIAL PIT LOG</h1>						Pit No. STPK01 Sheet 1 of 1		
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 18/12/2007				Hole Type:		
Project No: JER6591-Temp		Easting: 338514		Equipment:		Orientation: 262°		TP		
Location:		Northing: 185603		JCB 3CX		Pit Length: 3.42 m		Scale:		
Client:		Ground Level (mAOD): 5.58		Logged By: GS		Pit Width: 0.72 m		1:25		
Backfill	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results						
					0.00		5.58		MADE GROUND: Light reddish brown very gravelly clay. Gravel sized fragments are subangular to angular fine to coarse of clinker, concrete, brick and slag. With low cobble content, cobble sized fragments are subangular of clinker, concrete, brick and slag. (MG)	
		0.34 0.34 0.34 0.60	ES1 L001 ES001 D2			(0.84)				
					0.84		4.74		Soft to firm light grey mottled brown CLAY with frequent roots and rootlets up to 2mm diameter. (Estuarine Alluvium) (TFD)	1
		1.20 1.20 1.20 - 1.27 1.27 1.27 1.27 1.27 1.27 1.27	B005 ES005 B5 ES3 ES003 D4 IVN03 IVN01 IVN02	55kPa 60kPa 55kPa		(2.00)				2
		2.00 - 2.30	B8							
		2.30 2.31 2.31 2.31 2.31	D7 ES6 IVN05 IVN06 IVN04	15kPa 20kPa 20kPa						
					2.84		2.74		Very soft light grey slightly silty CLAY with occasional pockets of dark brown black organic matter and rare roots and rootlets up to 6mm in diameter. (Estuarine Alluvium) (TFD)	3
		3.00 3.00 - 3.30	ES011 B11			(0.52)				
		3.30 3.36	D10 ES9							
									End of Pit at 3.36m	
										4
										5
Remarks: 1. Trial pit complete at 3.36m.										
Groundwater:										
Stability: All faces stable										
										

		TRIAL PIT LOG						Pit No. STPL01 Sheet 1 of 1					
Project Name: M4 CaN (Temp)		Co-ordinates:		Date(s): 18/12/2007				Hole Type: TP					
Project No: JER6591-Temp		Easting: 339528		Equipment:		Pit Length: 3.50 m Pit Width: 0.45 m							
Location:		Northing: 185721		JCB 3CX				Scale: 1:25					
Client:		Ground Level (mAOD): 5.15		Logged By: GS									
Backfill	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale			
		Depth (m)	Type	Results									
					0.00	(0.16)	5.15		TOPSOIL. (TOP)				
					0.16		4.99				Soft light grey mottled brown silty slightly sandy CLAY. With frequent roots and rootlets up to 2mm diameter. (Estuarine Alluvium) (TFD)		
		0.31	ES1									1	
		0.54	D2										
		0.54 - 1.00	B3										
		0.54	ES003										
		0.54	B003										
		1.00 - 1.39	B6			(1.72)							
		1.15	IVN03	14kPa									
		1.15	IVN02	15kPa									
		1.15	IVN01	15kPa									
		1.39	D5										
		1.39	ES4										
		1.88 - 2.22	B9			1.88		3.27				Very soft grey silty slightly sandy CLAY. With frequent pockets of dark brown black organic material and frequent roots and rootlets up to 4mm in diameter. (Estuarine Alluvium) (TFD)	2
		1.88	ES009										
1.88	B009												
2.20	D8												
2.22	ES7												
2.22	IVN05	10kPa											
2.22	IVN06	10kPa											
2.22	IVN04	8kPa											
3.00 - 3.69	B12			(2.31)					3				
3.60	D11												
3.69	ES10												
4.00 - 4.19	B15								4				
4.19	D14												
4.19	ES13												
End of Pit at 4.19m										5			
Remarks: 1. Trial pit complete at 4.19m.													
Groundwater:													
Stability: All faces stable													
													

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH525

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 3

Start Date 24 February 2015 Easting 338301.6

Scale 1 : 50

End Date 26 February 2015 Northing 185578.3 Ground level 5.95mOD

Depth 22.70 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
24/02/15 0800hrs								Large slag BOULDERS (Driller's description). (MG)			
	1D	1.00 - 1.45	1.00	S 5					1.00	4.95	
	2B	1.00 - 1.50									
	3D*	1.00 - 1.20		Vo 0.2					1.30	4.65	
	4D	1.50 - 1.95	1.50	S 8				Soft dark grey slightly gravelly silty CLAY. Gravel is angular and subangular fine to coarse brick, slag and limestone. (MG)			
	5B	1.50 - 2.00									
	6D*	1.50 - 1.70		Vo 0.2				Stiff yellowish brown and grey slightly gravelly silty sandy CLAY. Gravel is angular and subangular fine to coarse slag and limestone. (MG)			
	7B	2.00 - 2.50									
	8D*	2.00 - 2.20		Vo 0.2					2.50	3.45	
		2.50		V 36							
24/02/15 1630hrs 1.50m	9UT	2.50 - 2.95	2.50					Very soft dark grey slightly sandy silty CLAY. (TFD)			
	11D*	2.75 - 3.00		Vo 0.0				2.54m: Low strength.			
25/02/15 0800hrs	10D	2.95 - 3.05									
	12D	3.00 - 3.45	3.00	S<1							
	13B	3.00 - 3.50									
	14D*	3.00 - 3.50		Vo 0.0							
	15B	3.50 - 4.00									
	16D*	3.50 - 4.00		Vo 0.0							
		3.95		V 36							
	17P	4.00 - 5.00	4.00					3.95m: Low strength.			
	18B	5.00 - 5.50									
		5.55		V 10							
	19P	5.50 - 6.50	5.50					5.55m: Extremely to very low strength.			
	20B	6.50 - 7.00									
		7.10		V 12							
	21P	7.00 - 7.60	7.00					7.10m: Very low strength.			
25/02/15 1700hrs NR									7.60	-1.65	
26/02/15 0800hrs								Very soft grey silty CLAY interbedded with firm dark brown fibrous PEAT. (PEAT)			
								Continued Next Page	{8.00}		

EQUIPMENT: Light cable percussive (shell and auger) rig and Geotechnical Pioneer rig. METHOD: Cable percussion (200mm) 0.00-2.00m and (150mm) 2.00-12.20m. Waterflush rotary core drilled (116mm) 12.20-22.70m. CASING: 200mm diam to 2.00m, 150mm diam to 12.20m.

BACKFILL: On completion, borehole backfilled with bentonite pellets 22.70-11.80m. A slotted standpipe (50mm) with geo-sock was installed to 11.60m, granular response zone 11.80-9.80m and bentonite seal 9.80-2.80m. A second slotted standpipe (35mm) with geo-sock was installed to 2.60m, granular response zone 2.80-0.50m, bentonite seal 0.50-0.25m, concrete and stopcock cover 0.25-0.00m.

REMARKS: Hole advanced by chiselling 0.00-1.00m (1hr10mins) and 10.90-12.20m (2hr). Downhole magnetometry for UXO risk mitigation undertaken 0.00-11.00m. No anomalies encountered. Bentonite seal for aquifer protection installed during drilling 1.00-2.00m, prior to reduction in casing diameter.

Permeability test undertaken at 7.00m- 8.00m.

MMG = Mercia Mudstone Group. Weathering zone after Chandler RJ and Forster CIRIA C570; Engineering in Mercia Mudstone (2001).

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	AGS	CONTRACT	CHECKED
1.50	1.50	1.30	20	Medium flow.		30238	EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH525

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 3

Start Date 24 February 2015 Easting 338301.6

Scale 1 : 50

End Date 26 February 2015 Northing 185578.3 Ground level 5.95mOD

Depth 22.70 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
26/02/15 1620hrs 5.90m 27/02/15 0915hrs 7.87m	22D	8.00 - 8.45	8.00	S 15							
	23B	8.50 - 9.00									
	24UT	9.50 - 9.95	9.50								
	25D	9.95 - 10.05									
	26D	10.10 - 10.20						Stiff dark reddish brown slightly gravelly CLAY. Gravel is subangular and subrounded fine and medium sandstone and siltstone. (RTD)	10.10	-4.15	
	27B	10.50 - 11.00									
	28D	11.00 - 11.45	11.00	S 39							
	29B	11.50 - 12.20									
	30D	12.20 - 12.43	12.10	S*113							
	31C	12.20 - 12.50			97	NA					
	32C	12.50 - 13.70	12.10		100			12.90 - 13.05m: Light greenish grey.			
	33C	13.70 - 15.20	12.10		100	NA		13.60 - 13.70m: Light greenish grey.	13.70	-7.75	
								Very stiff fissured dark reddish brown very gravelly CLAY. Gravel is subangular and subrounded fine and medium lithorelicts of extremely weak mudstone. Fissures are subhorizontal to 20° and subvertical extremely closely spaced. (MMG) (Grade III)			
	34C	15.20 - 16.70	12.10		100 19 0			Stiff fissured reddish brown gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of extremely weak mudstone and very stiff clay. Fissures are subhorizontal to 20° very closely spaced planar smooth. (MMG) (Grade III)	14.80	-8.85	
								15.55 - 15.70m: 70° to subvertical planar smooth.	15.60	-9.65	
								Weak thinly laminated reddish brown MUDSTONE with rare light greenish grey reduction spots (up to 20mm). Fractures are subhorizontal to 20° and subvertical very closely and closely spaced planar smooth. (MMG) (Grade I/II)			
	35C	16.70 - 18.20	12.10		93 5 0			15.60 - 16.20m: Light greenish grey. 15.70 - 15.80m: Tending to light greenish grey clay. 16.20 - 16.30m: Tending to reddish brown clay. 16.70 - 17.10m: Tending to light greenish grey clay.			
								17.30 - 17.40m: Tending to reddish brown clay. 17.50 - 17.60m: Tending to reddish brown clay. 17.60 - 18.20m: Subvertical fracture.			
								Continued Next Page	{18.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks											
									CONTRACT 30238		CHECKED EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH525

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 3 of 3

Start Date 24 February 2015 Easting 338301.6

Scale 1 : 50

End Date 26 February 2015 Northing 185578.3 Ground level 5.95mOD

Depth 22.70 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
27/02/15 1420hrs 2.60m	36C	18.20 - 19.70	12.10		100 62 37			Very weak and weak thinly laminated reddish brown MUDSTONE with rare light greenish grey reduction spots (up to 20mm). Fractures are subhorizontal to 20° and subvertical closely and medium spaced planar smooth. (MMG) (Grade I/II) 19.20 - 19.25m: 20° fracture with a veneer of reddish brown clay. 21.25 - 21.80m: 80° to vertical fracture undulating smooth. 22.00 - 22.40m: Tending to reddish brown clay. 22.40m: Calcite crystals (up to 20mm).	18.60	-12.65	
					80 120 400						
	37C	19.70 - 21.20	12.10		100 100 61						
	38C	21.20 - 22.70	12.10		100 90 57						
								Borehole completed at 22.70m.	22.70	-16.75	
									{28.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks									CONTRACT 30238		CHECKED EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH526

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 3 March 2015 Easting 338509.4

Scale 1 : 50

End Date 9 March 2015 Northing 185587.2 Ground level 5.95mOD

Depth 17.70 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
03/03/15 1100hrs	1B 2D* 3B 4D*	0.20 - 0.50 0.20 - 0.50 0.50 - 1.00 0.50 - 1.00		Vo 0.0 Vo 0.0				SLAG (Driller's description). (MG) Orangish brown and grey angular and subangular fine to coarse limestone GRAVEL with low subangular sandstone cobble content. (MG)	0.20	5.75	
03/03/15 1700hrs Dry	5B 6D*	1.00 - 1.45 1.00 - 1.50 1.00 - 1.50	1.00 1.45	C 10 Vo 0.0				1.00 - 1.30m: Loose to medium dense.	1.30	4.65	
04/03/15 0800hrs Dry	7UT 8D* 9D 10B 11D*	1.50 - 1.95 1.50 - 1.70 2.00 - 2.45 2.00 - 2.50 2.00 - 2.50	1.50 2.00	Vo 0.0 S 4 Vo 0.0				Firm light grey mottled brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse limestone. (MG) Very soft light grey mottled brown CLAY. (TFD)	1.50	4.45	
	12UT 13D 14D*	2.50 - 2.95 3.00 - 3.45 3.00 - 3.50	2.50 3.00								
	15UT 16D* 17D 18B 19D*	3.50 - 3.95 3.50 - 3.70 4.00 - 4.45 4.00 - 4.50 4.00 - 4.50	3.50 4.00	Vo 0.0 S<1 Vo 0.0					4.00	1.95	
	UT 20B 21D 22B 23D*	4.50 - 4.95 4.50 - 5.00 5.00 - 5.45 5.00 - 5.50 5.00 - 5.50	4.50 5.00					Very soft dark grey silty CLAY. (TFD)			
	24B	5.50 - 6.00									
04/03/15 1700hrs 3.50m	25D	6.50 - 6.95	6.50	S 10				Firm dark grey peaty CLAY. (TFDP)	6.60	-0.65	
05/03/15 0800hrs 2.65m								Firm spongy black PEAT (Driller's description). (PEAT)	7.00	-1.05	
	26B	7.50 - 8.00							7.70	-1.75	
	27D	8.00 - 8.45	8.00	S 8				Soft dark grey peaty CLAY. (TFDP)	8.00	-2.05	
								Continued Next Page	{8.00}		

EQUIPMENT: Light cable percussive (shell and auger) rig and Geotechnical pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Cable percussion (200mm) 1.00-11.50m. Waterflush rotary core drilled (140mm) 11.50-17.70m.

CASING: 200mm diam to 11.50m and 140mm diam to 11.70m.

BACKFILL: On completion, hole backfilled with bentonite pellets 17.70-0.40m and gravel 0.40-0.00m.

REMARKS: Downhole magnetometry for UXO risk mitigation undertaken 0.00-10.00m. No anomalies encountered.

Permeability test undertaken at 6.00m- 7.00m.

MMG = Mercia Mudstone Group. Weathering zone after Chandler RJ and Forster CIRIA C570; Engineering in Mercia Mudstone (2001).

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
2.50	2.50	2.10	20	


CONTRACT
30238
CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH526

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 3 March 2015 Easting 338509.4

Scale 1 : 50

End Date 9 March 2015 Northing 185587.2 Ground level 5.95mOD

Depth 17.70 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend	
05/03/15 1700hrs 8.15m	28B	8.00 - 8.50						Firm black fibrous PEAT. (PEAT)	8.50	-2.55		
	29B	8.50 - 9.00					Soft dark grey peaty CLAY. (TFDP)					
	30D 31B	9.50 - 9.95 9.50 - 10.00	9.50	S 18			Stiff dark reddish brown slightly gravelly CLAY. Gravel is subangular fine to coarse mudstone lithorelicts. (MMG) 10.00 - 11.70m: Very stiff.	9.50	-3.55			
	32D	10.00 - 10.45	10.00	S 43								
	33B	10.50 - 11.00										
	09/03/15 1040hrs 0.83m	34D 35C	11.50 - 11.81 11.70 - 13.20	11.50 11.70	S*81	100		Stiff dark reddish brown slightly gravelly CLAY. Gravel is subangular fine to coarse extremely weak mudstone lithorelicts of very stiff clay and extremely weak mudstone. Fissures are subhorizontal to 20° and subvertical extremely closely spaced planar smooth. (MMG) (Grade III)	11.70	-5.75		
		36C	13.20 - 14.70	11.70		100						
		37C	14.70 - 16.20	11.70		100 44 40						
	09/03/15 1715hrs 2.96m	38C	16.20 - 17.70	11.70		100 83 20		Weak and medium strong reddish brown MUDSTONE. Fractures are subhorizontal to 20° and subvertical closely to medium spaced locally non intact planar smooth. (MMG) (Grade I) 16.30 - 16.35m: Tending to reddish brown clay. 16.60 - 16.80m: Tending to light greenish grey clay. 16.60 - 17.40m: Light greenish grey. 17.00 - 17.10m: 40° fracture planar smooth.	15.60	-9.65		
									17.70	-11.75		
								Borehole completed at 17.70m.	{18.00}			
water strike (m) casing (m) rose to (m) time to rise (m) remarks									AGS		CONTRACT 30238	CHECKED EC

BOREHOLE LOG



CLIENT WELSH GOVERNMENT

BH527

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 3

Start Date 9 March 2015 Easting 338871.9

Scale 1 : 50

End Date 12 March 2015 Northing 185644.4 Ground level 5.95mOD

Depth 19.10 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
09/03/15 0800hrs	1B	0.20 - 0.50						Dark grey sandy angular and subangular fine to coarse slag and limestone GRAVEL. (MG)			
	2D*	0.20 - 0.30		Vo 0.0							
	3B	0.50 - 1.00									
	4D*	0.50 - 1.00		Vo 0.0							
		1.00 - 1.08	1.00	C*200				1.00m: Very dense.			
	5D*	1.00 - 1.10		Vo 0.1							
		1.50 - 1.95	1.50	C 5				Soft dark greenish grey slightly gravelly CLAY. Gravel is angular and subangular fine to coarse limestone. (MG)	1.50	4.45	
	6D*	1.50 - 1.60		Vo 0.0					1.75	4.20	
	7B	1.75 - 2.00						Soft dark grey slightly sandy silty CLAY. (TFD)			
	8D	2.00 - 2.45	2.00	S 5							
	9B	2.00 - 2.50									
	10D*	2.00 - 2.50		Vo 0.0							
	11P	2.50 - 3.50	2.50								
	12B	2.50 - 3.00									
09/03/15 1700hrs 4.10m	13P	3.00 - 4.00	3.00								
	14B	4.00 - 4.50									
	15D*	4.00 - 4.50		Vo 0.0							
		4.50		V 28							
	16P	4.50 - 4.70	4.50						4.60	1.35	
	17UT	4.70 - 5.15	4.70					Woody PEAT (Driller's description). (PEAT)	4.70	1.25	
	18D	5.00 - 5.15						Very soft dark grey peaty silty CLAY. (TFDP)			
		5.50 - 6.00									
	19B										
10/03/15 0800hrs 1.10m	20D	6.50 - 6.70	6.50	S<1							
	21B	6.50 - 7.00									
		7.50 - 8.00									
	22B										
Continued Next Page									{8.00}		

EQUIPMENT: Light cable percussive (shell and auger) rig and Geotechnical pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Cable percussion (200mm) 1.00-2.00m and (150mm) 2.00m to 13.10m. Waterflush rotary core drilled (116mm) 13.10-19.10m. CASING: 200mm diam to 2.00m and 150mm diam to 12.60m.

BACKFILL: On completion, borehole backfilled with bentonite pellets 19.10-19.00m. A slotted standpipe (50mm) with geo-sock was installed to 19.00m, granular response zone 19.00-12.90m and bentonite seal 12.90-9.00m. A second slotted standpipe (35mm) with geo-sock was installed to 9.00m, granular response zone 9.00-4.90m, bentonite seal 4.90-0.50m, concrete and stopcock cover 0.50-0.00m.

REMARKS: Downhole magnetometry for UXO risk mitigation undertaken 0.00-11.00m. No anomalies encountered. Bentonite seal for aquifer protection installed during drilling 2.00m, prior to reduction in casing diameter. MMG = Mercia Mudstone Group. Weathering zone after Chandler RJ and Forster CIRIA C570; Engineering in Mercia Mudstone (2001).

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water
flush.CONTRACT
30238CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH527

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 3

Start Date 9 March 2015 Easting 338871.9

Scale 1 : 50

End Date 12 March 2015 Northing 185644.4 Ground level 5.95mOD

Depth 19.10 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
	23UT	8.00 - 8.45	8.00								
	24D	8.45 - 8.55									
	25B	9.00 - 9.50									
	26D	9.50 - 9.95	9.50	S 28				Stiff dark reddish brown and greenish grey slightly gravelly CLAY. Gravel is subangular fine to coarse mudstone lithorelicts. (MMG) (Grade III)	9.50	-3.55	
	27B	10.50 - 11.00									
	28D	11.00 - 11.45	11.00	S 42				11.00 - 13.10m: Very stiff.			
10/03/15 1700hrs 3.10m											
11/03/15 0800hrs 10.60m	29B	12.00 - 12.50									
11/03/15 1700hrs 10.60m	30D	12.50 - 12.67	12.50	S*500							
	31D	12.70 - 13.00									
12/03/15 1130hrs 11.28m	32C	13.10 - 14.60	12.60		100 23 0	NA		13.00 - 14.20m: Light greenish grey.	13.10	-7.15	
								Very stiff fissured reddish brown CLAY. Relict fissures are randomly orientated very closely spaced. (MMG) (Grade IVb)			
								13.50m: Subhorizontal band (30mm) of extremely weak mudstone.			
								13.70m: 20° band (50mm) of extremely weak thinly laminated mudstone.	14.25	-8.30	
	33C	14.60 - 16.10	12.60		100 46 0	NI 20 60		Extremely weak thinly laminated reddish brown MUDSTONE recovered non intact. Fractures are subhorizontal to 20° and 70° to subvertical very closely spaced planar smooth rarely stained back. (MMG) (Grade II)	15.30	-9.35	
	34C	16.10 - 17.60	12.60		100 36 0	NI 40 60		Extremely weak thinly laminated reddish brown MUDSTONE locally disintegrated to subrounded coarse mudstone lithorelicts with 30% stiff clay matrix. Fractures are subhorizontal to 20° and 70° to subvertical extremely closely and very closely spaced planar smooth rarely stained back. (MMG) (Grade II/III)	16.45	-10.50	
								15.70m: 70° fracture planar smooth stained black.			
	35C	17.60 - 19.10	12.60		100 56 36	NA		Extremely weak to weak thinly laminated reddish brown MUDSTONE locally recovered non intact. Fractures are subhorizontal to 20° and 70° to subvertical very closely spaced planar smooth rarely stained back. (MMG) (Grade II)	17.70	-11.75	
								16.55 - 16.65m: Greenish grey gravelly clay.	18.00	-12.05	
								Continued Next Page	{18.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks											
Groundwater not encountered prior to use of water flush.								AGS	CONTRACT 30238	CHECKED EC	



CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Start Date 9 March 2015 Easting 338871.9


End Date 12 March 2015 Northing 185644.4 Ground level 5.95mOD

BH527

Sheet 3 of 3

Scale 1 : 50

Depth 19.10 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
12/03/15 1700hrs 2.31m						NI 90 200	<div>Very stiff greenish grey gravelly CLAY. Gravel is subangular fine to coarse lithorelicts of extremely weak mudstone. Fissures are subhorizontal to 20° and 70° to subvertical very closely spaced planar smooth. (MMG) (Grade III)</div> <div>Weak thickly laminated reddish brown MUDSTONE. Fissures are subhorizontal to 20° and 70° very closely and closely spaced planar smooth frequently stained black. (MMG) (Grade II)</div> <div>Borehole completed at 19.10m.</div>	19.10	-13.15		
									{28.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks									CONTRACT 30238		CHECKED EC
Groundwater not encountered prior to use of water flush.											

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH528

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 3 March 2015 Easting 339268.2

Scale 1 : 50

End Date 4 March 2015 Northing 185680.5 Ground level 5.20mOD

Depth 17.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
03/03/15 1000hrs	1B 2D*	0.25 - 0.40 0.25 - 0.40 0.35		Vo 0.1 H 36				Grass over firm dark grey mottled orangish brown silty CLAY with frequent rootlets (up to 1mm diam). (TFD)	1.20	4.00	
	3B 4D*	0.70 - 0.90 0.70 - 0.90		Vo 0.0							
	5B 6D*	1.00 - 1.20 1.00 - 1.20		Vo 0.0							
	7UT 10X	1.20 - 1.65 1.20 - 2.40	Nil					Very soft dark bluish grey silty CLAY with frequent plant fragments (up to 50mm). (TFD)			
	8D 11D*	1.65 - 1.80 1.70 - 1.90									
	9D	1.80 - 2.25	Nil	S<1							
	12D*	2.20 - 2.40									
	13UT 16X	2.40 - 2.85 2.40 - 3.50	2.40								
	14D 15D	2.85 - 3.00 3.00 - 3.45	2.40	S 1							
	17D*	3.30 - 3.50									
	18UT 21X	3.50 - 3.95 3.50 - 4.60	3.50								
	19D 20D	3.95 - 4.10 4.10 - 4.55	3.50	S<1							
	22UT 25X	4.60 - 5.05 4.60 - 6.10	4.60								
	23D 24D	5.05 - 5.20 5.20 - 5.65	4.60	S<1							
	26UT 28X	6.10 - 6.55 6.10 - 7.60	6.10					Firm black fibrous PEAT. (PEAT)	5.95	-0.75	
	27D	6.55 - 6.70						Soft dark bluish grey organic CLAY with frequent plant fragments (up to 50mm). (TFD)	6.60	-1.40	
								7.10 - 7.15m: Firm black fibrous peat.			
	29D 30X	7.60 - 8.05 7.60 - 9.10	7.60	S<1							
Continued Next Page									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Dynamic sampled (113mm) 1.20-11.00m. Waterflush rotary core drilled (116mm) 11.00-17.00m. CASING: 140mm diam to 10.60m.

BACKFILL: On completion, a slotted standpipe (50mm) with geo-sock was installed to 17.00m, granular response zone 17.00-11.80m and bentonite seal 11.80-7.00m. A second slotted standpipe (35mm) with geo-sock was installed to 7.00m, granular response zone 7.00-6.00m, bentonite seal 6.00-0.25m, concrete and raised cover 0.25-0.00m. REMARKS: Downhole magnetometry for UXO risk mitigation undertaken 0.00-10.60m. No anomalies encountered.

Permeability test undertaken at 8.90m- 10.60m. MMG = Mercia Mudstone Group. Weathering zone after Chandler RJ and Forster CIRIA C570; Engineering in Mercia Mudstone (2001). Falling head permeability test undertaken at 10.60m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	AGS	CONTRACT	CHECKED
0.25	Nil	0.20	20			30238	EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH528

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 3 March 2015

Easting 339268.2

Scale 1 : 50

End Date 4 March 2015

Northing 185680.5 Ground level 5.20mOD

Depth 17.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
03/03/15 1740hrs 1.80m	31UT 33X	9.10 - 9.55 9.10 - 10.60	9.10	S*56	100	NA		8.40 - 8.60m: Firm black fibrous peat.	8.80	-3.60	
	32D	9.55 - 9.70						Firm light brown slightly sandy slightly gravelly CLAY. Gravel is subangular fine and medium sandstone. (TFD) Firm light greenish grey slightly sandy silty CLAY. (TFD)	9.10	-3.90	
04/03/15 1100hrs 1.83m	34D 35X	10.60 - 11.02 10.60 - 11.00	9.10 10.60	S*56	100	NA		Very stiff dark reddish brown very gravelly CLAY with frequent light greenish grey reduction spots (up to 20mm). Gravel is subangular fine to coarse extremely weak mudstone and very stiff clay. Fissures are subhorizontal to 20° and subvertical extremely closely spaced planar smooth. (MMG) (Grade III)	10.60	-5.40	
	36C	11.00 - 12.50	10.60								
	37C	12.50 - 14.00	10.60		100	NA		Very stiff dark reddish brown very gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of extremely weak mudstone. Fissures are subhorizontal to 20° extremely closely spaced planar smooth. (MMG) (Grade III)	12.50	-7.30	
	38C	14.00 - 15.50	10.60								
	39C	15.50 - 17.00	10.60		100	NA		14.15 - 14.40m: Light greenish grey. 15.20 - 15.40m: Tending to extremely weak mudstone.			
04/03/15 1400hrs 2.15m								Borehole completed at 17.00m.	17.00	-11.80	
									{18.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks									CONTRACT 30238		CHECKED EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH529

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 3

Start Date 23 March 2015 Easting 339657.7

Scale 1 : 50

End Date 25 March 2015 Northing 185730.8 Ground level 5.10mOD

Depth 18.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
23/03/15 1150hrs	1B 2D*	0.20 - 0.50		Vo 24.0				Grass over firm dark greenish grey mottled orangish brown silty CLAY with frequent rootlets. (TFD)			
	3B 4D*	0.50 - 0.80		Vo 23.8							
	5B 6D*	0.80 - 1.20		Vo 15.0							
	P	1.20 - 2.00	Nil						1.20	3.90	
	7X	1.20 - 2.00						Soft dark grey silty CLAY. (TFD)			
23/03/15 1325hrs 1.52m	8D*	1.50 - 1.60									
24/03/15 0930hrs 1.62m	9X	2.00 - 2.50	2.00								
	10D*	2.30	2.00	V 14				2.30m: Very low strength.			
	11X	2.40 - 2.50 2.50 - 3.30									
	12X	3.30 - 3.80									
	13D*	3.50 - 3.60 3.60	2.00	V 24							
	14X	3.80 - 4.60	3.80								
	15D	4.60 - 5.05	3.80	S 2					4.60	0.50	
	16X	4.60 - 5.50						Very soft dark grey and black peaty silty CLAY. (TFDP)			
									5.15	-0.05	
	17D	5.50 - 5.95	3.80	S 2				Very soft black fibrous PEAT. (PEAT)			
	18X	5.50 - 7.00	5.50						5.60	-0.50	
								Very loose dark grey silty fine and medium SAND. (TFD)			
	19D	7.00 - 7.45	5.50	S<1							
	20X	7.00 - 8.50	7.00						7.25	-2.15	
								Very soft dark grey silty peaty CLAY. (TFDP)			
								7.70 - 7.80m: Tending to firm black fibrous peat.	7.80	-2.70	
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Dynamic sampled (113mm) 1.20-9.50m. Waterflush rotary core drilled (116mm) 9.50-18.50m.

CASING: 140mm diam to 9.00m.

BACKFILL: On completion, hole backfilled with bentonite pellets.

REMARKS: Downhole magnetometry for UXO risk mitigation undertaken 0.00-9.50m. No anomalies encountered.

MMG = Mercia Mudstone Group. Weathering zone after Chandler RJ and Forster CIRIA C570; Engineering in Mercia Mudstone (2001). Falling head permeability test undertaken at 10.60m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
0.90	Nil	0.52	20	


CONTRACT
30238
CHECKED
EC

BOREHOLE LOG



CLIENT WELSH GOVERNMENT

BH529

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 3

Start Date 23 March 2015 Easting 339657.7

Scale 1 : 50

End Date 25 March 2015 Northing 185730.8 Ground level 5.10mOD

Depth 18.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
24/03/15 1640hrs 0.40m	21D	8.50 - 8.95	7.00	S 17				Stiff light greenish grey slightly sandy silty CLAY with frequent plant fragments (up to 50mm). (TFD)			
25/03/15 0850hrs 0.50m	22X	8.50 - 9.50	8.50								
	23D	9.50 - 9.85	8.50	S*83							
	24C	9.50 - 11.00	9.00		92	NA		9.50 - 10.10m: Very stiff.	10.10	-5.00	
								Very stiff fissured light greenish grey slightly gravelly CLAY. Gravel is angular and subangular fine to coarse very stiff clay and extremely weak mudstone lithorelicts. Fissures are subhorizontal to 20° planar smooth. (MMG) (Grade III)			
	25C	11.00 - 11.32 11.00 - 12.50	9.00	C*88	100 0 0	NI		Extremely weak thinly bedded light greenish grey MUDSTONE. Fractures are subhorizontal to 20° and subvertical extremely closely spaced planar smooth. Recovered non intact. (MMG) (Grade II)	11.30	-6.20	
	26C	12.50 - 14.00	9.00		97 23 0			Extremely weak locally weak thinly bedded reddish brown MUDSTONE. Fractures are subhorizontal to 20° and subvertical extremely closely spaced planar smooth. Recovered non intact. (MMG) (Grade III) 13.00 - 13.10m: Tending to stiff reddish brown clay.	12.50	-7.40	
	27C	14.00 - 15.50	9.00		99 27 0			13.70 - 13.80m: Tending to stiff reddish brown clay.			
	28C	15.50 - 17.00	9.00		95 30 10						
						NI 60 150		Weak thinly laminated to very thinly bedded dark reddish brown MUDSTONE. Fractures are subhorizontal to 20° extremely closely and closely spaced planar smooth. (MMG) (Grade II)	16.55	-11.45	
	29C	17.00 - 18.50	9.00		92 79 17				17.60	-12.50	
						250		Weak thinly bedded light greenish grey MUDSTONE. Fractures are subhorizontal to 20° and subvertical	18.00	-12.90	
								Continued Next Page	{18.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks											
									CONTRACT 30238		CHECKED EC



BH529

Sheet 3 of 3

Scale 1 : 50

End Date 25 March 2015

Northing 185730.8

Northing 185730.8 Ground level 5.10mOD

Depth 18.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
25/03/15 1545hrs 1.30m						NI		medium spaced locally non intact planar smooth. (MMG) (Grade II) 17.80 - 18.00m: Tending to light greenish grey clay.	18.50	-13.40	
								Weak thinly laminated to very thinly bedded light greenish grey MUDSTONE. Fractures are subhorizontal to 20° extremely closely and very closely spaced planar smooth. (MMG) (Grade I/II) Borehole completed at 18.50m.			
									{28.00}		

water strike (m)

casing (m)

rose to (m)

time to rise (m)

remarks

AGS

CONTRACT

30238

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EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH530

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 3

Start Date 18 March 2015 Easting 339811.7

Scale 1 : 50

End Date 20 March 2015 Northing 185831.4 Ground level 6.25mOD

Depth 21.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
18/03/15 0800hrs	1B 2D*	0.20 - 0.50 0.20 - 0.50		Vo 0.3				Soft dark grey CLAY with frequent rootlets (up to 1mm). (MG)	0.50	5.75	
	3B 4D*	0.50 - 0.80 0.50 - 0.80		H 43 Vo 3.9				Soft dark grey mottled light bluish grey slightly sandy silty CLAY with rare fibrous roots (up to 3mm diam) and rootlets (up to 1mm diam). (TFD)			
	5B 6D*	0.80 - 1.00 0.80 - 1.00		Vo 6.2							
	6UT 7D	1.00 - 1.45 1.45 - 1.50	Nil	S 5							
	8D 9X 10D*	1.50 - 1.95 1.50 - 2.00 1.50 - 1.60	Nil	S 5							
	11UT 12D	2.00 - 2.45 2.45 - 2.50	Nil	S 6				2.00 - 2.50m: Firm.			
	13D 14X 15D*	2.50 - 2.95 2.50 - 3.00 2.50 - 2.60	Nil	S 6							
	16UT 17D	3.00 - 3.45 3.50 - 3.95	Nil	S 1				3.00 - 4.10m: Very soft.			
	18X 19D*	3.50 - 4.00 3.50 - 3.60	Nil	S 1							
	UT 20X	4.00 - 4.45 4.00 - 4.50	Nil	S<1				Very soft dark grey mottled light grey CLAY. (TFD)	4.10	2.15	
	21D 22X	4.50 - 4.95 4.50 - 5.00	Nil	S<1							
	23D 24X	5.00 - 5.45 5.00 - 6.50	5.00	S 4				Soft black clayey fibrous PEAT with fine fibrous organic fragments (up to 5mm). (PEAT)	4.90 5.00	1.35 1.25	
								Very soft light grey mottled yellowish grey CLAY. (TFD)	5.25	1.00	
								Spongy black pseudofibrous PEAT with rare rootlets (up to 1mm diam). (PEAT)			
	25D 26X	6.50 - 6.95 6.50 - 8.00	5.00 6.50	S 1				Very soft light grey mottled black very peaty CLAY with frequent rootlets (up to 1mm diam) and organic material (up to 3mm). (TFDP)	6.85	-0.60	
18/03/15 1700hrs 3.40m	27D	8.00 - 8.45	6.50	S 2				Light grey very clayey SAND with rare rootlets. (TFD)	7.65 7.75 7.95	-1.40 -1.50 -1.70	
Continued Next Page									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Dynamic sampled (128mm) 1.00-4.00m and (113mm) 4.00-10.60m. Waterflush rotary core drilled (116mm) 10.60-21.00m.

CASING: 140mm diam to 9.80m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 21.00m, granular response zone 21.00-12.00m and bentonite seal 12.00-8.00m. A second slotted standpipe (35mm) was installed to 8.00m, granular response zone 8.00-5.00m, bentonite seal 5.00-0.20m, concrete and stopcock cover 0.20-0.00m.

REMARKS: Downhole magnetometry for UXO risk mitigation undertaken 0.00-10.60m. No anomalies encountered. Falling head permeability test undertaken at 8.00m- 9.50m. MMG = Mercia Mudstone Group. Weathering zone after Chandler RJ and Forster CIRIA C570; Engineering in Mercia Mudstone (2001).

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
30238CHECKED
EC



BH530

CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 3

Start Date	18 March 2015	Easting	339811.7
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Scale 1 : 50

End Date	20 March 2015	Northing	185831.4	Ground level	6.25mOD
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Depth 21.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
19/03/15 0800hrs 0.37m	28X	8.00 - 9.50	8.00					Soft light grey sandy CLAY with rare rootlets. (TFD)	8.75	-2.50	
								Very soft light grey mottled dark grey slightly sandy silty CLAY with rare rootlets (up to 1mm diam). (TFD)			
	29D	9.50 - 9.95	8.00	S 23				8.45 - 8.75m: Slightly gravelly. Gravel is rounded fine to coarse sandstone.			
	30X	9.50 - 10.60	9.50					Stiff light greenish grey slightly sandy silty CLAY with rare fragments of black organic material (up to 2mm). (TFD)			
	31D	10.60 - 10.83	9.50	S*158					10.80	-4.55	
	32C	10.60 - 11.95			86			Stiff fissured light greenish grey slightly sandy gravelly CLAY. Gravel is subangular and subrounded fine to coarse lithorelicts of very stiff clay and extremely weak mudstone. (MMG) (Grade III)			
	33C	11.95 - 12.11 11.95 - 13.40	9.50	C*176					12.85	-6.60	
					90 0 0			Extremely weak and very weak thinly laminated light reddish brown MUDSTONE recovered non intact as sandy subangular fine to coarse gravel. (MMG) (Grade II)			
	34C	13.40 - 14.90	9.50						14.15	-7.90	
					100 0 0			Stiff fissured light greenish grey sandy gravelly CLAY. Gravel is subangular and angular fine and medium lithorelicts of very stiff clay and extremely weak mudstone. (MMG) (Grade III)			
	35C	14.90 - 16.40	9.50						14.40	-8.15	
					100			Very stiff fissured reddish brown sandy gravelly CLAY. Gravel is subangular fine to coarse mudstone lithorelicts. (MMG) (Grade III)			
	36C	16.40 - 17.90	9.50						16.40	-10.15	
					98			Very stiff locally stiff fissured reddish brown gravelly CLAY. Gravel is subangular and subrounded fine to coarse lithorelicts of extremely weak and very weak mudstone. Fissures are subhorizontal to 20° and subvertical very closely and closely spaced undulating smooth. (MMG) (Grade III)			
19/03/15 1700hrs 2.60m									17.90	-11.65	
								Continued Next Page	{18.00}		

water strike (m)

casing (m)

rose to (m)

time to rise (m)

remarks

Groundwater not encountered prior to use of water flush.

AGS

CONTRACT 30238

CHECKED EC



CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Start Date 18 March 2015 Easting 339811.7

End Date 20 March 2015 Northing 185831.4 Ground level 6.25mOD

BH530

Sheet 3 of 3

Scale 1 : 50

Depth 21.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
20/03/15 0910hrs 2.20m	37C	17.90 - 19.00	9.80		100 0 0	NI		Weak thinly laminated to very thinly bedded reddish brown MUDSTONE recovered non intact. (MMG) (Grade II)	18.25	-12.00	
					NA			Very stiff fissured light bluish grey gravelly CLAY. Gravel is subangular and subrounded fine to coarse lithorelicts of extremely weak siltstone. (MMG) (Grade III)	18.80	-12.55	
	38C	19.00 - 20.50	9.80		100 8 8	NI		Weak and medium strong thinly laminated to very thinly bedded reddish brown MUDSTONE recovered non intact. (MMG) (Grade I/II)	19.25	-13.00	
					NA		Stiff and very stiff fissured reddish brown gravelly CLAY. Gravel is subangular and subrounded fine and medium mudstone lithorelicts. Fissures are subhorizontal to 20° and subvertical planar smooth. (MMG) (Grade IVa)	20.15	-13.90		
						NI 50 120		19.65 - 19.80m: Very weak thinly laminated reddish brown mudstone.			
20/03/15 1230hrs 3.20m	39C	20.50 - 21.00	9.80		100 36 24			Very weak and weak thinly laminated to very thinly bedded reddish brown MUDSTONE. Fractures are 20° very closely and closely spaced planar smooth. (MMG) (Grade I)	21.00	-14.75	
							Borehole completed at 21.00m.				

TRIAL PIT LOG



TP510

CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 13 February 2015 Easting 338872.1

Scale 1 : 25

End Date 13 February 2015 Northing 185638.5 Ground level 5.90mOD

Depth 4.50 m

water record	sample/test			description	depth (m)	level (m)	legend
	no/type	result	depth (m)				
1.05m: Rapid ingress	1B		0.00- 0.30	Dark purplish grey sandy angular and subangular fine to coarse slag GRAVEL with rare angular and subangular slag cobbles. (MG)	0.90	5.00	
	2D*	Vo 0.8	0.00- 0.30				
	3B		0.70- 0.90				
	4D*	Vo 1.1	0.70- 0.90				
	5B	H 53	1.00- 1.20	Firm locally stiff dark bluish grey mottled light orangish brown slightly gravelly sandy CLAY with rare angular and subangular slag cobbles. Gravel is angular and subangular fine slag. (MG)	1.80	4.10	
	6D*	Vo 1.2	1.00- 1.20				
	7B		1.60- 1.80				
	8D*	Vo 1.4	1.60- 1.80				
	9B		1.80- 2.00	Soft light bluish grey slightly sandy CLAY with rare organic fragments (<1mm). (TFD)	2.50	3.40	
	10D*	Vo 0.5 H 28	1.80- 2.00 2.00				
	11B		2.50- 2.70	Very soft dark bluish grey sandy CLAY with frequent organic fragments (up to 3mm). (TFD)			
	12D*	Vo 0.5	2.50- 2.70				
		H 17	3.00				
	13B		3.10- 3.30				
	14D*	Vo 0.6	3.10- 3.30				
	15B		3.70- 3.90				
	16D*	Vo 0.8	3.70- 3.90				

Notes

Trial pit excavated by JCB 3CX mechanical excavator.
Groundwater encountered at 1.05m.
Trial pit sides remained stable and vertical.
Trial pit dimensions 0.90x2.60x4.50m.
On completion, the trial pit was backfilled with materials arising.

Sketch of Foundation - Not to scale. All dimensions in metres.



CONTRACT

30238

CHECKED

EC

TRIAL PIT LOG



TP510

CLIENT

WELSH GOVERNMENT

SITE

M4 CORRIDOR AROUND NEWPORT

Start Date

13 February 2015

Easting

338872.1

Scale

1 : 25

End Date

13 February 2015

Northing

185638.5

Ground level

5.90mOD

Depth

4.50 m

Sheet

2 of 2

water record	sample/test			description	depth (m)	level (m)	legend
	no/type	result	depth (m)				
3.80m		H 13	4.00				
	17B		4.30- 4.50				
	18D*	Vo 1.0	4.30- 4.50				
				Trial pit completed at 4.50m.	4.50	1.40	

Notes

Trial pit excavated by JCB 3CX mechanical excavator.
Groundwater encountered at 1.05m.
Trial pit sides remained stable and vertical.
Trial pit dimensions 0.90x2.60x4.50m.
On completion, the trial pit was backfilled with materials arising.

Sketch of Foundation - Not to scale. All dimensions in metres.

CONTRACT

30238

CHECKED

EC

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

TRIAL PIT LOG



TP511

CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 13 February 2015 Easting 338633.9

Scale 1 : 25

End Date 13 February 2015 Northing 185592.3 Ground level 5.85mOD

Depth 4.50 m

water record	sample/test			description	depth (m)	level (m)	legend
	no/type	result	depth (m)				
1.05m: Rapid ingress	1B		0.00- 0.40	Dark purplish grey sandy angular and subangular fine to coarse slag GRAVEL with medium subangular slag cobble content. (MG)	0.40	5.45	
	2D*	Vo 0.3	0.00- 0.40				
				Dark brownish grey sandy angular and subangular fine to coarse slag GRAVEL with medium subangular slag cobble content. (MG)			
	3B		0.70- 0.90	0.70 - 0.90m: Frequent angular to subangular coarse dark yellowish brown slag gravel.	0.90	4.95	
	4D*	Vo 0.4	0.70- 0.90				
		H 67	1.00	Firm dark bluish grey slightly sandy slightly gravelly CLAY. Gravel is angular and subangular slag. (MG)			
	5B		1.30- 1.50				
	6D*	Vo 1.9	1.30- 1.50	Firm light grey mottled dark orangish brown slightly sandy CLAY. (TFD)	1.50	4.35	
	7B		1.90- 2.10				
	8D*		1.90- 2.10				
		H 74	2.00				
	9B		2.50- 2.70		2.70	3.15	
	10D*	Vo 0.8	2.50- 2.70				
				Soft light bluish grey sandy CLAY with frequent organic fragments (up to 3mm). (TFD)			
		H 31	3.00				
	11B		3.10- 3.30				
	12D*	Vo 0.6	3.10- 3.30				
	13B		3.70- 3.90				
	14D*	Vo 1.2	3.70- 3.90				

Notes

Trial pit excavated by JCB 3CX mechanical excavator.
Groundwater encountered at 1.05m.
Trial pit sides remained stable and vertical.
Trial pit dimensions 0.80x2.50x4.50m.
On completion, the trial pit was backfilled with materials arising.

Sketch of Foundation - Not to scale. All dimensions in metres.



CONTRACT

30238

CHECKED

EC

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS



TP511

CLIENT

WELSH GOVERNMENT

SITE

M4 CORRIDOR AROUND NEWPORT

Start Date

13 February 2015

Easting

338633.9

Scale

1 : 25

End Date

13 February 2015

Northing

185592.3

Ground level


5.85mOD

Depth

4.50 m

Sheet

2 of 2

water record	sample/test			description	depth (m)	level (m)	legend
	no/type	result	depth (m)				
0.90m		H 19	4.00		4.50	1.35	
	15B		4.30- 4.50				
	16D*	Vo 1.0	4.30- 4.50	Trial pit completed at 4.50m.			
Notes				Sketch of Foundation - Not to scale. All dimensions in metres.			
Trial pit excavated by JCB 3CX mechanical excavator. Groundwater encountered at 1.05m. Trial pit sides remained stable and vertical. Trial pit dimensions 0.80x2.50x4.50m. On completion, the trial pit was backfilled with materials arising.							
EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS				<div><div></div><div>CONTRACT 30238</div><div>CHECKED EC</div></div>			




TP512

Sheet 1 of 1

Scale 1 : 25

Depth 3.00 m

<p>Notes</p> <p>Trial pit excavated by tracked 8 tonne mechanical excavator. Groundwater encountered at 1.50m. Trial pit sides collapsed at 1.5m. Trial pit dimensions 3.10x0.60x3.00m. On completion, the trial pit was backfilled with materials arising.</p>	<p>Sketch of Foundation - Not to scale. All dimensions in metres.</p>				
<p>EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS</p>	<div>  <table border="1"> <tr> <td>CONTRACT</td> <td>CHECKED</td> </tr> <tr> <td>30238</td> <td>EC</td> </tr> </table> </div>	CONTRACT	CHECKED	30238	EC
CONTRACT	CHECKED				
30238	EC				

Geotechnical Engineering Ltd, Tel. 01452 527743 30238 YODA.GPJ TRIALJH.GPJ GEOTECH.GLB 16/07/2015 15:53:36 TP SF/RE



TP513

Sheet 1 of 1

Scale 1 : 25

Depth 3.60 m

Geotechnical Engineering Ltd. Tel. 01452 527743 30238 YODA.GPJ TRIALJH.GPJ GEOTECH.GLB 16/07/2015 15:53:37 TP SF/RE

Trial pit excavated by tracked 8 tonne mechanical excavator.
Groundwater encountered at 2.90.
Trial pit sides collapsed below 2.00m.
Trial pit dimensions 3.30x0.60x3.60m.
On completion, the trial pit was backfilled with materials arising.

Sketch of Foundation - Not to scale. All dimensions in metres.




30238


EC

A2 Appendix 2

Gas and Groundwater Monitoring Results

Project Name New M4 Preliminary Ground Investigation						Groundwater Readings For Installations						
Project No. F15056												
Engineer Ove Arup & Partners Ltd						Fig no.						
Client Transport Wales, Welsh Assembly Government						01						
NOTES: SPIE=Piezometer, SP=Standpipe For multiple installations, use different Installation IDs. For piezometers installation depth = tip depth. For standpipes = base of pipe												
COMMENTS SBHM01 RC installation extends 0.50m above ground level. - symbol indicates water level is above GL All groundwater levels are recorded from ground level												
Exploratory Hole ID	Installation Details			Recorded Water Level								
	Type	Depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
SBHC01 RC	SPIE	8.05		30/01/2008	09:50	2.45	25/02/2008	14:34	2.48	07/03/2008	14:25	2.60
SBHD03 CP	SPIE	10.00		30/01/2008	11:01	0.47	25/02/2008	14:52	0.43	07/03/2008	14:05	0.56
SBHD05 RC	SPIE	12.00		31/01/2008	09:00	1.02	25/02/2008	15:35	1.05	07/03/2008	13:50	1.77
SBHD06 RC	SP	15.00		30/01/2008	13:00	1.13	21/02/2008	10:30	1.39	07/03/2008	13:30	1.39
SBHD08 RC	SPIE	29.50		30/01/2008	13:50	1.20	25/02/2008	15:58	2.02	07/03/2008	13:35	1.40
SBHE02RD	SPIE	25.00		31/01/2008	09:25	2.18	25/02/2008	16:20	2.09	07/03/2008	13:10	2.48
SBHE04 RC	SPIE	17.20		31/01/2008	09:15	2.31	25/02/2008	16:11	2.51	07/03/2008	13:20	2.59
SBHF01 RC	SPIE	19.00		31/01/2008	09:40	5.69	25/02/2008	16:32	5.72	07/03/2008	12:50	5.43
SBHF02A CP	SPIE	17.00		01/02/2008	14:40	7.61	25/02/2008	17:13	7.57	07/03/2008	12:30	9.00
SBHF03 RC	SPIE	18.00		31/01/2008	10:35	6.97	26/02/2008	08:55	6.77	07/03/2008	12:15	7.22
SBHH01 RC	SPIE	25.00		31/01/2008	11:15	3.45	26/02/2008	09:39	3.42	07/03/2008	11:28	3.65
SBHH02 RC	SPIE	14.90		31/01/2008	11:10	3.42	26/02/2008	09:20	3.88	07/03/2008	11:35	3.64
SBHH05 RC	SPIE	21.50		31/01/2008	11:30	2.22	26/02/2008	10:01	2.13	07/03/2008	11:05	3.10
SBHH06 CP	SP	12.30		30/01/2008	15:30	3.75	21/02/2008	08:00	3.76	07/03/2008	11:10	3.87
SBHH07A RC	SPIE	24.85		30/01/2008	14:50	1.70	26/02/2008	10:40	1.34	07/03/2008	11:00	1.07
SBHJ01 CP	SP	7.50		01/02/2008	12:20	1.34	21/02/2008	11:45	5.98	06/03/2008	12:28	1.82
SBHJ03 CP	SP	5.20		01/02/2008	08:00	0.54	27/02/2008	16:15	0.70	07/03/2008	10:45	0.68
SBHJ04	SP	13.10		01/02/2008	11:55	6.61	22/02/2008	13:55	6.67	06/03/2008	11:46	6.75
SBHJ05	SP	11.50		01/02/2008	11:10	8.91	22/02/2008	09:00	9.07	06/03/2008	11:23	9.16
SBHJ06 CP	SP	4.10		01/02/2008	11:45	1.31	21/02/2008	15:30	1.32	06/03/2008	10:50	1.33
SBHJ07 CP	SP	10.40		01/02/2008	11:43	1.35	21/02/2008	14:40	1.40	06/03/2008	12:05	1.56
SBHJ08A CP	SP	7.40		01/02/2008	11:35	3.49	21/02/2008	13:05	2.31	06/03/2008	10:57	2.67
SBHJ09 CP	SP	2.20		01/02/2008	11:30	0.65	21/02/2008	12:25	0.85	06/03/2008	11:00	0.90
SBHJ10 CP	SP	10.00		01/02/2008	10:40	2.30	21/02/2008	13:45	2.24	06/03/2008	10:40	2.16
SBHK01 CP	SP	6.80		01/02/2008	10:55	0.70	25/02/2008	10:30	1.00	06/03/2008	14:24	1.06
SBHK02 CP	SP	11.20		01/02/2008	10:50	1.34	25/02/2008	11:20	1.33	06/03/2008	14:18	1.47
SBHK03 CP	SP	5.90		01/02/2008	10:45	0.87	25/02/2008	12:00	0.89	06/03/2008	14:15	1.00
SBHK04 CP	SP	12.20		01/02/2008	10:25	1.45	25/02/2008	12:30	1.60	06/03/2008	12:30	1.60
SBHL02 RC	SPIE	15.20		01/02/2008	10:35	2.27	25/02/2008	12:49	2.31	06/03/2008	14:00	2.42
SBHL03 RC	SPIE	15.00		31/01/2008	16:20	0.61	26/02/2008	11:15	0.51	07/03/2008	10:25	0.66
SBHM01 RC	SPIE	21.00		01/01/1900	08:20	-0.26	26/02/2008	11:30	-0.26	07/03/2008	10:17	0.05
SBHM02 RC	SPIE	20.00		01/02/2008	08:25	0.19	26/02/2008	11:41	0.49	07/03/2008	10:14	0.68
SBHN01A RC	SPIE	14.90		01/02/2008	15:20	8.49	27/02/2008	17:15	12.23	07/03/2008	14:45	13.18
SBHN02 RC	SPIE	20.40		31/01/2008	15:55	3.67	26/02/2008	11:57	4.19	07/03/2008	10:05	4.84
SBHN03 RC	SPIE	15.00		31/01/2008	15:45	1.07	26/02/2008	12:03	1.73	07/03/2008	09:55	2.34
SBHN04 RC	SPIE	10.00		31/01/2008	15:30	9.99	26/02/2008	14:42	DRY	07/03/2008	09:45	DRY
Recorded by: S Davis			Checked by: I Swain			Approved by: I Swain						
Date: 30/01/08-07/03/08			Date: 16/04/2008			Date: 17/04/2008						
Form No. SI GWR			Revision No. 2.03			Issue Date 07/01/2008						

[illegible]

Project Name New M4 Preliminary Ground Investigation						Groundwater Readings For Installations						
Project No. F15056												
Engineer Ove Arup & Partners Ltd						Fig no.						
Client Transport Wales, Welsh Assembly Government						03						
NOTES: SPIE=Piezometer, SP=Standpipe For multiple installations, use different Installation IDs. For piezometers installation depth = tip depth. For standpipes = base of pipe												
COMMENTS SBHM01 RC installation extends 0.50m above ground level. - symbol indicates water level is above GL All groundwater levels are recorded from ground level												
Exploratory Hole ID	Installation Details			Recorded Water Level								
	Type	Depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
SBHC01 RC	SPIE	8.05		20/03/2008	16:30	2.57	04/04/2008	08:00	2.59	18/04/2008	07:40	2.66
SBHD03 CP	SPIE	10.00		20/03/2008	16:45	0.58	04/04/2008	08:13	0.53	18/04/2008	08:00	0.60
SBHD05 RC	SPIE	12.00		20/03/2008	16:00	1.08	04/04/2008	09:15	1.22	18/04/2008	08:30	1.32
SBHD06 RC	SP	15.00		20/03/2008	17:55	1.20	04/04/2008	09:30	1.33	18/04/2008	08:40	1.44
SBHD08 RC	SPIE	29.50		19/03/2008	18:30	1.28	04/04/2008	10:00	1.39	18/04/2008	08:52	1.52
SBHE02RD	SPIE	25.00		20/03/2008	16:20	2.23	04/04/2008	08:50	2.46	18/04/2008	09:00	2.54
SBHE04 RC	SPIE	17.20		20/03/2008	15:45	2.20	04/04/2008	09:00	1.80	18/04/2008	08:15	1.80
SBHF01 RC	SPIE	19.00		20/03/2008	15:30	5.50	04/04/2008	08:40	5.55	18/04/2008	13:58	5.58
SBHF02A CP	SPIE	17.00		20/03/2008	15:10	5.60	04/04/2008	10:28	5.70	18/04/2008	13:45	5.77
SBHF03 RC	SPIE	18.00		20/03/2008	14:55	7.20	04/04/2008	10:36	7.38	18/04/2008	13:40	7.42
SBHH01 RC	SPIE	25.00		20/03/2008	14:25	3.60	04/04/2008	15:00	3.60	18/04/2008	13:10	3.62
SBHH02 RC	SPIE	14.90		20/03/2008	14:30	4.27	04/04/2008	15:05	3.64	18/04/2008	13:13	3.70
SBHH05 RC	SPIE	21.50		20/03/2008	17:30	2.17	04/04/2008	15:15	2.78	18/04/2008	11:34	2.90
SBHH06 CP	SP	12.30		17/03/2008	15:20	3.88	04/04/2008	15:20	3.89	17/04/2008	14:15	3.90
SBHH07A RC	SPIE	24.85		20/03/2008	13:55	1.33	04/04/2008	15:28	1.92	18/04/2008	11:43	0.88
SBHJ01 CP	SP	7.50		19/03/2008	14:15	1.81	03/04/2008	16:05	1.90	17/04/2008	12:40	1.80
SBHJ03 CP	SP	5.20		19/03/2008	16:40	0.78	03/04/2008	18:25	0.82	17/04/2008	15:55	0.80
SBHJ04	SP	13.10		17/03/2008	13:35	6.64	03/04/2008	18:10	6.74	17/04/2008	13:08	6.80
SBHJ05	SP	11.50		18/03/2008	13:50	9.02	03/04/2008	17:39	9.10	17/04/2008	13:31	9.11
SBHJ06 CP	SP	4.10		17/03/2008	12:55	1.29	03/04/2008	17:43	1.33	17/04/2008	15:05	1.20
SBHJ07 CP	SP	10.40		17/03/2008	10:25	1.59	03/04/2008	17:47	1.50	17/04/2008	13:58	1.47
SBHJ08A CP	SP	7.40		18/03/2008	10:00	2.50	03/04/2008	17:55	2.50	17/04/2008	15:33	2.50
SBHJ09 CP	SP	2.20		18/03/2008	10:25	0.69	03/04/2008	17:58	0.82	17/04/2008	15:22	0.90
SBHJ10 CP	SP	10.00		17/03/2008	09:15	2.10	03/04/2008	17:50	2.00	17/04/2008	13:55	2.00
SBHK01 CP	SP	6.80		19/03/2008	10:45	0.88	03/04/2008	16:40	1.00	17/04/2008	11:40	0.94
SBHK02 CP	SP	11.20		19/03/2008	11:15	1.46	03/04/2008	16:45	1.48	17/04/2008	11:43	1.46
SBHK03 CP	SP	5.90		19/03/2008	11:45	1.04	03/04/2008	16:48	1.07	17/04/2008	11:46	0.98
SBHK04 CP	SP	12.20		19/03/2008	12:15	1.64	03/04/2008	16:52	1.67	17/04/2008	12:05	1.60
SBHL02 RC	SPIE	15.20		19/03/2008	12:50	2.44	03/04/2008	17:00	2.45	17/04/2008	12:00	2.45
SBHL03 RC	SPIE	15.00		20/03/2008	13:25	0.76	08/04/2008	15:40	0.64	18/04/2008	09:50	0.62
SBHM01 RC	SPIE	21.00		20/03/2008	13:05	-0.21	08/04/2008	15:48	-0.45	18/04/2008	11:55	0.01
SBHM02 RC	SPIE	20.00		20/03/2008	13:10	0.61	08/04/2008	15:52	0.61	18/04/2008	11:50	0.61
SBHN01A RC	SPIE	14.90		20/03/2008	12:55	12.14	08/04/2008	16:05	12.58	18/04/2008	12:48	13.27
SBHN02 RC	SPIE	20.40		20/03/2008	12:45	4.26	08/04/2008	16:12	2.64	18/04/2008	12:45	4.85
SBHN03 RC	SPIE	15.00		20/03/2008	12:30	1.60	08/04/2008	16:17	2.07	18/04/2008	12:35	2.37
SBHN04 RC	SPIE	10.00		20/03/2008	12:10	DRY	08/04/2008	16:28	DRY	18/04/2008	10:55	DRY
Recorded by: S Davis			Checked by: I Swain			Approved by: I Swain						
Date: 17/03/08-17/04/08			Date: 21/04/2008			Date: 21/04/2008						
Form No. SI GWR			Revision No. 2.03			Issue Date 07/01/2008						

[illegible]

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH525	19/03/15 12:00:00	1037	2								0.4	9		5 litres purged, base depth 2.60m.	
BH525	19/03/15 12:01:00										0.4				
BH525	19/03/15 12:02:00										0.0				
BH525	19/03/15 12:03:00										0.0				
BH525	19/03/15 12:04:00										0.0				
BH525	19/03/15 12:05:00			0.0	3.2	19.1	63.4	0	0	0.2					
BH525	19/03/15 12:06:00			0.0	2.4	19.2	55.7	0	0	0.0					
BH525	19/03/15 12:07:00			0.0	2.4	19.0	54.1	0	0	0.0					
BH525	19/03/15 12:08:00			0.0	2.2	18.9	51.3	0	0	0.0					
BH525	19/03/15 12:09:00			0.0	2.1	18.8	48.8	0	0	0.0					
BH525	19/03/15 12:10:00			0.0	2.0	18.7	46.1	0	0	0.0					
BH525	19/03/15 12:11:00			0.0	1.9	18.6	42.7	0	0	0.0					
BH525	19/03/15 12:12:00			0.0	1.6	18.4	37.0	0	0	0.0					
BH525	19/03/15 12:13:00			0.0	1.5	18.4	36.2	0	0	0.0					
BH525	19/03/15 12:14:00			0.0	1.5	18.2	33.6	0	0	0.0			1.32		
BH525	26/03/15 12:30:00	1008	-0.32								0.0	12		4 litres purged, base depth 2.60m.	
BH525	26/03/15 12:31:00										0.0				
BH525	26/03/15 12:32:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH525	26/03/15 12:33:00										0.0			
BH525	26/03/15 12:34:00										0.0			
BH525	26/03/15 12:35:00			0.0	9.9	15.0	#	0	2	0.0				
BH525	26/03/15 12:36:00			0.0	7.5	13.2	#	0	3	0.0				
BH525	26/03/15 12:37:00			0.0	5.8	11.7	#	0	3	0.0				
BH525	26/03/15 12:38:00			0.0	5.2	10.1	#	0	3	0.0				
BH525	26/03/15 12:39:00			0.0	5.0	9.1	99.0	0	3	0.0				
BH525	26/03/15 12:40:00			0.0	4.8	8.7	96.0	0	3	0.0				
BH525	26/03/15 12:41:00			0.0	4.7	8.5	93.0	0	4	0.0				
BH525	26/03/15 12:42:00			0.0	4.7	8.2	93.0	0	4	0.0				
BH525	26/03/15 12:43:00			0.0	4.6	8.0	92.0	0	4	0.0				
BH525	26/03/15 12:44:00			0.0	4.6	8.0	90.0	0	3	0.0			1.64	
BH525	02/04/15 12:00:00	1027	-0.92								0.0	9		4 litres purged, base depth 2.60m.
BH525	02/04/15 12:01:00										0.0			
BH525	02/04/15 12:02:00										0.0			
BH525	02/04/15 12:03:00										0.0			
BH525	02/04/15 12:04:00										0.0			
BH525	02/04/15 12:05:00			0.0	4.4	5.1	87.0	0	1	0.3				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks		
BH525	02/04/15 12:06:00	995	1	0.0	4.3	4.1	86.0	0	2	0.5	0.4	17	1.66			
BH525	02/04/15 12:07:00			0.0	4.3	3.6	84.0	0	1	0.2						
BH525	02/04/15 12:08:00			0.0	4.2	3.2	83.0	0	2	0.2						
BH525	02/04/15 12:09:00			0.0	4.1	3.2	81.0	0	2	0.0						
BH525	02/04/15 12:10:00			0.0	3.9	3.4	77.0	0	2	0.0						
BH525	02/04/15 12:11:00			0.0	3.8	3.8	74.0	0	2	0.0						
BH525	02/04/15 12:12:00			0.0	3.6	4.3	70.0	0	2	0.0						
BH525	02/04/15 12:13:00			0.0	3.4	4.9	67.0	0	2	0.0						
BH525	02/04/15 12:14:00			0.0	3.3	5.6	64.0	0	2	0.0						
BH525	07/05/15 14:39:00															
BH525	07/05/15 14:40:00															
BH525	07/05/15 14:41:00															
BH525	07/05/15 14:42:00															
BH525	07/05/15 14:43:00															
BH525	07/05/15 14:44:00					0.0	3.6	0.3	81.4	0					0	1.2
BH525	07/05/15 14:45:00					0.0	3.7	0.1	85.2	0					0	1.2
BH525	07/05/15 14:46:00					0.0	3.7	0.0	86.6	0					0	1.1
BH525	07/05/15 14:47:00					0.0	3.7	0.3	83.8	0					0	1.1
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.																
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GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH525	07/05/15 14:48:00			0.0	3.6	0.7	82.1	0	0	1.1				
BH525	07/05/15 14:49:00			0.0	3.5	1.2	80.0	0	0	1.0				
BH525	07/05/15 14:50:00			0.0	3.3	2.2	75.9	0	0	1.0				
BH525	07/05/15 14:51:00			0.0	3.0	3.5	69.3	0	0	1.0				
BH525	07/05/15 14:52:00			0.0	2.7	4.7	62.7	0	0	1.0				
BH525	07/05/15 14:53:00			0.0	2.6	5.6	58.9	0	0	1.0				
BH525	07/05/15 14:54:00												Dry	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

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GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH525	19/03/15 12:14:00												1.80	58 litres purged, base depth 11.60m. 57 litres purged, base depth 11.60m. 58 litres purged, base depth 11.60m.	
BH525	26/03/15 12:44:00												2.02		
BH525	02/04/15 12:14:00												1.80		
BH525	07/05/15 14:55:00												3.26		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH527	20/03/15 10:00:00	10332	3								1.3	7	0.67	37 litres purged, base depth 9.00m.	
BH527	20/03/15 10:01:00										0.9				
BH527	20/03/15 10:02:00									1.3					
BH527	20/03/15 10:03:00								0.9						
BH527	20/03/15 10:04:00								0.4						
BH527	20/03/15 10:05:00			0.0	0.0	19.8	0.0	0	0	0.5					
BH527	20/03/15 10:06:00			0.0	0.0	19.8	0.0	0	0	0.4					
BH527	20/03/15 10:07:00			0.0	0.0	19.8	0.0	0	0	0.3					
BH527	20/03/15 10:08:00			0.0	0.0	19.8	0.0	0	0	0.3					
BH527	20/03/15 10:09:00			0.0	0.0	19.7	0.0	0	0	0.8					
BH527	20/03/15 10:14:00													Upsurge at 5min 10sec. Unable to obtain further readings.	
BH527	27/03/15 08:30:00	1023	1								0.1	9			32 litres purged, base depth 9.00m.
BH527	27/03/15 08:31:00										0.6				
BH527	27/03/15 08:32:00									0.4					
BH527	27/03/15 08:33:00									0.3					
BH527	27/03/15 08:34:00									0.2					
BH527	27/03/15 08:35:00			0.0	0.0	19.9	0.0	0	0	0.9					
BH527	27/03/15 08:36:00			0.0	0.0	19.9	0.0	0	0	0.6					
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238	

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH527	27/03/15 08:37:00			0.0	0.0	19.9	0.0	0	0	0.5				
BH527	27/03/15 08:38:00			0.0	0.0	19.9	0.0	0	0	0.4				
BH527	27/03/15 08:39:00			0.0	0.0	19.9	0.0	0	0	0.3				
BH527	27/03/15 08:40:00			0.0	0.0	19.9	0.0	0	0	0.2				
BH527	27/03/15 08:41:00			0.0	0.0	19.9	0.0	0	0	0.1				
BH527	27/03/15 08:42:00			0.0	0.0	19.9	0.0	0	0	0.1				
BH527	27/03/15 08:43:00			0.0	0.0	19.9	0.0	0	0	0.1				
BH527	27/03/15 08:44:00			0.0	0.0	19.9	0.0	0	0	0.1			1.75	
BH527	13/04/15 09:30:00	1037	-1.05								0.0	12		33 litres purged, base depth 9.00m.
BH527	13/04/15 09:31:00										0.0			
BH527	13/04/15 09:32:00										0.0			
BH527	13/04/15 09:33:00										0.0			
BH527	13/04/15 09:34:00										0.0			
BH527	13/04/15 09:35:00			0.0	3.4	19.6	61.0	0	0	2.5				
BH527	13/04/15 09:36:00			0.0	2.5	19.9	45.0	0	0	3.0				
BH527	13/04/15 09:37:00			0.0	1.8	20.1	35.0	0	0	3.1				
BH527	13/04/15 09:38:00			0.0	1.6	20.2	31.0	0	0	3.1				
BH527	13/04/15 09:39:00			0.0	1.4	20.2	26.0	0	0	3.2				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks		
BH527	13/04/15 09:40:00	1001	0	0.0	1.2	20.3	23.0	0	0	3.1	0.0	15	1.48			
BH527	13/04/15 09:41:00			0.0	1.0	20.3	20.0	0	0	3.0						
BH527	13/04/15 09:42:00			0.0	0.9	20.3	18.0	0	0	3.0						
BH527	13/04/15 09:43:00			0.0	0.8	20.4	16.0	0	0	2.9						
BH527	13/04/15 09:44:00			0.0	0.8	20.3	16.0	0	0	2.9						
BH527	08/05/15 09:32:00															
BH527	08/05/15 09:33:00															
BH527	08/05/15 09:34:00															
BH527	08/05/15 09:35:00															
BH527	08/05/15 09:36:00															
BH527	08/05/15 09:37:00					0.0	0.0	20.1	0.0	0					0	0.0
BH527	08/05/15 09:38:00					0.0	0.0	20.1	0.0	0					0	0.0
BH527	08/05/15 09:39:00					0.0	0.0	20.1	0.0	0					0	0.0
BH527	08/05/15 09:40:00					0.0	0.0	20.1	0.0	0					0	0.0
BH527	08/05/15 09:41:00					0.0	0.0	20.1	0.0	0					0	0.0
BH527	08/05/15 09:42:00					0.0	0.0	20.1	0.0	0					0	0.0
BH527	08/05/15 09:43:00					0.0	0.0	20.1	0.0	0					0	0.0
BH527	08/05/15 09:44:00					0.0	0.0	20.1	0.0	0					0	0.0
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.															CONTRACT 30238	CHECKED EC

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GAS AND GROUNDWATER LEVELS



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SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH527	08/05/15 09:45:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH527	08/05/15 09:46:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH527	08/05/15 09:47:00												2.74	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

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GAS AND GROUNDWATER LEVELS



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SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH527	20/03/15 10:14:00												1.89	102 litres purged, base depth 19.00m. 102 litres purged, base depth 19.00m. 102 litres purged, base depth 19.00m.	
BH527	27/03/15 08:44:00												1.71		
BH527	13/04/15 09:44:00												1.91		
BH527	08/05/15 09:48:00												3.10		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH528	20/03/15 12:00:00	1031	1								0.4	10		13 litres purged, base depth 7.00m. Slow recharge during purging.
BH528	20/03/15 12:01:00										0.0			
BH528	20/03/15 12:02:00										0.0			
BH528	20/03/15 12:03:00										0.0			
BH528	20/03/15 12:04:00										0.0			
BH528	20/03/15 12:05:00			0.0	0.0	20.3	0.0	0	0	0.4				
BH528	20/03/15 12:06:00			0.0	0.0	20.1	0.0	0	0	0.3				
BH528	20/03/15 12:07:00			0.0	0.0	20.1	0.0	0	0	0.2				
BH528	20/03/15 12:08:00			0.0	0.0	20.1	0.0	0	0	0.1				
BH528	20/03/15 12:09:00			0.0	0.0	20.1	0.0	0	0	0.1				
BH528	20/03/15 12:10:00			0.0	0.0	20.1	0.0	0	0	0.1				
BH528	20/03/15 12:11:00			0.0	0.0	20.1	0.0	0	0	0.1				
BH528	20/03/15 12:12:00			0.0	0.0	20.1	0.0	0	0	0.1				
BH528	20/03/15 12:13:00			0.0	0.0	20.1	0.0	0	0	0.1				
BH528	20/03/15 12:14:00			0.0	0.0	20.1	0.0	0	0	0.1			0.49	
BH528	27/03/15 10:30:00	1028	-1.18								0.0	9		10 litres purged, base depth 7.00m. Purging dry, with slow recharge.
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH528	27/03/15 10:31:00										0.0			
BH528	27/03/15 10:32:00										0.0			
BH528	27/03/15 10:33:00										0.0			
BH528	27/03/15 10:34:00										0.0			
BH528	27/03/15 10:35:00			0.0	0.0	20.9	0.0	0	0	0.0				
BH528	27/03/15 10:36:00			0.0	0.0	20.8	0.0	0	0	0.0				
BH528	27/03/15 10:37:00			0.0	0.0	20.8	0.0	0	0	0.0				
BH528	27/03/15 10:38:00			0.0	0.0	20.8	0.0	0	0	0.0				
BH528	27/03/15 10:39:00			0.0	0.0	20.8	0.0	0	0	0.0				
BH528	27/03/15 10:40:00			0.0	0.0	20.8	0.0	0	0	0.0				
BH528	27/03/15 10:41:00			0.0	0.0	20.7	0.0	0	0	0.0				
BH528	27/03/15 10:42:00			0.0	0.0	20.7	0.0	0	0	0.0				
BH528	27/03/15 10:43:00			0.0	0.0	20.7	0.0	0	0	0.0				
BH528	27/03/15 10:44:00			0.0	0.0	20.6	0.0	0	0	0.0			0.99	
BH528	13/04/15 12:00:00	1032	0.54								0.0	13		12 litres purged, base depth 7.00m. Purging dry with slow recharge.
BH528	13/04/15 12:01:00										0.0			
BH528	13/04/15 12:02:00										0.0			
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH528	13/04/15 12:03:00	1019	0								0.0	15	0.58	Upsurge at 2min 45sec. Unable to obtain further readings. Purging dry, with slow recharge.
BH528	13/04/15 12:04:00										0.0			
BH528	13/04/15 12:05:00			8.1	31.0	11.8	#	0	4	0.0				
BH528	13/04/15 12:06:00			7.8	30.0	12.1	#	0	5	0.0				
BH528	13/04/15 12:14:00													
BH528	08/05/15 10:36:00										0.0			
BH528	08/05/15 10:37:00										0.0			
BH528	08/05/15 10:38:00										0.0			
BH528	08/05/15 10:39:00										0.0			
BH528	08/05/15 10:40:00										0.0			
BH528	08/05/15 10:41:00				0.0	0.0	20.3	0.0	0	0	0.0			
BH528	08/05/15 10:42:00				0.0	0.0	20.3	0.0	0	0	0.0			
BH528	08/05/15 10:43:00				0.0	0.0	20.2	0.0	0	0	0.0			
BH528	08/05/15 10:44:00				0.0	0.0	20.2	0.0	0	0	0.0			
BH528	08/05/15 10:45:00				1.3	0.0	19.9	0.0	0	0	0.0			
BH528	08/05/15 10:46:00				0.5	0.2	20.0	0.0	0	0	0.0			
BH528	08/05/15 10:47:00				0.0	0.0	20.2	0.0	0	0	0.0			
BH528	08/05/15 10:48:00				0.0	0.0	20.2	0.0	0	0	0.0			
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

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GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH528	08/05/15 10:49:00			0.0	0.0	20.2	0.0	0	0	0.0					
BH528	08/05/15 10:50:00			0.0	0.0	20.2	0.0	0	0	0.0					
BH528	08/05/15 10:51:00												1.63		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238	CHECKED EC

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GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH528	20/03/15 12:14:00												1.28	94 litres purged, base depth 17.00m. 92 litres purged, base depth 17.00m. 92 litres purged, base depth 17.00m.	
BH528	27/03/15 10:44:00												1.30		
BH528	13/04/15 12:14:00												1.65		
BH528	08/05/15 10:52:00												2.90		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

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Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH530	30/03/15 12:00:00	1014	0								0.0	10		29 litres purged, base depth 8.00m.	
BH530	30/03/15 12:01:00										0.0				
BH530	30/03/15 12:02:00										0.0				
BH530	30/03/15 12:03:00										0.0				
BH530	30/03/15 12:04:00										0.0				
BH530	30/03/15 12:05:00			0.0	0.0	20.3	0.0	0	0	0.5					
BH530	30/03/15 12:06:00			0.0	0.0	20.3	0.0	0	0	0.4					
BH530	30/03/15 12:07:00			0.0	0.0	20.3	0.0	0	0	0.2					
BH530	30/03/15 12:08:00			0.0	0.0	20.3	0.0	0	0	0.2					
BH530	30/03/15 12:09:00			0.0	0.0	20.3	0.0	0	0	0.1					
BH530	30/03/15 12:10:00			0.0	0.0	20.3	0.0	0	0	0.1					
BH530	30/03/15 12:11:00			0.0	0.0	20.3	0.0	0	0	0.1					
BH530	30/03/15 12:12:00			0.0	0.0	20.3	0.0	0	0	0.0					
BH530	30/03/15 12:13:00			0.0	0.0	20.3	0.0	0	0	0.0					
BH530	30/03/15 12:14:00			0.0	0.0	20.3	0.0	0	0	0.0					
												1.52			
BH530	14/04/15 13:30:00	1027	-0.07								0.0	16		26 litres purged, base depth 8.00m.	
BH530	14/04/15 13:31:00										0.0				
BH530	14/04/15 13:32:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH530	14/04/15 13:33:00										0.0			
BH530	14/04/15 13:34:00										0.0			
BH530	14/04/15 13:35:00			5.3	14.8	15.0	#	0	10	0.0				
BH530	14/04/15 13:36:00			5.3	14.7	15.1	#	0	9	0.0				
BH530	14/04/15 13:37:00			5.1	14.4	15.2	#	0	9	0.0				
BH530	14/04/15 13:38:00			5.1	14.1	15.2	#	0	8	0.0				
BH530	14/04/15 13:39:00			5.0	13.9	15.3	#	0	8	0.0				
BH530	14/04/15 13:40:00			4.9	13.6	15.4	#	0	7	0.0				
BH530	14/04/15 13:41:00			4.8	13.3	15.6	#	0	6	0.0				
BH530	14/04/15 13:42:00			4.8	13.4	15.5	#	0	4	0.0				
BH530	14/04/15 13:43:00			4.8	13.2	15.5	#	0	6	0.0				
BH530	14/04/15 13:44:00			4.7	13.0	15.4	#	0	4	0.0			2.07	
BH530	21/04/15 09:30:00	1040	-0.82								0.0	12		27 litres purged, base depth 8.00m.
BH530	21/04/15 09:31:00										0.0			
BH530	21/04/15 09:32:00										0.0			
BH530	21/04/15 09:33:00										0.0			
BH530	21/04/15 09:34:00										0.0			
BH530	21/04/15 09:35:00			3.7	8.4	17.7	#	0	1	0.3				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH530	21/04/15 09:36:00	1019	0	2.6	5.2	18.7	97.0	0	1	0.5		15	1.84	
BH530	21/04/15 09:37:00			2.0	3.7	19.2	69.0	0	1	0.7				
BH530	21/04/15 09:38:00			1.6	3.0	19.4	55.0	0	0	1.1				
BH530	21/04/15 09:39:00			1.3	2.2	19.7	42.0	0	0	1.1				
BH530	21/04/15 09:40:00			1.2	1.9	19.7	37.0	0	0	1.1				
BH530	21/04/15 09:41:00			1.0	1.6	19.9	30.0	0	0	1.1				
BH530	21/04/15 09:42:00			0.8	1.4	19.9	27.0	0	0	1.1				
BH530	21/04/15 09:43:00			0.7	1.2	20.0	24.0	0	0	1.0				
BH530	21/04/15 09:44:00			0.7	1.1	20.0	22.0	0	0	1.0				
BH530	11/05/15 09:21:00										0.0			
BH530	11/05/15 09:22:00										0.0			
BH530	11/05/15 09:23:00										0.0			
BH530	11/05/15 09:24:00										0.0			
BH530	11/05/15 09:25:00										0.0			
BH530	11/05/15 09:26:00			0.0	0.0	20.2	0.0	0	0	0.0				
BH530	11/05/15 09:27:00			0.1	0.0	20.1	1.3	0	0	0.0				
BH530	11/05/15 09:28:00			0.4	0.2	20.0	7.0	0	0	0.0				
BH530	11/05/15 09:29:00			0.6	0.4	19.9	10.3	0	0	0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH530	11/05/15 09:30:00			0.8	0.5	19.9	12.9	0	0	0.0				
BH530	11/05/15 09:31:00			0.9	0.6	19.8	15.0	0	0	0.0				
BH530	11/05/15 09:32:00			0.9	0.6	19.8	15.4	0	0	0.0				
BH530	11/05/15 09:33:00			1.2	0.7	19.7	18.9	0	0	0.0				
BH530	11/05/15 09:34:00			0.5	0.6	19.9	11.2	0	0	0.0				
BH530	11/05/15 09:35:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH530	11/05/15 09:36:00												2.62	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH530	30/03/15 12:14:00												2.00	114 litres purged, base depth 21.00m. 112 litres purged, base depth 21.00m. 111 litres purged, base depth 21.00m.	
BH530	14/04/15 13:44:00												2.19		
BH530	21/04/15 09:44:00												2.44		
BH530	11/05/15 09:37:00												3.49		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC

A3 Appendix 3

Soil Laboratory Data

M4CAN
Soil Analysis Results & Screening Assessment
CL-27
01/07/2015

Sample Reference		BHK3	BHK3	BHK4	BHK4	CH51	CH52A	CH53A	CH54A	RBBH003	RBBH004	RBBH005	SBHK03 CP	SBHK02 CP	STPK01	STPK02	BH526	BH526	BH527	BH527	BH530	TP510	TP510
Location Type		BH	BH	BH	BH	TP	TP	TP	TP	BH	BH	BH	BH	BH	TP	TP	BH	BH	BH	BH	BH	TP	TP
Specimen Depth (m)		0	1	1	2	0	0.3	0.4	0.4	0.5	0.5	0.5	1	1	0.34	0.3	0.0 - 0.2	0.4 - 0.5	0.2 - 0.3	0.5 - 1.0	0.2 - 0.5	0.0 - 0.3	1.0 - 1.2
OD Level (m)		6	5	4.5	3.5	5.73	5.19	5.13	5.95				4.83	4.53	5.24	5.74	5.95	5.55	5.75	5.25	6.05	5.9	4.9
Sample Type		B	B	D	D	D	D	D	D				ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES
Geology Code		MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG
Cluster Code		1997 GI	1997 GI	1997 GI	1997 GI	2000 GI	2000 GI	2000 GI	2000 GI	2002 GI	2002 GI	2002 GI	2007 GI	2007 GI	2007 GI	2007 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI
Inorganics																							
Antimony	mg/kg	11.7	12.2	3.6	4.2	2.82	15.2	1.15	8.3	<3	<3	<3	21	36	<1.5	14							
Arsenic	mg/kg														<3	<3	<3	10	32	34	38	38	19
Barium	mg/kg												120	71	80	81							
Boron	mg/kg	<0.2	<0.2	1.5	0.9	0.9	1.6	6	0.8	2.7	1.1	2.8					0.64	0.63	1.9	1.9	1.6	1.9	1.4
Boron Water Soluble	mg/kg												3.5	<3.5	<3.5	<3.5							
Cadmium	mg/kg	0.8	0.7	8	8.6	0.13	0.15	1.6	0.13	<1	<1	<1	<0.3	<0.3	0.6	<0.3	0.28	0.27	0.4	0.32	<0.1	0.26	<0.1
Chromium	mg/kg	46.7	51.5	561.4	504.3	706	53	670	36	913	305	805	590	590	55	440	140	170	890	920	47	1200	1200
Copper	mg/kg	32.9	26.1	21.6	18.1	24	15	19	10	17	18	9	<6	7	10	6	0	2.1	11	29	20	19	14
Lead	mg/kg	46.7	43	60.9	60.9	62	59	71	35	66	57	32	28	460	38	<2	7.7	6.9	11	12	33	63	20
Mercury	mg/kg	0.1	<0.1	0.4	0.4	0.07	<0.01	0.02	<0.01	<0.5	<0.5	<0.5	<0.6	<0.6	<0.6	<0.6	0.26	0.33	1.3	1.2	<0.1	0.48	0.62
Molybdenum	mg/kg												<0.6	1.5	<0.6	<0.6							
Manganese	mg/kg								42100	16700	6600												
Nickel	mg/kg	43.1	51.1	40.2	40.2	5	42	7	27	2	6	6	<0.9	<0.9	4	<0.9	16	19	40	54	36	34	63
Selenium	mg/kg	0.3	0.2	0.1	<0.1	1.63	<0.5	1.6	<0.5	1.22	3.44	1.15	<3	<3	<3	<3	0	0	<0.2	<0.2	<0.2	<0.2	<0.2
Zinc	mg/kg	115.2	99.6	85.9	80.8	69	118	61	69	60	57	65	170	73	110	120	53	48	140	140	120	240	87
Iron	mg/kg					14300		131000		168000	87000	169000			110000								
Cyanide (total)	mg/kg	0.2	0.2	0.2	0.1	3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide (free)	mg/kg	<0.1	<0.1	<0.1	<0.1		<1	<1									<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Thiocyanate	mg/kg	<1	<1	<1	<1				<0.5	1	0.8												
Ferro/ferricyanide	mg/kg	<10	<10	<10	<10																		
Acid Soluble Sulphate	mg/kg					4020	678	2660	866	2160	5820	2750											
Sulphate (soluble)	g/l												<0.003	<0.003	0.076	<0.003							
Sulphate (total)	mg/kg	650	297	828	1146																		
Sulphide	mg/kg	2.3	3.1	27.4		6	<1	66															
Other																							
Asbestos Presence Screen	None												NFD	NFD	NFD	NFD	NAD	NAD	NAD	NAD	NAD	NAD	NAD
Asbestos Identification	%																<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Loss on Ignition	%												1.2	1.1	1.7	3.2							
Total Organic Carbon	%												0.3	<0.2	0.9	0.4							
Organic Matter	%																						
pH Value	pH Units	7.8	8.1	11.5	11.5	12.2	8	12.2	10	12.9	12.4	12.7	11.73	12.31	8.6	12.53	10.9	10.9	12.3	12.2	8.1	12.8	12.9
Material >2mm	%																						
Organics																							
PAH (Screening)	mg/kg					82	11	26	<10														
TPH FTIR (AR)	mg/kg					198	37	225	<20														
OIL FTIR	mg/kg					585	95	164	77														
Phenols																							
Phenol Index	mg/kg					<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5											
Phenols Monohydric	mg/kg	<1	<1	<1	<1																		
Phenols (total)	mg/kg	<1	<1	<1	<1								<0.15	<0.15	<0.15	<0.15							

M4CAN
Soil Analysis Results & Screening Assessment
CL-27
01/07/2015

Geological Formation legend	
MG	Made Ground
TFD	Tidal Flat Deposits

Sample Reference	Units	CH52A	CH53A	SBHK01 CP	SBHK02 CP	SBHK02 BH	SBHK03 CP	SBHK03 BH	SBHK04 CP	STPK01	STPK01	STPK01	STPK02	STPK02	STPK02	BH526	BH528	BH529	BH530	TP510	TP512	TP513	
Location Type		TP	TP	BH	BH	BH	BH	BH	BH	TP	TP	TP	TP	TP	TP	BH	BH	BH	BH	TP	TP	TP	
Specimen Depth (m)		1.2	1.1	3	3	4.5	2	7	0.3	1	1.2	1.27	3	1.24	2	3	1.5 - 1.7	0.25 - 0.4	0.0 - 0.4	0.8 - 1.0	1.8 - 2.0	0.0 - 0.1	1.0 - 1.1
OD Level (m)		4.29	4.43	2.26	2.53	1.03	3.83	-1.17	5.25	4.55	4.38	4.31	2.58	4.8	4.04	3.04	4.45	4.95	5.1	5.45	4.1	5.1	5.3
Sample Type		D	D	U	ES	U	ES	U	ES	ES	B	ES	B	ES	B	B	ES	ES	ES	ES	ES	ES	ES
Geology Code		TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD
Cluster Code		2000 GI	2000 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	
Inorganics																							
Antimony	mg/kg				2.9		2.3		2.6	2.3		1.8		3.2									
Arsenic	mg/kg	2.23	13.2		6		5		11	4		7		10		16	18	8.3	19	6.9	13	14	
Barium	mg/kg				32		47		49	57		76		<6									
Boron	mg/kg	2	1													0.8	1.5	1.2	1.3	1.3	0.2	0.66	
Boron Water Soluble	mg/kg				<3.5		<3.5		<3.5	<3.5		<3.5		<3.5		0.19	<0.1	<0.1	<0.1	<0.1	0.26	<0.1	
Cadmium	mg/kg	0.14	0.17		<0.3		<0.3		<0.3	<0.3		<0.3		<0.3									
Chromium	mg/kg	647	48		32		48		43	35		49		1800		110	44	32	44	36	32	32	
Copper	mg/kg	23	13		10		10		10	9		<6		45		4.9	4.1	9	13	2.7	12	8.5	
Lead	mg/kg	65	53		980		21		25	19		20		25		27	28	19	34	9.4	36	19	
Mercury	mg/kg	<0.01	<0.01		<0.6		<0.6		<0.6	<0.6		<0.6		<0.6		0.16	<0.1	<0.1	<0.1	<0.1	0.12	<0.1	
Molybdenum	mg/kg				<0.6		<0.6		0.8	<0.6		<0.6		<0.6									
Manganese	mg/kg																						
Nickel	mg/kg	4	38		21		24		32	36		26		30		29	35	24	34	9.8	27	32	
Selenium	mg/kg	1.46	<0.5		<3		<3		<3	<3		<3		<3		<0.2	<0.2	<0.2	<0.2	0.31	0.21	<0.2	
Zinc	mg/kg	44	130		660		160		100	95		100		100		100	120	71	110	30	74	68	
Iron	mg/kg				24000																		
Cyanide (total)	mg/kg	<1	<1		<1		<1		<1	<1		<1		<1		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Cyanide (free)	mg/kg	<1	<1													<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Thiocyanate	mg/kg																						
Ferro/ferricyanide	mg/kg																						
Acid Soluble Sulphate	mg/kg	1750	644																				
Sulphate (soluble)	g/l				0.1		0.56		0.018	0.021		0.081		0.042									
Sulphate (total)	mg/kg																						
Sulphide	mg/kg	48	<1																				
Other																							
Asbestos Presence Screen	None				NFD		NFD		NFD	NFD		NFD		NFD		NAD							
Asbestos Identification	%															<0.001							
Loss on Ignition	%								5.1														
Total Organic Carbon	%								58			0.7											
Organic Matter	% Units			1.9		2.3		1.6			2.2	2		1.3	2.1								
pH Value	pH Units	12.3	9		8.28		8.2		7.95	8.26		8.29		8.62		9.9	8	8.2	8.2	10.8	7.1	8.3	
Material >2mm	%			<0.1		7.4		<0.1			57.2		<0.1		57.7	1.4							
Organics																							
PAH (Screening)	mg/kg	12	<10																				
TPH FTIR (AR)	mg/kg	190	55																				
OIL FTIR	mg/kg	133	43																				
Phenols																							
Phenol Index	mg/kg	<0.5	<0.5																				
Phenols Monohydric	mg/kg																						
Phenols (total)	mg/kg				<0.15		<0.15		<0.15	<0.15		<0.15		<0.15									

M4CAN		Screening Values and Assessment						
Soil Analysis Results & Screening Assessment CL-27 01/07/2015			Exceeds S4ULs criteria					
		X	Laboratory detection level higher than screening criterion					
		Notes						
Sample Reference	Units	NFD = No Fibres Detected						
Location Type		NAD = No Asbestos Detected						
Specimen Depth (m)		Chromium VI criteria used						
OD Level (m)		Elemental Mercury criteria used						
Sample Type		Screening criterion for lead is C4SL in the absence of a S4UL						
Geology Code								
Cluster Code		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	Selected S4ULs Criteria	No. Data Exceeding S4ULs Criteria
Inorganics								
Antimony	mg/kg	10	9	36	1.8	SBHK02 CP @ 1mbGL		1
Arsenic	mg/kg	37	31	55	1.15	TP510 @ 0.0 - 0.3mbGL	170	0
Barium	mg/kg	10	9	120	32	SBHK03 CP @ 1mbGL		1
Boron	mg/kg	27	25	6	0.63	CH53A @ 0.4mbGL	46000	0
Boron Water Soluble	mg/kg	10	1	3.5	3.5	SBHK03 CP @ 1mbGL		9
Cadmium	mg/kg	37	18	8.6	0.13	BHK4 @ 2mbGL	190	0
Chromium	mg/kg	37	37	1800	32	STPK02 @ 1.24mbGL	33	33
Copper	mg/kg	37	35	45	0	STPK02 @ 1.24mbGL	44000	0
Lead	mg/kg	37	36	980	6.9	SBHK02 CP @ 3mbGL	1300	0
Mercury	mg/kg	37	13	1.3	0.02	BH527 @ 0.2 - 0.3mbGL	30	0
Molybdenum	mg/kg	10	2	1.5	0.8	SBHK02 CP @ 1mbGL		8
Manganese	mg/kg	3	3	42100	6600	RBBH003 @ 0.5mbGL		0
Nickel	mg/kg	37	34	63	2	TP510 @ 1.0 - 1.2mbGL	980	0
Selenium	mg/kg	37	13	3.44	0	RBBH004 @ 0.5mbGL	1800	0
Zinc	mg/kg	37	37	660	30	SBHK02 CP @ 3mbGL	170000	0
Iron	mg/kg	7	7	169000	14300	RBBH005 @ 0.5mbGL		0
Cyanide (total)	mg/kg	37	5	3	0.1	CH51 @ 0mbGL		32
Cyanide (free)	mg/kg	22	0	None > LOD	None > LOD			22
Thiocyanate	mg/kg	7	2	1	0.8	RBBH004 @ 0.5mbGL		5
Ferro/ferricyanide	mg/kg	4	0	None > LOD	None > LOD			4
Acid Soluble Sulphate	mg/kg	9	9	5820	644	RBBH004 @ 0.5mbGL		0
Sulphate (soluble)	g/l	10	7	0.56	0.018	SBHK03 CP @ 2mbGL		3
Sulphate (total)	mg/kg	4	4	1146	297	BHK4 @ 2mbGL		0
Sulphide	mg/kg	9	7	66	2.3	CH53A @ 0.4mbGL		2
Other								
Asbestos Presence Screen	None	18	0	None > LOD	None > LOD			18
Asbestos Identification	%	8	0	None > LOD	None > LOD			8
Loss on Ignition	%	5	5	5.1	1.1	SBHK04 CP @ 0.3mbGL		0
Total Organic Carbon	%	6	5	58	0.3	SBHK04 CP @ 0.3mbGL		1
Organic Matter	%	7	7	2.3	1.3	SBHK02 CP @ 4.5mbGL		0
pH Value	pH Units	37	37	12.9	7.1	RBBH003 @ 0.5mbGL	6-9	20
Material >2mm	%	7	4	57.7	1.4	STPK02 @ 2mbGL		3
Organics								
PAH (Screening)	mg/kg	6	4	82	11	CH51 @ 0mbGL	1.1	4
TPH FTIR (AR)	mg/kg	6	5	225	37	CH53A @ 0.4mbGL	3200	0
OIL FTIR	mg/kg	6	6	585	43	CH51 @ 0mbGL		0
Phenols								
Phenol Index	mg/kg	9	0	None > LOD	None > LOD		440	0
Phenols Monohydric	mg/kg	4	0	None > LOD	None > LOD		440	0
Phenols (total)	mg/kg	14	0	None > LOD	None > LOD		440	0

		Notes						
Sample Reference	Units	NFD = No Fibres Detected NAD = No Asbestos Detected Chromium VI criteria used Elemental Mercury criteria used Screening criterion for lead is CASL in the absence of a S4UL						
Location Type								
Specimen Depth (m)								
OD Level (m)								
Sample Type								
Geology Code								
Cluster Code		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	Selected S4ULs Criteria	No. Data Exceeding S4ULs Criteria
BTEX								
GRO (C4-C12)	mg/kg	10	2	0.025	0.014	STPK01 @ 1.27mbGL		8
MTBE	mg/kg	12	0	None > LOD	None > LOD			12
Benzene	mg/kg	16	0	None > LOD	None > LOD		27	0
Toluene	mg/kg	16	0	None > LOD	None > LOD		56000	0
Ethyl benzene	mg/kg	16	0	None > LOD	None > LOD		5700	0
m & p Xylene	mg/kg	16	2	0.025	0.014	STPK01 @ 1.27mbGL	5900	0
o Xylene	mg/kg	16	0	None > LOD	None > LOD		6600	0
TPH								
TPH >C6-C8.	mg/kg	6	0	None > LOD	None > LOD		7800	0
TPH >C8-C10.	mg/kg	6	0	None > LOD	None > LOD		2000	0
TPH >C10-C12.	mg/kg	6	0	None > LOD	None > LOD		9200	0
TPH >C12-C16.	mg/kg	6	1	6.6	6.6	BH526 @ 0.4 - 0.5mbGL	10000	0
TPH >C16-C21.	mg/kg	6	3	11	3.1	BH526 @ 0.4 - 0.5mbGL	7600	0
TPH >C21-C35.	mg/kg	6	2	28	4.7	BH526 @ 0.4 - 0.5mbGL	7800	0
Aliphatics C5-C6	mg/kg	15	0	None > LOD	None > LOD		3200	0
Aliphatics >C6-C8	mg/kg	15	0	None > LOD	None > LOD		7800	0
Aliphatics >C8-C10	mg/kg	15	0	None > LOD	None > LOD		2000	0
Aliphatics >C10-C12	mg/kg	15	0	None > LOD	None > LOD		9700	0
Aliphatics >C12-C16	mg/kg	15	1	0.53	0.53	SBHK03 CP @ 2mbGL	25000	0
Aliphatics >C16-C21	mg/kg	15	3	3.3	1.2	SBHK04 CP @ 1mbGL	450000	0
Aliphatics >C21-C35	mg/kg	15	9	40	2.1	STPK02 @ 0.3mbGL	450000	0
Total Aliphatics C5-C35	mg/kg	10	9	40	3.3	STPK02 @ 0.3mbGL	2000	0
Aliphatics >C35-44	mg/kg	5	0	None > LOD	None > LOD		450000	0
Aromatics >C5-C7	mg/kg	5	0	None > LOD	None > LOD		26000	0
Aromatics C6-C7	mg/kg	10	0	None > LOD	None > LOD		7800	0
Aromatics >C7-C8	mg/kg	15	0	None > LOD	None > LOD		56000	0
Aromatics >EC8-EC10	mg/kg	15	2	0.025	0.014	STPK01 @ 1.27mbGL	3500	0
Aromatics >EC10-EC12	mg/kg	15	0	None > LOD	None > LOD		9200	0
Aromatics >EC12-EC16	mg/kg	15	4	7.4	1.7	SBHK03 CP @ 2mbGL	10000	0
Aromatics >EC16-EC21	mg/kg	15	7	5.3	0.86	SBHK02 CP @ 3mbGL	7600	0
Aromatics >EC21-EC35	mg/kg	15	10	21	1.9	SBHK02 CP @ 3mbGL	7800	0
Total Aromatics C6-C35	mg/kg	10	10	33	1.9	SBHK02 CP @ 3mbGL	3500	0
Aromatics >C35-44	mg/kg	5	0	None > LOD	None > LOD		7800	0
Total Aliphatic TPH	mg/kg	5	0	None > LOD	None > LOD		2000	0
Total Aromatic TPH	mg/kg	5	0	None > LOD	None > LOD			5
TPH (Aliphatics and Aromatics C5-C35)	mg/kg	10	10	49	6.8	STPK02 @ 0.3mbGL	2000	0
Total petroleum hydrocarbons	mg/kg	5	0	None > LOD	None > LOD		2000	0
PAH								
Acenaphthene	mg/kg	24	2	0.027	0.014	SBHK03 CP @ 1mbGL	29000	0
Acenaphthylene	mg/kg	24	5	0.012	0.005	STPK01 @ 0.34mbGL	29000	0
Anthracene	mg/kg	24	4	0.074	0.01	SBHK03 CP @ 1mbGL	150000	0
Benz(a)anthracene	mg/kg	24	9	0.31	0.017	STPK02 @ 1.24mbGL	49	0
Benzo(a)pyrene	mg/kg	24	7	0.21	0.014	SBHK03 CP @ 1mbGL	11	0
Benzo(b)fluoranthene	mg/kg	24	6	0.36	0.021	SBHK03 CP @ 1mbGL	13	0
Benzo(ghi)perylene	mg/kg	24	6	0.2	0.015	SBHK03 CP @ 1mbGL	1400	0
Benzo(k)fluoranthene	mg/kg	24	4	0.2	0.031	SBHK03 CP @ 1mbGL	370	0
Chrysene	mg/kg	24	8	0.43	0.01	SBHK03 CP @ 1mbGL	93	0
Dibenzo(ah)anthracene	mg/kg	24	4	0.071	0.01	SBHK03 CP @ 1mbGL	1.1	0
Fluoranthene	mg/kg	24	6	0.43	0.028	SBHK03 CP @ 1mbGL	6300	0
Fluorene	mg/kg	24	2	0.036	0.014	SBHK03 CP @ 1mbGL	20000	0
Indeno(123cd)pyrene	mg/kg	24	5	0.16	0.017	SBHK03 CP @ 1mbGL	150	0
Naphthalene	mg/kg	24	8	0.089	0.013	STPK01 @ 0.34mbGL	190	0
Phenanthrene	mg/kg	24	7	0.33	0.036	SBHK03 CP @ 1mbGL	6200	0
Pyrene	mg/kg	24	7	0.37	0.022	SBHK03 CP @ 1mbGL	15000	0
PAH 16 Total	mg/kg	25	9	3.2	0.055	SBHK03 CP @ 1mbGL		15

[illegible]

Notes								
Sample Reference	Units	NFD = No Fibres Detected NAD = No Asbestos Detected Chromium VI criteria used Elemental Mercury criteria used Screening criterion for lead is C4SL in the absence of a S4UL						
Location Type								
Specimen Depth (m)								
OD Level (m)								
Sample Type								
Geology Code								
Cluster Code		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	Selected S4ULs Criteria	No. Data Exceeding S4ULs Criteria
VOCs								
1,1,1,2-Tetrachloroethane	ug/kg	2	0	None > LOD	None > LOD			2
1,1,1-Trichloroethane	ug/kg	2	0	None > LOD	None > LOD			2
1,1-Dichloropropene	ug/kg	2	0	None > LOD	None > LOD			2
1,2,3-Trichloropropane	ug/kg	2	0	None > LOD	None > LOD			2
1,1,2-Trichloroethane	ug/kg	2	0	None > LOD	None > LOD			2
1,2,3-Trichlorobenzene	ug/kg	2	0	None > LOD	None > LOD		102	0
1,1-Dichloroethane	ug/kg	2	0	None > LOD	None > LOD			2
1,1-Dichloroethene	ug/kg	2	0	None > LOD	None > LOD			2
1,2-Dichloroethane	ug/kg	2	0	None > LOD	None > LOD			2
1,2-Dichlorobenzene	ug/kg	2	0	None > LOD	None > LOD			2
cis-1,2-Dichloroethene	ug/kg	2	0	None > LOD	None > LOD			2
1,2-Dichloropropane	ug/kg	2	0	None > LOD	None > LOD			2
1,2-Dibromo-3-Chloropropane	ug/kg	2	0	None > LOD	None > LOD			2
cis-1,3-Dichloropropene	ug/kg	2	0	None > LOD	None > LOD			2
1,3,5-Trimethylbenzene	ug/kg	2	0	None > LOD	None > LOD			2
1,2,4-Trichlorobenzene	ug/kg	2	0	None > LOD	None > LOD		220	0
1,2-Dibromoethane	ug/kg	2	0	None > LOD	None > LOD			2
1,2,4-Trimethylbenzene	ug/kg	2	0	None > LOD	None > LOD			2
1,3-Dichlorobenzene	ug/kg	2	0	None > LOD	None > LOD			2
1,4-Dichlorobenzene	ug/kg	2	0	None > LOD	None > LOD			2
1,3-Dichloropropane	ug/kg	2	0	None > LOD	None > LOD			2
2-Chlorotoluene	ug/kg	2	0	None > LOD	None > LOD			2
4-Chlorotoluene	ug/kg	2	0	None > LOD	None > LOD			2
4-isopropyltoluene	ug/kg	2	0	None > LOD	None > LOD			2
Benzene	ug/kg	6	0	None > LOD	None > LOD		27	0
Bromobenzene	ug/kg	2	0	None > LOD	None > LOD			2
Bromodichloromethane	ug/kg	2	0	None > LOD	None > LOD			2
Bromochloromethane	ug/kg	2	0	None > LOD	None > LOD			2
Bromomethane	ug/kg	2	0	None > LOD	None > LOD			2
Tribromomethane	ug/kg	2	0	None > LOD	None > LOD			2
Chloroethane	ug/kg	2	0	None > LOD	None > LOD			2
Chloroform	ug/kg	2	0	None > LOD	None > LOD		99	0
Chloroethene	ug/kg	2	0	None > LOD	None > LOD		0.059	0
Chloromethane	ug/kg	2	0	None > LOD	None > LOD			2
Chlorobenzene	ug/kg	2	0	None > LOD	None > LOD		56	0
Tetrachloromethane (Carbon Tetra Chloride)	ug/kg	2	0	None > LOD	None > LOD		2.9	0
Dichlorodifluoromethane	ug/kg	2	0	None > LOD	None > LOD			2
Dibromomethane	ug/kg	2	0	None > LOD	None > LOD			2
Ethylbenzene	ug/kg	6	0	None > LOD	None > LOD		5700	0
Dibromochloromethane	ug/kg	2	0	None > LOD	None > LOD			2
Hexachlorobutadiene (HCBD)	ug/kg	2	0	None > LOD	None > LOD		31	0
Isopropylbenzene	ug/kg	2	0	None > LOD	None > LOD			2
n-Butylbenzene	ug/kg	2	0	None > LOD	None > LOD			2
Methyl tert-butyl ether (MTBE)	ug/kg	2	0	None > LOD	None > LOD			2
m,p xylenes	ug/kg	6	0	None > LOD	None > LOD		5900	0
O-Xylene	ug/kg	6	0	None > LOD	None > LOD		6600	0
n-propylbenzene	ug/kg	2	0	None > LOD	None > LOD			2
trans-1,2-Dichloroethene	ug/kg	2	0	None > LOD	None > LOD			2
Styrene	ug/kg	2	0	None > LOD	None > LOD			2
Sec-Butylbenzene	ug/kg	2	0	None > LOD	None > LOD			2
Tert-Butylbenzene	ug/kg	2	0	None > LOD	None > LOD			2
trans-1,3-Dichloropropene	ug/kg	2	0	None > LOD	None > LOD			2
Tetrachloroethene	ug/kg	2	0	None > LOD	None > LOD		19	0
Toluene	ug/kg	6	0	None > LOD	None > LOD		56000	0
Trichlorofluoromethane	ug/kg	2	0	None > LOD	None > LOD			2
Trichloroethene	ug/kg	2	0	None > LOD	None > LOD		1.2	0
Ethylbenzene	ug/kg	2	0	None > LOD	None > LOD		5700	0
Benzene	ug/kg	2	0	None > LOD	None > LOD		27	0
m,p xylenes	ug/kg	2	0	None > LOD	None > LOD		5900	0
O-Xylene	ug/kg	2	0	None > LOD	None > LOD		6600	0
Toluene	ug/kg	2	0	None > LOD	None > LOD		56000	0

Sample Reference	Units	BHK3	BHK3	BHK4	BHK4	CHS1	CHS2A	CHS3A	CHS4A	RBBH003	RBBH004	RBBH005	SBHK03 CP	SBHK02 CP	STPK01	STPK02	BH526	BH526	BH527	BH527	BH530	TP510	TP510
Location Type		BH	BH	BH	BH	TP	TP	TP	TP	BH	BH	BH	BH	BH	TP	TP	BH	BH	BH	BH	BH	TP	TP
Specimen Depth (m)		0	1	1	2	0	0.3	0.4	0.4	0.5	0.5	0.5	1	1	0.34	0.3	0.0 - 0.2	0.4 - 0.5	0.2 - 0.3	0.5 - 1.0	0.2 - 0.5	0.0 - 0.3	1.0 - 1.2
OD Level (m)		6	5	4.5	3.5	5.73	5.19	5.13	5.95				4.83	4.53	5.24	5.74	5.95	5.55	5.75	5.25	6.05	5.9	4.9
Sample Type		B	B	D	D	D	D	D	D				ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES
Geology Code		MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG
Cluster Code		1997 GI	1997 GI	1997 GI	1997 GI	2000 GI	2000 GI	2000 GI	2000 GI	2002 GI	2002 GI	2002 GI	2007 GI	2007 GI	2007 GI	2007 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI
SVOCs																							
2,4,5-Trichlorophenol	mg/kg																			< 0.50			
2,4-Dichlorophenol	mg/kg																			< 0.50			
2,4,6-Trichlorophenol	mg/kg																			< 0.50			
2,4-Dimethylphenol	mg/kg																			< 0.50			
2,6-Dinitrotoluene	mg/kg																			< 0.50			
2-Methylnaphthalene	mg/kg																			< 0.50			
2,4-Dinitrotoluene	mg/kg																			< 0.50			
2-Methylphenol	mg/kg																			< 0.50			
2-Chlorophenol	mg/kg																			< 0.50			
2-Chloronaphthalene	mg/kg																			< 0.50			
2-Methyl-4,6-Dinitrophenol	mg/kg																			< 0.50			
4-Chloro-3-Methylphenol	mg/kg																			< 0.50			
3-Nitroaniline	mg/kg																			< 0.50			
4-Chloroaniline	mg/kg																			< 0.50			
2-Nitrophenol	mg/kg																			< 0.50			
4-Chlorophenyl Phenyl Ether	mg/kg																			< 0.50			
4-Bromophenyl Phenyl Ether	mg/kg																			< 0.50			
2-Nitroaniline	mg/kg																			< 0.50			
4-Methylphenol	mg/kg																			< 0.50			
4-Nitrophenol	mg/kg																			< 0.50			
n-nitrosodimethylamine	mg/kg																			< 0.50			
4-Nitroaniline	mg/kg																			< 0.50			
Azobenzene	mg/kg																			< 0.50			
Bis(2-chloroethyl)ether	mg/kg																			< 0.50			
Butylbenzylphthalate	mg/kg																			< 0.50			
Bis(2-chloroisopropyl)ether	mg/kg																			< 0.50			
Bis(2-ethylhexyl)phthalate	mg/kg																			< 0.50			
Bis(2-chloroethoxy)methane	mg/kg																			< 0.50			
Carbazole	mg/kg																			< 0.50			
Diethylphthalate	mg/kg																			< 0.50			
Dibenzofuran	mg/kg																			< 0.50			
Di-N-Octyl Phthalate	mg/kg																			< 0.50			
Di-N-Butyl Phthalate	mg/kg																			< 0.50			
Dimethylphthalate	mg/kg																			< 0.50			
Hexachlorobenzene (HCB)	mg/kg																			< 0.50			
Hexachloroethane	mg/kg																			< 0.50			
Hexachlorocyclopentadiene	mg/kg																			< 0.50			
Isophorone	mg/kg																			< 0.50			
N-Nitroso-Di-N-Propylamine	mg/kg																			< 0.50			
Nitrobenzene	mg/kg																			< 0.50			
Phenol	mg/kg																			< 0.50			
Pentachlorophenol (PCP)	mg/kg																			< 0.50			

Sample Reference	Units	CH52A	CH53A	SBHK01 CP	SBHK02 CP	SBHK02 CP	SBHK03 CP	SBHK03 CP	SBHK04 CP	SBHK04 CP	STPK01	STPK01	STPK01	STPK02	STPK02	STPK02	BH526	BH528	BH529	BH530	TP510	TP512	TP513
Location Type		TP	TP	BH	BH	BH	BH	BH	BH	BH	TP	TP	TP	TP	TP	TP	BH	BH	BH	BH	TP	TP	TP
Specimen Depth (m)		1.2	1.1	3	3	4.5	2	7	0.3	1	1.2	1.27	3	1.24	2	3	1.5 - 1.7	0.25 - 0.4	0.0 - 0.4	0.8 - 1.0	1.8 - 2.0	0.0 - 0.1	1.0 - 1.1
OD Level (m)		4.29	4.43	2.26	2.53	1.03	3.83	-1.17	5.25	4.55	4.38	4.31	2.58	4.8	4.04	3.04	4.45	4.95	5.1	5.45	4.1	5.1	5.3
Sample Type		D	D	U	ES	U	ES	U	ES	ES	B	ES	B	ES	B	B	ES	ES	ES	ES	ES	ES	ES
Geology Code		TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD	TFD
Cluster Code		2000 GI	2000 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2007 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI
SVOCs																							
2,4,5-Trichlorophenol	mg/kg																			< 0.50			
2,4-Dichlorophenol	mg/kg																			< 0.50			
2,4,6-Trichlorophenol	mg/kg																			< 0.50			
2,4-Dimethylphenol	mg/kg																			< 0.50			
2,6-Dinitrotoluene	mg/kg																			< 0.50			
2-Methylnaphthalene	mg/kg																			< 0.50			
2,4-Dinitrotoluene	mg/kg																			< 0.50			
2-Methylphenol	mg/kg																			< 0.50			
2-Chlorophenol	mg/kg																			< 0.50			
2-Chloronaphthalene	mg/kg																			< 0.50			
2-Methyl-4,6-Dinitrophenol	mg/kg																			< 0.50			
4-Chloro-3-Methylphenol	mg/kg																			< 0.50			
3-Nitroaniline	mg/kg																			< 0.50			
4-Chloroaniline	mg/kg																			< 0.50			
2-Nitrophenol	mg/kg																			< 0.50			
4-Chlorophenyl Phenyl Ether	mg/kg																			< 0.50			
4-Bromophenyl Phenyl Ether	mg/kg																			< 0.50			
2-Nitroaniline	mg/kg																			< 0.50			
4-Methylphenol	mg/kg																			< 0.50			
4-Nitrophenol	mg/kg																			< 0.50			
n-nitrosodimethylamine	mg/kg																			< 0.50			
4-Nitroaniline	mg/kg																			< 0.50			
Azobenzene	mg/kg																			< 0.50			
Bis(2-chloroethyl)ether	mg/kg																			< 0.50			
Butylbenzylphthalate	mg/kg																			< 0.50			
Bis(2-chloroisopropyl)ether	mg/kg																			< 0.50			
Bis(2-ethylhexyl)phthalate	mg/kg																			< 0.50			
Bis(2-chloroethoxy)methane	mg/kg																			< 0.50			
Carbazole	mg/kg																			< 0.50			
Diethylphthalate	mg/kg																			< 0.50			
Dibenzofuran	mg/kg																			< 0.50			
Di-N-Octyl Phthalate	mg/kg																			< 0.50			
Di-N-Butyl Phthalate	mg/kg																			< 0.50			
Dimethylphthalate	mg/kg																			< 0.50			
Hexachlorobenzene (HCB)	mg/kg																			< 0.50			
Hexachloroethane	mg/kg																			< 0.50			
Hexachlorocyclopentadiene	mg/kg																			< 0.50			
Isophorone	mg/kg																			< 0.50			
N-Nitroso-Di-N-Propylamine	mg/kg																			< 0.50			
Nitrobenzene	mg/kg																			< 0.50			
Phenol	mg/kg																			< 0.50			
Pentachlorophenol (PCP)	mg/kg																			< 0.50			

Sample Reference		Notes						
Location Type	Units	NFD = No Fibres Detected NAD = No Asbestos Detected Chromium VI criteria used Elemental Mercury criteria used Screening criterion for lead is C4SL in the absence of a S4UL						
Specimen Depth (m)								
OD Level (m)								
Sample Type								
Geology Code								
Cluster Code		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	Selected S4ULs Criteria	No. Data Exceeding S4ULs Criteria
SVOCs								
2,4,5-Trichlorophenol	mg/kg	2	0	None > LOD	None > LOD			2
2,4-Dichlorophenol	mg/kg	2	0	None > LOD	None > LOD			2
2,4,6-Trichlorophenol	mg/kg	2	0	None > LOD	None > LOD			2
2,4-Dimethylphenol	mg/kg	2	0	None > LOD	None > LOD			2
2,6-Dinitrotoluene	mg/kg	2	0	None > LOD	None > LOD			2
2-Methylnaphthalene	mg/kg	2	0	None > LOD	None > LOD			2
2,4-Dinitrotoluene	mg/kg	2	0	None > LOD	None > LOD			2
2-Methylphenol	mg/kg	2	0	None > LOD	None > LOD			2
2-Chlorophenol	mg/kg	2	0	None > LOD	None > LOD			2
2-Chloronaphthalene	mg/kg	2	0	None > LOD	None > LOD			2
2-Methyl-4,6-Dinitrophenol	mg/kg	2	0	None > LOD	None > LOD			2
4-Chloro-3-Methylphenol	mg/kg	2	0	None > LOD	None > LOD			2
3-Nitroaniline	mg/kg	2	0	None > LOD	None > LOD			2
4-Chloroaniline	mg/kg	2	0	None > LOD	None > LOD			2
2-Nitrophenol	mg/kg	2	0	None > LOD	None > LOD			2
4-Chlorophenyl Phenyl Ether	mg/kg	2	0	None > LOD	None > LOD			2
4-Bromophenyl Phenyl Ether	mg/kg	2	0	None > LOD	None > LOD			2
2-Nitroaniline	mg/kg	2	0	None > LOD	None > LOD			2
4-Methylphenol	mg/kg	2	0	None > LOD	None > LOD			2
4-Nitrophenol	mg/kg	2	0	None > LOD	None > LOD			2
n-nitrosodimethylamine	mg/kg	2	0	None > LOD	None > LOD			2
4-Nitroaniline	mg/kg	2	0	None > LOD	None > LOD			2
Azobenzene	mg/kg	2	0	None > LOD	None > LOD			2
Bis(2-chloroethyl)ether	mg/kg	2	0	None > LOD	None > LOD			2
Butylbenzylphthalate	mg/kg	2	0	None > LOD	None > LOD			2
Bis(2-chloroisopropyl)ether	mg/kg	2	0	None > LOD	None > LOD			2
Bis(2-ethylhexyl)phthalate	mg/kg	2	0	None > LOD	None > LOD			2
Bis(2-chloroethoxy)methane	mg/kg	2	0	None > LOD	None > LOD			2
Carbazole	mg/kg	2	0	None > LOD	None > LOD			2
Diethylphthalate	mg/kg	2	0	None > LOD	None > LOD			2
Dibenzofuran	mg/kg	2	0	None > LOD	None > LOD			2
Di-N-Octyl Phthalate	mg/kg	2	0	None > LOD	None > LOD			2
Di-N-Butyl Phthalate	mg/kg	2	0	None > LOD	None > LOD			2
Dimethylphthalate	mg/kg	2	0	None > LOD	None > LOD			2
Hexachlorobenzene (HCB)	mg/kg	2	0	None > LOD	None > LOD		30	0
Hexachloroethane	mg/kg	2	0	None > LOD	None > LOD			2
Hexachlorocyclopentadiene	mg/kg	2	0	None > LOD	None > LOD			2
Isophorone	mg/kg	2	0	None > LOD	None > LOD			2
N-Nitroso-Di-N-Propylamine	mg/kg	2	0	None > LOD	None > LOD			2
Nitrobenzene	mg/kg	2	0	None > LOD	None > LOD			2
Phenol	mg/kg	2	0	None > LOD	None > LOD		440	0
Pentachlorophenol (PCP)	mg/kg	2	0	None > LOD	None > LOD		110	0

A4 Appendix 4

Groundwater Laboratory Data

M4CAN
Groundwater Sample Analysis & Screening Assessment
CL-27
01/07/2015

Location		Screening Criteria		CH 51	CH52	CH52 A	RBBH003	RBBH003	RBBH003	RBBH004	RBBH004	RBBH004	RBBH005	RBBH005	RBBH005	SBHK01	SBHK01	SBHK02	SBHK02			
Monitoring Round	Units	EQS	DWS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	1	2			
Location Type				BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	
Response Zone (RZ) Details				TFD / PEAT			TFD / PEAT			TFD / PEAT			MG / TFD			TFD / PEAT			TFD / PEAT			
Depth																			1	6.8	1.33	11.2
Installation Details																						
Strata Water Level Encountered on Sampling				MG	MG	MG													TFD		MG	
Date Sampled				2000	2000	2000	05/03/2002			01/03/2002			01/03/2002			26/02/2008		20/03/2008		26/02/2008		20/03/2008
Metals																						
Arsenic Dissolved	ug/l	50	10	6	<1	<1	3	3	3	10	8	10	2	2	2	19	14	15	17			
Boron Dissolved	ug/l	2000	1000																			
Calcium Dissolved	ug/l							157000	143000				339000			130000	110000	220000	240000			
Chromium Dissolved	ug/l	50	5	<1	<1	22	<1	2	6	<1	5	<1	<1	<1	7	14	5	10				
Copper Dissolved	ug/l	10	2000	9	3	2	2	4	3	7	2	7	4	3	4	8	5.7	8.1	9			
Iron Dissolved	ug/l	1000	200			<10	10	<10	640	320	400	<10	20	<10	3000	890	260	<50				
Lead Dissolved	ug/l	1.2	10	<1	<1	<1	<1	<1	3	1	3	<1	1	2	1.6	0.5	2.7	0.4				
Magnesium Dissolved	ug/l						78300	70300				<30			170000	150000	140000	190000				
Manganese Dissolved	ug/l	30	50				0.00137	0.0015							1100	940	720	640				
Nickel Dissolved	ug/l	4	20	4	5	2	4	3	6	9	5	10	4	4	7	6.4	8.6	8.4	14			
Selenium Dissolved	ug/l		10	<1	<1	3	2	3	2	7	6	4	8	10	9	20	9	23	25			
Cadmium Dissolved	ug/l	0.15	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1							
Zinc Dissolved	ug/l	75		26	50	1																
Mercury Dissolved	ug/l	0.07	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1							
Cadmium Total	ug/l	0.15	5													8.8	12	0.5	0.8			
Zinc Total	ug/l	75					7	26	17	17	8	14	4	6	12	3000	4800	170	370			
Mercury Total	ug/l	0.07	1													0.02	0.05	0.01	<0.01			
Non-Metal Inorganics																						
Hardness Total	mg/l															990	870	1100	1200			
Total Alkalinity as CaCO3	mg/l							650	1140							1600	3300	590	880			
BOD	mg/l	5														8	12	<1	<1			
COD	mg/l							23	<5		52	49				6200	4900	270	550			
Potassium Dissolved	mg/l							23	21.5				11.8			53	51	38	48			
Sodium Dissolved	mg/l		200					264	268				112			1500	1200	1900	2500			
Nitrate as NO3	mg/l		50					1.1	<0.5				<0.5			<0.3	<0.3	<0.3	<0.3			
Total Diss Sulphur	mg/l			62	38.5	26.4																
Sulphate (soluble)	mg/l	400	250				276	347	295	144	174	126	106	120	160	110	71	330	160			
Chloride	mg/l	250	250					243	122				97			1900	1400	2900	3300			
Sulphide	mg/l							<0.2	<0.2			<0.2		<0.2		<0.5	<0.5	<0.5	<0.5			
Ammoniacal Nitrogen as N	mg/l	0.6					1.9	0.2	1.6	3.7	4.4	4.2	3.6	4.3	7.2	14	14	15	18			
Unionised ammonia	mg/l						0.008825344	0.000928984	0.007431869	1.369275706	0.100556975	0.289241744	3.595139111	4.2953868	7.190278222	0.374416609	0.943671965	0.327716059	0.64337657			
Total Ammonium as NH4	mg/l		0.5													18		19				
Phenols Monohydric	mg/l			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01			
Thiocyanate	mg/l					<0.1	<0.1	<0.1	<0.1	2.3	1.1	0.7	0.2	0.2	0.2							
Total Cyanide	mg/l	0.001	0.05	0.09	<0.025	<0.025	<0.05	<0.05	<0.05	0.32	0.4	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Free Cyanide	mg/l					<0.025																
Complex Cyanide	mg/l				<0.025	<0.025																
Carbon Dioxide Dissolved	ug/l															86		51				
pH Value	pH units	6-9	6.5-10	10.1	7.5	11.9	7.4	7.4	7.4	9.5	8.1	8.6	12.6	12.7	12.6	8.17	8.59	8.08	8.3			

MG	Made Ground
TFD	Tidal Flat Deposits
PEAT	Peat
MMG	Mercia Mudstone Group

Location	Strata Water Level Encountered on Sampling																																												
Monitoring Round	Units	SBHK03	SBHK03	SBHK04	SBHK04	BH527	BH527	BH527	BH527	BH527	BH527	BH528	BH528	BH528	BH528	BH528	BH528	BH530	BH530	BH530	BH530	BH530																							
Location Type		1	2	1	2	1		2		3		1		2		3		1		2		3																							
Response Zone (RZ) Details		BH	BH	BH	BH			BH						BH						BH																									
Depth		TDF / PEAT		TDF		MMG	TDF	MMG	TDF	MMG	TDF	MMG	TDF	MMG	TDF	MMG	TDF	MMG	TDF	MMG	TDF	MMG	TDF																						
Installation Details		0.89		5.9		8.87		12.2		2.92		7.66		1.93		7.29		1.99		4.71		1.76		6.44		1.53		6.8		1.64		6.29		2.53		5.45		2.47		4.57		2.97		5.07	
Strata Water Level Encountered on Sampling		MG		TDF		Deep		Shallow		Deep		Shallow		Deep		Shallow		Deep		Shallow		Deep		Shallow		Deep		Shallow		Deep		Shallow		Deep		Shallow		Deep		Shallow					
Date Sampled	26/02/2008		20/03/2008		26/02/2008		20/03/2008		20/03/2015		27/03/2015		13/04/2015		20/03/2015		27/03/2015		13/04/2015		30/03/2015		14/04/2015		21/04/2015																				
Metals																																													
Arsenic Dissolved	ug/l	4	23	16	2.1	15	5	23	40	15	15	38	29	58	I/S	24	17	110	18	120	18	21	22																						
Boron Dissolved	ug/l					600	780	1100	1500	1500	1400	970	1300	1500	I/S	1300	1800	860	1900	460	700	390	860																						
Calcium Dissolved	ug/l	120000	360000	420000	120000																																								
Chromium Dissolved	ug/l	4	15	9	9	41	12	130	77	35	18	120	110	240	I/S	83	63	110	84	27	18	22	15																						
Copper Dissolved	ug/l	7.8	5.7	12	2.8	81	2	40	13	9.9	2.2	110	41	56	I/S	53	32	39	29	13	4.7	56	12																						
Iron Dissolved	ug/l	250	75	<50	94																																								
Lead Dissolved	ug/l	0.8	0.9	4.8	<0.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	I/S	<1	<1	<1	<1	1.1	<1	<1	<1																						
Magnesium Dissolved	ug/l	120000	340000	320000	120000																																								
Manganese Dissolved	ug/l	740	850	1800	560																																								
Nickel Dissolved	ug/l	3	17	20	3.9	2.8	2.8	4	5.6	3.5	3.9	5.3	5.9	5.9	I/S	5.1	8	4.6	5.8	1.8	3.2	<1	1.6																						
Selenium Dissolved	ug/l	6	39	46	2	47	11	76	38	9	4.8	61	60	180	I/S	29	23	68	34	11	6.3	7.8	6.5																						
Cadmium Dissolved	ug/l					<0.08	0.78	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.13	I/S	<0.08	<0.08	<0.08	0.23	0.12	<0.08	<0.08	0.092																						
Zinc Dissolved	ug/l					6.9	4.8	6.1	3.8	16	18	10	5.3	12	I/S	22	29	4.7	8.5	24	50	4.1	5.6																						
Mercury Dissolved	ug/l					<0.5	1.2	1.1	0.94	<0.5	0.62	<0.5	<0.5	1.3	I/S	0.63	0.6	0.74	0.9	<0.5	<0.5	<0.5	<0.5																						
Cadmium Total	ug/l	<0.4	3.4	0.8	<0.4																																								
Zinc Total	ug/l	89	540	230	89																																								
Mercury Total	ug/l	<0.01	0.04	0.04	<0.01																																								
Non-Metal Inorganics																																													
Hardness Total	mg/l	760	2100	2300	690																																								
Total Alkalinity as CaCO3	mg/l	1000	1100	990	1000	940	380	1200	1200	1500	1500	680	1100	1000	I/S	1200	2000	1800	1300	2200	1900	2300	1900																						
BOD	mg/l	7	<1	<1	3																																								
COD	mg/l	160	1300	620	78																																								
Potassium Dissolved	mg/l	41	75	66	42																																								
Sodium Dissolved	mg/l	650	3500	3300	590																																								
Nitrate as NO3	mg/l	<0.3	<0.3	<0.3	<0.3																																								
Total Diss Sulphur	mg/l																																												
Sulphate (soluble)	mg/l	440	280	590	500																																								
Chloride	mg/l	380	5200	5300	350	1900	330	1900	790	1500	810	2700	2300	4300	I/S	4800	3500	1500	630	1700	850	2000	800																						
Sulphide	mg/l	<0.5	<0.5	<0.5	<0.5																																								
Ammoniacal Nitrogen as N	mg/l	5.3	35	27	5.6	2.6	2.3	3.4	6.6	3.6	7.5	7.6	16	11	I/S	12	31	6.3	3.6	6.9	7.6	4	4.7																						
Unionised ammonia	mg/l	0.442032876	1.144534248	0.327390078	0.795512594																																								
Total Ammonium as NH4	mg/l	6.8		35																																									
Phenols Monohydric	mg/l	<0.01	<0.01	<0.01	<0.01																																								
Thiocyanate	mg/l																																												
Total Cyanide	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05																						
Free Cyanide	mg/l					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05																						
Complex Cyanide	mg/l																																												
Carbon Dioxide Dissolved	ug/l	26		92																																									
pH Value	pH units	8.69	8.26	7.82	8.95	8.1	7.9	7.5	7.6	9.1	9	8.1	7.9	7.3	I/S	8.2	7.8	7.4	7.3	8.2	7.7	8.3	7.9																						

MACAN Groundwater Sample Analysis & Screening Assessment CL-27 01/07/2015		Screening Values & Assessment						
Location Monitoring Round Location Type Response Zone (RZ) Details Depth Installation Details Strata Water Level Encountered on Sampling Date Sampled		Units		Notes EQS calcium carbonate 100-150mg/l for heavy metals: chromium, copper, lead, nickel and zinc N/A = Not Available				
		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Installation Details of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS
Metals								
Arsenic Dissolved	ug/l	38	35	120	2	2 @ Deep	3	22
Boron Dissolved	ug/l	18	17	1900	390	@ Shallow	0	9
Calcium Dissolved	ug/l	11	11	420000	110000	1 @		
Chromium Dissolved	ug/l	38	30	240	2	2 @ Deep		9
Copper Dissolved	ug/l	38	37	110	2	1 @ Deep	14	0
Iron Dissolved	ug/l	17	11	3000	10	1 @	1	7
Lead Dissolved	ug/l	38	13	4.8	0.4	1 @	6	0
Magnesium Dissolved	ug/l	11	10	340000	70300	2 @		
Manganese Dissolved	ug/l	10	10	1800	0.00137	1 @	8	8
Nickel Dissolved	ug/l	38	36	20	1.6	1 @	20	0
Selenium Dissolved	ug/l	38	35	180	2	2 @ Deep		17
Cadmium Dissolved	ug/l	30	5	0.78	0.092	@ Shallow	2	0
Zinc Dissolved	ug/l	21	20	50	1	@	0	
Mercury Dissolved	ug/l	30	9	1.3	0.6	2 @ Deep	9	3
Cadmium Total	ug/l	8	6	12	0.5	2 @	6	2
Zinc Total	ug/l	17	17	4800	4	2 @	8	0
Mercury Total	ug/l	8	5	0.05	0.01	2 @	0	0
Non-Metal Inorganics								
Hardness Total	mg/l	8	8	2300	690	1 @		
Total Alkalinity as CaCO3	mg/l	28	27	3300	380	2 @		
BOD	mg/l	8	4	12	3	2 @	3	
COD	mg/l	12	11	6200	23	1 @		
Potassium Dissolved	mg/l	11	11	75	11.8	2 @		
Sodium Dissolved	mg/l	11	11	3500	112	2 @		10
Nitrate as NO3	mg/l	11	1	1.1	1.1	2 @		0
Total Diss Sulphur	mg/l	3	3	62	26.4	@		
Sulphate (soluble)	mg/l	17	17	550	71	1 @	3	8
Chloride	mg/l	29	28	5300	97	1 @	25	25
Sulphide	mg/l	12	0	None > LOD	None > LOD			
Ammoniacal Nitrogen as N	mg/l	35	34	35	0.2	2 @	33	
Unionised ammonia	mg/l	17	17	7.190278222	0.000928984	3 @		
Total Ammonium as NH4	mg/l	4	4	35	6.8	1 @		4
Phenols Monohydric	mg/l	20	0	None > LOD	None > LOD			
Thiocyanate	mg/l	10	6	2.3	0.2	1 @		
Total Cyanide	mg/l	38	4	0.4	0.09	2 @	4	4
Free Cyanide	mg/l	19	0	None > LOD	None > LOD			
Complex Cyanide	mg/l	2	0	None > LOD	None > LOD			
Carbon Dioxide Dissolved	ug/l	4	4	92	26	1 @		
pH Value	pH units	38	37	12.7	7.3	2 @	8	6

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[illegible]

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MG	Made Ground
TFD	Tidal Flat Deposits
PEAT	Peat
MMG	Mercia Mudstone Group

Location	Units	SBHK03	SBHK03	SBHK04	SBHK04	BHS27	BHS27	BHS27	BHS27	BHS27	BHS27	BHS28	BHS28	BHS28	BHS28	BHS28	BHS28	BHS30	BHS30	BHS30	BHS30	BHS30	BHS30
Monitoring Round		1	2	1	2	1						1						1					
Location Type		BH	BH	BH	BH																		
Response Zone (R2) Details		TFD / PEAT		TFD		MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD
Depth		0.89	5.9	8.87	12.2	2.92	7.66	1.93	7.29	1.99	4.71	1.76	6.44	1.53	6.8	1.64	6.29	2.53	5.45	2.47	4.57	2.97	5.07
Installation Details		MG		TFD		Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow
Strata Water Level Encountered on Sampling		MG		TFD		Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow
Date Sampled	26/02/2008	20/03/2008	26/02/2008	20/03/2008	20/03/2015		27/03/2015		13/04/2015		20/03/2015		27/03/2015		13/04/2015		30/03/2015		14/04/2015		21/04/2015		
Organics																							
GRO (C4-C12)	ug/l	<10	<10	<10	<10																		
MTBE	ug/l	<10	<10	<10	<10							<1	<1		<1	<1					<1	<1	
Benzene	ug/l	<10	<10	<10	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Toluene	ug/l	<10	<10	<10	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Ethyl benzene	ug/l	<10	<10	<10	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
m & p Xylene	ug/l	<10	<10	<10	<10	<1	<1	<1	<1	<1	<1	1.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
o Xylene	ug/l	<10	<10	<10	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
TPH																							
Aliphatics C5-C6	ug/l	<10	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Aliphatics >C6-C8	ug/l	<10	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Aliphatics >C8-C10	ug/l	<10	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Aliphatics >C10-C12	ug/l	<10	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Aliphatics >C12-C16 Aqueous	ug/l	<10	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	29	<0.1	<0.1	<0.1	<0.1	
Aliphatics >C16-C21 Aqueous	ug/l	<10	<10	<10	<10	<0.1	110	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	53	18	<0.1	<0.1	<0.1	
Aliphatics >C21-C35 Aqueous	ug/l	<10	<10	<10	<10	<0.1	1600	<0.1	<0.1	<0.1	<0												

M4CAN Groundwater Sample Analysis & Screening Assessment CL-27 01/07/2015		Screening Values & Assessment <div> <div>EQS</div> <div>Environmental Quality Standards</div> </div> <div> <div>DWS</div> <div>Drinking Water Standard</div> </div> <div> <div></div> <div>Exceeds EQS</div> </div> <div> <div>X</div> <div>Exceeds DWS</div> </div> <div> <div>X</div> <div>Laboratory detection level higher than screening criterion</div> </div>						
Location	Units	Notes EQS calcium carbonate 100-150mg/l for heavy metals: chromium, copper, lead, nickel and zinc N/A = Not Available						
Monitoring Round								
Location Type								
Response Zone (RZ) Details								
Depth								
Installation Details								
Strata Water Level Encountered on Sampling								
Date Sampled								
		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Installation Details of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS
Organics								
GRO (C4-C12)	ug/l	8	0	None > LOD	None > LOD			
MTBE	ug/l	14	0	None > LOD	None > LOD			
Benzene	ug/l	26	0	None > LOD	None > LOD		0	0
Toluene	ug/l	26	0	None > LOD	None > LOD		0	
Ethyl benzene	ug/l	26	0	None > LOD	None > LOD		0	
m & p Xylene	ug/l	26	1	1.3	1.3	1 @ Deep	0	
o Xylene	ug/l	26	0	None > LOD	None > LOD		0	
TPH								
Aliphatics C5-C6	ug/l	26	0	None > LOD	None > LOD			
Aliphatics >C6-C8	ug/l	26	0	None > LOD	None > LOD			
Aliphatics >C8-C10	ug/l	26	0	None > LOD	None > LOD			
Aliphatics >C10-C12	ug/l	26	0	None > LOD	None > LOD			
Aliphatics >C12-C16 Aqueous	ug/l	26	1	29	29	1 @ Deep		
Aliphatics >C16-C21 Aqueous	ug/l	26	3	110	18	@ Shallow		
Aliphatics >C21-C35 Aqueous	ug/l	26	3	1600	0.75	@ Shallow		
Total Aliphatics C5-C35 Aqueous	ug/l	8	1	270	270	1 @		
Aliphatics >C35-44	ug/l	18	1	46	46	@ Shallow		
Aromatics >C5-C7	ug/l	18	0	None > LOD	None > LOD			
Aromatics C6-C7	ug/l	8	0	None > LOD	None > LOD			
Aromatics >C7-C8	ug/l	26	0	None > LOD	None > LOD			
Aromatics >EC8-EC10	ug/l	26	0	None > LOD	None > LOD			
Aromatics >EC10-EC12	ug/l	26	0	None > LOD	None > LOD			
Aromatics >EC12-EC16 Aqueous	ug/l	26	1	3.8	3.8	1 @ Deep		
Aromatics >EC16-EC21 Aqueous	ug/l	26	3	16	5.6	@ Shallow		
Aromatics >EC21-EC35 Aqueous	ug/l	26	1	170	170	@ Shallow		
Total Aromatics C6-C35 Aqueous	ug/l	8	0	None > LOD	None > LOD			
Aromatics >C35-44	ug/l	18	0	None > LOD	None > LOD			
Total Aliphatic TPH	ug/l	18	3	1700	18	@ Shallow		
Total Aromatic TPH	ug/l	18	3	190	5.6	@ Shallow		
TPH (Aliphatics and Aromatics C5-C35)	ug/l	11	3	270	10	1 @		
Total petroleum hydrocarbons	ug/l	18	3	1900	23	@ Shallow		
TPH FTIR	ug/l	3	3	90	80	@		
TPH GC	ug/l	3	3	5700	270	@		
PCBs								
PCB- ARO	ug/l	1	1	1	1	@		
Cresols	ug/l	1	0	None > LOD	None > LOD			
Pcb-101 2,2',4,4',5,5' - Pentachlorobiphenyl	ug/l	12	0	None > LOD	None > LOD			
Pcb-118 2,2',3,4,4',5' - Pentachlorobiphenyl	ug/l	12	0	None > LOD	None > LOD			
Pcb-138 2,2',3,4,4',5' - Hexachlorobiphenyl	ug/l	12	0	None > LOD	None > LOD			
Pcb-153 2,2',4,4',5,5' - Hexachlorobiphenyl	ug/l	12	0	None > LOD	None > LOD			
Pcb-180 2,2',3,4,4',5,5' - Heptachlorobiphenyl	ug/l	12	0	None > LOD	None > LOD			
Pcb-28 2,4,4' - Trichlorobiphenyl	ug/l	12	0	None > LOD	None > LOD			
Pcb-52 2,2',5,5' - Tetrachlorobiphenyl	ug/l	12	0	None > LOD	None > LOD			

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Location	Units	Screening Criteria		CH 51	CH52	CH52 A	RBBH003	RBBH003	RBBH003	RBBH004	RBBH004	RBBH004	RBBH005	RBBH005	RBBH005	RBBH005	3	1	SBHK01	SBHK01	SBHK02	SBHK02	
Monitoring Round		EQS	DWS	TP	TP	TP	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	
Location Type				MG	MG	MG	TFD / PEAT			TFD / PEAT			MG / TFD			TFD / PEAT		TFD / PEAT		TFD / PEAT			
Response Zone (RZ) Details																1		6.8		1.33		11.2	
Depth																							
Installation Details				MG	MG	MG												TFD		MG			
Strata Water Level Encountered on Sampling				2000	2000	2000	05/03/2002			01/03/2002			01/03/2002			26/02/2008		20/03/2008		26/02/2008		20/03/2008	
Date Sampled																							
Phenols																							
Dimethylphenols	ug/l			<0.5																			
Trimethylphenols	ug/l			<0.5																			
2-Chlorophenol	ug/l	50																<1	<1	<1	<1		
2 - Methyl-4,6-Dinitrophenol	ug/l																						
2-Methylphenol	ug/l	100																<1	<1	<1	<1		
2-Nitrophenol	ug/l																	<1	<1	<1	<1		
2,4-Dichlorophenol	ug/l	20																<1	<1	<1	<1		
2,4-Dimethylphenol	ug/l																	<1	<1	<1	<1		
2,4,5-Trichlorophenol	ug/l																	<1	<1	<1	<1		
2,4,6-Trichlorophenol	ug/l																	<1	<1	<1	<1		
4-Chloro-3-methylphenol	ug/l	40																<1	<1	<1	<1		
4-Methylphenol	ug/l	100																<1	<1	<1	<1		
4-Nitrophenol	ug/l																	<1	<1	<1	<1		
Pentachlorophenol	ug/l	0.4																<1	<1	<1	<1		
Phenol	ug/l	7.7		<0.0005														<1	<1	<1	<1		
Phenols	mg/l	0.0077																<0.01	<0.01	<0.01	<0.01		
PAHs																							
2-Chloronaphthalene	ug/l																	<1	<1	<1	<1		
2-Methylnaphthalene	ug/l																	<1	<1	<1	<1		
Acenaphthene	ug/l			<0.05	<0.05	<0.05			<2			<2				<2		<1	<1	<1	<1		
Acenaphthylene	ug/l			<1.00	<1.00	<1.00			<2			<2				<2		<1	<1	<1	<1		
Anthracene	ug/l	0.1		<0.05	<0.05	0.07			<2			<2				<2		<1	<1	<1	<1		
Benzo(a)anthracene	ug/l			<0.05	<0.05	0.1			<2			<2				<2		<1	<1	<1	<1		
Benzo(a)pyrene	ug/l	0.00017	0.01	<0.05	<0.05	0.06			<2			<2				<2		<1	<1	<1	<1		
Benzo(b)fluoranthene	ug/l	0.017	0.1	<0.05	<0.05	0.07			<2			<2				<2		<1	<1	<1	<1		
Benzo(ghi)perylene	ug/l	0.0082	0.1	<0.05	<0.05	<0.05			<2			<2				<2		<1	<1	<1	<1		
Benzo(k)fluoranthene	ug/l	0.017	0.1	<0.05	<0.05	<0.05			<2			<2				<2		<1	<1	<1	<1		
Chrysene	ug/l			<0.05	<0.05	0.06			<2			<2				<2		<1	<1	<1	<1		
Dibenzo(a,h)anthracene	ug/l			<0.05	<0.05	<0.05			<2			<2				<2		<1	<1	<1	<1		
Fluoranthene	ug/l	0.0063		<0.05	<0.05	0.16			<2			<2				<2		<1	<1	<1	<1		
Fluorene	ug/l			<0.05	<0.05	0.47			<2			<2				<2		<1	<1	<1	<1		
Indeno(1,2,3-cd)pyrene	ug/l		0.1	<0.05	<0.05	<0.05			<2			<2				<2		<1	<1	<1	<1		
Naphthalene	ug/l	2		<0.50	<0.50	0.74			<2			<2				<2		<1	<1	<1	<1		
Phenanthrene	ug/l			<0.05	<0.05	0.69			<2			<2				<2		<1	<1	<1	<1		
Pyrene	ug/l			<0.05	<0.05	0.13			<2			<2				<2		<1	<1	<1	<1		
Total PAHs (USEPA 16)	ug/l			<2.20	<2.20	<3.80																	
Phthalates																							
Bis(2-ethylhexyl) phthalate	ug/l	1.3																<2	<2	<2	<2		
Butylbenzyl phthalate	ug/l	20																<1	<1	<1	<1		
Di-n-butyl phthalate	ug/l	8																<1	<1	<1	<1		
Di-n-Octyl phthalate	ug/l	20																<5	<5	<5	<5		
Diethyl phthalate	ug/l	200																<1	<1	<1	<1		
Dimethyl phthalate	ug/l	800																<1	<1	<1	<1		

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Geological Formation legend

MG	Made Ground
TFD	Tidal Flat Deposits
PEAT	Peat
MMG	Mercia Mudstone Group

Location	Units																															
Monitoring Round	SBHK03	SBHK03	SBHK04	SBHK04	BH527	BH527	BH527	BH527	BH527	BH528	BH528	BH528	BH528	BH528	BH528	BH528	BH528	BH530	BH530	BH530	BH530	BH530	BH530									
Location Type	1	2	1	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1									
Response Zone (RZ) Details	BH	BH	BH	BH	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD								
Depth	0.89	5.9	8.87	12.2	2.92	7.66	1.93	7.29	1.99	4.71	1.76	6.44	1.53	6.8	1.64	6.29	2.53	5.45	2.47	4.57	2.97	5.07										
Installation Details	MG				TFD				Deep				Shallow				Deep				Shallow				Deep				Shallow			
Strata Water Level Encountered on Sampling	MG				TFD				Deep				Shallow				Deep				Shallow				Deep				Shallow			
Date Sampled	26/02/2008	20/03/2008	26/02/2008	20/03/2008	20/03/2015		27/03/2015		13/04/2015		20/03/2015		27/03/2015		13/04/2015		30/03/2015		14/04/2015		21/04/2015											
Phenols																																
Dimethylphenols	ug/l																															
Trimethylphenols	ug/l																															
2-Chlorophenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
2-Methyl-4,6-Dinitrophenol	ug/l											<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
2-Methylphenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
2-Nitrophenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
2,4-Dichlorophenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
2,4-Dimethylphenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
2,4,5-Trichlorophenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
2,4,6-Trichlorophenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
4-Chloro-3-methylphenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
4-Methylphenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
4-Nitrophenol	ug/l	<1	<1	<1	<1																		<0.5	<0.5								
Pentachlorophenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
Phenol	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
Phenols	mg/l	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03								
PAHs																																
2-Chloronaphthalene	ug/l	<1	<1	<1	<1																											
2-Methylnaphthalene	ug/l	<1	<1	<1	<1																											
Acenaphthene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Acenaphthylene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Anthracene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Benzo(a)anthracene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Benzo(a)pyrene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Benzo(b)fluoranthene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Benzo(ghi)perylene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Benzo(k)fluoranthene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Chrysene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Dibenzo(a,h)anthracene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Fluoranthene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Fluorene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Indeno[1,2,3-cd]pyrene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Naphthalene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Phenanthrene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Pyrene	ug/l	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1									
Total PAHs (USEPA 16)	ug/l					<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2									
Phthalates																																
Bis(2-ethylhexyl) phthalate	ug/l	<2	<2	<2	<2							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
Butylbenzyl phthalate	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
Di-n-butyl phthalate	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
Di-n-Octyl phthalate	ug/l	<5	<5	<5	<5							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
Diethyl phthalate	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									
Dimethyl phthalate	ug/l	<1	<1	<1	<1							<0.5	<0.5			<0.5	<0.5					<0.5	<0.5									

MACAN Groundwater Sample Analysis & Screening Assessment CL-27 01/07/2015		Screening Values & Assessment							
		EQS	Environmental Quality Standards						
		DWS	Drinking Water Standard						
			Exceeds EQS						
		X	Exceeds DWS						
		X	Laboratory detection level higher than screening criterion						
Location		Units	Notes						
Monitoring Round			EQS calcium carbonate 100-150mg/l for heavy metals: chromium, copper, lead, nickel and zinc						
Location Type			N/A = Not Available						
Response Zone (RZ) Details									
Depth									
Installation Details									
Strata Water Level Encountered on Sampling									
Date Sampled		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Installation Details of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS	
Phenols									
Dimethylphenols	ug/l	1	0	None > LOD	None > LOD				
Trimethylphenols	ug/l	1	0	None > LOD	None > LOD				
2-Chlorophenol	ug/l	14	0	None > LOD	None > LOD		0		
2-Methyl-4,6-Dinitrophenol	ug/l	6	0	None > LOD	None > LOD				
2-Methylphenol	ug/l	14	0	None > LOD	None > LOD		0		
2-Nitrophenol	ug/l	14	0	None > LOD	None > LOD				
2,4-Dichlorophenol	ug/l	14	0	None > LOD	None > LOD		0		
2,4-Dimethylphenol	ug/l	14	0	None > LOD	None > LOD				
2,4,5-Trichlorophenol	ug/l	14	0	None > LOD	None > LOD				
2,4,6-Trichlorophenol	ug/l	14	0	None > LOD	None > LOD				
4-Chloro-3-methylphenol	ug/l	14	0	None > LOD	None > LOD		0		
4-Methylphenol	ug/l	14	0	None > LOD	None > LOD		0		
4-Nitrophenol	ug/l	8	0	None > LOD	None > LOD				
Pentachlorophenol	ug/l	14	0	None > LOD	None > LOD		0		
Phenol	ug/l	15	0	None > LOD	None > LOD		0		
Phenols	mg/l	26	0	None > LOD	None > LOD		0		
PAHs									
2-Chloronaphthalene	ug/l	8	0	None > LOD	None > LOD				
2-Methylnaphthalene	ug/l	8	0	None > LOD	None > LOD				
Acenaphthene	ug/l	32	0	None > LOD	None > LOD				
Acenaphthylene	ug/l	32	0	None > LOD	None > LOD				
Anthracene	ug/l	32	1	0.07	0.07	@	0		
Benzo(a)anthracene	ug/l	32	1	0.1	0.1	@			
Benzo(a)pyrene	ug/l	32	1	0.06	0.06	@	1	1	
Benzo(b)fluoranthene	ug/l	32	1	0.07	0.07	@	1	0	
Benzo(ghi)perylene	ug/l	32	0	None > LOD	None > LOD		0	0	
Benzo(k)fluoranthene	ug/l	32	0	None > LOD	None > LOD		0	0	
Chrysene	ug/l	32	1	0.06	0.06	@			
Dibenzo(a,h)anthracene	ug/l	32	0	None > LOD	None > LOD				
Fluoranthene	ug/l	32	1	0.16	0.16	@	1		
Fluorene	ug/l	32	1	0.47	0.47	@			
Indeno(1,2,3-cd)pyrene	ug/l	32	0	None > LOD	None > LOD			0	
Naphthalene	ug/l	32	1	0.74	0.74	@	0		
Phenanthrene	ug/l	32	1	0.69	0.69	@			
Pyrene	ug/l	32	1	0.13	0.13	@			
Total PAHs (USEPA 16)	ug/l	21	0	None > LOD	None > LOD				
Phthalates									
Bis(2-ethylhexyl) phthalate	ug/l	14	0	None > LOD	None > LOD		0		
Butylbenzyl phthalate	ug/l	14	0	None > LOD	None > LOD		0		
Di-n-butyl phthalate	ug/l	14	0	None > LOD	None > LOD		0		
Di-n-Octyl phthalate	ug/l	14	0	None > LOD	None > LOD		0		
Diethyl phthalate	ug/l	14	0	None > LOD	None > LOD		0		
Dimethyl phthalate	ug/l	14	0	None > LOD	None > LOD		0		

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Location	Units		Screening Criteria		CH 51	CH52	CH52 A	RBBH003	RBBH003	RBBH003	RBBH004	RBBH004	RBBH004	RBBH005	RBBH005	RBBH005	SBHK01	SBHK01	SBHK02	SBHK02				
Monitoring Round					1	2	3	1	2	3	1	2	3	1	2	3	1	2	1	2				
Location Type					TP	TP	TP	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH			
Response Zone (RZ) Details					MG	MG	MG	TFD / PEAT			TFD / PEAT			MG / TFD			TFD / PEAT			TFD / PEAT				
Depth																			1	6.8	1.33	11.2		
Installation Details																								
Strata Water Level Encountered on Sampling					MG	MG	MG												TFD			MG		
Date Sampled			2000	2000	2000	05/03/2002					01/03/2002					01/03/2002					26/02/2008	20/03/2008	26/02/2008	20/03/2008
VOCs																								
Full suite	ug/l									<LOD							<LOD							
1,1,1,2-Tetrachloroethane	ug/l																							
1,1,1-Trichloroethane	ug/l	100																						
1,1,2-Trichloroethane	ug/l	400																						
1,1-Dichloroethane	ug/l																							
1,1-Dichloroethene	ug/l																							
1,1-Dichloropropene	ug/l																							
1,2,3-Trichlorobenzene	ug/l	0.4																						
1,2,3-Trichloropropane	ug/l																							
1,2,4-Trichlorobenzene	ug/l	0.4																						
1,2,4-Trimethylbenzene	ug/l																							
1,2-Dibromo-3-Chloropropane	ug/l																							
1,2-Dibromoethane	ug/l																							
1,2-Dichlorobenzene	ug/l	20																						
1,2-Dichloroethane	ug/l	10	3																					
1,2-Dichloropropane	ug/l																							
1,3,5-Trimethylbenzene	ug/l																							
1,3-Dichloropropane	ug/l																							
1,4-Dichlorobenzene	ug/l	20																						
2-Chlorotoluene	ug/l																							
4-Chlorotoluene	ug/l																							
4-Isopropyltoluene	ug/l																							
Benzene	ug/l	10	1																					
Bromobenzene	ug/l																							
Bromochloromethane	ug/l		100																					
Bromodichloromethane	ug/l																							
Bromomethane	ug/l																							
Chlorobenzene	ug/l																							
Chloroethane	ug/l																							
Chloroethene	ug/l																							
Chloroform	ug/l	2.5	100																					
Chloromethane	ug/l																							
cis-1,2-Dichloroethene	ug/l																							
cis-1,3-Dichloropropene	ug/l																							
Dibromochloromethane	ug/l		100																					
Dibromomethane	ug/l																							
Dichlorodifluoromethane	ug/l																							
Ethylbenzene	ug/l	20																						
Hexachlorobutadiene (HCBD)	ug/l	0.6																						
Isopropylbenzene	ug/l																							
m,p xylenes	ug/l	30																						
Methyl tert-butyl ether (MTBE)	ug/l																							
n-Butylbenzene	ug/l																							
n-propylbenzene	ug/l																							
O-Xylene	ug/l	30																						
Sec-Butylbenzene	ug/l																							
Styrene	ug/l	50																						
Tert-Butylbenzene	ug/l																							
Tetrachloroethene	ug/l	10	10																					
Tetrachloromethane (Carbon Tetra Chloride)	ug/l	12	3																					
Toluene	ug/l	50																						
trans-1,2-Dichloroethene	ug/l																							
trans-1,3-Dichloropropene	ug/l																							
Tribromomethane	ug/l		100																					
Trichloroethene	ug/l	10	10																					
Trichlorofluoromethane	ug/l																							

MG	Made Ground
TFD	Tidal Flat Deposits
PEAT	Peat
MMG	Mercia Mudstone Group

Location		SBHK03		SBHK04		SBHK04		BH527	BH527	BH527	BH527	BH528	BH528	BH528	BH528	BH528	BH528	BH530	BH530	BH530	BH530	BH530	BH530
Monitoring Round		1	2	1	2	1	2	2	2	3	3	1	2	2	3	1	2	1	2	3	3	3	3
Location Type		BH		BH				BH				BH		BH				BH				BH	
Response Zone (RZ) Details		TFD / PEAT		TFD		MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD
Depth		0.89	5.9	8.87	12.2	2.92	7.66	1.93	7.29	1.99	4.71	1.76	6.44	1.53	6.8	1.64	6.29	2.53	5.45	2.47	4.57	2.97	5.07
Installation Details						Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow
Strata Water Level Encountered on Sampling		MG		TFD																			
Date Sampled		26/02/2008	20/03/2008	26/02/2008	20/03/2008	20/03/2015		27/03/2015		13/04/2015		20/03/2015		27/03/2015		13/04/2015		30/03/2015		14/04/2015		21/04/2015	
VOCs																							
Full suite	ug/l											<2	<2			<2	<2					<2	<2
1,1,1,2-Tetrachloroethane	ug/l											<1	<1			<1	<1					<1	<1
1,1,1-Trichloroethane	ug/l											<10	<10			<10	<10					<10	<10
1,1,2-Trichloroethane	ug/l											<1	<1			<1	<1					<1	<1
1,1-Dichloroethane	ug/l											<1	<1			<1	<1					<1	<1
1,1-Dichloropropene	ug/l											<1	<1			<1	<1					<1	<1
1,2,3-Trichlorobenzene	ug/l											<2	<2			<2	<2					<2	<2
1,2,3-Trichloropropane	ug/l											<50	<50			<50	<50					<50	<50
1,2,4-Trichlorobenzene	ug/l											<1	<1			<1	<1					<1	<1
1,2,4-Trimethylbenzene	ug/l											<1	<1			<1	<1					<1	<1
1,2-Dibromo-3-Chloropropane	ug/l											<50	<50			<50	<50					<50	<50
1,2-Dibromoethane	ug/l											<5	<5			<5	<5					<5	<5
1,2-Dichlorobenzene	ug/l											<1	<1			<1	<1					<1	<1
1,2-Dichloroethane	ug/l											<2	<2			<2	<2					<2	<2
1,2-Dichloropropane	ug/l											<1	<1			<1	<1					<1	<1
1,3,5-Trimethylbenzene	ug/l											<1	<1			<1	<1					<1	<1
1,3-Dichloropropane	ug/l											<2	<2			<2	<2					<2	<2
1,4-Dichlorobenzene	ug/l											<1	<1			<1	<1					<1	<1
2-Chlorotoluene	ug/l											<1	<1			<1	<1					<1	<1
4-Chlorotoluene	ug/l											<1	<1			<1	<1					<1	<1

MACAN Groundwater Sample Analysis & Screening Assessment CL-27 01/07/2015		Screening Values & Assessment								
		EQS		Environmental Quality Standards						
		DWS		Drinking Water Standard						
		X		Exceeds EQS						
		X		Exceeds DWS						
		X		Laboratory detection level higher than screening criterion						
Location		Units		Notes EQS calcium carbonate 100-150mg/l for heavy metals: chromium, copper, lead, nickel and zinc N/A = Not Available						
Monitoring Round										
Location Type										
Response Zone (RZ) Details										
Depth										
Installation Details										
Strata Water Level Encountered on Sampling										
Date Sampled		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Installation Details of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS		
VOCs										
Full suite	ug/l	2	0	None > LOD	None > LOD					
1,1,1,2-Tetrachloroethane	ug/l	6	0	None > LOD	None > LOD					
1,1,1-Trichloroethane	ug/l	6	0	None > LOD	None > LOD		0			
1,1,2-Trichloroethane	ug/l	6	0	None > LOD	None > LOD		0			
1,1-Dichloroethane	ug/l	6	0	None > LOD	None > LOD					
1,1-Dichloroethene	ug/l	6	0	None > LOD	None > LOD					
1,1-Dichloropropene	ug/l	6	0	None > LOD	None > LOD					
1,2,3-Trichlorobenzene	ug/l	6	0	None > LOD	None > LOD		0			
1,2,3-Trichloropropane	ug/l	6	0	None > LOD	None > LOD					
1,2,4-Trichlorobenzene	ug/l	6	0	None > LOD	None > LOD		0			
1,2,4-Trimethylbenzene	ug/l	6	0	None > LOD	None > LOD					
1,2-Dibromo-3-Chloropropane	ug/l	6	0	None > LOD	None > LOD					
1,2-Dibromoethane	ug/l	6	0	None > LOD	None > LOD					
1,2-Dichlorobenzene	ug/l	6	0	None > LOD	None > LOD		0			
1,2-Dichloroethane	ug/l	6	0	None > LOD	None > LOD		0	0		
1,2-Dichloropropane	ug/l	6	0	None > LOD	None > LOD					
1,3,5-Trimethylbenzene	ug/l	6	0	None > LOD	None > LOD					
1,3-Dichloropropane	ug/l	6	0	None > LOD	None > LOD					
1,4-Dichlorobenzene	ug/l	6	0	None > LOD	None > LOD		0			
2-Chlorotoluene	ug/l	6	0	None > LOD	None > LOD					
4-Chlorotoluene	ug/l	6	0	None > LOD	None > LOD					
4-Isopropyltoluene	ug/l	6	0	None > LOD	None > LOD					
Benzene	ug/l	18	0	None > LOD	None > LOD		0	0		
Bromobenzene	ug/l	6	0	None > LOD	None > LOD					
Bromochloromethane	ug/l	6	0	None > LOD	None > LOD			0		
Bromodichloromethane	ug/l	6	0	None > LOD	None > LOD					
Bromomethane	ug/l	6	0	None > LOD	None > LOD					
Chlorobenzene	ug/l	6	0	None > LOD	None > LOD					
Chloroethane	ug/l	6	0	None > LOD	None > LOD					
Chloroethene	ug/l	6	0	None > LOD	None > LOD					
Chloroform	ug/l	6	0	None > LOD	None > LOD		0	0		
Chloromethane	ug/l	6	0	None > LOD	None > LOD					
cis-1,2-Dichloroethene	ug/l	6	0	None > LOD	None > LOD					
cis-1,3-Dichloropropene	ug/l	6	0	None > LOD	None > LOD					
Dibromochloromethane	ug/l	6	0	None > LOD	None > LOD			0		
Dibromomethane	ug/l	6	0	None > LOD	None > LOD					
Dichlorodifluoromethane	ug/l	6	0	None > LOD	None > LOD					
Ethylbenzene	ug/l	18	0	None > LOD	None > LOD		0			
Hexachlorobutadiene (HCBD)	ug/l	6	0	None > LOD	None > LOD		0			
Isopropylbenzene	ug/l	6	0	None > LOD	None > LOD					
m,p xylenes	ug/l	18	1	1.3	1.3	1 @ Deep	0			
Methyl tert-butyl ether (MTBE)	ug/l	6	0	None > LOD	None > LOD					
n-Butylbenzene	ug/l	6	0	None > LOD	None > LOD					
n-propylbenzene	ug/l	6	0	None > LOD	None > LOD					
O-Xylene	ug/l	18	0	None > LOD	None > LOD		0			
Sec-Butylbenzene	ug/l	6	0	None > LOD	None > LOD					
Styrene	ug/l	6	0	None > LOD	None > LOD		0			
Tert-Butylbenzene	ug/l	6	0	None > LOD	None > LOD					
Tetrachloroethene	ug/l	6	0	None > LOD	None > LOD			0		
Tetrachloromethane (Carbon Tetra Chloride)	ug/l	6	0	None > LOD	None > LOD		0	0		
Toluene	ug/l	18	0	None > LOD	None > LOD		0			
trans-1,2-Dichloroethene	ug/l	6	0	None > LOD	None > LOD					
trans-1,3-Dichloropropene	ug/l	6	0	None > LOD	None > LOD					
Tribromomethane	ug/l	6	0	None > LOD	None > LOD			0		
Trichloroethene	ug/l	6	0	None > LOD	None > LOD		0	0		
Trichlorofluoromethane	ug/l	6	0	None > LOD	None > LOD					

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Location	Units	Screening Criteria		CH 51	CH52	CH52 A	RBBH003	RBBH003	RBBH003	RBBH004	RBBH004	RBBH004	RBBH005	RBBH005	RBBH005	SBHK01	SBHK01	SBHK02	SBHK02			
Monitoring Round		EQS	DWS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	1	2			
Location Type				TP	TP	TP	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH		
Response Zone (RZ) Details				MG	MG	MG	TFD / PEAT			TFD / PEAT			MG / TFD			TFD / PEAT		TFD / PEAT				
Depth																		1	6.8	1.33	11.2	
Installation Details																			TFD		MG	
Strata Water Level Encountered on Sampling				MG	MG	MG													TFD		MG	
Date Sampled				2000	2000	2000	05/03/2002			01/03/2002			01/03/2002			26/02/2008	20/03/2008	26/02/2008	20/03/2008			
Other Semi-Volatiles																						
1,2-Dichlorobenzene	ug/l	20														<1	<1	<1	<1			
1,2,4-Trichlorobenzene	ug/l	0.4														<1	<1	<1	<1			
1,3-Dichlorobenzene	ug/l	20														<1	<1	<1	<1			
1,4-Dichlorobenzene	ug/l	20														<1	<1	<1	<1			
2-Nitroaniline	ug/l															<1	<1	<1	<1			
2,4-Dinitrotoluene	ug/l															<1	<1	<1	<1			
2,6-Dinitrotoluene	ug/l															<1	<1	<1	<1			
2-Methylnaphthalene	ug/l																					
3-Nitroaniline	ug/l															<1	<1	<1	<1			
4-Bromophenylphenylether	ug/l															<1	<1	<1	<1			
4-Chloroaniline	ug/l															<1	<1	<1	<1			
4-Chlorophenylphenylether	ug/l															<1	<1	<1	<1			
4-Nitroaniline	ug/l															<1	<1	<1	<1			
Azobenzene	ug/l															<1	<1	<1	<1			
Bis(2-chloroethoxy)methane	ug/l															<1	<1	<1	<1			
Bis(2-chloroethyl)ether	ug/l															<1	<1	<1	<1			
Bis(2-chloroisopropyl)ether	ug/l																					
Carbazole	ug/l															<1	<1	<1	<1			
Dibenzofuran	ug/l															<1	<1	<1	<1			
Hexachlorobenzene	ug/l	0.05														<1	<1	<1	<1			
Hexachlorobutadiene	ug/l	0.6														<1	<1	<1	<1			
Hexachlorocyclopentadiene	ug/l															<1	<1	<1	<1			
Hexachloroethane	ug/l															<1	<1	<1	<1			
Isophorone	ug/l															<1	<1	<1	<1			
N-nitrosodi-n-propylamine	ug/l															<1	<1	<1	<1			
Nitrobenzene	ug/l															<1	<1	<1	<1			

MG	Made Ground
TFD	Tidal Flat Deposits
PEAT	Peat
MMG	Merica Mudstone Group

Location	Units	SBHK03	SBHK03	SBHK04	SBHK04	BH527	BH527	BH527	BH527	BH527	BH527	BH528	BH528	BH528	BH528	BH528	BH528	BH530	BH530	BH530	BH530	BH530	BH530
Monitoring Round		1	2	1	2	1	2	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
Location Type		BH	BH	BH	BH			BH															
Response Zone (RZ) Details		TFD / PEAT		TFD		MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD	MMG	TFD
Depth		0.89	5.9	8.87	12.2	2.92	7.66	1.93	7.29	1.99	4.71	1.76	6.44	1.53	6.8	1.64	6.29	2.53	5.45	2.47	4.57	2.97	5.07
Installation Details						Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow
Strata Water Level Encountered on Sampling		MG		TFD																			
Date Sampled	26/02/2008	20/03/2008	26/02/2008	20/03/2008	20/03/2015	27/03/2015	13/04/2015	20/03/2015	27/03/2015	13/04/2015	20/03/2015	27/03/2015	13/04/2015	30/03/2015	14/04/2015	21/04/2015							
Other Semi-Volatiles																							
1,2-Dichlorobenzene	ug/l	<1	<1	<1	<1																		
1,2,4-Trichlorobenzene	ug/l	<1	<1	<1	<1																		
1,3-Dichlorobenzene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
1,4-Dichlorobenzene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
2-Nitroaniline	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
2,4-Dinitrotoluene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
2,6-Dinitrotoluene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
2-Methylnaphthalene	ug/l										<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
3-Nitroaniline	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
4-Bromophenylphenylether	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
4-Chloroaniline	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
4-Chlorophenylphenylether	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
4-Nitroaniline	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Azobenzene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Bis(2-chloroethoxy)methane	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Bis(2-chloroethyl)ether	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Bis(2-chloroisopropyl)ether	ug/l										<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Carbazole	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Dibenzofuran	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Hexachlorobenzene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Hexachlorobutadiene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Hexachlorocyclopentadiene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Hexachloroethane	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Isophorone	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
N-nitrosodi-n-propylamine	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	
Nitrobenzene	ug/l	<1	<1	<1	<1						<0.5	<0.5			<0.5	<0.5					<0.5	<0.5	

MACAN Groundwater Sample Analysis & Screening Assessment CL-27 01/07/2015		Screening Values & Assessment						
		EQS Environmental Quality Standards						
		DWS Drinking Water Standard						
		Exceeds EQS						
		Exceeds DWS						
		Laboratory detection level higher than screening criterion						
Location		Notes EQS calcium carbonate 100-150mg/l for heavy metals: chromium, copper, lead, nickel and zinc N/A = Not Available						
Monitoring Round								
Location Type								
Response Zone (RZ) Details								
Depth								
Installation Details								
Strata Water Level Encountered on Sampling								
Date Sampled								
		No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Installation Details of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS
Other Semi-Volatiles								
1,2-Dichlorobenzene	ug/l	8	0	None > LOD	None > LOD		0	
1,2,4-Trichlorobenzene	ug/l	8	0	None > LOD	None > LOD		0	
1,3-Dichlorobenzene	ug/l	14	0	None > LOD	None > LOD		0	
1,4-Dichlorobenzene	ug/l	14	0	None > LOD	None > LOD		0	
2-Nitroaniline	ug/l	14	0	None > LOD	None > LOD			
2,4-Dinitrotoluene	ug/l	14	0	None > LOD	None > LOD			
2,6-Dinitrotoluene	ug/l	14	0	None > LOD	None > LOD			
2-Methylnaphthalene	ug/l	6	0	None > LOD	None > LOD			
3-Nitroaniline	ug/l	14	0	None > LOD	None > LOD			
4-Bromophenylphenylether	ug/l	14	0	None > LOD	None > LOD			
4-Chloroaniline	ug/l	14	0	None > LOD	None > LOD			
4-Chlorophenylphenylether	ug/l	14	0	None > LOD	None > LOD			
4-Nitroaniline	ug/l	14	0	None > LOD	None > LOD			
Azobenzene	ug/l	14	0	None > LOD	None > LOD			
Bis(2-chloroethoxy)methane	ug/l	14	0	None > LOD	None > LOD			
Bis(2-chloroethyl)ether	ug/l	14	0	None > LOD	None > LOD			
Bis(2-chloroisopropyl)ether	ug/l	6	0	None > LOD	None > LOD			
Carbazole	ug/l	14	0	None > LOD	None > LOD			
Dibenzofuran	ug/l	14	0	None > LOD	None > LOD			
Hexachlorobenzene	ug/l	14	0	None > LOD	None > LOD		0	
Hexachlorobutadiene	ug/l	14	0	None > LOD	None > LOD		0	
Hexachlorocyclopentadiene	ug/l	14	0	None > LOD	None > LOD			
Hexachloroethane	ug/l	14	0	None > LOD	None > LOD			
Isophorone	ug/l	14	0	None > LOD	None > LOD			
N-nitrosodi-n-propylamine	ug/l	14	0	None > LOD	None > LOD			
Nitrobenzene	ug/l	14	0	None > LOD	None > LOD			

A5 Appendix 5

Surface Water Laboratory Data

Monitoring Round / Location	Units	Screening Criteria			1 / EESW1	2 / EESW1	3 / EESW1	4 / EESW1	Q1 / 17.1	Q1 / 17.2	Q1 / 17.3	E1 / R14	E2 / R14	E3 / R14	E4 / R14	E1 / R15
Date Sampled					03/03/2004	15/06/2004	20/09/2004	06/05/2005	03/06/2015	03/06/2015	03/06/2015	11/12/2007	17/03/2008	23/06/2008	24/09/2008	11/12/2007
		EQS	DWS	CCW												
Metals & Non-Metal Inorganics																
Hardness Total	mg/l				2	2	<1	1	1.01	5.31	3.02	226	135	236	287	204
Arsenic Dissolved	ug/l	50	10													
Boron Dissolved	ug/l	2000	1000		180	90	60	80								
Calcium Dissolved	ug/l			300000					54.1	142	69	72	36	58	73	52
Cadmium Dissolved	ug/l	0.15	5	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.436					
Chromium Dissolved	ug/l		50		<1	<1	1	<1	1.42	5.79	2.25	<0.22	<0.22	<0.22	<0.22	<0.22
Copper Dissolved	ug/l	10	2000		<1	<1	<1	2				<0.85	<0.85	<0.85	<0.85	<0.85
Lead Dissolved	ug/l	1.2	10	250	<1	<1	<1	<1	0.143	0.049	0.21	<0.02	<0.02	<0.02	<0.02	<0.02
Magnesium Dissolved	ug/l											15	8.8	17	16	14
Nickel Dissolved	ug/l	4	20	100	8	7	4	4	2.23	4.1	2.44	<1	<1	<1	<1	<1
Selenium Dissolved	ug/l		10		3	3	1	2	0.69	1.51	6.22					
Zinc Dissolved	ug/l	75		1000	<2	11	6	<2								
Manganese Dissolved	ug/l	30	50		<2	<10	37	7								
Iron Dissolved	ug/l	1000	200		<10	<10	<10	<10								
Mercury Dissolved	ug/l	0.07	1		<0.1	<0.1	<0.1	<0.1								
Molybdenum Dissolved	ug/l															
Cadmium Total	ug/l	0.15	5	5								<0.5	<0.5	1.5	<0.5	<0.5
Zinc Total	ug/l	75		1000								28	52	22	38	99
BOD	mg/l	5		18					<1	2.4	15.7	9	8	2	3	3
Nitrate as N	mg/l		50	1	<0.3	1.4	<0.3	<0.3				<0.3	0.9	<0.3	<0.3	3.6
Nitrate as NO3	mg/l		50	1					41.5	<0.3	<0.3	1.3	3.99	<0.3	<0.3	15.9
Nitrite as N	mg/l		0.15	1								<0.1	<0.1	<0.1	<0.1	<0.1
Nitrite as NO2	mg/l		0.5	1					0.156	0.06	0					
Nitrogen, Total Oxidised as N	mg/l		50	2					9.43	<0.3	<0.3	<0.3	0.9	<0.3	<0.3	3.6
Phosphate, Ortho as P	mg/l			1	0.02	0.04	0.02	0.03				0.2	0.3	1.2	0.2	0.1
Phosphorus (tot.unfilt)	ug/l	120							229	1200	402					
Sulphate (soluble)	mg/l	400	250	300					24.6	42.3	114					
Sulphate as SO4	mg/l	400	250	300	400	367	171	245				47	<5	16	19	26
Toluene Extractable Material	mg/l				<6	<6	<6	81								
Chloride	mg/l	250	250	300	582	611	424	429	32.3	248	785	39	22	25	34	21
Sulphide	mg/l															
Ammoniacal Nitrogen as N	mg/l	0.6		1	3.2	3.2	2.1	1.7	0.426	0.369	0.266	0.04	0.22	<0.01	0.05	0.05
Cyanide Free	mg/l															
Cyanide Total	mg/l	0.001	0.05		0.07	<0.05	<0.05	<0.05								
Thiocyanate as SCN	mg/l				0.6	0.8	0.4	0.3								
Dissolved Oxygen	mg/l								6.5	2.48	14.6	2.54	5.27	1.03	1.63	9.58
Dissolved Oxygen (Saturation)	%	60										20.2	45.6	10.5	16.1	74.2
pH Value	pH units	6-9	6.5-10	6.8-8.5	12.1	11.8	8.6	10.2				7.3	7.3	7.7	7.3	7.6
Conductivity	us/cm				4490	3710	1940	1880								

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Monitoring Round / Location		E2 / R15	E3 / R15	E4 / R15	E1 / R16	E2 R/16	E3 / R16	E4 / R16	1 / SW506	2 / SW506	3 / SW506	1 /SW507	2 / SW507	3 / SW507	1 / SW508	3 / SW508
Date Sampled		17/03/2008	23/06/2008	24/09/2008	11/12/2007	17/03/2008	23/06/2008	24/09/2008	01/04/2015	15/04/2015	22/04/2015	01/04/2015	15/04/2015	22/04/2015	01/04/2015	22/04/2015
	Units															
Metals & Non-Metal Inorganics																
Hardness Total	mg/l	169	257	245	253	150	290	324								
Arsenic Dissolved	ug/l								1.5	4.6	1.5	1.9	2.8	2.2	1.4	<1
Boron Dissolved	ug/l								710	920	120	690	910	90	670	47
Calcium Dissolved	ug/l	82	63	56	63	84	71	84								
Cadmium Dissolved	ug/l								<0.08	2.9	0.097	<0.08	<0.08	<0.08	<0.08	<0.08
Chromium Dissolved	ug/l	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	9.3	6.2	<0.22	10	4.6	<0.22	10	<0.22
Copper Dissolved	ug/l	<0.85	<0.85	<0.85	<0.85	<0.85	<0.85	<0.85								
Lead Dissolved	ug/l	<0.02	7	<0.02	<0.02	<0.02	<0.02	<0.02	1	<0.02	1.3	<0.02	<0.02	<0.02	<0.02	<0.02
Magnesium Dissolved	ug/l	17	23	20	18	18	30	28								
Nickel Dissolved	ug/l	<1	<1	<1	<1	<1	<1	<1	1.5	4.2	1.3	1.6	1.5	2	1	<1
Selenium Dissolved	ug/l								<1	4.9	1.6	<1	1.9	1.5	<1	1.3
Zinc Dissolved	ug/l															
Manganese Dissolved	ug/l															
Iron Dissolved	ug/l															
Mercury Dissolved	ug/l															
Molybdenum Dissolved	ug/l															
Cadmium Total	ug/l	<0.5	1.8	<0.5	<0.5	<0.5	1.8	<0.5								
Zinc Total	ug/l	42	26	310	38	24	6	18								
BOD	mg/l	3	<1	1	<1	<1	1	<1								
Nitrate as N	mg/l	1.8	<0.3	3.1	2.2	1.5	<0.3	1.7								
Nitrate as NO3	mg/l	7.97	<0.3	13.733	9.7	6.64	<0.3	7.531								
Nitrite as N	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2								
Nitrite as NO2	mg/l															
Nitrogen, Total Oxidised as N	mg/l	1.8	<0.3	3.2	2.3	1.6	<0.3	1.9								
Phosphate, Ortho as P	mg/l	0.2	1.1	<0.1	0.2	0.2	1.1	<0.1								
Phosphorus (tot.unfilt)	ug/l															
Sulphate (soluble)	mg/l															
Sulphate as SO4	mg/l	26	25	26	42	25	23	33								
Toluene Extractable Material	mg/l															
Chloride	mg/l	28	38	21	28	25	37	29	49	52		210	250	320		
Sulphide	mg/l															
Ammoniacal Nitrogen as N	mg/l	0.15	<0.01	0.13	0.2	0.16	<0.01	0.19	0.044	0.044	0.075	0.35	0.16	1.2	0.13	0.35
Cyanide Free	mg/l								<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cyanide Total	mg/l															
Thiocyanate as SCN	mg/l															
Dissolved Oxygen	mg/l	7.58	9.61	6.98	8.67	7.99	8.14	6.01								
Dissolved Oxygen (Saturation)	%	64	98.2	64.7	66.8	67.8	85.6	57.7								
pH Value	pH units	7.6	7.9	7.6	7.6	7.6	8.1	7.6	8.7	8.9	8.6	8.7	8.9	8.5	8.9	8.6
Conductivity	us/cm															

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Screening Values and Assessment

EQS	Environmental Quality Standards
	Exceeds EQS
100	Exceeds DWS
<10	Laboratory detection level higher than screening criterion
BOL/ITA	Exceeds CCW

Monitoring Round / Location		Units
Date Sampled		
Metals & Non-Metal Inorganics		
Hardness Total		mg/l
Arsenic Dissolved		ug/l
Boron Dissolved		ug/l
Calcium Dissolved		ug/l
Cadmium Dissolved		ug/l
Chromium Dissolved		ug/l
Copper Dissolved		ug/l
Lead Dissolved		ug/l
Magnesium Dissolved		ug/l
Nickel Dissolved		ug/l
Selenium Dissolved		ug/l
Zinc Dissolved		ug/l
Manganese Dissolved		ug/l
Iron Dissolved		ug/l
Mercury Dissolved		ug/l
Molybdenum Dissolved		ug/l
Cadmium Total		ug/l
Zinc Total		ug/l
BOD		mg/l
Nitrate as N		mg/l
Nitrate as NO3		mg/l
Nitrite as N		mg/l
Nitrite as NO2		mg/l
Nitrogen, Total Oxidised as N		mg/l
Phosphate, Ortho as P		mg/l
Phosphorus (tot.unfilt)		ug/l
Sulphate (soluble)		mg/l
Sulphate as SO4		mg/l
Toluene Extractable Material		mg/l
Chloride		mg/l
Sulphide		mg/l
Ammoniacal Nitrogen as N		mg/l
Cyanide Free		mg/l
Cyanide Total		mg/l
Thiocyanate as SCN		mg/l
Dissolved Oxygen		mg/l
Dissolved Oxygen (Saturation)		%
pH Value		pH units
Conductivity		us/cm

Notes

EQS calcium carbonate 100 - 150mg/l for heavy metals: chromium, copper, lead, nickel and zinc
NDP - No determination possible

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Round of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS	No. Data Exceeding CCW
12	12	324	135	E4 / R16			
15	13	5.31	1	Q1 / 17.2	0	0	
12	12	920	47	2 / SW506	0	0	
15	15	142	36	Q1 / 17.2			0
15	3	2.9	0.097	2 / SW506	2	0	0
27	9	10	1	1 /SW507		0	
16	1	2	2	4 / EESW1	0	0	
27	6	7	0.049	E3 / R15	2	0	0
12	12	30	8.8	E3 / R16			
27	14	8	1	1 / EESW1	4	0	0
15	12	6.22	0.69	Q1 / 17.3		0	
4	2	11	6	2 / EESW1	0		0
4	2	37	7	3 / EESW1	1	0	
4	0	None > LOD	None > LOD		0	0	
4	0	None > LOD	None > LOD		0	0	
0	0	None > LOD	None > LOD				
12	3	1.8	1.5	E3 / R15	3	0	0
12	12	310	6	E4 / R15	2	0	0
15	10	15.7	1	Q1 / 17.3	3		0
16	8	3.6	0.9	E1 / R15		0	7
15	9	41.5	1.3	Q1 / 17.1		0	9
12	1	0.2	0.2	E4 / R16		1	0
3	3	0.156	0	Q1 / 17.1		0	0
15	8	9.43	0.9	Q1 / 17.1		0	4
16	14	1.2	0.02	E3 / R14			3
3	3	1200	229	Q1 / 17.2	3		0
3	3	114	24.6	Q1 / 17.3	0	0	0
16	15	400	16	1 / EESW1	0	2	2
4	1	81	81	4 / EESW1		0	0
24	24	785	21	Q1 / 17.3	6	6	6
0	0	None > LOD	None > LOD				
27	24	3.2	0.04	1 / EESW1	5		5
8	0	None > LOD	None > LOD				
4	1	0.07	0.07	1 / EESW1	1	1	
4	4	0.8	0.3	2 / EESW1			
15	15	14.6	1.03	Q1 / 17.3	0		
12	12	98.2	10.5	E3 / R15	7		
24	24	12.1	7.3	1 / EESW1	0	0	0
4	4	4490	1880	1 / EESW1		0	0

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Monitoring Round / Location	Units	Screening Criteria			1 / EESW1	2 / EESW1	3 / EESW1	4 / EESW1	Q1 / 17.1	Q1 / 17.2	Q1 / 17.3	E1 / R14	E2 / R14	E3 / R14	E4 / R14	E1 / R15	
Date Sampled					03/03/2004	15/06/2004	20/09/2004	06/05/2005	03/06/2015	03/06/2015	03/06/2015	11/12/2007	17/03/2008	23/06/2008	24/09/2008	11/12/2007	
		EQS	DWS	CCW													
Organics																	
GRO (C5-C12)	ug/l								<50	<50	<50						
MTBE	ug/l								<3	<3	<3						
Benzene	ug/l	10	1						<7	<7	<7						
Toluene	ug/l	50							<4	<4	<4						
Ethyl benzene	ug/l	20							<5	<5	<5						
m & p Xylene	ug/l	30							<8	<8	<8						
o Xylene	ug/l	30							<3	<3	<3						
TPH																	
Aliphatics C5-C6	ug/l								<10	<10	<10						
Aliphatics >C6-C8	ug/l								<10	<10	<10						
Aliphatics >C8-C10	ug/l								<10	<10	<10						
Aliphatics >C10-C12	ug/l								<10	<10	<10						
Aliphatics >C12-C16 Aqueous	ug/l								<10	<10	<10						
Aliphatics >C16-C21 Aqueous	ug/l								<10	<10	<10						
Aliphatics >C21-C35 Aqueous	ug/l								<10	<10	<10						
Total Aliphatics C12-C35 Aqueous	ug/l																
Aromatics >C5-C7	ug/l								<10	<10	<10						
Aromatics >C7-C8	ug/l								<10	<10	<10						
Aromatics >EC8-EC10	ug/l								<10	<10	<10						
Aromatics >EC10-EC12	ug/l								<10	<10	<10						
Aromatics >EC12-EC16 Aqueous	ug/l								<10	<10	<10						
Aromatics >EC16-EC21 Aqueous	ug/l								<10	<10	<10						
Aromatics >EC21-EC35 Aqueous	ug/l								<10	<10	<10						
Total Aromatics C12-C35 Aqueous	ug/l								<10	<10	<10						
Total Aliphatic TPH	ug/l																
TPH >C6-C8	ug/l											<40	<40	<40	<40	<40	
TPH >C8-C10	ug/l											<40	<40	<40	<40	<40	
TPH >C10-C16	ug/l											<80	<80	<80	<80	<80	
TPH >C16-C24	ug/l											<80	<80	<80	<80	<80	
TPH >C24-C40	ug/l											<200	<200	<200	<200	<200	
TPH >C6-C40	ug/l											<200	<200	<200	<200	<200	
Total petroleum hydrocarbons	ug/l												<200	<200	<200	<200	

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Monitoring Round / Location	Units	E2 / R15	E3 / R15	E4 / R15	E1 / R16	E2 R/16	E3 / R16	E4 / R16	1 / SW506	2 / SW506	3 / SW506	1 /SW507	2 / SW507	3 / SW507	1 / SW508	3 / SW508
Date Sampled		17/03/2008	23/06/2008	24/09/2008	11/12/2007	17/03/2008	23/06/2008	24/09/2008	01/04/2015	15/04/2015	22/04/2015	01/04/2015	15/04/2015	22/04/2015	01/04/2015	22/04/2015
Organics																
GRO (C5-C12)	ug/l															
MTBE	ug/l															
Benzene	ug/l									<1	<1	<1	<1	<1	<1	<1
Toluene	ug/l									<7	<7	<7	<7	<7	<7	<7
Ethyl benzene	ug/l									<4	<4	<4	<4	<4	<4	<4
m & p Xylene	ug/l									<5	<5	<5	<5	<5	<5	<5
o Xylene	ug/l									<8	<8	<8	<8	<8	<8	<8
	ug/l									<3	<3	<3	<3	<3	<3	<3
TPH																
Aliphatics C5-C6	ug/l									<10	<10	<10	<10	<10	<10	<10
Aliphatics >C6-C8	ug/l									<10	<10	<10	<10	<10	<10	<10
Aliphatics >C8-C10	ug/l									<10	<10	<10	<10	<10	<10	<10
Aliphatics >C10-C12	ug/l									<10	<10	<10	<10	<10	<10	<10
Aliphatics >C12-C16 Aqueous	ug/l									<10	<10	<10	<10	<10	<10	<10
Aliphatics >C16-C21 Aqueous	ug/l									<10	<10	<10	<10	<10	<10	<10
Aliphatics >C21-C35 Aqueous	ug/l									<10	<10	<10	<10	<10	<10	<10
Total Aliphatics C12-C35 Aqueous	ug/l															
Aromatics >C5-C7	ug/l									<10	<10	<10	<10	<10	<10	<10
Aromatics >C7-C8	ug/l									<10	<10	<10	<10	<10	<10	<10
Aromatics >EC8-EC10	ug/l									<10	<10	<10	<10	<10	<10	<10
Aromatics >EC10-EC12	ug/l									<10	<10	<10	<10	<10	<10	<10
Aromatics >EC12-EC16 Aqueous	ug/l									<10	<10	<10	<10	<10	<10	<10
Aromatics >EC16-EC21 Aqueous	ug/l									<10	<10	<10	<10	<10	<10	<10
Aromatics >EC21-EC35 Aqueous	ug/l									<10	<10	<10	<10	<10	<10	<10
Total Aromatics C12-C35 Aqueous	ug/l															
Total Aliphatic TPH	ug/l									<5	<5	<5	<5	<5	<5	<5
TPH >C6-C8	ug/l	<40	<40	<40	<40	<40	<40	<40	<40							
TPH >C8-C10	ug/l	<40	<40	<40	<40	<40	<40	<40	<40							
TPH >C10-C16	ug/l	<80	<80	<80	<80	<80	<80	<80	<80							
TPH >C16-C24	ug/l	<80	<80	<80	<80	<80	<80	<80	<80							
TPH >C24-C40	ug/l	<200	<200	<200	<200	<200	<200	<200	<200							
TPH >C6-C40	ug/l	<200	<200	<200	<200	<200	<200	<200	<200							
Total petroleum hydrocarbons	ug/l									<10	<10	<10	<10	<10	<10	<10

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Screening Values and Assessment	
EQS	Environmental Quality Standards
	Exceeds EQS
100	Exceeds DWS
<10	Laboratory detection level higher than screening criterion
BOL/ITA	Exceeds CCW

Monitoring Round / Location		Units
Date Sampled		
Organics		
GRO (C5-C12)		ug/l
MTBE		ug/l
Benzene		ug/l
Toluene		ug/l
Ethyl benzene		ug/l
m & p Xylene		ug/l
o Xylene		ug/l
TPH		
Aliphatics C5-C6		ug/l
Aliphatics >C6-C8		ug/l
Aliphatics >C8-C10		ug/l
Aliphatics >C10-C12		ug/l
Aliphatics >C12-C16 Aqueous		ug/l
Aliphatics >C16-C21 Aqueous		ug/l
Aliphatics >C21-C35 Aqueous		ug/l
Total Aliphatics C12-C35 Aqueous		ug/l
Aromatics >C5-C7		ug/l
Aromatics >C7-C8		ug/l
Aromatics >EC8-EC10		ug/l
Aromatics >EC10-EC12		ug/l
Aromatics >EC12-EC16 Aqueous		ug/l
Aromatics >EC16-EC21 Aqueous		ug/l
Aromatics >EC21-EC35 Aqueous		ug/l
Total Aromatics C12-C35 Aqueous		ug/l
Total Aliphatic TPH		ug/l
TPH >C6-C8		ug/l
TPH >C8-C10		ug/l
TPH >C10-C16		ug/l
TPH >C16-C24		ug/l
TPH >C24-C40		ug/l
TPH >C6-C40		ug/l
Total petroleum hydrocarbons		ug/l

Notes

EQS calcium carbonate 100 - 150mg/l for heavy metals: chromium, copper, lead, nickel and zinc

NDP - No determination possible

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Round of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS	No. Data Exceeding CCW
3	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD		0	0	
10	0	None > LOD	None > LOD		0		
10	0	None > LOD	None > LOD		0		
10	0	None > LOD	None > LOD		0		
10	0	None > LOD	None > LOD		0		
10	0	None > LOD	None > LOD				0
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				0
10	0	None > LOD	None > LOD				0
10	0	None > LOD	None > LOD				0
0	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				0
10	0	None > LOD	None > LOD				0
10	0	None > LOD	None > LOD				0
3	0	None > LOD	None > LOD				
7	0	None > LOD	None > LOD				
13	0	None > LOD	None > LOD				
13	0	None > LOD	None > LOD				
13	0	None > LOD	None > LOD				
13	0	None > LOD	None > LOD				
13	0	None > LOD	None > LOD				
13	0	None > LOD	None > LOD				
13	0	None > LOD	None > LOD				
7	0	None > LOD	None > LOD				

Monitoring Round / Location	Units	Screening Criteria			1 / EESW1	2 / EESW1	3 / EESW1	4 / EESW1	Q1 / 17.1	Q1 / 17.2	Q1 / 17.3	E1 / R14	E2 / R14	E3 / R14	E4 / R14	E1 / R15	
Date Sampled					03/03/2004	15/06/2004	20/09/2004	06/05/2005	03/06/2015	03/06/2015	03/06/2015	11/12/2007	17/03/2008	23/06/2008	24/09/2008	11/12/2007	
		EQS	DWS	CCW													
Phenols																	
2-Chlorophenol	ug/l	50															
2 - Methyl-4,6-Dinitrophenol	ug/l																
2-Methylphenol	ug/l	100															
2-Nitrophenol	ug/l																
2,4-Dichlorophenol	ug/l	20															
2,4-Dimethylphenol	ug/l																
2,4,5-Trichlorophenol	ug/l																
2,4,6-Trichlorophenol	ug/l																
4-Chloro-3-methylphenol	ug/l	40															
4-Methylphenol	ug/l	100															
Pentachlorophenol	ug/l	0.4															
Phenol	ug/l	7.7															
Phenols	mg/l	0.0077															
Phenol Index	mg/l				0.05	<0.05	<0.05	<0.05									
PAHs																	
2-Chloronaphthalene	ug/l																
2-Methylnaphthalene	ug/l																
Acenaphthene	ug/l								<0.015	<0.015	<0.015						
Acenaphthylene	ug/l								<0.1	<0.1	<0.1						
Anthracene	ug/l	0.1							<0.015	<0.015	<0.015						
Benzo(a)anthracene	ug/l								<0.017	<0.017	<0.017						
Benzo(a)pyrene	ug/l	0.00017	0.01						<0.1	<0.1	<0.1						
Benzo(b)fluoranthene	ug/l	0.017	0.1						<0.1	<0.1	<0.1						
Benzo(k)fluoranthene	ug/l	0.017	0.1						<0.1	<0.1	<0.1						
Benzo(ghi)perylene	ug/l	0.0082	0.1						<0.016	<0.016	<0.016						
Indeno(1,2,3-cd)pyrene	ug/l		0.1						<0.1	<0.1	<0.1						
Chrysene	ug/l								<0.1	<0.1	<0.1						
Dibenzo(a,h)anthracene	ug/l								<0.1	<0.1	<0.1						
Fluoranthene	ug/l	0.0063							<0.1	<0.1	<0.1						
Fluorene	ug/l								<0.1	<0.1	<0.1						
Naphthalene	ug/l	2							0.318	<0.1	<0.1						
Phenanthrene	ug/l								<0.1	<0.1	<0.1						
Pyrene	ug/l								<0.1	<0.1	<0.1						
Total PAHs (USEPA 16)	ug/l								<0.344	<0.344	<0.344						

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Screening Values and Assessment	
EQS	Environmental Quality Standards
	Exceeds EQS
100	Exceeds DWS
<10	Laboratory detection level higher than screening criterion
BOL/ITA	Exceeds CCW

Monitoring Round / Location		Units
Date Sampled		
Phenols		
2-Chlorophenol		ug/l
2 - Methyl-4,6-Dinitrophenol		ug/l
2-Methylphenol		ug/l
2-Nitrophenol		ug/l
2,4-Dichlorophenol		ug/l
2,4-Dimethylphenol		ug/l
2,4,5-Trichlorophenol		ug/l
2,4,6-Trichlorophenol		ug/l
4-Chloro-3-methylphenol		ug/l
4-Methylphenol		ug/l
Pentachlorophenol		ug/l
Phenol		ug/l
Phenols		mg/l
Phenol Index		mg/l
PAHs		
2-Chloronaphthalene		ug/l
2-Methylnaphthalene		ug/l
Acenaphthene		ug/l
Acenaphthylene		ug/l
Anthracene		ug/l
Benzo(a)anthracene		ug/l
Benzo(a)pyrene		ug/l
Benzo(b)fluoranthene		ug/l
Benzo(k)fluoranthene		ug/l
Benzo(ghi)perylene		ug/l
Indeno(1,2,3-cd)pyrene		ug/l
Chrysene		ug/l
Dibenzo(a,h)anthracene		ug/l
Fluoranthene		ug/l
Fluorene		ug/l
Naphthalene		ug/l
Phenanthrene		ug/l
Pyrene		ug/l
Total PAHs (USEPA 16)		ug/l

Notes							
EQS calcium carbonate 100 - 150mg/l for heavy metals: chromium, copper, lead, nickel and zinc							
NDP - No determination possible							
No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Round of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS	No. Data Exceeding CCW
7	0	None > LOD	None > LOD		0		
7	0	None > LOD	None > LOD				
7	0	None > LOD	None > LOD		0		
7	0	None > LOD	None > LOD				
7	0	None > LOD	None > LOD		0		
7	0	None > LOD	None > LOD				
7	0	None > LOD	None > LOD				
7	0	None > LOD	None > LOD		0		
7	0	None > LOD	None > LOD		0		
7	0	None > LOD	None > LOD		0		
7	0	None > LOD	None > LOD		0		0
0	0	None > LOD	None > LOD				
7	0	None > LOD	None > LOD				
7	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD		0		
10	0	None > LOD	None > LOD		0	0	
10	0	None > LOD	None > LOD		0	0	
10	0	None > LOD	None > LOD		0	0	
10	0	None > LOD	None > LOD			0	0
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD		0		
10	0	None > LOD	None > LOD				
10	1	0.318	0.318	Q1 / 17.1	0		
10	0	None > LOD	None > LOD				
10	0	None > LOD	None > LOD				
3	0	None > LOD	None > LOD				0

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Screening Values and Assessment	
EQS	Environmental Quality Standards
	Exceeds EQS
100	Exceeds DWS
<10	Laboratory detection level higher than screening criterion
BOL/ITA	Exceeds CCW

Monitoring Round / Location	Units
Date Sampled	
Styrene	ug/l
Tert-Butylbenzene	ug/l
Tetrachloroethene	ug/l
Tetrachloromethane (Carbon Tetra Chloride)	ug/l
Toluene	ug/l
trans-1,2-Dichloroethene	ug/l
trans-1,3-Dichloropropene	ug/l
Tribromomethane	ug/l
Trichloroethene	ug/l
Trichlorofluoromethane	ug/l

Notes
EQS calcium carbonate 100 - 150mg/l for heavy metals: chromium, copper, lead, nickel and zinc
NDP - No determination possible

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Round of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS	No. Data Exceeding CCW
8	0	None > LOD	None > LOD		0		
8	0	None > LOD	None > LOD				
8	0	None > LOD	None > LOD		0	0	
8	0	None > LOD	None > LOD		0	0	
8	0	None > LOD	None > LOD		0		
8	0	None > LOD	None > LOD				
8	0	None > LOD	None > LOD				
8	0	None > LOD	None > LOD				
8	0	None > LOD	None > LOD			0	
8	0	None > LOD	None > LOD		0	0	
8	0	None > LOD	None > LOD				

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Monitoring Round / Location	Units	E2 / R15	E3 / R15	E4 / R15	E1 / R16	E2 R/16	E3 / R16	E4 / R16	1 / SW506	2 / SW506	3 / SW506	1 /SW507	2 / SW507	3 / SW507	1 / SW508	3 / SW508
Date Sampled		17/03/2008	23/06/2008	24/09/2008	11/12/2007	17/03/2008	23/06/2008	24/09/2008	01/04/2015	15/04/2015	22/04/2015	01/04/2015	15/04/2015	22/04/2015	01/04/2015	22/04/2015
Phthalates																
Bis(2-ethylhexyl) phthalate	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Butylbenzyl phthalate	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Di-n-butyl phthalate	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Di-n-Octyl phthalate	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Diethyl phthalate	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dimethyl phthalate	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Other Semi-Volatiles																
1,2-Dichlorobenzene	ug/l								<1	<1	<1	<1	<1	<1	<1	<1
1,2,4-Trichlorobenzene	ug/l								<1	<1	<1	<1	<1	<1	<1	<1
1,3-Dichlorobenzene	ug/l								<1	<1	<1	<1	<1	<1	<1	<1
1,4-Dichlorobenzene	ug/l								<1	<1	<1	<1	<1	<1	<1	<1
2-Nitroaniline	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dinitrotoluene	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,6-Dinitrotoluene	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylnaphthalene	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3-Nitroaniline	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Bromophenylphenylether	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloroaniline	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chlorophenylphenylether	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Nitroaniline	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Azobenzene	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bis(2-chloroethoxy)methane	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bis(2-chloroethyl)ether	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bis(2-chloroisopropyl)ether	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbazole	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenzofuran	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobutadiene	ug/l								<0	<1	<1	<1	<1	<1	<1	<1
Hexachlorocyclopentadiene	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachloroethane	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Isophorone	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrobenzene	ug/l								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
PCBs																
Pcb-101 2,2',4,5,5' - Pentachlorobiphenyl	ug/l								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pcb-118 2,3',4,4' 5 - Pentachlorobiphenyl									<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pcb-138 2,2',3,4,4',5' - Hexachlorobiphenyl	ug/l								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pcb-153 2,2',4,4',5,5' - Hexachlorobiphenyl									<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pcb-180 2,2',3,4,4',5,5' - Heptachlorobiphenyl	ug/l								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pcb-28 2,4,4' - Trichlororobiphenyl	ug/l								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pcb-52 2,2',5,5' - Tetrachlorobiphenyl	ug/l								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

A6 Appendix 6

Soil Leachate Laboratory Data

A7 Appendix 7

Site Walkover Photographs



Plate 01: CL27 – Elver Pill Reen



Plate 02: CL27 – Elver Pill Reen

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591

Checked By:

Date: Nov 2015



Plate 03: CL27 – Elver Pill Reen



Plate 04: CL27 – Elver Pill Reen

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: Nov 2015

A8 Appendix 8

Relevant Extract of Additional Environmental Data



Plate 01: Extract of 1991 Aerial Photograph



Plate 02: Extract of 1998 Aerial Photograph

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: Oct 2015



Plate 03: Extract of 2006 Aerial Photograph

Plate 04:

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: Oct 2015

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment
Report Annex D
CL-29 Spoil Heaps, Llanwern
Approach Road

M4CaN-DJV-EGT-ZG_GEN-RP-EN-0020

At Issue | March 2016

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Figure 2	Conceptual Site Model

Appendices

Appendix 1	Exploratory Records
Appendix 2	Tabulated Gas and Groundwater Monitoring
Appendix 3	Tabulated Groundwater Laboratory Data
Appendix 4	Site Walkover Photographs
Appendix 5	Relevant Extract of Additional Environmental Data

1 Introduction

1.1 Background

- 1.1.1** This report relates to an area of land potentially affected by contamination (CL-29) known as the 'Spoil Heaps, Llanwern Approach Road' herein referred to as the 'Site'.
- 1.1.2** The Site is located at approximate chainage 20,100 upon an existing spoil heap adjacent to the north of the railway line (see Figure 1).

1.2 Reporting Context

- 1.2.1** The Site has been assessed as part of ground investigations and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the 'Scheme') and informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the chapter on Geology and Soils.
- 1.2.2** In 2014, a Preliminary Sources Study Report (2014 PSSR) was prepared as an initial land contamination appraisal (Ove, Arup & Partners, 2014) as part of Design Manual for Roads and Bridges (DMRB) Stage 2 Assessments for a number of potential route options. This identified a number of individual areas that may have been affected by contamination as a result of historical activities at the Site. In addition, this report draws upon the 2015 Supplementary Ground Investigation report on behalf of the Welsh Government (Geotechnical Engineering, 2015). This report relates to the area defined on the Site Location Plan Figure 1.
- 1.2.3** The overarching rationale and approach for the assessment of areas of land along the proposed new section of motorway with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

- 1.3.1** The key objectives of this report are set out below:
- Undertake a risk assessment of the Site and determine whether potential risks to human health or controlled waters could exist based upon the Scheme.
 - Identify the need for further assessment and investigation in order to refine potential land contamination risks and inform the need for remediation/mitigation.
 - To provide information to support the Ground Investigation Report (GIR) and Geotechnical Design Report (GDR) required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

1.4.1 The subsequent report structure is as follows:

- Section 2: Site Location and Description.
- Section 3: The Scheme – This section details the new section of motorway alignment and associated features at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and historical land photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and any relevant environmental information presented in the 2014 PSSR.
- Section 6: Scope of Ground Investigation Works – This section describes the previous and supplementary ground investigation data available for the Site.
- Section 7: Ground Conditions – This section describes the main findings of the intrusive site investigation including the ground conditions encountered and any visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contaminant linkages and presents the human health and controlled waters assessments.
- Section 9: Refined Conceptual Site Model – This section presents the Conceptual Site Model (CSM) for the Site and identifies potential contaminant linkages, based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations – This section provides conclusions concerning the likelihood of land contamination associated with the Site affecting the Scheme and requirements for remediation/mitigation.

2 Site Location and Description

- 2.1.1** The Site is located in the eastern part of the new section of motorway, where the A4810 crosses the mainline railway, with a centre point at National Grid Reference ST 415 820. The Site location is shown on Figure 1.
- 2.1.2** The Site is situated within an agricultural field and is bounded to the west by the A4180 and the south by the railway cutting. Access was not possible during the 1995 or 2015 Site walkover survey. A single storey ruined building has been identified among brambles and scrub using the historical information available.
- 2.1.3** It is noted that the 2014 PSSR included a second parcel of land within the Site, south of the railway line. This comprised an old quarry. Given the new section of motorway and associated land take does not include this area and the quarry is separated from the alignment by the railway cutting and the A4810 embankment, no potential contamination linkages are considered applicable. The former quarry is no longer considered as a potential source of contamination for the purpose of the Land Contamination Assessment Report (Appendix 11.1 of the ES).
- 2.1.4** The Site will be assessed in terms of the suitability of materials to remain *in situ*.

3 The Scheme

- 3.1.1** The Site is situated at approximate chainage 20,100.
- 3.1.2** The section of highway impacting the Site is proposed to be on embankment with a carriageway approximately 10 m above existing ground level.
- 3.1.3** Given the absence of soft compressible strata, the use of piles is not being considered and instead, foundation would be taken onto the shallow rockhead.
- 3.1.4** The highway verges are to be soft landscaped, incorporating highway drainage predominantly as open swales/channels.
- 3.1.5** Subject to suitability of the materials encountered, it is currently proposed that all existing ground will be left *in situ* with the embankment constructed above.

4 Site History

- 4.1.1** The 2014 PSSR historical searches were based on Ordnance Survey (OS) plans, literature reviews, information provided by British Steel, Natural Resources Wales (NRW) (formerly Environment Agency Wales), Newport City Council and aerial photographic interpretation.
- 4.1.2** This is supplemented by a review of historical maps obtained in 2015 from the Welsh Government.
- 4.1.3** A summary of the Site's history is summarised below in Table 1.

Table 1: Site History

Date	Use	Source of Information
1843 - 1893	Site shown as an agricultural field, bounded to the south by a <u>railway</u> (running east – west).	1:10,560 Historical Mapping
1882	No significant change.	1882 OS Plan
1891 - 1912	No significant change.	1:10,560 Historical Mapping
1901	No significant change.	1901 OS plan
1904 - 1939	No significant change.	1:10,560 Historical Mapping
1921	No significant change.	1921 OS Plan
1964 - 1965	The <u>embankment of the railway</u> has extended.	1:10,560 Historical Mapping
1969	The A4810 is now evident.	Aerial Photography
1969 - 1971	No significant change.	1:10,560 Historical Mapping
1981	Evidence of a <u>possible structure</u> in the eastern area of the Site.	Aerial Photography
1985 - 1991	No significant change.	Aerial Photography
1998	The south-western area appears vegetated with bushes and trees	Aerial Photography
2006	<u>Storage of unknown materials / rubble in the northern area of the Site.</u>	Aerial Photography
2009 - 2010	A pylon is present in the north-east corner. Rough vegetation in northern area with no obvious evidence of rubble being present.	Aerial Photography
2014	No significant change.	High Resolution Aerial Photography

Notes: Potential sources of contamination are underlined. Those within the temporary and permanent land take are shown in **bold**.

- 4.1.4** The 1995 PSSR identified a spoil heap as a potential source of contamination. The sources of information presented above supplement those used in the 2014 PSSR. In particular, the 2006 aerial photograph has identified a second heap of material and as a result, the Site boundary was revised to include the area to the north. Relevant extracts of the photographs are presented in Appendix 5.
- 4.1.5** Historically the Site is located in proximity to areas which may have been bombed during World War II which is discussed in the Explosive Ordnance Threat Assessment Report (Bactec, 2014). This categorises the site as low risk with respect to unexploded ordnance.

5 Environmental Setting

5.1 Geology

- 5.1.1** British Geological Survey (BGS) records indicate that the Site is underlain by Head Deposits of clay, silt, sand and gravel. These are underlain by the solid deposits of the Tintern Sandstone Formation, comprising sandstone with localised pebbles and subordinate marls.

5.2 Hydrology

- 5.2.1** The nearest water body is Bareland Street Reen East located 50 m south, on the other side of the A4180. This road also forms the northern boundary of the Gwent Levels Site of Specific Scientific Interest (SSSI).

5.3 Hydrogeology

- 5.3.1** NRW classifies the Tintern Sandstone Formation as a principal aquifer. The Head Deposits overlying the bedrock is classified by NRW as Unproductive Strata.
- 5.3.2** The Site does not lie within a groundwater source protection zone.

5.4 Environmental Information

- 5.4.1** No pollution incidents, abstraction licences, discharge points or landfills have been recorded within 300 m of the Site.

6 Scope of Investigations

6.1 General

6.1.1 No previous ground investigations are available for this Site. However a number of exploratory holes were advanced within 100 m of the Site. These have been considered in order to support an understanding of ground conditions beneath the Site and inform the groundwater quality and gas regime.

6.2 Scope of Works

6.2.1 The various off site intrusive ground investigations undertaken in the near vicinity of the Site are summarised in Table 2.

Table 2: Off Site Investigation Summary (Off Site)

Date	Contractor	Boreholes	Location from Site	Sampling
1997	Norwest Holst	BHM6	10 m north-east of the Site	None
2015	Geotechnical Engineering Ltd	BH539, BH540, BH541	80 m south-east, 8 m north-east and 50 m east of the Site, respectively	Groundwater

6.2.2 The well construction details of the off site boreholes are summarised below.

Table 3: Summary of Off Site Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (mbGL)	Base of Slotted Well Casing / Gravel Pack (mbGL)	Targeted Geology
BHM6	-	10	5	7.5	Tintern Sandstone
BH539	35	14.2	1	3	Head Deposits
	50		5	14.2	Tintern Sandstone
BH541	50	11.5	2	11.5	Tintern Sandstone

6.3 Surface Water Quality Monitoring

6.3.1 Surface water quality monitoring was not undertaken during the previous ground investigations of the Site.

6.4 Field Testing

6.4.1 Monitoring of Volatile Organic Compounds (VOCs) was undertaken on:

- three soil samples from BH539 at 0.2-0.5 mbGL, 0.5-1.0 mbGL and 1.0-1.2 mbGL;
- two soil samples from BH540 at 0.2-0.5 mbGL and 0.5-1.0 mbGL; and
- three soil samples from BH541 at 0.2-0.6 mbGL, 0.6-0.8 mbGL and 0.8-1.0 mbGL.

6.5 Groundwater Monitoring

6.5.1 A summary of the groundwater sampling, groundwater/monitoring and ground gas monitoring from the selected off site boreholes is shown in Table 4.

Table 4: Summary of Monitoring Rounds (Off Site)

Location Ref.	Number of Rounds (Date of Sampling)	Monitoring Details	Notes
BHM6	5 no. (15 th November 1997, 25 th November 1997, 2 nd December 1997, 10 th December 1997, 16 th December 1997)	Groundwater level	-
BH539	4 no. (24 th March 2015, 31 st March 2015, 16 th April 2015, 8 th May 2015)	Groundwater level / sampling Soil gas	Gas monitoring in 35 mm shallow installation only
BH541	4 no. (31 st March 2015, 16 th April 2015, 21 st April 2015, 8 th May 2015)	Groundwater level / sampling Soil gas	-

6.6 Laboratory Chemical Testing

6.6.1 A summary of laboratory analysis undertaken from the selected off site boreholes on groundwater is shown in Table 5.

Table 5: Summary of Previous Investigation Sampling

Site Investigation Date	No. of Soil Samples	No. of Leachate Samples	No. of Water Samples	Suites of Testing
2015	N/A	0	9	Metals, PAH, TPH, pH, cyanide, PCBs, VOCs, SVOCs, BTEX, phenols, inorganics

Soil Analysis

6.6.2 No soil data is available for the Site.

Soil Leaching Analysis

6.6.3 No soil leaching data is available for the Site.

Groundwater Analysis

6.6.4 The following sections summarise the laboratory analytical results for groundwater samples collected during the various intrusive investigation phases within the selected off site boreholes. The available data set has been tabulated and is presented in Appendix 3 with supporting laboratory certificates available in the relevant original reports.

6.6.5 The available data relates to samples taken from wells installed within the groundwater of the Head Deposits and Tintern Sandstone.

6.6.6 The available information is summarised in Table 6.

Table 6: Summary of Analytical Groundwater Data (Off Site)

Groundwater Unit	Number of Groundwater Analyses per Analytical Suites (number of well locations) – 2015 data							
	Metals & Inorganics	PAH	Total Petroleum Hydrocarbons	Phenol	BTEX	SVOCs	VOCs	PCBs
Perched Groundwater (Head Deposits)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	2 (1)	3 (1)	1 (1)
Groundwater (Tintern Sandstone Formation)	6 (2)	6 (2)	6 (2)	6 (2)	6 (2)	4 (2)	6 (2)	3 (2)

6.7 Gap Analysis of Available Data

6.7.1 There is no investigation data available for the Site.

7 Ground Conditions

7.1 Geology

7.1.1 The geological logs for all available exploratory holes excavated on or in close proximity to the Site are provided in Appendix 1. The observed geological sequence is consistent with that described in the 2014 PSSR report and is summarised in the following sections. Information from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) has also been used.

Superficial Deposits

7.1.2 Unconsolidated superficial deposits were encountered beneath the topsoil. These comprised Head Deposits, predominantly sand and gravel, encountered to 0.5 to 1.3 mbGL.

7.1.3 In borehole (BH539), a thin veneer of Tidal Flat Deposits to 2.35 mbGL was recorded. This was encountered as very soft clay.

Solid Geology

7.1.4 Beneath the superficial deposits the Tintern Sandstone Formation was encountered. This typically comprised sandstone with some interbedded thin mudstones/marls.

Geological Sequence Summary

7.1.5 The anticipated general geological sequence beneath the Site based on the nearby off site previous ground investigation is summarised Table 7.

Table 7: Summary of Geological Sequence (Off Site)

Unit	Description	Thickness Range (m)	Basal Depth (mbGL)
Made Ground	Unknown	unproven	unproven
Superficial Deposits (Head Deposits)	Typically sand and gravel and cobbles within a clay matrix	0.5* - 1.3*	0.6* - 1.3*
Superficial Deposits (Tidal Flat Deposits)	Soft clay	Absent*	-
Tintern Sandstone Formation	Sandstone with occasional bands of mudstone	>9.39* - >19.6*	Unproven*

Note: * inferred from off site exploratory holes.

7.2 Visual and Olfactory Evidence of Contamination

7.2.1 No records are available for the Site during the previous ground investigations.

7.2.2 PID monitoring was undertaken from three off site boreholes, three soil samples from BH539, two soil samples from BH540 and three soil samples from BH541. The PID meter recorded levels of between zero and 5.1 ppm within either the Tidal Flat Deposits or Head Deposits indicating the presence of low level naturally occurring VOCs.

7.3 Gas Monitoring

7.3.1 The gas monitoring data set collected during each of the previous monitoring rounds at the off site boreholes is summarised on the field data sheets provided in Appendix 2. The maximum concentrations are presented in Table 8.

7.3.2 Boreholes BH539 and BH541 are also considered to assess the gas regime for CL-30, located approximately 110 m to the east.

Table 8: Summary of Gas Monitoring Data (Off Site)

Location ID	Flow (l/hr)	VOCs (ppm)	CH ₄ (%/vol) ¹	Peak LEL (%)	CO ₂ (%/vol) ²	O ₂ (%/vol) ³	CO (ppm) ⁴	H ₂ S (ppm)
	Maximum	Maximum	Maximum	Maximum	Maximum	Minimum	Maximum	Maximum
BH539 (S)	2.1	4.7	0.1	1.0	0.4	20.0	1.0	0.0
BH541	0.0	6.0	0.1	18.9	1.0	19.2	64	0.0

7.4 Groundwater

Groundwater Encountered During Investigation

7.4.1 Groundwater strikes were encountered during the advancement of borehole BHM6 and BH539 and are summarised in Table 9.

Table 9: Summary of Groundwater Strike Data (Off Site)

Location	Strike Depth (mbGL)	Geological Formation	Level after 20 minutes (mbGL)	Comments
BHM6	6.5	Tintern Sandstone	0.0 (log indicate time taken to rise as 0)	Unclear if the recorded level and time for the rise is accurate.
	-	-	-	Water level recorded at 4.21 mbGL when borehole completed within the Tintern Sandstone (10 mbGL).
BH539	1.2	Tidal Flat Deposits	1.0	-

Groundwater Level During Monitoring Rounds

7.4.2 No groundwater level monitoring has been undertaken on site during the previous investigations.

7.4.3 The entire groundwater level data set gathered at the off site boreholes is provided in Appendix 2 and summarised in Table 10.

Table 10: Summary of Groundwater Level Data (Off Site)

Location	Installation #1	Depth of Response Zone (mbGL) and Geological Formation	No. Measurements	Minimum Depth (mbGL)	Maximum Depth (mbGL)	Comments (Indicative Water Levels - mOD)
BHM6	-	5 - 7.5 Tintern Sandstone	5	1.67	3.52	9.38 - 7.53
BH539	35 mm (S)	1 - 3 Head Deposits	4	0.56	2.03	5.79 - 4.32
	50 mm(D)	5 - 14.2 Tintern Sandstone	4	1.09	3.39	5.26 - 2.96
BH541	50 mm	2 - 11.5 Tintern Sandstone	4	6.67	8.15	4.68 - 3.20

Notes: #1 S denotes a shallow installation and D denotes deep installation.

Groundwater Summary

7.4.4 The main groundwater body present is anticipated to be within the Tintern Sandstone, with the resting levels recorded as variable in-between the monitoring visits. The resting groundwater as recorded in the 1997 borehole (BHM6) is seen to be above the levels recorded in the 2015 boreholes. The reason for this difference in water levels is unclear.

7.4.5 The Tintern Sandstone may be considered to be in hydraulic continuity with the groundwater within the Head Deposits.

8 Contamination Assessment

8.1 Introduction

8.1.1 The following sections provide details of the assessment of land contamination at the Site.

8.1.2 The outline Conceptual Site Model (CSM) presented within the 2014 PSSR has been reviewed and updated based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and the proposed Scheme. The main amendments to the 2014 PSSR model are summarised as follows:

- Removal of the backfill quarry as a source (off site and separated from the new section of motorway by the railway cutting).
- Removal of Bareland Street Reen East as a potential receptor (separated from the Site by the A4180 embankment).
- Update of the source-pathway-receptor linkage taking account of the above and more detailed assessments.
- Alteration of the site boundary and additional stockpiled material identified.

8.2 Preliminary Risk Assessments

Potential Sources

8.2.1 The two identified spoil mound materials are a potential source of contamination. It is probable that the older mound materials are residual earthworks material from the construction of the railway or road. The more recent stockpile is identified to be no longer present based on the aerial photograph. It is considered unlikely that these materials pose a significant risk to human health or controlled waters. However, this would require confirmation through additional investigation.

Potential Receptors

8.2.2 Receptors during the construction and the operational stages of the Scheme have been considered:

Construction

- Construction workers during Site development works.
- Groundwater within the Head Deposits and/or Tintern Sandstone.
- Site neighbours (railway/A4180 users) adjacent to construction works.

Operational

- Groundwater within the Head Deposits and/or Tintern Sandstone.
- Spoil materials, should any remain within the new section of motorway, are likely to be encapsulated or removed during the construction of the proposed bridge and embankment and therefore no direct exposure to potential contaminants would be possible. Therefore, general public, maintenance workers or neighbours of the Site are not considered potential receptors.

Potential Pathways

8.2.3 Pathways during the construction and the operational stages of the Scheme have been considered:

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils possible during construction works.
- Leaching of contaminants from the backfill materials and/or spoil heaps to groundwater.

8.3 Risk Evaluation

8.3.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the other data described herein, the following risk evaluation has been reconsidered and included:

- The Site has been subject to potential contaminating uses, including presence of a spoil mound comprising unknown materials.
- The construction of the embankment is likely to require excavation through Head Deposits into the top of the Tintern Sandstone. It is anticipated much of the spoil will be removed during that process.
- Site materials are to be reused subject to passing reuse criteria, or disposed off site.
- Groundwater levels within the principal aquifer associated with the sandstone are indicated to be at resting level within the Head Deposits.
- There is risk of increased potential soil leaching and migration to the shallow groundwater during spoil removal.

8.4 Human Health Risk Assessment

8.4.1 No screening assessment has been undertaken as no soil analysis data is available for the Site.

8.5 Controlled Water Screening Assessment

8.5.1 The rationale and approach for the controlled waters (Tier 1) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES) and the groundwater chemical results are presented in Appendix 3. No soil leachate or surface water data is available. All exceedances to the relevant generic criteria are summarised in Table 11 for groundwater.

8.5.2 Where an Environmental Quality Standard (EQS) is dependent on water hardness, i.e. some heavy metals, the hardness of the surface water receptor should normally be used. The Baseline Water Environment Report (Appendix 16.2 of the ES) indicates surface water to be generally moderately hard with hardness concentrations within a range of 100 to 150 mg/l as calcium carbonate. Therefore, EQSs within the water hardness range have been used for screening purposes.

Soil Leachate Results

8.5.3 No chemical soils leachate data is available for the Site.

Groundwater Results

8.5.4 Groundwater analysis results have been assessed from samples collected over number of rounds of groundwater monitoring results from off site boreholes BH539 and BH541 constructed in 2015. The groundwater samples were taken from the perched groundwater within the Head Deposits and from the aquifer associated with the Tintern Sandstone.

8.5.5 A summary of the exceedances of the screening criteria from all available ground results relating to the site is presented in Table 11 and discussed below.

Table 11: Groundwater Screening Exceedances (Off Site)

Determinant	Units	Range	EQS ¹	DWS ²	No. exceeded Screening Criteria (Total number of results) against EQS	Location	No. exceeded Screening Criteria (Total number of results) against DWS	Location
Perched Groundwater								
Copper	µg/l	<1 - 21	10	2000	1 (3)	BH539	0 (3)	-
Mercury	µg/l	<0.5 - 0.65	0.07	1	1 (3)	BH539	0 (3)	-
Nickel	µg/l	2.3 - 7	4	20	1 (3)	BH539	0 (3)	-
Phenols	µg/l	<0.03 - 0.03	0.007	-	1 (3)	BH539	0 (3)	-
Aquifer								
Copper	µg/l	<1 - 16	10	2000	1 (60)	BH539	0 (6)	-
Arsenic	µg/l	<1 - 25	50	10	0 (6)	-	1 (6)	BH541
Mercury	µg/l	<0.5 - 1.3	0.07	1	1 (6)	BH539	1 (6)	BH539
Nickel	µg/l	<1 - 6.2	4	20	2 (6)	BH539	0 (6)	-
Chloride	mg/l	13 - 620	250	250	1 (6)	BH541	1 (46)	BH541
Ammoniacal Nitrogen	mg/l	0 - 1.4	0.6	-	2 (6)	BH541, BH539	-	-

Notes: 1. Environmental Quality Standard. 2. Drinking Water Standards.

8.5.6 The review of the groundwater chemical testing results indicated that the deep groundwater off site has elevated levels of metals (arsenic, copper, mercury and nickel) and inorganics (chloride and ammoniacal nitrogen).

8.5.7 The perched groundwater within the Head Deposits is shown to have elevated metals (mercury, copper and nickel) and phenols.

8.5.8 All Polycyclic Aromatic Hydrocarbons (PAH), Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), phenols, Benzene, Toluene, Ethylbenzene and Xylene (BTEX), Total Petroleum Hydrocarbons (TPH) and Polychlorinated biphenyl (PCB) results were found below limit of detection within both water bodies.

8.5.9 It is noted the laboratory detection levels for mercury, cyanide, some PAH compounds, VOCs and SVOCs are higher than the applied screening criterion.

8.6 Ground Gas Risk Assessment

8.6.1 The only ground gas data available relates to off site boreholes BH539 and BH541. These have response zones within the Head Deposits (between 1 and 3 mbGL) and within the Tintern Sandstone (between 2 and 11.5 mbGL), respectively. Of the four rounds available, the following comments may be made:

- No monitoring was undertaken during low barometric pressure (less than 1000 millibars (mb)), with the lowest conditions being 1002 mb. As such worst case atmospheric conditions for potential ground gas generation may have not been monitored.
- Gas flow was generally recorded absent, with the exception of the second round for BH539 which peaked at 2.1 l/hr.
- Methane has been recorded nil or up to 0.1 % during all four rounds, below the screening criteria of 1 %. However, the Lower Explosion Limit (LEL) of up to 18.9 % is noted. Given the lack of correlation between methane concentration per volume and per LEL, it is considered these marginal readings to be caused by equipment inaccuracy rather than representative of the presence of actual methane gas.
- Carbon dioxide is identified between 0 and 1 %, below the screening criteria of 5 %.
- Trace of VOCs of up to 6 ppm has been recorded.
- Hydrogen sulphide was recorded zero throughout.
- Carbon monoxide was recorded absent on all rounds for BH539. The first round for BH541 identified a maximum concentration of up to 64 ppm, falling to 1 ppm on the second round and zero on the following two rounds. The maximum recorded concentration is above the screening criteria of 30 ppm. Given the obvious falling trend and absence of obvious source, this is considered likely to be caused by the installation works rather than indicative of carbon monoxide flux within the soils.
- Oxygen has been recorded to be ambient with concentrations between 19.2 and 20.7 %.

8.6.2 On the basis of the above, off site boreholes have not identified obvious soil gas sources. Given the nature of the potential source of contamination at the Site spoil heaps, the risks from ground gas associated with this feature, during construction and operation, are considered very low.

8.6.3 A gas risk assessment for natural soils has been undertaken and is set out within the Land Contamination Assessment Report (Appendix 11.1 of the ES).

- 8.6.4** Whilst the gas regime within the spoil heap remains unknown, its removal for the construction of the embankment is likely to remove much of the potential source. Depending on the nature of the material and the extent to remain *in situ*, additional investigation may be required to confirm risks.

8.7 Summary

- 8.7.1** The quality of the perched groundwater within the Head Deposits and the aquifer within the Tintern Sandstone are similar and shown to have elevated metals and inorganics (data from within 50 m of the Site). Hydrostatic linkage between the perched groundwater and the aquifer within the Tintern Sandstone is identified.
- 8.7.2** The elevated levels of metals and inorganics recorded in off site monitoring wells are considered unlikely to be evidence of contamination migrating from the mounds. However, verification sampling and testing should be undertaken to confirm this.
- 8.7.3** It is considered unlikely that any potential ground gases from former activities at the Site (spoil heaps) would cause a risk during the construction or operation of the Scheme. The risk from ground gas from natural sources at the Site is also considered very low.

9 Refined Conceptual Site Model

- 9.1.1** The incorporation of data from the 2015 Supplementary Ground Investigation has enabled the original CSM presented in the 2014 PSSR to be updated. Relevant contaminant (source-pathway-receptor) linkages are considered within the refined CSM. The assessment is based on the Scheme during construction and operational phases.
- 9.1.2** A CSM representing general ground conditions, overall layout of the new section of motorway and relevant source-pathway-receptors (each of which having a specific alpha-numerical symbol attached) are presented in Figure 2 and is described in Table 12.

Table 12: Refined Conceptual Site Model

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
Spoil materials (unknown material)	Construction					
	Construction workers (A)	Dermal contact with soil (1)	Likely	Low	Low	Construction workers are likely be exposed to Made Ground materials during Site construction works; however exposure duration will be short term only. Use of appropriate PPE and good hygiene practice throughout earthworks and construction phase is recommended. Dust suppression measures are recommended during construction works.
		Ingestion of soil (2)	Likely	Low	Low	No chemical analysis has been undertaken at the Site however exposed materials at the surface indicate possible backfill with quarry spoil. This is not considered to represent abnormal constraints to construction workers health and safety over and above those typical of a brownfield site.
		Inhalation of soil dust (3)	Likely	Low	Low	Additional investigation is required to confirm the nature of the material within the spoil and associated risks.
		Inhalation of soil gas or vapour (3)	Low	Low	Very low	Construction workers may be exposed to ground gas potentially generated by the spoil heap materials during the excavation works. Works taking place in open atmosphere. No on site ground gas data. Gas monitoring from nearby off site boreholes indicates no abnormal soil gas regime. Additional investigation and soil testing required to confirm the characteristic of the Made Ground and associated risks.
	Off site users during construction works (B)	Dermal contact with soil dust (1)	Unlikely	Low	Very low	During construction there is the possibility of dermal contact and inhalation of soil dust, short term exposure only.
		Ingestion of soil dust (2)	Unlikely	Low	Very low	Dust suppression measures are recommended during construction works.

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
		Inhalation of soil dust (3)	Unlikely	Low	Very low	
		Inhalation of soil gas or vapour (3)	Unlikely	Low	Very low	Any ground gas source, if present, will be of limited volume. Receptor in open space and of short term exposure. The Scheme will result in the mounds being removed.
	Groundwater within the Head Deposits (Dp) and principal aquifer within the Tintern Sandstone (Da)	Leaching/ migration (4)	Low	Low	Very low	The construction will remove some of the mound and thus reduce any risks to controlled waters. Verification sampling is needed to confirm the low risk to controlled waters and to check arisings are suitable for reuse on the Scheme.
	Operational					
Spoil materials (unknown material)	Groundwater within the Head Deposits (Dp) and Principal Aquifer within the Tintern Sandstone (Da)	Leaching/ migration (4)	Unlikely	Low	Very low	Any potentially contaminated materials are likely to be encapsulated within the proposed embankment (subject to compliance with reuse criteria) or removed. The construction will remove some of the mound and thus reduce any risks to controlled waters.

10 Conclusions and Recommendations

10.1 Conclusions

- 10.1.1** The Site has been subject to localised historical tipping of materials of unknown origin. No ground investigations have been undertaken at the Site, however based on the desk study information, gross contamination is not anticipated.
- 10.1.2** Gross contamination associated with the Site's historical use is not anticipated. Normal construction control measures will be required to facilitate the construction and ongoing operation of the Scheme.
- 10.1.3** There is no analytical data specific to the Site that falls within the footprint of the motorway corridor. This should be mitigated through the provision and implementation of a suitable verification sampling inspection strategy during construction to confirm conditions are as expected and clarify materials are appropriate for reuse.
- 10.1.4** During the construction phase, specific mitigation measures will be required to prevent inhalation pathways of dust to the general public off site and construction workers.
- 10.1.5** A suitable water management strategy will also be required to prevent impact to surface waters from run-off during construction.
- 10.1.6** Materials, including any mounds associated with tipping at the Site, will be partially removed or encapsulated and are considered likely to be suitable for reuse subject to provision of reuse criteria under a Materials Management Plan.
- 10.1.7** During the operational phase, the embankment will cover part of the Site, which will limit the infiltration of rainwater through the soils and thus potential leaching of soil contaminants into the groundwater. However, given the relatively high groundwater level within the Head Deposits, part of the Made Ground materials that could remain saturated beneath the embankment may provide a source of ongoing potential leachable contaminants.
- 10.1.8** In order to confirm the low to moderate risks associated with the Site in relation to both construction and operational phases, and the suitability for reuse within the new section of motorway, it is recommended that verification investigations are undertaken, including, as a minimum, testing of soils and soil leachate.

10.2 Recommendations

- 10.2.1** No ground investigation has been undertaken at the Site and although the likelihood of any contamination at the Site is relatively low, due to the Site's history, localised contamination may have occurred. As such, it is recommended that a limited ground investigation is undertaken to verify risk levels described in this report. Should contamination be identified that could cause an unacceptable risk to the identified receptors, then remedial requirements would be identified within a remediation strategy for the Scheme. Any materials from this Site will require verification testing to check their suitability for reuse.

10.2.2 A remediation strategy for the Scheme should be developed for the Site that includes:

- Addressing potential human health and controlled waters risk identified by the proposed additional ground investigation.
- Dealing with unexpected contamination.
- Verification sampling to confirm suitability of soils for reuse.
- Control measures (over and above good practise construction management) to prevent risks to construction workers and the general public during construction.
- Verification of material used as topsoil.

10.2.3 The remediation strategy should include a remediation options appraisal, remediation implementation plan and remediation verification plan.

10.2.4 The remediation strategy should be supported by a Scheme wide Materials Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

11 References

CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice, ISBN 978-1-905046-23-2.

Geotechnical Engineering Limited (2015) M4 Corridor Around Newport, Factual Report on Ground Investigation, 30238

Highways Agency (2008) Design Manual for Roads and Bridges. Vol. 4. Geotechnics and Drainage. Section 1. Earthworks; Part 2. HD22/08. Managing Geotechnical Risk.

Ove Arup & Partners (2014) M4 Corridor Around Newport, Preliminary Sources Study Report, 14/9197

Bactec (2014) Explosive Ordnance Threat Assessment in respect of M4 Corridor around Newport for Hyder Consulting (UK) Limited, 5750TA

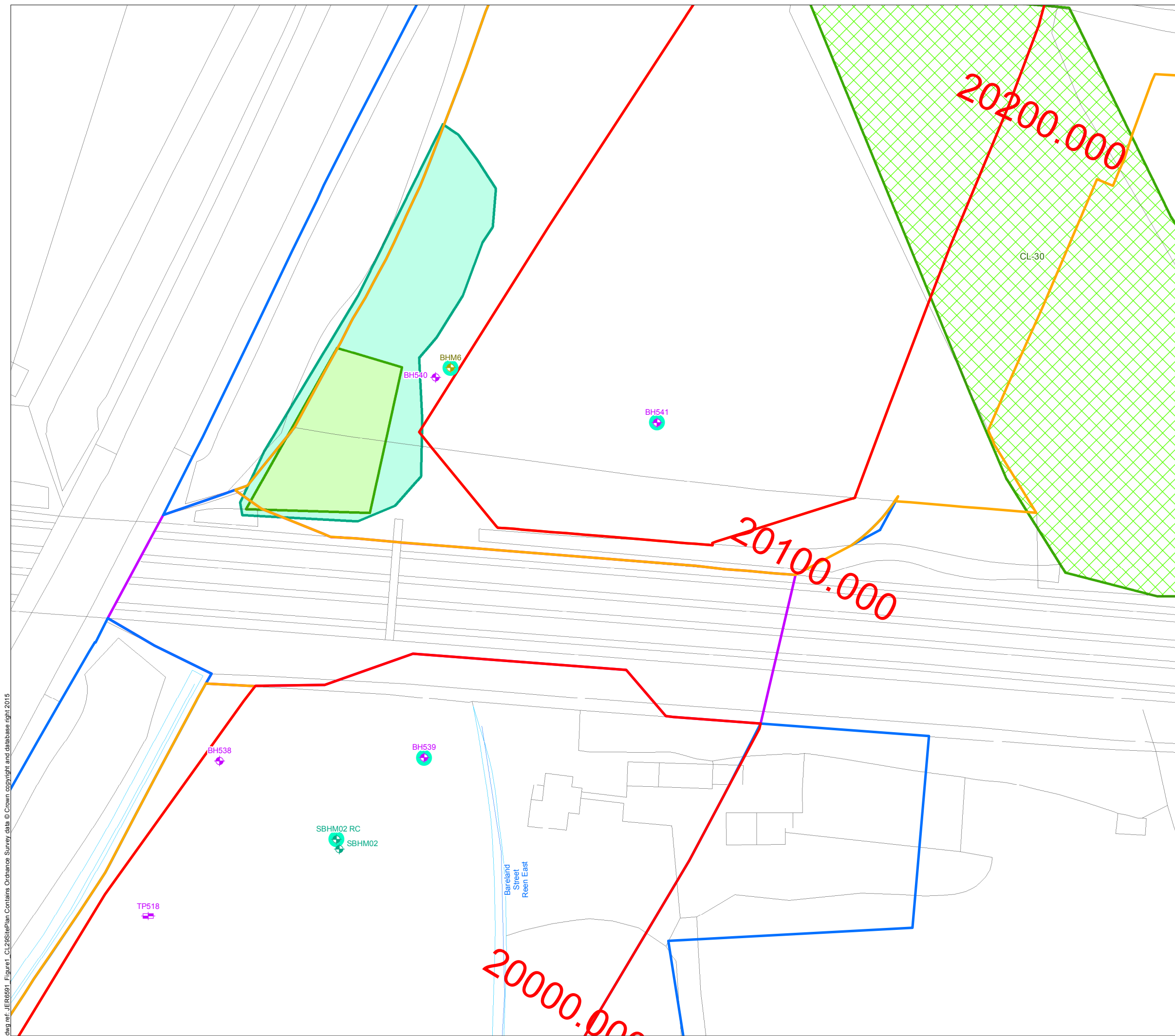
12 Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection

mAOD	Metres Above Ordnance Datum
mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O2	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures

dwg ref: JER6591_Figure1_CL29SitePlan Contains Ordnance Survey data © Crown copyright and database right 2015



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Potential Area of Land Contamination based on 2014 PSSR
- Revised Potential Area of Land Contamination
- Other Potential Area of Land Contamination

Investigation Locations

2015 (Geotechnical Engineering)

- Borehole
- Trial Pit

2007 (Norwest Holst)

- Borehole

1997 (Norwest Holst)

- Borehole
- Monitoring Well Installation

Llywodraeth Cymru
Welsh Government

Appendix 11.1 Annex D CL-29

Site Plan for CL-29

Figure: 1	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Scale: A3 @ 1:750

0 12.5 25 m

N

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dwg ref: JER6591_Figure1_CL29SitePlan

Legend

- Topsoil
- Made Ground - MG
- Stockpiled Soil Material
- Head Deposits (Predominantly Sand & Gravel)
- Tintern Sandstone - TS
- Proposed Embankment
- Perched Groundwater (Head Deposits)
- Groundwater (TS)
- Gas Migration Pathway

Potential Receptors

- Humans On-Site (Construction Workers)
- Humans Off-Site (Site Neighbours)
- Groundwater (Principal Aquifer)
- Groundwater (Secondary Aquifer)

Potential Pathways

- Dermal Contact
- Inhalation
- Ingestion
- Leaching / Migration

Potential Sources of Contamination

Possible contamination present on site associated with :

On-Site

- Potential for contamination to be present on site associated with: spoil heaps

NOTE
Drawing refined from PSSR Drawing Reference
M4-OA-17-00DR-Z-XX-0142 (April 2014)



Appendix 11.1 Annex D CL-29

Conceptual Site Model for CL-29

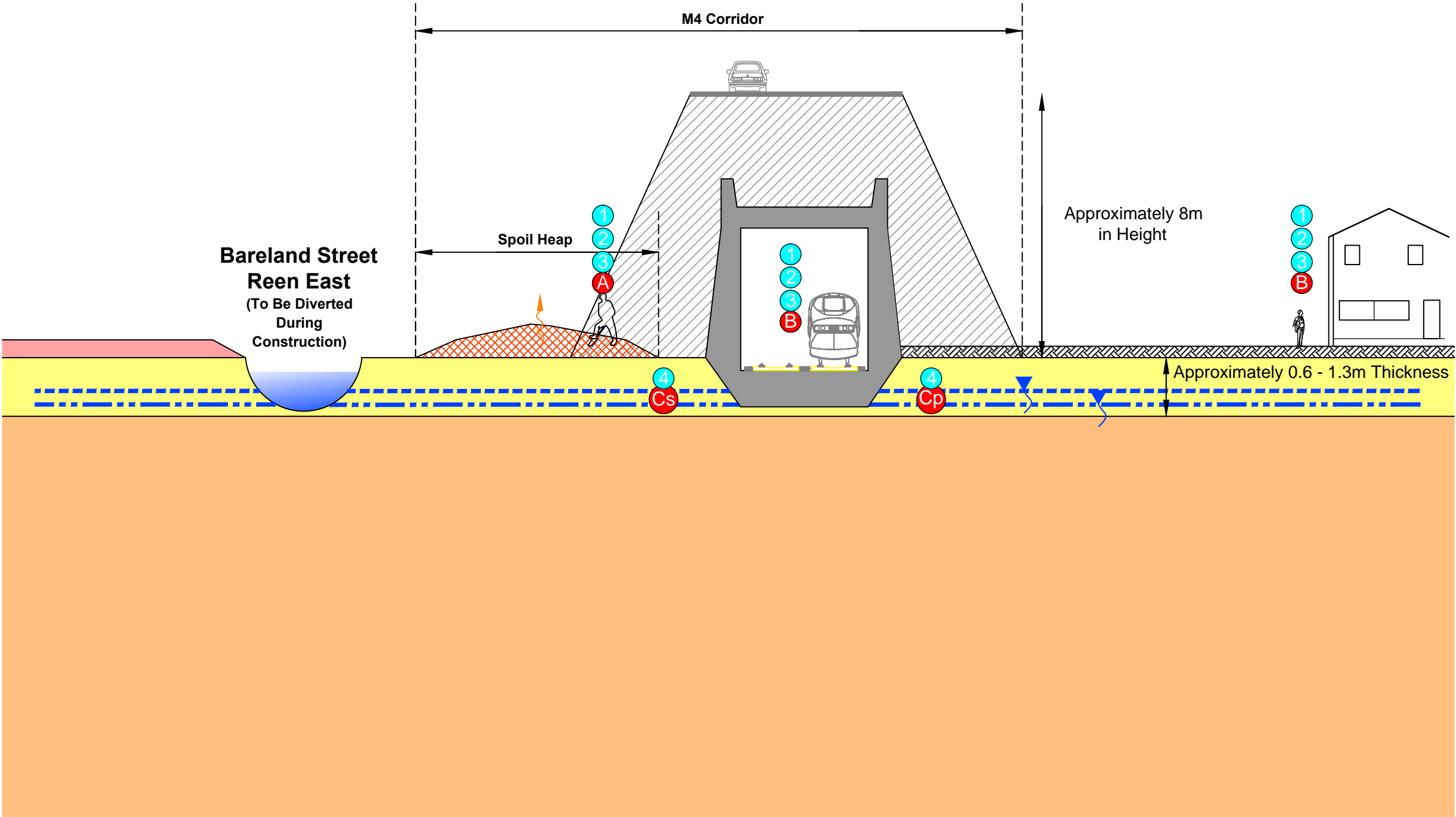
Figure: 2	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Not to Scale

Ground conditions based
on available information

dwg ref: JER6591_Figure2_CL29ConceptualSiteModel

CL- 29 Spoil Heaps, Llanwern Approach Road



Appendices

A1 Appendix 1

Exploratory Records



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHM6

Header

Contract No.	F10895	Method	Rotary Coring	Coordinates	341586.8 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187014.0 N
Client	Welsh Office	Driller	E.D	Ground Level	11.10m AOD
		Logged by	T.R/C.D	Orientation	Vertical
Consultant	Ove Arup and Partners	Core barrel	P	Date Started	11/11/1997
		Core bit	Saw Tooth	Date Completed	11/11/1997

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
11/11/1997	1800	10.00	2.50	4.21		0.00 2.00	2.00 10.00	mist mist	100% 100%	0* 92

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
120	10.00	140	2.50	11/11/1997	0000	6.50	0.00	0		2.50	0.00

GENERAL NOTES						SPT DETAILS		
						Depth	Type	Incremental blow count/penetration in mm
						1.00	S	N=25 (5,5,9,8,5,3)
						2.00	C	50/15mm (13,12,50)
						3.00	C	51/231mm (1,1,11,2,8,30)
						5.60	C	50/75mm*

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes.

Form ROTARY HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHM6

Sheet 1 of 1

Contract No.	F10895	Method	Rotary Coring	Coordinates	341586.8 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187014.0 N
Client	Welsh Office	Driller	E.D	Ground Level	11.10m AOD
Consultant	Ove Arup and Partners	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	11/11/1997
		Core bit	Saw Tooth	Date Completed	11/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
TOPSOIL		0.10	11.00							
Brown sandstone cobbles in CLAY (drillers description). (Head Deposits)		0.61	10.49							
Weathered SANDSTONE clayey (drillers description). (Tintern Sandstone)									25	1.00
									C50/15mm	1.45
				2.00 2.50	40	0	0	NI		2.00
										2.17
		2.50	8.60							
Greyish green fine to coarse grained thinly to medium sub-horizontally bedded occasionally thinly and thickly laminated SANDSTONE, strong completely fractured. (Tintern Sandstone)				2.50 3.00	36	0	0	NI		
									C51/231mm	3.00
				3.00 3.50	40	0	0	NI		3.38
		3.50	7.60							
Reddish brown fine to coarse grained medium sub-horizontally bedded slightly to moderately weathered micaceous SANDSTONE, strong with medium spaced very thin beds of fine gravelly sandstone and closely to medium spaced inclined discontinuities planar rough tight. (Tintern Sandstone)				3.50 4.00	46	10	0	NI		
---from 3.50 to 4.00m completely fractured										
---from 4.60 to 4.75m completely fractured				4.00 4.60	92	83	28	4		
---from 5.60 to 5.75m completely fractured										
---from 6.00 to 6.50m sub-vertical fracture (075°) planar rough tight				4.60 5.60	10	0	0	NI		
---from 6.50 to 6.75m moderately weathered									C50/75mm*	5.60
				5.60 6.00	25	0	0	NI		5.68
		6.50	4.60							
Reddish brown to greyish green fine to medium grained thinly to medium sub-horizontally bedded slightly to moderately weathered micaceous SANDSTONE, moderately strong to strong with closely spaced very thin interbedding of reddish brown mottled grey mudstone with closely to medium spaced sub-horizontal discontinuities planar rough tight. (Tintern Sandstone)				6.00 6.50	100	96	0	5		
---from 7.00 to 7.25m sub-vertical fracture (065°) planar rough tight									12	
---from 7.35 to 7.60m sub-vertical fracture (065°) planar rough tight				6.50 8.00	100	93	21		6	
		8.00	3.10							
SANDSTONE As Sheet 2				8.00 9.50	100	97	79	11		
				9.50 10.00	90	80	0	5		
Rotary drilling complete at 10.00 m.		10.00	1.10							

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH ROTARY LOG
Version	1.00
Revised	16/09/96

Form	NH ROTARY LOG
Version	1.00
Revised	16/09/96

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH539

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 6 March 2015 Easting 341581.4

Scale 1 : 50

End Date 9 March 2015 Northing 186934.6 Ground level 6.35mOD Depth 14.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
06/03/15 0900hrs	1B	0.20 - 0.50						Grass over very soft reddish brown sandy gravelly CLAY. Gravel is rounded fine and medium quartz. (TFD)			
	2D*	0.20 - 0.50		Vo 0.0							
	3B	0.50 - 1.00									
	4D*	0.50 - 0.10		Vo 0.0							
	5B	1.00 - 1.20						Very soft light brown slightly gravelly very sandy CLAY. Gravel is rounded fine and medium quartz. (TFD)	1.60	4.75	
	6D*	1.00 - 1.20		Vo 0.3							
	7D	1.20 - 1.65	Nil	S 3							
	8X	1.20 - 2.20									
	9D*	1.30 - 1.40						2.20 - 2.35m: Soft. Loose light brown clayey fine SAND. (TSG)	2.35	4.00	
	10D	2.20 - 2.65	Nil	S 6							
	11X	2.20 - 3.20							2.75	3.60	
	12D*	2.30 - 2.40									
	13D	3.20 - 3.65	Nil	S 20				Light brown clayey gravelly fine and medium SAND with rare lenses (up to 5mmx5mm) of bluish grey fine sand. Gravel is subrounded fine and medium sandstone. (TSG)	3.10	3.25	
	14X	3.20 - 3.90									
	15D*	3.30 - 3.40									
	16D	3.90 - 4.19	3.90	S*100							
	17C	3.90 - 4.90			89 0 0			Medium dense reddish brown clayey silty fine and medium SAND with rare lenses (up to 5x5mm) of bluish grey sand. (TSG)	3.90m: Very dense.		
						NA			4.40	1.95	
									4.80	1.55	
	18C	4.90 - 5.03 4.90 - 6.40	3.90	C*200	100 0 0	NI		Weak and medium strong bluish grey fine and medium SANDSTONE. Fractures are subhorizontal to 20° and 60-70° extremely closely spaced undulating and stepped smooth. (TSG)			
	19C	6.40 - 7.90	3.90		100 26 18	50 100 140 NI		Very weak reddish brown fine and medium SANDSTONE. Fractures are subhorizontal to 20° and 70° very closely and closely spaced undulating rough with a veneer of reddish brown clay. (TSG)	6.40	-0.05	
									6.80	-0.45	
								Reddish brown fine and medium SANDSTONE recovered non intact as slightly clayey sandy angular and subangular and fine to coarse sandstone gravel. (TSG)	7.50	-1.15	
									7.85	-1.50	
								Continued Next Page		{8.00}	

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Dynamic sampled (128mm) 1.20-3.20m, (113mm) 3.20-3.90m. Waterflush rotary core drilled (116mm) 3.90-14.20m.

CASING: 140mm diam to 6.40m.

BACKFILL: On completion, a slotted standpipe (50mm) with geo-sock was installed to 14.00m, granular response zone 14.20-5.00m and bentonite seal 5.00-3.00m. A second slotted standpipe (35mm) with geo-sock was installed to 3.00m, granular response zone 3.00-1.00m, bentonite seal 1.00-0.20m, concrete and stopcock cover 0.20-0.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
1.20	Nil	1.00	20	


CONTRACT
30238
CHECKED
EC

BOREHOLE LOG



CLIENT WELSH GOVERNMENT

BH539

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 6 March 2015 Easting 341581.4

Scale 1 : 50

End Date 9 March 2015 Northing 186934.6 Ground level 6.35mOD Depth 14.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend	
06/03/15 1550hrs 1.30m	20C	7.90 - 8.50	3.90		100 0 0			Bluish grey fine and medium SANDSTONE recovered non intact as clayey very sandy angular and subangular fine and medium sandstone gravel. (TSG)	8.50	-2.15		
	21C	8.50 - 8.80	3.90		100 0 0	NI		Weak reddish brown MUDSTONE recovered non intact as slightly clayey slightly sandy angular and subangular medium and coarse gravel. (TSG)	8.80	-2.45		
	09/03/15 0850hrs 1.10m	22C	8.80 - 8.90	3.90		100 0 0		NI	Light bluish grey mottled reddish brown MUDSTONE recovered non intact as slightly clayey slightly sandy subangular fine to coarse gravel. (TSG)	9.45		-3.10
		23C	8.90 - 10.00	6.40		100 0 0			Medium strong thinly laminated light bluish grey coarse SANDSTONE. Fractures are 20° extremely closely spaced undulating smooth with rare calcite crystals (up to 2mm). (TSG)			
09/03/15 1415hrs 1.90m	24C	10.00 - 11.20	6.40		100 49 32			Medium strong thinly laminated reddish brown coarse micaceous SANDSTONE with frequent greenish grey reduction spots (up to 30mm). Fractures are subhorizontal to 20° and 70° to subvertical extremely closely spaced undulating and stepped rough with a veneer of reddish brown clay. (TSG)	10.80	-4.45		
					NA				11.20	-4.85		
	25C	11.20 - 12.70	6.40		100 43 30	55	Stiff fissured reddish brown slightly sandy silty CLAY with localised bluish grey reduction spots (up to 30mm). (TSG)	11.85	-5.50			
					80 200 340		Strong thickly laminated light bluish grey fine to coarse SANDSTONE with frequent rounded medium and coarse gravel sized quartz inclusions. (TSG) 11.65 - 11.85m: Reddish brown.					
					100 90 77	30 140 300	Weak thinly laminated off-white mottled dark grey fine to coarse SANDSTONE. Fractures are subhorizontal to 20° and 60° to subvertical closely and medium spaced undulating rough with reddish brown clay veneer. (TSG) 12.60 - 12.70m: Reddish brown.	12.70	-6.35			
	26C	12.70 - 14.20	6.40				Weak and medium strong thinly laminated greenish grey fine to coarse SANDSTONE with frequent subangular to rounded fine to coarse gravel sized quartz and quartzite inclusions. Fractures are subhorizontal to 20° very closely to medium spaced undulating smooth. (TSG)	14.20	-7.85			
							Borehole completed at 14.20m.					
									{18.00}			
water strike (m) casing (m) rose to (m) time to rise (m) remarks									AGS CONTRACT 30238		CHECKED EC	

BOREHOLE LOG



CLIENT WELSH GOVERNMENT

BH540

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 24 March 2015 Easting 341583.7

Scale 1 : 50

End Date 25 March 2015 Northing 187012.1 Ground level 10.85mOD Depth 11.60 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
24/03/15 1000hrs	1B	0.20 - 0.50		Vo 0.4				Grass over brown sandy gravelly SILT. Gravel is subangular and subrounded fine to coarse sandstone. (HDD)	0.50	10.35	
	2D*	0.20 - 0.50		Vo 5.1				Brown and yellowish grey clayey sandy subangular and subrounded fine to coarse sandstone GRAVEL with a high subangular sandstone cobble content. (HDD)	1.00	9.85	
	3B	0.50 - 1.00						Limited recovery. Medium strong yellowish grey medium and coarse SANDSTONE recovered non intact. (TSG)			
	4D*	0.50 - 1.00									
	5C	1.00 - 1.50			60 0 0	NI					
	6C	1.50 - 1.88 1.50 - 2.00	1.40	C*67	70 0 0						
	7C	2.00 - 2.50			60 8 0						
	8C	2.50 - 2.86	1.40	C*71	90	NA		Hard reddish brown slightly sandy silty CLAY. (TSG)	2.50	8.35	
	9D*	2.50 - 3.00 2.50 - 2.60						Thickly laminated reddish brown and greenish grey clayey fine to coarse micaceous SAND. (TSG)	2.75 2.90	8.10 7.95	
	10C	3.00 - 4.50	1.40		43 3 0	NI		Limited recovery. Weak to medium strong yellowish grey medium and coarse SANDSTONE. Recovered non intact. (TSG)			
	11C	4.50 - 4.67 4.50 - 5.60	1.40	C*750	82 35 12	NI 50 130		Weak to medium strong reddish brown medium and coarse siliceous SANDSTONE. Fractures are subhorizontal, 50° and 70° very closely and closely spaced planar rough. (TSG)	4.50	6.35	
	12C	5.60 - 7.10	1.40		93 65 37	60 100 260		Weak reddish grey medium and coarse siliceous SANDSTONE. Fractures are subhorizontal and 50° closely and medium spaced planar rough. (TSG)	5.55	5.30	
	13C	7.10 - 8.60	1.40		20 50 110	120		Medium strong reddish brown fine and medium SANDSTONE. Fractures are subhorizontal and 20° very closely and closely spaced planar smooth. (TSG)	6.35	4.50	
					97 97 59	25 120 270		Medium strong reddish brown medium and coarse SANDSTONE with frequent subrounded and rounded fine and medium gravel sized inclusions of quartzite and mudstone. Fractures are subhorizontal and 20° closely spaced undulating rough. (TSG)	6.80 7.05	4.05 3.80	
Continued Next Page									{8.00}		

EQUIPMENT: Comacchio MC205 rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Waterflush rotary core drilled (116mm) 1.00-11.60m.

CASING: 140mm diam to 1.40m.

BACKFILL: On completion, hole backfilled with bentonite pellets.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
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BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH540

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 24 March 2015 Easting 341583.7

Scale 1 : 50

End Date 25 March 2015 Northing 187012.1 Ground level 10.85mOD

Depth 11.60 m

progress date/time water depth	sample no & type	depth (m) from to		casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
24/03/15 1640hrs 3.60m	14C	8.60 - 10.10	1.40			79 73 48			Weak to strong thinly bedded reddish brown locally greenish grey fine and medium SANDSTONE. Fractures are subhorizontal and 20° very closely to medium spaced planar smooth. (TSG)			
25/03/15 0845hrs 3.50m												
	15C	10.10 - 11.60	1.40			90 80 37	180 180 310		9.15 - 9.80m: Fractures are 20°, 40° and 70° closely spaced planar smooth. 9.80 - 10.45m: Fractures are subhorizontal, 20° and 70° closely and medium spaced planar smooth. 9.90 - 10.05m: Greenish grey. 10.45 - 11.60m: Fractures are subhorizontal, 20° and 70° closely and medium spaced undulating rough. 10.70 - 11.50m: Greenish grey. 10.80 - 10.90m: Non-intact.			
25/03/15 1030hrs 3.60m												
											</	



BH541

CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date	26 March 2014	Easting	341628.8
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Scale 1 : 50

End Date	30 March 2015	Northing	187002.9	Ground level	11.35mOD
----------	---------------	----------	----------	--------------	----------

Depth 11.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
26/03/15 1445hrs	1B 2D* 3B 4D* 5B 6D* 7D 8X	0.20 - 0.60 0.20 - 0.60 0.60 - 0.80 0.60 - 0.80 0.80 - 1.00 0.80 - 1.00 1.00 - 1.43 1.00 - 1.30		Vo 2.2 Vo 3.4 Vo 3.2 S*57 Nil Nil				Grass over reddish brown slightly gravelly silty fine and medium SAND with rare rootlets (up to 2mm diam). Gravel is rounded and well rounded medium and coarse quartzite. (HDD)	0.50	10.85	
	9C	1.30 - 2.00	1.30		79 21 0	NI 70 120		Dark reddish grey slightly gravelly fine to coarse SAND with a low angular sandstone cobble content. Gravel is angular and subangular fine to coarse sandstone. (HDD) 0.80 - 1.00m: Gravelly.	1.30	10.05	
	10C	2.00 - 2.26 2.00 - 3.50	1.30	C*143	100 52 24			Weak to medium strong very thinly bedded yellowish grey SANDSTONE. Fractures are subhorizontal, subvertical and 20° very closely and closely spaced planar rough. (TSG)			
26/03/15 1700hrs 0.40m						NA			3.30	8.05	
27/03/15 0840hrs 0.60m	11C	3.50 - 3.83 3.50 - 5.00	3.20	C*83	97 31 13	20 90 190		Very stiff reddish brown slightly sandy clayey SILT with frequent angular medium and coarse gravel sized extremely weak siltstone lithorelicts. (TSG)	3.65	7.70	
						NI 20 50		Weak very thinly bedded locally cross bedded reddish brown and greenish grey fine and medium SANDSTONE. Fractures are subhorizontal and 20° very closely and closely spaced planar rough. (TSG)	4.20	7.15	
	12C	5.00 - 5.70	3.20		100 20 20	NI		3.90 - 4.00m: Hard thinly laminated reddish brown slightly sandy clayey silt.			
								Weak locally extremely weak very thinly bedded reddish brown and grey fine and medium SANDSTONE. Fractures are extremely closely and very closely spaced subhorizontal, 20°, 50°, 70° and subvertical undulating rough. Locally non intact. (TSG)	5.20	6.15	
	13C	5.70 - 7.00	3.20		100 68 24	30 80 120		Extremely weak thinly laminated reddish brown MUDSTONE. Non intact. (TSG)	5.55	5.80	
								Very weak locally strong very thinly bedded reddish brown locally greenish grey fine and medium SANDSTONE. Fractures are subhorizontal, 20°, 70° and subvertical very closely and closely spaced undulating and planar rough. (TSG)			
	14C	7.00 - 8.50	3.20		97 59 31	40 90 240			7.40	3.95	
								Weak very thinly bedded reddish brown and greenish grey fine and medium SANDSTONE. Fractures are subhorizontal, 50°, 70° and subvertical very closely and			
								Continued Next Page	8.00		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Dynamic sampled (113mm) 1.00-1.30m. Waterflush rotary core drilled (116mm) 1.30-11.50m.

CASING: 140mm diam to 3.20m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 11.50m, granular response zone 11.50-2.00m, bentonite seal 2.00-0.30m, concrete and raised helmet cover 0.30-0.00m.

REMARKS: Driller noted reduced flush returns 1.30-5.70m (60-80% returned) and loss of flush 5.70-11.50m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
------------------	------------	-------------	--------------------	---------

Groundwater not encountered prior to use of water
flush



CONTRACT
30238

CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH541

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 26 March 2014 Easting 341628.8

Scale 1 : 50

End Date 30 March 2015 Northing 187002.9 Ground level 11.35mOD Depth 11.50 m

progress date/time water depth	sample no & type	depth (m) from to		casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend	
27/03/15 1630hrs 6.30m 30/03/15 0840hrs 6.90m 30/03/15 1310hrs 6.80m	15C	8.50 - 8.90		3.20		75 30 30			closely spaced planar rough. (TSG) 8.05 - 8.10m: Cross bedded.	8.65 8.75	2.70 2.60		
	16C	8.90 - 10.00		3.20		91 7 0	100 NI 40 90		Medium strong reddish brown (80% clast supported) subangular and subrounded fine and medium gravel sized clasts of mudstone and sandstone CONGLOMERATE. (TSG)				
	17C	10.00 - 11.00		3.20		100 38 0	20 70 95		Extremely weak to weak thinly interbedded reddish brown and greenish grey MUDSTONE and SANDSTONE locally with clay infill (up to 5mm) along subhorizontal fractures. Fractures are subhorizontal, 70° and subvertical extremely closely and very closely spaced undulating and planar rough. Locally non intact. (TSG)	10.30	1.05		
	18C	11.00 - 11.50		3.20		100 18 0	20 30 50		Weak thinly laminated reddish brown locally greenish grey SILTSTONE. Fractures are subhorizontal, subvertical and 50° very closely and closely spaced undulating rough. (TSG)	11.15 11.50	0.20 -0.15		
									Borehole completed at 11.50m.				
										{18.00}			
water strike (m) casing (m) rose to (m) time to rise (m) remarks													
Groundwater not encountered prior to use of water flush.												CONTRACT 30238	CHECKED EC

A2 Appendix 2

Tabulated Gas and Groundwater Monitoring

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH539	24/03/15 10:30:00	1016	2								0.4	7		10 litres purged, base depth 3.00m.	
BH539	24/03/15 10:31:00										0.0				
BH539	24/03/15 10:32:00										0.0				
BH539	24/03/15 10:33:00										0.0				
BH539	24/03/15 10:34:00										0.0				
BH539	24/03/15 10:35:00			0.0	0.0	20.1	0.0	0	0	0.4					
BH539	24/03/15 10:36:00			0.0	0.0	20.0	0.0	0	0	0.2					
BH539	24/03/15 10:37:00			0.0	0.0	20.0	0.0	0	0	0.1				Upsurge at 3min 20sec. Unable to obtain further readings.	
BH539	24/03/15 10:44:00												0.56		
BH539	31/03/15 11:00:00	1017	-0.78								0.0	11		10 litres purged, base depth 3.00m.	
BH539	31/03/15 11:01:00										0.0				
BH539	31/03/15 11:02:00										0.0				
BH539	31/03/15 11:03:00										0.0				
BH539	31/03/15 11:04:00										0.0				
BH539	31/03/15 11:05:00			0.0	0.0	20.9	0.0	0	0	2.7					
BH539	31/03/15 11:06:00			0.0	0.0	20.9	0.0	0	0	2.6					
BH539	31/03/15 11:07:00			0.0	0.0	20.9	0.0	0	0	2.5				Upsurge at 3min 20sec. Unable to obtain further readings.	
BH539	31/03/15 11:14:00												0.71		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238	CHECKED EC



SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks								
BH539	16/04/15 09:02:00										0.0			8 litres purged, base depth 3.00m.								
BH539	16/04/15 09:03:00										0.0											
BH539	16/04/15 09:04:00										0.0											
BH539	16/04/15 09:05:00										0.4				0.1	20.2	1.0	0	1	4.7		
BH539	16/04/15 09:06:00										0.4				0.1	20.2	1.0	0	0	4.7		
BH539	16/04/15 09:07:00										0.3				0.1	20.2	1.0	0	0	4.4		
BH539	16/04/15 09:14:00																					
BH539	16/04/15 11:00:00										1019				-0.75						0.0	12
BH539	16/04/15 11:01:00																				0.0	
BH539	08/05/15 14:53:00										1002				7						1.6	15
BH539	08/05/15 14:54:00								1.2				Upsurge at 3min 20sec. Unable to obtain further readings.									
BH539	08/05/15 14:55:00								1.2													
BH539	08/05/15 14:56:00								2.1													
BH539	08/05/15 14:57:00								1.6													
BH539	08/05/15 14:58:00			0.0	0.0	20.3	0.0	0	0	0.0												
BH539	08/05/15 14:59:00			0.0	0.0	20.2	0.0	0	0	0.0												
BH539	08/05/15 15:00:00			0.0	0.0	20.2	0.0	0	0	0.0												
BH539	08/05/15 15:01:00			0.0	0.0	20.2	0.0	0	0	0.0												
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238		CHECKED EC						

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH539	08/05/15 15:02:00			0.0	0.0	20.2	0.0	0	0	0.0				
BH539	08/05/15 15:03:00			0.0	0.0	20.2	0.0	0	0	0.0				
BH539	08/05/15 15:04:00			0.0	0.0	20.2	0.0	0	0	0.0				
BH539	08/05/15 15:05:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH539	08/05/15 15:06:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH539	08/05/15 15:07:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH539	08/05/15 15:08:00												2.03	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH539	24/03/15 10:44:00												1.09	77 litres purged, base depth 14.00m. 76 litres purged, base depth 14.00m. 74 litres purged, base depth 14.00m.	
BH539	31/03/15 11:14:00												1.23		
BH539	16/04/15 09:14:00												1.65		
BH539	08/05/15 15:09:00												3.39		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH541	31/03/15 13:00:00	1016	-0.49								0.0	14		28 litres purged, base depth 11.50m.	
BH541	31/03/15 13:01:00										0.0				
BH541	31/03/15 13:02:00										0.0				
BH541	31/03/15 13:03:00										0.0				
BH541	31/03/15 13:04:00										0.0				
BH541	31/03/15 13:05:00			0.3	0.0	20.1	0.0	0	64	4.2					
BH541	31/03/15 13:06:00			0.3	0.0	20.1	0.0	0	63	3.7					
BH541	31/03/15 13:07:00			0.3	0.0	20.0	0.0	0	62	3.1					
BH541	31/03/15 13:08:00			0.3	0.0	19.9	0.0	0	61	2.3					
BH541	31/03/15 13:09:00			0.3	0.0	19.9	0.0	0	61	2.6					
BH541	31/03/15 13:10:00			0.3	0.0	19.8	0.0	0	60	2.3					
BH541	31/03/15 13:11:00			0.3	0.0	19.8	0.0	0	58	2.1					
BH541	31/03/15 13:12:00			0.3	0.0	19.9	0.0	0	57	2.1					
BH541	31/03/15 13:13:00			0.3	0.0	20.0	0.0	0	55	1.9					
BH541	31/03/15 13:14:00			0.3	0.0	20.2	0.0	0	52	1.8			6.67		
BH541	16/04/15 14:15:00	1014	0.11								0.0	18		28 litres purged, base depth 11.50m.	
BH541	16/04/15 14:16:00										0.0				
BH541	16/04/15 14:17:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH541	16/04/15 14:18:00										0.0			
BH541	16/04/15 14:19:00										0.0			
BH541	16/04/15 14:20:00			0.8	0.1	19.5	2.0	0	1	6.0				
BH541	16/04/15 14:21:00			0.8	0.1	19.4	2.0	0	1	5.3				
BH541	16/04/15 14:22:00			0.9	0.1	19.4	2.0	0	1	4.4				
BH541	16/04/15 14:23:00			0.9	0.1	19.4	2.0	0	0	4.1				
BH541	16/04/15 14:24:00			0.9	0.1	19.4	2.0	0	1	3.7				
BH541	16/04/15 14:25:00			0.9	0.1	19.4	2.0	0	1	3.4				
BH541	16/04/15 14:26:00			0.9	0.1	19.3	2.0	0	1	3.2				
BH541	16/04/15 14:27:00			1.0	0.1	19.3	2.0	0	1	3.0				
BH541	16/04/15 14:28:00			1.0	0.1	19.2	2.0	0	1	2.7				
BH541	16/04/15 14:29:00			1.0	0.1	19.2	2.0	0	0	2.6			6.73	
BH541	21/04/15 11:00:00	1038	-0.81								0.0	13		28 litres purged, base depth 11.50m.
BH541	21/04/15 11:01:00										0.0			
BH541	21/04/15 11:02:00										0.0			
BH541	21/04/15 11:03:00										0.0			
BH541	21/04/15 11:04:00										0.0			
BH541	21/04/15 11:05:00			0.0	0.1	20.7	1.0	0	0	3.6				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (litr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH541	21/04/15 11:06:00	1017	0	0.0	0.1	20.7	1.0	0	0	3.1		15	6.71	
BH541	21/04/15 11:07:00			0.0	0.1	20.7	1.0	0	0	2.8				
BH541	21/04/15 11:08:00			0.1	0.1	20.6	1.0	0	0	2.7				
BH541	21/04/15 11:09:00			0.2	0.1	20.5	1.0	0	0	2.5				
BH541	21/04/15 11:10:00			0.4	0.1	20.4	1.0	0	0	2.3				
BH541	21/04/15 11:11:00			0.6	0.1	20.3	1.0	0	0	2.1				
BH541	21/04/15 11:12:00			0.6	0.1	20.2	1.0	0	0	2.1				
BH541	21/04/15 11:13:00			0.7	0.1	20.2	1.0	0	0	2.0				
BH541	21/04/15 11:14:00			0.7	0.1	20.2	1.0	0	0	1.9				
BH541	11/05/15 10:24:00										0.0			
BH541	11/05/15 10:25:00										0.0			
BH541	11/05/15 10:26:00										0.0			
BH541	11/05/15 10:27:00										0.0			
BH541	11/05/15 10:28:00										0.0			
BH541	11/05/15 10:29:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH541	11/05/15 10:30:00			0.0	0.0	20.1	1.3	0	0	0.0				
BH541	11/05/15 10:31:00			0.0	0.0	20.1	7.0	0	0	0.0				
BH541	11/05/15 10:32:00			0.0	0.0	20.1	10.3	0	0	0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH541	11/05/15 10:33:00			0.0	0.0	20.1	12.9	0	0	0.0				
BH541	11/05/15 10:34:00			0.0	0.0	20.1	15.0	0	0	0.0				
BH541	11/05/15 10:35:00			0.0	0.0	20.1	15.4	0	0	0.0				
BH541	11/05/15 10:36:00			0.0	0.0	20.1	18.9	0	0	0.0				
BH541	11/05/15 10:37:00			0.0	0.0	20.0	11.2	0	0	0.0				
BH541	11/05/15 10:38:00			0.0	0.0	20.0	0.0	0	0	0.0				
BH541	11/05/15 10:39:00												8.15	11.5
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

NORWEST HOLST SOIL ENGINEERING LTD.

M4 RELIEF ROAD MAGOR TO CASTLETON STAGE 2

PIEZOMETER RECORDS BHM6

DATE	TIME(24hr)	WATER LEVEL(m)	WATER LEVEL mOD
15/11/97	14:00	3.52	7.53
25/11/97	15:25	3.17	7.88
02/12/97	11:00	1.67	9.38
10/12/97	14:30	1.86	9.19
16/12/97	15:35	1.93	9.12

TIP DEPTH:6.53m

TYPE OF COVER:BARREL

HEIGHT OF COVER A.B.G.L.:0.22m

HEIGHT OF PIPE A.B.G.L.:0.14m

COMMENTS:

A3 Appendix 3

Tabulated Groundwater Laboratory Data

M4CAN
Groundwater Sample Analysis & Screening Assessment
CL-29
01/07/2015

Geological Formation Legend

HD	Head
TS	Tintern Sandstone Formation

Screening Values & Assessment

EQS	Environmental Quality Standards
DWS	Drinking Water Standard
	Exceeds EQS
X	Exceeds DWS
X	Laboratory detection level higher than screening criterion

Notes

	Offsite borehole location
N/A	Detail Unknown

Monitoring Round		Units		Screening Criteria		1		2		3		1		2		3	
Location	BH539					BH539	BH539	BH539	BH541	BH541	BH541						
Location Type																	
Response Zone (RZ) Details																	
Depth																	
Installation Details																	
Date sampled		EQS	DWS														
				HD	TS	N/A	N/A	N/A	N/A	TS	TS	TS					
				Shallow	Deep	2.1	2.84	1.49	3.04	6.67	6.73	6.72					
				24/03/2015	31/03/2015	16/04/2015	31/03/2015	16/04/2015	21/04/2015								
Metals																	
Arsenic	ug/l	50	10	2	<1	3.2	3.4	1.9	<1	1.9	<1	2.5					
Barium	ug/l	2000	1000	820	760	160	70	1000	960	800	1000	140					
Cadmium	ug/l	0.15	5	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08					
Chromium	ug/l		50	3.3	6.6	25	33	1.8	2.4	26	2.3	14					
Copper	ug/l	10	2000	<1	1.9	16	21	<1	<1	9.9	<1	8.1					
Lead	ug/l	1.2	10	<1	<1	<1	<1	<1	<1	<1	<1	<1					
Mercury	ug/l	0.07	1	0.65	1.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					
Nickel	ug/l	4	20	7	6.2	6.3	2.3	3.3	1.3	1.4	<1	2.6					
Selenium	ug/l	10	15	4	2.9	3.1	1	2.7	1.3	1.4	3.9						
Zinc	ug/l	75	10	1.4	1.1	5.9	7.6	2.5	3.4	3.3	<1	2.9					
Non-Metal Inorganics																	
Total Alkalinity as CaCO3	mg/l			£10	460	230	280	330	250	210	240	800					
Chloride	mg/l	250	250	32	70	31	73	25	70	13	14	£20					
Ammoniacal Nitrogen as N	mg/l	0.6		0.45	0.23	0.78	0.17	0.41	0.041	0	0.054	1.4					
Total Cyanide	mg/l	0.001	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05					
Free Cyanide	mg/l			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05					
pH Value	pH units	6-9	6.5-10	7.7	7.8	7.8	7.9	8.4	8.6	8.1	8.6	8.3					
Phenols																	
Phenol	ug/l	7.7				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					
Phenols	mg/l	0.0077		0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03					
BTEX																	
Benzene	ug/l	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1					
Toluene	ug/l	50		<1	<1	<1	<1	<1	<1	<1	<1	<1					
Ethyl benzene	ug/l	20		<1	<1	<1	<1	<1	<1	<1	<1	<1					
m & p Xylene	ug/l	30				<1	<1	<1	<1	<1	<1	<1					
o Xylene	ug/l	30		<1	<1	<1	<1	<1	<1	<1	<1	<1					
TPH																	
Aliphatics C5-C6	ug/l			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					
Aliphatics >C6-C8	ug/l			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					
Aliphatics >C8-C10	ug/l			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					
Aliphatics >C10-C12	ug/l			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					
Aliphatics >C12-C16	ug/l			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					
Aliphatics >C16-C21	ug/l			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					
Aliphatics >C21-C35	ug/l			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					
Aliphatics >C35-44	ug/l			<0.1	<0.1	<0.1	<0.1</										

[illegible]

A4 Appendix 4

Site Walkover Photographs



Plate 01: CL29 – View looking south



Plate 02: CL29 – View looking north

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

D  te: May 2015



Plate 01: CL29 – View looking west

A5 Appendix 5

Relevant Extract of Additional Environmental Data



Plate 01: Extract of 1991 Aerial Photograph showing disturbed ground and stored materials.



Plate 02: Extract of 2006 Aerial Photograph showing disturbed ground and stored materials.

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: Oct 2015

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment
Report Annex D

CL-30 Green Moor Quarry
Landfill Land Contamination
Assessment Report

M4CaN-DJV-EGT-ZG_GEN-RP_EN-0032

At Issue | March 2016

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Appendix 1	Exploratory Records
Appendix 2	Tabulated Gas and Groundwater Monitoring
Appendix 3	Tabulated Groundwater Laboratory Data
Appendix 4	Site Walkover Photographs

1 Introduction

1.1 Background

1.1.1 This report relates to an area of land potentially affected by contamination (CL-30) known as the 'Green Moor Quarry Landfill' herein referred to as the 'Site'.

1.1.2 The Site is located between chainage 20,100 and 20,225 (see Figure 1), upon an infilled quarry.

1.2 Reporting Context

1.2.1 The Site has been assessed as part of ground investigations and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the 'Scheme'). This report informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the chapter on Geology and Soils.

1.2.2 In 2014, a Preliminary Sources Study Report (PSSR) was prepared as an initial land contamination appraisal (Ove Arup & Partners, 2014) as part of Design Manual for Roads and Bridges (DMRB) Stage 2 Assessments for a number of potential routes. This identified a number of individual areas that may have been affected by contamination as a result of historical activities at the Site. In addition, this report draws upon the 2015 Supplementary Ground Investigation Works undertaken on behalf of the Welsh Government (Geotechnical Engineering, 2015). This report relates to the area defined in the Site Plan shown in Figure 1.

1.2.3 The overarching rationale and approach for the assessment of areas of land along the Scheme with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

1.3.1 The key objectives of this report are set out below:

- Undertake a risk assessment of the Site and determine whether potential risks to human health or controlled waters could exist based upon the Scheme.
- Identify the need for further assessment and investigation in order to refine potential land contamination risks and inform the need for remediation/mitigation.
- To provide information to support the Ground Investigation Report (GIR) and Geotechnical Design Report (GDR) required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

1.4.1 The subsequent report structure is as follows:

- Section 2: Site Location and Description – This section summarises the Site's description.
- Section 3: The Scheme – This section details the new section of motorway alignment and associated features at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and historical land photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and any relevant environmental information presented in the 2014 PSSR.
- Section 6: Scope of Investigations – This section describes the previous and supplementary ground investigation data available for the Site.
- Section 7: Ground Conditions – This section describes the main findings of the intrusive site investigation including the ground conditions encountered and visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contaminant linkages and presents the human health and controlled waters assessments.
- Section 9: Refined Conceptual Site Model – This section presents the Conceptual Site Model (CSM) for the Site and identifies potential contaminant linkages, based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations – This section provides conclusions concerning the likelihood of land contamination associated with the Site affecting the Scheme and requirements for remediation/mitigation.
- Section 11: References – This section details the key reference documents referred to within the text.
- Section 12: Glossary – This section details the key terms and acronyms used throughout the report.

2 Site Location and Description Setting

- 2.1.1** The Site is located south of Magor, centred at National Grid Reference (NGR) ST 417 870. The Site comprises an area of in-filled quarry, the location of which is shown on Figure 1.
- 2.1.2** Review of aerial photography and walkover surveys undertaken in 2014 and 2015 indicated that the Site forms part of a field. The field slopes gently southwards from approximately 20 to 10 m AOD towards the South Wales to London Mainline, which is positioned within a cut (at some 8 m AOD) and delineates the southern extent of the Site. A brewery is located approximately 150 m north of the Site and residential dwellings at Magor are approximately 100 m to the east.
- 2.1.3** Underground pipework with a visible chamber in the south of the Site, (understood to be part of effluent treatment drainage from the brewery), runs north-south directly through the Site. The hamlet of Barecroft Common occupies the northern edge of the Caldicot Levels directly to the south of the railway line.
- 2.1.4** The Site's southern boundary with the railway line comprises a soil embankment.
- 2.1.5** Photographs of the Site are included in Appendix 4

3 The Scheme

- 3.1.1** The Site is located between approximate chainage 20,100 to 20,225 as shown in Figure 1.
- 3.1.2** The new section of motorway crosses the northern half of the Site and includes a 10 m high embankment which crosses the north-western part of the Site. A bridge over the South Wales to London Mainline is located approximately 60 m to the north. The remainder of the Site is excluded from the temporary and permanent land take.

4 Site History

- 4.1.1** The 2014 PSSR historical searches have been based on Ordnance Survey plans, literature reviews, information provided by British Steel, Natural Resources Wales (NRW) (formally Environment Agency Wales), Newport City Council and aerial photographic interpretation.
- 4.1.2** This is supplemented by a review of historical maps obtained in 2015 from Welsh Government. No relevant additional information has been identified from this review.
- 4.1.3** A summary of the Site's history is presented in Table 1 below.

Table 1: Site History

Date	Use	Source of Information
1843 - 1893	The Site comprises a Quarry . It is bound to the south by a railway, beyond which is Barecroft Common.	1:10,560 Historical Mapping
1891 - 1912	The Quarry is now marked as 'Old Quarry' indicating its disuse.	1:10,560 Historical Mapping
1904 - 1939	No significant change.	1:10,560 Historical Mapping
1964 - 1965	No significant change.	1:10,560 Historical Mapping
1969	The area of the quarry appears to have been infilled .	Aerial Photography
1969 - 1971	No significant change. The Site is shown as rough ground with what appears to be a pond in the southern tip.	1:10,560 Historical Mapping
1981	The pond appears to have been infilled, however the image is not clear.	Aerial Photography
1985 - 1996	The remainder of the Site is no longer recorded as rough ground but an agricultural field.	1 : 10,000 Historical Mapping
2006	There is an area of rough vegetation indicated in the south-west corner.	Aerial Photography
2009 - 2010	No significant change.	Aerial Photography
2014	The housing development of Magor to the east has been developed to within approximately 100 m of the Site.	Aerial Photography

Notes. Potential sources of contamination are underlined. Those within the temporary and permanent land take are shown in **bold**.

- 4.1.4** Historically the site is located in proximity to areas which may have been bombed during World War II which is discussed in the Explosive Ordnance Threat Assessment Report (Bactec, 2014). This report categorises the site as low risk with respect to unexploded ordnance.

5 Environmental Setting

5.1 Geology

- 5.1.1** British Geological Survey (BGS) data indicate that the Site is underlain by the bedrock of the Tintern Sandstone Formation. There are no superficial deposits in the southern area of the Site, however, River Terrace Deposits are shown to be present within the northern section of the Site.

5.2 Hydrology

- 5.2.1** There are no surface water features on Site. To the south of the South Wales to London Mainline railway there are a number of drainage ditches and reens, the nearest of which is located approximately 60 m to the south.

5.3 Hydrogeology

- 5.3.1** NRW classifies the River Terrace Deposits as a Secondary A Aquifer and the bedrock as a Principal Aquifer.
- 5.3.2** The Site does not lie within a groundwater Source Protection Zone (SPZ).

5.4 Environmental Information

- 5.4.1** NRW records do not identify any pollution incidents, sewage discharge consents, abstraction licences or any waste management facilities as located on or within 300 m of the Site.
- 5.4.2** The CL-29 Spoil Heap site (Annex D of Appendix 11.1 of the ES) is located 85 m to the west of the Site. This is small material stockpile which is not considered to represent a likely offsite source of potential contamination relative to the Site.

6 Scope of Investigations

6.1 General

6.1.1 No previous intrusive ground investigations have been undertaken at this Site. However a number of exploratory holes were advanced within 100 m of the Site. These have been considered in order to support an understanding of ground conditions beneath the Site and inform the groundwater quality and gas regime if relevant.

6.2 Scope of Works

6.2.1 The intrusive ground investigations undertaken in the vicinity of the Site are summarised in Table 2.

Table 2: Investigation Summary (off site)

Date	Contractor	Boreholes	Location from Site	Sampling
1997	Norwest Holst	BHM6	100 m west	Groundwater level
		BHM7	120 m north	No monitoring well installed.
2015	Geotechnical Engineering Limited	BH539	130 m south-west	Groundwater level, sampling Ground gas (BH540 no monitoring well installed)
		BH540	110 m west	
		BH541	60 m west	
		BH542	120 m north	

6.2.2 Boreholes BH539 and BH541 are also considered within the CL-29 Spoil Heap site (Annex D of Appendix 11.1 of the ES).

6.2.3 The construction details of the above offsite boreholes are summarised in Table 3 below.

Table 3: Summary of Offsite Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (m bGL)	Base of Slotted Well Casing / Gravel Pack (m bGL)	Targeted Geology
BHM6	Unknown	10.0	5	7.5	Tintern Sandstone
BH539	35	14.2	1	3	Head Deposits
	50		5	14.2	Tintern Sandstone
BH541	50	11.5	2	11.5	Tintern Sandstone
BH542	35	16	1	4	Tintern Sandstone
	50		10	16	Tintern Sandstone

6.3 Surface Water Quality Sampling

6.3.1 Surface water quality monitoring was not undertaken during the previous ground investigations of the Site.

6.4 Field Testing

6.4.1 Photo Ionisation Detector (PID) monitoring for Volatile Organic Compounds (VOCs) was not undertaken in any of the selected offsite boreholes during the previous ground investigations.

6.5 Groundwater Monitoring

6.5.1 A summary of the groundwater sampling, groundwater monitoring and ground gas monitoring rounds is shown in Table 4.

Table 4: Summary of Monitoring Rounds (offsite)

Location Ref. (Borehole Diameter)	Number of Rounds (Date of Sampling)	Monitoring Details	Notes
BHM6	5 no. 15 th November 1997, 25 th November 1997, 2 nd December 1997, 10 th December 1997, 16 th December 1997	Groundwater level	
BH539 (35mm)	4 no. 24 th March 2015, 31 st March 2015, 16 th April 2015, 8 th May 2015	Groundwater level and sampling Ground Gas	Gas monitoring in 35 mm shallow installation only
BH539 (50mm)			
BH541 (50mm)	4 no. 31 st March 2015, 16 th April 2015, 21 st April 2015, 11 th May 2015	Groundwater level and sampling Ground Gas	
BH542 (35mm)	3 no. 24 th March 2015, 31 st March 2015, 16 th April 2015	Groundwater level Ground Gas	Gas monitoring in 35 mm shallow installation only
BH542 (50mm)			

6.6 Laboratory Chemical Testing

6.6.1 A summary of all laboratory analysis undertaken on groundwater offsite is shown in Table 5.

Table 5: Summary of Previous Investigation Sampling (offsite)

Site Investigation Date	No. of Soil Samples	No. of Leachate Samples	No. of Water Samples	Suites of Testing
1997	N/A	N/A	-	
2015	N/A	0	9	Metals, PAH, TPH, pH, cyanide, PCBs, VOCs, SVOCs, BTEX, phenols, inorganics

Soil Analysis

6.6.2 Chemical analytical soil data was not collected during previous ground investigations at the Site.

Soil Leaching Analysis

6.6.3 Chemical analytical leachate data was not collected during previous ground investigations at the Site.

Groundwater Analysis

6.6.4 The following section summarise the laboratory analytical results for groundwater samples collected during the 2015 ground investigation within the selected offsite boreholes. The available data set has been tabulated and is presented in Appendix 3 with supporting laboratory certificates available in the relevant original report (Geotechnical Engineering, 2015).

6.6.5 The available data relate to samples taken from wells installed within the groundwater of the Superficial Deposits and Tintern Sandstone Formation deposits.

6.6.6 The available information is summarised in Table 6.

Table 6: Summary of Analytical Groundwater Data (offsite)

Groundwater Unit	Number of Groundwater Analyses per Analytical Suites (Number of Well Locations) – 2015 Data							
	Metals & Inorganics	PAH	TPH	Phenol	BTEX	SVOCs	VOCs	PCBs
Perched Groundwater (Superficial Deposits)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	2 (1)	2 (1)	1 (1)
Groundwater (Tintern Sandstone Formation)	6 (2)	6 (2)	6 (2)	6 (2)	6 (2)	4 (2)	4 (2)	3 (2)

6.7 Gap Analysis of Available Data

6.7.1 There is no ground investigation data available for the Site; as such no chemical analysis data are available and therefore, no quantitative risk assessment can be undertaken.

7 Ground Conditions

7.1 Geology

7.1.1 The geological logs for all available exploratory holes excavated on or in close proximity to the Site are provided in Appendix 1. The observed geological sequence is consistent with that discussed in the 2014 PSSR report and is summarised in the following sections. Information from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) has also been used.

Topsoil

7.1.2 Topsoil was encountered in two exploratory locations to depths of 0.1 - 0.4 m bGL.

Made Ground

7.1.3 Made Ground was not encountered during the previous ground investigations.

Superficial Deposits

7.1.4 Unconsolidated superficial deposits were encountered beneath the topsoil. These comprised predominantly sand and gravel, encountered to 0.5 – 1.3 m bGL. Whilst the field records identify this as 'Head Deposits', it is believed they represent the River Terrace Deposits in line with BGS records.

7.1.5 In borehole (BH539) a thin veneer of Tidal Flat Deposits to 2.35 m bGL was recorded. This was encountered as very soft clay. This would indicate that the formation extends further north than indicated by the published geological data. However, the Tidal Flat Deposits are not anticipated to underlie the Site.

Bedrock

7.1.6 Beneath the superficial deposits the Tintern Sandstone Formation was encountered. This typically comprised sandstone with interbedded thin mudstones/marls.

Geological Sequence Summary

7.1.7 The general geological sequence identified during the previous ground investigations at closest vicinity to the Site is summarised in Table 7.

Table 7: Summary of Geological Sequence

Unit	Description	Thickness Range (m)	Basal Depth (m bGL)
Made Ground	Unknown	Unproven	Unproven
River Terrace Deposits	Clayey sandstone gravel or cobbles. Slightly gravelly sand.	Absent*-1.3*	Absent*-1.3*
Tintern Sandstone	Bedded sandstone. Horizons of clay/silt/conglomerate. Interbedded mudstone and sandstone	>9.39* - >19.6*	Unproven*

Note: * inferred from offsite exploratory holes.

7.1.8 The solid geology beneath the Site is anticipated to be similar to that detailed above although the rockhead is likely to be at a lower elevation given the historical quarrying process. The overlying superficial deposits (Head and/or Tidal Flat Deposits) if formerly present, are likely to have been removed and Made Ground of unknown thickness and composition is likely to overlay the Tintern Sandstone. The Site is currently used as a grazing field and it is assumed a layer of topsoil is present across the Site.

7.2 Visual and Olfactory Evidence of Contamination

7.2.1 No records are available for the Site.

7.3 Gas Monitoring (Off Site)

7.3.1 The gas monitoring dataset collected during each of the previous monitoring rounds at the offsite boreholes is summarised on the field data sheets provided in Appendix 2. The maximum ground gas concentrations are presented in Table 8.

7.3.2 Boreholes BH539 and BH541 have also been considered during the assessment of the gas regime for CL-29 Spoil Heap site (Annex D of Appendix 11.1 of the ES), located approximately 85 m to the west.

Table 8: Summary of Gas Monitoring Data (offsite)

Location ID (Borehole Diameter)	Flow (l/hr) Max.	VOCs (ppm) Max.	CH ₄ (%/vol) Max.	Peak LEL (%) Max.	CO ₂ (%/vol) Max.	O ₂ (%/vol) Min.	CO (ppm) Max.	H ₂ S (ppm) Max.
BH539 (35 mm)	2.1	4.7	0.1	1.0	0.4	20	1.0	0.0
BH541	0.0	6.0	0.1	18.9	1.0	19.2	64	0.0
BH542 (35 mm)	0.2	14.6	0.1	2.0	6.6	0.2	13	0.0

7.4 Groundwater

Groundwater Encountered During Investigation (offsite)

7.4.1 A water strike was encountered during the advancement of the offsite boreholes BHM6 during the 1997 investigation and BH539 during the 2015 investigation, as detailed on the geological logs provided in Appendix 1. This together with additional water level information provided by the exploratory borehole records is summarised below in Table 9.

Table 9: Summary of Groundwater Level Data During Investigation (offsite)

Location	Strike Depth (m bGL)	Geological Formation	Level after 20 minutes (m bGL)	Comments
BH539	1.2	Tidal Flat Deposits	1.0	
BHM6	6.5	Tintern Sandstone	0.0 (log start time taken to rise is 0)	Uncertain on the accuracy of the recorded resting level

7.4.2 Groundwater was not encountered in any other offsite boreholes during the previous ground investigations.

Groundwater Level Dataset (offsite)

7.4.3 The groundwater level dataset gathered from the selected boreholes offsite is provided in Appendix 2 and summarised in Table 10.

Table 10: Summary of Groundwater Level During Monitoring Rounds (offsite)

Location	Installation	Depth of response zone (m bGL) and Geological Formation	No. Measurements	Minimum Depth (m bGL)	Maximum Depth (m bGL)	Comments
BHM6	Unknown	5 – 7.5 (Tintern Sandstone formation)	5	1.67	3.52	
BH539	35 mm	1 – 3 (Tidal Flat Deposits)	3	0.56	1.06	
	50 mm	5 – 14.2 (Tintern Sandstone formation)	3	1.09	1.65	
BH541	50 mm	2 – 11.5 (Tintern Sandstone formation)	4	6.67	8.15	
BH542	50 mm	10 -16 (Tintern Sandstone formation)	3	Dry	Dry	

Groundwater Summary

7.4.4 The main groundwater body present is anticipated to be within the Tintern Sandstone, with variable resting levels recorded in between monitoring visits.

7.4.5 The Tintern Sandstone formation is considered to be in hydraulic continuity with the groundwater within the Head Deposits.

7.4.6 The offsite boreholes are considered to be up gradient to the Site based on a general groundwater flow south-eastwards (Appendix 16.2 of the ES).

8 Contamination Assessment

8.1 Introduction

8.1.1 The following sections provide details of the assessment of land contamination at the Site.

8.1.2 The Conceptual Site Model (CSM) presented within the 2014 PSSR has been reviewed and updated based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and the revised design of the Scheme. The main alterations to the 2014 PSSR model are summarised as follows:

- addition of ground, groundwater and gas datasets from nearby boreholes;
- consideration of revised land use post construction;
- removal of surface water receptor; and
- update of the source-pathway-receptor linkages taking into account the above, and more detailed assessments.

8.2 Preliminary Risk Assessments

Potential Sources

8.2.1 The potential sources of contamination and associated contaminants which may be present within the Site are detailed below.

- Infill materials of an unknown nature, potentially comprising waste deposited between the late 1960s and early 1980s.
- Considering the age of the infill materials ground gas and leachate production may still be occurring.
- Groundwater and surface water potentially impacted by landfill leachate.

Potential Receptors

8.2.2 Receptors during the construction and the operational stages of the Scheme that have been considered are as follows.

Construction

- Construction workers during Site development works.
- General public adjacent to construction works including existing A4180 and railway users and residents located within 100 m of the Site.
- Groundwater within the superficial deposits and/or within the Tintern Sandstone formation.

Operational

- General public end users.
- Site neighbours adjacent to areas of permanent land take.
- Maintenance workers.

- Groundwater (principal aquifer) within the bedrock.

Potential Pathways

8.2.3 Pathways during the construction and the operational stages of the Scheme that have been considered are as follows.

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils possible during construction works and maintenance works.
- Dermal contact, ingestion, inhalation pathways possible for general offsite public.
- Leaching of contaminants from the infill material into underlying groundwater aquifer.
- Vertical or lateral migration of potential ground gases associated with infill material.

8.3 Risk Evaluation

8.3.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the other new data described herein, the following risk evaluation has been reconsidered and includes the below.

- The Site has been subject to backfilling of an unknown material.
- The proposed 13 m high embankment will encapsulate or remove any contaminated infill materials within its footprint. This will reduce or remove exposure linkages to motorway users and maintenance workers. However, the landfill extends beyond permanent and temporary land take (outside embankment) and any potential linkages will remain.
- Motorway users will be within an open environment with no proposed structures or other confined spaces. Pathways linkages to M4 users during its operation are therefore limited to air born dust.
- Bedrock directly beneath the Site is classified as a principal aquifer.
- Hardstanding cover which is proposed in some areas of the new motorway corridor is likely to limit infiltration thus reducing leaching in these areas.
- The nearest surface water feature is located 60 m to the south, over the railway line. As such it is considered there is no reasonable pathway between the Site and surface water feature.
- No onsite investigation has been undertaken.
- No significant abnormal ground gas regime has been identified in the offsite boreholes.

8.4 Human Health Risk Assessment

8.4.1 No investigation, sampling or analysis was undertaken onsite during the previous investigations and therefore no human health (Tier 2) screening assessment can be undertaken.

8.5 Controlled Waters Screening Assessment

8.5.1 The rationale and approach for the controlled waters (Tier 1) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES) and the groundwater chemical results are presented in Appendix 3. No soil leachate or surface water data is available. All exceedances of relevant generic criteria are summarised in Table 11 for groundwater.

8.5.2 Where an Environmental Quality Standard (EQS) is dependent on water hardness, i.e. some heavy metals, the hardness of the surface water receptor should normally be used. The Groundwater Baseline Report (Appendix 16.2 of the ES) indicates surface water to be generally moderately hard with hardness concentrations within a range of 100 to 150 mg/l (reported as calcium carbonate). Therefore EQSs within this water hardness range have been used for screening purposes.

Groundwater Results (offsite)

8.5.3 In the absence of onsite data and for the purpose of this report, nearby available groundwater analytical data has been considered. This data was included to help identify the local groundwater quality within the vicinity of the Site in order to identify any obvious contamination fingerprint that could be associated with potential contamination from the Site itself.

8.5.4 The groundwater analysis results include data from three rounds of groundwater monitoring results from offsite boreholes, BH541 and BH539, undertaken in 2015. The groundwater samples were taken from the aquifer body within the Tintern Sandstone formation and the perched groundwater within the Head Deposits.

8.5.5 A summary of exceedances with respect to the screening criteria is presented in Table 11 and discussed below.

Table 11: Controlled Waters Screening Exceedances - Groundwater (offsite)

Determinand	Units	Range	EQS	DWS	No. Exceeded Screening Criteria (Total Number of Results) Against EQS	Location of Exceedance	No. Exceeded Screening Criteria (Total Number of Results) Against DWS	Location of Exceedance
Perched Groundwater								
Copper	ug/l	<1 - 21	10	2000	1 (3)	BH539	-	-
Mercury	ug/l	0.65	0.07	1	1 (3)	BH539	-	-
Nickel	ug/l	2.3 - 7	4	20	1 (3)	BH539	-	-
Phenols	ug/l	<0.03 - 0.03	0.007 7	-	1 (3)	BH539	-	-
Aquifer								
Arsenic	ug/l	<1 - 25	50	10	-	-	1 (6)	BH541
Copper	ug/l	<1 - 16	10	2000	1 (6)	BH539	-	-
Mercury	ug/l	<0.5 - 1.3	0.07	1	1 (6)	BH539	1 (6)	BH539
Nickel	ug/l	<1 - 6.3	4	20	2 (6)	BH539 (x2)	-	-
Chloride	mg/l	13 - 620	250	250	1 (6)	BH541	1 (6)	BH541
Ammoniacal Nitrogen	mg/l	<0.01 - 1.4	0.6	-	2 (6)	BH539, BH541	-	-

8.5.6 Review of the groundwater chemical testing results indicated that the deep groundwater offsite has elevated levels of metals (arsenic, copper, mercury and nickel) and inorganics (chloride and ammoniacal nitrogen).

8.5.7 The perched groundwater within the Head Deposits is shown to be impacted by metals (copper, mercury and nickel) and phenols.

8.5.8 All PAH, VOCs, SVOCs, phenols, BTEX, TPH and PCB results were found below their respective limits of detection within both water bodies.

8.5.9 It is noted that the laboratory detection levels for mercury, cyanide, some PAH compounds, VOCs and SVOCs are higher than the applied screening criterion.

8.6 Ground Gas Risk Assessment

8.6.1 The only ground gas data available relates to offsite boreholes BH539, BH541 and BH542. These boreholes have response zones screened within the Head Deposits (between 1 and 3 m bGL) and within the Tintern Sandstone Formation (between 2 and 11.5 m bGL and between 1 and 4 m bGL), respectively. Of the four gas monitoring rounds available for BH539 and BH541 and the three rounds for BH542, the following comments below have been made:

- No monitoring was undertaken during low barometric pressure (less than 1000 mb), with the lowest conditions being 1010 mb. As such worst case

atmospheric conditions for potential ground gas generation may have not been monitored.

- Gas flow was generally recorded as absent with the exception of the second round for BH539, with a peak of 2.1 l/hr, and the second round for BH542 with a peak of 0.2 l/hr.
- Methane has been recorded as nil or up to 0.1 % during all four rounds in all three boreholes which is below the initial screening criteria of 1 %. However, the Lower Explosion Limit of up to 18.9 % in BH541 is noted. Given the lack of correlation between methane concentration per volume and per LEL, it is considered these marginal readings to be caused by equipment inaccuracy rather than representative of the presence of actual methane gas. Further monitoring is recommended to confirm gas regime.
- Carbon dioxide is identified between 0 and 1 %, below the screening criteria of 5 % in BH539 and BH541. However, in BH542 carbon dioxide is identified in concentrations up to 6.6 %, above that of the screening criteria.
- Traces of Volatile Organic Compounds of up to 6 ppm have been recorded in BH539 and BH541. BH542 records VOCs of up to 14.6 ppm.
- Hydrogen sulphide was undetected throughout all monitoring rounds.
- Carbon monoxide was recorded as generally absent on all rounds for BH539. BH542 recorded up to 13 ppm. The first round for BH541 identified a maximum of up to 64 ppm, falling to 1 ppm on the second round and nil on the following two rounds. The maximum recorded concentration is above the screening criteria of 30 ppm. Given the obvious falling trend and absence of obvious source, this is considered to be likely caused by the well installation works rather indicative of carbon monoxide flux within the soils.
- Oxygen has been recorded at ambient levels with concentrations between 19.2 and 20.7 % in BH539 and BH541. It is recorded at low concentrations of between 0.2 and 11.4 % in BH542.

8.6.2 On the basis of the above, offsite boreholes have not identified obvious ground gas sources.

8.6.3 A gas risk assessment has been undertaken and is set out within the Land Contamination Assessment Report (Appendix 11.1 of the ES). Given the lack of any significant gas source being identified, a summary of potential causes of abnormal gas concentrations is provided below:

- elevated CO concentrations may be attributed to ambient vehicle emissions;
- depleted O₂ levels may be the result of natural biological activity;
- low level VOCs may be considered naturally occurring.

8.6.4 The gas regime and nature of the backfill materials within the Site remain unknown and ground investigation to include ground gas monitoring is recommended to confirm possible risks.

8.7 Summary

- 8.7.1** The quality of the perched groundwater within the Head Deposits and the aquifer within the sandstone are similar and are shown to have been impacted by metals and inorganics (data from within 100 m from the Site).
- 8.7.2** A Linkage between the perched groundwater and the aquifer within the Tintern Sandstone formation is inferred.
- 8.7.3** The quality in these groundwater bodies are representative of the general baseline conditions seen in this area of Newport as defined within the Baseline Water Environment Report (RPS, 2015). Although no obvious impacts from the Site are identified, the monitoring points are considered to be located upgradient and therefore, may not provide a clear line of evidence. Ground investigation within the Site is recommended to verify possible risks.
- 8.7.4** Offsite boreholes screened within the Head Deposits and Tintern Sandstone Formation have indicated no obvious ground gas source however gas data from the previous ground investigations is not available for the Site itself.

9 Refined Conceptual Site Model

- 9.1.1** The incorporation of data from the 2015 Supplementary Ground Investigation has enabled the original CSM presented in the 2014 PSSR to be updated. The assessment is based on the Scheme during construction and operational phases.
- 9.1.2** A CSM representing general ground conditions, overall Scheme layout and relevant source-pathway-receptors (each of which having a specific alpha-numerical symbol attached) is presented in Figure 2 and is described in Table 12.

Table 12: Site Conceptual Model

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
Quarry in-fill materials. Details not known	Construction					
	Construction Workers (C)	Direct dermal (1)	Likely	Moderate	Moderate	Construction workers may be exposed to the infill materials during Site construction works; however exposure duration will be short term only. Use of PPE and good hygiene practice throughout earthworks and construction phase is considered sufficient to mitigate risks presented.
		Ingestion (3)	Likely	Moderate	Moderate	Current land contamination status at the Site is unknown but not foreseen to represent abnormal constraints to construction worker's health and safety over and above those typical of a brownfield Site.
		Inhalation of soil dust (2)	Likely	Moderate	Moderate	Dust suppression measures are recommended during construction works. Construction workers may be exposed to ground gas potentially generated by the quarry in-fill materials during the excavation and ground improvement works.
		Inhalation of ground gas or vapour (2)	Likely	Moderate	Moderate	No onsite ground gas data is available. Gas monitoring from nearby offsite boreholes indicates the presence of low concentrations of VOCs and occasional slightly elevated carbon dioxide, with no obvious gas source identified. Ground investigation, ground gas monitoring and soil testing is required to confirm the characteristics of the infill materials and their associated risks. offsite

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Offsite users / Barecroft Common residents (B)	Dermal contact with soil dust (1)	Low	Moderate	Moderate to low	Current land contamination status at the Site is unknown.
		Ingestion of soil dust (3)	Low	Moderate	Moderate to low	During construction there is the possibility of Site neighbours/general public inhaling soil dust. Short term exposure only.
		Inhalation of soil dust (2)	Low	Moderate	Moderate to low	Dust suppression measures are recommended during construction works. Potential for lateral gas migration through bedrock.
		Inhalation of ground gas or vapour (2)	Low	Moderate	Moderate to low	Ground investigation, ground gas monitoring and soil testing is required to confirm the characteristic of the infill materials and their associated risks.
	Groundwater (Principal Aquifer) (Da)	Leaching/migration of contaminants from backfill materials to groundwater (4)	Low likelihood	Moderate	Moderate to low	The elevation of the quarry base in relation to the water table is unknown and therefore there is a risk of the infill materials being within the groundwater zone. During the embankment construction there is a risk for potential contaminants to be mobilised and migrate to groundwater. Ground improvement techniques may be used to improve geotechnical properties of the infill material. Taking care not to create new/increase vertical pathways. Foundation works risk assessment would be required on confirmation of ground improvement method. Ground investigation is required to confirm the characteristics of the infill materials and their associated risks.
Onsite Quarry in-fill materials. Details not known	Operational					
	Maintenance Workers (C)	Direct dermal contact (1)	Low	Low	Very low	Current land contamination status at the Site is unknown.
		Ingestion (3)	Low	Low	Very low	Infill material within the footprint of the

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
		Inhalation of soil dust (2)	Low	Low	Very low	<p>embankment will be encapsulated and therefore the exposure to contamination will be limited outside of the motorway embankment (outside land take). Areas outside the motorway hardstanding are likely to have topsoil cover and vegetation establishment, reducing the potential for exposure.</p> <p>Exposure duration will be short term only. Site specific risk assessments will be required in line with health and safety guidance. This will enable safe methodologies and appropriate levels of PPE to be put in place. As such all significant risks will be duly considered and suitably mitigated.</p> <p>Additional investigation and soil testing is required to confirm the characteristics of the infill materials and their associated risks.</p> <p>Current contamination status is not foreseen to represent abnormal constraints to maintenance worker's health and safety over and above those typical of a brownfield site.</p>
		Inhalation of ground gas or vapours (2)	Low	Low	Very low	<p>No onsite ground gas data is available. Gas monitoring from nearby offsite boreholes indicates the presence of low concentrations of VOCs and carbon dioxide, with no obvious gas source identified.</p> <p>Additional investigation and soil testing required to confirm the characteristic of the infill materials and associated risks.</p>

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Future Motorway users (A) & Offsite users / Barecroft Common residents) (B)	Direct Dermal contact (1)	Unlikely	Low	Very low	Current land contamination status at the Site is unknown. Infill material within Scheme footprint to be encapsulated by the embankment and therefore the exposure to contamination will be limited outside the motorway embankment.
		Ingestion (3)	Unlikely	Low	Very low	Areas outside embankment also outside permanent land take. Dermal, inhalation and ingestion pathways associated to soil dust only.
		Inhalation of soil dust (2)	Unlikely	Low	Very low	Areas outside the motorway hardstanding are likely to have topsoil cover and vegetation establishment, reducing the potential for exposure. Off site receptors are located some 100 m from the proposed earthworks. offsite
	Future Motorway users (A)	Inhalation of ground gas or vapours (2)	Low	Low	Very low	No onsite ground gas data is available. Gas monitoring from nearby offsite boreholes indicates the presence of low concentrations of VOCs and carbon dioxide, possibly generated by the infill materials. Motorway end users to be within open space. Proposed 13 m high embankment and limited span over landfill associated with unlikely vertical gas migration. Additional investigation required to confirm the characteristic of the infill materials and associated risks.

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Offsite users / Barecroft Common residents) (B)	Inhalation of ground gas or vapours (2)	Low	Low	Very low	No onsite ground gas data. Gas monitoring from nearby offsite boreholes indicates presence of low concentrations of VOCs and carbon dioxide, possibly generated by the infill materials. Part of the landfill to be capped with embankment possibly increasing lateral ground gas migration. Additional investigation required to confirm the characteristic of the infill materials and associated risks.
	Groundwater - Aquifer (Da) within Tintern Sandstone formation	Leaching/migration (4) of contamination in infill materials	Low likelihood	Moderate	Moderate to low	The elevation of the quarry base in relation to the water table is unknown and therefore, there is a risk of the infill materials being within the groundwater zone. Ground improvement techniques may be used to improve geotechnical properties of the infill material taking care not to create new/increase vertical pathways. Foundation works risk assessment would be required on confirmation of ground improvement method. Ground investigation is required to confirm the characteristics of the infill materials and their associated risks.

10 Conclusions and Recommendations

10.1 Conclusions

- 10.1.1** No previous ground investigations have been undertaken at the Site, however, based on the desk study information, gross contamination is not anticipated.
- 10.1.2** During the construction phase, specific mitigation measures will be required to prevent inhalation pathways of dust to the general public off site and work force receptors, although such measures would be no more than typically expected on a construction site.
- 10.1.3** There is no analytical data specific to the Site that falls within the footprint of the motorway corridor or wider permanent land take.

10.2 Recommendations

- 10.2.1** Given the identified gap in the data and in order to verify the risk levels associated with the Site in relation to construction and operational phases, a scope of ground investigation works is required. Upon completion this report shall be reviewed and updated accordingly once the findings of the additional investigation are made available. The additional investigation will include:
- advancement of boreholes to collect soil samples;
 - installation of monitoring wells;
 - collection of groundwater samples; and
 - gas monitoring.
- 10.2.2** Upon review and assessment of the recommended ground investigation information, any contamination identified that could cause an unacceptable risk to the identified receptors will require appropriate remedial mitigation measures to be implemented. These measures would be identified within a remedial strategy for the Scheme. The remediation strategy is anticipated to include, but is not limited to:
- Addressing uncertain human health and controlled waters risk identified by the proposed ground investigation.
 - Risk assessment relating to ground improvement creating pathways enabling contaminants to enter surface water courses.
 - Dealing with unexpected contamination.
 - Control measures (over and above good practice construction management) to prevent risks to construction workers and the general public during construction.
 - Verification of material used as topsoil for suitability of use.
- 10.2.3** The remediation strategy should include a remediation options appraisal, remediation implementation plan and remediation verification plan. The remediation strategy should be supported by a Scheme wide Material Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

11 References

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RPS (2015) M4 Corridor Around Newport, Baseline Water Environment Report, M4CaN-DJV-EWE-ZG_GEN-RP-EN-0003

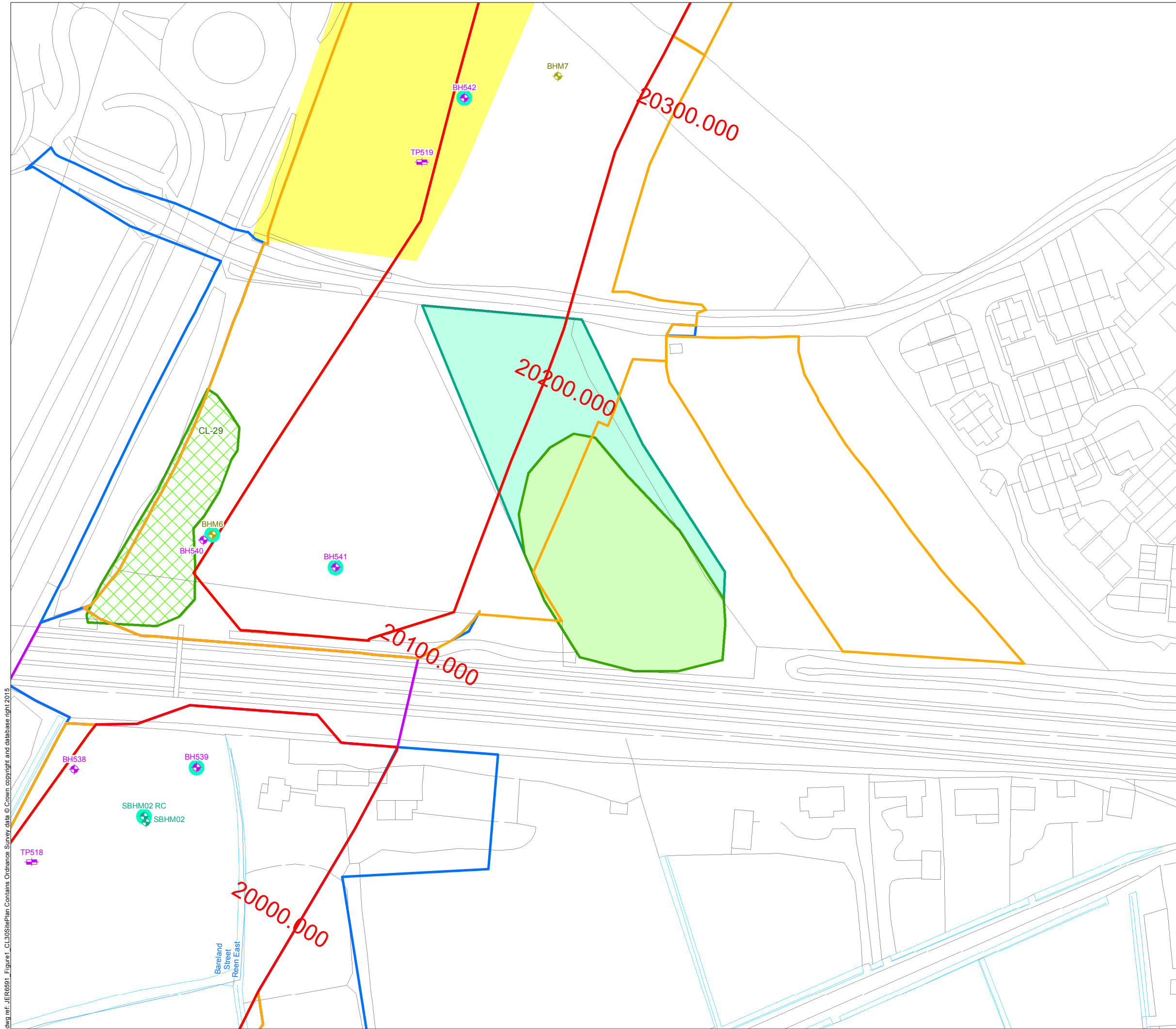
12 Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection
mAOD	Metres Above Ordnance Datum

mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O ₂	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures

dwg ref: JER6591_Figure1_CL30SitePlan Contains Ordnance Survey data © Crown copyright and database right 2015



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Potential Borrow Pit Area
- Potential Area of Land Contamination based on 2014 PSSR
- Revised Potential Area of Land Contamination
- Other Potential Area of Land Contamination

Investigation Locations

2015 (Geotechnical Engineering)

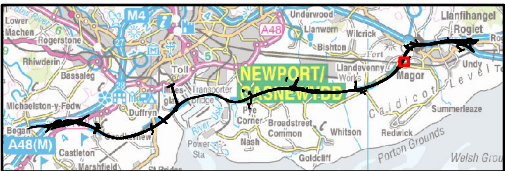
- Borehole
- Trial Pit

2007 (Norwest Holst)

- Borehole

1997 (Norwest Holst)

- Borehole
- Monitoring Well Installation



Llywodraeth Cymru
Welsh Government

Appendix 11.1 Annex D CL-30








Site Plan for CL-30

Figure: 1	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB


Scale: A3 @ 1:1,250
0 20 40 m







Legend

-  Topsoil
-  Infill Material
-  River Terrace Deposits - RTD
-  Tintern Sandstone - TS
-  Proposed Embankment
-  Groundwater (TS)
-  Gas Migration Pathway

Potential Receptors

-  Humans On-Site (M4 User)
-  Humans Off-Site (Site Neighbours)
-  Humans On-Site (Construction/Maintenance)
-  Groundwater (Aquifer)

Potential Pathways

-  Dermal Contact
-  Inhalation
-  Ingestion
-  Leaching / Migration

Potential Sources of Contamination

Possible contamination present on site associated with :

On-Site

- Infill materials
- Impacted groundwater
- Ground gas / leachate

NOTE
Drawing refined from PSSR Drawing Reference
M4-OA-17-00DR-Z-XX-0136 (January 2014)



Appendix 11.1 Annex D CL-30

Conceptual Site Model for CL-30

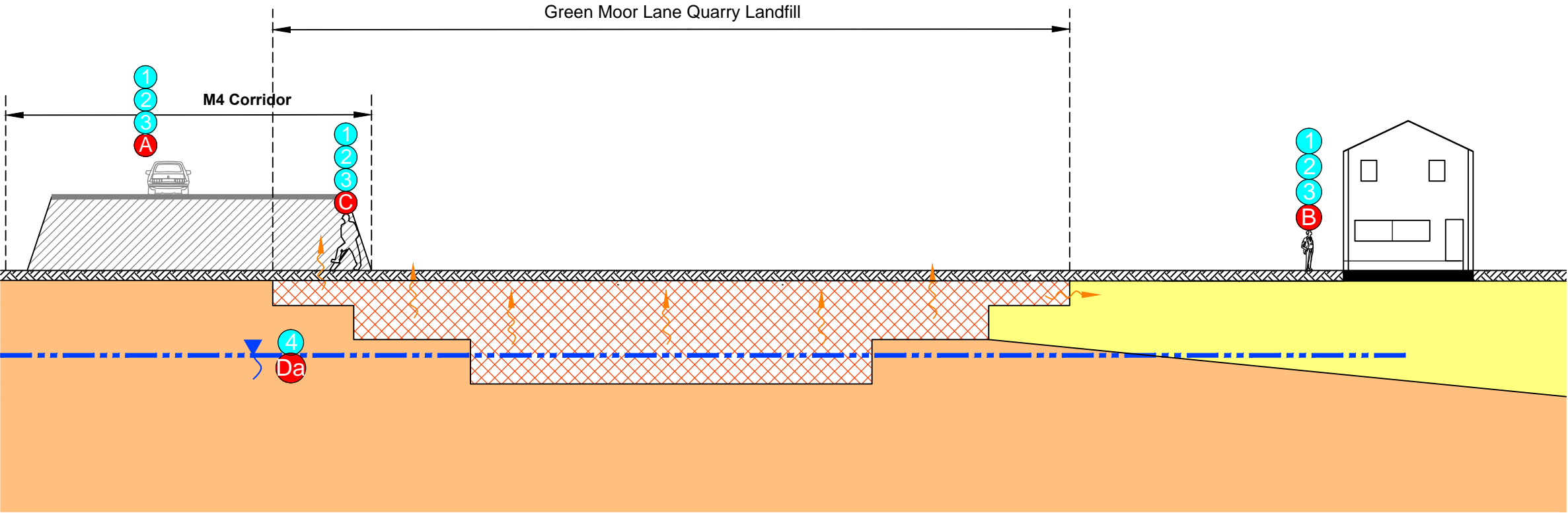
Figure: 2	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Not to Scale

Ground conditions based
on available information

dwg ref: JER6591_Figure2_CL30ConceptualSiteModel

CL-30 Green Moor Lane Quarry Landfill



Appendices

Appendix 1

Exploratory Records



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHM6

Header

Contract No.	F10895	Method	Rotary Coring	Coordinates	341586.8 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187014.0 N
Client	Welsh Office	Driller	E.D	Ground Level	11.10m AOD
		Logged by	T.R/C.D	Orientation	Vertical
Consultant	Ove Arup and Partners	Core barrel	P	Date Started	11/11/1997
		Core bit	Saw Tooth	Date Completed	11/11/1997

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
11/11/1997	1800	10.00	2.50	4.21		0.00 2.00	2.00 10.00	mist mist	100% 100%	0* 92

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
120	10.00	140	2.50	11/11/1997	0000	6.50	0.00	0		2.50	0.00

GENERAL NOTES						SPT DETAILS		
						Depth	Type	Incremental blow count/penetration in mm
						1.00	S	N=25 (5,5,9,8,5,3)
						2.00	C	50/15mm (13,12,50)
						3.00	C	51/231mm (1,1,11,2,8,30)
						5.60	C	50/75mm*

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes.

Form ROTARY HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHM6

Sheet 1 of 1

Contract No.	F10895	Method	Rotary Coring	Coordinates	341586.8 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187014.0 N
Client	Welsh Office	Driller	E.D	Ground Level	11.10m AOD
Consultant	Ove Arup and Partners	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	11/11/1997
		Core bit	Saw Tooth	Date Completed	11/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
TOPSOIL		0.10	11.00							
Brown sandstone cobbles in CLAY (drillers description). (Head Deposits)		0.61	10.49							
Weathered SANDSTONE clayey (drillers description). (Tintern Sandstone)									25	1.00 1.45
									C50/15mm	2.00 2.17
		2.50	8.60	2.00 2.50	40	0	0	NI		
Greyish green fine to coarse grained thinly to medium sub-horizontally bedded occasionally thinly and thickly laminated SANDSTONE, strong completely fractured. (Tintern Sandstone)				2.50 3.00	36	0	0	NI	C51/231mm	3.00 3.38
				3.00 3.50	40	0	0	NI		
		3.50	7.60	3.50 4.00	46	10	0	NI		
Reddish brown fine to coarse grained medium sub-horizontally bedded slightly to moderately weathered micaceous SANDSTONE, strong with medium spaced very thin beds of fine gravelly sandstone and closely to medium spaced inclined discontinuities planar rough tight. (Tintern Sandstone)				4.00 4.60	92	83	28	4		
---from 3.50 to 4.00m completely fractured										
---from 4.60 to 4.75m completely fractured				4.60 5.60	10	0	0	NI	C50/75mm*	5.60 5.68
---from 5.60 to 5.75m completely fractured										
---from 6.00 to 6.50m sub-vertical fracture (075°) planar rough tight				6.00 6.50	100	96	0	5		
---from 6.50 to 6.75m moderately weathered		6.50	4.60							
Reddish brown to greyish green fine to medium grained thinly to medium sub-horizontally bedded slightly to moderately weathered micaceous SANDSTONE, moderately strong to strong with closely spaced very thin interbedding of reddish brown mottled grey mudstone with closely to medium spaced sub-horizontal discontinuities planar rough tight. (Tintern Sandstone)				6.50 8.00	100	93	21	12		
---from 7.00 to 7.25m sub-vertical fracture (065°) planar rough tight								6		
---from 7.35 to 7.60m sub-vertical fracture (065°) planar rough tight		8.00	3.10	8.00 9.50	100	97	79	11		
SANDSTONE As Sheet 2				9.50 10.00	90	80	0	5		
Rotary drilling complete at 10.00 m.		10.00	1.10							

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH ROTARY LOG
Version	1.00
Revised	16/09/96

Form	NH ROTARY LOG
Version	1.00
Revised	16/09/96



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHM7

Header

Contract No.	F10895	Method	Cable Percussion	Coordinates	341704.6 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon	Ground Level	187170.2 N
Client	Welsh Office	Driller	ID	Orientation	23.80m AOD
Consultant	Ove Arup and Partners	Logged by	C.D	Date Started	Vertical
				Date Completed	21/10/1997

PROGRESS						DRILLING DETAILS			
Date	Time	Hole depth	Casing depth	Water depth	Remarks	Hardbore from depth	Hardbore to depth	Chiselling hours	Remarks
21/10/1997	0000	2.60	1.50	Dry		2.30	2.60	1.00	

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
150	2.60	150	1.50								

GENERAL NOTES					SPT DETAILS		
					Depth	Type	Incremental blow count/penetration in mm
					1.50	S	N=73 (5,7,13,15,19,26)
					2.30	S	50/50mm*
					* Seating blows only.		

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes, chiselling time in hours.

Form CP HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHM7

Sheet 1 of 1

Contract No.	F10895	Method	Cable Percussion	Coordinates	341704.6 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pileon		187170.2 N
Client	Welsh Office	Driller	I.D	Ground Level	23.80m AOD
Consultant	Ove Arup and Partners	Logged by	C.D	Orientation	Vertical
				Date Started	21/10/1997
				Date Completed	21/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Install- ation
TOPSOIL		0.40	23.40				
Stiff brown sandy CLAY (drillers description). (River Terrace)		0.60	23.20	U 0.50 - 1.00	(62)		
Yellowish brown mottled light reddish brown occasionally thinly laminated micaceous silty clayey fine and medium SAND. (River Terrace)		1.50	22.30	D 1.20 B 1.50 - 2.00 D 1.50	S73	S 1.50 1.95	
Light yellowish grey brown fine and medium grained thinly laminated highly to completely weathered micaceous silty SANDSTONE, very weak to weak with occasional orange iron staining along discontinuities. (Tintern Sandstone)		2.60	21.20	D 2.20 D 2.30	S50/50mm*	S 2.30 2.35	
---from 2.20m weak							
Cable Percussion boring complete at 2.60 m.							

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water
strikes. See legend sheet for key to symbols.

Form	NH CP LOG
Version	2.00
Revised	19/12/1996

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH539

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 6 March 2015 Easting 341581.4

Scale 1 : 50

End Date 9 March 2015 Northing 186934.6 Ground level 6.35mOD

Depth 14.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
06/03/15 0900hrs	1B 2D* 3B 4D*	0.20 - 0.50 0.20 - 0.50 0.50 - 1.00 0.50 - 0.10		Vo 0.0 Vo 0.0				Grass over very soft reddish brown sandy gravelly CLAY. Gravel is rounded fine and medium quartz. (TFD)			
	5B 6D* 7D 8X 9D*	1.00 - 1.20 1.00 - 1.20 1.20 - 1.65 1.20 - 2.20 1.30 - 1.40		Vo 0.3 S 3				Very soft light brown slightly gravelly very sandy CLAY. Gravel is rounded fine and medium quartz. (TFD)	1.60	4.75	
	10D 11X 12D*	2.20 - 2.65 2.20 - 3.20 2.30 - 2.40		Nil S 6				2.20 - 2.35m: Soft. Loose light brown clayey fine SAND. (TSG)	2.35	4.00	
	13D 14X 15D*	3.20 - 3.65 3.20 - 3.90 3.30 - 3.40		Nil S 20				Light brown clayey gravelly fine and medium SAND with rare lenses (up to 5mmx5mm) of bluish grey fine sand. Gravel is subrounded fine and medium sandstone. (TSG)	3.10	3.25	
	16D 17C	3.90 - 4.19 3.90 - 4.90	3.90	S*100	89 0 0			Medium dense reddish brown clayey silty fine and medium SAND with rare lenses (up to 5x5mm) of bluish grey sand. (TSG) 3.90m: Very dense.	4.40	1.95	
	18C	4.90 - 5.03 4.90 - 6.40	3.90	C*200	100 0 0		NA	Bluish grey silty fine and medium SAND. (TSG)	4.80	1.55	
	19C	6.40 - 7.90	3.90		100 26 18	50 100 140	NI	Weak and medium strong bluish grey fine and medium SANDSTONE. Fractures are subhorizontal to 20° and 60-70° extremely closely spaced undulating and stepped smooth. (TSG)	6.40	-0.05	
							NI	Very weak reddish brown fine and medium SANDSTONE. Fractures are subhorizontal to 20° and 70° very closely and closely spaced undulating rough with a veneer of reddish brown clay. (TSG)	6.80	-0.45	
							NI	Reddish brown fine and medium SANDSTONE recovered non intact as slightly clayey sandy angular and subangular and fine to coarse sandstone gravel. (TSG)	7.50	-1.15	
							NI	7.50m: 20° fracture undulating rough infilled (up to 2mm) with reddish brown clay.	7.85	-1.50	
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Dynamic sampled (128mm) 1.20-3.20m, (113mm) 3.20-3.90m. Waterflush rotary core drilled (116mm) 3.90-14.20m.

CASING: 140mm diam to 6.40m.

BACKFILL: On completion, a slotted standpipe (50mm) with geo-sock was installed to 14.00m, granular response zone 14.20-5.00m and bentonite seal 5.00-3.00m. A second slotted standpipe (35mm) with geo-sock was installed to 3.00m, granular response zone 3.00-1.00m, bentonite seal 1.00-0.20m, concrete and stopcock cover 0.20-0.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
1.20	Nil	1.00	20	


CONTRACT
30238
CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH539

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 6 March 2015 Easting 341581.4

Scale 1 : 50

End Date 9 March 2015 Northing 186934.6 Ground level 6.35mOD

Depth 14.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	I _f	instru- ment	description	depth (m)	reduced level (m)	legend					
06/03/15 1550hrs 1.30m	20C	7.90 - 8.50	3.90		100 0 0			Bluish grey fine and medium SANDSTONE recovered non intact as clayey very sandy angular and subangular fine and medium sandstone gravel. (TSG)	8.50	-2.15						
	21C	8.50 - 8.80	3.90		100 0 0	NI		Weak reddish brown MUDSTONE recovered non intact as slightly clayey slightly sandy angular and subangular medium and coarse gravel. (TSG)	8.80	-2.45						
	09/03/15 0850hrs 1.10m	22C	8.80 - 8.90	3.90		100 0 0		NI	Light bluish grey mottled reddish brown MUDSTONE recovered non intact as slightly clayey slightly sandy subangular fine to coarse gravel. (TSG)	9.45		-3.10				
		23C	8.90 - 10.00	6.40		100 0 0			Medium strong thinly laminated light bluish grey coarse SANDSTONE. Fractures are 20° extremely closely spaced undulating smooth with rare calcite crystals (up to 2mm). (TSG)							
09/03/15 1415hrs 1.90m	24C	10.00 - 11.20	6.40		100 49 32			Medium strong thinly laminated reddish brown coarse micaceous SANDSTONE with frequent greenish grey reduction spots (up to 30mm). Fractures are subhorizontal to 20° and 70° to subvertical extremely closely spaced undulating and stepped rough with a veneer of reddish brown clay. (TSG)	10.80	-4.45						
					NA			Medium strong thinly laminated reddish brown coarse micaceous SANDSTONE with frequent greenish grey reduction spots (up to 30mm). Fractures are subhorizontal to 20° and 70° to subvertical extremely closely spaced undulating and stepped rough with a veneer of reddish brown clay. (TSG)	11.20	-4.85						
	25C	11.20 - 12.70	6.40		100 43 30	55		Stiff fissured reddish brown slightly sandy silty CLAY with localised bluish grey reduction spots (up to 30mm). (TSG)	11.85	-5.50						
					80 200 340			Strong thickly laminated light bluish grey fine to coarse SANDSTONE with frequent rounded medium and coarse gravel sized quartz inclusions. (TSG) 11.65 - 11.85m: Reddish brown.								
					26C	12.70 - 14.20		6.40		100 90 77		30 140 300		Weak thinly laminated off-white mottled dark grey fine to coarse SANDSTONE. Fractures are subhorizontal to 20° and 60° to subvertical closely and medium spaced undulating rough with reddish brown clay veneer. (TSG) 12.60 - 12.70m: Reddish brown.	12.70	-6.35
										Weak and medium strong thinly laminated greenish grey fine to coarse SANDSTONE with frequent subangular to rounded fine to coarse gravel sized quartz and quartzite inclusions. Fractures are subhorizontal to 20° very closely to medium spaced undulating smooth. (TSG)						
									14.20	-7.85						
								Borehole completed at 14.20m.								
									{18.00}							
water strike (m) casing (m) rose to (m) time to rise (m) remarks																
									AGS		CONTRACT 30238	CHECKED EC				

BOREHOLE LOG



CLIENT WELSH GOVERNMENT

BH540

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 24 March 2015 Easting 341583.7

Scale 1 : 50

End Date 25 March 2015 Northing 187012.1 Ground level 10.85mOD

Depth 11.60 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
24/03/15 1000hrs	1B	0.20 - 0.50		Vo 0.4				Grass over brown sandy gravelly SILT. Gravel is subangular and subrounded fine to coarse sandstone. (HDD)	0.50	10.35	X
	2D*	0.20 - 0.50									X
	3B	0.50 - 1.00		Vo 5.1							X
	4D*	0.50 - 1.00						Brown and yellowish grey clayey sandy subangular and subrounded fine to coarse sandstone GRAVEL with a high subangular sandstone cobble content. (HDD)	1.00	9.85	X
	5C	1.00 - 1.50			60 0 0	NI		Limited recovery. Medium strong yellowish grey medium and coarse SANDSTONE recovered non intact. (TSG)			
	6C	1.50 - 1.88 1.50 - 2.00	1.40	C*67	70 0 0						
	7C	2.00 - 2.50			60 8 0						
	8C	2.50 - 2.86	1.40	C*71					2.50	8.35	
	9D*	2.50 - 3.00 2.50 - 2.60			90	NA		Hard reddish brown slightly sandy silty CLAY. (TSG)	2.75	8.10	X
	10C	3.00 - 4.50	1.40		43 3 0	NI		Thickly laminated reddish brown and greenish grey clayey fine to coarse micaceous SAND. (TSG)	2.90	7.95	X
								Limited recovery. Weak to medium strong yellowish grey medium and coarse SANDSTONE. Recovered non intact. (TSG)			
	11C	4.50 - 4.67 4.50 - 5.60	1.40	C*750	82 35 12	NI 50 130		Weak to medium strong reddish brown medium and coarse siliceous SANDSTONE. Fractures are subhorizontal, 50° and 70° very closely and closely spaced planar rough. (TSG)	4.50	6.35	
	12C	5.60 - 7.10	1.40		93 65 37	60 100 260		Weak reddish grey medium and coarse siliceous SANDSTONE. Fractures are subhorizontal and 50° closely and medium spaced planar rough. (TSG)	5.55	5.30	
	13C	7.10 - 8.60	1.40		20 50 110	120		Medium strong reddish brown fine and medium SANDSTONE. Fractures are subhorizontal and 20° very closely and closely spaced planar smooth. (TSG)	6.35	4.50	
					97 97 59	25 120 270		Medium strong reddish brown medium and coarse SANDSTONE with frequent subrounded and rounded fine and medium gravel sized inclusions of quartzite and mudstone. Fractures are subhorizontal and 20° closely spaced undulating rough. (TSG)	6.80	4.05	
									7.05	3.80	
								Continued Next Page	{8.00}		

EQUIPMENT: Comacchio MC205 rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Waterflush rotary core drilled (116mm) 1.00-11.60m.

CASING: 140mm diam to 1.40m.

BACKFILL: On completion, hole backfilled with bentonite pellets.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
30238CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH540

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 24 March 2015 Easting 341583.7

Scale 1 : 50

End Date 25 March 2015 Northing 187012.1 Ground level 10.85mOD

Depth 11.60 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
24/03/15 1640hrs 3.60m	14C	8.60 - 10.10	1.40		79 73 48			Weak to strong thinly bedded reddish brown locally greenish grey fine and medium SANDSTONE. Fractures are subhorizontal and 20° very closely to medium spaced planar smooth. (TSG)			
25/03/15 0845hrs 3.50m											
	15C	10.10 - 11.60	1.40		90 80 37			9.15 - 9.80m: Fractures are 20°, 40° and 70° closely spaced planar smooth. 9.80 - 10.45m: Fractures are subhorizontal, 20° and 70° closely and medium spaced planar smooth. 9.90 - 10.05m: Greenish grey. 10.45 - 11.60m: Fractures are subhorizontal, 20° and 70° closely and medium spaced undulating rough. 10.70 - 11.50m: Greenish grey. 10.80 - 10.90m: Non-intact.			
25/03/15 1030hrs 3.60m									11.60	-0.75	
								Borehole completed at 11.60m.			
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BH541

CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date	26 March 2014	Easting	341628.8
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Scale 1 : 50

End Date	30 March 2015	Northing	187002.9	Ground level	11.35mOD
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Depth 11.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
26/03/15 1445hrs	1B 2D* 3B 4D* 5B 6D* 7D 8X	0.20 - 0.60 0.20 - 0.60 0.60 - 0.80 0.60 - 0.80 0.80 - 1.00 0.80 - 1.00 1.00 - 1.43 1.00 - 1.30		Vo 2.2 Vo 3.4 Vo 3.2 S*57				Grass over reddish brown slightly gravelly silty fine and medium SAND with rare rootlets (up to 2mm diam). Gravel is rounded and well rounded medium and coarse quartzite. (HDD)	0.50	10.85	
	9C	1.30 - 2.00	1.30	Nil Nil	79 21 0	NI 70 120		Dark reddish grey slightly gravelly fine to coarse SAND with a low angular sandstone cobble content. Gravel is angular and subangular fine to coarse sandstone. (HDD) 0.80 - 1.00m: Gravelly.	1.30	10.05	
	10C	2.00 - 2.26 2.00 - 3.50	1.30	C*143	100 52 24			Weak to medium strong very thinly bedded yellowish grey SANDSTONE. Fractures are subhorizontal, subvertical and 20° very closely and closely spaced planar rough. (TSG)			
26/03/15 1700hrs 0.40m						NA			3.30	8.05	
27/03/15 0840hrs 0.60m	11C	3.50 - 3.83 3.50 - 5.00	3.20	C*83	97 31 13	20 90 190		Very stiff reddish brown slightly sandy clayey SILT with frequent angular medium and coarse gravel sized extremely weak siltstone lithorelicts. (TSG)	3.65	7.70	
						NI 20 50		Weak very thinly bedded locally cross bedded reddish brown and greenish grey fine and medium SANDSTONE. Fractures are subhorizontal and 20° very closely and closely spaced planar rough. (TSG)	4.20	7.15	
	12C	5.00 - 5.70	3.20		100 20 20	NI		3.90 - 4.00m: Hard thinly laminated reddish brown slightly sandy clayey silt.			
						30 80 120		Weak locally extremely weak very thinly bedded reddish brown and grey fine and medium SANDSTONE. Fractures are extremely closely and very closely spaced subhorizontal, 20°, 50°, 70° and subvertical undulating rough. Locally non intact. (TSG)	5.20	6.15	
	13C	5.70 - 7.00	3.20		100 68 24			Extremely weak thinly laminated reddish brown MUDSTONE. Non intact. (TSG)	5.55	5.80	
								Very weak locally strong very thinly bedded reddish brown locally greenish grey fine and medium SANDSTONE. Fractures are subhorizontal, 20°, 70° and subvertical very closely and closely spaced undulating and planar rough. (TSG)			
	14C	7.00 - 8.50	3.20		97 59 31	40 90 240			7.40	3.95	
								Weak very thinly bedded reddish brown and greenish grey fine and medium SANDSTONE. Fractures are subhorizontal, 50°, 70° and subvertical very closely and			
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Dynamic sampled (113mm) 1.00-1.30m. Waterflush rotary core drilled (116mm) 1.30-11.50m.

CASING: 140mm diam to 3.20m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 11.50m, granular response zone 11.50-2.00m, bentonite seal 2.00-0.30m, concrete and raised helmet cover 0.30-0.00m.

REMARKS: Driller noted reduced flush returns 1.30-5.70m (60-80% returned) and loss of flush 5.70-11.50m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
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Groundwater not encountered prior to use of water
flush



CONTRACT

30238

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BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH541

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 26 March 2014 Easting 341628.8

Scale 1 : 50

End Date 30 March 2015 Northing 187002.9 Ground level 11.35mOD

Depth 11.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
								closely spaced planar rough. (TSG) 8.05 - 8.10m: Cross bedded.			
	15C	8.50 - 8.90	3.20		75 30 30	100 NI 40 90			8.65 8.75	2.70 2.60	
	16C	8.90 - 10.00	3.20		91 7 0			Medium strong reddish brown (80% clast supported) subangular and subrounded fine and medium gravel sized clasts of mudstone and sandstone CONGLOMERATE. (TSG)			
27/03/15 1630hrs 6.30m								Extremely weak to weak thinly interbedded reddish brown and greenish grey MUDSTONE and SANDSTONE locally with clay infill (up to 5mm) along subhorizontal fractures. Fractures are subhorizontal, 70° and subvertical extremely closely and very closely spaced undulating and planar rough. Locally non intact. (TSG)			
30/03/15 0840hrs 6.90m	17C	10.00 - 11.00	3.20		100 38 0	20 70 95		Weak thinly laminated reddish brown locally greenish grey SILTSTONE. Fractures are subhorizontal, subvertical and 50° very closely and closely spaced undulating rough. (TSG)	10.30	1.05	
30/03/15 1310hrs 6.80m	18C	11.00 - 11.50	3.20		100 18 0	20 30 50		Medium strong greenish grey medium and coarse SANDSTONE. Fractures are 20° and 80° very closely spaced undulating rough. (TSG)	11.15 11.50	0.20 -0.15	
								Borehole completed at 11.50m.			
									{18.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks Groundwater not encountered prior to use of water flush.											
									CONTRACT 30238		CHECKED EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH542

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 18 February 2015 Easting 341672.7

Scale 1 : 50

End Date 20 February 2015 Northing 187162.9 Ground level 23.15mOD

Depth 16.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
18/02/15 1420hrs	1B 2D* 3B 4D* 5B 6D* 7D 8X 9C	0.00 - 0.30 0.00 - 0.30 0.30 - 0.80 0.30 - 0.80 0.80 - 1.00 0.80 - 1.00 1.00 - 1.29 1.00 - 1.20 1.20 - 2.00		Vo 3.8 Vo 9.0 Vo 7.0 S*73 Nil				Dark brown silty gravelly CLAY with medium subangular sandstone cobble content and frequent plant fragments (up to 2mm). Gravel is subangular fine to coarse sandstone. (HDD)	0.30	22.85	
								Light brown and greenish grey sandy subangular fine to coarse sandstone GRAVEL with medium subangular sandstone cobble content. (HDD)	1.00	22.15	
								Yellowish brown mottled reddish brown clayey gravelly SAND. Gravel is subangular fine to coarse sandstone. (TSG)	1.20	21.95	
18/02/15 1700hrs 0.40m		2.00 - 2.05	1.20	C*429	50 0 0	NI		Strong greenish grey mottled purplish brown coarse SANDSTONE. Fractures are subhorizontal to 20° closely spaced planar rough. Recovered non-intact. (TSG)	2.00	21.15	
19/02/15 0900hrs 1.10m	10C	2.00 - 3.00			100 33 12	NI 70 200		Weak to medium strong yellowish brown mottled purplish brown medium SANDSTONE. Fractures are subhorizontal and 20° and 70° to subvertical very closely and closely spaced planar rough locally infilled (up to 10mm) with reddish brown sandy clay. (TSG)			
	11C	3.00 - 3.45 3.00 - 4.00	1.20 3.00	C 4	40 0 0			2.20 - 2.40m: 70° fracture. 3.00 - 4.00m: Limited recovery. Recovered non intact.			
	12C	4.00 - 4.32 4.00 - 5.00	3.00	C*88	100 5 0						
	13C	5.00 - 5.45 5.00 - 6.00	3.00	C 34	85 12 0	NA		Stiff orangish brown sandy gravelly CLAY. Gravel is subangular fine to coarse sandstone. (TSG)	5.00	18.15	
						NI		Medium strong purplish brown fine SANDSTONE. Fractures are subhorizontal to 20° and 70° to subvertical planar rough. (TSG)	5.50	17.65	
	14C	6.00 - 6.22 6.00 - 7.00	3.00	C*143	100 65 49	NI 60 230		5.90 - 6.00m: Purplish brown mottled yellow sandy clay.	6.00	17.15	
								Medium strong and strong purplish brown mottled greenish grey coarse SANDSTONE. Fractures are subhorizontal to 20° closely and medium spaced planar rough locally infilled (up to 2mm) with purplish brown sandy clay. (TSG)			
	15C	7.00 - 7.15 7.00 - 8.50	3.00	C*231	100 70 48	NI 90 250		Weak purplish brown mottled greenish grey coarse SANDSTONE. Fractures are subhorizontal to 20° closely and medium spaced planar rough locally infilled (up to 2mm) with reddish brown sandy clay. (TSG)	7.00	16.15	
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Dynamic sampled (113mm) 1.00-1.20m. Waterflush rotary core drilled (116mm) 1.20-16.00m.

CASING: 140mm diam to 6.00m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 16.00m, granular response zone 16.00-10.00m and bentonite seal 10.00-4.00m. A second slotted standpipe (35mm) was installed to 4.00m, granular response zone 4.00-1.00m, bentonite seal 1.00-0.20m, concrete and stopcock cover 0.20-0.00m.

REMARKS: Driller notes reduced flush returns 1.20-8.50m: 80-90% returned.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
30238CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH542

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 18 February 2015 Easting 341672.7

Scale 1 : 50

End Date 20 February 2015 Northing 187162.9 Ground level 23.15mOD

Depth 16.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
19/02/15 1630hrs 0.60m											
20/02/15 0840hrs 3.14m	16C	8.50 - 10.00	6.00		100 69 60						
	17C	10.00 - 11.50	6.00		100 66 20			10.55 - 10.65m: Recovered non intact.			
	18C	11.50 - 13.00	6.00		100 80 31	40 80 200		Strong purplish brown mottled greenish grey coarse SANDSTONE. Fractures are subhorizontal to 20° and 70° to subvertical closely spaced planar rough locally infilled (up to 2mm) with reddish brown sandy clay. Surfaces stained light grey. (TSG)	11.60	11.55	
	19C	13.00 - 14.50	6.00		100 86 75	NI 150 250		13.00 - 13.20m: Fine sandstone. 13.00 - 15.20m: Fractures are subhorizontal to 20°.			
	20C	14.50 - 16.00	6.00		100 76 74			15.20 - 15.35m: Recovered non intact.	15.35	7.80	
20/02/15 1630hrs 3.00m								Strong purplish brown mottled greenish grey fine SANDSTONE. Fractures are subhorizontal to 20° closely and medium spaced planar rough locally infilled (up to 2mm) with reddish brown sandy clay. (TSG)	16.00	7.15	
								Borehole completed at 16.00m.			
									{18.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks Groundwater not encountered prior to use of water flush.									CONTRACT 30238		CHECKED EC

Appendix 2

Gas and Groundwater Monitoring Data

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks		
BH539	24/03/15 10:30:00	1016	2								0.4	7		10 litres purged, base depth 3.00m.		
BH539	24/03/15 10:31:00										0.0					
BH539	24/03/15 10:32:00										0.0					
BH539	24/03/15 10:33:00										0.0					
BH539	24/03/15 10:34:00										0.0					
BH539	24/03/15 10:35:00			0.0	0.0	20.1	0.0	0	0	0.4						
BH539	24/03/15 10:36:00			0.0	0.0	20.0	0.0	0	0	0.2						
BH539	24/03/15 10:37:00			0.0	0.0	20.0	0.0	0	0	0.1				Upsurge at 3min 20sec. Unable to obtain further readings.		
BH539	24/03/15 10:44:00												0.56			
BH539	31/03/15 11:00:00	1017	-0.78								0.0	11			10 litres purged, base depth 3.00m.	
BH539	31/03/15 11:01:00													0.0		
BH539	31/03/15 11:02:00													0.0		
BH539	31/03/15 11:03:00													0.0		
BH539	31/03/15 11:04:00												0.0			
BH539	31/03/15 11:05:00			0.0	0.0	20.9	0.0	0	0	2.7						
BH539	31/03/15 11:06:00			0.0	0.0	20.9	0.0	0	0	2.6						
BH539	31/03/15 11:07:00			0.0	0.0	20.9	0.0	0	0	2.5				Upsurge at 3min 20sec. Unable to obtain further readings.		
BH539	31/03/15 11:14:00												0.71			
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238	CHECKED EC	



SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks						
BH539	16/04/15 09:02:00										0.0			8 litres purged, base depth 3.00m.						
BH539	16/04/15 09:03:00										0.0									
BH539	16/04/15 09:04:00										0.0									
BH539	16/04/15 09:05:00										0.4				0.1	20.2	1.0	0	1	4.7
BH539	16/04/15 09:06:00										0.4				0.1	20.2	1.0	0	0	4.7
BH539	16/04/15 09:07:00										0.3				0.1	20.2	1.0	0	0	4.4
BH539	16/04/15 09:14:00	1019	-0.75									1.06	Upsurge at 3min 20sec. Unable to obtain further readings.							
BH539	16/04/15 11:00:00																			
BH539	16/04/15 11:01:00																			
BH539	08/05/15 14:53:00	1002	7																	
BH539	08/05/15 14:54:00																			
BH539	08/05/15 14:55:00																			
BH539	08/05/15 14:56:00																			
BH539	08/05/15 14:57:00																			
BH539	08/05/15 14:58:00																			
BH539	08/05/15 14:59:00			0.0	0.0	20.3	0.0	0	0	0.0										
BH539	08/05/15 15:00:00			0.0	0.0	20.2	0.0	0	0	0.0										
BH539	08/05/15 15:01:00			0.0	0.0	20.2	0.0	0	0	0.0										
BH539	08/05/15 15:01:00			0.0	0.0	20.2	0.0	0	0	0.0										
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238	CHECKED EC					

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH539	08/05/15 15:02:00			0.0	0.0	20.2	0.0	0	0	0.0				
BH539	08/05/15 15:03:00			0.0	0.0	20.2	0.0	0	0	0.0				
BH539	08/05/15 15:04:00			0.0	0.0	20.2	0.0	0	0	0.0				
BH539	08/05/15 15:05:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH539	08/05/15 15:06:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH539	08/05/15 15:07:00			0.0	0.0	20.1	0.0	0	0	0.0				
BH539	08/05/15 15:08:00												2.03	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH539	24/03/15 10:44:00												1.09	77 litres purged, base depth 14.00m. 76 litres purged, base depth 14.00m. 74 litres purged, base depth 14.00m.	
BH539	31/03/15 11:14:00												1.23		
BH539	16/04/15 09:14:00												1.65		
BH539	08/05/15 15:09:00												3.39		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH541	31/03/15 13:00:00	1016	-0.49								0.0	14		28 litres purged, base depth 11.50m.	
BH541	31/03/15 13:01:00										0.0				
BH541	31/03/15 13:02:00										0.0				
BH541	31/03/15 13:03:00										0.0				
BH541	31/03/15 13:04:00										0.0				
BH541	31/03/15 13:05:00			0.3	0.0	20.1	0.0	0	64	4.2					
BH541	31/03/15 13:06:00			0.3	0.0	20.1	0.0	0	63	3.7					
BH541	31/03/15 13:07:00			0.3	0.0	20.0	0.0	0	62	3.1					
BH541	31/03/15 13:08:00			0.3	0.0	19.9	0.0	0	61	2.3					
BH541	31/03/15 13:09:00			0.3	0.0	19.9	0.0	0	61	2.6					
BH541	31/03/15 13:10:00			0.3	0.0	19.8	0.0	0	60	2.3					
BH541	31/03/15 13:11:00			0.3	0.0	19.8	0.0	0	58	2.1					
BH541	31/03/15 13:12:00			0.3	0.0	19.9	0.0	0	57	2.1					
BH541	31/03/15 13:13:00			0.3	0.0	20.0	0.0	0	55	1.9					
BH541	31/03/15 13:14:00			0.3	0.0	20.2	0.0	0	52	1.8			6.67		
BH541	16/04/15 14:15:00	1014	0.11								0.0	18		28 litres purged, base depth 11.50m.	
BH541	16/04/15 14:16:00										0.0				
BH541	16/04/15 14:17:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH541	16/04/15 14:18:00										0.0			
BH541	16/04/15 14:19:00										0.0			
BH541	16/04/15 14:20:00			0.8	0.1	19.5	2.0	0	1	6.0				
BH541	16/04/15 14:21:00			0.8	0.1	19.4	2.0	0	1	5.3				
BH541	16/04/15 14:22:00			0.9	0.1	19.4	2.0	0	1	4.4				
BH541	16/04/15 14:23:00			0.9	0.1	19.4	2.0	0	0	4.1				
BH541	16/04/15 14:24:00			0.9	0.1	19.4	2.0	0	1	3.7				
BH541	16/04/15 14:25:00			0.9	0.1	19.4	2.0	0	1	3.4				
BH541	16/04/15 14:26:00			0.9	0.1	19.3	2.0	0	1	3.2				
BH541	16/04/15 14:27:00			1.0	0.1	19.3	2.0	0	1	3.0				
BH541	16/04/15 14:28:00			1.0	0.1	19.2	2.0	0	1	2.7				
BH541	16/04/15 14:29:00			1.0	0.1	19.2	2.0	0	0	2.6			6.73	
BH541	21/04/15 11:00:00	1038	-0.81								0.0	13		28 litres purged, base depth 11.50m.
BH541	21/04/15 11:01:00										0.0			
BH541	21/04/15 11:02:00										0.0			
BH541	21/04/15 11:03:00										0.0			
BH541	21/04/15 11:04:00										0.0			
BH541	21/04/15 11:05:00			0.0	0.1	20.7	1.0	0	0	3.6				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH541	21/04/15 11:06:00	1017	0	0.0	0.1	20.7	1.0	0	0	3.1	0.0	15	6.71		
BH541	21/04/15 11:07:00			0.0	0.1	20.7	1.0	0	0	2.8					
BH541	21/04/15 11:08:00			0.1	0.1	20.6	1.0	0	0	2.7					
BH541	21/04/15 11:09:00			0.2	0.1	20.5	1.0	0	0	2.5					
BH541	21/04/15 11:10:00			0.4	0.1	20.4	1.0	0	0	2.3					
BH541	21/04/15 11:11:00			0.6	0.1	20.3	1.0	0	0	2.1					
BH541	21/04/15 11:12:00			0.6	0.1	20.2	1.0	0	0	2.1					
BH541	21/04/15 11:13:00			0.7	0.1	20.2	1.0	0	0	2.0					
BH541	21/04/15 11:14:00			0.7	0.1	20.2	1.0	0	0	1.9					
BH541	11/05/15 10:24:00														
BH541	11/05/15 10:25:00														
BH541	11/05/15 10:26:00														
BH541	11/05/15 10:27:00														
BH541	11/05/15 10:28:00														
BH541	11/05/15 10:29:00			0.0	0.0	20.1	0.0	0	0	0.0					
BH541	11/05/15 10:30:00			0.0	0.0	20.1	1.3	0	0	0.0					
BH541	11/05/15 10:31:00			0.0	0.0	20.1	7.0	0	0	0.0					
BH541	11/05/15 10:32:00			0.0	0.0	20.1	10.3	0	0	0.0					
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC

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GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH541	11/05/15 10:33:00			0.0	0.0	20.1	12.9	0	0	0.0				
BH541	11/05/15 10:34:00			0.0	0.0	20.1	15.0	0	0	0.0				
BH541	11/05/15 10:35:00			0.0	0.0	20.1	15.4	0	0	0.0				
BH541	11/05/15 10:36:00			0.0	0.0	20.1	18.9	0	0	0.0				
BH541	11/05/15 10:37:00			0.0	0.0	20.0	11.2	0	0	0.0				
BH541	11/05/15 10:38:00			0.0	0.0	20.0	0.0	0	0	0.0				
BH541	11/05/15 10:39:00												8.15	11.5
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	
													CHECKED EC	

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH542	24/03/15 12:30:00	1010	0								0.0	8		0 litres purged, base depth 4.00m.	
BH542	24/03/15 12:31:00										0.0				
BH542	24/03/15 12:32:00										0.0				
BH542	24/03/15 12:33:00										0.0				
BH542	24/03/15 12:34:00										0.0				
BH542	24/03/15 12:35:00			3.1	0.0	0.4	0.0	0	10	14.6					
BH542	24/03/15 12:36:00			3.4	0.0	0.2	0.0	0	10	13.7					
BH542	24/03/15 12:37:00			3.2	0.0	0.3	0.0	0	10	12.6					
BH542	24/03/15 12:38:00			3.5	0.0	0.6	0.0	0	10	10.9					
BH542	24/03/15 12:39:00			4.1	0.0	1.0	0.0	0	10	9.5					
BH542	24/03/15 12:40:00			4.4	0.0	1.5	0.0	0	10	7.5					
BH542	24/03/15 12:41:00			4.9	0.0	2.2	0.0	0	10	6.9					
BH542	24/03/15 12:42:00			5.0	0.0	2.9	0.0	0	13	5.2					
BH542	24/03/15 12:43:00			4.8	0.0	4.0	0.0	0	0	5.6					
BH542	24/03/15 12:44:00			4.8	0.0	4.5	0.0	0	0	5.4			Dry		
BH542	31/03/15 12:30:00	1015	2.5								0.0	14		0 litres purged, base depth 4.00m.	
BH542	31/03/15 12:31:00										0.0				
BH542	31/03/15 12:32:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH542	31/03/15 12:33:00										0.0			
BH542	31/03/15 12:34:00										0.0			
BH542	31/03/15 12:35:00			4.0	0.0	7.5	0.0	0	3	7.5				
BH542	31/03/15 12:36:00			4.4	0.0	4.3	0.0	0	4	7.7				
BH542	31/03/15 12:37:00			4.6	0.0	3.9	0.0	0	4	7.6				
BH542	31/03/15 12:38:00			4.9	0.0	4.3	0.0	0	4	6.6				
BH542	31/03/15 12:39:00			5.3	0.0	5.5	0.0	0	4	5.5				
BH542	31/03/15 12:40:00			5.5	0.0	6.4	0.0	0	3	5.4				
BH542	31/03/15 12:41:00			5.6	0.0	7.0	0.0	0	4	5.5				
BH542	31/03/15 12:42:00			5.7	0.0	7.9	0.0	0	3	4.9				
BH542	31/03/15 12:43:00			5.8	0.0	8.7	0.0	0	3	4.3				
BH542	31/03/15 12:44:00			5.7	0.0	9.3	0.0	0	3	3.7			Dry	
BH542	16/04/15 13:00:00	1014	-0.17								0.1	17		0 litres purged, base depth 4.00m.
BH542	16/04/15 13:01:00										0.1			
BH542	16/04/15 13:02:00										0.1			
BH542	16/04/15 13:03:00										0.2			
BH542	16/04/15 13:04:00										0.1			
BH542	16/04/15 13:05:00			4.2	0.1	11.1	2.0	0	0	7.1				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH542	16/04/15 13:06:00			4.9	0.1	9.3	2.0	0	0	5.6				
BH542	16/04/15 13:07:00			5.7	0.1	7.7	2.0	0	0	4.8				
BH542	16/04/15 13:08:00			6.2	0.1	8.1	2.0	0	0	4.0				
BH542	16/04/15 13:09:00			6.4	0.1	8.7	2.0	0	1	3.5				
BH542	16/04/15 13:10:00			6.5	0.1	9.4	2.0	0	0	3.3				
BH542	16/04/15 13:11:00			6.6	0.1	9.8	1.0	0	0	3.2				
BH542	16/04/15 13:12:00			6.6	0.1	10.3	1.0	0	1	3.1				
BH542	16/04/15 13:13:00			6.6	0.1	10.9	1.0	0	1	2.9				
BH542	16/04/15 13:14:00			6.6	0.1	11.4	1.0	0	0	2.8			Dry	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Shallow install.													CONTRACT 30238	CHECKED EC

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH542	24/03/15 12:44:00												Dry	0 litres purged, base depth 16.00m.	
BH542	31/03/15 12:44:00												Dry	0 litres purged, base depth 16.00m.	
BH542	16/04/15 13:14:00												Dry	0 litres purged, base depth 16.00m.	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC

NORWEST HOLST SOIL ENGINEERING LTD.

M4 RELIEF ROAD MAGOR TO CASTLETON STAGE 2

PIEZOMETER RECORDS BHM6

DATE	TIME(24hr)	WATER LEVEL(m)	WATER LEVEL mOD
15/11/97	14:00	3.52	7.53
25/11/97	15:25	3.17	7.88
02/12/97	11:00	1.67	9.38
10/12/97	14:30	1.86	9.19
16/12/97	15:35	1.93	9.12

TIP DEPTH:6.53m

TYPE OF COVER:BARREL

HEIGHT OF COVER A.B.G.L:0.22m

HEIGHT OF PIPE A.B.G.L:0.14m

COMMENTS:

Appendix 3

Groundwater Laboratory Data

M4CAN
Groundwater Analysis Results & Screening Assessment
CL-30
04/08/2015

Geological Formation Legend

TSG	Tintern Sandstoen Group
HD	Head Deposits

Monitoring Round		Screening Criteria	1	2	3	1	2	3	1	2	3	1	2	3
Location			BHS41	BHS41	BHS41	BHS39	BHS39	BHS39	BHS39	BHS39	BHS39	BHS39	BHS39	BHS39
Depth			6.67	6.73	6.72	1.97	3.57	2.1	2.84	1.49	3.04			
Response Zone Details (RZ)			TSG			HD	TSG	HD	TSG	HD	TSG			
Drainage Area	Units	EQS	DWS	Major	Major	Major	Major	Major	Major	Major	Major	Major	Major	Major
				Area 5	Area 5	Area 5	Area 5	Area 5	Area 5	Area 5	Area 5	Area 5	Area 5	Area 5
				East	East	East	East	East	East	East	East	East	East	East
Installation Details				2-11.5	2-11.5	2-11.5	1-3	5-14.2	1-3	5-14.2	1-3	5-14.2	1-3	5-14.2
							Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep

Site Sampled	VOCS	31/03/2015	16/04/2015	21/04/2015	24/05/2015	24/09/2015	31/03/2015	31/03/2015	16/04/2015	16/04/2015
1,1,1,2-Tetrachloroethane	ug/l	<2	<2				<2	<2	<2	<2
1,1,1-Trichloroethane	ug/l	100	<1	<1			<10	<10	<10	<10
1,1,2-Trichloroethane	ug/l	400	<10	<10			<10	<10	<10	<10
1,1-Dichloroethane	ug/l		<1	<1			<1	<1	<1	<1
1,1-Dichloroethene	ug/l		<1	<1			<1	<1	<1	<1
1,1-Dichloropropane	ug/l		<1	<1			<1	<1	<1	<1
1,2,3-Trichlorobenzene	ug/l	0.4	<2	<2			<2	<2	<2	<2
1,2,3-Trichloropropane	ug/l		<50	<50			<50	<50	<50	<50
1,2,4-Trichlorobenzene	ug/l	0.4	<1	<1			<1	<1	<1	<1
1,2,4-Trimethylbenzene	ug/l		<50	<50			<50	<50	<50	<50
1,2-Dibromo-3-Chloropropane	ug/l		<50	<50			<50	<50	<50	<50
1,2-Dibromomethane	ug/l		<5	<5			<5	<5	<5	<5
1,2-Dichlorobenzene	ug/l	20	<1	<1			<1	<1	<1	<1
1,2-Dichloroethane	ug/l	10	3	<2			<2	<2	<2	<2
1,2-Dichloropropane	ug/l		<1	<1			<1	<1	<1	<1
1,3,5-Trimethylbenzene	ug/l		<1	<1			<1	<1	<1	<1
1,3-Dichloropropane	ug/l		<2	<2			<2	<2	<2	<2
1,4-Dichlorobenzene	ug/l	20	<1	<1			<1	<1	<1	<1
2-Chlorotoluene	ug/l		<1	<1			<1	<1	<1	<1
4-Chlorotoluene	ug/l		<1	<1			<1	<1	<1	<1
4-Chlorophenyltoluene	ug/l		<1	<1			<1	<1	<1	<1
Benzene	ug/l	10	1	<1	<1	<1	<1	<1	<1	<1
Bromobenzene	ug/l		<1	<1			<1	<1	<1	<1
Bromochloromethane	ug/l	100	<5	<5			<5	<5	<5	<5
Bromodichloromethane	ug/l		<5	<5			<5	<5	<5	<5
Bromomethane	ug/l		<5	<5			<5	<5	<5	<5
Chlorobenzene	ug/l		<1	<1			<1	<1	<1	<1
Chloroethane	ug/l		<1	<1			<1	<1	<1	<1
Chloroethene	ug/l		<1	<1			<1	<1	<1	<1
Chloroform	ug/l	2.5	100	<1	<1		<1	<1	<1	<1
Chloromethane	ug/l		<1	<1			<1	<1	<1	<1
1,1,2,3,4-Pentachlorobenzene	ug/l		<1	<1			<1	<1	<1	<1
1,1,2,3,4-Pentachloropropane	ug/l		<10	<10			<10	<10	<10	<10
Dibromochloromethane	ug/l	100	<10	<10			<10	<10	<10	<10
Dibromomethane	ug/l		<10	<10			<10	<10	<10	<10
Dichlorodibromomethane	ug/l		<1	<1			<1	<1	<1	<1
Ethylbenzene	ug/l	20	<1	<1	<1	<1	<1	<1	<1	<1
Hexachlorocyclopentadiene (HCB)	ug/l	0.6	<1	<1			<1	<1	<1	<1
Isopropylbenzene	ug/l		<1	<1			<1	<1	<1	<1
n-Butane	ug/l	30	<1	<1	<1	<1	<1	<1	<1	<1
Methyl tert-butyl ether (MTBE)	ug/l		<1	<1			<1	<1	<1	<1
n-Butylbenzene	ug/l		<1	<1			<1	<1	<1	<1
n-Propylbenzene	ug/l		<1	<1			<1	<1	<1	<1
2-Nitrene	ug/l	30	<1	<1	<1	<1	<1	<1	<1	<1
Sec-Butylbenzene	ug/l		<1	<1			<1	<1		

Screening Values & Assessment

EQS	Environmental Quality Standards
DWS	Drinking Water Standard
	Exceeds EQS
X	Exceeds DWS
X	Laboratory detection level higher than screening criterion

Notes

X	Offsite borehole location
X	Detail inferred, unspecified

[illegible]

Appendix 4

Site Walkover Photographs



Plate 01: CL30 – View Looking South



Plate 02: CL30 – View Looking North



Plate 03: CL30 – Slope towards railway line

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment

Report Annex D

CL-32 Magor Depot Land
Contamination Assessment
Report

M4CaN-DJV-EGT-ZG_GEN-RP-EN-0021

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Appendix 2	Gas and Groundwater Monitoring
Appendix 3	Soil Laboratory Data
Appendix 4	Groundwater Laboratory Data
Appendix 5	Soil Leachate Laboratory Data
Appendix 6	Relevant Extracts of Additional Environmental Data

1 Introduction

1.1 Background

1.1.1 This report relates to an area of land potentially affected by contamination (CL-32) known as 'Magor Depot' hereafter referred to as the 'Site'.

1.1.2 The Site is located between chainage 20,600 and 20,800 (see Figure 1), upon a former fuel depot.

1.2 Reporting Context

1.2.1 The Site has been associated with several phases of ground investigation and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the 'Scheme') and informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the chapter on Geology and Soils.

1.2.2 In 2014, a Preliminary Sources Study Report (PSSR, 2014) was prepared as an initial land contamination appraisal (Ove, Arup & Partners, 2014) as part of the Design Manual for Roads and Bridges (DMRB) Stage 2 Assessments for this Scheme. This identified a number of individual areas that may have been affected by contamination as a result of historical activities at the Site.

1.2.3 This report now draws upon information available from the 2015 Supplementary Ground Investigation Works undertaken (Geotechnical Engineering, 2015) as well as an additional targeted ground investigation on behalf of the Welsh Government (RPS, 2015). This report relates to the area defined in the Site Plan shown in Figure 1.

1.2.4 The overarching rationale and approach for the assessment of areas of land along the Scheme with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

1.3.1 The key objectives of this report are as follows.

- Undertake a risk assessment of the Site and determine whether potential risks to human health or controlled waters could exist as a result of the Scheme.
- Identify any further assessments and investigations that are needed in order to refine land contamination risks and inform on the need for remediation.
- To provide information to support the Ground Investigation Report and Geotechnical Design Report required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

- Section 2: Site Location and Description – This section summarises the Site description.
- Section 3: The Scheme – This section details the new section of motorway alignment and associated features at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and historical aerial photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and relevant environmental information presented in the 2014 PSSR.
- Section 6: Summary of Investigations – This section describes previous and supplementary investigations undertaken at the Site.
- Section 7: Ground Conditions – This section describes the main findings of the investigations including the ground conditions encountered and significant visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contaminant linkages and presents the human health and controlled waters assessments.
- Section 9: Refined Conceptual Site Model – This section presents the Conceptual Site Model (CSM) for the Site and identifies potential contaminant linkages, based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations – This section provides conclusions concerning the likelihood of land contamination associated with the Site affecting the Scheme and requirements for remediation / mitigation.
- Section 11: References – This section summarises the key documents referred to in this report.
- Section 12: Glossary – This section provides a summary of terms used in this report.

2 Site Location and Description

- 2.1.1** The Site is located approximately 500 m north west of Magor town centre and approximately 300 m south of the existing M4 Junction 23A. The Site is centred on National Grid Reference ST 419 875. Magor Depot is also known as Wilcrick Depot. The location and layout of the Site is presented on Figure 1.
- 2.1.2** The Site is bounded by the A4810 to the west and associated slip road to the south and east. The B4245 Newport Road forms the northern boundary. The Site is situated at an elevation of approximately 26.9 m AOD in the north-west sloping to approximately 20.5 m AOD in the south east.
- 2.1.3** The South Wales Trunk Road Agency (SWTRA) currently occupies the Site which comprises an office / cafeteria building, a salt hopper and storage sheds. The Site has previously been referred to as a fuel depot.
- 2.1.4** A Site walkover survey undertaken in September 2015 identified the Site as being an operational depot primarily used for the storage of rock salt, understood to be for use on roads during winter periods.
- 2.1.5** The Site was noted as being split level, separated by an embankment, each level having its own vehicular access. The upper level includes site offices, car parking areas, a salt storage building, and the top of the salt hopper. The lower level includes a maintenance building, external stores, the bottom of the salt hopper and external storage/vehicle access areas.
- 2.1.6** The majority of the Site comprises hardstanding with vegetated areas around the periphery and the embankment.

3 The Scheme

- 3.1.1** The Site is located on the proposed new section of motorway at approximate chainage 20,600 to 20,800. Reference should be made to Figure 1 for the Site location in relation to the Scheme proposals.
- 3.1.2** The proposed new section of motorway at this location is at a reduced elevation in relation to existing ground level and therefore, a cut to existing ground level is required. The highway verges are to be landscaped and incorporate highway drainage.
- 3.1.3** The intention is that materials arising from the excavations will be removed from their current location and reused within the Scheme.
- 3.1.4** A potential borrow pit area is located to the south of the Site and to the north Newport Road will be rerouted on an embankment approximately 2-4 m above existing ground level.

4 Site History

- 4.1.1** The 2014 PSSR historical searches were based on Ordnance Survey plans, literature reviews, information from Natural Resources Wales (NRW) (formerly Environment Agency Wales) and Newport City Council and aerial photographic interpretation.
- 4.1.2** This has been supplemented by the review of historical maps obtained in 2015 from the Welsh Government. Relevant extracts are presented in Appendix 6.
- 4.1.3** A summary of the Site's history is presented in Table 1 below.

Table 1: Site History

Date	Use	Source of information
1843 - 1893	The Site comprises agricultural fields. To the north is a road running north-west to south-east. To the south-east and north-east are <u>old quarries</u> , approximately 90 m and 75 m away respectively.	1:10,560 Historical Mapping
1891 - 1912	No significant change.	1:10,560 Historical Mapping
1904 - 1939	No significant change.	1:10,560 Historical Mapping
1964 - 1965	No significant change.	1:10,560 Historical Mapping
1962	No significant change.	Aerial photograph
1966	The Site appears to be under <u>construction</u> with excavation taking place.	Aerial photograph
1969	A rectangular building is present in the centre of the Site. A road loops the Site running along the east, south and west boundaries. The B4245 now runs along the Site's northern boundary. The M4 J23A has been developed approximately 200 m to the north. The town of Magor has expanded to within 150 m east of the Site.	Aerial photograph
1981	The majority of the Site appears to comprise a yard laid to hardstanding. A second industrial unit has been developed on the Site in the south-western area. Evidence of material stockpiling in the yard in the north-western area of the Site.	Aerial photograph
1985 - 1996	The Site is now labelled as a <u>depot</u> . The road running north-south along the western boundary has been extended. A brewery has been developed to the west. The town of Magor has expanded southwards and westwards. A Police Station is now located to the north.	1:10,000 Historical Mapping
1991	<u>Storage of materials identified on hardstanding.</u> A salt hopper is located in the centre of the Site.	Aerial Photography

Date	Use	Source of information
2006	<u>Storage of materials on hardstanding</u> . A number of <u>storage containers</u> are present. Two above ground <u>tanks</u> are located central northern site areas.	Aerial Photography
2009 - 2010	No significant change.	Aerial Photography
2013 - 2014	Two rectangular office buildings have been constructed in the north-west corner of the Site.	Aerial Photography

Notes: Potential sources of contamination are underlined. Those within the temporary and permanent land take are shown in **bold**.

- 4.1.4** The sources of information presented above supplement those used in the 2014 PSSR. In particular, the 2006 aerial image shows the presence of above ground tanks. Relevant photographic extracts are presented in Appendix 6.
- 4.1.5** Earthworks associated with the construction of the Motorway Maintenance Depot are identified within the Site history section of the 2014 PSSR. However no dates are given.
- 4.1.6** The Site is currently occupied by the South Wales Trunk Road Agency (SWTRA).
- 4.1.7** Historically the Site is located in proximity to areas which may have been bombed during World War II, which is discussed in the Explosive Ordnance Threat Assessment Report (Bactec, 2014). This report categorises the Site as low risk with respect to unexploded ordnance.

5 Environmental Setting

5.1 Geology

5.1.1 The geological map indicates there are no superficial deposits within the Site area. However River Terrace Deposits (sand and gravel) are shown immediately south of the Site.

5.1.2 British Geological Survey (BGS) data indicates that the western part of the Site is underlain by bedrock of the Tintern Sandstone Formation, and the eastern part is underlain by the Avon Group Carboniferous Limestones.

5.2 Hydrology

5.2.1 There are no surface water features within the Site boundary or within 500 m of the Site.

5.3 Hydrogeology

5.3.1 NRW classifies the Tintern Sandstone Formation and the Avon Group as Principal Aquifers.

5.3.2 The Site does not lie within a groundwater Source Protection Zone.

5.4 Environmental Information

5.4.1 No pollution incidents, abstraction licences, discharge points or landfill sites have been recorded within the Site or within 300 m of the Site.

5.4.2 One company located within 300 m to the west of the Site holds an environmental permit as detailed in Table 2.

Table 2: Environmental Permit (off site)

Address/ Licence	Industry	Process	Year	Release Environment	Substances Released
The Brewery, Newport Road, Mangor, Gwent BX7282IS	Other Industry	Animal, vegetable and food	2005 to 2012	Air	Carbon monoxide, carbon dioxide, nitrogen oxides, VOCs, inorganic chlorine compounds, hydrogen chloride, asbestos, ammonia

5.4.3 Residual levels of potential contamination associated with the above environmental permit are considered unlikely to affect the Site.

6 Scope of Investigations

6.1 General

6.1.1 Five intrusive ground investigations are available that include works within the Magor Depot Site. These are summarised below.

6.2 Scope of Works

6.2.1 The various intrusive ground investigations undertaken within the Site area are summarised in Table 3.

Table 3: Site Investigation Summary

Date	Contractor	Site Location	Boreholes	Window Sampler	Trial Pits	Sampling
1997	Norwest Holst	West	BHN3, BHN3A	-	-	Soil
2000	Exploration Associates	South-west	CH55, CH56	-	-	Soil & leachate
2008	Norwest Holst	North-west and south-east	-	SWSN01, SWSN02, SWSN02A	STPN01, STPN02	Soil & leachate
2015	Geotechnical Engineering	South	BH544	-	-	Soil
2015	Costain/Vinci Joint Venture (for Welsh Government)	South	CL32-02, CL32-03, CL32-06, CL32-07, CL32-08, CL32-09	-	-	Soil and groundwater

6.2.2 The construction details of all boreholes installed on the Site are summarised in Table 4.

Table 4: Summary of Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (m bGL)	Base of Slotted Well Casing / Gravel Pack (m bGL)	Targeted Geology
BH544	50	18.4	1	18.4	Bedrock (Tintern Sandstone Formation)
CL32-03	50	12.2	1	7	Bedrock (Tintern Sandstone Formation)
CL32-09	50	10.0	5	10	Bedrock (Tintern Sandstone Formation)

6.3 Surface Water Quality Sampling

6.3.1 Surface water quality monitoring was not undertaken during the previous ground investigations of the Site.

6.4 Field Testing

6.4.1 Photo Ionisation Detector (PID) monitoring for Volatile Organic Compounds (VOCs) was undertaken on shallow soil samples at location STPN01 (see Figure 1 for location).

6.5 Groundwater Monitoring

6.5.1 A summary of the groundwater sampling, groundwater monitoring and ground gas monitoring rounds undertaken at the onsite boreholes is shown in Table 5.

Table 5: Summary of Monitoring Rounds

Location Ref.	Number of Rounds (Date of Sampling)	Monitoring details	Notes
BH544 (50 mm)	5 no. 17 th April 2015, 24 th April 2015, 1 st May 2015, 11 th May 2015, 15 th October 2015	Groundwater – level and sampling Soil Gas	
CL32-03	1 no. 15 th October 2015	Groundwater – level and sampling Soil Gas	Borehole dry
CL32-09	1 no. 15 th October 2015	Groundwater – level and sampling Soil Gas	-

6.6 Laboratory Chemical Testing

6.6.1 A summary of all laboratory analysis undertaken on soil, groundwater and leachate samples is summarised in Table 6 below.

Table 6: Summary of Analysis

Site Investigation Date	No. of Soil Samples	No. of Leachate Samples	No. of Water Samples	Suites of Testing
1997	1	0	0	Metals, pH, phenols, sulphate and cyanide
2000	3	1	0	Metals, pH, phenols, sulphate, cyanide, PAH and TPH
2008	7	4	0	Metals, pH, phenol, sulphate, cyanide, asbestos, TPH, PAH, PCBs, BTEX, VOCs and SVOCs
2015	2	0	3	Metals, PAH, TPH, pH, cyanide, sulphate, sulphur, nitrate, MTBE, BTEX, phenols, VOCs, SVOCs, dibenzofurans, asbestos, PCBs, TOC
2015	5	0	2	Metals, GRO, TPH, PAH, pH, asbestos (soils) Metals, TPH, PAH, VOCs, SVOCs, sulphate, PCBs, pH and water quality parameters.

Soil Analysis

6.6.2 The following sections summarise the laboratory analytical results for soil samples collected during the various intrusive investigation phases. The available data set has been tabulated and is presented in Appendix 3 with supporting laboratory certificates available in the relevant original ground investigation reports (see Table 3).

6.6.3 For assessment, the analytical data from the Made Ground has been assessed separately from those of the natural soils (the various lithologies associated with the Bedrock i.e. Tintern Sandstone and Avon Group Limestones).

6.6.4 For the purpose of meeting the requirements of DMRB HD22/08 (Highways Agency, 2008), the historical data used to support the PSSR and the additional 2015 information (Geotechnical Engineering, 2015 and Costain/Vinci Joint Venture, 2015) have been differentiated in the following sections.

6.6.5 The available information used in this assessment is summarised in Table 7.

Table 7: Summary of Analytical Soil Data

Formation Unit	Number of Soil Analysis per Analytical Suite - 2015 data/ All GI data								
	Metals & Inorganics	PCBs	PAH	TPH	Phenol	BTEX	Pthalates	VOCs	SVOCs
Made Ground	6 / 11	1 / 3	6 / 10	5 / 9	1 / 6	1 / 3	1 / 2	1 / 3	1 / 2
Natural Soils	1 / 6	0 / 4	1 / 6	1 / 6	0 / 5	0 / 4	0 / 4	0 / 5	0 / 4

Soil Leaching Analysis

6.6.6 The available information is presented in Appendix 5 and summarised in Table 8.

Table 8: Summary of Soil Leaching Analytical Data

Formation Unit	Number of Soil Leachate Analysis per Analytical Suite - 2015 data / All GI data	
	Metals & Inorganics	Total Petroleum Hydrocarbon
Made Ground	0/1	0 / 1
Natural Soils	0/3	0 / 0

Groundwater Results

6.6.7 The following sections summarise the laboratory analytical results for groundwater samples collected during the various intrusive investigation phases. The available data has been tabulated and is presented in Appendix 4 with supporting laboratory certificates available in the relevant original reports.

6.6.8 The available data relates to groundwater samples taken from the wells installed within the groundwater of the Bedrock (Tintern Sandstone Formation) and is summarised in Table 9.

Table 9: Summary of Analytical Groundwater Data

Groundwater Unit	Number of Groundwater Analysis per Analytical Suite (number of well locations) - 2015 data / All GI Data						
	Metals & Inorganics	PAH	TPH	Phenol	BTEX	VOCs	SVOCs
Principal Aquifer (Bedrock)	5 (2) / 5 (2)	5 (2) / 5 (2)	5 (2) / 5 (2)	3 (1) / 3 (1)	5 (2) / 5 (2)	5 (2) / 5 (2)	5 (2) / 5 (2)

6.7 Gap Analysis of Available Data

6.7.1 The most recent ground investigation undertaken by RPS on behalf of Welsh Government (RPS, 2015) has sought to target gaps in the existing ground investigation data.

7 Ground Conditions

7.1 Geology

7.1.1 The geological logs for all available exploratory holes excavated on or in close proximity to the Site are provided in Appendix 1. The observed geological sequence is consistent with that discussed in the 2014 PSSR and is summarised in the following sections. Information from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and additional ground investigation undertaken on behalf of the Welsh Government (RPS, 2015) has also been used.

Made Ground

7.1.2 Made Ground was encountered beneath a concrete slab at all exploratory locations (with the exception of CH55 and CH56) with thicknesses generally ranging between 0.2 m and 0.7 m. At borehole BHN3, a localised thicker layer of 2.7 m was identified overlying 300 mm of topsoil.

7.1.3 Made Ground typically comprised limestone gravel representing a sub-base material. At borehole BHN3 the sub-base was underlain by Made Ground which comprised gravel and hardcore rubble with brick fragments.

7.1.4 At CH55, a concrete slab was not encountered but loose Made Ground was evident including slag and ash identified to 0.25 m depth.

Superficial Deposits

7.1.5 No superficial deposits were identified on site.

Solid Geology

7.1.6 Beneath the Made Ground a sequence of weathered bedrock was encountered.

7.1.7 The bedrock encountered comprised predominantly reddish brown occasionally green or yellow mudstone, sandstone, dolomite or siltstone with a discontinuous upper stratum of stiff clay of up to 1.6 m in thickness.

Geological Sequence Summary

7.1.8 The general geological sequence identified during the previous ground investigations is summarised in Table 10.

Table 10: Summary of Geological Sequence

Unit	Description	Thickness Range (m)	Basal Depth (m bGL)
Made Ground (Sub-base)	Hardstanding overlying sub-base with coarse sand and gravel	0.18 - 0.7	0.25 - 0.7
Made Ground	Discrete area including rubble overlying a 300 mm layer of topsoil (BHN3)	2.6 - 2.9	3 - 3.2
Bedrock	Interbedded mudstone, sandstone, dolomite, limestone and siltstone.	>17.8	unproven

7.2 Visual and Olfactory Evidence of Contamination

7.2.1 A summary of visual and olfactory evidence of contamination encountered during the previous ground investigations is summarised in Table 11.

Table 11: Visual and Olfactory Evidence of Contamination Summary

Location ID	Depth (m bGL)	Strata	Evidence of Potential Contamination
Most locations (exception of CH56)	GL to 0.25-3.2	Made Ground	Concrete, tarmacadam and demolition rubbles
CH55	0 - 0.25	Made Ground	Ash and slag
STPN01	0.6	Mercia Mudstone Group Marginal Facies (limestone)	Oil / diesel coming through fractures in the bedrock - buried diesel tank in vicinity.

7.2.2 The PID meter recorded zero levels, indicating that no volatiles were present.

7.2.3 Full details and observations noted during the drilling and trial pitting are presented on the exploratory logs provided in Appendix 1.

7.2.4 The more recent 2015 ground investigations have in part targeted the areas previously associated with evidence of potential contamination. Visual or olfactory evidence of contamination have not been identified in these areas.

7.3 Gas Monitoring

7.3.1 The gas monitoring data available is provided on the field data sheets in Appendix 2. The maximum gas concentrations (minimum for oxygen) are presented in Table 12 below. The gas monitoring data indicates low generation sources.

Table 12: Summary of Gas Monitoring Data

Location ID	Flow (l/hr)	VOCs (ppm)	CH ₄ (%/vol)	Peak LEL (%)	CO ₂ (%/vol)	O ₂ (%/vol)	CO (ppm)	H ₂ S (ppm)
	Max	Max	Max	Max	Max	Min	Max	Max
BH544	0.0	5.3	0.1	1.0	1.3	11.2	4	0
CL32-09	0.0	-	0.1	1.0	1.0	16.6	0	0
CL32-03	0.0	-	0.0	0.0	1.1	19.3	0	0

7.4 Groundwater

Groundwater Encountered During Investigation

7.4.1 Groundwater strikes were encountered during the construction of a number of boreholes as detailed on the geological logs provided in Appendix 1. These are summarised below in Table 13.

Table 13: Summary of Groundwater and Leachate Water Level Data

Location	Strike (m bGL)	Depth	Geological Formation	Level after 20 minutes (m bGL)	Comments
SWSN01	0.4		Made Ground (Sub-base)	0.4	Top of Sandstone
CL32-03	5.5		Tintern Sandstone Formation	-	-
CL32-09	2.7		Tintern Sandstone Formation	-	-

7.4.2 Groundwater was not identified in any other boreholes or trial pits during the previous ground investigations.

Groundwater Level During Monitoring Rounds

7.4.3 Data relating to groundwater levels for the Site are provided in Appendix 2 and summarised in Table 14.

Table 14: Summary of Groundwater Level Data

Location	Installation	Depth of Response Zone (m bGL) and Geological Formation	No. Measurements	Min Level (m bGL)	Max Level (m bGL)	Comments
BH544	Single	1 - 18.4 Bedrock (Tintern Sandstone)	3	8.34	9.72	Good recharge
CL32-09	Single	5 - 10.0 Bedrock (Tintern Sandstone)	1	8.14	8.14	Slow recharge

Groundwater Summary

7.4.4 A perched water body, probably discontinuous has been identified at the interface between the Made Ground and the underlying bedrock at the Site.

7.4.5 The deep groundwater body within the bedrock has been identified with a water level around 8 m bGL.

8 Contamination Assessment

8.1 Introduction

8.1.1 The following sections provide details of the assessment of land contamination at the Site.

8.1.2 The Conceptual Site Model (CSM) presented within the 2014 PSSR has been reviewed and updated based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015), the 2015 Ground Investigation (RPS, 2015) and the Scheme. The main alterations to the 2014 PSSR model are summarised as follows.

- Inclusion of groundwater quality and level data.
- Inclusion of gas monitoring data.
- Update of the source-pathway-receptor linkages taking account of the above and more detailed assessment.

8.2 Preliminary Risk Assessment

Potential Sources

8.2.1 The historical data review and walkover survey indicate the Site has been used as a fuel depot, for storage of chemical drums and as a maintenance depot. The Site also includes the presence of buried fuel tanks. These are a potential source of contamination at the Site. A buried diesel tank was identified in the south west of the Site during the 2007 site investigation.

8.2.2 It is anticipated that the Made Ground and fuel tanks and associated hydrocarbon contamination will be removed as part of the construction works and therefore, no source of contamination will remain post construction. However, there is a possibility of residual contamination remaining within the underlying bedrock presenting a risk to maintenance workers and controlled waters. Such impact has been identified near STPN01 where oil/diesel was reported to be evident within fractures in the bedrock.

Potential Receptors

8.2.3 Receptors during the construction and operational stages of the Scheme have been considered:

Construction

- Construction workers during site development works.
- General public adjacent to construction works.
- Groundwater in the Principal aquifer within the bedrock.

Operational

- Maintenance workers.
- General public end users.

- General public adjacent to permanent land take.
- Groundwater in the Principal aquifer within the bedrock.

Potential Pathways

8.2.4 Pathways during the construction and the operational stages of the Scheme have been considered.

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils possible during development and maintenance works.
- Inhalation pathways possible for general public end users and adjacent general public/workers.
- Leaching of contaminants from the Made Ground into the groundwater.
- Vertical or lateral migration of free phase hydrocarbon product or dissolved product to groundwater.
- Vertical or lateral migration of ground gas associated with Made Ground and hydrocarbon impacted soils or groundwater.

8.3 Risk Evaluation

8.3.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the other data described herein, the following risk evaluation has been reconsidered and included.

- The Site has been subject to potential contaminative uses, including use as a fuel depot and the presence of at least one buried diesel tank has been identified.
- Made Ground with perched shallow groundwater is directly overlying a Principal Aquifer.
- A below ground fuel tank may have impacted underlying soils, rock and groundwater. Given the shallow extent of Made Ground and the absence of superficial deposits, any below ground tanks are likely to be contained within the solid bedrock.
- Considering the identified land use, organic compounds are considered to be the main contaminants of concern.
- Made Ground was generally limited to sub-base type material with an overlying concrete slab. The latter would likely act as a barrier against vertical migration of accidental surface spillages, where condition and integrity is good.
- Details of the surface water drainage system are unknown.
- Visible oil/diesel has been identified within the bedrock in proximity to a buried diesel tank at the Site (STPN01).
- The proposed works will include a shallow cutting on the Site which will likely remove any Made Ground materials within the Scheme area. All buried fuel tanks, if present, would also be removed as part of the construction works.
- Hardstanding cover which is proposed in some areas of the motorway corridor is likely to limit infiltration thereby reducing leaching.

- No surface water features are identified within or in close proximity to the Site.
- Motorway users will be within an open environment with no proposed structures or other confined spaces.

8.4 Human Health Risk Assessment

8.4.1 The rationale and approach for the human health (Tier 2) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES). Soil chemical analysis results and the findings of the generic Tier 2 human health risk assessment are presented in Appendix 3. All exceedances of relevant generic risk assessment criteria are summarised in Table 15 and 16.

Table 15: Summary of Human Health Soil Screening Exceedances: Made Ground

Determinand	Units	Range	Screening Criteria	No. Samples Exceeding Screening Criteria (Total Number of Results)	Locations of Exceedances
pH	pH units	7.6 - 11.59	6 - 9	7 (11)	CH55, STPN02, SWSN01, BH544, CL32-06, CL32-08, CL32-09
Chromium	mg/kg	6.1 - 57.3	33	2 (11)	BHN3, CL32-06
PAH	mg/kg	<0.05 - 4980	1.1	2 (10)	CH55 x 2
TPH	mg/kg	<0.01 - 6100	3200	1 (5)	CH55

Table 16: Summary of Human Health Soil Screening Exceedances: Natural Soils

Determinand	Units	Range	Screening Criteria	No. Samples Exceeding Screening Criteria (Total Number of Results)	Locations of Exceedances
pH	pH units	8.1 - 9.49	6 - 9	3 (6)	STPN01, SWSN01, CL32-07
Chromium	mg/kg	18 - 35	33	1 (6)	SWSN02

8.4.2 Alkaline soil conditions have been identified in half of the samples, mainly within the Made Ground material but also within the bedrock at three locations.

8.4.3 Although exceedances for chromium are present in both Made Ground and the bedrock, the criterion relates to the hexavalent form. All results are considered to be within normal background range (<95 mg/kg) and therefore are not considered to represent a contaminant of concern (Appendix 11.1 of the ES).

8.4.4 The PAH exceedances are reported for samples analysed without speciation. In this instance the criterion for total PAH has been taken considering the most stringent PAH compound (Dibenzo(ah)anthracene). Whilst this is considered to be a conservative initial approach, it is noted that both these exceedances relate to superficial Made Ground material at one location (CH55) and are well above concentrations observed in the remaining data set for the same geological unit. This is likely to represent a discrete area of contamination.

8.4.5 In addition to the identified exceedances, elevated oil was identified within the Made Ground at CH55 with a concentration of 15,900 mg/kg. No VOC analysis was undertaken at this location to enable the molecular status of the oil to be determined.

8.4.6 The laboratory detection limit was higher than the screening criterion for some PAH and VOC compounds. Risks to human health associated with these are considered to be low given the low concentrations recorded.

8.5 Controlled Waters Screening Assessment

8.5.1 The rationale and approach for the controlled waters (Tier 1) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES) and the groundwater chemical results are presented in Appendix 4. All exceedances of relevant generic criteria are summarised in Table 17 for soil leachate.

8.5.2 Where an Environmental Quality Standard (EQS) is dependent on water hardness i.e. some heavy metals, the hardness of the surface water receptor would normally be used. The Baseline Water Environment Report (Appendix 16.2 of the ES) indicates surface water to be generally moderately hard with hardness concentrations within a range of 100 to 150 mg/l reported as calcium carbonate. Therefore, EQSs within this water hardness range have been used for screening purposes.

Soil Leachate Results

8.5.3 Five soil samples were subjected to leachate analysis. The majority of the soil leachate results were below the applied screening criteria, with the exception of the following contaminants shown in Table 17.

Table 17: Controlled Waters Screening Exceedances – Soil Leachate

Determinand	Units	Range	EQS	DWS	No. Exceeded EQS Screening Criteria (Total Number of results)	Location (Formation)	No. Exceeded DWS Screening Criteria (Total Number of Results)	Location (Formation)
Arsenic	ug/l	<1 - 22	50	10	0 (8)	-	1 (8)	STPN01 (Bedrock)
Copper	µg/l	<1 - 16	10	2,000	1 (8)	SWSN02 (Carboniferous Bedrock)	0 (8)	-
Nickel	µg/l	<1.5 - 10	4	20	2 (8)	STPN01, SWSN02 (Carboniferous Bedrock)	0 (8)	STPN02 (Made Ground)
Lead	µg/l	<1 - 3	1.2	10	3 (8)	STPN01, SWSN02 (Carboniferous Bedrock), SWSN01 (Made Ground)	0 (8)	-
Cyanide	mg/l	<0.05 - 0.61	0.001	0.05	1 (8)	STPN02 (Carboniferous Bedrock)	1 (8)	STPN02 (Carboniferous Bedrock)
pH	pH units	9.8	6 - 9	6 - 9	1 (1)	CH55 (Made Ground)	1 (1)	CH55 (Made Ground)

8.5.4 The identified exceedances are considered to be minor and unlikely to pose a significant risk to controlled waters.

8.5.5 The laboratory detection levels for cadmium and cyanide are higher than the applied screening criterion, within the historical data set.

Groundwater Results

8.5.6 The groundwater results assessment includes data from five monitoring rounds from BH544 and one monitoring round from CL32-09 undertaken in 2015. Groundwater samples were taken from the aquifer body within the Bedrock.

8.5.7 No exceedances of either the Environmental Quality Standards (EQS) or the Drinking Water Standards (DWS) were recorded.

8.5.8 All phenols, BTEX, TPH, PAH, VOCs and SVOCs results were reported as below the limits of detection.

8.5.9 However, it is noted that the laboratory detection limits for mercury, cyanide, phenols, some PAH compounds, VOCs and SVOCs were higher than their respective applied screening criteria.

8.5.10 The limited data currently indicates that the aquifer beneath the Site is not impacted by contamination associated with the historic land use.

8.6 Ground Gas Risk Assessment

8.6.1 The available ground gas data relates to on site boreholes that are associated with response zones screened within the bedrock. Of the rounds available the following comments may be made:

- One round was undertaken at low barometric pressure (less than 1000 mb), with a pressure reading of 992 mb measured during the fourth monitoring round involving BH544. As such it can be considered that worse case atmospheric conditions have been monitored for this borehole.
- Gas flow was recorded as absent during each monitoring round.
- Methane has been recorded at levels of up to 0.1% in BH544 on the first round, was absent for the subsequent three rounds and up to 0.1% in CL32-09. The concentrations are below the initial screening criteria of 1%. The Lower Explosion Limit of up to 1% is noted for each borehole and correlates with the low level methane concentrations reported.
- Carbon dioxide is identified at between 0.1% and 1.3% during all monitoring rounds. These concentrations are well below the Workplace Exposure Limit (WEL) of 5%.
- Traces of Volatile Organic Compounds of up to 5.3 ppm have been recorded.
- Hydrogen sulphide and carbon monoxide was not detected throughout the monitoring rounds.
- Oxygen has been recorded at low to ambient concentrations of between 11.2-20.8%.

8.6.2 Though occasional low levels of oxygen have been identified, the available data does not indicate abnormal gas concentrations and is consistent with the expected gas regime given the ground conditions.

8.6.3 A gas risk assessment has been undertaken and is set out within the Land Contamination Assessment Report (Appendix 11.1 of the ES).

8.6.4 Potential soil gas from the Site is therefore considered to be of low risk to the Scheme though it should be noted that VOCs may be released during tank removal and/or excavation within hydrocarbon impacted ground.

8.7 Summary

8.7.1 Discrete areas of elevated PAH (that would cause a potential risk to human health) have been identified within the Made Ground, however a conservative screening criteria was applied due to the lack of compound speciation within the analytical data .

8.7.2 TPH and PAH are also shown to be elevated at location CH55 within the Made Ground, where no concrete slab is evident.

8.7.3 STPN01 which was excavated in 2008 reported evidence of hydrocarbons within the bedrock. The 2015 boreholes sunk around the historical trial pit did not identify elevated organic contamination, indicating a localised impact.

8.7.4 Moderate leachability of both the Made Ground and bedrock has been identified with marginal exceedances of copper, nickel, lead, cyanide and pH.

8.7.5 The bedrock aquifer has no identifiable contaminant concentrations when compared to the Environment Quality Standards or the Drinking Water Standards. This would indicate that the quality of the aquifer observed beneath the Site has not been impacted by on site soil contamination.

9 Refined Conceptual Site Model

- 9.1.1** The incorporation of data from the 2015 Supplementary Ground Investigation and additional ground investigation on behalf of the Welsh Government has enabled the original CSM presented in the 2014 PSSR to be updated. The assessment is based on the Scheme during construction and operational phases.
- 9.1.2** A CSM representing general ground conditions, overall Scheme layout and relevant source-pathway-receptors (each of which has a specific alpha-numerical symbol attached) are presented in Figure 2 and is described in Table 18.

Table 18: Site Conceptual Model

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
On Site Localised elevated hydrocarbons identified from possible fuel/chemical spill. Made Ground associated with the depot, chemical and fuel storage.	Construction					
	Construction Workers (B)	Direct dermal (1)	Likely	Moderate	Moderate	Construction workers will be exposed to Made Ground materials, fuel tanks and associated hydrocarbon contamination during Site construction works; however exposure duration will be short term only. Prior to construction, a specific risk assessment will be required in line with CDM and health and safety legislation. This will enable safe methods of work and an appropriate level of PPE to be put in place. As such all risks will be duly considered and suitably mitigated to protect construction workers.
		Ingestion (3)	Likely	Moderate	Moderate	The current data set identified a limited number of exceedances of the selected screening criteria. Overall, current contamination status from the current dataset is not foreseen to represent abnormal constraints to construction workers' health and safety over and above those typical of a brownfield site.
		Inhalation of soil dust and hydrocarbon vapours (2)	Likely	Moderate	Moderate	During the previous ground investigation (Exploration Associates in 2000), discrete areas have been identified to be contaminated with hydrocarbon. Hydrocarbon contamination was not identified during the recent 2015 ground investigations, indicating a localised distribution of the contamination. However, if found to be present specific precautions may be required and possibly specialist contractors to enable remediation.
	General public: footpath users during construction works (C)	Dermal contact with soil dust (1)	Unlikely	Moderate	Low	During construction there is the possibility of inhalation of soil dust (short term exposure only). Dust suppression measures are recommended during construction works.
		Ingestion of soil dust (3)	Unlikely	Moderate	Low	

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
		Inhalation of soil dust (2)	Unlikely	Moderate	Low	VOCs may be released during tank removal and/or excavation within hydrocarbon impacted ground.
		Inhalation of soil gas or hydrocarbon vapours (2)	Unlikely	Moderate	Low	
	Groundwater - Aquifer within the Bedrock (Da)	Leaching/migration of contaminants from Made Ground, buried tank or fuel spill to aquifer (4)	Likely	Moderate	Moderate	Current dataset shows the aquifer not to be impacted by on site contamination. However leachability of contaminants is shown to be moderate. There is a risk of impacting soils and groundwater from fuel tanks and possible spillage. A method statement for the removal of the tanks will be required together with a remediation strategy to include a programme of groundwater monitoring.
	Operational					
	Maintenance Workers (B)	Direct dermal (1)	Unlikely	Low	Very low	Made Ground and some bedrock to be removed by the cutting therefore, exposure to Made Ground will be limited to outside the M4 corridor. Areas outside the motorway hardstanding are likely to receive topsoil cover and vegetation establishment, reducing potential of exposure. Exposure duration will be short term only. Site specific risk assessment will be required in line

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
		Ingestion (3)	Unlikely	Low	Very low	with health and safety guidance. This will enable safe methodology and an appropriate level of PPE to be put in place. As such, all risks will be duly considered and suitably mitigated.
		Ingestion of soil dust (2)	Unlikely	Low	Very low	The current data set identifies a limited number of exceedances of the selected screening criteria. Current contamination status is not foreseen to represent abnormal constraints to maintenance worker's health and safety over and above those typical of a brownfield site.
	Future Motorway Users (A)	Inhalation of hydrocarbon vapours (2)	Unlikely	Low	Very low	Motorway hardstanding will provide some level of barrier. Motorway users are within an open space. 2015 investigation identified hydrocarbon contamination to be localised, if still present.
	Groundwater - Aquifer within the bedrock (Da)	Leaching / migration of contaminants from hydrocarbon impacted soils to aquifer. (4)	Likely	Moderate	Moderate	Current dataset shows the aquifer not to be impacted by on site contamination. However leachability of contaminants is shown to be moderate. There is a risk of impacting soils and groundwater from fuel tanks and possible spillage. A method statement for the removal of the tanks will be required together with a remediation strategy to include a programme of groundwater monitoring.

10 Conclusions and Recommendations

10.1 Conclusions

- 10.1.1** Investigations at the Site have established that contamination associated with the Site's historical use has been found to be limited to two locations (CH55 and STPN01). In CH55 elevated organic compounds have been identified within the shallow soil. This is in an area of the Site where the concrete slab is absent and impacted soils may be present to greater depth although testing has indicated much reduced concentrations were identified at 0.25 m depth. Visual evidence of oil/fuel contamination within the bedrock has also been identified (STPN01). This would suggest historical leakage or spillage may have occurred. However, hydrocarbon contamination was not identified within surrounding soils during the recent ground investigation, indicating an absence of widespread contamination.
- 10.1.2** The risk assessment has identified that some residual risks to human health and controlled waters could exist in discrete areas of the Site and control measures are required to facilitate the construction and ongoing operation of the Scheme.
- 10.1.3** Buried fuel tanks exist that will need to be removed from Site during the works. Further investigation or inspection during construction is recommended to identify and confirm the location of all tanks. Prior to tank removal, a remedial method statement will be required which will require materials around the tank to be inspected for contamination and verification testing undertaken to determine if materials require remediation or are suitable for reuse within the Scheme.
- 10.1.4** The potential for reuse of contaminated materials will need to be verified through compliance with suitability for reuse criteria set out in the remediation strategy.
- 10.1.5** Should contaminated materials be designated for disposal, further waste characterisation and acceptance assessments may be required.
- 10.1.6** During the construction phase, specific mitigation measures will be required to prevent inhalation pathways of dust to the general public off site and construction workers, although such measures would be no more than typically expected on a construction site. A suitable water management strategy will also be required to prevent potential impact to surface waters from contaminant run-off.
- 10.1.7** The deep aquifer is currently not identified to be impacted by the Site usage and by on site soil contamination.

10.2 Recommendations

- 10.2.1** It is recommended that as a remediation strategy is required for the Scheme, the following measures should be included within it with respect to this Site;
- Dealing with unexpected contamination.
 - Verification sampling to confirm suitability of soils for reuse.
 - Control measures (over and above good practice construction management) to prevent risks to construction workers and the general public during construction.

- Works relating to tank decommissioning / removal and management of hydrocarbon impacted materials.
- Verification of material used as topsoil for suitability of use.

10.2.2 The remediation strategy should include a remediation options appraisal, remediation implementation plan and remediation verification plan. The remediation strategy should be supported by a Scheme wide Material Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

11 References

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Titan Environmental Surveys Ltd (2008) New M4 Magor to Castleton Baseline Surface Water Quality Final Report for Arup, Report Number HS0442/F1/2

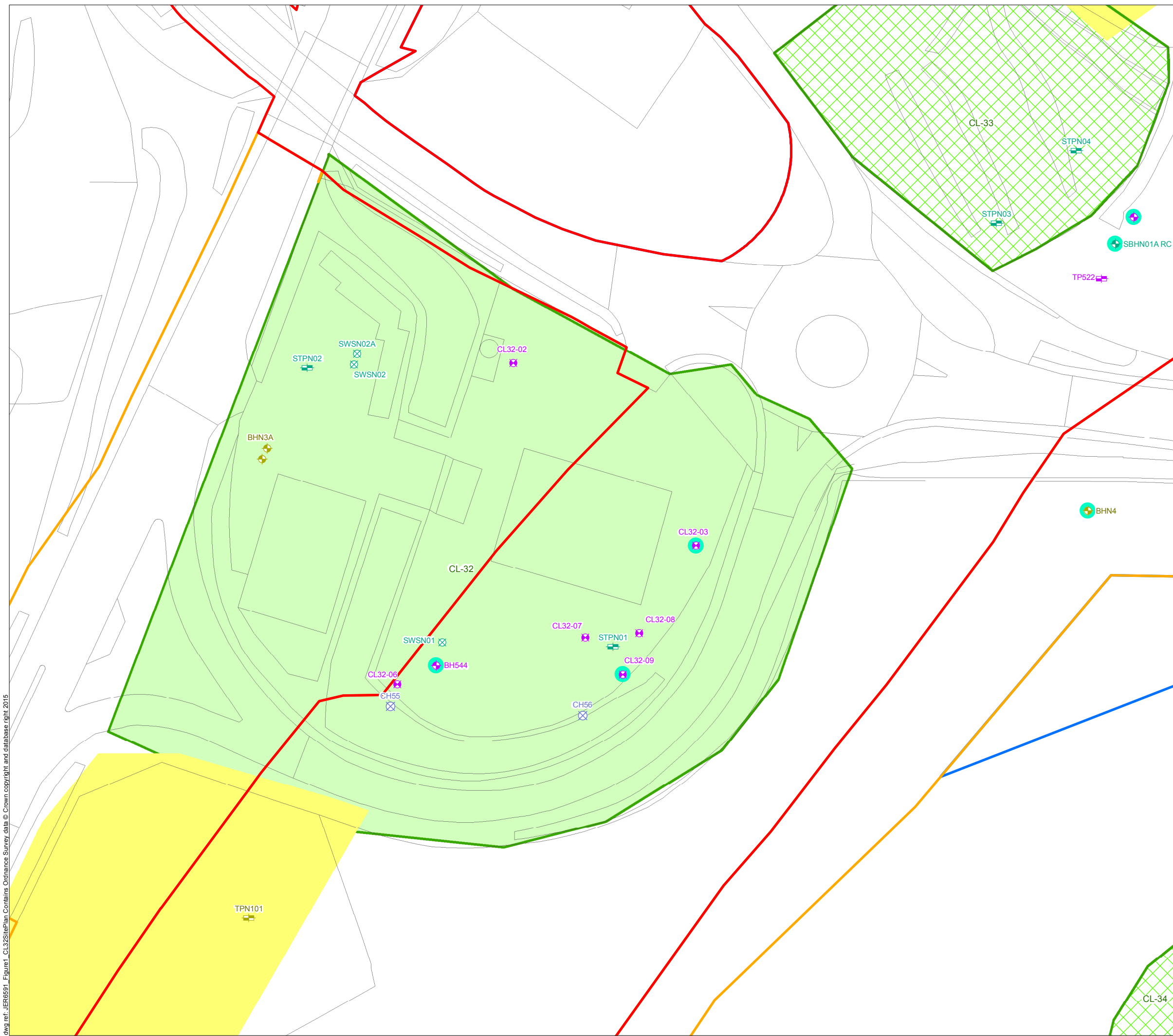
12 Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection
mAOD	Metres Above Ordnance Datum

mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O ₂	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures

dwg ref: JER6591_Figure1 CL32SitePlan Contains Ordnance Survey data © Crown copyright and database right 2015



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Potential Borrow Pit Area
- Potential Area of Land Contamination based on 2014 PSSR
- Other Potential Area of Land Contamination

Investigation Locations

2015 (Geotechnical Engineering)

- Borehole
- Trial Pit
- Window Sample

2007 (Norwest Holst)

- Borehole
- Trial Pit
- Window Sample

2000 (Exploration Associates)

- Window Sample

1997 (Norwest Holst)

- Borehole
- Trial Pit
- Monitoring Well Installation

Llywodraeth Cymru
Welsh Government

Appendix 11.1 Annex D CL-32

Site Plan for CL-32

Figure: 1	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Scale: A3 @ 1:750	0 12.5 25 m	N
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dwg ref: JER6591_Figure1_CL32SitePlan

Made Ground - MG
 Potential Fuel Spills
 Carboniferous Bedrock - CB
 Proposed Cutting
 Hardstanding
 Perched Groundwater (MG)
 Groundwater (CB)
 Gas Migration Pathway

- A** Humans On-Site (M4 User)
- B** Humans On-Site (Construction/Maintenance)
- C** Humans Off-Site (Site Neighbours)
- Dp** Groundwater (Perched)
- Da** Groundwater (Aquifer)

- 1 Dermal Contact
- 2 Inhalation
- 3 Ingestion
- 4 Leaching / Migration
- 5 Surface Run Off

Possible contamination present on site associated with :

- Historical & current site use as a fuel & chemical storage area & maintenance depot
- Evidence of localised fuel / chemical spillages
- Buried diesel fuel tank identified
- Oil / diesel contamination noted within the fractures in the bedrock in the vicinity of the buried diesel fuel tank

No significant sources have been identified



Conceptual Site Model for CL-32

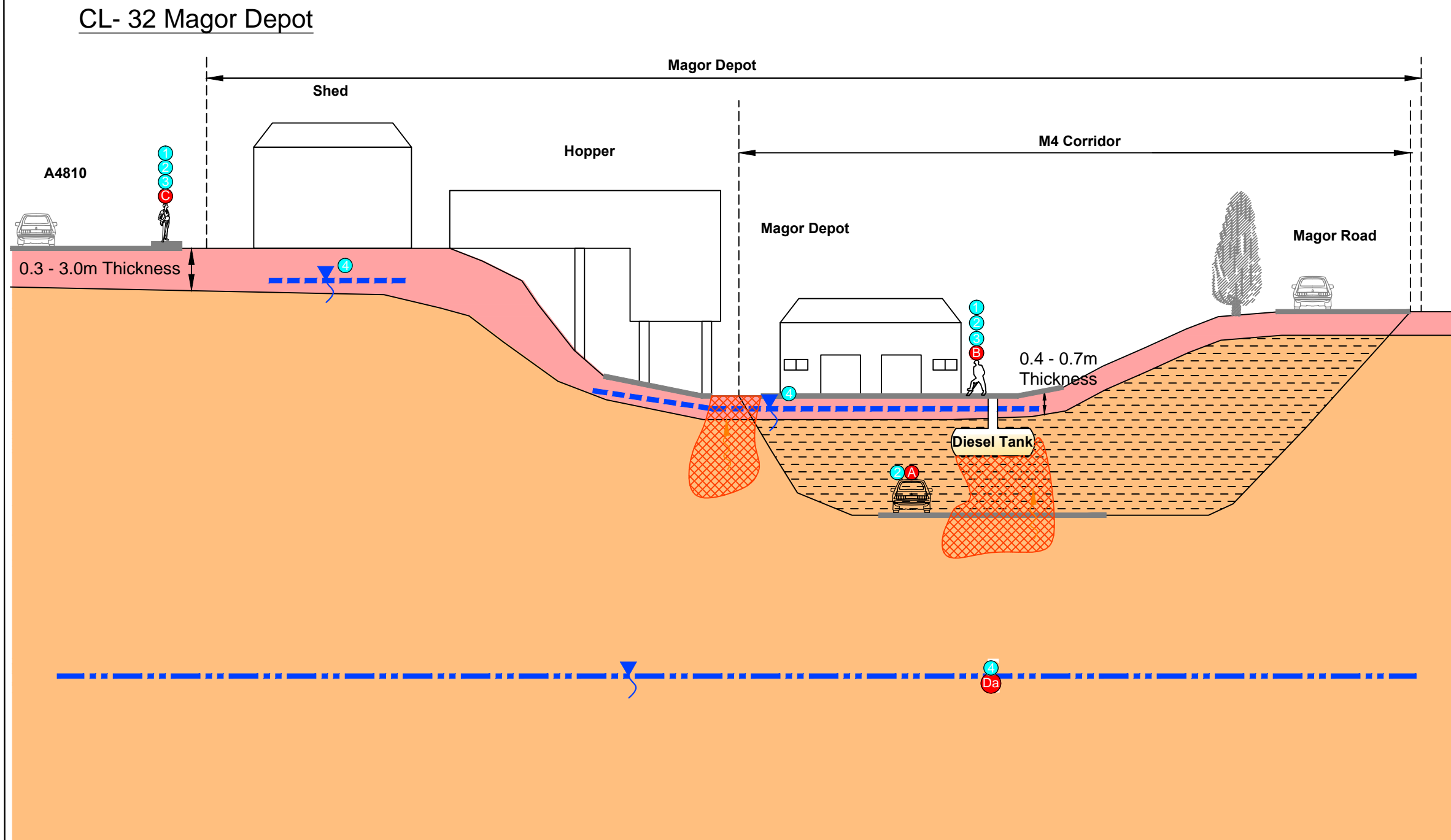
Revision: -

Status: At Issue

Checked: FB

Ground conditions based on available information

dwg ref: JER6591_Figure2_CL32ConceptualSiteModel



Appendices

Appendix 1

Exploratory Records



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHN3

Header

Contract No.	F10895	Method	Rotary Coring	Coordinates	341825.7 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187581.5 N
Client	Welsh Office	Driller	E.D	Ground Level	26.60m AOD
Consultant	Ove Arup and Partners	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	04/11/1997
		Core bit	Saw Tooth	Date Completed	04/11/1997

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
06/11/1997	1800	9.50	5.15	Dry		0.00	5.00	water & mist	100%	NR
07/11/1997	0800	9.50	5.15	Dry		5.00	6.50	water & mist	100%	92
07/11/1997	1800	12.30	5.15	Dry		6.50	8.00	water & mist	0%	92
						8.00	12.30	water & mist	100%	92

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
120	12.30	140	5.15								

GENERAL NOTES		SPT DETAILS		
1. 100mm diameter plastic pipe grouted to 11.70m on completion.		Depth	Type	Incremental blow count/penetration in mm
		1.00	S	N=11 (2,1,2,2,3,4)
		2.00	S	N=19 (2,2,4,4,5,6)
		3.00	S	N=8 (2,1,2,2,2,2)
		4.00	S	N=40 (4,5,7,7,11,15)

NB All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form ROTARY HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHN3

Sheet 1 of 2

Contract No.	F10895	Method	Rotary Coring	Coordinates	341825.7 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187581.5 N
		Driller	E.D	Ground Level	26.60m AOD
Client	Welsh Office	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	04/11/1997
Consultant	Ove Arup and Partners	Core bit	Saw Tooth	Date Completed	04/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
MADE GROUND: Concrete slab (drillers description).		0.20	26.40							
MADE GROUND: Hard core fill (drillers description).		0.40	26.20							
MADE GROUND: Clayey marl fill (drillers descriptions).									S11 1.00 1.45	
									S19 2.00 2.45	
TOPSOIL (drillers description).		2.70	23.90							
		3.00	23.60						S8 3.00 3.45	
Reddish brown CLAY (drillers description). (Marginal Facies of Mercia Mudstone Group)		3.55	23.05							
Soft reddish brown weathered marl MUDSTONE (drillers description). (Marginal Facies of Mercia Mudstone Group)		4.15	22.45						S40 4.00 4.45	
Greyish brown green marl (drillers description). (Marginal Facies of Mercia Mudstone Group)		5.00	21.60							
Reddish brown mottled greyish green medium to thinly sub-horizontally bedded moderately to highly weathered slightly sandy MUDSTONE, moderately weak to moderately strong with closely to medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)				5.00 6.50	100	72	28	4 NI		
---from 5.38m greyish brown completely to highly weathered moderately weak to weak		6.30	20.30					5 2		
---from 5.56 to 5.79m completely fractured				6.50 7.50	43	34	12	6		
Reddish brown mottled green fine grained medium to thinly sub-horizontally bedded moderately to slightly weathered very silty SANDSTONE, moderately strong to moderately weak with closely to medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)				7.50 8.00	96	92	74	3		
		8.00	18.60							
Reddish brown mottled yellowish green medium to thinly sub-horizontally bedded thinly laminated slightly to moderately weathered sandy DOLOMITE, moderately strong to strong with closely to medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)		8.65	17.95	8.00 9.50	100	97	79	8		
---from 8.20 to 8.35m fine to medium gravel sized vugs										
		9.89	16.71					3		

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH ROTARY LOG
Version	1.00
Revised	16/09/96



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHN3

Sheet 2 of 2

Contract No.	F10895	Method	Rotary Coring	Coordinates	341825.7 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187581.5 N
		Driller	E.D	Ground Level	26.60m AOD
Client	Welsh Office	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	04/11/1997
Consultant	Ove Arup and Partners	Core bit	Saw Tooth	Date Completed	04/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
Reddish brown fine to medium grained thinly to medium sub-horizontally bedded slightly weathered silty SANDSTONE, strong with very closely spaced thin laminations to very thin beds of yellowish brown sandy dolomite and closely to medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)		10.29	16.31	9.50 11.00	100	97	71	2		
		11.00	15.60					5		
(9.89-10.29) Yellowish brown medium sub-horizontally bedded fresh to slightly weathered slightly silty very sandy DOLOMITE, strong to very strong with occasional fine gravel sized vugs and undulating thin to thick laminations of calcite. (Marginal Facies of Mercia Mudstone Group)		11.53	15.07	11.00 12.30	100	95	46	4		
								4		
		12.30	14.30					4		
Yellowish to reddish brown thinly sub-horizontally bedded slightly weathered silty very sandy DOLOMITE, strong closely spaced thick laminations to thin beds of reddish brown mottled green moderately weathered sandy mudstone moderately weak very closely to closely spaced discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)										
---from 10.40 to 10.63m very closely spaced undulating thin laminations of calcite										
Reddish brown fine to medium grained thinly to medium sub-horizontally bedded slightly weathered silty dolomitic SANDSTONE, strong with occasional fine gravel size vugs and closely spaced thick laminations to very thin beds of reddish brown mottled greyish green moderately to highly weathered sandy mudstone with very closely to medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)										
---from 11.30 to 11.45m sub-vertical undulating thin laminations of calcite										
Reddish brown occasionally mottled greyish green thinly to medium sub-horizontally bedded moderately weathered sandy MUDSTONE, moderately weak to moderately strong with closely spaced sub-horizontal discontinuities planar rough to smooth tight. (Marginal Facies of Mercia Mudstone Group)										
---from 12.00 to 12.30m slightly to moderately weathered slightly sandy, very strong										
Rotary drilling complete at 12.30 m.										

NB All depths in metres, all diameters in millimetres.

See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form NH ROTARY LOG

Version 1.00

Revised 16/09/96



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHN3A

Header

Contract No.	F10895	Method	Cable Percussion	Coordinates	341826.7 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon	Ground Level	187583.7 N
Client	Welsh Office	Driller	LM	Orientation	26.60m AOD
Consultant	Ove Arup and Partners	Logged by	C.D	Date Started	Vertical
				Date Completed	20/11/1997

PROGRESS						DRILLING DETAILS			
Date	Time	Hole depth	Casing depth	Water depth	Remarks	Hardbore from depth	Hardbore to depth	Chiselling hours	Remarks
20/11/1997	1030	4.90	3.20	Dry		4.50	4.75	1.00	

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
150	4.90	150	3.20								

GENERAL NOTES					SPT DETAILS		
					Depth	Type	Incremental blow count/penetration in mm
					2.00	S	N=11 (1,4,2,3,3,3)
					4.75	S	50/75mm (25,50)
					* Seating blows only.		

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes, chiselling time in hours.

Form CP HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - CABLE PERCUSSION

Borehole No.

BHN3A

Sheet 1 of 1

Contract No.	F10895	Method	Cable Percussion	Coordinates	341826.7 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Pilcon		187583.7 N
Client	Welsh Office	Driller	LM	Ground Level	26.60m AOD
Consultant	Ove Arup and Partners	Logged by	C.D	Orientation	Vertical
				Date Started	20/11/1997
				Date Completed	20/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Sampling	SPT N & (U blows)	SPT type & depth	Installation
CONCRETE		0.30	26.30	D 0.35 - 1.00 B 0.40			
MADE GROUND: Orangish brown silty clay with occasional sub-rounded siliceous gravel and gravel size pockets of sub-angular brick and rubble fragments to 2.00m.				U 1.00 - 1.45	(17)		
				D 1.45			
				D 1.70			
				D 2.00	S11	S 2.00	
				B 2.45 - 3.00		2.45	
				U 3.00 - 3.45	(41)		
Reddish brown mottled greyish green thinly laminated moderately to highly weathered MUDSTONE, very weak to weak with occasional thin laminations of yellowish brown fine to medium sand. (Marginal Facies of Mercia Mudstone Group)		3.20	23.40	D 3.45			
				D 3.80			
				D 4.00			
---from 4.00m purplish brown mottled greyish green							
---from 4.50m weak to moderately weak				D 4.75	S50/75mm	S 4.75	
Cable Percussion boring complete at 4.90 m.		4.90	21.70			4.90	






NB All depths in metres, all diameters in millimetres.

See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form NH CP LOG





Version 2.00

Revised 19/12/1996

Sampling					Strata				
Depth	Type	Casing Depth	Date/ Water	SPT N (Cu)	Description	Depth (Thickness)	Level	Legend	
0.00-0.25	T		05/02		MADE GROUND: Loose brown very silty sandy sub-angular to sub-rounded fine to coarse gravel of slag, ash and sandstone with much root material	G.L.	21.45		
0.25-0.75	TO		0000			0.25	21.20		
0.75-1.00	B				Purple and green grey very silty highly weathered MUDSTONE	(1.45)			
1.00-1.70	TO							1.70
1.70-1.75	T	NIL	DRY		1.75	19.70			
1.75					Red brown silty weathered MUDSTONE End of Borehole.				
Equipment: Hand Held Window Sampler					Groundwater No. Struck Behaviour		Sealed	Ground Level 21.45 m. OD Coordinates 341851.79 mE 187531.14 mN	
Borehole Dia (mm) 80 to 1.00m Casing Dia (mm) 60 to 1.75m					No groundwater encountered		Drilled by DC Logged by DC Checked by AF		
Remarks Refusal at 1.75m See key sheet and appendices for explanations.									
Borehole Record					Project M4 Relief Road - Stage 2. Preliminary Chemical Investigation Ove Arup & Partners		Contract 150006		
 Exploration Associates							Borehole CH55(1 of 1)		

Sampling					Strata			
Depth	Type	Casing Depth	Date/ Water	SPT N (Cu)	Description	Depth (Thickness)	Level	Legend
0.00-0.40	TO		05/02 0000 DRY		Soft to firm brown very silty slightly sandy CLAY with occasional to some root material	G.L. (0.40)	20.64	
0.40-0.60	T	NIL	DRY			0.40	20.24	
0.60					Red and yellow brown weathered MUDSTONE End of Borehole.	0.60	20.04	
Equipment: Hand Held Window Sampler Borehole Dia (mm) Casing Dia (mm) 80 to 0.60m					Groundwater No. Struck Behaviour Sealed No groundwater encountered		Ground Level 20.64 m OD Coordinates 341890.96 mE 187529.33 mN Drilled by DC Logged by DC Checked by AF	
Remarks Refusal at 0.60m See key sheet and appendices for explanations.								
Borehole Record					Project M4 Relief Road - Stage 2. Preliminary Chemical Investigation Ove Arup & Partners		Contract 150006 Borehole CH56(1 of 1)	
Exploration Associates								

Contract No.	F15056	Method	Machine Excavated	Coordinates	341897.20 E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	JCB 3CX	Ground Level	187543.24 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Date Started	20.00m AOD
Consultant	Ove Arup & Partners Ltd			Date Completed	03/12/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sampling	Remarks
MADE GROUND: Reinforced concrete.		0.20	19.80	ES1 0.30	
MADE GROUND: Reddish brown sandy angular to subangular fine to coarse gravel sized fragments of limestone.		0.40	19.60	D2 0.30	
Stiff friable green and red CLAY. (Head Deposits?)		0.60	19.40	B3 0.30	
Moderately weak to moderately strong greenish brown LIMESTONE. Moderately weathered. (Oil/diesel coming through fractures in rock). (Mercia Mudstone Group (Marginal Facies))		0.65	19.35	ES4 0.40	
Trial pit complete at 0.65 m.				D5 0.40	
				B6 0.40	
				ES7 0.60	
				D8 0.60	

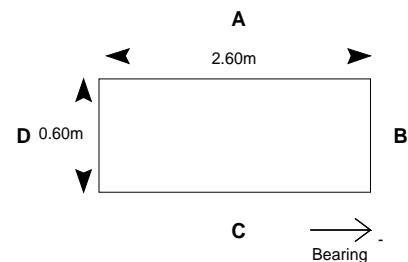
Stability All faces stable

Shoring None used

Groundwater None encountered during excavation

Remarks
1. Diesel tank buried in vicinity of trial pit.
2. Trial pit terminated at 0.65m due to hard strata.

Sketch Plan of Trial Pit




NOTES: All depths in metres, all soil strengths in kPa.
See legend sheet for key to symbols and abbreviations.
All bearings given relate to magnetic North

Form ARIAL TP LOG

Version 3.06

Revised 17/12/2007

Contract No.	F15056	Method	Machine Excavated	Coordinates	341834.86 E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	JCB 3CX	Ground Level	187600.05 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Date Started	26.89m AOD
Consultant	Ove Arup & Partners Ltd			Date Completed	04/12/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sampling		Remarks
MADE GROUND: Reinforced concrete.		0.20	26.69	D1	0.30	
MADE GROUND: Reddish brown angular to subangular fine to coarse gravel sized fragments of limestone.		0.40	26.49	B2	0.30	
Stiff dark reddish brown slightly sandy gravelly CLAY. Gravel is subangular to rounded fine to coarse of sandstone, siltstone, limestone, quartz and mudstone. (Head Deposits?) ---at 0.60m 1 No limestone boulder ---from 2.00m to 2.40m becoming light brown soft and friable				ES3	0.30	
				D4	0.50	
				B5	0.50	
				ES6	0.50	
				B7	0.60	
				D8	1.50	
				B9	2.00	
				D10	2.50	
				D11	3.50	
				B12	3.50	
Trial pit complete at 4.20 m.		4.20	22.69			

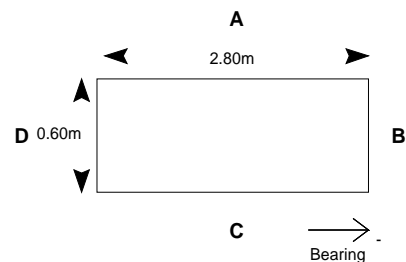
Stability All faces stable

Shoring None used

Groundwater None encountered during excavation

Remarks 1. Trial pit complete at 4.20m.

Sketch Plan of Trial Pit



NOTES: All depths in metres, all soil strengths in kPa.
See legend sheet for key to symbols and abbreviations.
All bearings given relate to magnetic North

Form ARIAL TP LOG

Version 3.06

Revised 17/12/2007



Norwest Holst Soil Engineering Ltd.

HAND VANE AND HAND PENETROMETER TESTS

Hole ID.
STPN02
Data Sheet

Contract No.	F15056	Method	Machine Excavated	Coordinates	341834.86E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	JCB 3CX	Ground Level	187600.05 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Orientation	26.89m AOD
Consultant	Ove Arup & Partners Ltd			Date Started	Vertical
				Date Completed	04/12/2007

Hand Vane				Hand Penetrometer		
Depth	Test No	Peak	Remoulded	Depth	Test No	Result
1.00	01	130.0	130.0			
1.00	02	130.0	130.0			
1.00	03	130.0	130.0			
2.00	04	100.0	40.0			
2.00	05	70.0	20.0			
2.00	06	90.0	50.0			
3.00	07	130.0	130.0			
3.00	08	130.0	130.0			
3.00	09	130.0	130.0			
4.00	10	130.0	130.0			
4.00	11	130.0	130.0			
4.00	12	130.0	130.0			



NOTES: All depths in metres, all diameters in millimetres, test results in kPa.

Form ARIAL HAND VANE/PEN

Version 3.03

Revised 18/01/2007

Contract No.	F15056	Method	Window Sampling	Coordinates	341862.37 E
Project	New M4 - Second Preliminary Ground Investigation				187544.21 N
		Sampling Rig	Hydraulic Hammer	Ground Level	19.92m AOD
Client	Transport Wales, Welsh Assembly Government	Driller	RK	Orientation	Vertical
		Logged by	DH	Date Started	03/12/2007
Consultant	Ove Arup & Partners Ltd			Date Completed	03/12/2007



Description of Strata	Legend	Depth Below G.L.	Datum Level	Sample type and depth		Progress	Installation
MADE GROUND: Concrete (rebar at 0.18m). (Driller's description)		0.25	19.67	ES1	0.30		
MADE GROUND: Sand and gravel. (Driller's description)		0.50	19.42	ES2	0.50		
Weathered SANDSTONE (Driller's description). (Mercia Mudstone Group (Marginal Facies))		0.60	19.32				
Sampling complete at 0.60 m.							

WATER STRIKES								GENERAL NOTES	
Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow	1. Inspection pit excavated from GL to 0.60m. 2. Window Sampling terminated at 0.60m due to refusal.	
03/12/2007		0.40	0.40	20	Seepage	NR	NR		

NOTES: All depths in metres, all diameters in millimetres,
Water strike rise time in minutes. See legend sheet
for key to symbols.

Form	ARIAL WINDOW LOG
Version	3.07
Revised	13/02/2008

Contract No.	F15056	Method	Window Sampling	Coordinates	341844.38 E
Project	New M4 - Second Preliminary Ground Investigation				187600.77 N
		Sampling Rig	Hydraulic Hammer	Ground Level	26.91m AOD
Client	Transport Wales, Welsh Assembly Government	Driller	RK	Orientation	Vertical
		Logged by	DH	Date Started	03/12/2007
Consultant	Ove Arup & Partners Ltd			Date Completed	03/12/2007


Description of Strata	Legend	Depth Below G.L.	Datum Level	Sample type and depth	Progress	Installation
MADE GROUND: Concrete (rebar at 0.18m). (Driller's description)		0.20	26.71	L1 1.20 - 1.80	From: 1.20 To: 1.80 Diameter: 100mm Recovery : 100% Blows: 12	
MADE GROUND: Sandy clay bands of sandstone. (Driller's description)		0.70	26.21			
Stiff reddish brown locally yellow slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular to well rounded fine to coarse of limestone, sandstone and mudstone. (Mercia Mudstone Group (Marginal Facies))		1.80	25.11			
Sampling complete at 1.80 m.						

WATER STRIKES								GENERAL NOTES	
Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow	1.Window Sampling from GL to 1.80m. 2.Window Sampling terminated at 1.80m due to refusal.	

NOTES: All depths in metres, all diameters in millimetres,
 Water strike rise time in minutes. See legend sheet
 for key to symbols.

Form	ARIAL WINDOW LOG
Version	3.07
Revised	13/02/2008

Contract No.	F15056	Method	Window Sampling	Coordinates	341845.05 E
Project	New M4 - Second Preliminary Ground Investigation				187602.93 N
		Sampling Rig	Hydraulic Hammer	Ground Level	26.94m AOD
Client	Transport Wales, Welsh Assembly Government	Driller	RK	Orientation	Vertical
		Logged by	DH	Date Started	03/12/2007
Consultant	Ove Arup & Partners Ltd			Date Completed	03/12/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sample type and depth	Progress	Installation
MADE GROUND: Concrete (rebar at 0.18m). (Driller's description)		0.20	26.74			
MADE GROUND: Sandy clay with lumps of sandstone. (Driller's description)		0.70	26.24			
Stiff orangish brown silty slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is angular to well rounded of limestone, sandstone, quartz and mudstone. (Mercia Mudstone Group (Marginal Facies)) ---from 1.40m to 1.70m yellow mottled light green				L1 1.20 - 1.90	From: 1.20 To: 1.90 Diameter: 100mm Recovery : 100% Blows: 14	
---from 1.90m to 2.10m becomes sandy				L2 1.90 - 2.30	From: 1.90 To: 2.30 Diameter: 90mm Recovery : 100% Blows: 13	
Sampling complete at 2.30 m.		2.30	24.64			

WATER STRIKES								GENERAL NOTES	
Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow	1.Window Sampling from GL to 2.30m. 2.Window Sampling terminated at 2.30m due to refusal.	

NOTES: All depths in metres, all diameters in millimetres,
Water strike rise time in minutes. See legend sheet
for key to symbols.

Form	ARIAL WINDOW LOG
Version	3.07
Revised	13/02/2008

BOREHOLE LOG



BH544

CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 3

Start Date 4 March 2015

Easting 341861.1

Scale 1 : 50

End Date 5 March 2015

Northing 187539.5 Ground level 19.95mOD

Depth 18.40 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
04/03/15 1145hrs	C	0.00 - 0.20			100		✓	MADE GROUND comprising TARMACADAM. (MG)	0.20	19.75	
	1B	0.20 - 0.40						Dark grey subangular medium to coarse limestone	0.50	19.45	
	2D*	0.20 - 0.40						GRAVEL. (MG)	0.60	19.35	
	3B	0.50 - 0.60						Light greyish brown slightly gravelly sandy CLAY. Gravel is subangular medium and coarse limestone. (MG)			
	4D*	0.50 - 0.60									
	5X	0.60 - 1.20	Nil								
	6D	1.20 - 1.65	Nil	S 27				Stiff fissured greenish grey mottled reddish brown gravelly CLAY. Gravel is subangular and subrounded fine and medium lithorelicts of very stiff clay to extremely weak mudstone. Localised relict fissures are randomly orientated extremely closely spaced planar smooth.			
	7X	1.20 - 1.90									
	8C	1.90 - 2.00 1.90 - 3.40	1.90	S*300	100 70 50	65 170 290		Weak and medium strong thinly laminated to very thinly bedded reddish brown MUDSTONE with frequent quartz veins. Fractures are subhorizontal to 20° and 65° to subvertical closely and medium spaced planar smooth.	2.20	17.75	
	9C	3.40 - 4.90	1.90		77 61 61			3.80 - 4.00m: Recovered non intact. 3.95 - 4.30m: Very stiff thickly laminated grey mottled reddish brown silty clay.	4.30	15.65	
04/03/15 1630hrs 4.40m	10C	4.90 - 4.99 4.90 - 6.40	1.90	C*300	290 355 530	100 97 97		Medium strong and strong reddish brown grey fine and medium SANDSTONE. Fractures are subhorizontal to 15° medium spaced undulating rough infilled (up to 2mm) with clay.			
	11C	6.40 - 7.90	1.90		67 35 16	NI 65 125		6.40 - 7.90m: Limited recovery. Frequent thick laminae of reddish brown clay. Fractures are closely spaced, locally non intact.			
		7.90 - 8.00	1.90	C*333				7.50 - 7.90m: Recovered non intact.	7.90	12.05	
Continued Next Page									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary core drilled (300mm) 0.00-0.20m. Hand dug inspection pit 0.20-0.60m. Dynamic sampled (113mm) 0.60-1.90. Waterflush rotary core drilled (116mm) 1.90-18.40m.

CASING: 140mm diam to 1.90m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 18.40m, granular response zone 18.40-1.00m, bentonite seal 1.00-0.20m, concrete and stopcock cover 0.20-0.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
30238CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH544

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 3

Start Date 4 March 2015

Easting 341861.1

Scale 1 : 50

End Date 5 March 2015

Northing 187539.5 Ground level 19.95mOD

Depth 18.40 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
05/03/15 0830hrs 4.70m	12C	7.90 - 9.40			100 75 45	NI 70 85		Very weak thinly laminated to very thinly bedded reddish brown MUDSTONE. Fractures are subhorizontal to 20° closely spaced locally non intact planar smooth infilled (up to 2mm) with clay.	8.40	11.55	
	13C	9.40 - 10.90	1.90		100 70 58	NI 110 320		Weak and medium strong reddish brown and grey fine SANDSTONE. Fractures are subhorizontal to 10° closely and medium spaced locally non intact undulating rough and planar smooth infilled (up to 2mm) with clay.			
	14C	10.90 - 12.40	1.90		100 85 57	NI 80 170		Weak grey mottled reddish brown SILTSTONE with closely spaced thick laminae of very stiff clay and extremely weak mudstone. Fractures are 10-20° closely spaced planar smooth.	10.50	9.45	
	15C	12.40 - 13.90	1.90		95 78 63	NI 100 130		Very weak thinly laminated grey mottled reddish brown SILTSTONE with frequent very thin beds of extremely weak grey mudstone. Fractures are 10-15° closely spaced locally non intact planar smooth infilled (up to 5mm) with grey clay.	11.25	8.70	
	16C	13.90 - 15.40	1.90		100 90 70	NI 70 130		Weak and medium strong grey mottled reddish brown and orangish brown SILTSTONE locally tending to fine and medium sandstone. Fractures are 10-15° and subvertical locally non intact planar smooth locally stained orangish brown.	12.35	7.60	
	17C	15.40 - 16.90	1.90		92 66 44	30 160 250		12.65 - 12.90m: Weak dark grey mudstone. 60-70° fracture stained dark orangish brown. 12.90 - 13.05m: Extremely weak grey mudstone.	13.40	6.55	
	18C	16.90 - 18.40	1.90		140	NI 50 110		Weak and medium strong grey mottled reddish brown and light greenish grey fine and medium SANDSTONE with rare thick laminae of grey clay. Fractures are subhorizontal to 20° closely and medium rarely very closely spaced planar rough.	14.90	5.05	
					98 78 74	NI 60 120		Extremely weak and very weak grey and dark grey locally mottled reddish brown MUDSTONE. Fractures are 10-20° very closely and closely spaced planar smooth with a veneer of grey clay frequently stained dark orangish brown.	16.20	3.75	
					120 170 290			15.70 - 15.80m: Strong dark grey calcareous mudstone.	16.55	3.40	
								Strong light grey and light bluish grey fine and medium SANDSTONE. Fractures are 10-20° closely spaced planar rough stained orangish brown.			
								Weak dark grey SILTSTONE. Fractures are 10-20° closely spaced planar smooth stained orangish brown.			
								16.55 - 17.20m: Frequent intersecting 40-60° fractures undulating smooth stained orangish brown.			
								17.65m: 10mm 10-20° calcite vein.			
								17.65 - 18.00m: Strong dark grey calcareous siltstone.			
								Continued Next Page	{18.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks								AGS	CONTRACT	CHECKED	
Groundwater not encountered prior to use of water flush.									30238	EC	



CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Start Date 4 March 2015 Easting 341861.1

End Date 5 March 2015 Northing 187539.5 Ground level 19.95mOD






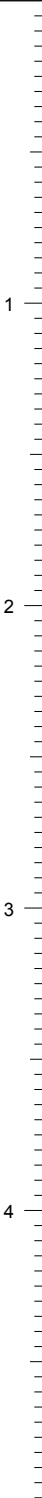

BH544

Sheet 3 of 3


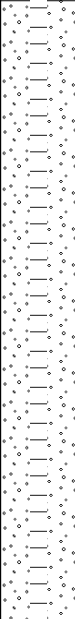



Scale 1 : 50




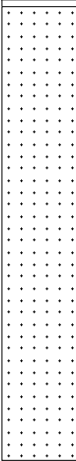

Depth 18.40 m











progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- -ment	description	depth (m)	reduced level (m)	legend
05/03/15 1620hrs 4.40m								Borehole completed at 18.40m.	18.40	1.55	x x x x x x x x x
									{28.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks									CONTRACT 30238		CHECKED EC
Groundwater not encountered prior to use of water flush.											









		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-02 Sheet 1 of 1		
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015				Hole Type:		
Project No: JFR8701		Easting: 341877		Drilling Method:				WLS		
Location: Wilcrick Depot, Magor		Northing: 187601		Windowless Sample Rig		Casing Diameter (mm)	Casing Depth (m)	Scale:		
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 19.99		Logged By: MR				1:25		
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results						
		0.52	PID1	0.0ppm	0.00	(0.22) (0.30) (0.48)	19.99	  	Concrete. (MADE GROUND)	
					0.22		19.77		Dark grey subangular medium and coarse limestone GRAVEL with medium cobble content. (MADE GROUND)	
					0.52		19.47		Brownish grey fine grained SANDSTONE. (TINTERN SANDSTONE FORMATION)	
					End of Borehole at 1.00m					
Remarks Hand pit excavated to 0.52m. No groundwater encountered. No visual or olfactory evidence of hydrocarbon contamination. Tintern Sandstone is Class B - Partially Weathered										
					Groundwater			Chiselling		
					Depth Strike (m)	Depth Casing (m)	Level After 20 Mins	Duration (hh:mm)	Top Depth (m)	Base Depth (m)
										
























		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-03 Sheet 2 of 3				
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015 - 29/09/2015				Hole Type:				
Project No: JFR8701		Easting: 341914		Drilling Method:		Pipe Diameter: 50mm		WLS				
Location: Wilcrick Depot, Magor		Northing: 187564		Windowless Sample Rig and Rotary Open Hole		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 20.11		Logged By: MR				1:25				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
										5		
										6		
					6.40	(2.20)	13.71		Reddish brown fine grained MUDSTONE. (TINTERN SANDSTONE FORMATION)	7		
						(4.30)				8		
										9		
Continued on next sheet												
Remarks						Groundwater		Chiselling				
Hand pit excavated to 0.97m. Windowless Sample drilling to 1.13m (refusal) followed by Rotary Open Hole drilling. No visual or olfactory evidence of hydrocarbon contamination. Borehole collapsed to 7.0 m BGL. Tintern Sandstone is Class C - Distinctly Weathered from 0.70 - 0.97 m and Class B - Partially Weathered from 0.99 - 1.13 m						Depth Strike (m)	Depth Casing (m)	Level After 20 Mins	Duration (hh:mm)		Top Depth (m)	Base Depth (m)
						5.50						


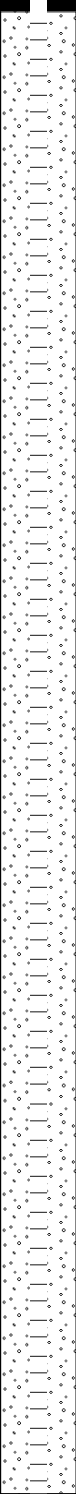
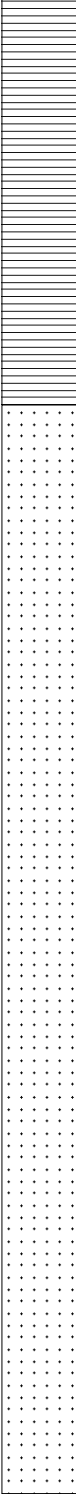

		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-03 Sheet 3 of 3				
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015 - 29/09/2015				Hole Type:				
Project No: JFR8701		Easting: 341914		Drilling Method:		Pipe Diameter: 50mm		WLS				
Location: Wilcrick Depot, Magor		Northing: 187564		Windowless Sample Rig and Rotary Open Hole		Casing Diameter (mm)		Casing Depth (m)				
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 20.11		Logged By: MR				Scale: 1:25				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
					10.70	(1.50)	9.41	 	Interbedded greyish brown fine to medium grained SANDSTONE and reddish brown fine grained MUDSTONE. Beds approximately 0.5 m - 1.0 m thick. (TINTERN SANDSTONE FORMATION)	10		
										11		
									End of Borehole at 12.20m	12		
										13		
										14		
Remarks						Groundwater			Chiselling			
Hand pit excavated to 0.97m. Windowless Sample drilling to 1.13m (refusal) followed by Rotary Open Hole drilling. No visual or olfactory evidence of hydrocarbon contamination. Borehole collapsed to 7.0 m BGL. Tintern Sandstone is Class C - Distinctly Weathered from 0.70 - 0.97 m and Class B - Partially Weathered from 0.99 - 1.13 m						Depth Strike (m)	Depth Casing (m)	Level After 20 Mins	Duration (hh:mm)	Top Depth (m)		Base Depth (m)
						5.50						



		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-06 Sheet 1 of 1			
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015				Hole Type:			
Project No: JFR8701		Easting: 341853		Drilling Method:				WLS			
Location: Wilcrick Depot, Magor		Northing: 187536		Windowless Sample Rig		Casing Diameter (mm)	Casing Depth (m)	Scale:			
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 20.04		Logged By: MR				1:25			
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale	
		Depth (m)	Type	Results							
		0.40 0.40	ES PID1	0.0ppm	0.00		20.04		Concrete. (MADE GROUND)		
						(0.20)	19.84		Dark grey subangular medium and coarse limestone		
						(0.15)	19.69		GRAVEL. (MADE GROUND)		
						(0.10)	19.59		Soft to firm greyish brown gravelly CLAY. Gravel is subangular medium and coarse limestone. (MADE GROUND)		
						(0.35)			Firm to very stiff grey gravelly CLAY. Gravel is subangular and subrounded fine and medium lithorelicts of extremely weak mudstone. (TINTERN SANDSTONE FORMATION)		
						(0.13)	19.24		Reddish brown fine grained MUDSTONE. (TINTERN SANDSTONE FORMATION)		
									End of Borehole at 0.93m		
Remarks					Groundwater			Chiselling			
Hand pit excavated to 0.8m. No groundwater encountered. No visual or olfactory evidence of hydrocarbon contamination. Borehole refused at 0.93m. Tintern Sandstone is Class E - Residual Soil from 0.45 to 0.80 m and Class C - Distinctly Weathered from 0.80 to 0.93 m					Depth Strike (m)	Depth Casing (m)	Level After 20 Mins	Duration (hh:mm)	Top Depth (m)	Base Depth (m)	

		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-07 Sheet 1 of 1				
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015				Hole Type:				
Project No: JFR8701		Easting: 341891		Drilling Method:				WLS				
Location: Wilcrick Depot, Magor		Northing: 187545		Windowless Sample Rig		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 20.04		Logged By: MR				1:25				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
		0.50 0.50	ES PID1	0.0ppm	0.00		20.04		Concrete. (MADE GROUND)			
					0.22	(0.22)	19.82		Dark grey subangular medium to coarse limestone GRAVEL. (MADE GROUND)			
					0.40	(0.18)	19.64		Soft yellowish grey gravelly SILT. Gravel is subangular and subrounded fine and medium lithorelicts siltstone. (TINTERN SANDSTONE FORMATION)			
					0.68	(0.28)	19.36		Yellowish grey SILTSTONE. (TINTERN SANDSTONE FORMATION)			
						(0.12)			End of Borehole at 0.80m			
<div>Remarks</div> <div>Hand pit excavated to 0.68m. No groundwater encountered. No visual or olfactory evidence of hydrocarbon contamination. Borehole refused at 0.8m</div> <div>Tintern Sandstone is Class E - Residual Soil from 0.40 to 0.68 m and Class D - Destroyed from 0.68 to 0.8m</div>												
				Groundwater			Chiselling					
Depth Strike (m)		Depth Casing (m)		Level After 20 Mins		Duration (hh:mm)		Top Depth (m)			Base Depth (m)	

		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-08 Sheet 1 of 1			
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015				Hole Type:			
Project No: JFR8701		Easting: 341903		Drilling Method:				WLS			
Location: Wilcrick Depot, Magor		Northing: 187546		Windowless Sample Rig		Casing Diameter (mm)	Casing Depth (m)	Scale:			
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 20.08		Logged By: MR				1:25			
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale	
		Depth (m)	Type	Results							
		0.55 0.55	ES PID1	0.0ppm	0.00		20.08	    	Concrete. (MADE GROUND)	1	
					0.22	(0.22)	19.86				Dark grey subangular medium to coarse limestone GRAVEL. (MADE GROUND)
					0.50	(0.11)	19.58				Soft brown slightly gravelly CLAY. Gravel is subangular medium and coarse limestone.
					0.61	(0.20)	19.47				(MADE GROUND)
					0.81	(0.31)	19.27				Firm to very stiff reddish brown gravelly CLAY. Gravel is subangular and subrounded fine and medium lithorelicts mudstone. (TINTERN SANDSTONE FORMATION)
											Reddish brown fine grained MUDSTONE. (TINTERN SANDSTONE FORMATION)
End of Borehole at 1.12m											
Remarks											
Hand pit excavated to 0.81m. No groundwater encountered. No visual or olfactory evidence of hydrocarbon contamination. Borehole refused at 1.12m. Tintern Sandstone is Class E - Residual Soil from 0.61 to 0.81 m and Class B - Partially Weathered from 0.81 to 1.12 m					Groundwater			Chiselling			
					Depth Strike (m)	Depth Casing (m)	Level After 20 Mins	Duration (hh:mm)	Top Depth (m)	Base Depth (m)	
											

		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-09 Sheet 1 of 3									
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015 - 29/09/2015				Hole Type:									
Project No: JFR8701		Easting: 341899		Drilling Method:		Pipe Diameter: 50mm		WLS									
Location: Wilcrick Depot, Magor		Northing: 187538		Windowless Sample Rig and Rotary Open Hole		Casing Diameter (mm)	Casing Depth (m)	Scale:									
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 20.15		Logged By: MR		15	2.00	1:25									
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale							
		Depth (m)	Type	Results													
		0.40	ES PID1	0.0ppm	0.00	(0.21)	20.15		Concrete. (MADE GROUND)								
		0.40			0.21	(0.14)	19.94		Dark grey subangular medium and coarse limestone GRAVEL. (MADE GROUND)								
					0.35	(0.05)	19.80		Soft red brown gravelly CLAY. Gravel is subangular medium and coarse limestone. (MADE GROUND)								
					0.40	(0.05)	19.75		Soft brown sandy gravelly CLAY. Gravel is subangular medium and coarse limestone. (MADE GROUND)								
					0.45	(0.30)	19.70		Greenish grey fine grained MUDSTONE. (TINTERN SANDSTONE FORMATION)								
					0.75	(0.15)	19.40		Brownish orange fine grained MUDSTONE. (TINTERN SANDSTONE FORMATION)								
		0.90				19.25		Interbedded greyish brown fine to medium grained SANDSTONE and reddish brown fine grained MUDSTONE. Beds approximately 0.5m - 1.0m thick. (TINTERN SANDSTONE FORMATION)									
		2.70					17.45		Reddish brown fine grained MUDSTONE. (TINTERN SANDSTONE FORMATION)								
											(3.60)						
		Remarks Hand pit excavated to 0.75m. Windowless Sample drilling to 0.9m (refusal) followed by Rotary Open Hole drilling. No visual or olfactory evidence of hydrocarbon contamination. Tintern Sandstone is Class C - Distinctly Weathered from 0.45 to 0.75 m and Class B - Partially Weathered from 0.75 to 0.90 m						Groundwater			Chiselling						
		Depth Strike (m)			Depth Casing (m)	Level After 20 Mins	Duration (hh:mm)	Top Depth (m)	Base Depth (m)								
		2.70			2.00												

		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-09 Sheet 2 of 3				
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015 - 29/09/2015				Hole Type:				
Project No: JFR8701		Easting: 341899		Drilling Method:		Pipe Diameter: 50mm		WLS				
Location: Wilcrick Depot, Magor		Northing: 187538		Windowless Sample Rig and Rotary Open Hole		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 20.15		Logged By: MR		15	2.00	1:25				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
						6.30		13.85		<p>Interbedded greyish brown fine to medium grained SANDSTONE and reddish brown fine grained MUDSTONE. Beds approximately 0.5m - 1.0m thick. (TINTERN SANDSTONE FORMATION)</p>	5	
											6	
											7	
											8	
											9	
Continued on next sheet												
Remarks Hand pit excavated to 0.75m. Windowless Sample drilling to 0.9m (refusal) followed by Rotary Open Hole drilling. No visual or olfactory evidence of hydrocarbon contamination. Tintern Sandstone is Class C - Distinctly Weathered from 0.45 to 0.75 m and Class B - Partially Weathered from 0.75 to 0.90 m						Groundwater			Chiselling			
						Depth Strike (m)	Depth Casing (m)	Level After 20 Mins	Duration (hh:mm)	Top Depth (m)	Base Depth (m)	
						2.70	2.00					

		<h1>WINDOW SAMPLE LOG</h1>						Borehole No. CL32-09 Sheet 3 of 3				
Project Name: M4 CaN Additional GI		Co-ordinates:		Date(s): 28/09/2015 - 29/09/2015				Hole Type:				
Project No: JFR8701		Easting: 341899		Drilling Method:		Pipe Diameter: 50mm		WLS				
Location: Wilcrick Depot, Magor		Northing: 187538		Windowless Sample Rig and Rotary Open Hole		Casing Diameter (mm)	Casing Depth (m)	Scale:				
Client: Costain & Vinci Joint Venture		Ground Level (mAOD): 20.15		Logged By: MR		15	2.00	1:25				
Well	Water Strike(s)	Samples & In Situ Testing			Depth (mbGL)	Thickness (m)	Level (mAOD)	Legend	Stratum Description	Scale		
		Depth (m)	Type	Results								
<div><div></div><div>End of Borehole at 10.00m</div></div>												
<div>Remarks</div> <div>Hand pit excavated to 0.75m. Windowless Sample drilling to 0.9m (refusal) followed by Rotary Open Hole drilling. No visual or olfactory evidence of hydrocarbon contamination. Tintern Sandstone is Class C - Distinctly Weathered from 0.45 to 0.75 m and Class B - Partially Weathered from 0.75 to 0.90 m</div>												
				Groundwater			Chiselling					
Depth Strike (m)		Depth Casing (m)		Level After 20 Mins		Duration (hh:mm)		Top Depth (m)			Base Depth (m)	
2.70		2.00										

Appendix 2

Gas and Groundwater Monitoring Dataset

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH544	17/04/15 11:30:00	1020	-0.35								0.0	12		60 litres purged, base depth 18.40m.	
BH544	17/04/15 11:31:00										0.0				
BH544	17/04/15 11:32:00										0.0				
BH544	17/04/15 11:33:00										0.0				
BH544	17/04/15 11:34:00										0.0				
BH544	17/04/15 11:35:00				0.8	0.1	12.1	1.0	0	0	5.3				
BH544	17/04/15 11:36:00				0.7	0.1	12.0	1.0	0	0	4.5				
BH544	17/04/15 11:37:00				0.6	0.1	12.6	1.0	0	0	3.5				
BH544	17/04/15 11:38:00				0.6	0.1	12.8	1.0	0	0	3.0				
BH544	17/04/15 11:39:00				0.6	0.1	12.5	1.0	0	0	2.8				
BH544	17/04/15 11:40:00				0.6	0.1	12.5	1.0	0	0	2.8				
BH544	17/04/15 11:41:00				0.7	0.1	12.3	1.0	0	0	2.5				
BH544	17/04/15 11:42:00				0.7	0.1	12.3	1.0	0	0	2.4				
BH544	17/04/15 11:43:00				0.7	0.1	12.4	1.0	0	0	2.3				
BH544	17/04/15 11:44:00				0.7	0.1	12.5	1.0	0	0	2.3				8.34
BH544	24/04/15 13:30:00	1012	-0.63								0.0	13		60 litres purged, base depth 18.40m.	
BH544	24/04/15 13:31:00										0.0				
BH544	24/04/15 13:32:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH544	24/04/15 13:33:00										0.0			
BH544	24/04/15 13:34:00										0.0			
BH544	24/04/15 13:35:00			1.3	0.1	14.5	1.0	0	0	4.7				
BH544	24/04/15 13:36:00			1.3	0.1	14.4	1.0	0	0	4.1				
BH544	24/04/15 13:37:00			1.3	0.1	14.3	1.0	0	0	3.7				
BH544	24/04/15 13:38:00			1.3	0.1	14.2	1.0	0	0	3.2				
BH544	24/04/15 13:39:00			1.3	0.1	14.2	1.0	0	0	3.1				
BH544	24/04/15 13:40:00			1.3	0.1	14.2	0.0	0	0	2.9				
BH544	24/04/15 13:41:00			1.3	0.1	14.1	1.0	0	0	2.7				
BH544	24/04/15 13:42:00			1.3	0.1	14.1	1.0	0	0	2.5				
BH544	24/04/15 13:43:00			1.3	0.1	14.1	1.0	0	0	2.5				
BH544	24/04/15 13:44:00			1.3	0.1	14.1	1.0	0	0	2.5			8.36	
BH544	01/05/15 11:00:00	992	-0.89								0.0	9		59 litres purged, base depth 18.40m.
BH544	01/05/15 11:01:00										0.0			
BH544	01/05/15 11:02:00										0.0			
BH544	01/05/15 11:03:00										0.0			
BH544	01/05/15 11:04:00										0.0			
BH544	01/05/15 11:05:00			0.0	0.0	20.8	0.0	0	0	2.3				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks		
BH544	01/05/15 11:06:00	1017	0	0.1	0.0	20.4	0.0	0	0	2.1	0.0	16	8.44			
BH544	01/05/15 11:07:00			0.3	0.0	18.8	1.0	0	0	2.0						
BH544	01/05/15 11:08:00			0.4	0.0	18.1	1.0	0	0	1.9						
BH544	01/05/15 11:09:00			0.6	0.0	17.8	1.0	0	0	1.7						
BH544	01/05/15 11:10:00			0.7	0.0	17.8	1.0	0	0	1.6						
BH544	01/05/15 11:11:00			0.7	0.0	17.9	1.0	0	0	1.5						
BH544	01/05/15 11:12:00			0.8	0.0	17.9	1.0	0	0	1.5						
BH544	01/05/15 11:13:00			0.8	0.0	18.0	1.0	0	0	1.4						
BH544	01/05/15 11:14:00			0.8	0.0	18.0	1.0	0	0	1.4						
BH544	11/05/15 12:42:00															
BH544	11/05/15 12:43:00															
BH544	11/05/15 12:44:00															
BH544	11/05/15 12:45:00															
BH544	11/05/15 12:46:00															
BH544	11/05/15 12:47:00					0.7	0.0	11.4	0.0	0					0	0.2
BH544	11/05/15 12:48:00					0.7	0.0	11.3	0.0	0					0	0.0
BH544	11/05/15 12:49:00					0.7	0.0	11.2	0.0	0					0	0.0
BH544	11/05/15 12:50:00					0.7	0.0	11.2	0.0	0					0	0.0
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC	

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH544	11/05/15 12:51:00			0.7	0.0	11.3	0.0	0	0	0.0				
BH544	11/05/15 12:52:00			0.8	0.0	11.3	0.0	0	0	0.0				
BH544	11/05/15 12:53:00			0.8	0.0	11.4	0.0	0	0	0.0				
BH544	11/05/15 12:54:00			0.8	0.0	11.5	0.0	0	0	0.0				
BH544	11/05/15 12:55:00			0.9	0.0	11.6	0.0	0	0	0.0				
BH544	11/05/15 12:56:00			0.9	0.0	11.6	0.0	0	0	0.0				
BH544	11/05/15 12:57:00												9.72	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

Gas Monitoring Record

Project Number:	JFR8701
Project Name:	Wilorick Depot
Date:	15/10/2015
Logger	EF

Weather:	Dry & cold
----------	------------

*mbgl - Meters below Ground Level

			Initial	10 secs	20 secs	30 secs	40 secs	50 secs	60 secs	70 secs	80 secs	90 secs	100 secs	110 secs	120 secs	130 secs	140 secs	150 secs	180 secs	300 secs	Groundwater Level (mbgl*)	Borehole Base (mbgl*)	Comments
Borehole ID	BH544	CH4 (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8.53	17.92	
Flow Rate (l/hr)	0	CO2 (%)	0	0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1			
Atmospheric Pressure (mbar)	1021	H2S (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Borehole Pressure (Pa)	Not Measured	O2 (%)	20.7	20.7	15	15	11.8	11.8	11.5	11.5	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4			
Time	10:30	LEL (%)	2	2	1	0	0	0	1	1	0	0	1	1	1	1	1	1	1	1			
Peak VOC	Not Measured	CO (ppm)	2	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			

			Initial	10 secs	20 secs	30 secs	40 secs	50 secs	60 secs	70 secs	80 secs	90 secs	100 secs	110 secs	120 secs	130 secs	140 secs	150 secs	180 secs	300 secs	Groundwater Level (mbgl*)	Borehole Base (mbgl*)	Comments
Borehole ID	CL32-09	CH4 (%)	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.14	10.18	
Flow Rate (l/hr)	0	CO2 (%)	0	0.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Atmospheric Pressure (mbar)	1021	H2S (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Borehole Pressure (Pa)	Not Measured	O2 (%)	20.4	19.7	18	18	16.7	16.7	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6			
Time	11:20	LEL (%)	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Peak VOC	Not Measured	CO (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			

			Initial	10 secs	20 secs	30 secs	40 secs	50 secs	60 secs	70 secs	80 secs	90 secs	100 secs	110 secs	120 secs	130 secs	140 secs	150 secs	180 secs	300 secs	Groundwater Level (mbgl*)	Borehole Base (mbgl*)	Comments
Borehole ID	CL32-03	CH4 (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.83	6.87	
Flow Rate (l/hr)	0	CO2 (%)	0	0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1			
Atmospheric Pressure (mbar)	1021	H2S (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Borehole Pressure (Pa)	Not Measured	O2 (%)	20.7	20.5	20.2	20	19.5	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3			
Time	12:15	LEL (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Peak VOC	Not Measured	CO (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			

Appendix 3

Soil Laboratory Data

Appendix 4

Groundwater Laboratory Data

Appendix 5

Soil Leachate Laboratory Data

M4CAN
Leachate Analysis Results & Screening Assessment
CL-32
08/07/2015

Geological Formation Legend

MG	Made Ground
B	Bedrock

Screening Values & Assessment

EQS	Environmental Quality Standards
DWS	Drinking Water Standard
	Exceeds EQS
X	Exceeds DWS
X	Laboratory detection level higher than screening criterion

Notes

EQS calcium carbonate 100 - 150mg/l for heavy metals: chromium, copper, lead, nickel and zinc

Sample Reference	Units	Screening Values		STPN01	STPN02	SWSN02	CH55	SWSN01
Specimen Depth (mbGL)		EQS	MRV	0.4	0.5	1.2	0	0.3
Level				19.6	26.39	25.71	21.45	19.62
Sample Type				ES	ES	L	D	ES
Geology Code				HD	HD	B	MG	MG
Cluster Code				2007 GI	2007 GI	2007 GI	2000 GI	2007 GI
2:1 Results								
Arsenic Dissolved	ug/l	50	10	22	3	1		<1
Boron Dissolved	ug/l	2000	1000	40	160			
Barium Dissolved	ug/l			27	22	290		36
Beryllium Dissolved	ug/l							<1
Cadmium Dissolved	ug/l	0.15	5	<0.4	<0.4	<0.5		<0.5
Chromium Dissolved	ug/l		50	23	15	22		1
Copper Dissolved	ug/l	10	2000	<1	8	16		2.9
Iron Dissolved	ug/l	1000	200					70
Mercury Dissolved	ug/l	0.07	1			0.02		<0.01
Molybdenum Dissolved	ug/l			4	41	5		<1
Nickel Dissolved	ug/l	4	20	10	2	8.3		<1.5
Lead Dissolved	ug/l	1.2	10	3	<1	2.2		2.8
Antimony Dissolved	ug/l		5	<5	<5	3		<1
Selenium Dissolved	ug/l		10	<1	<1	2		<1
Vanadium Dissolved	ug/l							4
Zinc Dissolved	ug/l	75		<3	<3	<5		<5
Total Cyanide	mg/l	0.001	0.05	<0.05	0.61	<0.05		<0.05
pH	pH units	6-9	6.5-10				9.8	
TPH FTIR	mg/l						0.8	
TPH GC	mg/l						IS	

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS
4	3	22	1	STPN01 @ 0.4mbGL	0	1
2	2	160	40	STPN02 @ 0.5mbGL	0	0
5	4	290	22	SWSN02 @ 1.2mbGL		
5	0	None > LOD	None > LOD			
4	0	None > LOD	None > LOD		0	0
4	4	23	1	STPN01 @ 0.4mbGL		0
4	3	16	2.9	SWSN02 @ 1.2mbGL	1	0
1	1	70	70	SWSN01 @ 0.3mbGL	0	0
2	1	0.02	0.02	SWSN02 @ 1.2mbGL	0	0
4	3	41	4	STPN02 @ 0.5mbGL		
4	3	10	2	STPN01 @ 0.4mbGL	2	0
4	3	3	2.2	STPN01 @ 0.4mbGL	3	0
4	1	3	3	SWSN02 @ 1.2mbGL		0
4	1	2	2	SWSN02 @ 1.2mbGL		0
4	1	4	4	SWSN01 @ 0.3mbGL		
4	0	None > LOD	None > LOD		0	
4	1	0.61	0.61	STPN02 @ 0.5mbGL	1	1
1	1	9.8	9.8	CH55 @ 0mbGL	1	0
1	1	0.8	0.8	CH55 @ 0mbGL		
1	0	None > LOD	None > LOD			

Appendix 6

Relevant Extracts of Additional Environmental Data



Plate 01: Extract of 2006 Aerial Photograph

Plate 02:

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment
Report Annex D
CL-33 B4245 Quarry

M4CaN-DJV-EGT-ZG_GEN-RP-EN-0022

At Issue | March 2016

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Appendix 3	Soil Laboratory Data
Appendix 4	Groundwater Laboratory Data
Appendix 5	Soil Leachate Laboratory Data
Appendix 6	Site Walkover Photographs
Appendix 7	Relevant Extract of Additional Environmental Data

1 Introduction

1.1 Background

1.1.1 This report relates to an area of land potentially affected by contamination (CL-33) known as the “B4245 Quarry” hereinafter referred to as the Site.

1.1.2 The Site is located between chainage 20,800 and 20,900, upon a partially backfilled quarry, within the grounds of a former vicarage (See Figure 1).

1.2 Reporting Context

1.2.1 The Site has been assessed as part of ground investigations and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the “Scheme”) and informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA for Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the Chapter on Geology and Soils (Chapter 11).

1.2.2 In 2014, a Preliminary Sources Study Report (PSSR 2014) was prepared as an initial land contamination appraisal (Ove Arup & Partners, 2014) as part of Design Manual for Roads and Bridges (DMRB) Stage 2 Assessments for a number of potential route options. This identified a number of individual areas that may have been affected by contamination as a result of historical activities at the site. In addition, this report draws upon the 2015 Supplementary Ground Investigation report on behalf of the Welsh Government (Geotechnical Engineering, 2015). This report relates to the area defined on the Site Location Plan Figure 1.

1.2.3 The overarching rationale and approach for the assessment of areas of land along the proposed new section of motorway with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

1.3.1 The key objectives of this report are set out below.

- Undertake a risk assessment of the Site and determine whether potential risks to human health or controlled waters could exist based upon the Scheme.
- Identify the need for further assessment and investigation in order to refine potential land contamination risks and inform the need for remediation/mitigation.
- To provide information to support the Ground Investigation Report (GIR) and Geotechnical Design Report (GDR) required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

1.4.1 The subsequent report structure is as follows.

- Section 2: Site Location and Description.
- Section 3: The Scheme – This section details the new section of motorway alignment and associated features at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and historical land photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and any relevant environmental information presented in the 2014 PSSR.
- Section 6: Scope of Ground Investigations Work – This section describes the previous and supplementary ground investigation data available for the Site.
- Section 7: Ground Conditions– This section describes the main findings of the intrusive site investigation including the ground conditions encountered and visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contaminant linkages and presents the human health and controlled waters assessments.
- Section 9: Refined Conceptual Site Model – This section presents the Conceptual Site Model (CSM) for the Site and identifies potential contaminant linkages, based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations - This section provides conclusions concerning the likelihood of land contamination associated with the Site affecting the Scheme and requirements for remediation/mitigation.

2 Site Location and Description

- 2.1.1** The Site is located in the eastern part of the study area approximately 500 m north west of Magor town centre and approximately 300 m south of the existing M4 Junction 23A. The Site is centred at National Grid Reference ST 420 876 and covers an area of approximately 0.35 hectares (ha). The location of the Site is shown on Figure 1.
- 2.1.2** The Site comprises a partially backfilled quarry within the grounds of a vicarage, Woodland House, and is surrounded by agricultural fields to the north, residential development to the east and bounded by the B4245 to the south.
- 2.1.3** Previous walkover surveys undertaken in September 1995, January 2014 and more recently in June 2015 found the quarry to be overgrown with trees and rough vegetation. The uneven and undulating topography indicates partial backfilling with a quarry face existing on the north eastern boundary. Details of the infill could not be defined by the walkover surveys. Photographs taken during the 2015 walkover survey are presented in Appendix 6.
- 2.1.4** Ground elevations within the Site range between approximately 17.5 m Above Ordnance Datum (AOD) and 21.0 m AOD.
- 2.1.5** The Site layout is shown in Figure 1.

3 The Scheme

- 3.1.1** The Site is located on the alignment of the new section of motorway at the Magor Junction, at chainage 20,800 to 20,900. Refer to Figure 1 for the Site location in relation to the Scheme.
- 3.1.2** The proposed alignment of the new section of motorway is positioned within a shallow cut at the Site location (depth currently not confirmed).
- 3.1.3** The depth of cut is anticipated to be up to 5 m and some, if not all, of the quarry in-fill material may be removed from its current location and either disposed of off site or, if suitable, reused within the Scheme. Any remaining in-fill materials below cutting level may be left *in situ*.
- 3.1.4** A new 5 m high embankment associated with the overbridge of the B4245 is to be constructed over part of the Site footprint. Here, infill material may be left *in situ* beneath the new embankment.

4 Site History

- 4.1.1** The 2014 PSSR historical searches have been based on Ordnance Survey (OS) plans, literature reviews, information provided by British Steel, Natural Resources Wales (NRW) (formerly Environment Agency Wales), Newport City Council and interpretation of aerial photography.
- 4.1.2** This is supplemented by a review of historical maps obtained in 2015 from Welsh Government. Relevant extracts are presented in Appendix 7.
- 4.1.3** A summary of the Sites history is presented in Table 1 below.

Table 1: Site History

Date	Use	Source of Information
1843 - 1893	The Site comprises an <u>Old Quarry with an Old Limekiln</u> in the south western corner. Adjacent to the east is a Vicarage and the Site is bound to the south by a road running northwest-southeast. Agricultural fields surround the Site to the north, west and south. Two other old quarries are located approximately 125 m to the southeast.	1:10,560 Historical Mapping
1882	No significant change.	OS map (2014 PSSR)
1891 - 1912	A few residential properties are located to the east.	1:10,560 Historical Mapping
1904 - 1939	No significant change.	1:10,560 Historical Mapping
1964 – 1965	Residential development to the east has increased.	1:10,560 Historical Mapping
1969	Site area overgrown with trees. Western area of the Site appears to be broken ground .	Aerial Photography
1969 - 1971	Old Quarries no longer identified on the map, however cuttings remain. The town of Magor is spreading to the east. An industrial building / depot has been developed approximately 50 m to the south. The M4 motorway and Junction 23A have been constructed approximately 125 m to the north.	1:10,560 Historical Mapping
1981	Site area marked as cutting.	1:2,500 Historical Mapping
1985	Area of broken ground appears vegetated.	Aerial Photography
1985 - 1996	The north of the Site is marked as wooded. Magor is now 100 m to the east and a brewery has been constructed 200 m to the west. A police station is located 50m to the west.	1 : 10,000 Historical Mapping
2006	The Site is completely wooded, though a depression is still evident.	Aerial Photography
2009 - 2010	No significant change.	Aerial Photography
2013 - 2014	No significant change.	Aerial Photography
2015	The quarry has been partially <u>backfilled</u> with fill of unknown origin and is heavily overgrown with mature vegetation.	Site walkover

*Notes. Potential sources of contamination are underlined. Those within the temporary and permanent land take are shown in bold.

- 4.1.4** The sources of information presented above supplement those used in the 2014 PSSR, in particular broken ground identified in aerial photographs from 1969 - 1981. Relevant extract of the photographs are presented in Appendix 6.

- 4.1.5** The review of historical plans indicated that the Site has been occupied by a disused quarry and a limekiln that were active prior to the 1880s.
- 4.1.6** The historical evidence suggests no change of land use post-quarry closure; the Site has remained derelict.
- 4.1.7** Historically the site is located in proximity to areas which may have been bombed during World War II which is discussed in the Explosive Ordnance Threat Assessment Report (Bactec, 2014). This categorises the site as low risk in respect to unexploded ordnance.

5 Environmental Setting

5.1 Geology

- 5.1.1** British Geological Survey (BGS) data indicates that superficial deposits are only present to the north of the Site, comprising River Terrace Deposits. The entire Site is underlain by bedrock of the Avon Group Carboniferous Limestones.

5.2 Hydrology

- 5.2.1** There are no surface water features within the Site boundary or in the near vicinity.
- 5.2.2** The nearest surface water body is St Brides Brook, located 560 m to the east, which flows in a north-south direction.

5.3 Hydrogeology

- 5.3.1** NRW classifies the adjacent River Terrace Deposits as a Secondary A Aquifer and the bedrock as a Principal Aquifer.
- 5.3.2** The Site does not lie within a groundwater source protection zone. However it lies within a groundwater vulnerability zone classified as a major aquifer, with intermediate leaching potential.

5.4 Environmental Information

- 5.4.1** NRW have no records of pollution incidents, sewage discharge, abstraction licences, landfills or waste management facilities within the Site area.
- 5.4.2** A record of one pollution incident is however shown within a 300 m radius of the Site. It had no impact on either land or water and the pollutant was not identified.
- 5.4.3** A discharge consent is marked some 130 m to the west of the Site. This discharge outlet is likely to be associated with the Magor Services and located on the St Bride's Brook, some 560 m to the east.
- 5.4.4** The Gwent Levels - Redwick & Llandeenny SSSI is located approximately 700 m to the south.
- 5.4.5** The presence of any residual contamination at the Site associated with the off site pollution incident is considered highly unlikely.

6 Scope of Investigations

6.1 General

6.1.1 One previous intrusive ground investigation has been undertaken within the Site. The information is summarised below.

6.2 Scope of Works

6.2.1 The intrusive ground investigation undertaken within the Site area is summarised in Table 2:

Table 2: Site Investigation Summary

Date	Contractor	Site Location	Boreholes	Window Sampler	Trial Pits	Sampling
2008	Norwest Holst	Northwest and southeast	-	-	STPN03, STPN04	Soil, leachate

6.2.2 No boreholes were excavated or installed onsite. However, a number of holes were advanced within 65 m of the Site. These have been considered in order to support understanding of ground conditions beneath the Site and the groundwater quality and gas regime if relevant.

Table 3: Investigation Summary (Off Site)

Date	Contractor	Location from Site	Boreholes	Sampling
2008	Norwest Holst	10 m south	SBHN01RC	Groundwater level
2015	Geotechnical Engineering	7m southeast	BH545	Groundwater level, sampling Soil gas
		65m southeast	BH549	

6.2.3 The construction details of the above off site boreholes are summarised in Table 4 below.

Table 4: Summary of Off Site Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (mbGL)	Base of Slotted Well Casing / Gravel Pack (mbGL)	Targeted Geology
SBHN01ARC	19 mm	15	14.4	15	Avon Group (Siltstone / Mudstone)
BH545	50 mm	13.0	3	13	Avon Group (Sandstone / Mudstone)
BH549	35 mm	12	2	4	Avon Group (Sandstone)
	50 mm		8	12	Avon Group (Mudstone)

6.3 Surface Water Quality Sampling

6.3.1 Surface water quality monitoring was not undertaken during the previous ground investigations of the site.

6.4 Field Testing

6.4.1 PID (Photo Ionisation Detector) monitoring for VOCs was undertaken on two soil samples on Site at 0.3 m and 1 m in STPN03 and STPN04 respectively.

6.5 Groundwater Monitoring

6.5.1 A summary of the groundwater sampling, groundwater / monitoring and ground gas monitoring rounds undertaken at the off site boreholes are summarised in Table 5.

Table 5: Summary of Monitoring Rounds (off Site)

Location Ref.	Number of rounds (date of sampling)	Monitoring details
SBHN01ARC	6 no.	Groundwater - level
BH545	4 no. (17 th April 2015, 24 th April 2015, 1 st May 2015, 11 th May 2015)	Groundwater - level and sampling Soil Gas
BH549 (35mm)	No data	
BH549 (50mm)	4 no. (17 th April 2015, 24 th April 2015, 1 st May 2015, 11 th May 2015)	Groundwater – level and sampling Soil Gas

6.6 Laboratory Chemical Testing

6.6.1 A summary of the laboratory analysis undertaken on soil, groundwater, leachate and surface water, onsite and off site is shown below. The results are presented in Appendix 5.

Table 6: Summary of previous investigation sampling (onsite)

Site Investigation date	No. of soil samples	No. of leachate samples	No. of water samples	Suites of testing
2008	4	2	-	Heavy metals, pH, sulphate, asbestos, cyanide, phenol, MTBE, BTEX, speciated TPH, speciated PAH, PCBs
2015	-	-	6*	Metals, inorganics, phenols, BTEX, TPH, PAH, VOCs, SVOCs, PCBs

Notes. *off site boreholes only

6.7 Gap Analysis of Available Data

6.7.1 The investigation data available for the site is considered limited both in relation to site coverage and in the laboratory analysis.

6.7.2 It is also noted that the intrusive investigation only refers to two shallow hand dug trial pits dated 2008.

7 Ground Conditions

7.1 Geology

7.1.1 The geological logs for all available exploratory logs excavated on or in close proximity to the Site are provided in Appendix 1. The observed geological sequence is consistent with that discussed in the 2014 PSSR report and is summarised in the following sections. Information from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) has also been used.

Topsoil

7.1.2 Topsoil was encountered in both exploratory holes located on site (STPN03 and STPN04) locations to 0.3 m bGL.

Made Ground

7.1.3 Made Ground was encountered beneath the topsoil in both locations (STPN03 and STPN04). It comprised a clay silt with gravel and occasional cobbles of limestone and brick as summarised in Table 7. Basal depth of the Made Ground has not been proven.

7.1.4 It is noted that some of the selected off site boreholes identified Made Ground material, e.g. to 0.8 m bGL in SBHN01 and 1.65 m in BH545 located south of the Site. It is currently unclear if this material is associated with the partial infill of the Quarry Site.

Bedrock

7.1.5 Off site boreholes have encountered sandstones, mudstones and limestones of the Avon group formation at shallow depths of between 2.1 and 2.35 m bGL.

Geological Sequence Summary

7.1.6 The general geological sequence identified during the previous ground investigations is summarised in Table 7.

Table 7: Summary of Geological Sequence

Unit	Description	Thickness Range (m)	Basal depth (m bGL)
Topsoil	Clayey topsoil.	0.3	0.3
Made Ground	Slightly sandy, slightly gravelly silt / clay with low cobble content. Gravel/cobbles of limestone and brick.	>1.0 - >1.2	unproven

7.1.7 The conceptual ground model included within the 2014 PSSR report has been revised in light of the 2015 information and is presented within Figure 2.

7.2 Visual and Olfactory Evidence of Contamination

7.2.1 A summary of visual and olfactory evidence of contamination encountered during the previous ground investigation is summarised in Table 8.

Table 8: Visual and Olfactory Evidence of Potential Contamination Summary

Location ID	Depth (m bGL)	Strata	Evidence of Potential Contamination
STPN03 and 04	0.3 - 1 / 1.2	Made Ground	Brick cobbles and gravels
East of the quarry	Surface	Black bound macadam	Visual observation during the 2008 ground investigation works

7.2.2 No visual or olfactory evidence of hydrocarbon contamination was identified during the trial pitting. The PID meter recorded zero VOC levels.

7.2.3 Full details and observations noted during the trial pitting are presented on the exploratory logs attached in Appendix 1.

7.3 Gas Monitoring (off site)

7.3.1 The gas monitoring dataset collected during each of the previous three monitoring rounds at the off site boreholes is summarised on the field data sheets provided in Appendix 2. The maximum gas concentrations are presented in Table 9.

Table 9: Summary of Gas Monitoring Data (off site)

Location ID	Flow (l/hr)	VOCs (ppm)	CH ₄ (%/vol)	Peak LEL (%)	CO ₂ (%/vol)	O ₂ (%/vol)	CO (ppm)	H ₂ S (ppm)
	Max	Max	Max	Max	Max	Min	Max	Max
BH545	0.0	6.3	0.1	1	2.9	17.0	0.0	0.0
BH549 (50 mm)	0.4	9.2	0.1	1	1.3	18.0	3	0.0

7.4 Groundwater

Groundwater Encountered During Investigation

7.4.1 No groundwater was encountered during the excavation of the trial pits onsite, nor the boreholes off site.

Groundwater Level Dataset (off site)

7.4.2 The groundwater level dataset gathered from the selected boreholes off site is provided in Appendix 2 and summarised in Table 10.

Table 10: Summary of Groundwater Level During Monitoring Rounds

Location	Installation ^{#1}	Depth of response zone (m bGL) and Geological Formation	No. Measurements	Minimum Depth (m bGL)	Maximum Depth (m bGL)	Comments
SBHN01 RC	19 mm	14.4-15 (Avon Group – Siltstone & Mudstone)	6	8.49	13.27	
BH549	(S) 35 mm	2 - 4 (Avon Group - Sandstone)	0			No data
	(D) 50 mm	8 - 12 (Avon Group - Mudstone)	4	7.68	9.12	
BH545	50 mm	3-13 m (Avon Group - Sandstone & Mudstone)	4	6.35	7.82	

Notes. #1: S denotes a shallow installation and D denotes deep installation.

Groundwater Summary

- 7.4.3** Notable groundwater beneath the Site is present within the sandstone and mudstone lithology of the Avon Group Bedrock.
- 7.4.4** Ground levels at each of the above borehole locations are similar. The maximum resting groundwater as recorded in the 2008 borehole (SBHN01) is much deeper than other recorded levels. The reason for this is uncertain.
- 7.4.5** The 2015 data indicates the groundwater level in BH549 to be deeper than those seen in borehole BH545 which is likely to be a reflection of the general south eastwards flow.

8 Contamination Assessment

8.1 Introduction

8.1.1 The following sections provide details of the assessment of land contamination at the Site.

8.1.2 The outline Conceptual Site Model (CSM) presented within the 2014 PSSR has been reviewed and updated based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and the Scheme. The main alterations to the 2014 PSSR model are summarised as follows.

- Addition of an embankment on Site as well as the proposed cutting.
- Addition of ground, groundwater and gas dataset from nearby boreholes.
- Revision of the source/pathway/receptor linkages.

8.2 Preliminary Risk Assessments

Potential Sources

8.2.1 The backfill of the quarry on the Site has been identified as the only potential source of contamination existing at the Site. The majority of the fill materials are likely to be removed as a result of the Scheme; however some may remain beneath the road or exposed as part of the cutting and could pose a risk to human health and underlying groundwater.

8.2.2 The investigations undertaken to date do not fully characterise the in-filled quarry and therefore the risks remain unconfirmed.

Potential Receptors

8.2.3 Receptors during the construction and the operational stages of the Scheme have been considered:

Construction

- Construction workers during Site development works.
- General public adjacent to construction works including residents located 150 m away from the Site.
- Groundwater (principal aquifer), excavations are unlikely to extend below groundwater level however any ground improvement works undertaken on the residual materials (if left in place) may affect the groundwater quality.

Operational

- General public end users;
- General public adjacent to permanent land take including residents located 150 m away from the Site.
- Maintenance workers.
- Groundwater (principal aquifer) within the bedrock.

Potential Pathways

8.2.4 Pathways during the construction and the operational stages of the Scheme have been considered:

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils possible during development works and maintenance works.
- Dermal contact, ingestion, inhalation pathways possible for general public end users and general public including residents located 150 m away from the Site.
- Leaching of contaminants from the backfill material into underlying groundwater aquifer.
- Vertical or lateral migration of potential ground gas associated with backfill material.

8.3 Risk Evaluation

8.3.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the other data described herein, the following risk evaluation has been reconsidered and included.

- The Site has been subject to unregulated backfilling of an unknown material, with current data only proven for the top meter.
- Proposed cut associated with the Scheme will remove a proportion of the infill material and that left *in situ* is likely to be engineered for stability or encapsulated by proposed embankment.
- Superficial Deposits to the north are classified as a Secondary A Aquifer. Bedrock directly beneath the Site is classified as a Principal Aquifer.
- Hardstanding cover proposed in some areas of the new section of motorway is likely to limit infiltration thus reducing leaching.
- There are no nearby surface water receptors and infill material is confined within a below ground quarry feature. Risks to surface water are not therefore considered further for the purpose of this report.
- Motorway users will be within an open environment with no proposed structures or other confined spaces.

8.4 Human Health Risk Assessment

8.4.1 The rationale and approach for the human health (tier 2) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES). Soil chemical analysis results and the findings of the generic Tier 2 human health risk assessment are presented in Appendix 3 of this report. There were no exceedances to the relevant generic risk assessment criteria with the exception of chromium.

8.4.2 The total chromium concentrations marginally exceed the screening criteria of 33 mg/kg in 2 samples of the Made Ground. The screening criteria is based upon the more toxic and anthropogenic chromium and thus the criteria is very conservative. Chromium concentrations are considered to be within normal

background data range (<95 mg/kg) and are not therefore considered to represent a contaminant of concern (Appendix 11.1 of the ES).

8.4.3 All phenols and BTEX were at levels below the laboratory limit of detection. PAHs and TPH were identified at low levels at both locations (total PAHs ranging from 0.21 to 1.7 mg/kg and total TPH from <0.1 to 17 mg/kg). From the four PCB test results, one was marginally above Limit of Detection (LOD) but remained below screening criteria. These are considered unlikely to pose a risk to human health.

8.4.4 No other exceedances of the applied assessment criteria have been identified and no asbestos fibres were detected visually or in samples analysed in the laboratory.

8.5 Controlled Waters Screening Assessment

8.5.1 The rationale and approach for the controlled water (Tier 1) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES) and the groundwater chemical results are presented in Appendix 4 of this report. All exceedances to the relevant generic criteria are summarised in Table 11 and Table 12 for soil leachate and groundwater, respectively.

8.5.2 Where an EQS is dependent on water hardness i.e. some heavy metals, the hardness of the surface water receptor should normally be used. The Baseline Water Environment report (Appendix 16.2 of the ES) indicates surface water to be generally moderately hard with hardness concentrations within a range of 100 to 150 mg/l as calcium carbonate. Therefore EQSs within this water hardness range have been used for screening purposes.

Soil Leaching Results

8.5.3 Two soil samples were subjected to leaching analysis the results of which are presented in Appendix 5. The majority of the soil leaching results were all below the applied screening criteria, with the exception of the following contaminants.

Table 11: Controlled Waters screening exceedances – soil leaching

Determinant	Units	Range	EQS	DWS	No. exceeded EQS Screening Criteria (Total number of results)	Location (formation)	No. exceeded DWS Screening Criteria (Total number of results)	Location
Lead	µg/l	<1 - 6	1.2	10	1 (4)	STPN03 (Made Ground)	0 (4)	-

Note: DWS – Drinking Water Standards

8.5.4 There are no surface water courses identified in the near vicinity, therefore, the identified single occurrence exceedance of the stringent EQS is considered to be minor and unlikely to pose a risk to Controlled Waters.

8.5.5 Certain laboratory detection levels in samples used in the previous ground investigation for cadmium and cyanide are higher than screening criteria. This is considered unlikely to pose a risk to controlled waters.

Groundwater Results (off site)

8.5.6 In the absence of onsite data and for the purpose of this report, nearby available groundwater analytical data has been considered. This aims to identify the local groundwater quality within the vicinity of the Site in order to identify any obvious contamination fingerprint that could be associated with any potential contamination from the Site itself.

8.5.7 The groundwater analysis results include data from three rounds of groundwater monitoring results from off site boreholes BH545 and BH549 undertaken in 2015. The groundwater samples were taken from the aquifer body beneath the Site within the Avon Group bedrock.

8.5.8 A summary of the exceedances of the screening criteria from all available results relating to this Site is presented in Table 12 and discussed below.

Table 12: Groundwater screening exceedances (off site)

Determinant	Units	Range	EQS	DWS	No. exceeded Screening Criteria (Total number of results) against EQS	Location	No. exceeded Screening Criteria (Total number of results) against DWS	Location
Aquifer (Avon Group)								
Mercury	µg/l	<0.5 - 0.55	0.07	1	2 (6)	BH545, BH549	0 (6)	-
Nickel	µg/l	<1 - 7	4	20	1 (6)	BH545	0 (6)	-
Chloride	mg/l	190 - 290	250	250	1 (6)	BH549	1 (6)	BH549

8.5.9 The review of the groundwater chemical testing results indicated that the deep groundwater beneath the Site has elevated levels of mercury, nickel and chloride when compared to Environmental Quality Standards criteria.

8.5.10 Against Drinking Water Standards, only chloride is identified in marginal exceedance within the Aquifer.

8.5.11 All TPH, PAH, VOCs, SVOCs, BTEX, phenols and PCB results were found below the limit of detection.

8.5.12 It is noted the laboratory detection levels for some metals, PAH compounds, VOCs and SVOCs are higher than applied screening criteria. This is considered unlikely to pose a risk to controlled waters.

8.6 Ground Gas Risk Assessment

8.6.1 The only ground gas data available relates to off site boreholes BH545 and BH549. These have a response zone within the Avon Group between depths of 3-13 m bgl and 8-12 m bgl, respectively. No data has been made available from the shallow installation of BH549 (2-4 m bgl). Of the 4 no rounds available, the following may be observed.

- No monitoring was undertaken during low barometric pressure (less than 1000 mb), with the lowest conditions being 1011 mb. As such, the worst case atmospheric conditions for potential ground gas generation may have not been monitored.
- Gas flow was generally recorded absent, with the exception of the May round for BH549 which recorded an initial flow of 0.4 l/hr before returning to 0 l/hr.
- Methane has been recorded as nil or up to 0.1 % during all 4 no. rounds, which is well below the screening criteria of 1 %. The Lower Explosion Limit was recorded of up to 1 %.
- Carbon dioxide is identified between 0.1-2.9 %. The data is below the Work Place exposure limit of 5 %.
- Trace of Volatile Organic Compounds of up to 9.2 ppm has been recorded.
- Hydrogen sulphide was recorded as zero throughout.
- Carbon monoxide was recorded absent on all rounds for BH545. However, in BH549 carbon monoxide was recorded of up to 3 ppm for the first two rounds reducing to zero for the following two. Maximum concentration remains well below the Work Place exposure limit of 30 ppm.
- Oxygen has been recorded to be marginally depleted to ambient with concentrations of 17-20.6 %.

8.6.2 The available off-site data does not identify obvious gas sources (trace levels of VOCs are considered to be naturally occurring) and is consistent with the expected gas regime given the ground conditions.

8.6.3 However, the gas regime within the backfilled quarry remains unknown and additional investigation is recommended to confirm risks.

8.7 Summary

8.7.1 The onsite Made Ground analysed has not identified exceedances and is therefore considered to pose a low risk to human health.

8.7.2 Very limited leachability has been identified from the Made Ground with marginal exceedance limited to lead on a single sample.

8.7.3 The off site aquifer has been identified to have elevated metals or chloride when compared to the Environment Quality Standards. Chloride is the only contaminant in exceedance of the Drinking Water Standards.

8.7.4 The off site groundwater quality status is in general keeping with the baseline quality seen within this area of Newport (Appendix 16.2 of the ES). The current limited information indicates no obvious effect to groundwater from the land use of CL-33.

8.7.5 The lack of contaminant linkage between the soil and groundwater data is identified.

8.7.6 The ground gas regime at the site is not known. The absence of an abnormal gas regime proven by the nearest off-site boreholes is noted.

9 Refined Conceptual Site Model

- 9.1.1** The incorporation of data from the 2015 Supplementary Ground Investigation has enabled the original CSM presented in the 2014 PSSR to be updated. All relevant contaminant (source-pathway-receptor) linkages are considered within the refined CSM. The assessment is based on the Scheme during its construction and operational phases.
- 9.1.2** A CSM representing general ground conditions, overall Scheme layout and relevant source-pathway-receptors (each of which having a specific alpha-numerical symbol attached) is presented in Figure 2 and is described in Table 13.

Table 13: Conceptual Site Model

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
Quarry in-fill materials	Construction					
	Construction Workers (B)	Direct dermal (1)	Likely	Moderate	Moderate	Construction workers will be exposed to the infill materials during Site construction works; however exposure duration will be short term only. Use of PPE and good hygiene practice throughout earthworks and construction phase is considered sufficient to mitigate risks presented. Current data set identify limited exceedances to the selected screening criteria. Current contamination status is not foreseen to represent abnormal constraints to construction workers health & safety over and above those typical of a brown field Site. Made Ground generally granular and may represent a possible pathway for vertical and lateral migration. Additional investigation and soil testing required to confirm the characteristic of Made Ground and associated risks. Dust suppression measures are recommended during construction works.
		Ingestion (2)	Likely	Moderate	Moderate	
		Inhalation of soil derived dust (3)	Likely	Moderate	Moderate	
		Inhalation of soil gas or vapour (3)	Likely	Moderate	Moderate	Construction workers may be exposed to ground gas potentially generated by the quarry in-fill materials during the excavation and ground improvement works. No onsite ground gas data. Gas monitoring from nearby off site boreholes indicates presence of low concentrations of VOCs and carbon dioxide. However the data does not present evidence of gas source. Additional investigation and soil testing required to confirm the characteristic of the Made Ground and associated risks.
	Site neighbours/	Dermal contact with	Low	Low	Low	During construction there is the possibility of

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	general public during construction works (C)	soil derived dust (1)				
		Ingestion of soil derived dust (2)	Low	Low	Low	Site neighbours/general public inhaling soil derived dust, short term exposure only.
		Inhalation of soil derived dust (3)	Low	Low	Low	However, considering the distance to the receptor (150m) the occurrence of the exposure is considered to be of low likelihood.
		Inhalation of soil gas or vapour (3)	Low	Low	Low	Dust suppression measures are recommended during construction works. Gas monitoring from nearby off site boreholes indicates presence of low concentrations of VOCs and carbon dioxide. However the data does not present evidence of gas source. Additional investigation and soil testing required to confirm the characteristic of the Made Ground and associated risks. Significant flux of gas not anticipated.
	Groundwater (Principal Aquifer) (Da)	Leaching / migration of contaminants from backfill materials to groundwater (4)	Likely	Moderate	Moderate-	The elevation of the quarry base in relation to the water table is unknown and therefore there is a risk of the infill materials being infiltrated by the groundwater during the ground improvement works and resulting in potential contaminants mobilisation and migration to groundwater. Confirmation of the vertical extent of the infill materials in relation to the underlying groundwater is required prior to the ground improvement works. Ground improvement works may create new / increase vertical pathways. Foundation works risk assessment would be required on confirmation of ground improvement method.
On Site	Operational					

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
Quarry in-fill materials	Maintenance Workers (B)	Direct dermal contact (1)	Low	Low	Low	Made Ground to be largely encapsulated by the embankment (or removed during construction) and therefore the exposure to contamination will be limited outside the motorway embankment.
		Ingestion (3)	Low	Low	Low	Areas outside the motorway hardstanding are likely to receive topsoil cover and vegetation establishment, reducing potential of exposure. In areas of cutting, exposed Made Ground may receive retaining structure for stability improvement.
		Inhalation of soil derived dust (2)	Low	Low	Low	Exposure duration will be short term only. Site specific risk assessment will be required in line with H&S guidance. This will enable safe methodology and appropriate level of PPE to be put in place. As such all risks will be duly considered and suitably mitigated.
		Inhalation of soil gas or vapours (2)	Likely	Moderate	Moderate	Additional investigation and soil testing required to confirm the characteristic of the Made Ground and associated risks. Current contamination status is not foreseen to represent abnormal constraints to maintenance workers health & safety over and above those typical of a brown field site.
						Maintenance workers may be exposed to ground gas potentially generated by the quarry in-fill materials. No onsite ground gas data. Gas monitoring from nearby off site boreholes indicates presence of low concentrations of VOCs and carbon dioxide. However the data does not present evidence of gas source. Additional investigation and soil testing required to confirm the characteristic of the Made Ground and associated risks.

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Future Motorway users (A)	Direct Dermal contact (1)	Unlikely	Low	Very low	Made Ground to be largely encapsulated by the embankment (or removed during construction) and therefore the exposure to contamination will be limited outside the motorway embankment. Dermal and ingestion pathways associated to soil derived dust only.
		Ingestion (2)	Unlikely	Low	Very low	Areas outside the motorway hardstanding are likely to receive topsoil cover and vegetation establishment, reducing potential of exposure. In areas of cutting, exposed Made Ground may receive retaining structure for stability improvement.
		Inhalation of soil derived dust (2)	Unlikely	Low	Very low	No onsite ground gas data. Gas monitoring from nearby off site boreholes indicates presence of low concentrations of VOCs and carbon dioxide, possibly generated by the infill materials.
		Inhalation of soil gas or vapours (2)	Low	Low	Low	Made Ground to be removed or encapsulated by the proposed embankment (subject to passing re-use criteria). End users to be within open space. Additional investigation required to confirm the characteristic of the Made Ground and associated risks.
	Off site users (C)	Direct Dermal contact of soil derived dust (1)	Unlikely	Low	Very low	As per Future Motorway Users (A) but off site receptors some 150 m from proposed earthworks.
		Ingestion of soil (2)	Unlikely	Low	Very low	
		Inhalation of soil derived dust (2)	Unlikely	Low	Very low	
		Inhalation of soil gas or vapours (2)	Unlikely	Low	Very low	

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Groundwater - Aquifer (Da) from the Glaciofluvial Deposits and/or Avon Group bedrock	Leaching/migration (4) if contamination in Made Ground	Likely	Moderate	Moderate-	The elevation of the quarry base in relation to the water table is unknown and therefore, there is a risk of the infill materials being infiltrated by the groundwater resulting in potential contaminant mobilisation and migration to groundwater. -Ground improvement works may create new / increase vertical pathways. Confirmation of the vertical extent of the infill materials in relation to the underlying groundwater is required prior to the ground improvement works. Foundation works risk assessment would be required on confirmation of ground improvement method.

10 Conclusions and Recommendations

10.1 Conclusions

- 10.1.1** The proposed earthworks include a shallow cut (depth currently unknown) through the south eastern end of the Site. The construction of an embankment is also considered, running over the Site on an east to west trend and bridging over the cutting section.
- 10.1.2** Limited ground investigations have been undertaken to enable the Site to be assessed for the risks of contamination on the Scheme including human health and controlled waters.
- 10.1.3** The nature and extent of the potential contamination has not been confirmed. However, it is unlikely to pose a risk to the Scheme.
- 10.1.4** In order to confirm the moderate to low risks associated with the Site in relation to both construction and operational phases, and the suitability for reuse within the Scheme, it is recommended that supplementary intrusive investigations are undertaken.
- 10.1.5** The results of the recommended supplementary investigations should be assessed in relation to identified receptors and inform the selection of appropriate health and safety and mitigation measures for the construction works and operational phase, if required.

10.2 Recommendations

- 10.2.1** Only limited ground investigation has been undertaken at the site and although the likelihood of any contamination at the site is relatively low, due to the site's history, localised contamination may have occurred. As such it is recommended that a supplementary ground investigation is undertaken to verify the risk levels described in this report. Should contamination be identified that could cause an unacceptable risk to the identified receptors, then remedial requirements would be identified within a remedial strategy for the Scheme.
- 10.2.2** A remediation strategy for the Scheme should be developed that for this Site should include the following.
- Addressing potential human health and controlled waters risk identified by the proposed additional ground investigation.
 - Monitoring and risk assessment of perched water if identified to be present within the backfilled quarry and if applicable of the aquifer beneath.
 - Dealing with unexpected contamination.
 - Verification sampling strategy to confirm suitability for soils for retention / re-use.
 - Control measures (over and above good practice construction management) to prevent risks to construction workers and the general public during construction.
 - Verification of material used as topsoil.

10.2.3 The remediation strategy should include a remediation options appraisal, remediation implementation plan and remediation verification plan.

10.2.4 The remediation strategy should be supported by a Scheme wide Material Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

11 References

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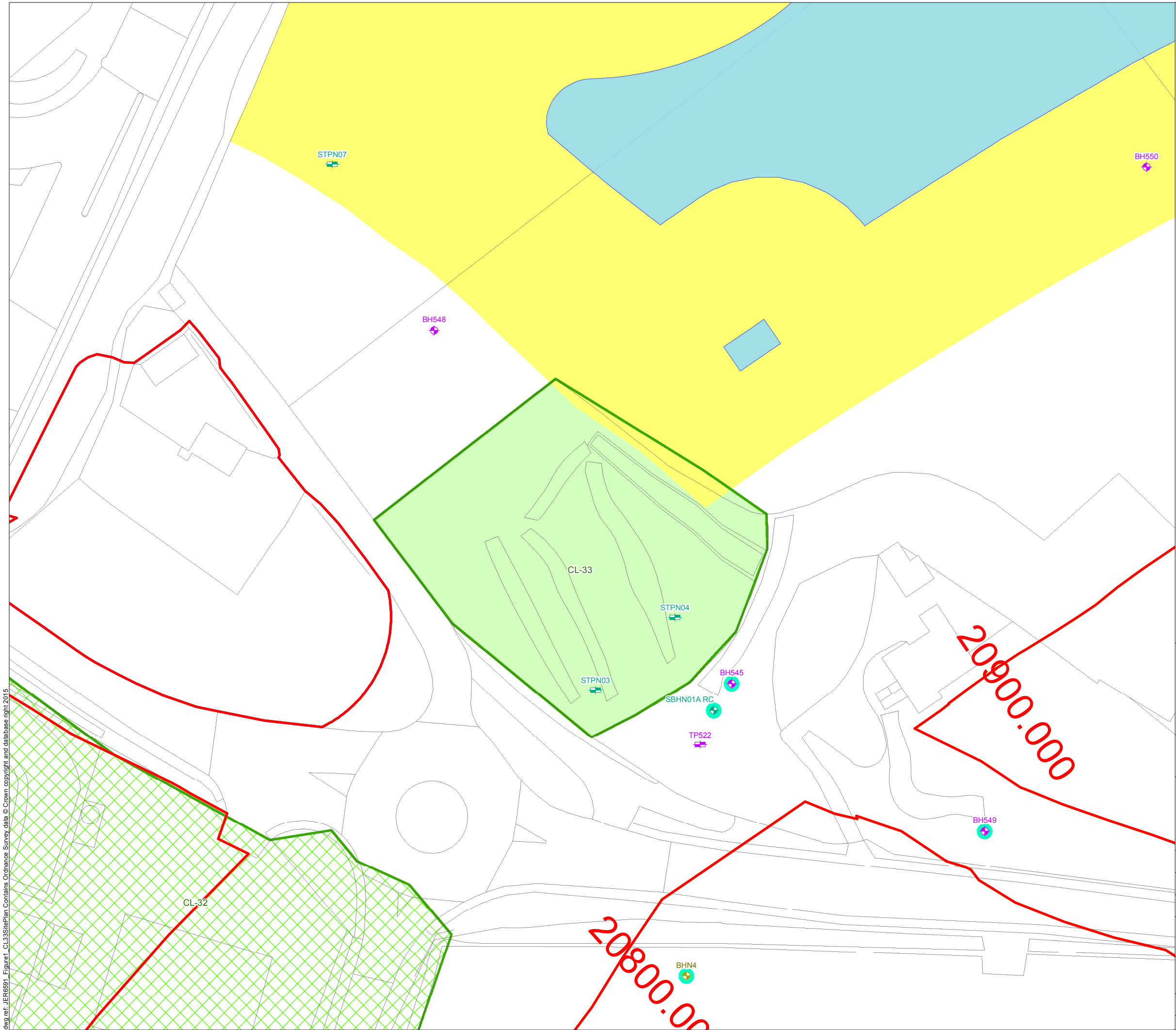
12 Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection
mAOD	Metres Above Ordnance Datum

mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O ₂	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures

dwg ref: JER6591_Figure1_CL33SitePlan Contains Ordnance Survey data © Crown copyright and database right 2015



- Legend**
- Permanent Highway Land within Fenceline (including Water Treatment Areas)
 - Other Permanent Land Take
 - Temporary Construction Land
 - Proposed Water Treatment Area (WTA)
 - Potential Borrow Pit Area
 - Potential Area of Land Contamination based on 2014 PSSR
 - Other Potential Area of Land Contamination

Investigation Locations

2015 (Geotechnical Engineering)

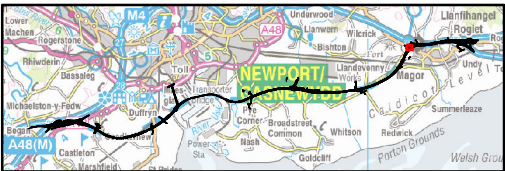
- Borehole
- Trial Pit

2007 (Norwest Holst)

- Borehole
- Trial Pit

1997 (Norwest Holst)

- Borehole
- Monitoring Well Installation

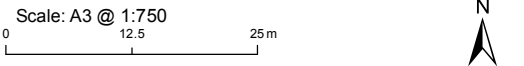


Llywodraeth Cymru
Welsh Government

Appendix 11.1 Annex D CL-33

Site Plan for CL-33

Figure: 1	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB



Legend

- Made Ground (Infill Material)
- River Terrace Deposits - RTD
- Avon Group (Mudstone/Sandstone - AG
- Avon Group (Limestone) - AG
- Proposed Embankment
- Proposed Cutting
- Groundwater (AG)
- Possible Ground Improvement to Improve Bearing Capacity of Made Ground
- Gas Migration Pathway

Potential Receptors

- Humans On-Site (M4 User)
- Humans On-Site (Construction/Maintenance)
- Humans Off-Site (Site Neighbours)
- Groundwater (Perched)
- Groundwater (Aquifer)

Potential Pathways

- Dermal Contact
- Inhalation
- Ingestion
- Leaching / Migration

Potential Sources of Contamination

Possible contamination present on site associated with :

On-Site

- Quarry infill materials

NOTE
Drawing refined from PSSR Drawing Reference
M4-OA-17-00DR-Z-XX-0153 (April 2014)



Appendix 11.1 Annex D CL-33

Conceptual Site Model for CL-33

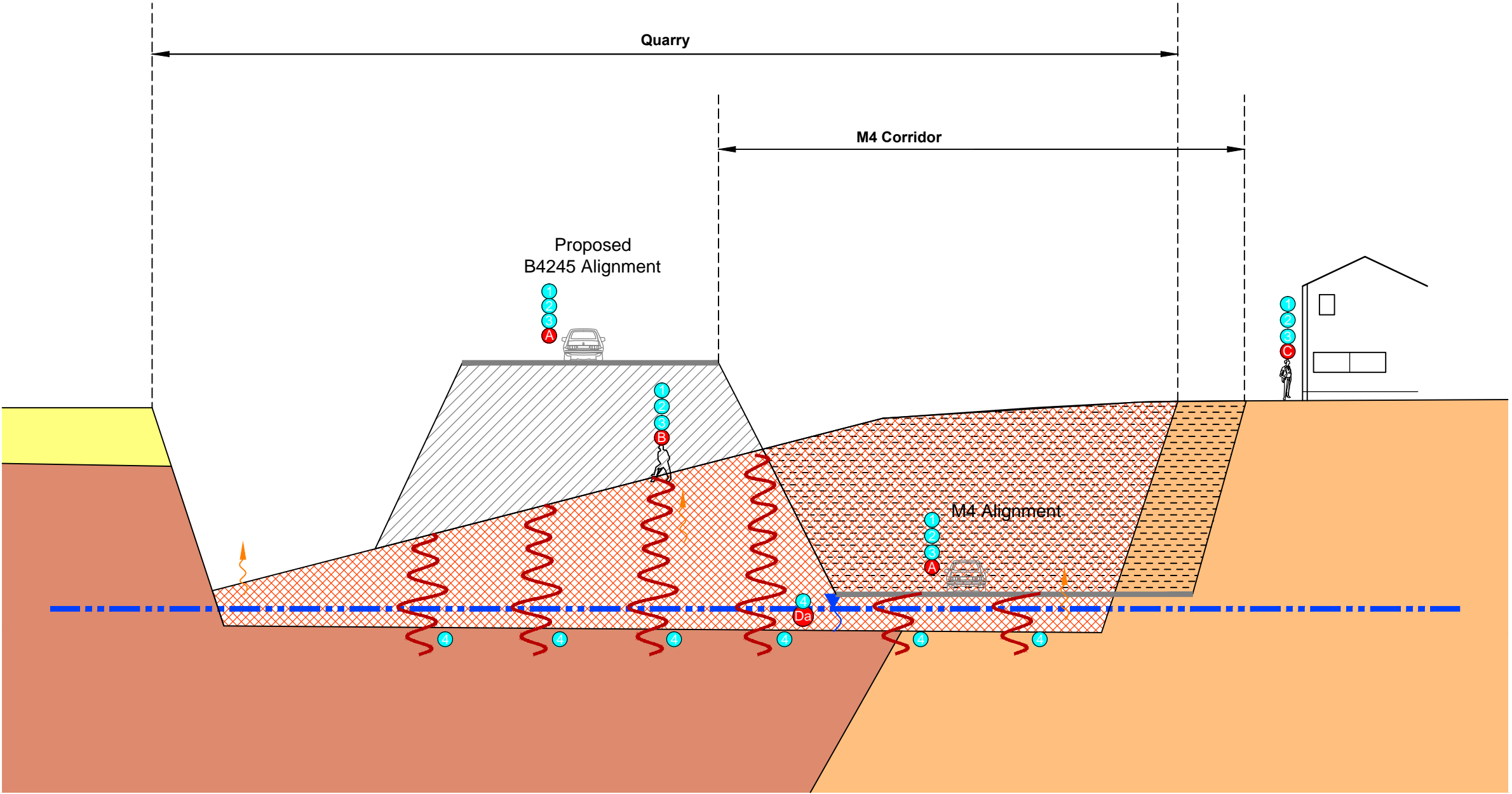
Figure: 2	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Not to Scale

Ground conditions based
on available information

dwg ref: JER6591_Figure2_CL33ConceptualSiteModel

CL- 33 B4245 Quarry



dwg ref: JER6591_Figure2_CL33ConceptualSiteModel

Appendices

Appendix 1

Exploratory Records

Contract No.	F15056	Method	Rotary Coring	Coordinates	341960.35 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187619.31 N
		Driller	BB	Ground Level	18.90m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	17/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	18/12/2007

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
17/12/2007	1730	8.00	3.50	5.10	End of Shift	0.00	2.00	Air/Mist	100%	0.00*
18/01/2008	0730	8.00	3.50	1.80	Start of Shift	2.00	9.30	Air/Mist	100%	92.0
18/01/2008	1730	9.30	3.50	NR	End of Hole					

CASING				WATER STRIKES							
Hole diam.	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
121	9.30	121	3.50	17/12/2007	1100	3.45	3.20	20	Seepage	NR	NR

GENERAL NOTES				SPT DETAILS				
1.Rotary Openhole from GL to 2.00m. 2.Rotary Coring from 2.00m to 9.30m. 3.Rotary coring terminated at 9.30m, refer to SBHN01A for redrill. 4.Borehole grouted upon completion. 5.0.00* indicates openhole drilling.				Depth	Type	Incremental blow count/penetration	Casing	Water Depth
				1.20	S	N=8 (1,1,2,2,2,2)	0.00	DRY
				2.00	S	N=24 (2,2,4,6,6,8)	0.00	DRY
				3.00	S	N=26 (2,3,3,6,7,10)	2.00	DRY
				4.00	S	N=24 (14,7,5,4,5,10)	3.50	1.20
				5.00	S	N=93 (3,22,18,25,25,25)	3.50	1.70
				6.00	S	90/160mm (25,74,16)	3.50	1.90
				7.00	S	100/30mm (25,100)	3.50	1.50

NOTES: All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form	ARIAL ROTARY HEADER
Version	3.06
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341960.35 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187619.31 N
		Driller	BB	Ground Level	18.90m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PWF	Date Started	17/12/2007
		Core bit	TC	Date Completed	18/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TOR	SCR	ROD	IF	SPT N & depth	Installation
Turf over firm brown TOPSOIL. (Driller's description)		0.20	18.70							
MADE GROUND: Very dense brick/boulder fill. (Driller's description)		0.80	18.10							
Stiff red brown mottled yellowish brown silty CLAY. (Driller's description)		2.00	16.90						1.20 S8 1.65	
Zone of core loss. Stiff red brown mottled yellowish brown silty CLAY. (Driller's description)		3.00	15.90	2.00 3.00		NA	NA		2.00 S24 2.45	
Very weak to extremely weak greyish brown MUDSTONE. (Mercia Mudstone Group (Marginal Facies)) ---from 3.00m to 3.34m recovered as non intact core (gravelly clay. Gravel is angular fine to medium sized fragments) ---from 3.38m to 4.00m assumed zone of core loss		4.00	14.20	3.00 4.00	38	4	0	NI NI NI	3.00 S26 3.45	
---from 4.00m to 4.28m recovered as non intact core (gravelly clay. Gravel is angular fine to medium sized fragments)		4.70	14.20	4.00 4.70	87	43	24		4.00 S24 4.45	
---from 4.57m to 4.61m recovered as non intact core (gravelly clay. Gravel is angular fine to medium sized fragments)		5.00	13.90	4.70 5.00		NA	NA			
---from 4.61m to 4.70m assumed zone of core loss		6.00	12.90	5.00 6.00	55	35	35	NI NI 310	5.00 S93 5.45	
Zone of core loss										
Very weak to extremely weak greyish brown MUDSTONE (Mercia Mudstone Group (Marginal Facies)) ---from 5.00m to 5.19m recovered as non intact core (gravelly clay. Gravel is angular fine to medium sized fragments) ---from 5.35m to 5.55m occasional thick laminations of weak reddish brown mudstone. Highly weathered ---from 5.55m to 6.00m assumed zone of core loss		7.00	7.05	6.00 7.00	75	75	44		6.00 S90/160mm 6.21	
Very weak to weak thinly laminated reddish brown MUDSTONE. Discontinuities 1) 0 -10 deg extremely closely to medium spaced undulating rough. (Mercia Mudstone Group (Marginal Facies)) ---from 7.00m to 7.53m with many extremely closely spaced laminations of weak grey mudstone and weak grey siltstone. Highly weathered ---from 7.53m to 7.89m some very closely spaced laminations of weak to medium strong light grey siltstone. Moderately weathered ---from 7.68m to 7.72m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments of mudstone) ---from 7.89m to 8.19m many very closely spaced thick laminations of weak to medium strong light greyish brown siltstone. Moderately weathered ---at 8.21m 1 No thick discontinuous lamination of very weak grey mudstone. Highly weathered ---at 8.24m 1 No thick discontinuous lamination of very		8.00	9.60	7.00 8.00	96	92	47	NI 110 220	7.00 S100/30mm 7.05	
		9.30	9.60	8.00 9.30	90	67	55			

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341960.35 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187619.31 N
		Driller	BB	Ground Level	18.90m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	17/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	18/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	ROD	IF	SPT N & depth	Installation
<p>Remaining Detail : 8.24m - 8.24m : weak grey mudstone. Highly weathered;;; 8.26m - 8.27m : ---from 8.26m to 8.27m recovered as non intact core (angular fine to medium gravel sized fragments);;; 8.30m - 8.36m : ---from 8.30m to 8.36m many extremely closely spaced thin laminations of weak grey siltstone. Moderately weathered;;; 8.36m - 8.50m : ---from 8.36m to 8.50m 1 No medium bed of medium strong light grey siltstone. Moderately weathered;;; 8.50m - 8.69m : ---from 8.50m to 8.69m recovered as non intact core (angular fine to coarse gravel sized fragments of mudstone);;; 9.15m - 9.17m : ---from 9.15m to 9.17m 1 No thin bed of weak to medium strong grey siltstone. Moderately weathered;;; 9.17m - 9.30m : ---from 9.17m to 9.30m assumed zone of core loss</p> <p>Rotary drilling complete at 9.30 m.</p>										

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341999.49 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187625.32 N
		Driller	BB	Ground Level	20.48m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	18/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	09/01/2008

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
18/12/2007	1730	2.00	1.80	DRY	End of Shift	0.00	2.00	Air/Mist	100%	0.00*
19/12/2007	0730	2.00	1.80	DRY	Start of Shift	2.00	5.60	Air/Mist	0%	92.0
19/12/2007	1730	6.60	3.00	5.00	End of Shift	5.60	6.60	Air/Mist	10%	92.0
20/12/2007	0730	6.60	3.00	6.50	Start of Shift	6.60	9.40	Air/Mist	100%	92.0
20/12/2007	1730	9.40	6.50	8.00	End of Shift	9.40	15.00	Air/Mist	100%	92.0
08/01/2008	0730	9.40	6.50	5.50	Start of Shift					
08/01/2008	1730	10.60	6.50	5.50	End of Shift					
09/01/2008	0730	10.60	6.50	5.00	Start of Shift					
09/01/2008	1730	15.00	6.50	NR	End of Hole					

CASING				WATER STRIKES							
Hole diam.	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
121	15.00	121	6.50								

GENERAL NOTES	SPT DETAILS				
1.Rotary Openhole drilling from GL to 2.00m. 2.Rotary Coring 2.00m to 15.00m. 3.19mm piezometer installed, tip at 14.90m, with response zone 14.40m to 15.00m. 5.0.00* indicates openhole drilling.	Depth	Type	Incremental blow count/penetration	Casing	Water Depth
	1.00	S	N=8 (2,2,2,2,2)	0.00	DRY
	2.00	S	N=13 (3,2,3,4,4,2)	0.00	DRY
	3.20	S	21/300mm - Abandoned	1.80	DRY
	4.20	S	N=22 (17,8,7,7,4,4)	3.00	4.00
	5.20	S	33/300mm - Abandoned	3.00	5.00
	6.60	S	N=72 (4,8,14,19,24,15)	3.00	6.50
	7.60	S	N=67 (6,10,11,19,8,29)	6.50	6.50
	8.60	S	100/130mm (25,50,50)	6.50	8.00
	9.40	S	100/160mm (9,14,30,50,20)	6.30	5.50

NOTES: All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form ARIAL ROTARY HEADER

Version 3.06

Revised 17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341999.49 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187625.32 N
		Driller	BB	Ground Level	20.48m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PWF	Date Started	18/12/2007
		Core bit	TC	Date Completed	09/01/2008

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TOR	SOB	ROD	FE	SPT N & depth	Installation
Brown CLAY with frequent limestone, sandstone cobbles. (Driller's description)		0.60	19.88							
Dark brown reddish brown silty CLAY with frequent limestone/sandstone cobbles. (drillers description)									1.00 1.45 S8	
Boulder of strong to very strong yellowish brown fine to medium grained sandstone ---from 2.00m to 2.12m recovered as non intact core (subangular gravel sized fragments) ---from 2.12m to 2.50m assumed zone of core loss ---from 2.89m to 3.20m assumed zone of core loss		2.00	18.48	2.00 2.50 24 NA NA					2.00 2.45 S13	
---from 3.24m to 3.25m reddish brown ---from 3.28m to 3.29m grey ---from 3.34m to 3.70m assumed zone of core loss				2.50 3.20 56 NA NA			NA		3.20 3.62 S21/300mm - Attached	
Zone of core loss. reddish brown silty clay with frequent sandstone gravelly bands. (Driller's description)		3.70	16.78	3.20 3.70 24 NA NA						
				3.70 4.20 NA NA			NA		4.20 4.65 S22	
		4.70	15.78	4.20 4.70 NA NA						
Firm to stiff brown slightly gravelly CLAY with occasional rootlets. Gravel is angular fine to coarse of sandstone ---from 5.16m to 5.20m assumed zone of core loss				4.70 5.20 92 0 0					5.20 5.63 S33/300mm - Attached	
				5.20 5.40 100 0 0			NA			
		5.60	14.88	5.40 5.60 75 2 0			NI 50			
Weak to very weak reddish brown locally greyish brown MUDSTONE. (Mercia Mudstone Group(Marginal Facies)) ---from 5.60m to 5.80m thin bed of strong red limestone. ---from 5.81m to 7.05m recovered as non intact core (firm to stiff slightly gravelly clay. Gravel sized fragments are angular fine to medium) ---from 6.60m becomes greyish brown				5.60 6.60 100 0 0					6.60 7.05 S72	
---from 7.07m to 7.12m recovered as non intact core (firm to stiff slightly gravelly clay. Gravel sized fragments are angular fine to medium) ---from 7.12m to 7.60m assumed zone of core loss ---from 7.60m to 7.86m recovered as non intact core (firm to stiff slightly gravelly clay. Gravel sized fragments angular fine to medium) ---from 7.90m to 8.60m assumed zone of core loss				6.60 7.60 52 0 0			NI 20		7.60 8.05 S67	
---from 8.60m to 8.76m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments) ---from 9.04m to 9.18m recovered as non intact core (slightly gravelly clay. Gravel sized fragments are angular fine) ---from 9.18m to 9.40m assumed zone of core loss				7.60 8.60 30 7 0					8.60 8.81 S100/130mm	
		9.40	11.08	8.60 9.40 73 23 15			NI 30 125		9.40 9.71 S100/160mm	
		9.63	10.85							

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form ARIAL ROTARY LOG

Version 3.09

Revised 17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341999.49 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187625.32 N
		Driller	BB	Ground Level	20.48m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PWF	Date Started	18/12/2007
		Core bit	TC	Date Completed	09/01/2008

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	ROD	FL	SPT N & depth	Installation
9.40m - 9.63m : Extremely weak grey MUDSTONE. Destructured. Recovered as non intact core (soft to firm grey slightly gravelly clay. Gravel is angular to subangular fine to medium). (Mercia Mudstone Group (Marginal Facies))				9.40 10.60 78 56 43						
9.63m - 12.50m : Weak to moderately strong interlaminated grey MUDSTONE and reddish brown fine grained SANDSTONE. Moderately weathered and destructured. Discontinuities 1) 0 -15 deg very closely to closely spaced undulating rough locally clay infilled. (Mercia Mudstone Group (Marginal Facies)) Detail 9.78m - 9.80m : ---from 9.78m to 9.80m recovered as non intact core (grey gravelly clay. Gravel sized fragments are angular fine to coarse of mudstone) Detail 10.40m - 10.60m : ---from 10.40m to 10.60m assumed zone of core loss Detail 10.60m - 10.78m : ---from 10.60m to 10.78m 1 No thin bed of extremely weak grey mudstone. Destructured. Recovered as gravelly clay. Gravel sized fragments are angular fine to coarse Detail 11.70m - 11.75m : ---from 11.70m to 11.75m recovered as non intact core (angular coarse gravel sized fragments) Detail 11.75m - 11.80m : ---from 11.75m to 11.80m assumed zone of core loss Detail 12.30m - 12.32m : ---from 12.30m to 12.32m 1 No very thin bed of reddish brown sandstone. Moderately weathered Detail 12.38m - 12.43m : ---from 12.38m to 12.43m 1 No very thin bed of reddish brown sandstone. Moderately weathered ---from 10.40m to 10.60m assumed zone of core loss ---from 10.60m to 10.78m 1 No thin bed of extremely weak grey mudstone. Destructured. Recovered as gravelly clay. Gravel sized fragments are angular fine to coarse ---from 11.70m to 11.75m recovered as non intact core (angular coarse gravel sized fragments) ---from 11.75m to 11.80m assumed zone of core loss ---from 12.30m to 12.32m 1 No very thin bed of reddish brown sandstone. Moderately weathered ---from 12.38m to 12.43m 1 No very thin bed of reddish brown sandstone. Moderately weathered		12.50	7.98	10.60 11.80 96 73 62				NI 120 240		
				11.80 13.40 94 88 60					NI 220 410	
				13.40 15.00 90 89 63					NI 90 180	
									140 300 510	
Medium strong thin laminated reddish brown locally light reddish brown fine grained SANDSTONE. Locally with laminations of reddish brown and grey mudstone. (Mercia Mudstone Group (Marginal Facies)) ---from 12.73m to 12.88m 1 No thin bed of extremely weak reddish brown mudstone. Destructured. Recovered as slightly gravelly clay. Gravel sized fragments are angular fine to coarse ---from 13.29m to 13.30m 1 No 15mm void partially infilled with fine gravel sized quartz crystals ---from 13.31m to 13.40m assumed zone of core loss										
Interlaminated weak reddish brown SILTSTONE and very weak grey MUDSTONE. Discontinuities 1) 0-15 deg extremely closely to closely spaced undulating rough locally clay infilled. (Mercia Mudstone Group (Marginal Facies)) ---from 13.75m to 13.77m recovered as non intact core (gravelly clay. Gravel sized fragments are angular fine										

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341999.49 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187625.32 N
		Driller	BB	Ground Level	20.48m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	18/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	09/01/2008

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	ROD	IF	SPT N & depth	Installation
<p>13.40m - 14.10m : Remaining Detail : 13.75m - 13.77m : to coarse of mudstone);; 13.77m - 13.81m : ---from 13.77m to 13.81m 1 No discontinuity 90 deg undulating rough stained dark brown);; 13.78m - 13.81m : ---from 13.77m to 13.81m 1 No very thin bed of weak reddish brown fine grained sandstone. Moderately weathered</p> <p>14.10m - 15.00m : Strong to very strong reddish brown fine grained SANDSTONE. Moderately weathered. Discontinuities 1) 0 - 10 deg medium spaced undulating rough. 2) 0 - 10 deg very closely to closely spaced incipient discontinuities undulating infilled with quartz. (Mercia Mudstone Group (Marginal Facies));; 14.22m - 14.34m : ---from 14.22m to 14.34m 1 No stylolite 80 - 90 deg);; 14.82m - 15.00m : ---from 14.82m to 15.00m assumed zone of core loss</p> <p>Rotary drilling complete at 15.00 m.</p>										

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

Contract No.	F15056	Method	Hand Excavated	Coordinates	341975.28 E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	Hand Tools	Ground Level	187629.53 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Date Started	20.69m AOD
Consultant	Ove Arup & Partners Ltd			Date Completed	06/12/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sampling		Remarks
Brown clayey TOPSOIL.		0.30	20.39	ES1 D2 B3	0.30 0.30 0.30	
MADEGROUND: light brown slightly clayey slightly sandy slightly gravelly SILT with low cobble content. Gravel is angular to subrounded fine to coarse of limestone. Cobbles are subangular of limestone and brick. (Head Deposits)		1.20	19.49	ES4 D5 B6 ES4	1.00 1.00 1.00 1.00	
Trial pit complete at 1.20 m.						

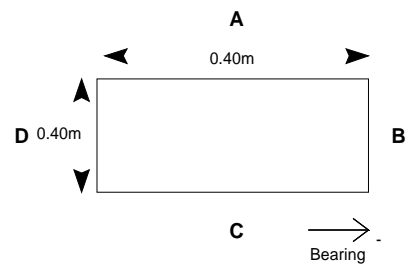
Stability All faces stable

Shoring None used

Groundwater None encountered during excavation

Remarks 1.Hand excavated trial pit complete at 1.20m.

Sketch Plan of Trial Pit



NOTES: All depths in metres, all soil strengths in kPa.
See legend sheet for key to symbols and abbreviations.
All bearings given relate to magnetic North

Form ARIAL TP LOG

Version 3.06

Revised 17/12/2007

Contract No.	F15056	Method	Hand Excavated	Coordinates	341991.56 E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	Hand Tools	Ground Level	187644.33 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Date Started	06/12/2007
Consultant	Ove Arup & Partners Ltd			Date Completed	06/12/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sampling	Remarks
Brown clayey TOPSOIL.		0.30	17.33	ES1 D2 B3	0.30 0.30 0.30
MADEGROUND: light brown silty slightly sandy slightly gravelly CLAY with low cobble content. Gravel is angular to subrounded fine to coarse of limestone and brick. Cobbles are subangular of limestone. (Head Deposits)		1.00	16.63	ES4 D5 B6	1.00 1.00 1.00
Trial pit complete at 1.00 m.					Unable to penetrate large limestone cobble/boulder

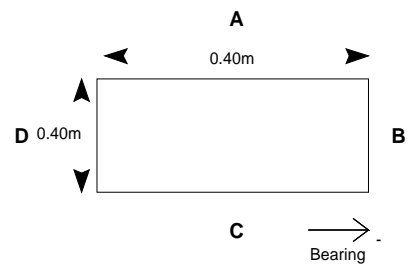
Stability All faces stable

Shoring None used

Groundwater None encountered during excavation

Remarks 1.Hand excavated trial pit terminated at 1.00m due to hard strata.

Sketch Plan of Trial Pit



NOTES: All depths in metres, all soil strengths in kPa.
See legend sheet for key to symbols and abbreviations.
All bearings given relate to magnetic North

Form ARIAL TP LOG

Version 3.06

Revised 17/12/2007

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH545

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 2 March 2015

Easting 342003.2

Scale 1 : 50

End Date 3 March 2015

Northing 187630.8 Ground level 19.15mOD

Depth 13.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
02/03/15 0930hrs	1B	0.20 - 0.50					✓	Grass over stiff reddish brown mottled light grey and pale yellow slightly sandy silty CLAY with low subrounded quartzite cobble content and frequent roots (up to 5mm) and rootlets (up to 1mm). (MG)	0.50	18.65	
	2D*	0.20 - 0.50		Vo 0.0							
	3B	0.50 - 1.00									
	4D*	0.50 - 0.70		Vo 0.0							
	5B	1.00 - 1.20									
	6D*	1.00 - 1.20		Vo 0.0				Stiff dark greyish brown slightly sandy gravelly silty CLAY with frequent roots (up to 4mm) and rootlets (up to 1mm). Gravel is subangular fine to coarse red brick and quartzite. (MG)	1.00	18.15	
	7D*	1.20 - 1.30							1.20	17.95	
	8D	1.20 - 1.65	Nil	S 9							
	9X	1.20 - 2.00									
								Firm locally soft friable dark greyish brown slightly sandy gravelly silty CLAY. Gravel is subangular fine to coarse quartzite. (MG)	1.65	17.50	
	10D*	1.80 - 2.00									
	11D	2.00 - 2.25	Nil	S*150				Stiff to very stiff dark greyish brown slightly sandy slightly gravelly silty CLAY. Gravel is subangular to rounded fine and medium sandstone. (MG)	2.20	16.95	
	12X	2.00 - 2.20							2.35	16.80	
	13C	2.20 - 3.00	2.10			75 68 58	NI 190 260	1.60 - 1.65m: Light greenish pink clayey gravel. Gravel is angular fine to coarse sandstone.			
								Very stiff reddish brown mottled purplish red and yellow slightly sandy gravelly silty CLAY with rare rootlets (up to 1mm) and gypsum crystals (up to 1mm). Gravel is subrounded fine to coarse sandstone.			
	14C	3.00 - 3.11 3.00 - 4.50	2.10	C*333		98 83 68		1.90 - 1.95m: Roots (up to 15mm diam).			
								Light grey to dark brownish grey clayey subangular and subrounded fine to coarse quartz and sandstone GRAVEL.			
								Medium strong to very strong bluish grey fine to coarse SANDSTONE. Fractures are subhorizontal to 20° extremely closely to medium spaced undulating rough stained orangish brown infilled (up to 2mm) with reddish brown clay.			
	15C	4.50 - 5.50	2.10			100 50 24		3.25 - 3.30m: Subhorizontal quartz vein (up to 1mm). 3.40 - 3.45m: Subhorizontal quartz vein (up to 1mm). 3.50 - 5.75m: Frequently infilled with quartz crystals (up to 2mm). 3.95 - 4.00m: Subhorizontal quartz vein (up to 1mm).			
									5.75	13.40	
	16C	5.50 - 7.00	2.10			80 22 15	NI	Drilling disturbed. Reddish brown SANDSTONE recovered non intact as subangular fine to coarse sandstone gravel.	6.00	13.15	
							NA	Stiff to very stiff reddish brown sandy silty CLAY locally tending to extremely weak mudstone.			
	17C	7.00 - 8.50	2.10			86		Stiff to very stiff fissured brownish red mottled dark grey sandy silty CLAY with rare very thin and thin beds of mudstone. Frequent thick laminae of black organic clay with strong organic odour and frequent light greenish grey reduction spots (up to 20mm).	7.00	12.15	
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Dynamic sampled (128mm) 1.20-2.00m and (113mm) 2.00-2.20m. Waterflush rotary core drilled (116mm) 2.20-13.00m.

CASING: 140mm diam to 2.10m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 12.50m, granular response zone 13.00-3.00m, bentonite seal 3.00-0.20m, concrete and stopcock cover 0.20-0.00m.

REMARKS: Driller notes loss of flush returns 3.00-13.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
30238CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH545

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 2 March 2015

Easting 342003.2

Scale 1 : 50

End Date 3 March 2015

Northing 187630.8 Ground level 19.15mOD

Depth 13.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
02/03/15 1645hrs 5.40m	18C	8.50 - 10.00	2.10		100 0 0		NI NA	<p>Reddish brown SANDSTONE recovered non intact as slightly sandy clayey angular and subangular fine to coarse sandstone gravel.</p> <p>Very stiff locally stiff thinly laminated to thickly bedded reddish brown mottled light grey and purplish red slightly sandy silty CLAY with frequent very thin and thin beds of strong thickly laminated reddish brown and light grey fine sandstone. Frequent subhorizontal undulating rough fissures.</p>	8.50 8.60	10.65 10.55	
	19C	10.00 - 11.50	2.10		100						
03/03/15 0830hrs 6.90m	20C	11.50 - 13.00	2.10		100 57 52		NI 140 340	<p>Stiff fissured thinly laminated dark grey slightly sandy silty CLAY. Fissures are subhorizontal extremely closely spaced planar smooth.</p>	11.35 11.75	7.80 7.40	
03/03/15 1020hrs 5.45m								<p>Weak thinly laminated reddish brown light grey SANDSTONE. Fractures are subhorizontal closely to medium spaced locally not intact planar rough with a veneer of reddish brown clay.</p>	13.00	6.15	
								Borehole completed at 13.00m.	{18.00}		
water strike (m) casing (m) rose to (m) time to rise (m) remarks Groundwater not encountered prior to use of water flush.									CONTRACT 30238		CHECKED EC

BOREHOLE LOG



CLIENT WELSH GOVERNMENT

BH549

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 3 March 2015 Easting 342054.9

Scale 1 : 50

End Date 4 March 2015 Northing 187600.6 Ground level 18.95mOD Depth 12.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
03/03/15 1315hrs	1B	0.20 - 0.30		Vo 0.0				Soft dark brown sandy CLAY with rare roots (up to 2mm diam). (MG)	0.30	18.65	
	2D*	0.20 - 0.30									
	3B	0.50 - 0.60		Vo 0.0				Firm reddish brown slightly sandy slightly gravelly CLAY with rare roots (up to 2mm diam). Gravel is subrounded fine to coarse siliceous.			
	4D*	0.50 - 0.60									
	5B	1.00 - 1.20		Vo 0.0							
	6D*	1.00 - 1.10									
	7D	1.20 - 1.65	Nil	S 12				Firm reddish brown mottled yellow gravelly silty CLAY. Gravel is subangular fine sandstone.	1.20	17.75	
	8X	1.20 - 2.00									
	9D	2.00 - 2.07	Nil	S*375							
	10X	2.00 - 2.10									
03/03/15 1645hrs 3.20m	11C	2.10 - 3.00	2.10		100 57 41	NI 130 220		Weak reddish brown mottled grey fine SANDSTONE with rare quartz veins. Fractures are subhorizontal to 15° closely to medium spaced undulating rough infilled (up to 2mm) with clay. 2.60m: Incipient fracture. 2.65m: Incipient fracture.	2.10	16.85	
	9C	3.00 - 3.20	2.10	C*300	100 100 85	NI 130 190					
		3.00 - 3.50									
	10C	3.50 - 4.00	2.10		100 89 89			Weak and medium strong reddish brown and grey fine SANDSTONE with rare quartz veins. Fractures are subhorizontal to 20° and 65° to subvertical closely spaced undulating rough infilled (up to 2mm) with clay.			
	11C	4.00 - 5.50	2.10		87 78 70						
04/03/15 0825hrs Dry	12C	5.50 - 7.00	2.10		80 51 51	NI 140 280		5.30 - 5.80m: Limited recovery. Medium strong and strong reddish brown and grey fine SANDSTONE. Fractures are subhorizontal to 20° and 55° to subvertical closely and medium spaced undulating rough infilled (up to 2mm) with clay. 5.80 - 6.20m: Recovered non intact.	5.50	13.45	
	13C	7.00 - 7.50	2.10		100 100 86						
	14C	7.50 - 9.00	2.10		80 54 30						
Continued Next Page									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Dynamic sampled (128mm) 1.20-2.00m and (113mm) 2.00-2.10m. Waterflush rotary core drilled (116mm) 2.10-12.00m.

CASING: 140mm diam to 2.10m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 12.00m, granular response zone 12.00-8.00m and bentonite seal 8.00-4.00m. A second slotted standpipe (35mm) was installed to 4.00m, granular response zone 4.00-2.00m, bentonite seal 2.00-0.20m, concrete and stopcock cover 0.20-0.00m.

REMARKS: Driller notes reduced flush returns 2.10-3.50m (90% returned) and loss of flush 3.50-12.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
30238CHECKED
EC



CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Start Date 3 March 2015 Easting 342054.9

End Date 4 March 2015 Northing 187600.6 Ground level 18.95mOD

BH549

Sheet 2 of 2


Scale 1 : 50

Depth 12.00 m


progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- -ment	description	depth (m)	reduced level (m)	legend	
04/03/15 1550hrs 8.20m	15C	9.00 - 10.50	2.10		100 71 9			Extremely weak and very weak thinly laminated to very thinly bedded grey and reddish brown MUDSTONE locally tending to claybound tabular fine to coarse gravel sized lithorelicts. Fractures are subhorizontal to 20° very closely and closely spaced planar smooth.	8.30	10.65		
	16C	10.50 - 12.00	2.10		100 78 66			Weak thinly laminated to very thinly bedded reddish brown and grey MUDSTONE. Fractures are subhorizontal to 20° closely and medium spaced planar smooth infilled (2mm) with clay. Locally disintegrated to fine to coarse gravel.	11.60	7.35		

Appendix 2

Gas & Groundwater Monitoring Data

Project Name New M4 Preliminary Ground Investigation						Groundwater Readings For Installations			Fig no. 01			
Project No. F15056												
Engineer Ove Arup & Partners Ltd												
Client Transport Wales, Welsh Assembly Government												
NOTES: SPIE=Piezometer, SP=Standpipe For multiple installations, use different Installation IDs. For piezometers installation depth = tip depth. For standpipes = base of pipe												
COMMENTS SBHM01 RC installation extends 0.50m above ground level. - symbol indicates water level is above GL All groundwater levels are recorded from ground level												
Exploratory Hole ID	Installation Details			Recorded Water Level								
	Type	Depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
SBHC01 RC	SPIE	8.05		30/01/2008	09:50	2.45	25/02/2008	14:34	2.48	07/03/2008	14:25	2.60
SBHD03 CP	SPIE	10.00		30/01/2008	11:01	0.47	25/02/2008	14:52	0.43	07/03/2008	14:05	0.56
SBHD05 RC	SPIE	12.00		31/01/2008	09:00	1.02	25/02/2008	15:35	1.05	07/03/2008	13:50	1.77
SBHD06 RC	SP	15.00		30/01/2008	13:00	1.13	21/02/2008	10:30	1.39	07/03/2008	13:30	1.39
SBHD08 RC	SPIE	29.50		30/01/2008	13:50	1.20	25/02/2008	15:58	2.02	07/03/2008	13:35	1.40
SBHE02RD	SPIE	25.00		31/01/2008	09:25	2.18	25/02/2008	16:20	2.09	07/03/2008	13:10	2.48
SBHE04 RC	SPIE	17.20		31/01/2008	09:15	2.31	25/02/2008	16:11	2.51	07/03/2008	13:20	2.59
SBHF01 RC	SPIE	19.00		31/01/2008	09:40	5.69	25/02/2008	16:32	5.72	07/03/2008	12:50	5.43
SBHF02A CP	SPIE	17.00		01/02/2008	14:40	7.61	25/02/2008	17:13	7.57	07/03/2008	12:30	9.00
SBHF03 RC	SPIE	18.00		31/01/2008	10:35	6.97	26/02/2008	08:55	6.77	07/03/2008	12:15	7.22
SBHH01 RC	SPIE	25.00		31/01/2008	11:15	3.45	26/02/2008	09:39	3.42	07/03/2008	11:28	3.65
SBHH02 RC	SPIE	14.90		31/01/2008	11:10	3.42	26/02/2008	09:20	3.88	07/03/2008	11:35	3.64
SBHH05 RC	SPIE	21.50		31/01/2008	11:30	2.22	26/02/2008	10:01	2.13	07/03/2008	11:05	3.10
SBHH06 CP	SP	12.30		30/01/2008	15:30	3.75	21/02/2008	08:00	3.76	07/03/2008	11:10	3.87
SBHH07A RC	SPIE	24.85		30/01/2008	14:50	1.70	26/02/2008	10:40	1.34	07/03/2008	11:00	1.07
SBHJ01 CP	SP	7.50		01/02/2008	12:20	1.34	21/02/2008	11:45	5.98	06/03/2008	12:28	1.82
SBHJ03 CP	SP	5.20		01/02/2008	08:00	0.54	27/02/2008	16:15	0.70	07/03/2008	10:45	0.68
SBHJ04	SP	13.10		01/02/2008	11:55	6.61	22/02/2008	13:55	6.67	06/03/2008	11:46	6.75
SBHJ05	SP	11.50		01/02/2008	11:10	8.91	22/02/2008	09:00	9.07	06/03/2008	11:23	9.16
SBHJ06 CP	SP	4.10		01/02/2008	11:45	1.31	21/02/2008	15:30	1.32	06/03/2008	10:50	1.33
SBHJ07 CP	SP	10.40		01/02/2008	11:43	1.35	21/02/2008	14:40	1.40	06/03/2008	12:05	1.56
SBHJ08A CP	SP	7.40		01/02/2008	11:35	3.49	21/02/2008	13:05	2.31	06/03/2008	10:57	2.67
SBHJ09 CP	SP	2.20		01/02/2008	11:30	0.65	21/02/2008	12:25	0.85	06/03/2008	11:00	0.90
SBHJ10 CP	SP	10.00		01/02/2008	10:40	2.30	21/02/2008	13:45	2.24	06/03/2008	10:40	2.16
SBHK01 CP	SP	6.80		01/02/2008	10:55	0.70	25/02/2008	10:30	1.00	06/03/2008	14:24	1.06
SBHK02 CP	SP	11.20		01/02/2008	10:50	1.34	25/02/2008	11:20	1.33	06/03/2008	14:18	1.47
SBHK03 CP	SP	5.90		01/02/2008	10:45	0.87	25/02/2008	12:00	0.89	06/03/2008	14:15	1.00
SBHK04 CP	SP	12.20		01/02/2008	10:25	1.45	25/02/2008	12:30	1.60	06/03/2008	12:30	1.60
SBHL02 RC	SPIE	15.20		01/02/2008	10:35	2.27	25/02/2008	12:49	2.31	06/03/2008	14:00	2.42
SBHL03 RC	SPIE	15.00		31/01/2008	16:20	0.61	26/02/2008	11:15	0.51	07/03/2008	10:25	0.66
SBHM01 RC	SPIE	21.00		01/01/1900	08:20	-0.26	26/02/2008	11:30	-0.26	07/03/2008	10:17	0.05
SBHM02 RC	SPIE	20.00		01/02/2008	08:25	0.19	26/02/2008	11:41	0.49	07/03/2008	10:14	0.68
SBHN01A RC	SPIE	14.90		01/02/2008	15:20	8.49	27/02/2008	17:15	12.23	07/03/2008	14:45	13.18
SBHN02 RC	SPIE	20.40		31/01/2008	15:55	3.67	26/02/2008	11:57	4.19	07/03/2008	10:05	4.84
SBHN03 RC	SPIE	15.00		31/01/2008	15:45	1.07	26/02/2008	12:03	1.73	07/03/2008	09:55	2.34
SBHN04 RC	SPIE	10.00		31/01/2008	15:30	9.99	26/02/2008	14:42	DRY	07/03/2008	09:45	DRY
Recorded by: S Davis			Checked by: I Swain			Approved by: I Swain						
Date: 30/01/08-07/03/08			Date: 16/04/2008			Date: 17/04/2008						
Form No. SI GWR			Revision No. 2.03			Issue Date 07/01/2008						

[illegible]

Project Name New M4 Preliminary Ground Investigation						Groundwater Readings For Installations			Fig no. 03			
Project No. F15056												
Engineer Ove Arup & Partners Ltd												
Client Transport Wales, Welsh Assembly Government												
NOTES: SPIE=Piezometer, SP=Standpipe For multiple installations, use different Installation IDs. For piezometers installation depth = tip depth. For standpipes = base of pipe												
COMMENTS SBHM01 RC installation extends 0.50m above ground level. - symbol indicates water level is above GL All groundwater levels are recorded from ground level												
Exploratory Hole ID	Installation Details			Recorded Water Level								
	Type	Depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
SBHC01 RC	SPIE	8.05		20/03/2008	16:30	2.57	04/04/2008	08:00	2.59	18/04/2008	07:40	2.66
SBHD03 CP	SPIE	10.00		20/03/2008	16:45	0.58	04/04/2008	08:13	0.53	18/04/2008	08:00	0.60
SBHD05 RC	SPIE	12.00		20/03/2008	16:00	1.08	04/04/2008	09:15	1.22	18/04/2008	08:30	1.32
SBHD06 RC	SP	15.00		20/03/2008	17:55	1.20	04/04/2008	09:30	1.33	18/04/2008	08:40	1.44
SBHD08 RC	SPIE	29.50		19/03/2008	18:30	1.28	04/04/2008	10:00	1.39	18/04/2008	08:52	1.52
SBHE02RD	SPIE	25.00		20/03/2008	16:20	2.23	04/04/2008	08:50	2.46	18/04/2008	09:00	2.54
SBHE04 RC	SPIE	17.20		20/03/2008	15:45	2.20	04/04/2008	09:00	1.80	18/04/2008	08:15	1.80
SBHF01 RC	SPIE	19.00		20/03/2008	15:30	5.50	04/04/2008	08:40	5.55	18/04/2008	13:58	5.58
SBHF02A CP	SPIE	17.00		20/03/2008	15:10	5.60	04/04/2008	10:28	5.70	18/04/2008	13:45	5.77
SBHF03 RC	SPIE	18.00		20/03/2008	14:55	7.20	04/04/2008	10:36	7.38	18/04/2008	13:40	7.42
SBHH01 RC	SPIE	25.00		20/03/2008	14:25	3.60	04/04/2008	15:00	3.60	18/04/2008	13:10	3.62
SBHH02 RC	SPIE	14.90		20/03/2008	14:30	4.27	04/04/2008	15:05	3.64	18/04/2008	13:13	3.70
SBHH05 RC	SPIE	21.50		20/03/2008	17:30	2.17	04/04/2008	15:15	2.78	18/04/2008	11:34	2.90
SBHH06 CP	SP	12.30		17/03/2008	15:20	3.88	04/04/2008	15:20	3.89	17/04/2008	14:15	3.90
SBHH07A RC	SPIE	24.85		20/03/2008	13:55	1.33	04/04/2008	15:28	1.92	18/04/2008	11:43	0.88
SBHJ01 CP	SP	7.50		19/03/2008	14:15	1.81	03/04/2008	16:05	1.90	17/04/2008	12:40	1.80
SBHJ03 CP	SP	5.20		19/03/2008	16:40	0.78	03/04/2008	18:25	0.82	17/04/2008	15:55	0.80
SBHJ04	SP	13.10		17/03/2008	13:35	6.64	03/04/2008	18:10	6.74	17/04/2008	13:08	6.80
SBHJ05	SP	11.50		18/03/2008	13:50	9.02	03/04/2008	17:39	9.10	17/04/2008	13:31	9.11
SBHJ06 CP	SP	4.10		17/03/2008	12:55	1.29	03/04/2008	17:43	1.33	17/04/2008	15:05	1.20
SBHJ07 CP	SP	10.40		17/03/2008	10:25	1.59	03/04/2008	17:47	1.50	17/04/2008	13:58	1.47
SBHJ08A CP	SP	7.40		18/03/2008	10:00	2.50	03/04/2008	17:55	2.50	17/04/2008	15:33	2.50
SBHJ09 CP	SP	2.20		18/03/2008	10:25	0.69	03/04/2008	17:58	0.82	17/04/2008	15:22	0.90
SBHJ10 CP	SP	10.00		17/03/2008	09:15	2.10	03/04/2008	17:50	2.00	17/04/2008	13:55	2.00
SBHK01 CP	SP	6.80		19/03/2008	10:45	0.88	03/04/2008	16:40	1.00	17/04/2008	11:40	0.94
SBHK02 CP	SP	11.20		19/03/2008	11:15	1.46	03/04/2008	16:45	1.48	17/04/2008	11:43	1.46
SBHK03 CP	SP	5.90		19/03/2008	11:45	1.04	03/04/2008	16:48	1.07	17/04/2008	11:46	0.98
SBHK04 CP	SP	12.20		19/03/2008	12:15	1.64	03/04/2008	16:52	1.67	17/04/2008	12:05	1.60
SBHL02 RC	SPIE	15.20		19/03/2008	12:50	2.44	03/04/2008	17:00	2.45	17/04/2008	12:00	2.45
SBHL03 RC	SPIE	15.00		20/03/2008	13:25	0.76	08/04/2008	15:40	0.64	18/04/2008	09:50	0.62
SBHM01 RC	SPIE	21.00		20/03/2008	13:05	-0.21	08/04/2008	15:48	-0.45	18/04/2008	11:55	0.01
SBHM02 RC	SPIE	20.00		20/03/2008	13:10	0.61	08/04/2008	15:52	0.61	18/04/2008	11:50	0.61
SBHN01A RC	SPIE	14.90		20/03/2008	12:55	12.14	08/04/2008	16:05	12.58	18/04/2008	12:48	13.27
SBHN02 RC	SPIE	20.40		20/03/2008	12:45	4.26	08/04/2008	16:12	2.64	18/04/2008	12:45	4.85
SBHN03 RC	SPIE	15.00		20/03/2008	12:30	1.60	08/04/2008	16:17	2.07	18/04/2008	12:35	2.37
SBHN04 RC	SPIE	10.00		20/03/2008	12:10	DRY	08/04/2008	16:28	DRY	18/04/2008	10:55	DRY
Recorded by: S Davis			Checked by: I Swain			Approved by: I Swain						
Date: 17/03/08-17/04/08			Date: 21/04/2008			Date: 21/04/2008						
Form No. SI GWR			Revision No. 2.03			Issue Date 07/01/2008						

[illegible]

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH545	17/04/15 09:00:00	1022	-1.05								0.0	8		36 litres purged, base depth 12.50m.	
BH545	17/04/15 09:01:00										0.0				
BH545	17/04/15 09:02:00										0.0				
BH545	17/04/15 09:03:00										0.0				
BH545	17/04/15 09:04:00										0.0				
BH545	17/04/15 09:05:00			2.8	0.1	18.0	1.0	0	0	5.4					
BH545	17/04/15 09:06:00			2.8	0.1	17.9	1.0	0	0	5.1					
BH545	17/04/15 09:07:00			2.8	0.1	17.9	1.0	0	0	6.3					
BH545	17/04/15 09:08:00			2.8	0.1	17.9	1.0	0	0	6.1					
BH545	17/04/15 09:09:00			2.8	0.1	17.9	1.0	0	0	5.8					
BH545	17/04/15 09:10:00			2.8	0.1	17.9	1.0	0	0	5.5					
BH545	17/04/15 09:11:00			2.8	0.1	17.9	1.0	0	0	5.3					
BH545	17/04/15 09:12:00			2.8	0.1	17.9	1.0	0	0	4.9					
BH545	17/04/15 09:13:00			2.8	0.1	17.9	1.0	0	0	4.6					
BH545	17/04/15 09:14:00			2.7	0.1	17.9	1.0	0	0	4.4			6.35		
BH545	24/04/15 10:00:00	1015	-1.1								0.0	12		35 litres purged, base depth 12.50m.	
BH545	24/04/15 10:01:00										0.0				
BH545	24/04/15 10:02:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH545	24/04/15 10:03:00										0.0			
BH545	24/04/15 10:04:00										0.0			
BH545	24/04/15 10:05:00			0.1	0.1	20.6	1.0	0	0	2.5				
BH545	24/04/15 10:06:00			1.1	0.1	19.4	1.0	0	0	4.3				
BH545	24/04/15 10:07:00			1.9	0.1	18.3	1.0	0	0	5.0				
BH545	24/04/15 10:08:00			2.3	0.1	17.6	1.0	0	0	4.9				
BH545	24/04/15 10:09:00			2.4	0.1	17.4	1.0	0	0	4.8				
BH545	24/04/15 10:10:00			2.4	0.1	17.4	1.0	0	0	4.6				
BH545	24/04/15 10:11:00			2.5	0.1	17.3	1.0	0	0	4.5				
BH545	24/04/15 10:12:00			2.6	0.1	17.2	1.0	0	0	4.2				
BH545	24/04/15 10:13:00			2.7	0.1	17.1	1.0	0	0	4.0				
BH545	24/04/15 10:14:00			2.7	0.1	17.0	1.0	0	0	3.9			6.65	
BH545	01/05/15 08:30:00	1014	-0.51								0.0	8		33 litres purged, base depth 12.50m.
BH545	01/05/15 08:31:00										0.0			
BH545	01/05/15 08:32:00										0.0			
BH545	01/05/15 08:33:00										0.0			
BH545	01/05/15 08:34:00										0.0			
BH545	01/05/15 08:35:00			2.7	0.0	18.3	0.0	0	0	3.4				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks							
BH545	01/05/15 08:36:00	1021	0	2.7	0.0	18.2	0.0	0	0	3.8	0.0	16	6.85								
BH545	01/05/15 08:37:00			2.7	0.0	18.2	1.0	0	0	3.8											
BH545	01/05/15 08:38:00			2.7	0.0	18.2	1.0	0	0	3.8											
BH545	01/05/15 08:39:00			2.8	0.0	18.2	1.0	0	0	3.7											
BH545	01/05/15 08:40:00			2.8	0.0	18.2	1.0	0	0	3.6											
BH545	01/05/15 08:41:00			2.9	0.0	18.3	1.0	0	0	3.3											
BH545	01/05/15 08:42:00			2.9	0.0	18.3	1.0	0	0	3.2											
BH545	01/05/15 08:43:00			2.9	0.0	18.3	1.0	0	0	2.9											
BH545	01/05/15 08:44:00			2.9	0.0	18.3	1.0	0	0	2.7											
BH545	11/05/15 11:37:00																				
BH545	11/05/15 11:38:00																				
BH545	11/05/15 11:39:00																				
BH545	11/05/15 11:40:00																				
BH545	11/05/15 11:41:00																				
BH545	11/05/15 11:42:00					0.1	0.0	19.3	0.0	0					0	0.4					
BH545	11/05/15 11:43:00					0.1	0.0	19.2	0.0	0					0	0.5					
BH545	11/05/15 11:44:00					0.2	0.0	19.2	0.0	0					0	0.6					
BH545	11/05/15 11:45:00					0.2	0.0	19.1	0.0	0					0	0.7					
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.															CONTRACT 30238	CHECKED EC					

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GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH545	11/05/15 11:46:00			0.3	0.0	19.0	0.0	0	0	0.8				
BH545	11/05/15 11:47:00			0.4	0.0	19.0	0.0	0	0	0.9				
BH545	11/05/15 11:48:00			0.5	0.0	18.9	0.0	0	0	1.0				
BH545	11/05/15 11:49:00			0.6	0.0	18.9	0.0	0	0	1.0				
BH545	11/05/15 11:50:00			0.7	0.0	18.7	0.0	0	0	1.0				
BH545	11/05/15 11:51:00			0.8	0.0	18.7	0.0	0	0	1.1				
BH545	11/05/15 11:52:00												7.82	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH549	17/04/15 10:00:00	1021	-0.73								0.0	12		25 litres purged, base depth 12.00m.	
BH549	17/04/15 10:01:00										0.0				
BH549	17/04/15 10:02:00										0.0				
BH549	17/04/15 10:03:00										0.0				
BH549	17/04/15 10:04:00										0.0				
BH549	17/04/15 10:05:00			1.3	0.1	18.0	1.0	0	3	9.2					
BH549	17/04/15 10:06:00			1.3	0.1	18.1	1.0	0	3	8.6					
BH549	17/04/15 10:07:00			1.3	0.1	18.1	1.0	0	3	7.9					
BH549	17/04/15 10:08:00			1.3	0.1	18.1	1.0	0	3	7.4					
BH549	17/04/15 10:09:00			1.3	0.1	18.1	1.0	0	3	7.2					
BH549	17/04/15 10:10:00			1.3	0.1	18.1	1.0	0	3	7.1					
BH549	17/04/15 10:11:00			1.3	0.1	18.1	1.0	0	3	6.9					
BH549	17/04/15 10:12:00			1.3	0.1	18.2	1.0	0	3	6.9					
BH549	17/04/15 10:13:00			1.3	0.1	18.2	1.0	0	2	6.9					
BH549	17/04/15 10:14:00			1.3	0.1	18.2	1.0	0	2	6.9			7.68		
BH549	24/04/15 11:00:00	1011	0								0.0	13		17 litres purged, base depth 12.00m.	
BH549	24/04/15 11:01:00										0.0				
BH549	24/04/15 11:02:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH549	24/04/15 11:03:00										0.0			
BH549	24/04/15 11:04:00										0.0			
BH549	24/04/15 11:05:00			0.8	0.1	19.8	1.0	0	2	4.7				
BH549	24/04/15 11:06:00			0.8	0.1	19.8	1.0	0	1	4.6				
BH549	24/04/15 11:07:00			0.8	0.1	19.8	1.0	0	1	4.5				
BH549	24/04/15 11:08:00			0.7	0.1	19.8	1.0	0	1	4.5				
BH549	24/04/15 11:09:00			0.7	0.1	19.8	1.0	0	1	4.4				
BH549	24/04/15 11:10:00			0.7	0.1	19.8	1.0	0	1	4.3				
BH549	24/04/15 11:11:00			0.7	0.1	19.8	1.0	0	1	4.3				
BH549	24/04/15 11:12:00			0.7	0.1	19.8	1.0	0	0	4.2				
BH549	24/04/15 11:13:00			0.7	0.1	19.8	1.0	0	0	4.2				
BH549	24/04/15 11:14:00			0.7	0.1	19.7	1.0	0	0	4.2			9.12	
BH549	01/05/15 09:30:00	1013	-1.09								0.0	8		24 litres purged, base depth 12.00m.
BH549	01/05/15 09:31:00										0.0			
BH549	01/05/15 09:32:00										0.0			
BH549	01/05/15 09:33:00										0.0			
BH549	01/05/15 09:34:00										0.0			
BH549	01/05/15 09:35:00			0.9	0.0	19.6	0.0	0	0	3.7				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks		
BH549	01/05/15 09:36:00	1020	2	0.8	0.0	19.7	0.0	0	0	3.4	0.4	16	7.89			
BH549	01/05/15 09:37:00			0.8	0.0	19.8	1.0	0	0	3.3						
BH549	01/05/15 09:38:00			0.8	0.0	19.8	1.0	0	0	3.3						
BH549	01/05/15 09:39:00			0.8	0.0	19.8	1.0	0	0	3.3						
BH549	01/05/15 09:40:00			0.8	0.0	19.8	1.0	0	0	3.2						
BH549	01/05/15 09:41:00			0.8	0.0	19.8	1.0	0	0	3.2						
BH549	01/05/15 09:42:00			0.8	0.0	19.8	1.0	0	0	3.1						
BH549	01/05/15 09:43:00			0.8	0.0	19.8	1.0	0	0	3.1						
BH549	01/05/15 09:44:00			0.8	0.0	19.8	1.0	0	0	3.1						
BH549	11/05/15 13:38:00															
BH549	11/05/15 13:39:00															
BH549	11/05/15 13:40:00															
BH549	11/05/15 13:41:00															
BH549	11/05/15 13:42:00															
BH549	11/05/15 13:43:00					0.9	0.0	18.5	0.0	0					0	1.2
BH549	11/05/15 13:44:00					0.6	0.0	19.1	0.0	0					0	0.7
BH549	11/05/15 13:45:00					0.3	0.0	19.4	0.0	0					0	0.4
BH549	11/05/15 13:46:00					0.2	0.0	19.6	0.0	0					0	0.3
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene. Deep install.														CONTRACT 30238	CHECKED EC	

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH549	11/05/15 13:47:00			0.2	0.0	19.5	0.0	0	0	0.5				
BH549	11/05/15 13:48:00			0.2	0.0	19.6	0.0	0	0	0.4				
BH549	11/05/15 13:49:00			0.2	0.0	19.6	0.0	0	0	0.6				
BH549	11/05/15 13:50:00			0.2	0.0	19.6	0.0	0	0	0.7				
BH549	11/05/15 13:51:00			0.2	0.0	19.6	0.0	0	0	0.7				
BH549	11/05/15 13:52:00			0.2	0.0	19.6	0.0	0	0	0.7				
BH549	11/05/15 13:53:00												8.95	
<div>remarks</div> <div># denotes result exceeding capacity of gas monitoring equipment</div> <div>VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.</div> <div>Deep install.</div>													<div>CONTRACT</div> <div>30238</div>	<div>CHECKED</div> <div>EC</div>

Appendix 3

Soil Laboratory Data

M4CAN
Soil Analysis Results & Screening Assessment
CL-33
08/07/2015

Geological Formation Legend	
MG	Made Ground

Sample Reference	Units	STPN03	STPN03	STPN04	STPN04
Specimen Depth (m)		0.3	1	0.3	1
OD Level (m)		20.39	19.69	17.33	16.63
Sample Type		B	ES	D	ES
Geology Code		MG	MG	MG	MG
Cluster Code		2007 GI	2007 GI	2007 GI	2007 GI
1,2,3-Trichlorobenzene	ug/kg				
1,2,3-Trichloropropane	ug/kg				
1,2,4-Trichlorobenzene	ug/kg				
1,2,4-Trimethylbenzene	ug/kg				
1,2-Dibromo-3-Chloropropane	ug/kg				
1,2-Dibromoethane	ug/kg				
1,2-Dichlorobenzene	ug/kg				
1,2-Dichloroethane	ug/kg				
1,2-Dichloropropane	ug/kg				
1,3,5-Trimethylbenzene	ug/kg				
1,3-Dichlorobenzene	ug/kg				
1,3-Dichloropropane	ug/kg				
1,4-Dichlorobenzene	ug/kg				
2-Chlorotoluene	ug/kg				
4-Chlorotoluene	ug/kg				
4-Isopropyltoluene	ug/kg				
Benzene	ug/kg				
Bromobenzene	ug/kg				
Bromochloromethane	ug/kg				
Bromodichloromethane	ug/kg				
Bromomethane	ug/kg				
Chlorobenzene	ug/kg				
Chloroethane	ug/kg				
Chloroethene	ug/kg				
Chloroform	ug/kg				
Chloromethane	ug/kg				
cis-1,2-Dichloroethene	ug/kg				
cis-1,3-Dichloropropene	ug/kg				
Dibromochloromethane	ug/kg				
Dibromomethane	ug/kg				
Dichlorodifluoromethane	ug/kg				
Ethylbenzene	ug/kg				
Hexachlorobutadiene (HCBD)	ug/kg				
Isopropylbenzene	ug/kg				
m,p xylenes	ug/kg				
Methyl tert-butyl ether (MTBE)	ug/kg				
n-Butylbenzene	ug/kg				
n-propylbenzene	ug/kg				
O-Xylene	ug/kg				
Sec-Butylbenzene	ug/kg				
Styrene	ug/kg				
Tert-Butylbenzene	ug/kg				
Tetrachloroethene	ug/kg				
Tetrachloromethane (Carbon Tetra Chloride)	ug/kg				
Toluene	ug/kg				
trans-1,2-Dichloroethene	ug/kg				
trans-1,3-Dichloropropene	ug/kg				
Tribromomethane	ug/kg				
Trichloroethene	ug/kg				
Trichlorofluoromethane	ug/kg				
SVOCs					
2,4,5-Trichlorophenol	mg/kg				
2,4,6-Trichlorophenol	mg/kg				
2,4-Dichlorophenol	mg/kg				
2,4-Dimethylphenol	mg/kg				
2,4-Dinitrotoluene	mg/kg				
2,6-Dinitrotoluene	mg/kg				
2-Chloronaphthalene	mg/kg				
2-Chlorophenol	mg/kg				
2-Methyl-4,6-Dinitrophenol	mg/kg				
2-Methylnaphthalene	mg/kg				
2-Methylphenol	mg/kg				
2-Nitroaniline	mg/kg				
2-Nitrophenol	mg/kg				
3-Nitroaniline	mg/kg				
4-Bromophenyl Phenyl Ether	mg/kg				
4-Chloro-3-Methylphenol	mg/kg				
4-Chloroaniline	mg/kg				
4-Chlorophenyl Phenyl Ether	mg/kg				
4-Methylphenol	mg/kg				
4-Nitroaniline	mg/kg				
4-Nitrophenol	mg/kg				
Azobenzene	mg/kg				
Bis(2-chloroethoxy)methane	mg/kg				
Bis(2-chloroethyl)ether	mg/kg				
Bis(2-chloroisopropyl)ether	mg/kg				
Bis(2-ethylhexyl)phthalate	mg/kg				
Butylbenzylphthalate	mg/kg				
Carbazole	mg/kg				
Dibenzofuran	mg/kg				
Diethylphthalate	mg/kg				
Dimethylphthalate	mg/kg				
Di-N-Butyl Phthalate	mg/kg				
Di-N-Octyl Phthalate	mg/kg				
Hexachlorobenzene (HCB)	mg/kg				
Hexachlorocyclopentadiene	mg/kg				
Hexachloroethane	mg/kg				
Isophorone	mg/kg				
Nitrobenzene	mg/kg				
n-nitrosodimethylamine	mg/kg				
N-Nitroso-Di-N-Propylamine	mg/kg				
Pentachlorophenol (PCP)	mg/kg				
Phenol	mg/kg				

Screening Values and Assessment	
	Exceeds S4ULs criteria
X	Laboratory detection level higher than screening criterion

Notes

NFD = No Fibres Detected

Chromium VI criteria used

Elemental Mercury criteria used

Screening criterion for lead is C4SL in the absence of a S4UL

[illegible]

Appendix 4

Groundwater Laboratory Data

Appendix 5

Soil Leachate Laboratory Data

M4CAN
Leachate Analysis Results & Screening Assessment
CL-33
08/07/2015

Geological Formation Legend

MG	Made Ground
----	-------------

Sample Reference	Units	Screening Criteria		STPN03	STPN04
Specimen Depth		EQS	DWS	0.3	0.3
Level				20.39	17.33
Sample Type				D	B
Geology Code				MG	MG
Cluster Code				2007 GI	2007 GI
2:1 Leachate Results					
Arsenic Dissolved	ug/l	50	10	2	<1
Boron Dissolved	ug/l	2000	1000	50	150
Barium Dissolved	ug/l			24	18
Cadmium Dissolved	ug/l	0.15	5	<0.4	<0.4
Chromium Dissolved	ug/l		50	2	4
Copper Dissolved	ug/l	10	2000	3	3
Molybdenum Dissolved	ug/l			2	<1
Nickel Dissolved	ug/l	4	20	2	2
Lead Dissolved	ug/l	1.2	10	6	<1
Antimony Dissolved	ug/l		5	<5	<5
Selenium Dissolved	ug/l		10	<1	<1
Zinc Dissolved	ug/l	75		<3	<3
Total Cyanide	mg/l	0.001	0.05	<0.05	<0.05

WAC

Location	Units	STPN03	STPN04
Depth		0.3	0.3
Antimony Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0	0
Arsenic Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0.02	0
Barium Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0.05	0.14
Boron Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0	0.4
Cadmium Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0	0
Chromium Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0	0
Copper Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0	0.23
Lead Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0	0.02
Molybdenum Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0.02	0
Nickel Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0.02	0.02
Selenium Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0.03	0
Total Cyanide (CEN 10:1C)	mg/kg	0	0
Zinc Dissolved (CEN 10:1C) (ICP-MS)	mg/kg	0	0.22

Screening Values & Assessment

EQS	Environmental Quality Standards
DWS	Drinking Water Standard
	Exceeds EQS
X	Exceeds DWS
X	Laboratory detection level higher than screening criterion

Notes

EQS calcium carbonate 100 - 150mg/l for heavy metals: chromium, copper, lead, nickel and zinc

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS
2	1	2	2	STPN03 @ 0.3mbGL	0	0
2	2	150	50	STPN04 @ 0.3mbGL	0	0
2	2	24	18	STPN03 @ 0.3mbGL		
2	0	None > LOD	None > LOD		0	0
2	2	4	2	STPN04 @ 0.3mbGL		0
2	2	3	3	STPN03 @ 0.3 / STPN04 @ 0.3mbGL	0	0
2	1	2	2	STPN03 @ 0.3mbGL		
2	2	2	2	STPN03 @ 0.3 / STPN04 @ 0.3mbGL	0	0
2	1	6	6	STPN03 @ 0.3mbGL	1	0
2	0	None > LOD	None > LOD			0
2	0	None > LOD	None > LOD			0
2	0	None > LOD	None > LOD		0	
2	0	None > LOD	None > LOD		0	0

Appendix 6

Site Walkover Photographs



Plate 01: CL33 – View Looking West Across Site



Plate 02: CL33 – View Looking North Across Site

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: June 2015

Appendix 7

Relevant Extract of Additional Environmental Data

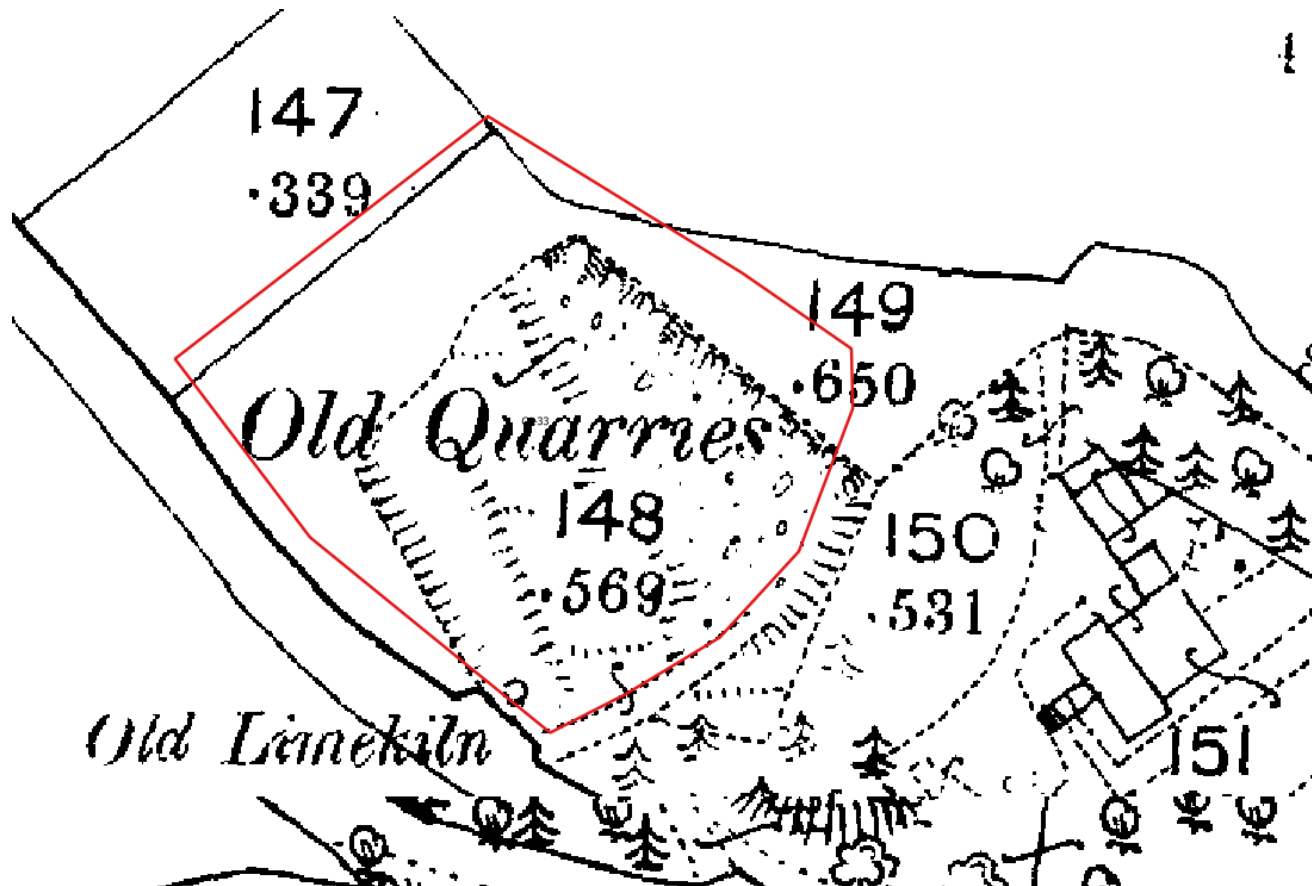


Plate 01: Extract of 1843 – 1893 historical map showing the Old Quarry on the Site.



Plate 02: Extract of 1981 infra red image highlighting broken ground on the Site.



Plate 03: Extract of 2014 High Resolution Aerial Photograph.

Plate 04:

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment
Report Annex D

CL-35 Magor Services Land
Contamination Report

M4CaN-DJV-EGT-ZG_GEN-RP-EN-0023

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Job number JER 6591

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Appendix 1	Exploratory Records
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Appendix 4	Site Walkover Photographs
Appendix 5	Relevant Extract of Additional Environmental Data

1 Introduction

1.1 Background

1.1.1 This report relates to an area of land potentially affected by contamination (CL-35) known as 'Magor Services' hereinafter referred to as the Site.

1.1.2 The Site is located between chainage 20,900 and 21,200 (See Figure 1), upon a motorway service station.

1.2 Reporting Context

1.2.1 The Site has been assessed as part of ground investigations and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the "Scheme") and informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the chapter on Geology and Soils.

1.2.2 In 2014, a Preliminary Sources Study Report (2014 PSSR) was prepared as an initial land contamination appraisal (Ove, Arup & Partners, 2014) as part of DMRB Stage 2 Assessments for this Scheme. This identified a number of individual areas that may have been affected by contamination as a result of historical activities at the Site. In addition, this report draws upon the 2015 Supplementary Ground Investigation Works undertaken on behalf of the Welsh Government (Geotechnical Engineering, 2015). This report relates to the area defined on the Site Location Plan Figure 1.

1.2.3 The overarching rationale and approach for the assessment of areas of land along the Scheme with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

1.3.1 The key objectives of this report are as follows:

- Undertake a risk assessment of the site and determine whether potential risks to human health or controlled waters could exist based upon the Scheme.
- Identify the need for further assessment and investigation in order to refine potential land contamination risks and inform the need for remediation/mitigation.
- To provide information to support the Ground Investigation Report (GIR) and Geotechnical Design Report (GDR) required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

1.4.1 The remainder of this report is structured as follows:

- Section 2: Site Location and Description – This section summarises the Site description.

- Section 3: The Scheme – This section details the Scheme alignment and associated features and at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and historical land photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and any relevant environmental information presented in the 2014 PSSR.
- Section 6: Scope of Ground Investigations Work – This section describes the previous and supplementary ground investigation data available for the Site.
- Section 7: Ground Conditions – This section describes the main findings of the intrusive site investigation including the ground conditions encountered and visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contaminant linkages and presents the human health and controlled waters assessments.
- Section 9: Refined Site Conceptual Model – This section presents the Conceptual Site Model (CSM) for the Site and identifies potential contaminant linkages, based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations – This section provides conclusions concerning the likelihood of land contamination associated with the Site affecting the Scheme and requirements for remediation/mitigation.

2 Site Location and Description

2.1 Site Location

- 2.1.1** The CL-35 site is located within the eastern part of the Scheme immediately north of Junction 23A of the M4 and is centred on National Grid Reference ST422 880. The location of the Site is presented on Figure 1. The Site covers an area of approximately 7.5 ha.
- 2.1.2** The Site is a service station that broadly comprises a main services building with hotel, a petrol station, car/HGV parking and landscaped/vegetated areas.
- 2.1.3** The slip roads to the M4/A4810 interchange form the southern boundary of the Site. The Site is bounded by minor roads and fields to the northwest and northeast. The services were under construction in 1991 and first opened in 1996, with further development in 1998.
- 2.1.4** Site walkover surveys undertaken in January 2014 and May 2015 identified that the Site appears to have been constructed on a fill platform, some 3 m to 4 m in height. Evidence of minor fly tipping, particularly around the parking areas, was identified and included tyres, plastics and wood. Photographs from the Site walkover are provided in Appendix 4.
- 2.1.5** Site layout is shown in Figure 1.

3 The Scheme

- 3.1.1** The Site is located on the M4 Corridor around Newport at approximate chainage 20,900 and 21,200. Refer to Figure 1 for the Site location in relation to the Scheme.
- 3.1.2** The reconstruction of the Magor Interchange would include realignment of the M48 to the north. This would result in an embankment into the south eastern corner of the CL-35 Site area.
- 3.1.3** The existing St Bridge's Road bounds the eastern boundary of the Site and its alignment would be altered to include so up to 4 m cutting along a short section of the Site. The removed soils may either be reused within the Scheme, if proven to be suitable for reuse, or disposed to a suitable landfill.

4 Site History

- 4.1.1** The 2014 PSSR historical searches have been based on Ordnance Survey plans, literature reviews, information provided by British Steel, Natural Resources Wales (NRW) (formerly Environment Agency Wales), Newport City Council and aerial photographic interpretation.
- 4.1.2** This is supplemented by a review of historical maps opened in 2015 from Welsh Government. Relevant extracts are presented in Appendix 5.
- 4.1.3** A summary of the Site's history is presented in Table 1 below.

Table 1: Summary of Site History

Date	Land Use & Surrounding Land Use (200m)	Source of Information
1843 - 1893	The Site comprises a number of agricultural fields and is bound to the northeast and northwest by minor roads. A small copse is located in the east. St Brides Brook is located running north-south approximately 90m to the east.	1:10,560 Historical Mapping
1891 - 1912	No significant change	1:10,560 Historical Mapping
1904 - 1939	No significant change	1:10,560 Historical Mapping
1964 – 1965	No significant change	1:10,560 Historical Mapping
1969	The <u>M4 motorway and Junction 23A</u> have been constructed along the southern boundary of the Site. The copse onsite is no longer there. The town of Magor has expanded to within 175 m to the south of the Site.	Aerial Photography
1969 - 1971	No significant change	1:10,560 Historical Mapping
1985 - 1996	No significant change	1:10,000 Historical Mapping
1991	<u>Construction of the service station</u> complex is in progress across the Site.	Aerial Photography
1998	A service station has been developed in the centre of the Site with associated landscaping around it. The <u>petrol station</u> is located in the southwest of Site.	Aerial Photography
2006	No significant change	Aerial Photography
2009 - 2010	A hotel is under construction approximately 90 m to the southwest of the Site.	Aerial Photography
2013 - 2014	The vegetation around the areas of hardstanding has matured.	Aerial Photography

*Notes. Potential sources of contamination are underlined. Those within the temporary and permanent land take are shown in bold.

- 4.1.4** The sources of information presented above supplement those used in the 2014 PSSR. Relevant extract of the photographs are presented in Appendix 5.
- 4.1.5** The review of the Site history indicates the Site remained as open fields until the construction of the service station in the late 1990s.
- 4.1.6** Historically the Site is located in proximity to areas which may have been bombed during World War II which is discussed in the Explosive Ordnance Threat Assessment Report (Bactec, 2014). This categorises the Site as low risk with respect to unexploded ordnance

5 Environmental Setting

5.1 Geology

- 5.1.1** British Geological Survey (BGS) data indicates that superficial deposits are only present along the eastern boundary of the Site comprising River Terrace Deposits. The bedrock underlying the south of the Site comprises dolomitic conglomerate of the Mercia Mudstone Group (marginal facies) and the north of the Site comprises the Avon Group Carboniferous Limestones.

5.2 Hydrology

- 5.2.1** A drainage pond is present in the southeast corner of the Site which appears to be part of the services drainage system rather than the neighbouring M4 drainage system. St Bride's Brook is located approximately 75 m to the east of the Site.

5.3 Hydrogeology

- 5.3.1** NRW classifies the River Terrace Deposits as a Secondary A Aquifer and the bedrock as a Principal Aquifer.
- 5.3.2** The Site does not lie within a groundwater source protection zone. However it lies within a groundwater vulnerability zone classified as a major aquifer with intermediate leaching potential.

5.4 Environmental Information

- 5.4.1** NRW records indicate a single pollution incident occurred within the Site which had minor impact on land and no impact on air and water. The incident was in relation to an unauthorised waste management activity in relation to metal waste. Another pollution incident occurred within the Site but this had no impact on land, air or water. Two further pollution incidents occurred within 300 m of the Site which had no impact on land, however had a minor impact on water due to discharge of oils/fuel to the St Bride's Brook.
- 5.4.2** Based on the above the onsite incident could represent a minor source of potential contamination that should require due consideration in the relation to the Scheme.
- 5.4.3** A discharge consent to an unidentified non-tidal watercourse has been held by the service station since 1995. The discharge point is shown to be located approximately 200 m to the south of the Site. However, there are no watercourses at this location. The location of the discharge consent therefore appears to be different to the one shown but it is anticipated that the discharge consent will be to St Bride's Brook as there are no other watercourses in the vicinity of the Site.
- 5.4.4** NRW records indicate no further pollution incidents, landfills, abstraction or discharge points are located within 300 m of the Site.
- 5.4.5** The Magor Marsh SSSI is located approximately 1 km to the south.

6 Scope of Investigations

6.1 General

6.1.1 Two intrusive ground investigations have been undertaken within the Site. The information has been summarised below.

6.1.2 For the purpose of meeting the requirements of Volume 4, Section 1, Part 2 of the DMRB (Highways Agency, 2008), the historical data used to support the 2014 PSSR has differentiated from additional 2015 Supplementary Ground Investigation data (Geotechnical Engineering, 2015).

6.2 Scope of Works

6.2.1 The various intrusive ground investigations undertaken within the Site area are summarised in Table 2.

Table 2: Site Investigation Summary

Date	Contractor	Site Location	Boreholes	Window Sampler	Trial Pits	Sampling
1997	Norwest Holst	Southeast	BHN7 BHN8	-	-	None
2015	Geotechnical Engineering	Central	BH551	-	-	Soil

6.2.2 The well construction details of all boreholes installed on the Site are summarised in Table 3.

Table 3: Summary of Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (mbGL)	Base of Slotted Well Casing / Gravel Pack (mbGL)	Targeted Geology
BHN7	50 (unspecified on logs)	20.2	Unspecified	20.2	Mercia Mudstone Group marginal Facies (Dolomite / Sandstone)
BHN8	50 (unspecified on logs)	15	4.5	9.5	Mercia Mudstone Group Marginal Facies (Dolomite)

6.3 Surface Water Quality Sampling

6.3.1 Surface water quality monitoring was undertaken on four occasions at the following location during winter 2007 and spring and summer 2008.

Table 4: Surface Water Monitoring Locations

Surface water location ID	Location description	Comments
R19	Located at St Brides Brook, approximately 230m southeast of the Site.	Fast flow; water brown in colour. SW outfalls draining into reën above sampling point.

6.3.2 The surface water chemical results are presented in the baseline surface quality monitoring interim report by Titan Environmental Surveys Limited (Titan Environmental Survey Ltd, 2008) which also presents the baseline water quality monitoring programme of watercourse located near the proposed alignment at the time of the study.

6.3.3 The results and a review of all sample locations are also presented in the Baseline Water Environment report (Appendix 16.2 of the ES).

6.4 Field Testing

6.4.1 Monitoring of Volatile Organic Compounds (VOCs) was undertaken on three soil samples from BH551 at 0-0.4 mbGL, 0.4-0.8 mbGL and 0.8-1.2 mbGL

6.5 Groundwater Monitoring

6.5.1 A summary of the groundwater sampling, groundwater / monitoring and ground gas monitoring is shown in Table 6.

Table 5: Summary of Monitoring Rounds

Location Ref.	Number of rounds (Date of sampling)	Monitoring details	Notes
BHN8	6no.	Groundwater level	

6.6 Laboratory Chemical Testing

6.6.1 A summary of the contamination results from the previous site investigations is shown below.

Table 6: Summary of previous investigation sampling

Site Investigation date	No. of soil samples	No. of leachate samples	No. of water samples	Suites of testing
2015	1	0	0	Metals, PAH, pH, cyanide

Soil Analysis

6.6.2 The following sections summarise the laboratory analytical results for the single soil samples collected during the various intrusive investigation phases. The available data set has been tabulated and is presented in Appendix 2. The supporting laboratory certificates available in the relevant original ground investigation report.

6.6.3 The analytical data relates to topsoil material as summarised below:

Table 7: Summary of Analytical Soil Data

Unit	Number of Soil Analysis per Analytical Suite - 2015 data								
	Metals & inorganics	PCB	PAH	TPH	Phenol	BTEX	Pthalates	VOC	SVOC
Topsoil	1	0	1	0	0	0	0	0	0

Note: PAH - Polycyclic Aromatic Hydrocarbons, TPH - Total Petroleum Hydrocarbon, VOC – Volatile Organic Compounds, SVOC – Semi Volatile Organic Compounds

Soil Leaching Analysis

6.6.4 No leachate analysis has been undertaken for the Site during the previous ground investigation.

Groundwater Results

6.6.5 No groundwater analysis has been undertaken for the Site or within the immediate vicinity during the previous ground investigation.

Surface Water Results

6.6.6 The following sections summarise the laboratory analytical results for surface water samples collected during the various monitoring rounds. The available data set has been tabulated in a table format and is presented in Appendix 3 with supporting laboratory certificates available in the relevant original reports.

Table 8: Summary of Analytical Surface Water Data

Surface Water System	Number of Water Analysis per Analytical Suite (number of locations) – 2015 data / All GI data				
	Metals & inorganics	Water quality parameters	Polycyclic Aromatic Hydrocarbons	Total Petroleum Hydrocarbon	BTEX
St Brides Brook	0 (1) / 4 (1)	0 (1) / 4 (1)	0 (1) / 0 (1)	0 (1) / 4 (1)	0 (1) / 2 (1)

6.7 Gap Analysis of Available Data

6.7.1 The investigation data available for the Site is limited both in term of intrusive scope of works and analytical data. In particular, the laboratory data does not include full organic analytical suite, despite this being the main contaminants of concerns. Also there is no groundwater data available.

7 Ground Conditions

7.1 Geology

7.1.1 The geological logs for all available exploratory holes excavated on or in close proximity to the Site are provided in Appendix 1. The observed geological sequence is consistent with that discussed in the PSSR report and is summarised in the following sections. Information from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) has also been used.

Superficial Deposits

7.1.2 Unconsolidated superficial deposits were encountered in all locations. These comprised Head Deposits, generally comprising a reddish brown sandy clay at thicknesses of 0.8 – 3 m. A gravelly sand with occasional cobbles was encountered below a clay topsoil within BH551.

7.1.3 The 2014 PSSR indicated that these superficial deposits may have been partially reworked during the construction of the service station as engineered fill. Evidence of reworking is not evident from the available borehole records.

Solid Geology

7.1.4 The bedrock was encountered at relatively shallow depth below the Head deposits and comprised Marginal Facies of the Mercia Mudstone Group (MFMMG). This included a number of different lithologies; namely sandstone, dolomite, mudstones, conglomerate and breccia.

7.1.5 The base of the MFMMG was unproven during either ground investigation.

Geological Sequence Summary

7.1.6 The general geological sequence identified during the previous ground investigations is summarised in Table 9.

Table 9: Summary of Geological Sequence

Unit	Description	Thickness Range (m)	Basal depth (mbGL)
Head Deposits	Reddish brown sandy clay, gravelly sand.	0.8 - 3	1.2 - 3
Marginal Facies of the Mercia Mudstone Group	Dolomite, sandstone, mudstone, conglomerate and breccia.	>12->17.2	unproven

7.1.7 Given the limited onsite data, a review of exploratory borehole and trial records outside the Site Boundary has been undertaken to further improve the understanding of ground and groundwater conditions. Boreholes SBHN03RC (Norwest 2008), boreholes BH552 and BH554 (Geotechnical Engineering, 2015) and trial pit STPN05 (Geotechnical Engineering, 2015). These are located some 10-20 m south east of the Site.

7.1.8 From this additional information, predominantly coarse material of the river terrace deposits may be present at the south eastern corner of the Site beneath

the Head Deposits. The River Terrace Deposits are anticipated to be up to 3 m in thickness and overlies the MFMMG bedrock.

7.1.9 The conceptual ground model included within the 2014 PSSR report has been revised in light of the 2015 information and is presented within Figure 2.

7.2 Visual and Olfactory Evidence of Contamination

7.2.1 No visual or olfactory evidence of contamination was identified during the previous ground investigations.

7.2.2 PID monitoring was undertaken on three soil samples from BH551. The PID meter recorded levels of between 1.2 and 1.9 ppm within the Head Deposits and Mercia Mudstone indicating the presence of low level naturally occurring VOCs.

7.2.3 Full details and observations noted during the drilling are presented on the exploratory logs attached in Appendix 1.

7.3 Gas Monitoring

7.3.1 No gas monitoring dataset from the previous ground investigations is available for the Site.

7.4 Groundwater

Groundwater Encountered During Investigation

7.4.1 A water strike was encountered during the advancement of borehole BHN7 during the 1997 investigation as detailed on the geological logs provided in Appendix 1. This together with additional water level information provided by the exploratory borehole records is summarised below:

Table 10: Summary of Groundwater & Leachate Water Level Data

Location	Strike Depth (m bGL)	Geological Formation	Level after 20 minutes (mbGL)	Comments
BHN7	12.1	Marginal Facies of the Mercia Mudstone Group (Dolomite)	0.0 (log state time taken to rise is 0)	Uncertain on the accuracy of the recorded resting level
				Water level recorded at 12.1 and 12.51 m bGL (5.49 m AOD) when borehole taken into dolomite within MFMMG (15.7 m bGL)
				Water level recorded at 12.27 m bGL (5.73 m AOD) when borehole taken into sandstone within MFMMG (20.2 m bGL)
BHN8				Water level recorded at 5.2 m bGL (7 m AOD) when borehole taken into conglomerate within MFMMG (10 m bGL)

Location	Strike Depth (m bGL)	Geological Formation	Level after 20 minutes (mbGL)	Comments
				Water level recorded at 5.69 m bGL (6.51 m AOD) when borehole complete within mudstone of MFMMG (15 m bGL)

7.4.2 Groundwater was not encountered in any other boreholes.

Groundwater Level Dataset

7.4.3 The entire groundwater level dataset gathered is provided in Norwest Holst, 1997 report and summarised in Table 11.

Table 11: Summary of Groundwater Level Data

Location	Installation ^{#1}	Depth of response zone (mbGL) and Geological Formation	No. Measurements	Minimum Depth (mbGL)	Maximum Depth (mbGL)	Comments
BHN8	50 mm	4.5 - 9.5 MFMMG (Dolomite & Conglomerate)	6	4.07	5.64	

Notes. #1: S denotes a shallow installation and D denotes deep installation.

Groundwater Summary

7.4.4 The main deep groundwater body within the bedrock is likely to be influenced by the variable sequence of mudstone, conglomerates and sandstone. It has been identified with a fairly stable resting water level around 4-5 m bGL (6.5-8 m AOD) within the dolomite of the MFMMG at borehole BHN08.

7.4.5 The off site borehole SBHN03 indicating water level at around 0.4-0.8 m bGL during drilling with the river terrace deposits. The piezometric equipment installed 8 m into the MFMMG recorded a resting water level between 1.07-2.37 m bGL (9.39-9.69 m AOD) indicating possible hydraulic continuity between the superficial deposits and bedrock.

7.4.6 Perched groundwater is anticipated within the more granular horizons of the Head Deposits and within the river terrace deposits.

7.4.7 The various perched and deep groundwater bodies are considered to be in hydraulic continuity with the St Brides Brook, although this would need to be confirmed given the limited groundwater levels available.

8 Contamination Assessment

8.1.1 The following sections provide details of the assessment of land contamination at the site.

8.1.2 The outline Conceptual Site Model (CSM) presented within the 2014 PSSR has been reviewed and updated based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and the Scheme. The main alteration to the 2014 PSSR model are summarised as follows:

- Review of possible sources.
- Addition of off site groundwater and gas dataset.
- Alteration of the geological model.
- Update of the source/pathway/receptor linkages taking account of the above and more detailed assessments.

8.2 Preliminary Risk Assessment

Potential Sources

8.2.1 The Site is being used as a service station and any associated potentially contaminated soil, hydrocarbons and buried fuel tanks has been identified as a potential source of contamination. The area of the petrol station does not form part of the Scheme and therefore the liabilities associated with any contamination that it may cause would remain with the current land owner. Also the proposed earthworks associated with the M4 highway relates to the edges of the service station ownership, in undeveloped woodland areas. Potentially contaminated soil, hydrocarbons and buried fuel tanks associated with the service station are therefore considered as “off site” sources in the context of the M4 highway Scheme.

8.2.2 Potential contamination sources to the M4 Scheme are therefore migratory by products from contamination soils, hydrocarbon and buried fuel tanks, through soil matrix, perched groundwater or aquifer.

8.2.3 Fill material has been used for services development. No evidence of man-made material has been identified in the limited data and it is assumed the fill, if present, consists or reworked soils of the Head Deposits. On the basis of the current information, fill material is not considered a potential source of contamination.

8.2.4 As the fly tipping observed during the site walkover in the northern area of the services was only minor, it is not anticipated to be a potential source of contamination and is located away from the Scheme.

Potential Receptors

8.2.5 Receptors during the construction and the operational stages of the Scheme have been considered:

Construction

- Construction workers during site development works.

- Service Station users (staff/personnel and visitors).
- Groundwater in the Secondary A aquifer within the River Terrace Deposits and the Principal aquifer within the bedrock.
- St Brides Brook located approximately 75 m east from the Site.

Operational

- Maintenance workers.
- General public end users.
- Groundwater in the Secondary A aquifer within the River Terrace Deposits and the Principal aquifer within the bedrock.
- St Brides Brook located approximately 75 m east from the Site.

Potential Pathways

8.2.6 Pathways during the construction and the operational phases of the Scheme have been considered:

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils possible during construction and maintenance works.
- Dermal contact (dust only), ingestion (dust only) and inhalation (dust and hydrocarbon vapour) pathways possible for general public end users.
- Lateral migration of hydrocarbon contamination from the underlying perched water (within the Head Deposit) or aquifers (within the superficial deposits and the underlying bedrock) from off site sources onto the Site during any dewatering associated with the construction phase or land drainage during the operation.
- Lateral migration of perched water with elevated contaminants within the Head Deposit or aquifers to land drainage (surface waters).

8.3 Risk Evaluation

8.3.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the other data described herein, the following risk evaluation has been reconsidered and included:

- Proposed cutting for the St Bridge's Road realignment is to recess the existing face closer towards the service station. The M4 slip road at the southern end of the Site will require new embankment. The land take as part of the earthworks on both highways only relates to undeveloped wooded areas of Magor Stations where no potential contaminated land sources area anticipated.
- There have been two recorded pollution incidents within the Site (exact location unknown) although they had either minor or no impact.
- The main contamination of concern to affect the M4 corridor are associated with hydrocarbons, subject to be a mechanism of transport given the sources are outside the area of cutting.

- The main mechanism of transport is considered to be associated with migration of hydrocarbon from groundwater with elevated concentrations of the river terrace deposits and/or bedrock.
- The presence of hardstanding at ground level within the fuel station and car park and the underlying predominantly cohesive Head Deposits would limit vertical contamination migration from accidental spillage into the aquifer. The buried tanks may however be within or at close proximity to the rockhead.
- The predominantly cohesive Head Deposits would limit lateral contamination migration from accidental spillage or leakages within the soil matrix. The distance source / receptors is noted to be in excess of 50 m. In the absence of viable pathways, the lateral migration in the soil matrix is not considered further in the conceptual model.
- The bedrock beneath the site contains a Principal Aquifer overlain by a thin layer of head deposits. The superficial deposits (river terrace deposits) to the north east contain a Secondary A Aquifer. These are anticipated to be in hydraulic continuity.
- Perched groundwater within the Head Deposits is not considered a water resource due to its anticipated low vertical hydraulic continuity with the aquifer beneath, low permeability and storage capacity. This is considered as pore waters and not as an aquifer.
- New cutting may intersect soils, perched water within the Head Deposits or groundwater within the aquifers with possible elevated hydrocarbon concentrations and increase the risk of migration into new highway drainage.
- Motorway users will be within open environment with no proposed structure or other confined spaces.

8.4 Human Health Risk Assessment

8.4.1 The rationale and approach for the human health (Tier 2) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES). Soil chemical analysis results and the findings of the generic tier 2 human health risk assessment are presented in Appendix 2.

8.4.2 There were no exceedances of the single soil sample (topsoil) to the relevant criteria screening criteria onsite.

8.5 Controlled Waters Screening Assessment

8.5.1 The rationale and approach for the controlled waters (Tier 1) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES) and the surface water chemical results are presented in Appendix 3. All exceedances to the relevant criteria is summarised in Table 12 for surface waters.

8.5.2 Where an EQS is dependent on water hardness (i.e. some heavy metals), the hardness of the surface water receptor should normally be used. The Baseline Water Environment Report (Appendix 16.2 of the ES) indicates surface water to be generally moderately hard with hardness in a range of 100 to 150 mg/l as calcium carbonate. Therefore EQSs within this water hardness range have been used for screening purposes

Groundwater Results

- 8.5.3** There is no analytical data available for groundwater beneath or in the vicinity of the Site from the previous ground investigations.

Surface Water

- 8.5.4** A total of four surface water samples were taken and analysed from St Brides Brook located approximately 230 m southeast of the Site. A summary of the exceedances of the screening criteria are shown in Table 12 below.

Table 12: Summary of Surface Water Screening Assessment

Parameter	Unit	No. Analyses	No. Analyses Above LOD	Minimum Concentration	Max Concentration	Location & Round with Max. Concentration	EQS	No. Analyses Exceeding EQS	DWS	No Analyses Exceeding DWS	CCW Trigger Level	No Analyses Exceeding CCW Trigger Level
Cadmium	ug/l	4	4	<0.5	1.4	R19 / E3	0.15	1	5	0	5	0
Dissolved Oxygen	%	4	4	93.8	106.5	R19 / E2	60	4	-	-	-	-
Nitrate as NO3	mg/l	4	4	10.2	15.1	R19 / E1	-	-	50	0	1	4
Nitrate as N	mg/l	4	4	2.3	3.4	R19 / E1 & E2	-	-	50	0	1	4
TON	mg/l	4	4	2.3	3.4	R19 / E1 & E2	-	-	50	0	2	4

8.5.5 The water quality within St Brides Brook is generally good, with cadmium as the only parameter to exceed its EQS.

8.5.6 Nitrate (NO₃), Nitrate (as N) and Total Oxidised Nitrogen were consistently recorded above NRW trigger levels throughout all monitoring rounds.

8.5.7 Dissolved oxygen was recorded as consistently above the EQS of <60 %.

8.5.8 As cadmium has been identified at a low concentration within the single soil sample from the Site, there is no evidence to indicate that the Site is impacting the surface water quality of St Brides Brook. The results are presented in baseline water quality monitoring report Titan Environmental Services Report (Titan Environmental Surveys Ltd, 2008).

8.6 Ground Gas Risk Assessment

8.6.1 No gas data from the previous ground investigations is available for this Site or immediate surrounding and therefore no risk assessment has been undertaken.

8.7 Summary

8.7.1 Given the limited intrusive and analytical information to date, further assessment is recommended.

8.7.2 The monitoring point located down stream of St Bides Brook relative to the site does not show obvious impact that may be attributed to the Site.

9 Refined Conceptual Model

- 9.1.1** The incorporation of data from the 2015 supplementary Ground Investigation has enabled the original CSM presented in the 2014 PSSR to be updated. Relevant contaminant (Source-Pathway-Receptor) linkages are considered within the refined CSM. The assessment is based on the Scheme during construction and operational phases.
- 9.1.2** A CSM representing general ground conditions, overall Scheme layout and relevant source/pathway/receptors (each of which having a specific alpha-numerical symbol attached) are presented in Figure 2 and is described in Table 13.

Table 13: Site Conceptual Model

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
On Site Potential hydrocarbon contamination from the area of petrol filling station transported via groundwater of the aquifers	Construction					
	Construction Workers (B)	Direct dermal with contaminated soils and groundwater (1)	Low	Moderate	Moderate to low	Current limited data set (visually based) identified no gross contamination to be present. Overall current contamination status is not foreseen to represent abnormal constraints to construction workers health & safety over and above those typical of a brown field Site. Localised areas with elevated hydrocarbon concentrations, if present may however require specific precautions and possibly specialist contractors to enable remediation. Further investigations are required to delineate the possible presence of hydrocarbon contamination.
		Ingestion of soils and groundwater (3)	Low	Moderate	Moderate to low	
		Inhalation of soil dust (2)	Low	Moderate	Moderate to low	
		Inhalation of hydrocarbon vapours (2)	Low	Moderate	Moderate to low	
	Services users (staff/personnel and visitors) (A)	Direct dermal with soil dust(1)	Low	Moderate	Moderate to low	During construction there is the possibility of dermal contact and inhalation of soil dust with elevated hydrocarbon concentrations, short term exposure only. Dust suppression measures are recommended during construction works. Further investigations are required to delineate the possible presence of hydrocarbon contamination.
		Ingestion of soil dust(3)	Low	Moderate	Moderate to low	
		Inhalation of soil dust (2)	Low	Moderate	Moderate to low	
		Inhalation of hydrocarbon vapours (2)	Low	Moderate	Moderate- to low	

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Groundwaters (Ca)	Migration (4)	Low	Moderate	Moderate to low	Potential contaminants in the groundwaters and surround soils may be mobilised during ground disturbance works. Dewatering works to support construction phase may draw additional contamination from the source areas (fuel service). Further investigation is recommended to confirm any potential risk.
	Surface water (land drainage) (D)	Saturated flow within groundwater (4)	Low	Moderate	Moderate to low	Perched (shallow) groundwater may be intercepted by the land drainage. Surface water data does not indicate existing elevated contaminant concentrations that may be attributed to the Site land use. Proposed cutting may increase dewatering effect beneath the service station and increase flux of contamination. Potential contaminants in the groundwaters and surround soils may be mobilised during ground disturbance works. Further investigation is recommended to confirm any potential risk.
		Surface water run-off (5)	Low	Moderate	Moderate to low	Surface water run-off may deteriorate the quality of surface water. Construction process to adopt surface water control and management.
	Operational					

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Maintenance Workers (B)	Direct dermal(1)	Unlikely	Moderate	Low	Areas outside the motorway hardstanding are likely to receive topsoil cover and vegetation establishment, reducing potential of exposure. Exposure duration will be short term only. Site specific risk assessment will be required in line with H&S guidance. This will enable safe methodology and appropriate level of PPE to be put in place. As such all-risks will be duly considered and suitably mitigated.
		Ingestion(3)	Unlikely	Moderate	Low	Hydrocarbon vapours that may be released by the residual hydrocarbon contamination post shallow remedial works would accumulate within confined spaces such as inspection manholes.
		Inhalation of soil dust (2)	Unlikely	Moderate	Low	Migration of hydrocarbon from off site sources may continue following transport mechanism of the groundwaters.
		Inhalation of hydrocarbon vapours (2)	Unlikely	Moderate	Low	Further investigation is recommended to confirm any potential risk.
	Future Motorway Users (A) and Services users (staff/personnel) (C)	Direct dermal (1)	Unlikely	Moderate	Low	During operation there is the possibility of short term exposure only.
		Ingestion(3)	Unlikely	Moderate	Low	Further investigation is recommended to confirm any potential risk.
		Inhalation of soil dust (2)	Unlikely	Moderate	Low	
	Groundwater (Ca)	Migration (4)	Low	Moderate	Moderate to low	Dewatering works associated with cutting (if below groundwater level) may draw additional contamination from the source areas (fuel service). Further investigation is recommended to confirm any potential risk.

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Surface water (land drainage) (D)	Saturated flow within groundwater (4)	Low	Moderate	Moderate to low	<p>Perched (shallow) groundwater may be intercepted by the land drainage.</p> <p>Surface water data does not indicate existing elevated contaminants that may be attributed to the Site land use.</p> <p>Proposed cutting may increase dewatering effect beneath the service station and increase flux of contamination.</p> <p>Further investigation is recommended to confirm any potential risk.</p>

10 Conclusions and Recommendations

- 10.1.1** Limited ground Investigations have been at the Site to assess risks from land contamination associated with the construction and operation of the Scheme including human health and controlled waters.
- 10.1.2** Gross contamination associated with the Site's historical and current use has not been identified. Visual or olfactory evidence of oil/fuel contamination within the soils or bedrock has not visually been reported within the borehole records.
- 10.1.3** The review of the existing information indicates that the in-fill materials used for the construction of the services, if present, comprises reworked Head Deposits. As such it is unlikely to pose a viable risk to the Scheme.
- 10.1.4** In order to confirm the moderate to low risks associated with the Site in relation to both construction and operational phases, and the suitability for reuse within the Scheme, it is recommended that supplementary intrusive investigations are undertaken.
- 10.1.5** The investigatory works should mainly target the area of proposed works but should also consider the area within the confirmed land take for the Scheme.
- 10.1.6** The results of the recommended supplementary investigations should be assessed in relation to identified receptors and inform the selection of appropriate health and safety and mitigation measures for the construction works and operational phase, if required.

10.2 Recommendations

- 10.2.1** Only limited ground investigation has been undertaken at the Site and although the likelihood of any contamination within the land take at the Site is relatively low, due the remote locations to the potential sources, localised contamination may have occurred. As such it is recommended that a supplementary ground investigation is undertaken to verify risk levels described in this report. Should contamination be identified that could cause an unacceptable risk to the identified receptors, then remedial requirements would be identified within a remedial strategy for the Scheme.
- 10.2.2** A remediation strategy for the Scheme should be developed that for this Site includes:-
- Addressing potential human health risk and controlled water risk identified by the proposed additional ground investigation.
 - Dealing with unexpected contamination.
 - Verification sampling strategy to confirm suitability for soils for retention / re-use.
 - Control measures to prevent risks to construction workers and the general public during construction.
 - Verification of imported topsoils.
- 10.2.3** The remediation strategy should include a remediation options appraisal, remediation implementation plan and remediation verification plan.

- 10.2.4** The remediation strategy should be supported by a Scheme wide Material Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

11 References

Bactec (2014) Explosive Ordnance Threat Assessment in respect of M4 Corridor around Newport for Hyder Consulting (UK) Limited, 5750TA.

Geotechnical Engineering (2015) M4 Corridor Around Newport, Factual Report on Ground Investigation, 30238

Highways Agency (2008) Design Manual for Roads and Bridges. Vol. 4. Geotechnics and Drainage. Section 1. Earthworks; Part 2. HD22/08. Managing Geotechnical Risk.

Ove Arup & Partners (2014) M4 Corridor Around Newport, Preliminary Sources Study Report, 14/9197

Titan Environmental Surveys Ltd (2008) New M4 Magor to Castleton Baseline Surface Water Quality Final Report for Arup, Report Number HS0442/F1/2

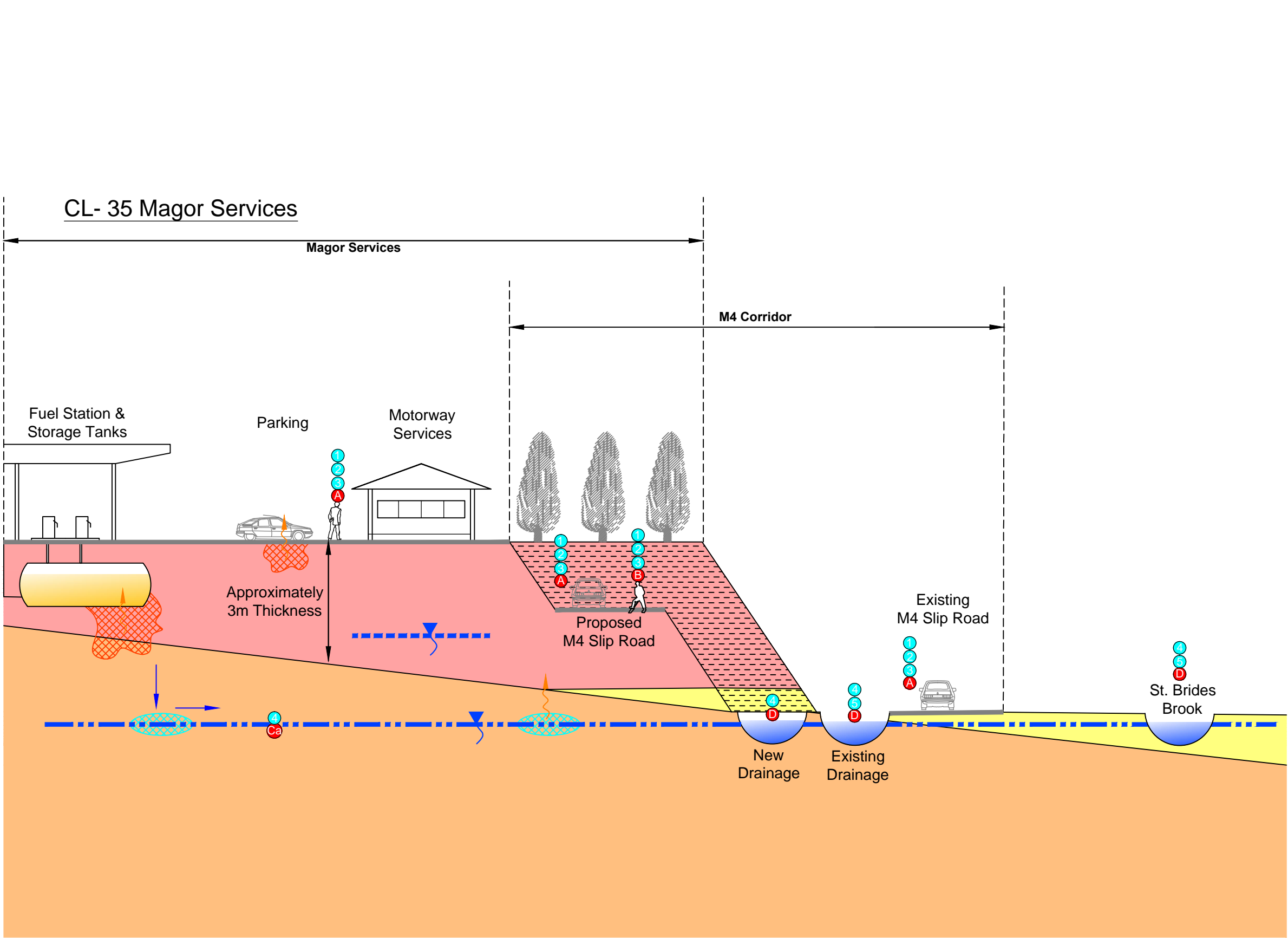
CL:AIRE (2011) Definition of Waste. Development Industry Code of Practice, Version 2, March 2011, ISBN 978-1-905046-23-2

12 Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection
mAOD	Metres Above Ordnance Datum

mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O ₂	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures



Legend

- Made Ground - MG / Reworked Head Deposits
- River Terrace Deposits - RTD
- Mercia Mudstone (Marginal Facies) - MMG MF
- Potential Fuel Spills
- Potentially Impacted Groundwater with Hydrocarbon Contamination
- Proposed Cutting
- Hardstanding
- Perched Groundwater (Head Deposits)
- Groundwater (RTD / MMG MF)
- Anticipated Groundwater Flow Direction
- Gas Migration Pathway

Potential Receptors

- Humans On-Site (M4 Users and Adjacent Service Users)
- Humans On-Site (Construction/Maintenance)
- Groundwater (Aquifer)
- Surface Water

Potential Pathways

- Dermal Contact
- Inhalation
- Ingestion
- Leaching/Migration
- Surface Run Off

Potential Sources of Contamination

Possible contamination present on site associated with :

On-Site (M4 Corridor Only)

- Groundwater impacted by hydrocarbons from off-site source (see below)

Off-Site

- Historical and current site use as a fuel service station
- Fuel/lubricant spillages from vehicles in fuel station/parking
- Buried fuel tanks

NOTE
Drawing refined from PSSR Drawing Reference
M4-OA-17-00DR-Z-XX-0143 (April 2014)



Appendix 11.1 Annex D CL-35

Conceptual Site Model for CL-35

Figure: 2	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Not to Scale

Ground conditions based
on available information

dwg ref: JER6591_Figure2_CL35ConceptualSiteModel

Appendices

Appendix 1

Exploratory Records



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHN7

Sheet 1 of 3

Contract No.	F10895	Method	Rotary Coring	Coordinates	342203.2 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187870.0 N
Client	Welsh Office	Driller	E.D	Ground Level	18.00m AOD
Consultant	Ove Arup and Partners	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	31/10/1997
		Core bit	Saw Tooth	Date Completed	01/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
Soft reddish brown sandy CLAY (drillers description). (Head Deposits)										
									S4 1.00	
									1.45	
									S5 2.00	
									2.45	
		3.00	15.00					NI	S52 3.00	
								0	3.45	
								NI		
								0		
				3.00 4.30	45	23	11	NI		
Yellowish brown with occasional fine to medium gravel size vugs thinly to medium sub-horizontally bedded slightly to moderately weathered DOLOMITE moderately strong to strong with medium spaced very thin to thin beds of grey dolomitic limestone with closely spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)										
---from 3.00 to 3.10m completely fractured										
---from 3.20 to 3.32m completely fractured										
---from 3.45 to 3.59m completely fractured				4.30 5.90	98	81	58	6		
---from 4.30 to 4.42m completely fractured										
---from 4.30m medium spaced thin beds of reddish yellow very sandy dolomite				5.90 6.30	78	0	0	NI		
---from 5.90 to 6.30m completely fractured										
				6.30 7.80	98	84	47	5		
---from 6.94 to 7.30m moderately to highly weathered										
---from 7.30m slightly weathered				7.80 8.20	100	95	68	2		
				8.20 9.70	40	39	33	8		
		9.26	8.74							
LIMESTONE As Sheet 2										
								0		
								NI		

NB All depths in metres, all diameters in millimetres.

See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form NH ROTARY LOG

Version 1.00

Revised 16/09/96



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHN7

Sheet 2 of 3

Contract No.	F10895	Method	Rotary Coring	Coordinates	342203.2 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187870.0 N
Client	Welsh Office	Driller	E.D	Ground Level	18.00m AOD
		Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	31/10/1997
Consultant	Ove Arup and Partners	Core bit	Saw Tooth	Date Completed	01/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
Yellowish brown thinly sub-horizontally bedded slightly to moderately weathered sandy DOLOMITE strong with occasional fine to medium gravel size vugs with medium spaced very thin to thin beds of reddish brown fine to medium grained silty dolomitic sandstone with closely to medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)		10.40	7.60	9.70 10.40	99	76	41	3		
				10.40 11.10	90	30	26	NI		
		11.10	6.90					1		
				11.10 12.00	97	59	32	NI		
								2		
								NI		
				12.00 13.50	100	75	48	5		
								2		
				13.50 14.30	100	84	60	4		
				14.30 15.70	100	86	27	19		
				15.70 17.20	99	71	21	15		
								NI		
								3		
								7		
				17.20 18.70	31	26	7	3		
		17.89	0.11					7		
				18.70 20.20	95	92	45	9		

NB All depths in metres, all diameters in millimetres.

See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form NH ROTARY LOG

Version 1.00

Revised 16/09/96

Form	NH ROTARY LOG
Version	1.00
Revised	16/09/96



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHN8

Header

Contract No.	F10895	Method	Rotary Coring	Coordinates	342293.3 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187853.0 N
Client	Welsh Office	Driller	E.D	Ground Level	12.20m AOD
Consultant	Ove Arup and Partners	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	01/11/1997
		Core bit	Saw Tooth	Date Completed	02/11/1997

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
01/11/1997	1600	10.00	4.15	Dry		4.00	7.50	air & mist	good	92
02/11/1997	0800	10.00	4.15	5.20		7.50	15.00	air & mist	lost	92
02/11/1997	1600	15.00	4.15	5.69						

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
120	15.00	140	5.15								

GENERAL NOTES				SPT DETAILS		
				Depth	Type	Incremental blow count/penetration in mm
				1.00	S	50/31mm (1,1,50)
				2.00	S	N=19 (4,5,5,4,5,5)
				3.00	S	25/10mm (12,13,25)
				4.00	C	45/150mm (12,13,25,20)

NB All depths in metres, all diameters in millimetres,
water strike rise time in minutes.

Form ROTARY HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHN8

Sheet 1 of 2

Contract No.	F10895	Method	Rotary Coring	Coordinates	342293.3 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187853.0 N
Client	Welsh Office	Driller	E.D	Ground Level	12.20m AOD
Consultant	Ove Arup and Partners	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	01/11/1997
		Core bit	Saw Tooth	Date Completed	02/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
Brown sandy CLAY with cobbles (drillers description). (Head Deposits)									S50/31mm 1.00 1.18	
Reddish brown very sandy CLAY (drillers description). (Head Deposits)		1.53	10.67						S19 2.00 2.45	
Weathered SANDSTONE (drillers description).		2.05	10.15						S25/10mm 3.00 3.16	
		4.00	8.20						C45/150mm 4.00 4.17	
Yellowish brown thinly sub-horizontally bedded slightly to moderately weathered sandy DOLOMITE moderately strong to strong with occasional fine to medium gravel size vugs and closely spaced very thin to thin beds of reddish brown fine to medium grained dolomitic sandstone and medium spaced thin beds of grey dolomitic limestone with very closely to closely spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)				4.00 5.50	100	75	25	15		
				5.50 6.50	91	81	77	4		
		6.50	5.70	6.50 7.00	100	60	60	NI 2		
				7.00 8.50	99	83	51	9		
---from 6.50 to 6.75m completely fractured								NI		
---from 8.50 to 8.75m completely fractured								3		
---from 9.10 to 9.20m completely fractured				8.50 10.00	66	37	25	NI 3		
								NI		

NB All depths in metres, all diameters in millimetres.

See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form NH ROTARY LOG

Version 1.00

Revised 16/09/96



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHN8

Sheet 2 of 2

Contract No.	F10895	Method	Rotary Coring	Coordinates	342293.3 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		187853.0 N
Client	Welsh Office	Driller	E.D	Ground Level	12.20m AOD
Consultant	Ove Arup and Partners	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	01/11/1997
		Core bit	Saw Tooth	Date Completed	02/11/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
Reddish brown fine to coarse grained thinly to medium sub-horizontally bedded slightly to moderately weathered dolomitic sandstone CONGLOMERATE moderately strong to strong with occasional fine to medium gravel size vugs and medium spaced very thin to thin beds of grey dolomitic limestone and reddish brown fine to coarse grained dolomitic sandstone and yellowish brown dolomite with closely spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)		10.20	2.00	10.00 10.60	88	65	48	0		
								4		
								NI		
								0		
		11.25	0.95	10.60 11.90	76	63	63	0		
Reddish brown thickly sub-horizontally bedded slightly weathered dolomitic sandstone CONGLOMERATE, strong with occasional gravel size vugs and medium sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)										
---from 10.60 to 10.75m completely fractured										
				11.90 13.50	88	87	78	7		
Reddish brown fine to medium grained thinly to medium sub-horizontally bedded slightly to moderately weathered dolomitic SANDSTONE, strong with occasional fine to medium gravel size vugs and closely spaced thin to medium beds of grey dolomitic limestone, yellowish brown dolomite and sandstone dolomite conglomerate with medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)		13.50	-1.30							
				13.50 14.40	100	61	34	4		
								NI		
Reddish brown medium sub-horizontally bedded moderately to highly weathered slightly sandy MUDSTONE, weak to moderately weak with widely spaced very thin beds of yellowish brown silty sandy dolomite with closely to medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)				14.40 15.00	83	55	55	1		
---from 14.10 to 14.50m highly weathered very weak completely fractured		15.00	-2.80							
Rotary drilling complete at 15.00 m.										

NB All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	NH ROTARY LOG
Version	1.00
Revised	16/09/96

Contract No.	F15056	Method	Rotary Coring	Coordinates	342343.57 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Hands England Tractor		187858.96 N
		Driller	TF/SL	Ground Level	10.76m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	06/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	PCD	Date Completed	12/12/2007

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
06/12/2007	1730	5.20	4.20	NR	End of Shift	1.20	6.90	Air/Mist	100%	0.00*
07/12/2007	0730	4.20	4.20	NR	Start of Shift	6.90	24.15	Air/Mist	100%	92.0
07/12/2007	1730	6.20	6.10	NR	End of Shift					
08/12/2007	0730	7.00	6.10	0.80	Start of Shift					
08/12/2007	1730	7.60	7.00	0.40	End of Shift					
11/12/2007	0730	9.20	7.00	2.05	Start of Shift					
11/12/2007	1730	14.75	7.00	2.20	End of Shift					
12/12/2007	0730	14.75	7.00	2.10	Start of Shift					
12/12/2007	1730	24.15	7.00	2.15	End of Hole					

CASING				WATER STRIKES							
Hole diam.	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
121	24.15	121	7.00	06/12/2007		2.20	NR	NR	Seepage	1.20	NR
				07/12/2007		6.00	NR	NR	Seepage	6.00	NS

GENERAL NOTES	SPT DETAILS				
1.Service inspection pit hand excavated from GL to 1.20m. 2.Rotary Openhole drilling from 1.20m to 9.20m. 3.Rotary Coring from 9.20m to 24.15m. 4.19mm piezometer installed tip at 15.00m, with response zone from 14.60m to 15.20m. 5.0.00* indicates openhole drilling.	Depth	Type	Incremental blow count/penetration	Casing	Water Depth
	1.20	S	N=9 (1,2,2,2,3,2)	1.20	NR
	2.20	S	N=8 (3,3,3,2,1,2)	2.20	NR
	3.20	S	N=8 (1,1,1,2,3,2)	3.20	NR
	4.20	S	N=18 (2,3,6,4,3,5)	4.20	NR
	5.20	S	N=24 (3,3,4,6,7,7)	5.20	NR
	6.10	S	100/130mm (14,11,27,73)	6.10	NR
	7.00	S	50/50mm (9,16,50)	7.00	NR

NOTES: All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form ARIAL ROTARY HEADER

Version 3.06

Revised 17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	342343.57 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Hands England Tractor		187858.96 N
		Driller	TF/SL	Ground Level	10.76m AOD
		Logged by	DH	Orientation	Vertical
Client	Transport Wales, Welsh Assembly Government	Core barrel	PWF	Date Started	06/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	PCD	Date Completed	12/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	RCD	FL	SPT N & depth	Installation
Sandy SOIL. (Driller's description)										
									1.20 S9 1.65	
Sandy claybound GRAVELS. (Driller's description)		2.10	8.66						2.20 S8 2.65	
									3.20 S8 3.65	
									4.20 S18 4.65	
SAND and GRAVELS. (Driller's description)		5.20	5.56						5.20 S24 5.65	
									6.10 S100/130mm 6.31	
Brown angular to rounded fine to coarse GRAVEL of sandstone, limestone and mudstone with occasional cobbles of sandstone. (Fluvial Alluvium) ---from 6.90m to 6.98m 1 No cobble of strong to very strong reddish brown fine to coarse grained sandstone ---from 6.98m to 7.00m assumed zone of core loss ---from 7.23m to 7.60m assumed zone of core loss		6.90	3.86	6.90 7.00 80 NA NA					7.00 S50/50mm 7.20	
				7.00 7.60 38 NA NA				NA		
		7.78	2.98	7.60 8.30 100 44 14						
Moderately strong to strong reddish brown matrix supported CONGLOMERATE. Clasts are angular to rounded fine to coarse gravel sized fragments of limestone, sandstone, quartz, siltstone and mudstone. Cobble and boulder sized fragments of limestone and sandstone. Matrix of reddish brown limestone. Discontinuities: 1) 0 - 15 deg very closely to medium spaced undulating rough. 2) 20 - 40 deg closely to medium spaced undulating rough. (Mercia Mudstone Group ((Marginal Facies) ---from 8.02m to 8.19m recovered as non intact core (angular medium to coarse gravel sized fragments)				8.30 9.20 100 64 34				NI 100 200		
				9.20 10.30 91 83 74						

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form ARIAL ROTARY LOG
Version 3.09
Revised 17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	342343.57 E
Project	New M4 - Second Preliminary Ground Drilling Rig		Hands England Tractor		187858.96 N
	Investigation	Driller	TF/SL	Ground Level	10.76m AOD
		Logged by	DH	Orientation	Vertical
Client	Transport Wales, Welsh Assembly Government	Core barrel	PWF	Date Started	06/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	PCD	Date Completed	12/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TOR	SCR	ROD	U	SPT N & depth	Installation
<p>Remaining Detail : 8.69m - 8.80m : ---from 8.69m to 8.80m recovered as non intact core (angular to subangular medium to coarse gravel sized fragments)</p> <p>Detail 9.20m - 9.24m : ---from 9.20m to 9.24m recovered as non intact core (subangular cobble sized fragments)</p> <p>---from 11.30m to 11.35m recovered as non intact core (angular fine to coarse gravel sized fragments)</p> <p>---from 11.93m to 11.94m recovered as non intact core (angular fine to coarse gravel sized fragments)</p> <p>---from 12.65m to 12.72m recovered as non intact core (angular cobble sized fragments)</p> <p>---from 13.83m to 13.95m recovered as non intact core (angular fine to coarse gravel sized fragments)</p> <p>Very weak reddish brown mottled greenish grey MUDSTONE with occasional thick laminations of sandstone. Recovered as stiff slightly gravelly clay. Gravel is angular fine to coarse of sandstone and mudstone. (Mercia Mudstone Group (Marginal Facies))</p>										
				10.30 12.00	96	94	74		70 110 270	
				12.00 13.05	100	94	82		NI 120 230	
				13.05 13.95	100	88	88		NI 190 570	
		13.95	-3.19	13.95 14.15	100	0	0			
				14.15 14.75	100	0	0		NI NI NI	
		15.40	-4.64	14.75 17.20	98	67	67		50 270 580	
				17.20 18.50	86	44	39		NI 30 110	
		18.50	-7.74						NI NI NI	
		19.35	-8.59	18.50 20.70	90	33	13		NI	

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form ARIAL ROTARY LOG
Version 3.09
Revised 17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	342343.57 E
Project	New M4 - Second Preliminary Ground Drilling Rig		Hands England Tractor		187858.96 N
	Investigation	Driller	TF/SL	Ground Level	10.76m AOD
		Logged by	DH	Orientation	Vertical
Client	Transport Wales, Welsh Assembly Government	Core barrel	PWF	Date Started	06/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	PCD	Date Completed	12/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	RQD	FL	SPT N & depth	Installation
17.05m - 18.50m : Remaining Detail : 17.64m - 17.67m : ---from 17.64m to 17.67m recovered as non intact core (subangular medium to coarse gravel sized fragments of mudstone) Detail 5m - 17.89m : ---from 17.75m to 17.89m recovered as non intact core (subangular medium to coarse gravel sized fragments of mudstone) Detail 18.17m - 18.32m : ---from 18.17m to 18.32m recovered as non intact core (gravelly clay. Gravel sized fragments are subangular fine to medium of mudstone)		20.70	-9.94					80 160		
18.50m - 19.35m : Very weak reddish brown locally mottled grey MUDSTONE. Recovered as slightly sandy gravel sized fragments subangular fine to coarse of mudstone. (Mercia Mudstone Group ((Marginal Facies))		21.24	-10.48					NI 60 110		
19.35m - 20.70m : Weak indistinctly laminated reddish brown SILTSTONE. Discontinuities 1) 0 - 10 deg very closely to closely spaced undulating rough. (Mercia Mudstone Group (Marginal Facies)) Detail 19.36m - 19.40m : ---from 19.35m to 19.40m 1 No incipient fracture 80 - 90 deg undulating stained grey green Detail 19.40m - 19.43m : ---from 19.40m to 19.43m recovered as non intact core (subangular fine to coarse gravel sized fragments) Detail 19.57m - 19.62m : ---from 19.57m to 19.62m 1 No discontinuity 90 deg undulating rough stained greyish green Detail 20.01m - 20.01m : ---from 19.80m to 19.85m recovered as non intact core (angular coarse gravel sized fragments) Detail 20.02m - 20.10m : ---from 20.00m to 20.10m 1 No discontinuity 85 deg undulating rough Detail 20.22m - 20.24m : ---from 20.22m to 20.24m 2 No thick laminations of yellowish brown limestone Detail 20.30m - 20.47m : ---from 20.30m to 20.47m recovered as non intact core (angular fine to coarse gravel sized fragments) ---from 19.80m to 19.85m recovered as non intact core (angular coarse gravel sized fragments) ---from 20.00m to 20.10m 1 No discontinuity 85 deg undulating rough ---from 20.22m to 20.24m 2 No thick laminations of yellowish brown limestone ---from 20.30m to 20.47m recovered as non intact core (angular fine to coarse gravel sized fragments)		22.00	-11.24	20.70 22.60 78 56 33				NI 210 300		
Weak to medium strong yellowish brown speckled black locally stained reddish brown medium grained LIMESTONE. Discontinuities 1) 0 - 10 deg closely spaced undulating rough. (Mercia Mudstone Group (Marginal Facies)) ---from 20.70m to 20.80m 1 No incipient fracture 80 deg undulating				22.60 24.15 98 98 82				30 140 370		
Weak reddish brown mottled greenish grey MUDSTONE. Discontinuities: 1) 0 -10 deg very closely to medium spaced undulating rough. (Mercia Mudstone Group (Marginal Facies)) ---from 21.30m to 21.33m 1 No very thin bed of reddish brown siltstone, 1 No discontinuity 60-70 deg undulating rough		24.15	-13.39							


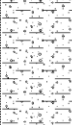

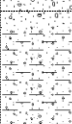
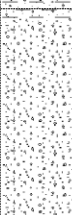
NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form ARIAL ROTARY LOG

Version 3.09

Revised 17/12/2007

Contract No.	F15056	Method	Machine Excavated	Coordinates	342346.86 E
Project	New M4 - Second Preliminary Ground Investigation				187866.41 N
Client	Transport Wales, Welsh Assembly Government	Equipment	JCB 3CX	Ground Level	10.55m AOD
		Logged by	WA	Date Started	30/11/2007
Consultant	Ove Arup & Partners Ltd			Date Completed	30/11/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sampling	Remarks
TOPSOIL.					
Soft locally firm brown silty slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone, siltstone and limestone. (Head Deposits)		0.40	10.15	D1 0.50 B2 0.50	
Orangish brown fine SAND with low cobble content, cobbles are subangular of limestone. (Head Deposits)		1.30	9.25	D3 1.30	
Soft brown sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse of limestone. (Head Deposits)		1.80	8.75	D4 2.00 B5 2.00	
Brown silty fine to coarse SAND and subangular to rounded fine to coarse GRAVEL of limestone, sandstone, siltstone and quartz. (Head Deposits)		2.60	7.95	D6 2.50 B7 2.50	
				D8 3.50	
Trial pit complete at 4.00 m.		4.00	6.55		

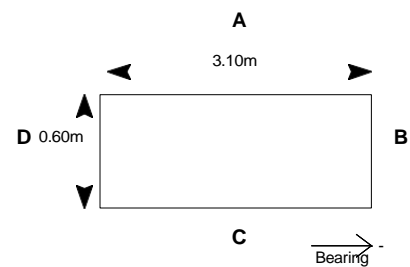
Stability Heavy collapse from 2.50m all faces

Shoring None used

Groundwater None encountered during excavation

Remarks 1. Trial pit complete at 4.00m due to continual collapse.

Sketch Plan of Trial Pit



NOTES: All depths in metres, all soil strengths in kPa.
See legend sheet for key to symbols and abbreviations.
All bearings given relate to magnetic North

Form	ARIAL TP LOG
Version	3.06
Revised	17/12/2007



STPN05
Data Sheet

[illegible]

Form	ARIAL HANDVANE/PEN
Version	3.03
Revised	18/01/2007

BOREHOLE LOG



CLIENT WELSH GOVERNMENT

BH551

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 25 February 2015 Easting 342206.7

Scale 1 : 50

End Date 27 February 2015 Northing 187937.5 Ground level 16.95mOD Depth 13.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
25/02/15 1300hrs	1B 2D*	0.00 - 0.40 0.00 - 0.40		Vo 1.2				Grass over reddish brown slightly sandy slightly gravelly CLAY with rare rootlets (up to 1mm diam). Gravel is subangular medium and coarse sandstone. (HDD)	0.40	16.55	
	3B 4D*	0.40 - 0.80 0.40 - 0.80		Vo 1.9				Reddish brown silty sandy subangular and subrounded fine to coarse sandstone GRAVEL with low angular sandstone cobble content and rare rootlets (up to 1mm diam). (MMMMF)	0.80	16.15	
	5B 6D*	0.80 - 1.20 0.80 - 1.20		Vo 1.9				Light grey clayey sandy subangular and subrounded fine to coarse sandstone GRAVEL with medium subangular sandstone cobble content. (MMMMF)	1.20	15.75	
	7X	1.20 - 1.60		Nil				Weak light brown and light reddish brown BRECCIA recovered non intact as angular fine to coarse gravel. Clasts are angular fine to coarse gravel of limestone and sandstone. (MMMMF)	1.60	15.35	
25/02/15 1700hrs	8C	1.60 - 2.20		Nil	83 32 32	NI 80 190					
	9C	2.20 - 2.30		Nil	100 100 100						
26/02/15 0900hrs 2.00m	10C	2.30 - 3.20			72 32 13			1.20 - 1.80m: Recovered non intact as sandstone gravel.			
	11C	3.20 - 3.38 3.20 - 4.20	3.20	C*176	100 92 76	250		Strong light brown, light grey and pinkish brown BRECCIA composed of 60-70% very angular to subangular fine to coarse gravel and cobbles of calcareous mudstone and siltstone. Matrix is light brown with frequent locally abundant voids (up to 2mm). Fractures are 40-60° closely spaced planar rough locally non intact. (MMMMF)	3.40	13.55	
	12C	4.20 - 5.70	3.20		100 79 74	90 250 570		3.15 - 3.40m: Medium strong purplish brown fine and medium sandstone. 3.39m: Contact 50°.			
	13C	5.70 - 7.20	3.20		100 83 83			Weak and medium strong light pinkish brown, yellowish brown, grey and red BRECCIA composed of 60-80% angular to subrounded fine to coarse gravel and cobbles of siltstone, sandstone and quartzite. Matrix is light brown and orangish brown with 2-5% voids (up to 10mm). Fractures are 10-30° rarely 50-70° closely and medium spaced planar rough frequently stained dark orangish brown and black. (MMMMF)			
	14C	7.20 - 8.70	3.20		100 85 85			5.45 - 5.80m: Drilling disturbed. Recovered non intact.			

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Dynamic sampled (113mm) 1.20-1.60m. Waterflush rotary core drilled (116mm) 1.60-13.00m. CASING: 140mm diam to 3.20m.

BACKFILL: On completion, hole backfilled with bentonite pellets 13.20-0.20m and local materials 0.20-0.00.

REMARKS: Downhole magnetometry for UXO risk mitigation undertaken 0.00-3.20m. No anomalies encountered.

MMG = Mercia Mudstone Group. Weathering zone after Chandler RJ and Forster CIRIA C570; Engineering in Mercia Mudstone (2001).

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered.

CONTRACT
30238CHECKED
EC



BH551

Sheet 2 of 2

Scale 1 : 50

[illegible]

CHECKED	
EC	

Appendix 2

Soil Laboratory Data

M4CAN
Soil Analysis Results & Screening Assessment
CL-35
08/07/2015

Sample Reference	Units	BH551
Location Type		
Specimen Depth (m)		0 - 0.4
OD Level (m) (from top of sample range w		16.95
Sample Type		ES
Geology Code		TS
Cluster Code		2015 GI
Inorganics		
Arsenic	mg/kg	20
Boron	mg/kg	<0.4
Cadmium	mg/kg	1.1
Chromium	mg/kg	20
Copper	mg/kg	22
Lead	mg/kg	95
Mercury	mg/kg	0.12
Nickel	mg/kg	22
Selenium	mg/kg	0.52
Zinc	mg/kg	270
Cyanide (total)	mg/kg	<0.5
Cyanide (free)	mg/kg	<0.5
Other		
pH Value	pH Units	7.6
PAH		
Acenaphthene	mg/kg	0.27
Acenaphthylene	mg/kg	0.28
Anthracene	mg/kg	0.12
Benz(a)anthracene	mg/kg	0
Benzo(a)pyrene	mg/kg	0.26
Benzo(b)fluoranthene	mg/kg	0
Benzo(ghi)perylene	mg/kg	0
Benzo(k)fluoranthene	mg/kg	0
Chrysene	mg/kg	0.53
Dibenzo(ah)anthracene	mg/kg	<0.1
Fluoranthene	mg/kg	0.3
Fluorene	mg/kg	0.19
Indeno(123cd)pyrene	mg/kg	<0.1
Naphthalene	mg/kg	0.24
Phenanthrene	mg/kg	0.32
Pyrene	mg/kg	0.18
PAH 16 Total	mg/kg	2.7

Screening Values and Assessment

	Exceeds S4ULs Criteria
X	Laboratory detection level higher than screening criterion

Geological Formation Legend

TS	Tintern Sandstone
----	-------------------

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	Selected S4ULs Criteria	No. Data Exceeding S4ULs Criteria
1	1	20	20	BH551 @ 0 - 0.4mbGL	170	0
1	0	None > LOD	None > LOD		46000	0
1	1	1.1	1.1	BH551 @ 0 - 0.4mbGL	190	0
1	1	20	20	BH551 @ 0 - 0.4mbGL	33	0
1	1	22	22	BH551 @ 0 - 0.4mbGL	44000	0
1	1	95	95	BH551 @ 0 - 0.4mbGL	1300	0
1	1	0.12	0.12	BH551 @ 0 - 0.4mbGL	30	0
1	1	22	22	BH551 @ 0 - 0.4mbGL	980	0
1	1	0.52	0.52	BH551 @ 0 - 0.4mbGL	1800	0
1	1	270	270	BH551 @ 0 - 0.4mbGL	170000	0
1	0	None > LOD	None > LOD			1
1	0	None > LOD	None > LOD			1
1	1	7.6	7.6	BH551 @ 0 - 0.4mbGL	6-9	0
1	1	0.27	0.27	BH551 @ 0 - 0.4mbGL	29000	0
1	1	0.28	0.28	BH551 @ 0 - 0.4mbGL	29000	0
1	1	0.12	0.12	BH551 @ 0 - 0.4mbGL	150000	0
1	1	0	0	BH551 @ 0 - 0.4mbGL	49	0
1	1	0.26	0.26	BH551 @ 0 - 0.4mbGL	11	0
1	1	0	0	BH551 @ 0 - 0.4mbGL	13	0
1	1	0	0	BH551 @ 0 - 0.4mbGL	1400	0
1	1	0	0	BH551 @ 0 - 0.4mbGL	370	0
1	1	0.53	0.53	BH551 @ 0 - 0.4mbGL	93	0
1	0	None > LOD	None > LOD		1.1	0
1	1	0.3	0.3	BH551 @ 0 - 0.4mbGL	6300	0
1	1	0.19	0.19	BH551 @ 0 - 0.4mbGL	20000	0
1	0	None > LOD	None > LOD		150	0
1	1	0.24	0.24	BH551 @ 0 - 0.4mbGL	190	0
1	1	0.32	0.32	BH551 @ 0 - 0.4mbGL	6200	0
1	1	0.18	0.18	BH551 @ 0 - 0.4mbGL	15000	0
1	1	2.7	2.7	BH551 @ 0 - 0.4mbGL		0

Appendix 3

Surface Water Data

M4CAN
Surface Water Sample Analysis &
Screening Assessment
CL-35
16/07/2015

Monitoring Round / Location	Units	Screening Criteria			E1 / R19	E2 / R19	E3 / R19	E4 / R19
Date Sampled					07/12/2007	17/03/2008	23/06/2008	24/09/2008
		EQS	DWS	CCW				
Metals & Non-Metal Inorganics								
Hardness Total	mg/l				200	199	204	228
Calcium Dissolved	mg/l			300000	50	78	51	58
Chromium Dissolved	ug/l		50		<0.22	<0.22	<0.22	<0.22
Copper Dissolved	ug/l	10	2000		<5	<5	<5	<5
Lead Dissolved	ug/l	1.2	10	250	<5	<5	<5	<5
Magnesium Dissolved	ug/l				14	14	17	16
Nickel Dissolved	ug/l	4	20	100	<5	<5	<5	<5
Cadmium Total	ug/l	0.15	5	5	0	0	1.4	0
Zinc Total	ug/l	75		1000	20	10	17	13
BOD	mg/l	5		18	2	<1	<1	1
Nitrite as NO2	mg/l		0.5	1		<0.05	<0.05	<0.05
Nitrate as NO3	mg/l		50	1	15.1	15.06	10.2	13.733
Nitrate as N	mg/l		50	1	3.4	3.4	2.3	3.1
Nitrite as N	mg/l		0.15217	1	<0.1	<0.1	<0.1	<0.1
Nitrogen, Total Oxidised as N	mg/l		50	2	3.4	3.4	2.3	3.1
Sulphate (soluble)	mg/l	400	250	300		36.5	59.2	48.8
Sulphate as SO4	mg/l	400	250	300	17	16	20	17
Phosphate, Ortho as P	mg/l			1	<0.1	0.2	0.8	<0.1
Chloride	mg/l	250	250	300	15	14	12	13
Ammoniacal Nitrogen as N	mg/l	0.6		1	0.06	0.06	0.05	<0.04
pH Value	pH units	6-9	6.5-10	6.8-8.5	8.1	8.1	8.3	7.9
Dissolved Oxygen	%	60			105.1	106.5	98.4	93.8
Oxygen, dissovled	mg/l				11.86	12.24	10.46	10.17
Organics								
MTBE	ug/l					<3		<3
Benzene	ug/l	10	1			<7		<7
Toluene	ug/l	50				<4		<4
Ethyl benzene	ug/l	20				<5		<5
m & p Xylene	ug/l	30				<8		<8
o Xylene	ug/l	30				<3		<3
TPH								
TPH >C6-C8	ug/l				<10	<10	<10	<10
TPH >C8-C10	ug/l				<10	<10	<10	<10
TPH >C10-C16	ug/l				<20	<20	<20	<20
TPH >C16-C24	ug/l				<20	<20	<20	<20
TPH >C24-C40	ug/l				<50	<50	<50	<50
TPH >C6-C40	ug/l				<50	<50	<50	<50

Notes

EQS calcium carbonate 200-250mg/l for heavy metals: chromium, copper, lead, nickel and zinc
NDP - No determination possible

Screening Values and Assessment

EQS	Environmental Quality Standards
MRV	Minimum Reporting values
	Exceeds EQS
100	Exceeds DWS
<10	Laboratory detection level higher than screening criterion
BOL/ITA	Exceeds CCW

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Round of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS	No. Data Exceeding CCW
4	4	228	199	E4 / R19		0	
4	4	78	50	E2 / R19		0	0
4	0	None > LOD	None > LOD			0	
4	0	None > LOD	None > LOD		0	0	
4	0	None > LOD	None > LOD		0	0	0
4	4	17	14	E3 / R19		0	
4	0	None > LOD	None > LOD		0	0	0
4	4	1.4	0	E3 / R19	1	0	0
4	4	20	10	E1 / R19	0	0	0
4	2	2	1	E1 / R19	0	2	0
3	0	None > LOD	None > LOD			0	0
4	4	15.1	10.2	E1 / R19		0	4
4	4	3.4	2.3	E1 / R19		0	4
4	0	None > LOD	None > LOD			0	0
4	4	3.4	2.3	E1 / R19		0	4
3	3	59.2	36.5	E3 / R19	0	0	0
4	4	20	16	E3 / R19	0	0	0
4	2	0.8	0.2	E3 / R19		2	0
4	4	15	12	E1 / R19	0	0	0
4	3	0.06	0.05	E1 / R19	0	1	0
4	4	8.3	7.9	E3 / R19	0	0	0
4	4	106.5	93.8	E2 / R19	4	0	
4	4	12.24	10.17	E2 / R19		0	
2	0	None > LOD	None > LOD			2	
2	0	None > LOD	None > LOD		0	0	
2	0	None > LOD	None > LOD		0	2	
2	0	None > LOD	None > LOD		0	2	
2	0	None > LOD	None > LOD		0	2	
2	0	None > LOD	None > LOD		0	2	

M4CAN
Surface Water Sample Analysis &
Screening Assessment
CL-35
16/07/2015

Monitoring Round / Location	Units	Screening Criteria			E1 / R19	E2 / R19	E3 / R19	E4 / R19
Date Sampled					07/12/2007	17/03/2008	23/06/2008	24/09/2008
		EQS	DWS	CCW				
Metals & Non-Metal Inorganics								
Hardness Total	mg/l				200	199	204	228
Calcium Dissolved	mg/l			300000	50	78	51	58
Chromium Dissolved	ug/l		50		<0.22	<0.22	<0.22	<0.22
Copper Dissolved	ug/l	10	2000		<5	<5	<5	<5
Lead Dissolved	ug/l	1.2	10	250	<5	<5	<5	<5
Magnesium Dissolved	ug/l				14	14	17	16
Nickel Dissolved	ug/l	4	20	100	<5	<5	<5	<5
Cadmium Total	ug/l	0.15	5	5	<0.5	<0.5	1.4	<0.5
Zinc Total	ug/l	75		1000	20	10	17	13
BOD	mg/l	5		18	2	<1	<1	1
Nitrite as NO2	mg/l		0.5	1		<0.05	<0.05	<0.05
Nitrate as NO3	mg/l		50	1	15.1	15.06	10.2	13.733
Nitrate as N	mg/l		50	1	3.4	3.4	2.3	3.1
Nitrite as N	mg/l		0.15217	1	<0.1	<0.1	<0.1	<0.1
Nitrogen, Total Oxidised as N	mg/l		50	2	3.4	3.4	2.3	3.1
Sulphate (soluble)	mg/l	400	250	300		36.5	59.2	48.8
Sulphate as SO4	mg/l	400	250	300	17	16	20	17
Phosphate, Ortho as P	mg/l			1	<0.1	0.2	0.8	<0.1
Chloride	mg/l	250	250	300	15	14	12	13
Ammoniacal Nitrogen as N	mg/l	0.6		1	0.06	0.06	0.05	<0.04
pH Value	pH units	6-9	6.5-10	6.8-8.5	8.1	8.1	8.3	7.9
Dissolved Oxygen	%	60			105.1	106.5	98.4	93.8
Oxygen, dissovled	mg/l				11.86	12.24	10.46	10.17
Organics								
MTBE	ug/l					<3		<3
Benzene	ug/l	10	1			<7		<7
Toluene	ug/l	50				<4		<4
Ethyl benzene	ug/l	20				<5		<5
m & p Xylene	ug/l	30				<8		<8
o Xylene	ug/l	30				<3		<3
TPH								
TPH >C6-C8	ug/l				<10	<10	<10	<10
TPH >C8-C10	ug/l				<10	<10	<10	<10
TPH >C10-C16	ug/l				<20	<20	<20	<20
TPH >C16-C24	ug/l				<20	<20	<20	<20
TPH >C24-C40	ug/l				<50	<50	<50	<50
TPH >C6-C40	ug/l				<50	<50	<50	<50

Notes

EQS calcium carbonate 200-250mg/l for heavy metals: chromium, copper, lead, nickel and zinc
NDP - No determination possible

Screening Values and Assessment

EQS	Environmental Quality Standards
MRV	Minimum Reporting values
	Exceeds EQS
100	Exceeds DWS
<10	Laboratory detection level higher than screening criterion
BOL/ITA	Exceeds CCW

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Round of Maximum Concentration	No. Data Exceeding EQS	No. Data Exceeding DWS	No. Data Exceeding CCW
4	4	228	199	R9 / E4		0	
4	4	78	50	R9 / E4		0	0
4	0	None > LOD	None > LOD			0	
4	0	None > LOD	None > LOD		0	0	
4	0	None > LOD	None > LOD	R8 / E3	0	0	0
4	4	17	14	R9 / E4		0	
4	0	None > LOD	None > LOD		0	0	0
4	1	1.4	1.4	R9 / E3	1	0	0
4	4	20	10	R9 / E4	0	0	0
4	2	2	1	R9 / E4	0		0
3	0	None > LOD	None > LOD			0	0
4	4	15.1	10.2	R9 / E2		0	4
4	4	3.4	2.3	R9 / E2		0	4
4	0	None > LOD	None > LOD			0	0
4	4	3.4	2.3	R9 / E2		0	4
3	3	59.2	36.5	12.1 / Q1	0	0	0
4	4	20	16	R9 / E4	0	0	0
4	2	0.8	0.2	R8 / E3		2	0
4	4	15	12	R9 / E4	0	0	0
4	3	0.06	0.05	12.1 / Q1	0	1	0
4	4	8.3	7.9	R9 / E3	0	0	0
4	4	106.5	93.8	R9 / E2	4	0	
4	4	12.24	10.17	12.1 / Q1		0	
2	0	None > LOD	None > LOD				
2	0	None > LOD	None > LOD		0	0	
2	0	None > LOD	None > LOD		0		
2	0	None > LOD	None > LOD		0		
2	0	None > LOD	None > LOD		0		
2	0	None > LOD	None > LOD		0		

Parameter	Unit	No. Analyses	No. Analyses Above LOD	Minimum Concentration	Maximum Concentration	Location & Round with Max. Concentration	EQS	No. Analyses Exceeding EQS
Copper	ug/l	4	0	None > LOD	None > LOD		10	0
Lead	ug/l	4	0	None > LOD	None > LOD		1.2	0
Nickel	ug/l	4	0	None > LOD	None > LOD		4	0
Cadmium	ug/l	4	4	0	1.4	R9 / E3	0.15	1
Zinc	ug/l	4	4	10	20	R9 / E4	75	0
BOD	mg/l	4	4	0	2	R9 / E4	5	0
Sulphate	mg/l	7	7	16	59.2	12.1 / Q1	400	0
Phosphorus	mg/l	4	4	630	696	13.2 / Q1	120	2
Chloride	mg/l	2	2	12	15	R9 / E4	250	0
Ammoniacal	mg/l	4	3	0.05	0.06	12.1 / Q1	0.6	0
pH	pH units	4	4	7.9	8.3	R9 / E3	6-9	0
Dissolved Oxy	%	4	4	93.8	106.5	R9 / E2	60	0

Appendix 4

Site Walkover Photographs



Plate 01: CL35 – Car Park – View Looking North



Plate 02: CL35 – Petrol Filling Station – View Looking West

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591

Checked By:

Date: May 2015



Plate 03: CL35 – Car Wash – View Looking North



Plate 04: CL35 – Petrol Filling Station & Access Road – View Looking West

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: May 2015



Plate 05: CL35 – Coach Park – View Looking Northeast



Plate 06: CL35 – Lorry Park – View Looking West

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: May 2015



Plate 07: CL35 – Waste Container



Plate 08: CL35 – Service Compound

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: May 2015



Plate 09: CL35 – Wooded Area Southeastern Section of Site



Plate 10: CL35 – View of Service Station Looking West

Appendix 5

Relevant Extract of Additional Aerial Photography



Plate 01: Extract of 1991 Aerial Photograph showing construction of the Magor Service Station in progress.

Plate 02:

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment
Report Annex D

CL-38 Knollbury Cesspits Land
Contamination Assessment
Report

M4CaN-DJV-EGT-ZG_GEN-RP_EN-0033

At Issue | March 2016

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Figure 1	Site Plan
Figure 2	Conceptual Site Model

Appendices

Appendix 1	Exploratory Records
Appendix 2	Tabulated Gas and Groundwater Monitoring
Appendix 3	Tabulated Soil Laboratory Data

1 Introduction

1.1 Background

1.1.1 This report relates to the contamination area CL-38 known as 'Knollbury Cesspits' hereafter referred to as the 'Site'.

1.1.2 The Site is located between chainage 21,650 and 21,800 (see Figure 1) within a caravan park.

1.2 Reporting Context

1.2.1 The Site has been assessed as part of ground investigations and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the 'Scheme'). This report informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the chapter on Geology and Soils.

1.2.2 In 2014, a Preliminary Sources Study Report (PSSR) was prepared as an initial land contamination appraisal (Ove Arup & Partners, 2014) as part of Design Manual for Roads and Bridges (DMRB) Stage 2 Assessments for this Scheme. This identified a number of individual areas that may have been affected by contamination as a result of historical activities at the Site.

1.2.3 This report now draws upon information available from the 2015 Supplementary Ground Investigation Works undertaken on behalf of the Welsh Government (Geotechnical Engineering, 2015). This report relates to the area defined in the Site Plan shown in Figure 1.

1.2.4 The overarching rationale and approach for the assessment of areas of land along the Scheme with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

1.3.1 The key objectives of this report are set out below.

- Undertake a risk assessment of the Site and determine whether potential risks to human health or controlled waters could exist based upon the Scheme.
- Identify any further assessment investigations that are needed in order to refine land contamination risks and inform on the need for remediation.
- To provide information to support the Ground Investigation Report and Geotechnical Design Report required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

1.4.1 The subsequent report structure is as follows.

- Section 2: Site Location and Description – This section summarises the Site description.
- Section 3: The Scheme – This section details the M4 Corridor around Newport alignment and associated features at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and historical aerial photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and relevant environmental information presented in the 2014 PSSR.
- Section 6: Scope of Investigations – This section describes previous and supplementary investigations undertaken at the Site.
- Section 7: Ground Conditions – This section describes the main findings of the investigations including the ground conditions encountered and significant visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contaminant linkages and presents the human health and controlled waters assessments.
- Section 9: Refined Conceptual Site Model – This section presents the Conceptual Site Model (CSM) for the Site and identifies potential contaminant linkages, based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations – This section provides conclusions concerning the likelihood of land contamination associated with the Site affecting the Scheme and requirements for remediation/mitigation.
- Section 11: References – This section details the key reference documents referred to within the text.
- Section 12: Glossary – This section details the key terms and acronyms used throughout the report.

2 Site Setting

- 2.1.1** The Site comprises the Beeches Farm Caravan Park which is located immediately to the north west of Beeches Farm off Grange Road to the north of the existing M4. The location and layout of the Site is presented on Figure 1 which includes the three potential areas of land contamination as defined by the 2014 PSSR considered to represent the approximate locations of the three cess pits identified during the 1995 walk over survey.
- 2.1.2** A review of aerial photography in 2015 indicated the caravan park site contains static caravans, access roads and grassed areas and is bounded by tree hedging.
- 2.1.3** No access was gained during the 2014 and 2015 walkover surveys. The 1995 walk over survey identified the presence of 3 No. cesspits within the park described as concrete underground tanks.

3 The Scheme

- 3.1.1** The Site is located on the line of the main alignment at approximate chainage 21,650 to 21,800. Reference should be made to Figure 1 for the Site location in relation to the Scheme.
- 3.1.2** In this area, the new section of motorway would join the existing M4, requiring widening of the existing highway with the resulting new highway encroaching over the southern end of the Site. The intention is that materials arising from the excavation would be removed from their current location and reused within the Scheme.
- 3.1.3** A small borrow pit is also proposed adjacent to the western Site boundary and the areas to the north, east and west are to be used for topsoil stockpiling.

4 Site History

- 4.1.1** The 2014 PSSR historical searches were based on Ordnance Survey plans, literature reviews, information provided by British Steel, Natural Resources Wales (NRW) (formerly Environment Agency Wales), Newport City Council and aerial photographic interpretation.
- 4.1.2** This has been supplemented from the review of historical maps obtained in 2015 from the Welsh Government. No relevant additional information has been identified from this review.
- 4.1.3** A summary of the Site's history is presented in Table 1 below.

Table 1: Site History

Date	Use	Source of information
1843 - 1893	The Site is shown within fields.	1:10,560 Historical Mapping
1891 - 1912	No significant change.	1:10,560 Historical Mapping
1904 - 1939	The north western half is shown to be occupied in part by woodland. The north eastern corner of the Site is located within the Beeches Farm (buildings are as current layout).	1:10,560 Historical Mapping
1964- 1965	No significant change.	1:10,560 Historical Mapping
1969 - 1971	The Beeches Farm development is shown to have extended northwards and now includes Beeches Farm Caravan Park. All sites are now included within this development area.	1:10,560 Historical Mapping
1985 - 1996	No significant change.	1:10,000 Historical Mapping
1995	The presence of 3 no. <u>cesspits</u> noted during a site walkover undertaken by Ove Arup and Partners. These are located at the north-western and north-eastern corners and mid-way along the north-eastern boundary of the caravan park.	Walkover survey (1995 PSSR)
2006	No significant change.	Aerial Photography
2009 - 2010	No significant change.	Aerial Photography
2013 - 2014	No significant change.	Aerial Photography

Notes. Potential sources of contamination are underlined. Those within the temporary and permanent land take are shown in **bold**.

- 4.1.4** Historically the Site is located in proximity to areas which may have been bombed during World War II, which is discussed in the Explosive Ordnance Threat Assessment Report (Bactec, 2014). This categorises the Site as low risk with respect to unexploded ordnance.

5 Environmental Setting

5.1 Geology

- 5.1.1** British Geological Survey (BGS) data indicates that no superficial deposits underlie the Site. The bedrock beneath the Site comprises the Black Rock Limestone Subgroup (Dolostone).

5.2 Hydrology

- 5.2.1** There are no surface water features within the Site boundary. The nearest watercourse is St Brides Brook located approximately 260 m west of the Site.

5.3 Hydrogeology

- 5.3.1** NRW classifies the bedrock as a Principal Aquifer.
- 5.3.2** The Site does not lie within a groundwater Source Protection Zone (SPZ). However it lies within a groundwater vulnerability zone classified as a principal aquifer.

5.4 Environmental Information

- 5.4.1** No pollution incidents, abstraction licences, discharge points or landfill sites have been recorded within the Site or within 300 m of the Site.

6 Scope of Investigations

6.1 General

6.1.1 One intrusive ground investigation (2015) has been undertaken at this Site and this is summarised in Table 2. Furthermore, one borehole (SBHN04) was advanced within 10 m of the Site. This has been considered in order to support understanding of ground conditions beneath the Site and inform on the soil, groundwater quality and gas regime as given its location it may be within the zone of influence of one of the cesspits.

6.2 Scope of Works

6.2.1 The various intrusive ground investigations undertaken within the Site area are summarised in Table 2.

Table 2: Site Investigation Summary

Date	Contractor	Site Location	Boreholes	Window Sampler	Trial Pits	Sampling
2008	Norwest Holst	Western Site	SBHN04	-	-	None
2015	Geotechnical Engineering Limited	South-east	BH557	-	-	

6.2.2 The construction details of all boreholes installed on the Site are summarised in Table 3.

Table 3: Summary of Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (m bGL)	Base of Slotted Well Casing / Gravel Pack (m bGL)	Targeted Geology
SBHN04 RC	19	10.7	9.6	10.0	Carboniferous Limestone Group
BH557	50	16.0	2.0	16.0	Carboniferous Limestone Group

6.3 Surface Water Quality Monitoring

6.3.1 Surface water quality monitoring was not undertaken during previous ground investigations of the Site.

6.4 Field Testing

6.4.1 Photo Ionisation Detector (PID) monitoring for Volatile Organic Compounds (VOCs) was not undertaken in either the on site or off site selected boreholes during the previous ground investigations.

6.5 Groundwater Monitoring

6.5.1 A summary of the groundwater sampling, groundwater monitoring and ground gas monitoring rounds at the selected boreholes is shown in Table 4.

Table 4: Summary of Monitoring Rounds

Location Ref.	Number of Rounds (Date of Sampling)	Monitoring Details	Notes
SBHN04 RC (19mm)	1 no. (31 st January 2008)	Groundwater Level	-
BH557	4 no. (29 th April 2015, 7 th May 2015, 13 th May 2015, 20 th May 2015)	Groundwater Level, Ground Gas	-

6.6 Laboratory Chemical Testing

6.6.1 A summary of all laboratory analysis undertaken on soils, groundwater, leachate and surface water from the previous site investigations is provided below in Table 5.

Table 5: Summary of Previous Investigation Sampling

Site Investigation Date	No. of Soil Samples	No. of Leachate Samples	No. of Water Samples	Suites of Testing
2008	0	0	0	-
2015	2	-	-	Inorganics, pH, MTBE, BTEX, TPH, PAH, Phenols, PCBs, VOCs, SVOCs

Soil Analysis

6.6.2 The following sections summarise the laboratory analytical results for soil samples collected onsite during the various intrusive investigation phases. The available data set has been tabulated and is presented in Appendix 3 with the supporting laboratory certificates available in the relevant original ground investigation reports.

6.6.3 The available information is summarised below in Table 6.

Table 6: Summary of Analytical Soil Data

Formation Unit	Number of Soil Analysis per Analytical Suite - 2015 Data					
	Inorganics	VOCs & SVOCs	PAH	TPH	Phenol	BTEX
Natural Soils	2	1	2	2	2	2

6.7 Gap Analysis of Available Data

6.7.1 The investigation data available for the Site is considered to be limited both in relation to Site coverage and in the laboratory analysis.

6.7.2 No chemical analysis of groundwater or soil leachate data is available for this Site and therefore limited quantitative risk assessment has been undertaken.

7 Ground Conditions

7.1 Geology

7.1.1 The two geological exploratory borehole logs (SBHN04 and BH557) for the available intrusive locations on and off site are provided in Appendix 1. The observed geological sequence is broadly consistent with that discussed in the 2014 PSSR report and is now supplemented with information from an additional borehole. This is summarised in the following sections. Information from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) has also been used.

Topsoil

7.1.2 Topsoil was encountered in both boreholes at thicknesses ranging between 0.4 - 0.6 m.

Superficial Deposits

7.1.3 Unconsolidated superficial deposits were encountered in both locations. These comprised Head Deposits.

7.1.4 Head Deposits generally comprised sandy gravelly clay and were found at thicknesses of between 1.2 - 1.6 m.

Solid Geology

7.1.5 Below the Head Deposits the Carboniferous Limestone was encountered (at depths of 1.8 – 2 m bGL). The Limestone was typically described as medium strong to strong yellowish grey oolitic or shelly limestone.

Geological Sequence Summary

7.1.6 The general geological sequence identified during the previous ground investigations is summarised in Table 7.

Table 7: Summary of Geological Sequence

Unit	Description	Thickness Range (m)	Basal Depth (m bGL)
Topsoil	Topsoil	0.4 - 0.6	0.4 - 0.6
Head Deposits	Sandy gravelly clay with a low cobble content. Gravels and cobbles of angular to sub angular limestone.	1.2 - 1.6	1.8 - 2
Carboniferous Limestone	Moderately strong to very strong light grey limestone.	>8.3 - >14	Unproven

Note: ">" excess of

7.2 Visual and Olfactory Evidence of Contamination

7.2.1 Visual and olfactory evidence of contamination was not encountered during the drilling of the boreholes.

7.2.2 Full details and observations noted during the drilling are presented on the exploratory logs provided in Appendix 1.

7.3 Gas Monitoring

7.3.1 The gas monitoring dataset collected at BH557 during each of the four monitoring rounds is summarised on the field data sheets provided in Appendix 2. The maximum gas concentrations (minimum for oxygen) are presented in Table 8.

Table 8: Summary of Gas Monitoring Data

Location ID	Flow (l/hr)	VOCs (ppm)	CH ₄ (%/vol)	Peak LEL (%)	CO ₂ (%/vol)	O ₂ (%/vol)	CO (ppm)	H ₂ S (ppm)
	Max.	Max.	Max.	Max.	Max.	Min.	Max.	Max.
BH557	0.0	3.3	0.1	1.0	3.3	16.3	1	0

7.4 Groundwater

Groundwater Encountered During Investigation

7.4.1 Groundwater was not encountered during the previous investigations.

Groundwater Level During Monitoring Rounds

7.4.2 Data relating to groundwater levels for the Site are provided in Appendix 2 and summarised in Table 9.

Table 9: Summary of Groundwater Level Data During Investigation

Location	Installation ^{#1}	Depth of Response Zone (m bGL) and Geological Formation	No. Measurements	Min Level (m bGL)	Max Level (m bGL)	Comments
SBHN04 RC	D	9.6 – 10.0 Carboniferous Limestone	1	9.99	9.99	-
BH557	D	2 - 16 Carboniferous Limestone Group	4	14.02	15.70	-

Notes: #1 S denotes a shallow installation and D denotes deep installation.

Groundwater Summary

7.4.3 A deep groundwater body within the bedrock has been identified with a water level around 10 - 15 m bGL.

8 Contamination Assessment

8.1 Introduction

8.1.1 The following sections provide details of the assessment of land contamination at the Site.

8.1.2 The Conceptual Site Model (CSM) presented within the 2014 PSSR has been reviewed and updated based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and the revised design of the Scheme. The main alterations to the 2014 PSSR model are summarised below.

- Addition of a gas data set.
- Inclusion of a maintenance worker receptor in the area containing cess pits.
- Update of the source-pathway-receptor linkages taking into account the above and more detailed assessments.

8.2 Preliminary Risk Assessment

Potential Sources

8.2.1 The cesspits are understood to include a concrete underground tank with sewage inlet located below ground level.

8.2.2 A potential source of contamination will be soils impacted by sewage which may have leaked over the years of the cesspit's usage. The ground investigation indicated no shallow groundwater to be present in the area of the cesspits. The proposed land take is unlikely to encounter deep groundwater.

8.2.3 Any impacted soils are likely to contain sewage related contaminants including:

- metals e.g. arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel and zinc;
- inorganic ions e.g. sulphates, chlorides, ammonium, phosphates;
- pathogenic organisms;
- acids/alkalis; and
- hazardous gases (methane, carbon dioxide and hydrogen sulphide).

Potential Receptors

8.2.4 Receptors during the construction and the operational stages of the Scheme that have been considered.

Construction

- Construction workers during site development works.
- General public are unlikely to be in the vicinity of construction works.
- Principal aquifer.

Operational

- Maintenance worker.
- Principal aquifer.

Potential Pathways

8.2.5 Pathways during the construction and the operational stages of the Scheme that have been considered.

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils possible during development and maintenance works.
- Leaching of contaminants from the sewage into the underlying groundwater aquifer (in the event of leakage).

8.3 Risk Evaluation

8.3.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the other data described herein, the following risk evaluation has been reconsidered and includes:

- The area of permanent land take encroaches slightly upon the western most cesspit.
- Leakages may have occurred contaminating surrounding soils.
- No reported olfactory evidence of sewage reported in the borehole records.

8.4 Human Health Risk Assessment

8.4.1 The rationale and approach for the human health (Tier 2) screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1). Soil chemical analysis results and the findings of the generic tier 2 human health risk assessments are presented in Appendix 3.

8.4.2 No exceedance of the applied assessment criteria have been identified within the topsoil or natural ground samples analysed in the laboratory.

8.5 Controlled Waters Screening Assessment

8.5.1 No chemical analysis of leachate or groundwater was undertaken during previous investigation of the Site and therefore no quantitative risk assessment can be undertaken.

8.6 Ground Gas Risk Assessment

8.6.1 The only ground gas data available relates to the borehole BH557 which has a response zone within the Carboniferous Limestone (2 – 16 m bGL). Of the four monitoring rounds available, the below comments may be made.

- No monitoring was undertaken during low barometric pressure (less than 1000 mb), with the lowest pressure conditions being 1009 mb. As such gas

emissions during worst case atmospheric conditions may have not been monitored.

- Gas flow was generally unrecorded with the exception of the fourth round with a negative flow -1.2 l/hr.
- Methane has been recorded at nil or up to 0.1 % during all 4 no. rounds, which are below the screening criteria of 1 % and a correlating LEL of 0.0 %.
- Carbon dioxide was identified between 0.4 - 3.3 %, which are below the screening criteria of 5 %.
- Trace of Volatile Organic Compounds of up to 3.3 ppm have been recorded.
- Hydrogen sulphide was not recorded during any monitoring round.
- Carbon monoxide was recorded in the first three rounds with a maximum concentration of 1 ppm. This is below the screening criteria of 30 ppm.
- Oxygen has been recorded to be at relatively normal levels (ambient) with concentrations between 16.3-20.1 %.

8.6.2 On the basis of the above the gas regime at the Site does not appear to have been influenced by previous historical uses and is instead driven by soil gas within natural soils. A gas risk assessment has been undertaken and is set out within the Land Contamination Assessment Report (Appendix 11.1 of the ES).

9 Refined Conceptual Site Model

- 9.1.1** The incorporation of data from the 2015 Supplementary Ground Investigation has enabled the original CSM presented in the 2014 PSSR to be updated. Relevant contaminant (source-pathway-receptor) linkages are considered within the refined CSM. The assessment is based on the Scheme during construction and operational phases.
- 9.1.2** A CSM representing general ground conditions, overall Scheme layout and relevant source-pathway-receptors (each of which has a specific alpha-numerical symbol attached) is presented in Figure 2 and is described below in Table 10.

Table 10: Conceptual Site Model

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
On Site Sewage, sewage sediments, soils surrounding the cesspits and sewage impacted groundwater	Construction					
	Construction Workers (B)	Direct dermal (1)	Unlikely	Low	Very low	Construction workers may be exposed to soils impacted by sewage during construction works; however exposure duration will be short term only.
		Ingestion (3)	Unlikely	Low	Very low	Septic tanks located outside areas of construction. Prior to construction, a specific risk assessment will be required in line with CDM and health and safety legislation. This will enable safe methods of work and an appropriate level of PPE to be put in place. As such all risks will be duly considered and suitably mitigated to protect construction workers. Receptors are within open space with no proposed confined space works. No chemical data is available for the Site. However no obvious olfactory evidence of sewage reported in exploratory holes.
		Inhalation of soil derived dust (2)	Unlikely	Low	Very low	Anticipated contamination status is not foreseen to represent abnormal constraints to maintenance workers health and safety over and above those typical of a brownfield site.
		Inhalation of soil gases (2)	Unlikely	Low	Very low	Provision and implementation of a suitable verification sampling inspection strategy during
	Motorway users (A) and off site General Public (C)	Direct Dermal contact of soil dust (1)	Unlikely	Low	Very low	Dermal and ingestion pathways associated to soil dust only. Short term exposure only. End users to be within open space.
		Ingestion of soil dust (3)	Unlikely	Low	Very low	Dust suppression measures are recommended during construction works. Chemical analysis of soils unknown.

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
		Inhalation of soil dust (2)	Unlikely	Low	Very low	Provision and implementation of a suitable verification sampling inspection strategy during construction to confirm risks is recommended.
		Inhalation of soil gas or vapours (2)	Unlikely	Low	Very low	
	Groundwater - Aquifer within the Bedrock (Da)	Leaching / migration of contaminants to aquifer (4)	Unlikely	Low	Very low	Groundwater some 10 m below ground level. Potential for migration of contaminants from potentially impacted soils during excavation however it is expected that groundwater will not be encountered during construction works. Provision and implementation of a suitable verification sampling inspection strategy during construction to confirm risks is recommended.
	Operational					
	Maintenance Workers (B)	Direct dermal (1)	Unlikely	Low	Very low	Potentially impacted soils will be vegetated within area of permanent land take and therefore the exposure to contamination will be limited. Exposure duration will be short term only.
		Ingestion (3)	Unlikely	Low	Very low	Site specific risk assessment will be required in line with health and safety guidance. This will enable safe methodology and an appropriate level of PPE to be put in place. As such all risks will be duly considered and suitable mitigated.
		Inhalation of soil derived dust (2)	Unlikely	Low	Very low	Provision and implementation of a suitable verification sampling inspection strategy during construction to confirm risks is recommended
	Future motorway users (A) and off site users (C)	Dermal contact with dust (1)	Unlikely	Low	Very low	Potentially impacted soils will be vegetated within area of permanent land take and therefore the exposure to contamination will be

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
		Ingestion of dust (3)	Unlikely	Low	Very low	limited. Exposure duration will be short term only for M4 users. Sceptic tank located outside land take. Provision and implementation of a suitable verification sampling inspection strategy during construction to confirm risks is recommended.
		Inhalation of soil dust (2)	Unlikely	Low	Very low	
		Inhalation of soil gas or vapours (2)	Unlikely	Low	Very low	
	Groundwater - Aquifer within the bedrock (Da)	Leaching/migration of contaminants to aquifer (4)	Unlikely	Low	Very low	Groundwater some 10 m below ground level. Provision and implementation of a suitable verification sampling inspection strategy during construction to confirm risks is recommended

10 Conclusions and Recommendations

10.1 Conclusions

- 10.1.1** The Scheme proposals include the widening of the existing M4 highway which encompasses the southern end of the Site. A borrow pit is also proposed south west of the Site.
- 10.1.2** Ground investigations have been undertaken adjacent to and at the Site to assess risks from land contamination associated with the construction and operation of the Scheme including human health and controlled waters risks.
- 10.1.3** The status of the underground tanks is not clear but assuming they are still present and operational it is considered there is a low potential for soils impacted by sewage related contamination to be encountered at the Site. Although, no analytical data is available in the area of the cess pits identified during the 1995 walkover, risks to human health and controlled waters have been qualitatively rather than quantitatively assessed.
- 10.1.4** The potential for contamination at the site is likely to present only a low risk to the Scheme. Any areas of significant sewage related contamination are likely to be localised, if indeed any is present at all. The cess pits will not be affected during the construction of the Scheme as they are outside the land take.
- 10.1.5** Due to the proximity of the proposed works to the existing cesspit tanks, there is a very low risk that construction workers may be directly exposed to soils impacted by sewage related contamination. Use of standard health and safety measures is considered sufficient for construction workers in this part of the Scheme.
- 10.1.6** It is anticipated that materials encountered within the Site are unlikely to be contaminated and are likely to pose a very low risk to human health and controlled waters both during construction and operation.
- 10.1.7** Should contaminated soils be encountered; these will be dealt with through adoption of a discovery strategy to be detailed within the remediation strategy.
- 10.1.8** It is expected that groundwater will not be encountered during the construction works.
- 10.1.9** Materials are likely to be suitable for reuse subject to the provision and compliance of reuse criteria under a Material Management Plan.
- 10.1.10** Post construction, the embankment itself and topsoil and subsoil cover along the motorway corridor will break potential human health pathways to end users and maintenance workers. However, topsoil materials placed at the surface will need to be checked for contamination.

10.2 Recommendations

- 10.2.1** Other than dealing with the unlikely event of encountering unexpected contamination at the Site, remediation is not expected to be required. The site wide remediation strategy being developed for the Scheme will set out the following procedures during construction activities to be undertaken at the Site:

- Dealing with unexpected contamination.
- Verification of imported topsoils for suitability of use.

10.2.2 The remediation strategy should be supported by a Scheme wide Material Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

11 References

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Geotechnical Engineering Limited (2015) M4 Corridor Around Newport, Factual Report on Ground Investigation, 30238
Highways Agency (2008) Design Manual for Roads and Bridges. Vol. 4. Geotechnics and Drainage. Section 1. Earthworks; Part 2. HD22/08. Managing Geotechnical Risk

Ove Arup & Partners (2014) M4 Corridor Around Newport, Preliminary Sources Study Report, 14/9197

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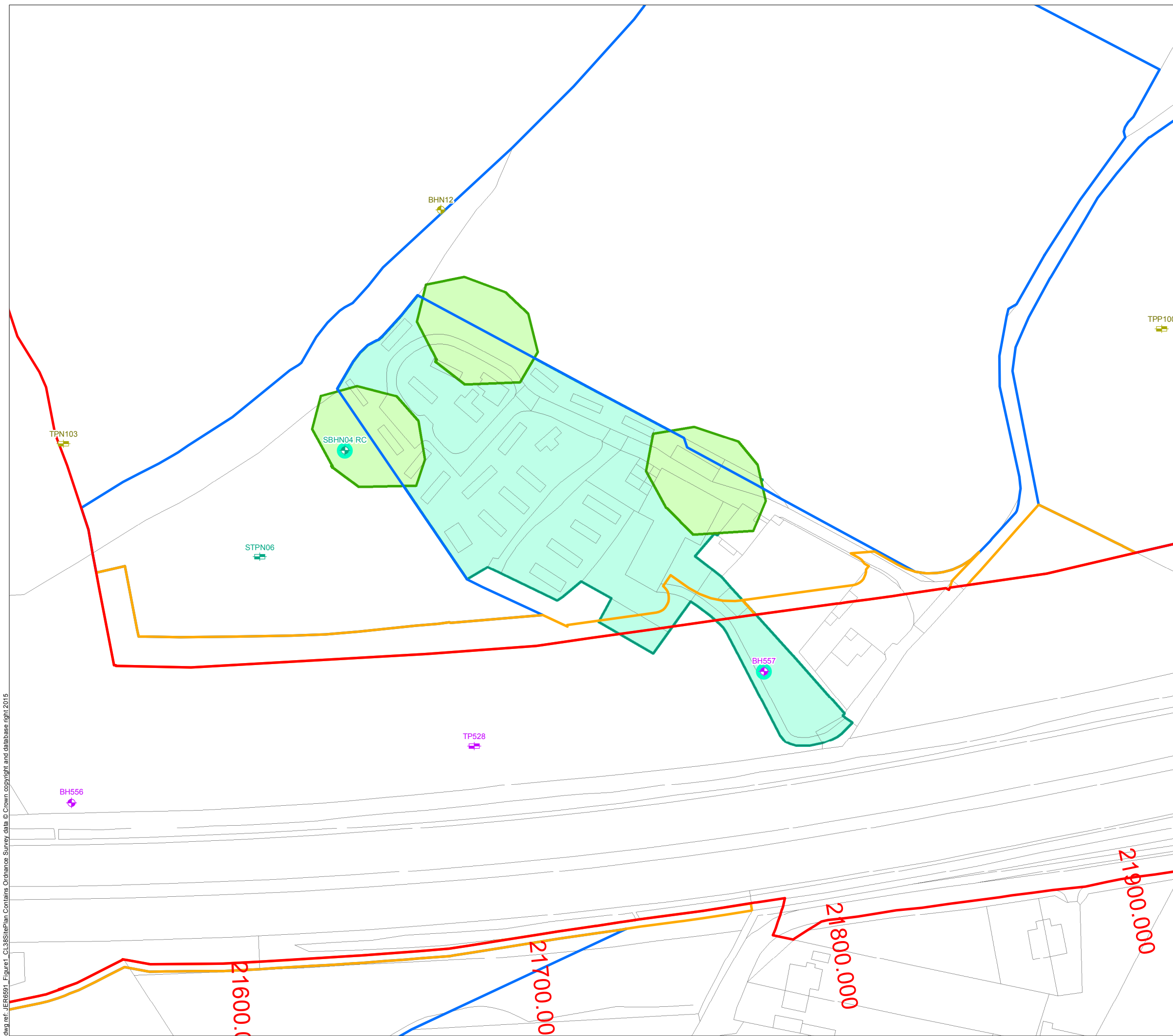
12 Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection
mAOD	Metres Above Ordnance Datum

mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O ₂	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures

dwg ref: JER6591_Figure1_CL38SitePlan Contains Ordnance Survey data © Crown copyright and database right 2015



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Potential Area of Land Contamination based on 2014 PSSR
- Revised Potential Area of Land Contamination

Investigation Locations

2015 (Geotechnical Engineering)

- Borehole
- Trial Pit

2007 (Norwest Holst)

- Borehole
- Trial Pit

1997 (Norwest Holst)

- Borehole
- Trial Pit
- Monitoring Well Installation

NEWPORT

Llywodraeth Cymru
Welsh Government

Appendix 11.1 Annex D CL-38

Site Plan for CL-38

Figure: 1	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Scale: A3 @ 1:1,250

0 20 40 m

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dwg ref: JER6591_Figure1_CL38SitePlan

Legend

- Sewage Impacted Soils
- Sewage & Impacted Sediments
- Head Deposits
- Black Rock Limestone Formation - BR
- Proposed Cutting
- Groundwater (BR)

Potential Receptors

- Humans On-Site (M4 User)
- Humans On-Site (Construction/Maintenance)
- Humans Off-Site (Site Neighbours)
- Groundwater (Aquifer)

Potential Pathways

- Dermal Contact
- Inhalation
- Ingestion
- Leaching / Migration

Potential Sources of Contamination

Possible contamination present on site associated with :

On-Site

- Sewage & sediments within cess pits
- Soils impacted by leaking sewage
- Sewage impacted groundwater

NOTE
Drawing refined from PSSR Drawing Reference
M4-OA-17-00DR-Z-XX-0154 (January 2014)



Appendix 11.1 Annex D CL-38

Conceptual Site Model for CL-38

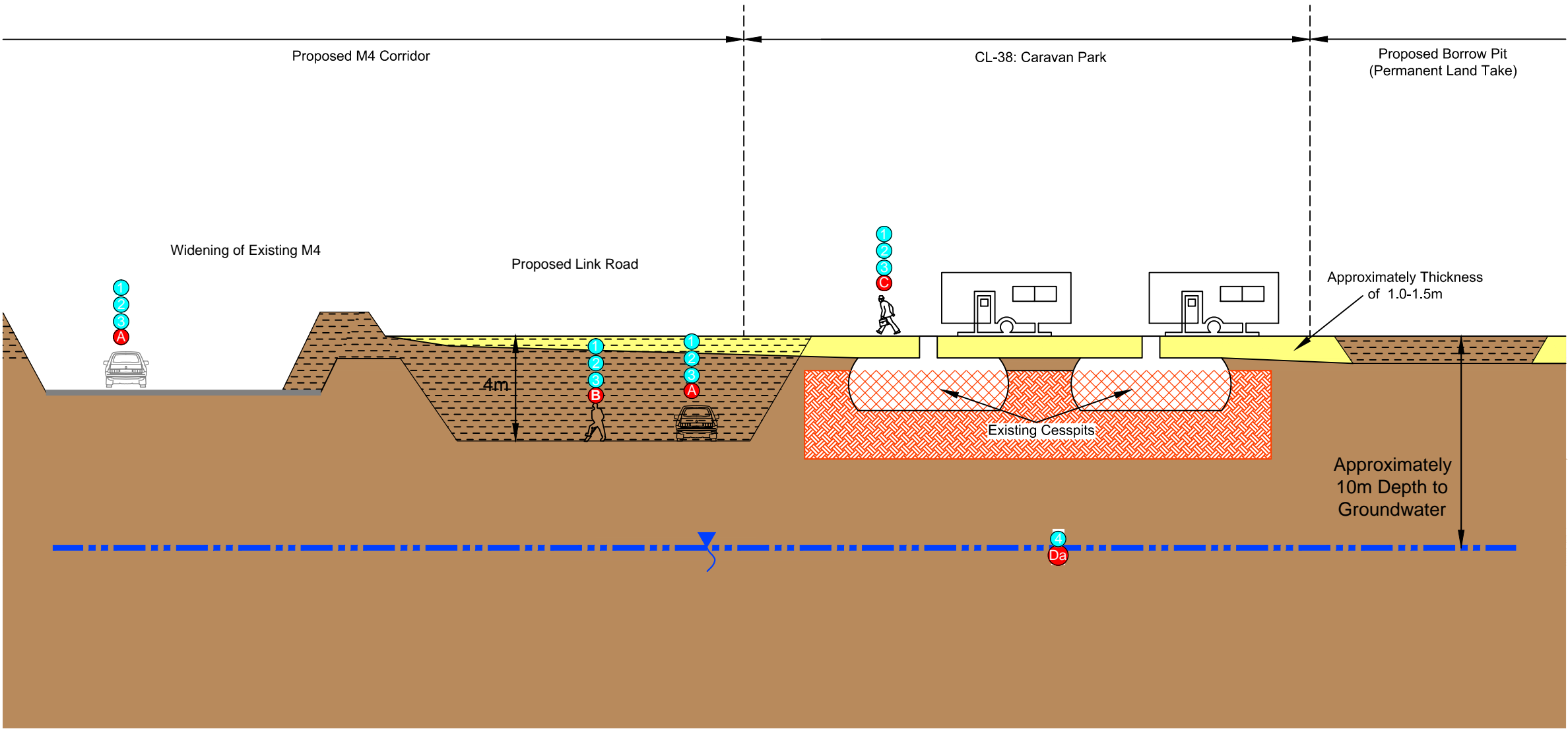
Figure: 2	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Not to Scale

Ground conditions based on available information

dwg ref: JER6591_Figure2_CL38ConceptualSiteModel

CL- 38 Knollbury Cesspits



Appendices

Appendix 1

Exploratory Records

Contract No.	F15056	Method	Rotary Coring	Coordinates	342748.57 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187933.62 N
		Driller	BB	Ground Level	32.88m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	11/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	13/12/2007

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
11/12/2007	1730	3.00	1.80	2.80	End of Shift	0.00	1.80	Air/mist	100%	0.00*
12/12/2007	0730	3.00	1.80	2.80	Start of Shift	1.80	10.10	Air/mist	100%	92.0
12/12/2007	1730	6.75	1.80	6.60	End of Shift					
13/12/2007	0730	6.75	1.80	6.60	Start of Shift					
13/12/2007	1730	10.10	1.80	8.70	End of Hole					

CASING				WATER STRIKES							
Hole diam.	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
121	10.10	121	1.80								

GENERAL NOTES				SPT DETAILS				
1.Rotary Openhole drilling from GL to 1.80m. 2.Rotary Coring from 1.80m to 10.10m. 3.19mm piezometer installed, tip at 10.00m, with response zone from 9.60m to 10.00m. 4.0.00* indicates openhole drilling.				Depth	Type	Incremental blow count/penetration	Casing	Water Depth
				1.00	S	100/300mm (17,8,17,17,30,36)	0.00	DRY
				2.00	S	100/10mm (25,100)	0.00	1.90
				3.00	S	100/17mm (25,100)	1.80	2.80

NOTES: All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form	ARIAL ROTARY HEADER
Version	3.06
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	342748.57 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187933.62 N
		Driller	BB	Ground Level	32.88m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PWF	Date Started	11/12/2007
		Core bit	TC	Date Completed	13/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	ROD	FE	SPT N & depth	Installation
Turf over brown TOPSOIL.										
Light brown fine SANDS with frequent sandstone gravelly bands.		0.60	32.28						1.00 1.42 S100/300mm	
Brown silty CLAY with frequent limestone cobbles.		1.30	31.58							
Strong to very strong light grey LIMESTONE with medium to widely locally closely spaced stylolites 0 - 20 deg. Discontinuities 1) 0 -10 deg closely to widely spaced undulating rough locally infilled with greenish grey clay locally stained orangish brown. (Carboniferous Limestone Group) ---from 2.00m to 2.33m 1 No discontinuity 80-85 deg undulating rough to smooth stained brown ---from 2.20m to 2.28m 2 No 15mm diameter partially calcite infilled voids ---from 2.33m to 2.40m assumed zone of core loss ---from 2.40m to 2.78m 1 No discontinuity 80-85 deg undulating to planar rough to smooth stained brown ---from 2.87m to 2.88m 2 No incipient discontinuities 30 deg undulating calcite infilled ---from 4.47m to 4.50m assumed zone of core loss ---at 5.04m 1 No 20mm diameter void partially infilled with calcite ---from 5.12m to 5.14m many fine to medium gravel sized voids ---from 6.84m to 7.08m 2 No discontinuities 70-80 deg undulating rough to smooth stained brown ---from 8.30m to 8.53m 1 No discontinuity 70-75 deg planar rough to smooth stained brown ---from 8.53m to 8.53m 1 No thick lamination of green grey clay		1.80	31.08	1.80 2.00 40 40 0 2.00 2.40 83 83 30 2.40 3.00 100 100 57 3.00 4.50 98 98 90 4.50 5.37 100 100 100 5.37 6.75 100 100 100 6.75 8.00 97 94 87 8.00 8.90 100 100 88 8.90 9.80 100 100 100 9.80 10.10 100 100 100				50 100 180 110 180 310 70 320 620	2.00 2.04 S100/10mm 3.00 3.05 S100/17mm	

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form ARIAL ROTARY LOG

Version 3.09

Revised 17/12/2007



Hole ID.
SBHN04 RC
Sheet 2 of 2

Contract No.	F15056	Method	Rotary Coring	Coordinates	342748.57 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187933.62 N
		Driller	BB	Ground Level	32.88m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	11/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	13/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	ROD	IF	SPT N & depth	Installation
<p>Strong to very strong light grey LIMESTONE with medium to widely locally closely spaced stylolites 0 - 20 deg. Discontinuities 1) 0 -10 deg closely to widely spaced undulating rough locally infilled with greenish grey clay locally stained orangish brown. (Carboniferous Limestone Group)</p> <p>Rotary drilling complete at 10.10 m.</p>		10.10	22.78							

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH557

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 2

Start Date 13 March 2015 Easting 342890.9

Scale 1 : 50

End Date 17 March 2015 Northing 187858.6 Ground level 35.40mOD Depth 16.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
13/03/15 0830hrs	1B	0.00 - 0.20		Vo 9.2			✓	Firm brown slightly sandy silty CLAY with frequent roots (up to 2mm diam). (TOP)	0.40	35.00	
	2D*	0.00 - 0.20									
	3B	0.20 - 0.40		Vo 8.4							
	4D*	0.20 - 0.40									
	5B	0.40 - 1.00		Vo 10.0				Very stiff brown slightly sandy slightly gravelly silty CLAY. Gravel is subrounded and rounded fine to coarse limestone. (HDD)			
	6D*	0.40 - 1.00									
		1.00 - 1.45	Nil	C 36							
	7X	1.00 - 1.90									
	8D*	1.40 - 1.50									
13/03/15 1630hrs 0.25m		1.90 - 2.16	Nil	C*125							
	X	1.90 - 2.00									
16/03/15 0800hrs Dry	9C	2.00 - 2.30	2.00		100 0 0	NI		1.90 - 2.00m: No recovery.	2.00	33.40	
	10C	2.30 - 3.00			85 0 0			Medium strong yellowish grey oolitic LIMESTONE recovered non intact as sandy subangular fine to coarse limestone gravel. Low subangular limestone cobble content. (CL)			
	11C	3.00 - 3.04 3.00 - 4.50	2.00	C**	100 66 36	50 100 150		Medium strong yellowish grey slightly sandy oolitic LIMESTONE with localised randomly orientated calcite veins (up to 2mm thick). Fractures are subhorizontal to 20° and 70° to subvertical closely spaced planar smooth stained mottled orangish brown with black specks or a clay veneer. (CL)	3.00	32.40	
	12C	4.50 - 6.00	2.00		100 96 82	40 300 800		Strong grey shelly LIMESTONE with localised randomly orientated calcite veins (up to 2mm). Fractures are subhorizontal to 20° and 70° to subvertical medium and widely spaced rarely very closely spaced planar smooth stained orangish brown and speckled black. (CL)	4.80	30.60	
	13C	6.00 - 7.50	2.00		100 90 83			5.00m: Horizontal band (50mm) of calcareous mudstone. 5.10 - 5.40m: Horizontal planar smooth fractures with grey clay veneer and frequent linear subhorizontal voids (up to 20mm). Shell fragments dissolved. 5.70m: Weak. 5.90m: Horizontal planar smooth fracture with grey clay veneer. 6.15m: Horizontal band (10mm) of grey calcareous mudstone.			
	14C	7.50 - 9.00	2.00		100 93 83			7.50 - 8.50m: Locally interlaminated yellowish brown.			
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.00m. Dynamic sampled (113mm) 1.00-2.00m. Waterflush rotary core drilled (116mm) 2.00-16.00m.

CASING: 140mm diam to 2.00m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 16.00m, granular response zone 16.00-2.00m, bentonite seal 2.00-0.20m, concrete and stopcock cover 0.20-0.00m.

REMARKS: Driller notes reduced flush returns 2.00-4.50m (80% returned), 4.50-10.50m (10% returned) and loss of flush 10.50-16.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
30238CHECKED
EC

BOREHOLE LOG

CLIENT WELSH GOVERNMENT

BH557

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 2 of 2

Start Date 13 March 2015 Easting 342890.9

Scale 1 : 50

End Date 17 March 2015 Northing 187858.6 Ground level 35.40mOD

Depth 16.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru- ment	description	depth (m)	reduced level (m)	legend
16/03/15 1700hrs 6.60m	15C	9.00 - 10.50	2.00		97 86 54			8.80 - 9.00m: Brownish yellow. 9.30 - 9.85m: Subvertical planar smooth fracture with brown clay veneer. 9.80 - 9.90m: Frequent linear voids (up to 20mm). Shell fragments dissolved. 9.85m: Brownish yellow horizontal band (50mm). 10.00m: Medium strong.			
17/03/15 0840hrs 10.40m	16C	10.50 - 12.00	2.00		100 95 88	200 200 300		10.70m: White subangular coarse gravel sized calcite crystal.			
	17C	12.00 - 13.50	2.00		100 100 100						
	18C	13.50 - 15.00	2.00		100 100 100			13.20 - 14.00m: Frequent fine gravel sized voids and laminae (up to 30mm) of oolitic limestone. Shell fragments dissolved out. 14.25 - 14.45m: Interlaminated with bands (up to 80mm) of shell fragments and oolitic limestone.			
17/03/15 1610hrs 11.90m	19C	15.00 - 16.00	2.00		100 100 100				16.00	19.40	
								Borehole completed at 16.00m.	{18.00}		
<div> <div>water strike (m)</div> <div>casing (m)</div> <div>rose to (m)</div> <div>time to rise (m)</div> <div>remarks</div> </div> <div>Groundwater not encountered prior to use of water flush.</div> <div> <div>AGS</div> <div>CONTRACT</div> <div>30238</div> </div> <div>CHECKED</div> <div>EC</div>											

Appendix 2

Gas and Groundwater Monitoring Dataset

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH557	29/04/15 12:00:00	1010	-0.62								0.0	11		6 litres purged, base depth 16.00m.	
BH557	29/04/15 12:01:00										0.0				
BH557	29/04/15 12:02:00										0.0				
BH557	29/04/15 12:03:00										0.0				
BH557	29/04/15 12:04:00										0.0				
BH557	29/04/15 12:05:00			1.2	0.0	20.0	0.0	0	1	3.3					
BH557	29/04/15 12:06:00			1.2	0.0	19.9	0.0	0	0	3.0					
BH557	29/04/15 12:07:00			1.3	0.0	19.9	0.0	0	0	2.6					
BH557	29/04/15 12:08:00			1.3	0.0	19.8	0.0	0	0	2.6					
BH557	29/04/15 12:09:00			1.4	0.0	19.8	0.0	0	1	2.9					
BH557	29/04/15 12:10:00			1.6	0.0	19.7	0.0	0	0	2.9					
BH557	29/04/15 12:11:00			1.7	0.0	19.6	0.0	0	0	2.8					
BH557	29/04/15 12:12:00			1.8	0.1	19.5	1.0	0	0	2.7					
BH557	29/04/15 12:13:00			2.1	0.0	19.4	0.0	0	0	2.3					
BH557	29/04/15 12:14:00			2.2	0.0	19.3	0.0	0	0	2.1			14.02		
BH557	07/05/15 10:15:00	1009	0								0.0	14	Purged dry after 3 litres. Waited 30 mins. No recharge. No sample obtained. Base depth 16.00m.		
BH557	07/05/15 10:16:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH557	07/05/15 10:17:00										0.0			
BH557	07/05/15 10:18:00										0.0			
BH557	07/05/15 10:19:00										0.0			
BH557	07/05/15 10:20:00			0.4	0.0	20.1	0.0	0	0	0.8				
BH557	07/05/15 10:21:00			0.4	0.0	20.1	0.0	0	0	0.8				
BH557	07/05/15 10:22:00			0.5	0.0	20.1	0.0	0	0	0.8				
BH557	07/05/15 10:23:00			0.6	0.0	20.0	0.0	0	0	0.8				
BH557	07/05/15 10:24:00			0.7	0.0	19.8	0.0	0	0	0.9				
BH557	07/05/15 10:25:00			0.9	0.0	19.6	0.0	0	1	0.9				
BH557	07/05/15 10:26:00			1.2	0.0	19.4	0.0	0	0	1.0				
BH557	07/05/15 10:27:00			1.6	0.0	19.1	0.0	0	0	0.9				
BH557	07/05/15 10:28:00			2.0	0.0	18.8	0.0	0	0	0.9				
BH557	07/05/15 10:29:00			2.1	0.0	18.7	0.0	0	0	0.9			14.26	
BH557	13/05/15 09:00:00	1016	0								0.0	12	14.84	Not enough water in installation to obtain sample.
BH557	13/05/15 09:01:00										0.0			
BH557	13/05/15 09:02:00										0.0			
BH557	13/05/15 09:03:00										0.0			
BH557	13/05/15 09:04:00										0.0			
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT


Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH557	13/05/15 09:05:00	1026	-1	2.0	0.0	17.7	0.0	0	1	2.0				
BH557	13/05/15 09:06:00			2.0	0.0	17.7	0.0	0	0	1.9				
BH557	13/05/15 09:07:00			2.1	0.0	17.6	0.0	0	0	1.8				
BH557	13/05/15 09:08:00			2.2	0.0	17.5	0.0	0	0	1.7				
BH557	13/05/15 09:09:00			2.3	0.0	17.4	0.0	0	0	1.6				
BH557	13/05/15 09:10:00			2.4	0.0	17.3	0.0	0	0	1.5				
BH557	13/05/15 09:11:00			2.7	0.0	17.2	0.0	0	0	1.4				
BH557	13/05/15 09:12:00			2.8	0.0	17.1	0.0	0	0	1.3				
BH557	13/05/15 09:13:00			3.0	0.0	17.1	0.0	0	0	1.1				
BH557	13/05/15 09:14:00			3.1	0.0	17.0	0.0	0	0	1.0				
BH557	20/05/15 11:24:00										-0.4	14		
BH557	20/05/15 11:25:00										-0.4			
BH557	20/05/15 11:26:00										-1.2			
BH557	20/05/15 11:27:00										-0.4			
BH557	20/05/15 11:28:00										-0.4			
BH557	20/05/15 11:29:00			3.3	0.0	16.6	0.0	0	0	1.3				
BH557	20/05/15 11:30:00			3.3	0.0	16.6	0.0	0	0	1.2				
BH557	20/05/15 11:31:00			3.3	0.0	16.4	0.0	0	0	1.1				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS


CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH557	20/05/15 11:32:00			3.3	0.0	16.4	0.0	0	0	1.0					
BH557	20/05/15 11:33:00			3.3	0.0	16.4	0.0	0	0	1.0					
BH557	20/05/15 11:34:00			3.3	0.0	16.4	0.0	0	0	1.0					
BH557	20/05/15 11:35:00			3.3	0.0	16.4	0.0	0	0	0.8					
BH557	20/05/15 11:36:00			3.3	0.0	16.4	0.0	0	0	0.8					
BH557	20/05/15 11:37:00			3.3	0.0	16.3	0.0	0	0	0.7					
BH557	20/05/15 11:38:00			3.3	0.0	16.3	0.0	0	0	0.5					
BH557	20/05/15 11:39:00												15.70		
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC

Project Name New M4 Preliminary Ground Investigation						Groundwater Readings For Installations						
Project No. F15056												
Engineer Ove Arup & Partners Ltd						Fig no.						
Client Transport Wales, Welsh Assembly Government						01						
NOTES: SPIE=Piezometer, SP=Standpipe For multiple installations, use different Installation IDs. For piezometers installation depth = tip depth. For standpipes = base of pipe												
COMMENTS SBHM01 RC installation extends 0.50m above ground level. - symbol indicates water level is above GL All groundwater levels are recorded from ground level												
Exploratory Hole ID	Installation Details			Recorded Water Level								
	Type	Depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
SBHC01 RC	SPIE	8.05		30/01/2008	09:50	2.45	25/02/2008	14:34	2.48	07/03/2008	14:25	2.60
SBHD03 CP	SPIE	10.00		30/01/2008	11:01	0.47	25/02/2008	14:52	0.43	07/03/2008	14:05	0.56
SBHD05 RC	SPIE	12.00		31/01/2008	09:00	1.02	25/02/2008	15:35	1.05	07/03/2008	13:50	1.77
SBHD06 RC	SP	15.00		30/01/2008	13:00	1.13	21/02/2008	10:30	1.39	07/03/2008	13:30	1.39
SBHD08 RC	SPIE	29.50		30/01/2008	13:50	1.20	25/02/2008	15:58	2.02	07/03/2008	13:35	1.40
SBHE02RD	SPIE	25.00		31/01/2008	09:25	2.18	25/02/2008	16:20	2.09	07/03/2008	13:10	2.48
SBHE04 RC	SPIE	17.20		31/01/2008	09:15	2.31	25/02/2008	16:11	2.51	07/03/2008	13:20	2.59
SBHF01 RC	SPIE	19.00		31/01/2008	09:40	5.69	25/02/2008	16:32	5.72	07/03/2008	12:50	5.43
SBHF02A CP	SPIE	17.00		01/02/2008	14:40	7.61	25/02/2008	17:13	7.57	07/03/2008	12:30	9.00
SBHF03 RC	SPIE	18.00		31/01/2008	10:35	6.97	26/02/2008	08:55	6.77	07/03/2008	12:15	7.22
SBHH01 RC	SPIE	25.00		31/01/2008	11:15	3.45	26/02/2008	09:39	3.42	07/03/2008	11:28	3.65
SBHH02 RC	SPIE	14.90		31/01/2008	11:10	3.42	26/02/2008	09:20	3.88	07/03/2008	11:35	3.64
SBHH05 RC	SPIE	21.50		31/01/2008	11:30	2.22	26/02/2008	10:01	2.13	07/03/2008	11:05	3.10
SBHH06 CP	SP	12.30		30/01/2008	15:30	3.75	21/02/2008	08:00	3.76	07/03/2008	11:10	3.87
SBHH07A RC	SPIE	24.85		30/01/2008	14:50	1.70	26/02/2008	10:40	1.34	07/03/2008	11:00	1.07
SBHJ01 CP	SP	7.50		01/02/2008	12:20	1.34	21/02/2008	11:45	5.98	06/03/2008	12:28	1.82
SBHJ03 CP	SP	5.20		01/02/2008	08:00	0.54	27/02/2008	16:15	0.70	07/03/2008	10:45	0.68
SBHJ04	SP	13.10		01/02/2008	11:55	6.61	22/02/2008	13:55	6.67	06/03/2008	11:46	6.75
SBHJ05	SP	11.50		01/02/2008	11:10	8.91	22/02/2008	09:00	9.07	06/03/2008	11:23	9.16
SBHJ06 CP	SP	4.10		01/02/2008	11:45	1.31	21/02/2008	15:30	1.32	06/03/2008	10:50	1.33
SBHJ07 CP	SP	10.40		01/02/2008	11:43	1.35	21/02/2008	14:40	1.40	06/03/2008	12:05	1.56
SBHJ08A CP	SP	7.40		01/02/2008	11:35	3.49	21/02/2008	13:05	2.31	06/03/2008	10:57	2.67
SBHJ09 CP	SP	2.20		01/02/2008	11:30	0.65	21/02/2008	12:25	0.85	06/03/2008	11:00	0.90
SBHJ10 CP	SP	10.00		01/02/2008	10:40	2.30	21/02/2008	13:45	2.24	06/03/2008	10:40	2.16
SBHK01 CP	SP	6.80		01/02/2008	10:55	0.70	25/02/2008	10:30	1.00	06/03/2008	14:24	1.06
SBHK02 CP	SP	11.20		01/02/2008	10:50	1.34	25/02/2008	11:20	1.33	06/03/2008	14:18	1.47
SBHK03 CP	SP	5.90		01/02/2008	10:45	0.87	25/02/2008	12:00	0.89	06/03/2008	14:15	1.00
SBHK04 CP	SP	12.20		01/02/2008	10:25	1.45	25/02/2008	12:30	1.60	06/03/2008	12:30	1.60
SBHL02 RC	SPIE	15.20		01/02/2008	10:35	2.27	25/02/2008	12:49	2.31	06/03/2008	14:00	2.42
SBHL03 RC	SPIE	15.00		31/01/2008	16:20	0.61	26/02/2008	11:15	0.51	07/03/2008	10:25	0.66
SBHM01 RC	SPIE	21.00		01/01/1900	08:20	-0.26	26/02/2008	11:30	-0.26	07/03/2008	10:17	0.05
SBHM02 RC	SPIE	20.00		01/02/2008	08:25	0.19	26/02/2008	11:41	0.49	07/03/2008	10:14	0.68
SBHN01A RC	SPIE	14.90		01/02/2008	15:20	8.49	27/02/2008	17:15	12.23	07/03/2008	14:45	13.18
SBHN02 RC	SPIE	20.40		31/01/2008	15:55	3.67	26/02/2008	11:57	4.19	07/03/2008	10:05	4.84
SBHN03 RC	SPIE	15.00		31/01/2008	15:45	1.07	26/02/2008	12:03	1.73	07/03/2008	09:55	2.34
SBHN04 RC	SPIE	10.00		31/01/2008	15:30	9.99	26/02/2008	14:42	DRY	07/03/2008	09:45	DRY
Recorded by: S Davis			Checked by: I Swain			Approved by: I Swain						
Date: 30/01/08-07/03/08			Date: 16/04/2008			Date: 17/04/2008						
Form No. SI GWR			Revision No. 2.03			Issue Date 07/01/2008						

[illegible]

Project Name New M4 Preliminary Ground Investigation						Groundwater Readings For Installations			Fig no. 03			
Project No. F15056												
Engineer Ove Arup & Partners Ltd												
Client Transport Wales, Welsh Assembly Government												
NOTES: SPIE=Piezometer, SP=Standpipe For multiple installations, use different Installation IDs. For piezometers installation depth = tip depth. For standpipes = base of pipe												
COMMENTS SBHM01 RC installation extends 0.50m above ground level. - symbol indicates water level is above GL All groundwater levels are recorded from ground level												
Exploratory Hole ID	Installation Details			Recorded Water Level								
	Type	Depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
SBHC01 RC	SPIE	8.05		20/03/2008	16:30	2.57	04/04/2008	08:00	2.59	18/04/2008	07:40	2.66
SBHD03 CP	SPIE	10.00		20/03/2008	16:45	0.58	04/04/2008	08:13	0.53	18/04/2008	08:00	0.60
SBHD05 RC	SPIE	12.00		20/03/2008	16:00	1.08	04/04/2008	09:15	1.22	18/04/2008	08:30	1.32
SBHD06 RC	SP	15.00		20/03/2008	17:55	1.20	04/04/2008	09:30	1.33	18/04/2008	08:40	1.44
SBHD08 RC	SPIE	29.50		19/03/2008	18:30	1.28	04/04/2008	10:00	1.39	18/04/2008	08:52	1.52
SBHE02RD	SPIE	25.00		20/03/2008	16:20	2.23	04/04/2008	08:50	2.46	18/04/2008	09:00	2.54
SBHE04 RC	SPIE	17.20		20/03/2008	15:45	2.20	04/04/2008	09:00	1.80	18/04/2008	08:15	1.80
SBHF01 RC	SPIE	19.00		20/03/2008	15:30	5.50	04/04/2008	08:40	5.55	18/04/2008	13:58	5.58
SBHF02A CP	SPIE	17.00		20/03/2008	15:10	5.60	04/04/2008	10:28	5.70	18/04/2008	13:45	5.77
SBHF03 RC	SPIE	18.00		20/03/2008	14:55	7.20	04/04/2008	10:36	7.38	18/04/2008	13:40	7.42
SBHH01 RC	SPIE	25.00		20/03/2008	14:25	3.60	04/04/2008	15:00	3.60	18/04/2008	13:10	3.62
SBHH02 RC	SPIE	14.90		20/03/2008	14:30	4.27	04/04/2008	15:05	3.64	18/04/2008	13:13	3.70
SBHH05 RC	SPIE	21.50		20/03/2008	17:30	2.17	04/04/2008	15:15	2.78	18/04/2008	11:34	2.90
SBHH06 CP	SP	12.30		17/03/2008	15:20	3.88	04/04/2008	15:20	3.89	17/04/2008	14:15	3.90
SBHH07A RC	SPIE	24.85		20/03/2008	13:55	1.33	04/04/2008	15:28	1.92	18/04/2008	11:43	0.88
SBHJ01 CP	SP	7.50		19/03/2008	14:15	1.81	03/04/2008	16:05	1.90	17/04/2008	12:40	1.80
SBHJ03 CP	SP	5.20		19/03/2008	16:40	0.78	03/04/2008	18:25	0.82	17/04/2008	15:55	0.80
SBHJ04	SP	13.10		17/03/2008	13:35	6.64	03/04/2008	18:10	6.74	17/04/2008	13:08	6.80
SBHJ05	SP	11.50		18/03/2008	13:50	9.02	03/04/2008	17:39	9.10	17/04/2008	13:31	9.11
SBHJ06 CP	SP	4.10		17/03/2008	12:55	1.29	03/04/2008	17:43	1.33	17/04/2008	15:05	1.20
SBHJ07 CP	SP	10.40		17/03/2008	10:25	1.59	03/04/2008	17:47	1.50	17/04/2008	13:58	1.47
SBHJ08A CP	SP	7.40		18/03/2008	10:00	2.50	03/04/2008	17:55	2.50	17/04/2008	15:33	2.50
SBHJ09 CP	SP	2.20		18/03/2008	10:25	0.69	03/04/2008	17:58	0.82	17/04/2008	15:22	0.90
SBHJ10 CP	SP	10.00		17/03/2008	09:15	2.10	03/04/2008	17:50	2.00	17/04/2008	13:55	2.00
SBHK01 CP	SP	6.80		19/03/2008	10:45	0.88	03/04/2008	16:40	1.00	17/04/2008	11:40	0.94
SBHK02 CP	SP	11.20		19/03/2008	11:15	1.46	03/04/2008	16:45	1.48	17/04/2008	11:43	1.46
SBHK03 CP	SP	5.90		19/03/2008	11:45	1.04	03/04/2008	16:48	1.07	17/04/2008	11:46	0.98
SBHK04 CP	SP	12.20		19/03/2008	12:15	1.64	03/04/2008	16:52	1.67	17/04/2008	12:05	1.60
SBHL02 RC	SPIE	15.20		19/03/2008	12:50	2.44	03/04/2008	17:00	2.45	17/04/2008	12:00	2.45
SBHL03 RC	SPIE	15.00		20/03/2008	13:25	0.76	08/04/2008	15:40	0.64	18/04/2008	09:50	0.62
SBHM01 RC	SPIE	21.00		20/03/2008	13:05	-0.21	08/04/2008	15:48	-0.45	18/04/2008	11:55	0.01
SBHM02 RC	SPIE	20.00		20/03/2008	13:10	0.61	08/04/2008	15:52	0.61	18/04/2008	11:50	0.61
SBHN01A RC	SPIE	14.90		20/03/2008	12:55	12.14	08/04/2008	16:05	12.58	18/04/2008	12:48	13.27
SBHN02 RC	SPIE	20.40		20/03/2008	12:45	4.26	08/04/2008	16:12	2.64	18/04/2008	12:45	4.85
SBHN03 RC	SPIE	15.00		20/03/2008	12:30	1.60	08/04/2008	16:17	2.07	18/04/2008	12:35	2.37
SBHN04 RC	SPIE	10.00		20/03/2008	12:10	DRY	08/04/2008	16:28	DRY	18/04/2008	10:55	DRY
Recorded by: S Davis			Checked by: I Swain			Approved by: I Swain						
Date: 17/03/08-17/04/08			Date: 21/04/2008			Date: 21/04/2008						
Form No. SI GWR			Revision No. 2.03			Issue Date 07/01/2008						

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Appendix 3

Tabulated Soil Laboratory Data

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment

Report Annex D

CL-39 The Elms Road Old

Quarry and Lime Kiln

M4CaN-DJV-EGT-ZG_GEN-RP-EN-0024-P02

Contents

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1 Introduction

1.1 Background

- 1.1.1** This report relates to an area of land potentially affected by contamination (CL39) known as 'The Elms Road Old Quarry and Lime Kiln', herein referred to as the 'Site'.
- 1.1.2** The Site is located between chainage 22,500 and 22,600 (shown in Figure 1), associated with a small area of land historically used as a former quarry and limekiln.

1.2 Reporting Context

- 1.2.1** The Site has been assessed as part of ground investigations and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the 'Scheme') and informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the chapter on Geology and Soils
- 1.2.2** In 2014, a Preliminary Sources Study Report (2014 PSSR) was prepared as an initial land contamination appraisal (Ove Arup & Partners, 2014) as part of Design Manual for Roads and Bridges (DMRB) Stage 2 Assessments for a number of potential route options. This identified a number of individual areas that may have been affected by contamination as a result of historical activities at the Site. In addition, this report draws upon the 2015 Supplementary Ground Investigation report on behalf of the Welsh Government (Geotechnical Engineering, 2015). This report relates to the area defined on the Site Plan in Figure 1.
- 1.2.3** The overarching rationale and approach for the assessment of areas of land along the proposed new section of motorway with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

- 1.3.1** The key objectives of this report are as follows:
- Undertake a risk assessment of the Site and determine whether potential risks to human health or controlled waters could exist based upon the Scheme.
 - Identify the need for further assessment and investigation in order to refine potential land contamination risks and inform the need for remediation/mitigation.
 - To provide information to support the Ground Investigation Report (GIR) and Geotechnical Design Report (GDR) required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

1.4.1 The remainder of this report is structured as follows:

- Section 2: Site Location and Description – This section summarises the Site description.
- Section 3: The Scheme – This section details the new section of motorway alignment and associated features at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and land photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and relevant environmental information presented in the 2014 PSSR.
- Section 6: Scope of Ground Investigations Work – This section describes any previous and supplementary ground investigation data available for the Site.
- Section 7: Ground Conditions – This section describes the main findings of the intrusive Site investigation including the ground conditions encountered and visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contaminant linkages and presents the human health and controlled waters assessments.
- Section 9: Refined Conceptual Site Model – This section presents the Conceptual Site Model (CSM) for the Site and identifies potential contaminant linkages, based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations – This section provides conclusions concerning the likelihood of land contamination associated with the Site affecting the Scheme and requirements for remediation/mitigation.
- Section 11: References – This section summarises the key documents referred to in this report.
- Section 12: Glossary – This section provides a summary of the terms used in this report.

2 Site Location and Description

- 2.1.1** The Site is located some 25 m north of the existing M4 motorway near Magor, with centre point at National Grid Reference (NGR) ST 436 880. The Site comprises a small area of a former quarry and limekiln. The location and layout of the Site is presented in Figure 1.
- 2.1.2** The Site is currently used for agricultural purposes and forms part of a field used for grazing. The Site is oval in shape and covers an area of some 450 m². A public footpath crosses the Site. Agricultural buildings (no residential occupation has been noted) are located some 50 m to the north.
- 2.1.3** The review of aerial photography and a walkover survey undertaken in January 2014 indicated that the Site comprises a partially backfilled quarry with the top section of the quarried face still visible and marking the potential extent of the Site. The backfill materials appear to comprise quarry spoil with an abundance of angular cobbles. The surface of the backfill slopes towards the centre of the Site that forms a depression. Mature trees are present along the perimeter of the quarried area. Two arched entrances cut into the rock remain and mark shallow (3 m) cuts into the rock, possibly part of the old limekiln, in the north of the Site.

3 The Scheme

- 3.1.1** The Site is located at chainage 22,500 to 22,600. Refer to Figure 1 for the Site location in relation to the Scheme.
- 3.1.2** The Site is on the line of the proposed link road connecting the existing M4 motorway with the new section of motorway. The new link road runs in a part cut and part embankment. The cut (northern boundary) and embankment (southern boundary) are anticipated to be less than 1 m. The link road runs parallel to the existing M4 motorway. No works on the existing motorway are proposed for this part of the Scheme. A slip road supported by a bridge crosses the existing motorway some 110 m to the east of the Site.
- 3.1.3** The shallow cutting would result in the removal of some, if not all, of the infill materials. The preference is for the removed infill materials to be reused within the Scheme.

4 Site History

- 4.1.1** The 2014 PSSR historical searches were based on Ordnance Survey plans, literature reviews, information provided by British Steel, Natural Resources Wales (NRW) (formerly Environment Agency Wales), Newport City Council and aerial photographic interpretation.
- 4.1.2** This is supplemented with the review of historical maps obtained in 2015 from Welsh Government. Relevant extracts are presented in Appendix 3.
- 4.1.3** A summary of the Site's history is presented in Table 1 below.

Table 1: Site History

Date	Use	Source of Information
1843-1893	The Site is shown to be occupied by an old quarry with old limekiln shown in the northern part of the Site.	1:10,560 Historical Mapping
1882-1921	No significant changes.	OS maps
1891-1912	No significant changes.	1:10,560 Historical Mapping
1904-1939	No significant changes.	1:10,560 Historical Mapping
1964-1965	No significant changes.	1:10,560 Historical Mapping
1969-1971	The limekiln is no longer shown.	1:10,560 Historical Mapping
1969	Part of a field; Site area overgrown with trees (as at present).	Aerial Photography
1981	Bare ground or a structure identifiable in the area previously identified as a limekiln.	Aerial Photography (infra red)
1985	Bare ground identified in the fields surrounding the Site, beyond the Site boundary. Considered to be due to agricultural activity.	Aerial Photography
1985-1996	The quarry is no longer shown.	1:10,000 Historical Mapping
1991	Bare ground no longer identified.	Aerial Photography
2006	The Site is occupied by woodland.	Aerial Photography
2009-2010	No significant changes.	Aerial Photography
2013-2014	No significant changes.	Aerial Photography

Notes: Potential sources of contamination are underlined. Those within the temporary and permanent land take are shown in **bold**.

- 4.1.4** The sources of information presented above supplement those used in the 2014 PSSR. Relevant extracts of the photographs are presented in Appendix 3.
- 4.1.5** The review of historical plans indicates the Site to be an old quarry and a limekiln. A Site walkover survey undertaken in 2014 indicated the Site to have been partially backfilled.
- 4.1.6** Historically the Site is located in proximity to areas which may have been bombed during World War II which is discussed in the Explosive Ordnance Threat

Assessment Report (Bactec, 2014). This categorises the site as low risk with respect to unexploded ordnance.

5 Environmental Setting

5.1 Geology

- 5.1.1** The British Geological Survey (BGS) records indicate the Site to be directly underlain by solid geology of the Mercia Mudstone Group (sandstone).
- 5.1.2** The Black Rock Limestones of the Dolostone subgroup lies uncomfortably at depth and is shown to outcrop further north of the Site.
- 5.1.3** No superficial deposits are indicated to be present. This is consistent with the observations of the residual rock face remaining following quarrying.

5.2 Hydrology

- 5.2.1** No surface water features are located within the Site boundary. A drain associated with the existing M4 drainage is located approximately 50 m south. The nearest watercourse is St Brides Brook located approximately 1,100 m to the west of the Site. St Brides Brook connects with Mill Reen further south.

5.3 Hydrogeology

- 5.3.1** Natural Resources Wales (NRW) records indicate the Mercia Mudstone to be a Secondary A Aquifer whilst the Black Rock Limestone has been classed as a Principal Aquifer.
- 5.3.2** The Site does not lie within a groundwater source protection zone. However it lies within a groundwater vulnerability zone classified as a major aquifer with intermediate leaching potential.

5.4 Environmental Information

- 5.4.1** NRW records do not identify any pollution incidents, sewage discharge or abstraction licences, or any waste management facilities in the vicinity of the Site.
- 5.4.2** No further environmental information relevant to this Site has been identified.

6 Scope of Investigations

6.1 General

- 6.1.1** No previous ground investigation information has been identified for this Site. However a number of exploratory holes were advanced within 100 m of the Site. These have been considered in order to support an understanding of ground conditions beneath the Site and inform the groundwater quality and gas regime.

6.2 Scope of Works

- 6.2.1** The various off site intrusive ground investigations undertaken in the near vicinity of the Site are summarised in Table 2.

Table 2: Site Investigation Summary (Off Site)

Date	Contractor	Boreholes	Trial Pits	Location from Site	Sampling
1997	Norwest Holst	BHP5	-	Approximately 50 m north	None
2015	Geotechnical Engineering	BH560	TP532	Approximately 35 m south-west and 75 m south-east, respectively	None

- 6.2.2** The well construction details of the above off site boreholes are summarised in Table 3.

Table 3: Summary of Off Site Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (mbGL)	Base of Slotted Well Casing / Gravel Pack (mbGL)	Targeted Geology
BHP5	Unknown	8.05	4.5	7.5	Black Rock Limestone
BH560	50 mm	7	1	7	Marginal Facies of the Mercia Mudstone Group

6.3 Surface Water Quality Sampling

- 6.3.1** Surface water quality monitoring was not undertaken during the previous ground investigations of the Site.

6.4 Field Testing

- 6.4.1** No field testing has been undertaken on Site.

6.5 Groundwater and Land Gas Monitoring

- 6.5.1** A summary of the groundwater sampling, groundwater and ground gas monitoring undertaken at the selected off site boreholes are shown in Table 4.

Table 4: Summary of Monitoring Rounds (Off Site)

Location Ref.	Number of rounds (Date of Sampling)	Monitoring Details	Notes
BHP5	6 no.	Groundwater – levels	-
BH560 (50 mm)	3 no. 29 th April 2015, 7 th May 2015, 13 th May 2015	Groundwater – level ground gas	-

6.6 Laboratory Chemical Testing

6.6.1 No laboratory analysis is available for soil, groundwater, leachate or surface water samples within the Site from the previous ground investigations. No groundwater analytical data is available for the selected off site exploratory holes.

6.7 Gap Analysis of Available Data

6.7.1 There is no investigation data available for the Site from the previous ground investigations and therefore no quantitative risk assessment has been undertaken.

7 Ground Conditions

7.1 Geology

7.1.1 The geological logs for all available exploratory holes excavated in the vicinity of the Site are provided in Appendix 1. Borehole BH560 is located approximately 35 m to the south west of the Site, TP532 approximately 75 m south-east and BHP5 approximately 50 m to the north. The observed geological sequence is consistent with that described in the 2014 PSSR report and summarised in the following sections. Information from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) has also been used.

Superficial Deposits

7.1.2 Unconsolidated superficial deposits were encountered within both boreholes to depths of between 0.6 and 2 mbGL. It comprises a reddish brown slightly sandy gravelly clay with frequent plant fragments. This material represents local Head Deposits. However, given Site observations, Head Deposits on the Site are likely to be thin.

Solid Geology

7.1.3 Within BH560 the bedrock encountered was sandstone, representing the Marginal Facies of the Mercia Mudstone Group to 7 mbGL (19 mAOD).

7.1.4 Within borehole BHP5, the Mercia Mudstone was also encountered, although comprising predominantly conglomerate to 4.8 mbGL (22.07 mAOD) overlying dolomite to 5.9 mbGL (21 mAOD). Beneath the dolomite, grey limestone was encountered to the base of the borehole at 18.85 mAOD. Whilst the borehole records indicate the formation as of the Mercia Mudstone Group, it is considered this may represent the Black Rock Limestone.

Geological Sequence Summary

7.1.5 The anticipated general geological sequence beneath the Site, based on the nearby off site ground investigation records, is summarised in Table 5 below.

Table 5: Summary of Geological Sequence (Based On Off Site Investigation)

Unit	Description	Thickness Range (m)	Basal Depth (mbGL)
Infill Made Ground (within the quarry pit)	Unknown	unproven	unproven
Head Deposits (outside the quarry pit)	Slightly sandy gravelly clay	0.6* – 2*	0.6* – 2*
Marginal Facies of the Mercia Mudstone Group	Sandstone bedrock	> 5*	> 7*
Black Rock Limestone	Limestone bedrock	unproven	unproven

Note: * inferred from off site exploratory holes.

7.1.6 The conceptual site model included within the 2014 PSSR report has been revised in light of the 2015 information and is presented within Figure 2.

7.2 Visual and Olfactory Evidence of Contamination

7.2.1 No visual or olfactory evidence of contamination was identified within the site. No intrusive records are available.

7.3 Gas Monitoring

7.3.1 The gas monitoring data available from previous monitoring is summarised on the field data sheets provided in Appendix 2. The maximum gas concentrations (minimum for oxygen) are presented in Table 6.

Table 6: Summary of Gas Monitoring Data (Off Site)

Location ID	Flow (l/hr)	VOCs (ppm)	CH ₄ (%/vol)	Peak LEL (%)	CO ₂ (%/vol)	O ₂ (%/vol)	CO (ppm)	H ₂ S (ppm)
	Max.	Max.	Max.	Max.	Max.	Min.	Max.	Max.
BH560 50 mm	0	2.9	0.1	1	8.1	9.6	2	0

7.4 Groundwater

Groundwater Encountered During Investigation

7.4.1 No records are available from the previous ground investigations.

Groundwater Levels During Monitoring Rounds

7.4.2 Groundwater levels recorded from the selected off site boreholes are provided in Table 7.

Table 7: Summary of Groundwater Level During Monitoring Rounds (Off Site)

Location	Installation	Depths of Response Zone (mbGL) and Geological Formation	No. Measurements	Min Depth (mbGL)	Max Depth (mbGL)	Comments
BHP5	No data	4.5 - 7.5 (Black Rock Limestone)	6	Dry	6.22	-
BH560	50 mm	1 - 7 (MFMMG)	3	Dry	Dry	BH560 was dry on all monitoring occasions

Groundwater Summary

7.4.3 Groundwater is indicated from the off site BHP5 to be within the solid strata at a resting level at about 6 mbGL.

8 Contamination Assessment

8.1.1 The following sections provide details of the assessment of land contamination at the Site.

8.1.2 The conceptual site model presented within the 2014 PSSR has been reviewed based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and the Scheme. The main alteration to the 2014 PSSR model are summarised as follows:

- Revision of the anticipated geological sequence beneath the Site.
- Removal of St Brides Brook as a potential receptor.
- Inclusion of a ditch to the south between the Site and the motorway as a receptor.
- Inclusion of motorway end users as a receptor.
- Inclusion of a ground gas source within the quarry infill.
- Update of the source-pathway-receptor linkages taking into account of the above and more detailed assessments.

Potential Sources

8.1.3 The material used for the backfilling of the pit is a potential source of contamination and ground gas. Observations made during the 2014 walkover survey indicated infill materials exposed at the surface to comprise quarry spoil with a resultant low potential for contamination and ground gas generation.

8.1.4 Some infill is anticipated to be removed as part of the proposed cutting of the new slip road. Beneath the proposed embankment, the Made Ground may be left in place.

8.1.5 Perched water within the backfill material may be present at the base of the quarry.

Potential Receptors

8.1.6 Receptors during the construction and operational stages of the Scheme have been considered:

Construction

- Construction workers during Site development works.
- General Public (existing M4 user) / Site neighbours (users of the agricultural buildings located some 50 m to the north-east) adjacent to construction works.
- Groundwater (Secondary Aquifer/Principal Aquifer) during earthworks operation and soils improvement/treatment works.

Operational

- Maintenance workers.
- General public end users.

- Groundwater (Secondary Aquifer/Principal Aquifer).

Potential Pathways

8.1.7 Pathways during the construction and operational stages of the Scheme have been considered:

- Dermal contact, ingestion, inhalation pathways possible during construction works.
- Inhalation pathways possible during operation works.
- Leaching of contaminants from the fill materials to the Principal Aquifer during excavation or soil treatment.

8.2 Risk Evaluation

8.2.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the other data described herein, the following risk evaluation has been reconsidered and included the following:

- The quarry backfill is indicated to potentially comprise quarry soil materials although this is based on visual evidence at the surface and remained unconfirmed.
- Full depth of infill unknown.
- The Site topography is indicated to be at approximately 25 mAOD and groundwater within the bedrock around 20 mAOD therefore there is potential for the infill materials to extend below the underlying aquifer.
- The Scheme is likely to require part removal of infill materials, part capping (from the embankment construction).
- Hardstanding cover is likely to limit infiltration thus reducing leaching.
- Raised ground gas (carbon dioxide) with depleted oxygen levels has been identified in the off site borehole (BH560) some 35 m south-west. Source of off site abnormal gas has not been established.
- The nearest surface water is the St Brides Brook which is discounted as a viable receptor given its distance to the Site (1.1 km).
- Motorway users will be within an open environment with no proposed structures or other confined spaces.

8.3 Human Health Risk Assessment

8.3.1 No chemical soils data is available for the Site from the previous ground investigations.

8.4 Controlled Waters Screening Assessment

8.4.1 No groundwater quality or soil leachate data is available on site or in the near vicinity from the previous ground investigations.

8.5 Ground Gas Risk Assessment

8.5.1 No monitoring wells were installed on site during the previous investigations and therefore no gas monitoring data is available. Off site gas monitoring is available for borehole BH560 some 35 m south-west of the Site. The monitoring well is installed within the Black Rock Limestone which is found below the Mercia Mudstone at the Site. The following initial comments may be made:

- No monitoring was undertaken during low barometric pressure (less than 1000 mb), with the lowest conditions being 1011 mb. As such worst case atmospheric conditions for potential ground gas generation may have not been monitored.
- Gas flow was recorded absent during all rounds.
- Methane has been recorded of up to 0.1 % on the first round and absent for the subsequent two rounds. The concentrations are at or below the initial screening criteria of 1 %. The Lower Explosion Limit of up to 1 % is noted for the first round reducing and nil for the following two. Given the lack of correlation between methane concentration per volume and per LEL, it is considered these marginal readings to be caused by equipment inaccuracy rather than representative of the presence of actual methane gas.
- Carbon dioxide is identified to be generally between 4 and 8.1 % across the monitoring data. The concentrations are generally at or above the screening criteria of 5 %.
- Trace of Volatile Organic Compounds of up to 2.9 ppm has been recorded.
- Hydrogen sulphide was not detected throughout the monitoring.
- Carbon monoxide was identified with a maximum concentration of 2 ppm which is lower than the Work Place Exposure Limit of 30 ppm.
- Oxygen has been recorded to be at ambient or depleted concentrations of between 9.6 and 20.6 %.

8.5.2 The available data identifies raised carbon dioxide and depleted oxygen conditions and these may be related to the presence of limestone bedrock rather than gas migration from any materials used to backfill the quarry at the Site.

8.5.3 Further assessment of the gas regime at the Site will be required to confirm associated risks.

9 Refined Conceptual Site Model

- 9.1.1** The incorporation of data from the 2015 supplementary Ground Investigation has enabled the CSM presented in the 2014 PSSR to be updated. All relevant contaminant (source-pathway-receptor) linkages have been considered within the refined CSM. The assessment is based on the proposed Scheme during construction and operational phases.
- 9.1.2** A CSM representing general ground conditions, overall Scheme layout and relevant source-pathway-receptors (each of which having a specific alpha-numerical symbol attached) is presented in Figure 2 and is described in Table 8.

Table 8: Conceptual Site Model

Contamination Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
Potentially contaminated Made Ground	Construction					
	Construction workers (Bc)	Direct dermal (1)	Likely	Moderate	Moderate	Construction workers will possibly be exposed to Made Ground materials during Site construction works; however exposure duration will be short term only. Prior to construction, a specific risk assessment will be required in line with CDM and health and safety guidance. This will enable safe methodology and appropriate levels of PPE to be put in place. As such all risks will be duly considered and suitably mitigated to protect construction workers. No data available for the Site. Current contamination status is not foreseen to represent abnormal constraints to construction workers health and safety over and above those typical of a brownfield site.
		Ingestion (3)	Likely	Moderate	Moderate	Absence of ground gas data from Made Ground formation. Additional monitoring data may be considered.
		Inhalation of soil dust (2)	Likely	Moderate	Moderate	Dust suppression measures are recommended during construction works. Made Ground subject to ground improvement to improve its bearing capacity. This may increase vertical pathways from any potential ground gas

Contamination Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
		Inhalation of ground gas or vapours (2)	Likely	Moderate	Moderate	and mobilise potential contamination to groundwater or surface waters. No chemical analysis has been undertaken at the Site however exposed materials at surface indicate possible backfill with quarry spoil. Construction to be within open space. Any earthworks within confined space would require specified risk assessment, control measures and PPE. Off site abnormal gas regime identified some 35 m south-west. Additional investigation required to confirm the potential presence of any Made Ground and associated risks.
	Off site users during construction works (C)	Dermal contact with soil dust (1)	Low	Low	Low	During construction there is the possibility of short term exposure only. Dust suppression measures are recommended during construction works. Off-site receptors are at least 50 m from proposed earthworks. Off site abnormal gas regime identified some 35m south west. Significant flux of gas not anticipated. Additional investigation and soil testing required to confirm the characteristic of the Made Ground and associated risks.
		Ingestion of soil dust (3)	Low	Low	Low	
		Inhalation of soil dust (2)	Low	Low	Low	
		Inhalation of ground gas or vapour (3)	Low	Low	Low	

Contamination Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Groundwater aquifer (Da)	Mobilisation of contaminants due to excavation and/or ground improvement works (4)	Likely	Moderate	Moderate	It is considered that the base of the quarry may extend below the water table. Excavation works or ground improvement may cause mobilisation of contaminants within the backfill materials and migration into the underlying aquifer. No data available. A foundations works risk assessment is required to confirm the absence of risk to controlled waters. Additional investigation required to confirm the presence of Made Ground and associated risks.
	Operation					
Potentially contaminated Made Ground	Maintenance workers (Bm)	Inhalation of ground gas (2)	Unlikely	Moderate	Low	Made Ground to be fully encapsulated (subject to passing reuse criteria) or removed therefore the exposure to contamination will be limited to ground gas inhalation. Exposure duration will be short term only. Site specific risk assessment will be required in line with health and safety guidance. This will enable safe methodology and appropriate levels of PPE to be put in place. As such all risks will be duly considered and suitably mitigated. Infill not anticipated to pose gassing potential. However abnormal gas regime identified on an adjacent off site borehole. Additional investigation required to confirm the presence of Made Ground and associated risks.

Contamination Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	Future motorway users (A) and off-site users (C)	Inhalation of ground gas (2)	Unlikely	Moderate	Low	<p>Made Ground to be removed or encapsulated entirely by the proposed cutting and embankment (subject to passing reuse criteria) removing direct pathways.</p> <p>New pathways for ground gas to be created with possible ground improvement works. Presence of pavement provides a barrier to migration gases.</p> <p>Receptors within open space.</p> <p>Off site receptors are some 50 m from proposed earthworks.</p> <p>Infill not anticipated to pose gassing potential. However abnormal gas regime identified on an adjacent off site borehole.</p> <p>Additional investigation required to confirm the presence of Made Ground and associated risks.</p>
Potentially contaminated Made Ground	Groundwater aquifer (Da)	Leaching of potential contaminants and downward migration (4)	Likely	Moderate	Moderate	<p>Ground improvement may provide pathways for migration of potential contaminant from the infill, if remaining post construction.</p> <p>Hardstanding will reduce infiltration and thus reduce leaching potential.</p> <p>No data available.</p> <p>A foundations works risk assessment is required to confirm the absence of risk to controlled waters.</p> <p>Additional investigation required to confirm the presence of Made Ground and associated risks.</p>

10 Conclusions and Recommendations

10.1 Conclusions

- 10.1.1** No ground investigations have been undertaken at the Site during the previous ground investigations, however, based on the desk study information gross contamination is not anticipated. The preliminary risk assessment has identified that low risks to human health and low to moderate risks to controlled waters could exist.
- 10.1.2** Normal construction control measures will be required to facilitate the construction and ongoing operation of the scheme.
- 10.1.3** During the construction phase, specific mitigation measures will be required to prevent inhalation pathways of dust to the general public off site and construction workers. A suitable water management strategy will also be required to prevent impact to surface waters from run-offs.
- 10.1.4** Materials from excavations are considered likely to be suitable for reuse subject to compliance with reuse criteria under a Materials Management Plan.
- 10.1.5** Abnormal ground gas regime has been identified in an adjacent off site borehole, although this may simply be associated limestone bands within the bedrock rather than associated with any historical activities undertaken at the Site.

10.2 Recommendations

- 10.2.1** In order to confirm the low to moderate risks associated with the Site in relation to both construction and operational phases, it is recommended that intrusive investigation including testing of soils, soil leachate and possible gas and groundwater is undertaken.
- 10.2.2** Upon review and assessment of the recommended ground investigation information, any contamination identified that could cause an unacceptable risk to the identified receptors will require appropriate remedial mitigation measures. These measures would be identified within a remediation strategy for the Scheme. A remediation strategy for the Scheme should be developed that for the Site includes the following:
- Addressing potential human health and controlled waters risk identified by the proposed additional ground investigation.
 - Risk assessment of possible ground improvement creating pathways enabling contaminants migration.
 - Dealing with unexpected contamination.
 - Verification sampling to confirm suitability of soils for reuse.
 - Control measures (over and above good practice construction management) to prevent risks to construction workers and the general public during construction.
 - Verification of material used as topsoil.

10.2.3 The remediation strategy should include a remediation options appraisal, remediation implementation plan and remediation verification plan.

10.2.4 The remediation strategy should be supported by a Scheme wide Materials Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

11 References

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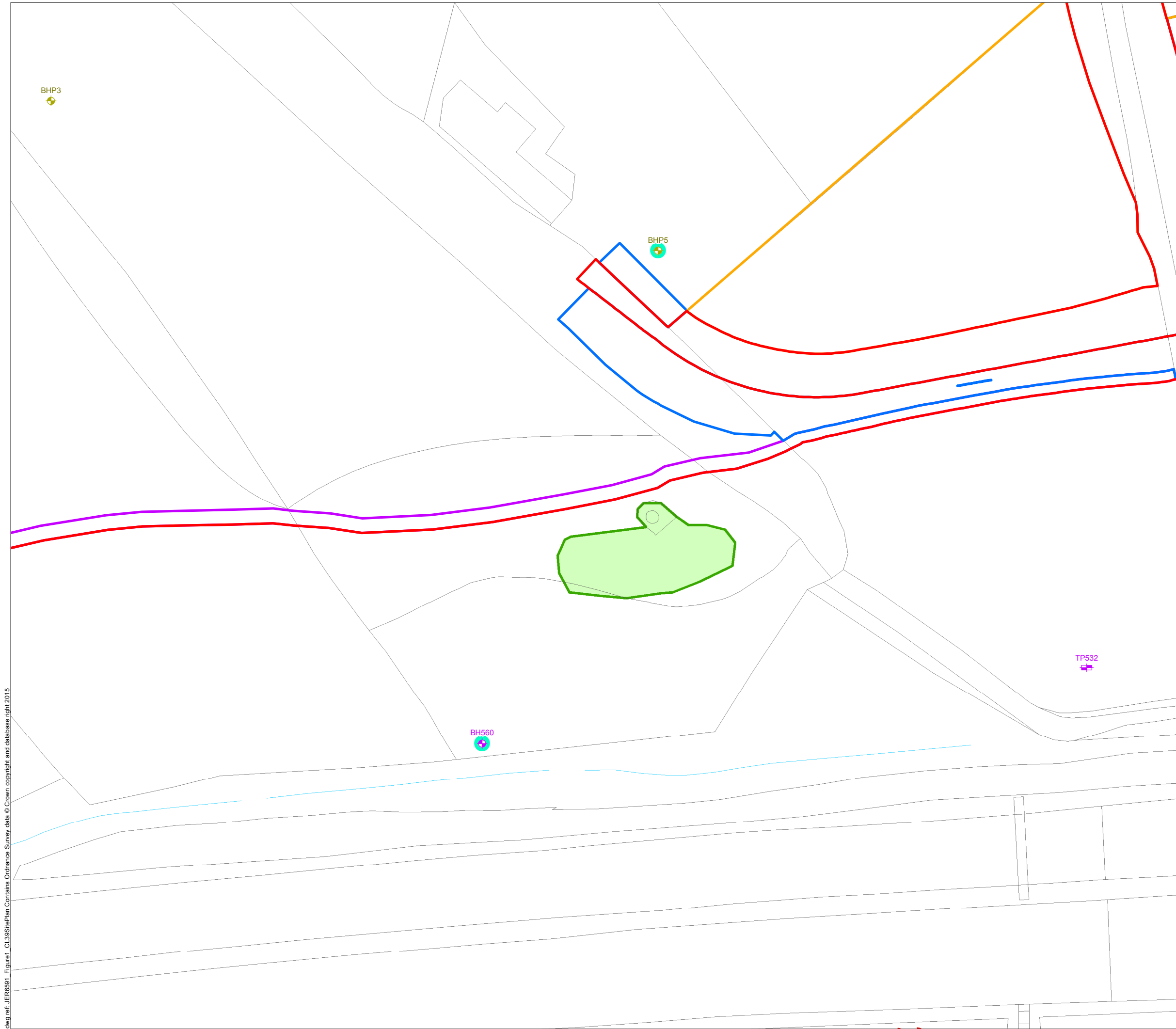
12 Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection
mAOD	Metres Above Ordnance Datum

mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O ₂	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures

dwg ref: JER6591_Figure1_CL39SitePlan Contains Ordnance Survey data © Crown copyright and database right 2015



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Potential Area of Land Contamination based on 2014 PSSR

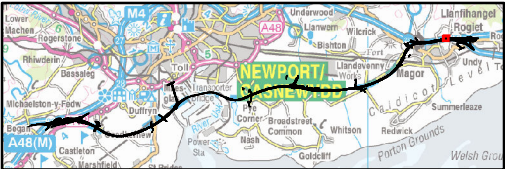
Investigation Locations

2015 (Geotechnical Engineering)

- Borehole
- Trial Pit

1997 (Norwest Holst)

- Borehole
- Monitoring Well Installation



Llywodraeth Cymru
Welsh Government

Appendix 11.1 Annex D CL-39

Site Plan for CL-39

Figure: 1	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

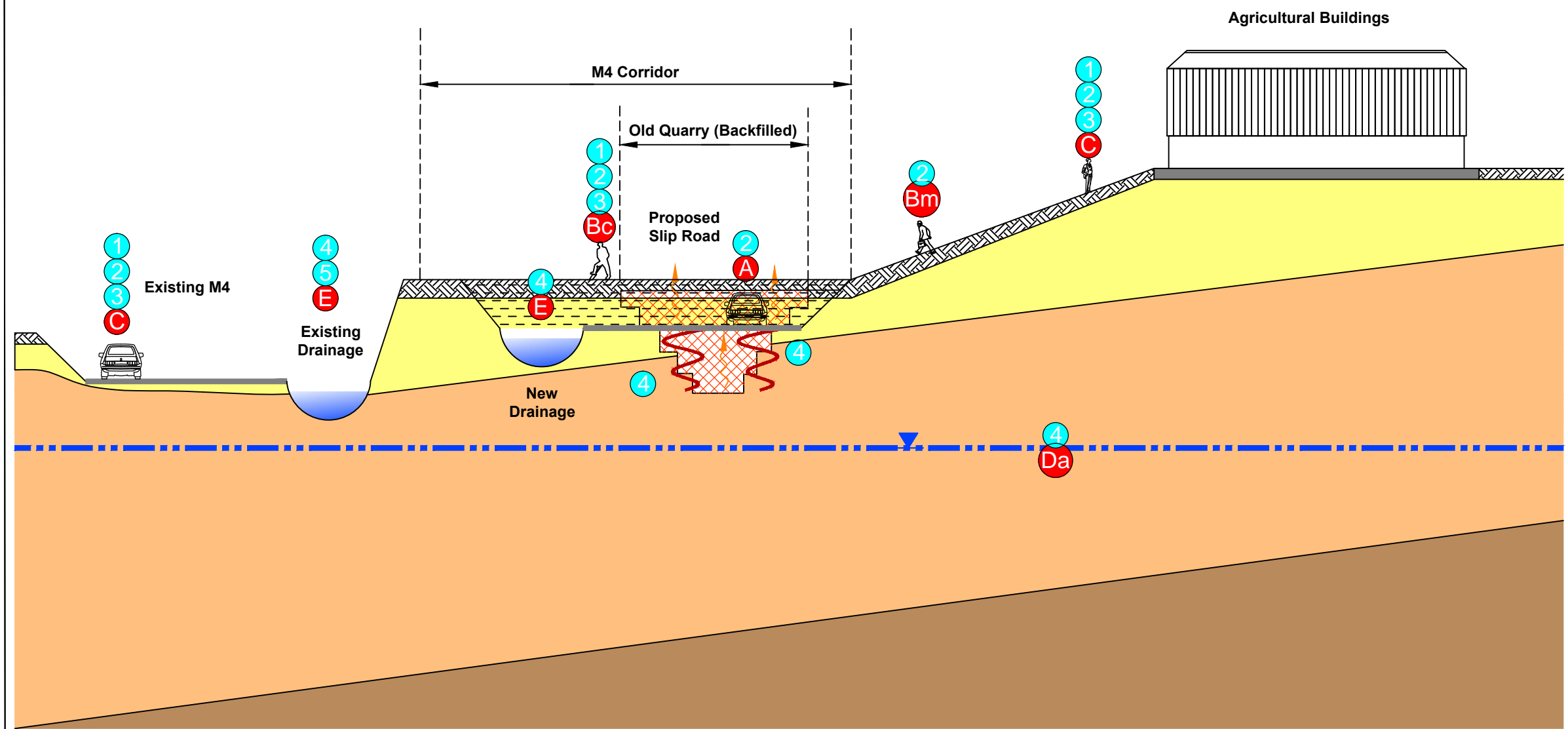
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dwg ref: JER6591_Figure1_CL39SitePlan

CL-39 Old Quarry and Limekiln



Legend

- Topsoil
- Infill
- Head Deposits (Predominantly Cohesive)
- Mercia Mudstone Group Marginal Facies - MM GMF
- Black Rock Limestone Formation - BR
- Proposed Cutting
- Groundwater (BR)
- Possible Ground Improvement to Improve Bearing Capacity of Made Ground
- Hardstanding
- Gas Migration Pathway

Potential Receptors

- Humans On-Site (M4 User)
- Humans On-Site (Construction)
- Humans On-Site (Maintenance)
- Humans Off-Site (Site Neighbours)
- Groundwater (Aquifer)
- Groundwater (Perched)
- Surface Water

Potential Pathways

- Dermal Contact
- Inhalation
- Ingestion
- Leaching / Migration
- Surface Run Off

Potential Sources of Contamination

Possible contamination present on site associated with :

On-Site

- Potential for contamination to be present on site associated with infill material

NOTE
Drawing refined from PSSR Drawing Reference
M4-OA-17-00DR-Z-XX-0126 (April 2014)



Appendix 11.1 Annex D CL-39

Conceptual Site Model for CL-39

Figure: 2	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Not to Scale

Ground conditions based
on available information

dwg ref: JER6591_Figure2_CL39ConceptualSiteModel

Appendices

Appendix 1

Exploratory Records



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHP5

Header

Contract No.	F10895	Method	Rotary Coring	Coordinates	343650.1 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		188062.0 N
		Driller	E.D	Ground Level	26.90m AOD
Client	Welsh Office	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	27/10/1997
Consultant	Ove Arup and Partners	Core bit	Saw Tooth	Date Completed	27/10/1997

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
27/10/1997	1800	8.05	2.10	Dry		0.00 2.00	2.00 8.05	air & mist	100%	NR 92

CASING				WATER STRIKES							
Hole diameter	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
120	8.05	140	2.10								

GENERAL NOTES				SPT DETAILS		
1. Borehole open holed from ground level to 2.00m. 2. Piezometer installed, tip at 7.00m.				Depth	Type	Incremental blow count/penetration in mm
				1.00	S	N=17 (1,2,4,4,4,5)

NB All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form ROTARY HEADER

Version 2.00

Revised 25/06/1997



Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG - ROTARY

Borehole No.

BHP5

Sheet 1 of 1

Contract No.	F10895	Method	Rotary Coring	Coordinates	343650.1 E
Project	M4 Relief Road Magor to Castleton Stage 2	Drilling Rig	Knebel 77		188062.0 N
Client	Welsh Office	Driller	E.D	Ground Level	26.90m AOD
Consultant	Ove Arup and Partners	Logged by	T.R/C.D	Orientation	Vertical
		Core barrel	P	Date Started	27/10/1997
		Core bit	Saw Tooth	Date Completed	27/10/1997

Description of Strata	Legend	Depth Below G.L.	O.D. Level	Coring and Sampling	TCR	SCR	RQD	FI	SPT N & depth	Installation
Sandy CLAY (drillers description). (Head Deposits) ---at 1.00m firm to stiff									S17 1.00 1.45	
Yellowish brown thinly to medium sub-horizontally bedded moderately weathered dolomitic CONGLOMERATE strong with medium spaced sub-horizontal discontinuities planar rough slightly open to tight and many gravel size vugs. (Marginal Facies of Mercia Mudstone Group) ---from 2.00 to 2.45m highly weathered very weak completely fractured ---from 3.00 to 4.10m with some fine to medium gravel size vugs ---from 4.10m very thinly to thinly sub-horizontally bedded moderately to highly weathered		2.00	24.90	2.00 3.60	100	66	58	NI 4		
				3.60 4.10	100	30	28	3		
		4.83	22.07	4.10 5.60	90	65	37	4 5		
Yellowish brown thinly sub-horizontally bedded slightly weathered DOLOMITE strong and with occasional fine gravel size vugs closely to medium spaced thick laminations to very thin beds of yellowish grey dolomitic limestone with closely spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group) ---from 4.83 to 5.10m yellowish green		5.90	21.00	5.60 7.20	97	94	80	2 3		
Grey medium to thickly sub-horizontally bedded fresh to slightly weathered LIMESTONE very strong with medium spaced sub-horizontal discontinuities planar rough tight. (Marginal Facies of Mercia Mudstone Group)				7.20 8.00	94	88	88	3		
Rotary drilling complete at 8.05 m.		8.05	18.85							

NB All depths in metres, all diameters in millimetres.

See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form NH ROTARY LOG

Version 1.00

Revised 16/09/96

BOREHOLE LOG



CLIENT WELSH GOVERNMENT

BH560

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 1

Start Date 16 February 2015 Easting 343614.1

Scale 1 : 50

End Date 17 February 2015 Northing 187961.2 Ground level 26.00mOD Depth 7.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	lf	instru -ment	description	depth (m)	reduced level (m)	legend
16/02/15 0930hrs	1B	0.00 - 0.30					/	Grass over reddish brown slightly sandy gravelly CLAY with frequent plant fragments (up to 5mm). Gravel is subangular fine and medium sandstone. (TOP)	0.30	25.70	
	2D*	0.00 - 0.30		Vo 0.9							
	3B	0.30 - 0.60									
	4D*	0.30 - 0.60		Vo 2.8					0.60	25.40	
	5C	0.60 - 1.00		Nil	100 0 0	NI					
16/02/15 1620hrs 0.30m	6C	1.00 - 1.12		Nil	100 0 0			Reddish brown mottled grey slightly sandy gravelly CLAY with medium subangular sandstone cobble content and frequent plant fragments (up to 5mm). Gravel is subangular fine and medium sandstone. (HDD)			
		1.00 - 2.00	1.00	C*273							
17/02/15 0925hrs 1.80m	7C	2.00 - 2.20	1.00		100 0 0			Strong and very strong thinly bedded light and dark grey medium SANDSTONE. Fractures are subhorizontal to 20° and 70° to subvertical very closely spaced planar rough stained orangish brown locally mottled black. Recovered non intact. (MMMF)			
	8C	2.20 - 2.50	1.00		100 0 0						
	9C	2.50 - 3.00	1.00		100 0 0				3.00	23.00	
	10C	3.00 - 4.00	1.60		100 63 63	NI 200 500					
	11C	4.00 - 5.50	1.60		93 58 53						
17/02/15 1530hrs 1.05m	12C	5.50 - 7.00	1.60		100 60 57			5.00 - 5.50m: Recovered non intact.			
								Borehole completed at 7.00m.	7.00	19.00	
									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-0.60m. Waterflush rotary core drilled (116mm) 0.60-7.00m.

CASING: 140mm diam to 1.60m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 7.00m, granular response zone 7.00-1.00m, bentonite seal 1.00-0.20m, concrete and raised cover 0.20-0.00m.

REMARKS: Driller notes reduced flush returns 2.00-7.00m: 50-60% returned.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m) casing (m) rose to (m) time to rise (min) remarks

Groundwater not encountered prior to use of water flush.

CONTRACT
30238CHECKED
EC

TRIAL PIT LOG



TP532

CLIENT WELSH GOVERNMENT

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 1

Start Date 16 February 2015 Easting 343737.8

Scale 1 : 50

End Date 16 February 2015 Northing 187976.7 Ground level 21.10mOD

Depth 1.70 m

water record	sample/test			description	depth (m)	level (m)	legend
	no/type	result	depth (m)				
Dry	1B	Vo 0.1	0.00- 0.20	Grass over soft locally firm dark brown sandy CLAY with frequent rootlets (<1mm diam.).	0.20	20.90	
	2D*		0.00- 0.20				
	3D*		0.20- 0.40				
	4B	Vo 1.3	0.50- 0.70				
	5D*		0.70- 0.90	Firm dark brown slightly gravelly slightly sandy CLAY. Gravel is angular and subangular fine to coarse sandstone. 0.60 - 0.90m: Light brown.	0.90	20.20	
	6D*		0.90- 1.10				
	7B	Vo 1.0	1.20- 1.40	Light yellowish brown very silty very gravelly fine to coarse SAND, Gravel is angular and subangular fine to coarse sandstone. Rare sandstone cobbles.			
	8D*		1.50- 1.70		1.70	19.40	
Trial pit completed at 1.70m.							

Notes

Trial pit excavated by JCB 3CX mechanical excavator.
Groundwater not encountered.
Trial pit sides remained stable and vertical.
Trial pit dimensions 0.70x2.50x1.70m.
On completion, the trial pit was backfilled with materials arising.
Trial pit terminated 1.70m due to the strength of the ground.

Sketch of Foundation - Not to scale. All dimensions in metres.



CONTRACT

30238

CHECKED

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

Contract No.	F15056	Method	Rotary Coring	Coordinates	341960.35 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187619.31 N
		Driller	BB	Ground Level	18.90m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	17/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	18/12/2007

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
17/12/2007	1730	8.00	3.50	5.10	End of Shift	0.00	2.00	Air/Mist	100%	0.00*
18/01/2008	0730	8.00	3.50	1.80	Start of Shift	2.00	9.30	Air/Mist	100%	92.0
18/01/2008	1730	9.30	3.50	NR	End of Hole					

CASING				WATER STRIKES							
Hole diam.	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
121	9.30	121	3.50	17/12/2007	1100	3.45	3.20	20	Seepage	NR	NR

GENERAL NOTES				SPT DETAILS				
1.Rotary Openhole from GL to 2.00m. 2.Rotary Coring from 2.00m to 9.30m. 3.Rotary coring terminated at 9.30m, refer to SBHN01A for redrill. 4.Borehole grouted upon completion. 5.0.00* indicates openhole drilling.				Depth	Type	Incremental blow count/penetration	Casing	Water Depth
				1.20	S	N=8 (1,1,2,2,2,2)	0.00	DRY
				2.00	S	N=24 (2,2,4,6,6,8)	0.00	DRY
				3.00	S	N=26 (2,3,3,6,7,10)	2.00	DRY
				4.00	S	N=24 (14,7,5,4,5,10)	3.50	1.20
				5.00	S	N=93 (3,22,18,25,25,25)	3.50	1.70
				6.00	S	90/160mm (25,74,16)	3.50	1.90
				7.00	S	100/30mm (25,100)	3.50	1.50

NOTES: All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form	ARIAL ROTARY HEADER
Version	3.06
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341960.35 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187619.31 N
		Driller	BB	Ground Level	18.90m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PWF	Date Started	17/12/2007
		Core bit	TC	Date Completed	18/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TOR	SCR	ROD	IF	SPT N & depth	Installation
Turf over firm brown TOPSOIL. (Driller's description)		0.20	18.70							
MADE GROUND: Very dense brick/boulder fill. (Driller's description)		0.80	18.10							
Stiff red brown mottled yellowish brown silty CLAY. (Driller's description)		2.00	16.90						1.20 S8 1.65	
Zone of core loss. Stiff red brown mottled yellowish brown silty CLAY. (Driller's description)		3.00	15.90	2.00 3.00	NA	NA			2.00 S24 2.45	
Very weak to extremely weak greyish brown MUDSTONE. (Mercia Mudstone Group (Marginal Facies)) ---from 3.00m to 3.34m recovered as non intact core (gravelly clay. Gravel is angular fine to medium sized fragments) ---from 3.38m to 4.00m assumed zone of core loss		4.00	14.20	3.00 4.00	38	4	0	NI NI NI	3.00 S26 3.45	
---from 4.00m to 4.28m recovered as non intact core (gravelly clay. Gravel is angular fine to medium sized fragments)		4.70	14.20	4.00 4.70	87	43	24		4.00 S24 4.45	
---from 4.57m to 4.61m recovered as non intact core (gravelly clay. Gravel is angular fine to medium sized fragments) ---from 4.61m to 4.70m assumed zone of core loss		5.00	13.90	4.70 5.00	NA	NA		NI NI 310	5.00 S93 5.45	
Zone of core loss		6.00	12.90	5.00 6.00	55	35	35		6.00 S90/160mm 6.21	
Very weak to extremely weak greyish brown MUDSTONE (Mercia Mudstone Group (Marginal Facies)) ---from 5.00m to 5.19m recovered as non intact core (gravelly clay. Gravel is angular fine to medium sized fragments) ---from 5.35m to 5.55m occasional thick laminations of weak reddish brown mudstone. Highly weathered ---from 5.55m to 6.00m assumed zone of core loss		7.00	7.05	6.00 7.00	75	75	44		7.00 S100/30mm 7.05	
Very weak to weak thinly laminated reddish brown MUDSTONE. Discontinuities 1) 0 -10 deg extremely closely to medium spaced undulating rough. (Mercia Mudstone Group (Marginal Facies)) ---from 7.00m to 7.53m with many extremely closely spaced laminations of weak grey mudstone and weak grey siltstone. Highly weathered ---from 7.53m to 7.89m some very closely spaced laminations of weak to medium strong light grey siltstone. Moderately weathered ---from 7.68m to 7.72m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments of mudstone) ---from 7.89m to 8.19m many very closely spaced thick laminations of weak to medium strong light greyish brown siltstone. Moderately weathered ---at 8.21m 1 No thick discontinuous lamination of very weak grey mudstone. Highly weathered ---at 8.24m 1 No thick discontinuous lamination of very		9.30	9.60	7.00 8.00	96	92	47	NI 110 220		
				8.00 9.30	90	67	55			

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341960.35 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187619.31 N
		Driller	BB	Ground Level	18.90m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	17/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	18/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	ROD	IF	SPT N & depth	Installation
<p>Remaining Detail : 8.24m - 8.24m : weak grey mudstone. Highly weathered;;; 8.26m - 8.27m : ---from 8.26m to 8.27m recovered as non intact core (angular fine to medium gravel sized fragments);;; 8.30m - 8.36m : ---from 8.30m to 8.36m many extremely closely spaced thin laminations of weak grey siltstone. Moderately weathered;;; 8.36m - 8.50m : ---from 8.36m to 8.50m 1 No medium bed of medium strong light grey siltstone. Moderately weathered;;; 8.50m - 8.69m : ---from 8.50m to 8.69m recovered as non intact core (angular fine to coarse gravel sized fragments of mudstone);;; 9.15m - 9.17m : ---from 9.15m to 9.17m 1 No thin bed of weak to medium strong grey siltstone. Moderately weathered;;; 9.17m - 9.30m : ---from 9.17m to 9.30m assumed zone of core loss</p> <p>Rotary drilling complete at 9.30 m.</p>										

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341999.49 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187625.32 N
		Driller	BB	Ground Level	20.48m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	18/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	09/01/2008

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
18/12/2007	1730	2.00	1.80	DRY	End of Shift	0.00	2.00	Air/Mist	100%	0.00*
19/12/2007	0730	2.00	1.80	DRY	Start of Shift	2.00	5.60	Air/Mist	0%	92.0
19/12/2007	1730	6.60	3.00	5.00	End of Shift	5.60	6.60	Air/Mist	10%	92.0
20/12/2007	0730	6.60	3.00	6.50	Start of Shift	6.60	9.40	Air/Mist	100%	92.0
20/12/2007	1730	9.40	6.50	8.00	End of Shift	9.40	15.00	Air/Mist	100%	92.0
08/01/2008	0730	9.40	6.50	5.50	Start of Shift					
08/01/2008	1730	10.60	6.50	5.50	End of Shift					
09/01/2008	0730	10.60	6.50	5.00	Start of Shift					
09/01/2008	1730	15.00	6.50	NR	End of Hole					







CASING				WATER STRIKES							
Hole diam.	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
121	15.00	121	6.50								

GENERAL NOTES				SPT DETAILS				
1.Rotary Openhole drilling from GL to 2.00m. 2.Rotary Coring 2.00m to 15.00m. 3.19mm piezometer installed, tip at 14.90m, with response zone 14.40m to 15.00m. 5.0.00* indicates openhole drilling.				Depth	Type	Incremental blow count/penetration	Casing	Water Depth
				1.00	S	N=8 (2,2,2,2,2)	0.00	DRY
				2.00	S	N=13 (3,2,3,4,4,2)	0.00	DRY
				3.20	S	21/300mm - Abandoned	1.80	DRY
				4.20	S	N=22 (17,8,7,7,4,4)	3.00	4.00
				5.20	S	33/300mm - Abandoned	3.00	5.00
				6.60	S	N=72 (4,8,14,19,24,15)	3.00	6.50
				7.60	S	N=67 (6,10,11,19,8,29)	6.50	6.50
				8.60	S	100/130mm (25,50,50)	6.50	8.00
				9.40	S	100/160mm (9,14,30,50,20)	6.30	5.50

NOTES: All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form	ARIAL ROTARY HEADER
Version	3.06
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341999.49 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187625.32 N
		Driller	BB	Ground Level	20.48m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PWF	Date Started	18/12/2007
		Core bit	TC	Date Completed	09/01/2008

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling		TOR	SOB	ROD	FE	SPT N & depth		Installation	
Brown CLAY with frequent limestone, sandstone cobbles. (Driller's description)		0.60	19.88							1.00 S8	1.45		
Dark brown reddish brown silty CLAY with frequent limestone/sandstone cobbles. (drillers description)													
Boulder of strong to very strong yellowish brown fine to medium grained sandstone ---from 2.00m to 2.12m recovered as non intact core (subangular gravel sized fragments) ---from 2.12m to 2.50m assumed zone of core loss ---from 2.89m to 3.20m assumed zone of core loss ---from 3.24m to 3.25m reddish brown ---from 3.28m to 3.29m grey ---from 3.34m to 3.70m assumed zone of core loss		2.00	18.48		2.00	2.50	24	NA	NA	2.00 S13	2.45		
					2.50	3.20	56	NA	NA	NA			
					3.20	3.70	24	NA	NA		3.20 S21/300mm - Attached	3.62	
Zone of core loss. reddish brown silty clay with frequent sandstone gravelly bands. (Driller's description)		3.70	16.78		3.70	4.20		NA	NA	NA	4.20 S22	4.65	
					4.20	4.70		NA	NA				
Firm to stiff brown slightly gravelly CLAY with occasional rootlets. Gravel is angular fine to coarse of sandstone ---from 5.16m to 5.20m assumed zone of core loss		4.70	15.78		4.70	5.20	92	0	0				
					5.20	5.40	100	0	0	NA	5.20 S33/300mm - Attached	5.63	
					5.40	5.60	75	2	0	NI			
										50			
Weak to very weak reddish brown locally greyish brown MUDSTONE. (Mercia Mudstone Group(Marginal Facies)) ---from 5.60m to 5.80m thin bed of strong red limestone. ---from 5.81m to 7.05m recovered as non intact core (firm to stiff slightly gravelly clay. Gravel sized fragments are angular fine to medium) ---from 6.60m becomes greyish brown ---from 7.07m to 7.12m recovered as non intact core (firm to stiff slightly gravelly clay. Gravel sized fragments are angular fine to medium) ---from 7.12m to 7.60m assumed zone of core loss ---from 7.60m to 7.86m recovered as non intact core (firm to stiff slightly gravelly clay. Gravel sized fragments angular fine to medium) ---from 7.90m to 8.60m assumed zone of core loss ---from 8.60m to 8.76m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments) ---from 9.04m to 9.18m recovered as non intact core (slightly gravelly clay. Gravel sized fragments are angular fine) ---from 9.18m to 9.40m assumed zone of core loss		5.60	14.88		5.60	6.60	100	0	0				
					6.60	7.60	52	0	0	NI NI 20	6.60 S72	7.05	
					7.60	8.60	30	7	0		7.60 S67	8.05	
					8.60	9.40	73	23	15	NI 30 125	8.60 S100/130mm	8.81	
		9.40	11.08							NI	9.40	9.71	
		9.63	10.85							NI			

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form ARIAL ROTARY LOG
Version 3.09
Revised 17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	341999.49 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187625.32 N
		Driller	BB	Ground Level	20.48m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PWF	Date Started	18/12/2007
		Core bit	TC	Date Completed	09/01/2008

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling		TCR	SCR	ROD	FL	SPT N & depth	Installation
9.40m - 9.63m : Extremely weak grey MUDSTONE. Destructured. Recovered as non intact core (soft to firm grey slightly gravelly clay. Gravel is angular to subangular fine to medium). (Mercia Mudstone Group (Marginal Facies))				9.40	10.60	78	56	43			
9.63m - 12.50m : Weak to moderately strong interlaminated grey MUDSTONE and reddish brown fine grained SANDSTONE. Moderately weathered and destructured. Discontinuities 1) 0 -15 deg very closely to closely spaced undulating rough locally clay infilled. (Mercia Mudstone Group (Marginal Facies)) Detail 9.78m - 9.80m : ---from 9.78m to 9.80m recovered as non intact core (grey gravelly clay. Gravel sized fragments are angular fine to coarse of mudstone) Detail 10.40m - 10.60m : ---from 10.40m to 10.60m assumed zone of core loss Detail 10.60m - 10.78m : ---from 10.60m to 10.78m 1 No thin bed of extremely weak grey mudstone. Destructured. Recovered as gravelly clay. Gravel sized fragments are angular fine to coarse Detail 11.70m - 11.75m : ---from 11.70m to 11.75m recovered as non intact core (angular coarse gravel sized fragments) Detail 11.75m - 11.80m : ---from 11.75m to 11.80m assumed zone of core loss Detail 12.30m - 12.32m : ---from 12.30m to 12.32m 1 No very thin bed of reddish brown sandstone. Moderately weathered Detail 12.38m - 12.43m : ---from 12.38m to 12.43m 1 No very thin bed of reddish brown sandstone. Moderately weathered ---from 10.40m to 10.60m assumed zone of core loss ---from 10.60m to 10.78m 1 No thin bed of extremely weak grey mudstone. Destructured. Recovered as gravelly clay. Gravel sized fragments are angular fine to coarse ---from 11.70m to 11.75m recovered as non intact core (angular coarse gravel sized fragments) ---from 11.75m to 11.80m assumed zone of core loss ---from 12.30m to 12.32m 1 No very thin bed of reddish brown sandstone. Moderately weathered ---from 12.38m to 12.43m 1 No very thin bed of reddish brown sandstone. Moderately weathered Medium strong thin laminated reddish brown locally light reddish brown fine grained SANDSTONE. Locally with laminations of reddish brown and grey mudstone. (Mercia Mudstone Group (Marginal Facies)) ---from 12.73m to 12.88m 1 No thin bed of extremely weak reddish brown mudstone. Destructured. Recovered as slightly gravelly clay. Gravel sized fragments are angular fine to coarse ---from 13.29m to 13.30m 1 No 15mm void partially infilled with fine gravel sized quartz crystals ---from 13.31m to 13.40m assumed zone of core loss Interlaminated weak reddish brown SILTSTONE and very weak grey MUDSTONE. Discontinuities 1) 0-15 deg extremely closely to closely spaced undulating rough locally clay infilled. (Mercia Mudstone Group (Marginal Facies)) ---from 13.75m to 13.77m recovered as non intact core (gravelly clay. Gravel sized fragments are angular fine				10.60	11.80	96	73	62	NI 120 240		
		12.50	7.98	11.80	13.40	94	88	60		NI 220 410	
		13.40	7.08							NI 90 180	
		14.10	6.38	13.40	15.00	90	89	63		140 300 510	
		15.00	5.48								

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007


Contract No.	F15056	Method	Rotary Coring	Coordinates	341999.49 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187625.32 N
		Driller	BB	Ground Level	20.48m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PWF	Date Started	18/12/2007
		Core bit	TC	Date Completed	09/01/2008

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	ROD	IF	SPT N & depth	Installation
<p>13.40m - 14.10m : Remaining Detail : 13.75m - 13.77m : to coarse of mudstone);; 13.77m - 13.81m : ---from 13.77m to 13.81m 1 No discontinuity 90 deg undulating rough stained dark brown);; 13.78m - 13.81m : ---from 13.77m to 13.81m 1 No very thin bed of weak reddish brown fine grained sandstone. Moderately weathered</p> <p>14.10m - 15.00m : Strong to very strong reddish brown fine grained SANDSTONE. Moderately weathered. Discontinuities 1) 0 - 10 deg medium spaced undulating rough. 2) 0 - 10 deg very closely to closely spaced incipient discontinuities undulating infilled with quartz. (Mercia Mudstone Group (Marginal Facies));; 14.22m - 14.34m : ---from 14.22m to 14.34m 1 No stylolite 80 - 90 deg);; 14.82m - 15.00m : ---from 14.82m to 15.00m assumed zone of core loss</p> <p>Rotary drilling complete at 15.00 m.</p>										

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

Contract No.	F15056	Method	Hand Excavated	Coordinates	341975.28 E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	Hand Tools	Ground Level	187629.53 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Date Started	20.69m AOD
Consultant	Ove Arup & Partners Ltd			Date Completed	06/12/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sampling		Remarks
Brown clayey TOPSOIL.		0.30	20.39	ES1 D2 B3	0.30 0.30 0.30	
MADEGROUND: light brown slightly clayey slightly sandy slightly gravelly SILT with low cobble content. Gravel is angular to subrounded fine to coarse of limestone. Cobbles are subangular of limestone and brick. (Head Deposits)		1.20	19.49	ES4 D5 B6 ES4	1.00 1.00 1.00 1.00	
Trial pit complete at 1.20 m.						

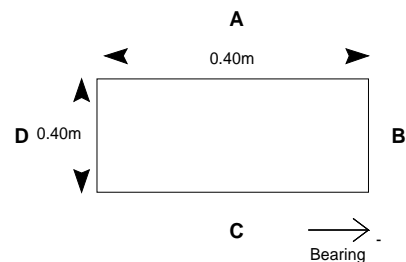
Stability All faces stable

Shoring None used

Groundwater None encountered during excavation

Remarks 1.Hand excavated trial pit complete at 1.20m.

Sketch Plan of Trial Pit



NOTES: All depths in metres, all soil strengths in kPa.
 See legend sheet for key to symbols and abbreviations.
 All bearings given relate to magnetic North

Form ARIAL TP LOG

Version 3.06

Revised 17/12/2007

Contract No.	F15056	Method	Hand Excavated	Coordinates	341991.56 E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	Hand Tools	Ground Level	187644.33 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Date Started	06/12/2007
Consultant	Ove Arup & Partners Ltd			Date Completed	06/12/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sampling		Remarks
Brown clayey TOPSOIL.		0.30	17.33	ES1 D2 B3	0.30 0.30 0.30	Unable to penetrate large limestone cobble/boulder
MADEGROUND: light brown silty slightly sandy slightly gravelly CLAY with low cobble content. Gravel is angular to subrounded fine to coarse of limestone and brick. Cobbles are subangular of limestone. (Head Deposits)		1.00	16.63	ES4 D5 B6	1.00 1.00 1.00	
Trial pit complete at 1.00 m.						

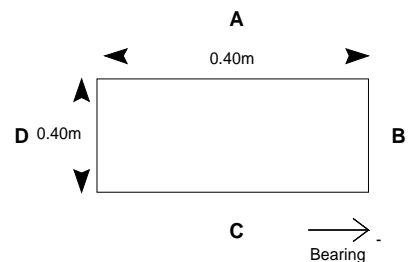
Stability All faces stable

Shoring None used

Groundwater None encountered during excavation

Remarks 1.Hand excavated trial pit terminated at 1.00m due to hard strata.

Sketch Plan of Trial Pit



NOTES: All depths in metres, all soil strengths in kPa.
 See legend sheet for key to symbols and abbreviations.
 All bearings given relate to magnetic North

Form ARIAL TP LOG

Version 3.06

Revised 17/12/2007

Appendix 2

Tabulated Gas Monitoring Data

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks	
BH560	29/04/15 13:30:00	1011	-0.56								0.0	13		0 litres purged, dry. Base depth 7.00m.	
BH560	29/04/15 13:31:00										0.0				
BH560	29/04/15 13:32:00										0.0				
BH560	29/04/15 13:33:00										0.0				
BH560	29/04/15 13:34:00										0.0				
BH560	29/04/15 13:35:00			0.2	0.1	20.6	1.0	0	0	2.9					
BH560	29/04/15 13:36:00			0.9	0.0	20.1	0.0	0	1	2.4					
BH560	29/04/15 13:37:00			2.6	0.0	18.7	0.0	0	1	2.1					
BH560	29/04/15 13:38:00			4.0	0.1	17.5	0.0	0	1	2.1					
BH560	29/04/15 13:39:00			5.1	0.0	16.5	1.0	0	2	2.1					
BH560	29/04/15 13:40:00			6.1	0.0	15.6	0.0	0	2	1.9					
BH560	29/04/15 13:41:00			6.7	0.0	15.1	0.0	0	2	1.8					
BH560	29/04/15 13:42:00			6.8	0.1	15.0	0.0	0	2	1.7					
BH560	29/04/15 13:43:00			6.9	0.0	15.0	0.0	0	2	1.6					
BH560	29/04/15 13:44:00			6.9	0.1	15.0	1.0	0	2	1.5			Dry		
BH560	07/05/15 12:30:00	1011	0								0.0	15		0 litres purged, dry. Base depth 7.00m.	
BH560	07/05/15 12:31:00										0.0				
BH560	07/05/15 12:32:00										0.0				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.														CONTRACT 30238	CHECKED EC

GAS AND GROUNDWATER LEVELS

CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH560	07/05/15 12:33:00										0.0			
BH560	07/05/15 12:34:00										0.0			
BH560	07/05/15 12:35:00			2.1	0.0	16.5	0.0	0	0	1.0				
BH560	07/05/15 12:36:00			2.8	0.0	16.4	0.0	0	0	0.8				
BH560	07/05/15 12:37:00			2.3	0.0	17.0	0.0	0	0	0.7				
BH560	07/05/15 12:38:00			4.1	0.0	14.7	0.0	0	0	0.9				
BH560	07/05/15 12:39:00			3.2	0.0	15.9	0.0	0	0	0.8				
BH560	07/05/15 12:40:00			3.2	0.0	15.8	0.0	0	0	0.8				
BH560	07/05/15 12:41:00			2.7	0.0	16.3	0.0	0	0	0.7				
BH560	07/05/15 12:42:00			2.6	0.0	16.6	0.0	0	0	0.7				
BH560	07/05/15 12:43:00			3.0	0.0	16.0	0.0	0	0	0.8				
BH560	07/05/15 12:44:00			3.3	0.0	15.8	0.0	0	0	0.8			Dry	
BH560	13/05/15 11:00:00	1016	0								0.0	16		0 litres purged, dry. Base depth 7.00m.
BH560	13/05/15 11:01:00										0.0			
BH560	13/05/15 11:02:00										0.0			
BH560	13/05/15 11:03:00										0.0			
BH560	13/05/15 11:04:00										0.0			
BH560	13/05/15 11:05:00			8.0	0.0	9.6	0.0	0	1	2.8				
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

Geotechnical Engineering Limited

GAS AND GROUNDWATER LEVELS



CLIENT: WELSH GOVERNMENT

SITE: M4 CORRIDOR AROUND NEWPORT

Borehole /trial pit no.	date and time	barometric pressure (mb)	pressure differentiation (mm H ₂ O)	carbon dioxide (%)	methane (%)	oxygen (%)	LEL (%)	hydrogen sulphide (ppm)	carbon monoxide (ppm)	VOC (ppm)	gas flow (ltr/hr)	temperature (°C)	water level (m - bgl)	remarks
BH560	13/05/15 11:06:00			8.0	0.0	9.6	0.0	0	0	2.5				
BH560	13/05/15 11:07:00			8.1	0.0	9.6	0.0	0	0	2.3				
BH560	13/05/15 11:08:00			8.1	0.0	9.6	0.0	0	0	2.0				
BH560	13/05/15 11:09:00			8.1	0.0	9.6	0.0	0	0	1.7				
BH560	13/05/15 11:10:00			8.1	0.0	9.6	0.0	0	0	1.5				
BH560	13/05/15 11:11:00			8.1	0.0	9.7	0.0	0	0	1.3				
BH560	13/05/15 11:12:00			8.1	0.0	9.8	0.0	0	0	1.3				
BH560	13/05/15 11:13:00			8.0	0.0	10.0	0.0	0	0	1.3				
BH560	13/05/15 11:14:00			8.0	0.0	10.1	0.0	0	0	1.3			Dry	
remarks # denotes result exceeding capacity of gas monitoring equipment VOC - Photoionisation Detector Mini RAE 2000 measures VOC vapours with 10.6eV lamp calibrated against isobutylene.													CONTRACT 30238	CHECKED EC

Appendix 3

Relevant Extract of Additional Environmental Data



Plate 01: Extract of 1843-1893 map of the Site area showing the Old Quarry and Limekiln.



Plate 02: Extract of 1985 Aerial Photograph.

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: Oct 2015



Plate 03: Extract of 2014 high resolution aerial photograph showing the vegetated nature of the Site.

Welsh Government

M4 Corridor around Newport

Land Contamination Assessment
Report Annex D
CL-41 Severn Junction Tunnel
Yard

M4CaN-DJV-EGT-ZG_GEN-RP-EN-0025-P02

At Issue | March 2016

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Figure 1	Site Plan
Figure 2	Conceptual Site Model

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Appendix 1	Exploratory Records
Appendix 2	Soil Laboratory Data
Appendix 3	Surface Water Data
Appendix 4	Groundwater Level
Appendix 5	Relevant Extract of Additional Environmental Data

1 Introduction

1.1 Background

1.1.1 This report relates to the potentially contaminated land area CL-41 known as the 'Severn Junction Tunnel Yard' herein referred to as the 'Site'.

1.1.2 The Site is located between chainage 23,800 and 24,000 (see Figure 1), upon an area of former railway land.

1.2 Reporting Context

1.2.1 The Site has been assessed as part of ground investigations and monitoring associated with the wider works for the M4 Corridor around Newport (M4CaN) (hereafter referred to as the 'Scheme') and informs the baseline for the environmental impact assessment (EIA) for the Scheme. The EIA is reported in the M4CaN Environmental Statement (ES) of which this document is an appendix to the chapter on Geology and Soils.

1.2.2 In 2014, a Preliminary Sources Study Report (2014 PSSR) was prepared as an initial land contamination appraisal (Ove Arup and Partners, 2014) as part of Design Manual for Roads and Bridges (DMRB) Stage 2 Assessments for a number of potential route options. This identified a number of individual areas that may have been affected by contamination as a result of historical activities. In addition, this report draws upon the 2015 Supplementary Ground Investigation report (Geotechnical Engineering, 2015) on behalf of the Welsh Government.

1.2.3 The overarching rationale and approach for the assessment of areas of land along the new section of motorway with potential contamination is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES).

1.3 Objectives

1.3.1 The key objectives of this report are set out below:

- Undertake a risk assessment of the Site and determine whether potential risks to human health or controlled waters could exist based upon the Scheme.
- Identify the need for further assessment and investigation in order to refine potential land contamination risks and inform the need for remediation/mitigation.
- To provide information to support the Ground Investigation Report (GIR) and Geotechnical Design Report (GDR) required under DMRB HD22/08 (Highways Agency, 2008).

1.4 Report Structure

1.4.1 The remainder of this report is structured as follows:

- Section 2: Site Location and Description.
- Section 3: The Scheme – This section details the M4CaN alignment and associated features at the Site.
- Section 4: Site History – This section summarises the history of the Site based on historical maps and historical land photographs.
- Section 5: Environmental Setting – This section summarises the Site description, published geology, hydrology and hydrogeology and relevant environmental information presented in the 2014 PSSR.
- Section 6: Scope of Ground Investigations Work – This section describes previous and supplementary ground investigation data available at the Site.
- Section 7: Ground Conditions – This section describes the main findings of the intrusive site investigations including the ground conditions encountered and significant visual or olfactory evidence of contamination identified.
- Section 8: Contamination Assessment – This section describes the findings of the Tier 1 and Tier 2 contamination risk assessment based upon potential contamination sources, potential receptors and potential contaminant linkages and presents the human health and controlled waters assessments.
- Section 9: Refined Conceptual Site Model – This section presents the Conceptual Site Model (CSM) for the Site and identifies potential contaminant linkages based upon the findings of the data presented within Sections 2 to 7.
- Section 10: Conclusions and Recommendations – This section provides conclusions concerning the likelihood of land contamination associated with the Site affecting the Scheme and requirements for remediation/mitigation.

2 Site Location and Description

- 2.1.1** The Site is located at the eastern end of the Scheme, in the area of the Magor Interchange, centred at National Grid Reference (NGR) ST 451 876. It comprises an area of former railway land, the Severn Junction Tunnel Yard. The location and Site layout is provided on Figure 1.
- 2.1.2** The existing M4 transects the Site into eastern and western parts. The western part is bounded by a railway line to the south. The eastern part extends further to the south across the mainline railway lines. Agricultural land bounds the Severn Junction Tunnel Yard to the north. A row of residential properties is located to the north-eastern part.
- 2.1.3** The Scheme only crosses the central part of the Site in the area where the existing M4 embankment and railway bridge are located.
- 2.1.4** The Site is longitudinal in shape and covers an area of some 26.6 hectares (ha), out of which 7.5 ha falls within the Scheme.
- 2.1.5** A walkover survey undertaken in January 2014 indicated that the Site formed derelict land. Whilst access to the very central area of the Site was not possible, access was made to the western area and the eastern areas via publically accessible routes.
- 2.1.6** Evidence of former industrial activity was noted during the walkover of the western area with slag evident at the surface, fragments of railway trucks and building foundations, derelict buildings and an embankment running along the central part of the Site. During the visit remains of bonfires and littering was noted across the visible areas of the Site.

3 The Scheme

- 3.1.1** The Site is situated at approximate chainage 23,800 to 24,000 and Figure 1 shows the Site location in relation to the Scheme. Only the central part of the Site falls within the study area for the purpose of this report.
- 3.1.2** The Scheme within the Site area comprises widening of the embankment of the existing motorway that will form part of the permanent works.
- 3.1.3** Currently there are no proposals to alter the railway bridge.

4 Site History

- 4.1.1** The 2014 PSSR historical searches have been based on Ordnance Survey plans, literature reviews, information provided by British Steel, Natural Resources Wales (NRW) (formerly Environment Agency Wales), Newport City Council and aerial photographic interpretation.
- 4.1.2** This is supplemented by a review of historical maps obtained in 2015 from Welsh Government. Relevant extracts are presented in Appendix 5.
- 4.1.3** A summary of the Site's history is presented in Table 1 below.

Table 1: Site History

Date	Use	Source of Information
1843-1893	A railway line bounds the western part of the <u>Severn Junction Tunnel Yard</u> with fields and occasional woodland further north. Fields and a network of reens/drains surround the railway line which cuts through the eastern part of the yard.	1:10,560 Historical Mapping
1891-1912	Additional <u>railway lines/sidings</u> are shown in the eastern part of the yard.	1:10,560 Historical Mapping
1904-1939	Additional railway lines/sidings are shown in the eastern part of the yard. A <u>tank</u> is shown on the northern boundary of the eastern half.	1:10,560 Historical Mapping
1921 - 1938	Severn Tunnel Junction marshalling yard raised area.	Ordnance Survey (OS) map
1964-1965	Additional railway lines/sidings are shown in the eastern part of the yard.	1:10,560 Historical Mapping
1969	Railway sidings cover the entire yard including the central area.	Aerial Photography
1969-1971	No significant change.	1:10,560 Historical Mapping
1981	No significant change. Storage of railway carriages observed within the yard. Five buildings are observed within the northern boundary of the eastern area and a further building within the central eastern area. A track runs along the northern boundary of the western area.	Aerial Photography
1981-83	Railway sidings are no longer shown.	OS 1:250 Historical Mapping
1985	Railway sidings still visible.	Aerial Photography
1991	Railway sidings no longer identified within the yard. Western area appears to be roughly vegetated. Track remains along the northern boundary.	Aerial Photography (image only available for the western area)
1996	<u>M4 Severn Crossing</u> constructed within the Site.	Internet Research
1998	Majority of the Site area appears to be scrub vegetation. With several tracks, including a hardstanding track in the central eastern area. The footprint of the railway sidings is still visible. M4 now seen to cross the railway in the current position in the central area of the Site. Three buildings remain along the northern boundary of the eastern area of the Site (two demolished).	Aerial Photography

Date	Use	Source of Information
2006	The western area of the Site is vegetated with wooded areas. Tracks have been developed across the western area and there is evidence of possible <u>fly-tipping</u> .	Aerial Photography (image only available for the western area)
2009-2010	No significant changes.	Aerial Photography (image only available for the western area)
2013-2014	No significant change in the western area. Railway sidings, a storage shed and a track are identified alongside the railway line in the eastern area. Tracks and <u>disturbed ground</u> identified in the central area leading to an approximately 50 m x 15 m area of what appears to be plastic sheeting, approximately 20 m to the east of the proposed land take area. Storage of materials identified on the hardstanding track adjacent. Small scale earthworks identified 25 m beyond the northern boundary of the Site, approximately 450 m east of the proposed land take area.	Aerial Photography
2014	No significant change in the western area. Plastic sheeting no longer identified. Area of bare ground in the central area of the Site (200 m east of proposed land take area) has increased in size.	High Resolution Aerial Photography

*Notes: Potential sources of contamination are underlined.

- 4.1.4** The sources of information presented above supplement those used in the 2014 PSSR. In particular, the 2013/2014 aerial photograph has identified new potentially contaminative activities in the vicinity of the proposed land take area. Relevant extracts of the photographs are presented in Appendix 4.
- 4.1.5** The review of historical plans and published information on the history of the Severn Tunnel Junction Yard indicates that it has been a railway depot and sidings since the late 1880s until 1987, when it was closed.
- 4.1.6** In mid-1990, the Severn Crossing was constructed with the motorway crossing the Site.
- 4.1.7** Historically the Site was in the vicinity of areas that may have been bombed during World War II which is described in detail within the Explosive Ordnance Threat Assessment Report (Bactec, 2014). There is thus a risk from unexploded ordnance at the Site which is categorised as a low risk site (Bactec, 2014).

5 Environmental Setting

5.1 Geology

5.1.1 British Geological Survey (BGS) records indicate much of the Site is underlain by Tidal Flat Deposits. The deposits extend further and cover the eastern part of the Severn Junction Tunnel Yard. The northern end of the Site and eastern part of the yard are indicated to have no superficial deposits with pockets of River Terrace Deposits present in the vicinity.

5.1.2 Beneath the Site and the majority of the Severn Junction Tunnel Yard, the bedrock comprises the Mercia Mudstone Group together with Black Rock Limestone.

5.2 Hydrology

5.2.1 No surface water features are located within the Site boundary. Two land drainage ditches are located to the north of the central part of the Site stretching between the Site and Red Barn Farm.

5.2.2 A lake forms part of the Manor House farm land. It is located to the north of the eastern part of the Site (outside the study area).

5.2.3 A number of ponds and ditches are located directly to the south of the eastern Site area (to the north of the existing Toll facilities). From the OS plan it is unclear if these ditches connect to the wider network of reens of the Caldicot Levels Site of Special Scientific Interest (SSSI) located further to the south.

5.2.4 Vurlong Reen appears to commence south of the western Site area, across the railway line and connects to the reens of the Caldicot Levels.

5.3 Hydrogeology

5.3.1 NRW classifies the bedrock at the Site as a Secondary B Aquifer in the Mercia Mudstone (mudstone) in the central region, Secondary B Aquifer in the Mercia Mudstone (sandstone) in the east, and the Mercia Mudstone Marginal Facies (conglomerate) in the west and Black Rock Limestone at the western tip of Site as Principal Aquifers.

5.3.2 The River Terrace Deposits are classified as a Secondary A Aquifer and the Tidal Flat Deposits as Unproductive Strata.

5.3.3 The Site does not lie within a groundwater source protection zone, however parts of the Site lie within groundwater vulnerability zones. To the west an area of the

Site is classified as a minor aquifer with intermediate leaching potential and the western tip is classified as a major aquifer with intermediate leaching potential.

5.4 Environmental Information

5.4.1 NRW records do not identify any pollution incidents, sewage discharge or abstraction licences, or any waste management facilities on or in close proximity of the Site.

5.4.2 The Gwent Levels – Magor and Undy SSSI is located approximately 200 m to the south.

6 Scope of Investigations

6.1 General

6.1.1 Two ground investigations include works that have been undertaken within the Site. The information provided covers the existing M4 motorway and has been summarised below.

6.2 Scope of Works

6.2.1 The intrusive investigations that have been undertaken within the Site area are summarised in Table 2.

Table 2: Site Investigation Summary – On Site

Date	Contractor	Site Location	Boreholes	Window Sampler	Trial Pits	Sampling
2008	Norwest Holst	Central	SBHQ06RC	-	STPQ06	Soil
2015	Geotechnical Engineering	Central	BH567	-	-	Soil

6.2.2 To improve the understanding of ground conditions, the off site borehole, summarised in Table 3 has also been considered.

Table 3: Site Investigation Summary – Off Site

Date	Contractor	Off Site Location	Boreholes	Window Sampler	Trial Pits	Sampling
2015	Geotechnical Engineering	26 m south	BH568	-	-	Soil

6.2.3 The construction details of all boreholes installed on the Site are summarised in Table 4.

Table 4: Summary of Borehole Construction Details

Borehole ID	Diameter (mm)	Total Drilled Depth (m)	Top of Slotted Well Casing / Gravel Pack (mbGL)	Base of Slotted Well Casing / Gravel Pack (mbGL)	Targeted Geology
SBHQ06RC	19	8	7.1	8	Mercia Mudstone

6.3 Surface Water Quality Monitoring

6.3.1 Surface water quality monitoring was undertaken on two occasions at location R20 during spring and summer 2008 and on one occasion at location 20.1 during spring 2015. The locations are described in Table 5.

Table 5: Surface Water Monitoring Locations

Surface Water Location ID	Location Description	Comments
R20/IDB 24a	Located at Pratt Reen, approximately 100 m south of the Site.	Dry on four occasions.
20.1	Located at Pratt Reen, approximately 70 m south of the Site.	Low flow, large amounts of vegetation within the reen.

6.3.2 The historical surface water chemical results are presented in the Baseline Surface Water Quality Monitoring Report by Titan Environmental Surveys Limited (2008). This is supplemented by the 2015 monitoring programme undertaken as part of the Baseline Water Environment Report (Appendix 16.2 of the ES).

6.4 Field Testing

6.4.1 Monitoring of Volatile Organic Compounds (VOCs) was undertaken on two shallow soil samples from trial pit STPQ06 at 0.3 and 1.0 mbGL.

6.5 Groundwater Monitoring

6.5.1 A summary of the groundwater sampling, groundwater/monitoring and ground gas monitoring is shown in Table 6.

Table 6: Summary of Monitoring Rounds

Location Ref.	Number of Rounds (Date of Monitoring/Sampling)	Monitoring Details	Notes
SBHQ06RC	6no. (31 January 2008, 26 February 2008, 7 March 2008, 20 March 2008, 8 April 2008 and 18 April 2008)	Groundwater levels	-

6.6 Laboratory Chemical Testing

6.6.1 A summary of the contamination results from the previous Site investigations is shown in Table 7 and Table 8.

Table 7: Summary of Previous Investigation Sampling – Intrusive Exploratory Locations

Site Investigation Date	No. of Soil Samples	No. of Leachate Samples	No. of Water Samples	Suites of Testing
2008	1	0	0	Heavy metals, pH, cyanide, phenol, MTBE, BTEX, GRO, TPH, PAH
2015	0	0	0	-

Table 8: Summary of Previous Investigation Sampling – Surface Water

Site Investigation Date	No. of Soil Samples	No. of Leachate Samples	No. of Water Samples	Suites of Testing
2008	0	0	4	Nitrate, nitrite, phosphate, hardness, heavy metals, TPH, DO ¹ , BOD ² , ammoniacal nitrogen, suspended solids, chloride, TON, sulphate, calcium, magnesium
2015	0	0	1	Inorganics, PAH, TPH, BTEX

Notes: ¹ Dissolved Oxygen. ² Biochemical Oxygen Demand

Soil Analysis

6.6.2 The following sections summarise the laboratory analytical results for soil samples collected during the 2008 intrusive investigation phases. The available data has been tabulated and is presented in Appendix 2 and supporting laboratory certificates are available in the relevant original ground investigation reports (see Table 2).

6.6.3 The available soil data comprises one sample from the Made Ground from STPQ06.

6.6.4 The analytical soil data for the off site borehole BH568 have not been considered within the current report, given it lies outside the Site boundary. The analytical data has been considered within the overarching Land Contamination Assessment Report instead.

Soil Leaching Analysis

6.6.5 No soil leachate analysis was undertaken during the previous ground investigations.

Groundwater Analysis

6.6.6 No groundwater data is available for the borehole installed on site during the previous ground investigations.

Surface Water Analysis

6.6.7 The following sections summarise the laboratory analytical results for surface water samples collected during the various monitoring undertaken. The available data has been tabulated and is presented in Appendix 3 with supporting laboratory certificates available in the relevant original reports.

Table 9: Summary of Analytical Surface Water Data

Surface Water System	Number of Water Analysis per Analytical Suite (Number of Locations) – 2015 data / All GI data				
	Metals & Inorganics	Water Quality Parameters	Polycyclic Aromatic Hydrocarbons	Total Petroleum Hydrocarbon	BTEX
Pratt Reen North	1 (2) / 5 (2)	1 (2) / 5 (2)	1 (1) / 1 (1)	1 (2) / 5 (2)	1 (1) / 1 (1)

6.7 Gap Analysis of Available Data

6.7.1 The investigation data available for the Site is limited. In particular, the available information relates to two 2008 intrusive locations with only one sample of the Made Ground analysed.

7 Ground Conditions

7.1 Geology

7.1.1 The exploratory borehole logs for available locations excavated on or in close proximity to the Site are provided in Appendix 1. The observed geological sequence is consistent with that discussed in the 2014 PSSR report and is summarised below.

7.1.2 The conceptual site model within the 2014 PSSR report has been updated in light of the 2015 information and is included within Figure 2.

Made Ground

7.1.3 Made Ground was encountered in all exploratory locations with thicknesses ranging between 0.4 and 0.9 m as summarised in Table 10.

7.1.4 Made Ground is commonly present as a coarse material comprising gravel of concrete, brick, ash and clinker.

7.1.5 Borehole BH567, was located over the existing M4 embankment refused within tarmacadam at 0.4 bGL.

7.1.6 A nearby off site borehole (BH568, 2015) also sunk at the level of the existing highway, some 5 m south of the Site proved the embankment to include Made Ground, some 13.3 m (basal depth at 5.45 mAOD) in thickness overlying bedrock of the Mercia Mudstone. The Made Ground was identified to include predominantly limestone gravel and boulders with layers of clay. No extraneous material was recorded.

Superficial Deposits

7.1.7 Beneath the Made Ground generally soft brown becoming firm red brown sandy clay was encountered with thicknesses ranging from 3.6 m to 5.3 m (3.27 to >4.6 mAOD) .

7.1.8 Below this in SBHQ06RC, very dense sands were encountered (with no recovery) to 8 mbGL (1.27 mAOD).

7.1.9 These are identified as Head Deposits within the borehole records. Considering the published geological data, soil description, recorded strength and correlation with the off site 2015 borehole information; it is considered that the upper soft clay material (2.4 to 3 mbGL) represents the Tidal Flat Deposits. Beneath, both SBQ06RC and STPQ06 weathered Mercia Mudstone was encountered.

Solid Geology

- 7.1.10** As detailed above Mercia Mudstone is considered to have been encountered below 5.97 mAOD.
- 7.1.11** The nearby off site borehole BH568 identified the Mercia Mudstone below 5.45 mAOD and comprised a sequence of mudstone, limestone and sand.
- 7.1.12** Both on site and off site data on the depth of the rockhead correlate well.

Geological Sequence Summary

- 7.1.13** The general geological sequence identified during the Site investigation is summarised in Table 10.
- 7.1.14** On the basis of BH568 findings, it is noted that the existing embankment has been constructed directly over the rockhead with the Tidal Flat Deposits and weathered Mercia Mudstone removed.

Table 10: Summary of Geological Sequence

Unit	Description	Thickness Range (m)	Basal Depth (mAOD)
Made Ground	Gravel including ash, clinker, brick and concrete	>0.4 to 0.9	8.21 to 8.57
Superficial Deposits (Tidal Flat Deposit)	Soft - brown sandy clay	1.5 to 2.6	5.97 to 6.71
Mercia Mudstone Group - weathered	Firm to stiff reddish brown clay with sand bands	>2.1 to 4.7	3.3 to 5.45*
Mercia Mudstone Group - bedrock	Sequence of mudstone, limestone and sand (based on nearby off site borehole)	12.9*	- 7.45*
Mercia Mudstone Marginal Facies	Breccia (based on nearby off site borehole)	>0.3*	> - 7.75*

Note: *Based on off site borehole information

- 7.1.15** The conceptual site model included within the 2014 PSSR report has been revised in light of the 2015 information and is presented within Figure 2.

7.2 Visual and Olfactory Evidence of Contamination

- 7.2.1** A summary of visual and olfactory evidence of contamination encountered during the intrusive investigations is presented in Table 11.

Table 11: Visual and Olfactory Evidence of Contamination Summary

Location ID	Depth (mbGL)	Strata	Evidence of Potential Contamination
All locations	GL to >0.4-0.9	Made Ground	Ash, clinker, tarmacadam, concrete and brick
STPQ06	0.9 to 1.1	Tidal Flat Deposit	Grey staining

Note: * geological terminology altered to the one referred to in the borehole record.

7.2.2 No visual or olfactory evidence of hydrocarbon contamination was identified during the limited trial pitting and drilling undertaken on site. The PID meter recorded zero levels, indicating that no volatiles were present.

7.2.3 Full details and observations noted during the drilling and trial pitting are presented on the exploratory hole logs attached in Appendix 1.

7.3 Gas Monitoring

7.3.1 No gas monitoring data is available for the Site from the previous ground investigations.

7.4 Groundwater

Groundwater Encountered During Investigation

7.4.1 Groundwater strikes were encountered during the advancement of borehole SBHQ06RC as detailed on the geological log provided in Appendix 1. This is summarised in Table 12.

Table 12: Summary of Groundwater and Leachate Water Level Data

Location	Strike Depth (mbGL)	Geological Formation	Level after 20 minutes (mbGL)	Comments
SBHQ06RC	4.4	Mercia Mudstone*	3.41	-
	-	-	-	Water level recorded at 5 m bGL when borehole taken into the top of the sand layer of the Mercia Mudstone (7 m bGL)
	-	-	-	Water level recorded at 2.65 m bGL when borehole finished at a depth of 8 m bGL within Mercia Mudstone

Note: * geological terminology altered to the one referred to in the borehole record.

7.4.2 Groundwater was not recorded in the other boreholes or trial pits referenced.

Groundwater Level Data Set

7.4.3 The groundwater level data available for the Site is summarised in Table 13.

Table 13: Summary of Groundwater Level Data

Location	Installation ^{#1}	Depth of Response Zone (mbGL) and Geological Formation	No. Measurements	Minimum Depth (mbGL)	Maximum Depth (mbGL)	Comments
SBHQ06RC	19 mm	7.1 – 8 m (Mercia Mudstone)	6	3.89	6.63	-

Notes: #1 S denotes a shallow installation and D denotes deep installation. *Geological terminology altered to the one referred to in the borehole record.

Groundwater Summary

- 7.4.4** The groundwater monitoring of the borehole on site has reported a groundwater body within the Mercia Mudstones at a level of between 3.9 and 6.6 mbGL. The relatively high variability is considered to be representative of seasonal variation, although some marginal tidal influence cannot be discounted.

8 Contamination Assessment

8.1 Introduction

8.1.1 The following sections provide details of the assessment of land contamination at the Site.

8.1.2 The outline Conceptual Site Model (CSM) presented within the 2014 PSSR has been reviewed and updated based on data from the Supplementary Ground Investigation (Geotechnical Engineering, 2015) and the Scheme. The main amendments to the 2014 PSSR model are summarised as follows:

- Alteration to the ground and groundwater model.
- New ditch considered as a new pathway.
- Update of the source-pathway-receptor linkages taking account of above and more detailed assessments.

8.2 Preliminary Risk Assessments

Potential Sources

8.2.1 The Site was used as railway sidings between 1920 and the late 1980s and therefore subsurface contamination with contaminants typical to railway land can be expected. In particular these can include fuel oils, lubricating oils, and PAHs.

8.2.2 A limited thickness of Made Ground containing ash and clinker was encountered in all investigated locations.

8.2.3 A low embankment was noted to run along the western Site area. The nature of the fill materials is unknown.

8.2.4 The existing M4 embankment is an approximate 10 m high feature and comprises imported gravel, boulders and clays, apparently of reworked natural material. This is not considered a significant potential contamination source.

Potential Receptors

8.2.5 Receptors during the construction and the operational stages of the Scheme have been considered:

Construction

- Construction workers during Site development works.
- Adjacent general public/workers (users of the Severn Junction Tunnel Yard).
- Groundwater within the Mercia Mudstone.

- Nearby surface waters including the reens and existing surface water ditches within the Site and bordering the surrounding fields. This land drainage may be connected with the Gwent Levels SSSI wider network of reens and ditches, located south of the new section of motorway.

Operational

- General public end users and adjacent general public/workers (users of the Severn Junction Tunnel Yard).
- Maintenance workers.
- Groundwater within the Mercia Mudstone.
- Surface water, particularly nearby Vurlong Reen. If a new drainage ditch is created through the existing Made Ground a new pathway to surface waters could exist.

Potential Pathways

8.2.6 Pathways during the construction and the operational stages of the Scheme have been considered:

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils possible during construction and maintenance works.
- Dermal contact, ingestion, inhalation pathways, all dust related, possible to for general public end users and adjacent general public/workers.
- Leaching of contaminants from the Made Ground to groundwater.
- Surface water run-off into existing/new drainage system.

8.3 Risk Evaluation

8.3.1 Source-pathway-receptor linkages were considered in the 2014 PSSR using the historical data available up to 2008. With review of the new data described herein, the risk evaluation has been reconsidered and includes the following:

- The Site has been subject to a range of potential contaminating uses associated with use as a railway sidings/yard.
- Made Ground shown to be of limited thickness.
- Proposed embankment widening and overlying hardstanding (carriageway) is to be constructed at the Site which is to cover most of the motorway corridor reducing pathways from any contamination in shallow soils left *in situ* to motorway users and maintenance workers.
- Made Ground to be removed within the footprint of the embankment widening. Made Ground may be left in place outside the embankment and is likely to extend beyond the land take to facilitate the Scheme.
- Cohesive superficial deposits with low permeability overly a Secondary Aquifer associated with the River Terrace Deposits and Mercia Mudstone Group in the centre of the Site.

- Perched groundwater within the Tidal Flat Deposits, if present, is not considered a resource.
- Risk of ground gas emissions from the Made Ground is considered negligible given its small thickness and composition. Risk associated with ground gas is not considered further in the Conceptual Site Model.
- Motorway users will be within an open environment with no proposed structure or other confined spaces.

8.4 Human Health Risk Assessment

8.4.1 The rationale and approach for the screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES) and the soil chemical analysis results are presented in Appendix 2.

8.4.2 No exceedances of the relevant criteria were identified.

8.4.3 Presence of TPH is recorded however speciated data does not exceed the screening criteria.

8.5 Controlled Waters Screening Assessment

8.5.1 The rationale and approach for the screening assessment is detailed in the Land Contamination Assessment Report (Appendix 11.1 of the ES). No groundwater or leachate analyses are available in relation to the Site. All exceedances to the relevant generic criteria for surface waters are summarised in Table 14.

8.5.2 Where EQS is dependent on water hardness, i.e. some heavy metals, the hardness of the surface water receptor should normally be used. The Baseline Water Environment Report (Appendix 16.2 of the ES) indicates surface water to be generally moderately hard with hardness concentrations within a range of 100 to 150 mg/l as calcium carbonate. Therefore EQSs within this water hardness range have been used for screening purposes.

Groundwater

8.5.3 No groundwater analytical data is available for the Site from the previous ground investigations.

Leachate

8.5.4 No leachate analytical data is available for the Site from the previous ground investigations.

Surface Water

8.5.5 Six surface water samples have been taken and analysed from the Pratt Reen

located south of the Site. A summary of the exceedances to selected screening criteria are shown in Table 14 below.

Table 14: Summary Surface Water Exceedances

Parameter	Unit	No. Analyses	No. Analyses Above LOD	Min. Conc.	Max. Conc.	Location & Round with Max. Conc.	EQS	No. Analyses Exceeding EQS	DWS	No. Analyses Exceeding DWS	CCW Trigger Level	No. Analyses Exceeding CCW Trigger Level
Lead	µg/l	5	2	0.147	6	E3 / R20	1.2	1	10	0	250	0
Cadmium	µg/l	4	3	0.6	0.9	E3 / R20	0.15	3	5	0	5	0
BOD	mg/l	5	2	2	7	E3 / R20	5	1	-	-	18	0
Nitrate as N	mg/l	4	2	0.5	1.5	E2 / R20	-	-	50	0	1	1
Nitrate as NO ₃	mg/l	5	3	1.3	6.64	E2 / R20	-	-	50	0	1	3
Orthophosphate	mg/l	4	2	0.1	1.2	E3 / R20	-	-	-	-	1	1
Dissolved Oxygen	%	4	4	40.4	80	E2 / R20	60	3	-	-	-	-

- 8.5.6** Water quality within Pratt Reen North is generally observed to be good with only a small number of exceedances for some parameters above their respective EQS. Multiple exceedances were recorded for cadmium (total) and a single exceedance for lead was recorded at location R20.
- 8.5.7** Exceedances were recorded for nitrate (NO₃) above the CCW Trigger Levels and also of phosphorus.
- 8.5.8** Whilst BTEX and TPH concentrations were recorded below laboratory limit of detection for the 2015 data, concentrations of long chain organics have been identified on one of the four historical rounds for Pratt Reen North. Given the presence of similar heavy range TPH within the Made Ground, a possible linkage may be present between the soil and water quality within the reen. It is noted however, that the sampling point and indeed the Pratt Reen are located 800 m from the land take within the Site. Whilst there is no clear and direct hydraulic continuity between the Scheme land take within the Site and the receptor, some possible mobility of organic contamination is identified which may also impact nearer surface water receptors. Additional surface water quality data and near surface soil data would be required to confirm contaminant linkages.
- 8.5.9** The results are presented in the Baseline Water Environment Report (Appendix 16.2 of the ES).

8.6 Summary

- 8.6.1** The Made Ground at the Site has detected levels of PAH and TPH but remain below the relevant screening criteria.
- 8.6.2** The leachability of contaminants within the Made Ground has not been identified.
- 8.6.3** No groundwater monitoring on site or within the wider Severn Junction Tunnel Yard land use has been undertaken and therefore it is not known whether the Made Ground at the Site has affected the underlying groundwater.
- 8.6.4** Whilst the surface water quality of Pratt Reen is seen to be in keeping with the baseline seen in the area of Newport, a possible impact from the high TPH contaminants seen within the Made Ground is identified.

9 Refined Conceptual Site Model

- 9.1.1** The incorporation of data from the 2015 Supplementary Ground Investigation has enabled the original CSM presented in the 2014 PSSR to be updated. The assessment is based on the Scheme during its construction and operational phases.
- 9.1.2** A CSM representing general ground conditions, overall layout of the new section of motorway and relevant source-pathway-receptors (each of which having a specific alpha-numerical symbol attached) are presented in Figure 2 and is described in Table 15.

Table 15: Conceptual Site Model

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
Made Ground containing ash, clinker and/or slag incl. the embankment running across the western Site area. Contamination associated with railway land.	Construction					
	Construction workers (B)	Dermal contact (1)	Likely	Low	Low	Construction workers will possibly be exposed to Made Ground materials during Site construction works; however exposure duration will be short term only. Prior to construction, a specific risk assessment will be required in line with CDM and health and safety guidance. This will enable safe methods of work and appropriate levels of Personal Protective Equipment (PPE) to be put in place. As such all risks will be duly considered and suitably mitigated. Current data set does not identify exceedances to the screening criteria although elevated organic contamination is present. Data is limited to one soil sample of the 2008 investigation.
		Ingestion (2)	Likely	Low	Low	
		Inhalation of dust (3)	Likely	Low	Low	
	Off site users – Severn Tunnel Junction Yard (C)					Dust suppression measures are recommended during construction works. Data is based on limited information. Further investigations are required to delineate any potential contamination and confirm the risks and soil reuse potential.
		Dermal contact - dust(1)	Likely	Low	Low	
		Ingestion - dust (2)	Likely	Low	Low	
		Inhalation of dust (3)	Likely	Low	Low	The current data set does not identify exceedances to the screening criteria but is considered to be limited (one soil sample). Data based on limited information. Further investigations are required to delineate any potential contamination and confirm the risks and soil reuse potential. Dust suppression measures are recommended during construction works.
	Groundwater	Leaching/migration (4)	Likely	Low	Low	Much of the Made Ground is to be removed

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
	within granular superficial deposits (Da)					during the widening earthworks. In the areas left in place, thickness is anticipated to be limited. Existing 3 m Tidal Flat Deposit to be removed as part of the construction. No recorded perched water within the Made Ground or Tidal Flat Deposits. Absence of leachate data. The provision and implementation of a suitable verification sampling inspection strategy during construction to confirm risks is recommended.
	Surface water (land drainage) (E)	Leaching/migration (4)	Low	Moderate	Moderate to low	The quality of perched groundwater may become affected by contamination during the construction works, particularly in the area excavation (new drains and new embankment). Leachate data not available. Available surface water data identify possible soil–water linkage for TPH contaminant. Data based on limited information. Further investigations are required to delineate any potential contamination and confirm the risks and soil reuse potential.
		Surface water run-off (5)	Low	Low	Very low	Surface water run-off may further deteriorate the quality of surface water. Construction process to adopt surface water control and management.
	Operational					
	Maintenance workers (B)	Dermal contact (1)	Low	Low	Very low	Maintenance workers may be exposed to Made Ground materials outside the footprint of the embankment (outside the Scheme area); however exposure duration will be short term only. Areas outside the motorway hardstanding are likely to receive topsoil cover and
		Ingestion (2)	Low	Low	Very low	
		Inhalation of dust (3)	Low	Low	Very low	

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
						vegetation establishment, reducing potential of exposure. Data based on limited information. Further investigations are required to delineate any potential contamination and confirm the risks and soil reuse potential.
	Future motorway users (A) and adjacent off site users (C)	Dermal contact - dust(1)	Low	Low	Very low	Motorway users may be exposed to Made Ground materials outside the footprint of the embankment (outside the Scheme area); however exposure duration will be short term only. Areas outside the motorway hardstanding are likely to receive topsoil cover and vegetation establishment, reducing potential of exposure. Current dataset does not identify exceedances to the screening criteria but is considered to be limited (one soil sample). Data based on limited information. Further investigations are required to delineate any potential contamination and confirm the risks and soil reuse potential.
		Ingestion - dust (2)	Low	Low	Very low	
		Inhalation of dust (3)	Low	Low	Very low	
	Groundwater within the Mercia Mudstone (Da)	Leaching of contaminants as a result of groundwater infiltration (4)	Low	Moderate	Moderate to low	Made Ground containing ash/clinker/slag and contaminants related to railway land may be leaching contaminants as a result of groundwater infiltration; however the rate of contaminants downward migration is likely to be limited due to low permeability of the head deposits. Soil and soil leachate quality testing is recommended to confirm the risk. Made Ground is to be removed beneath the footprint of the embankment.
	Surface water (land drainage) (E)	Saturated flow within perched groundwater (4)	Low	Low	Low	Perched (shallow) groundwater may be intercepted by the land drainage. Hardstanding will reduce infiltration and thus reduce leaching potential.

10 Conclusions and Recommendations

10.1 Conclusions

- 10.1.1** Ground investigations have been undertaken that enable the Site to be assessed for the risks of contamination on the Scheme including human health and controlled waters.
- 10.1.2** The generic risk assessment has identified that low risks to human health and low to moderate risks to controlled waters could exist. Elevated TPH concentrations seen in the Made Ground and in the Pratt Reen may indicate a possible contaminant linkage.
- 10.1.3** Normal construction control measures will be required to facilitate the construction and ongoing operation of the Scheme.
- 10.1.4** During the construction phase, specific mitigation measures will be required to prevent inhalation pathways of dust to the general public off site and construction workers. A suitable water management strategy will also be required to prevent impact to surface waters from run-offs.
- 10.1.5** Materials are considered likely to be suitable for reuse subject to provision of reuse criteria under a Materials Management Plan.

10.2 Recommendations

- 10.2.1** Given the identified gap in the data (limited Site coverage and existing data related to the 2008 investigation) supplementary ground investigation works is required to verify the risk level identified in this report. The investigation will target the potential risks to controlled water from leaching contaminants. Upon completion of the ground investigation this report shall be reviewed and updated accordingly once the findings of the additional investigation are made available.
- 10.2.2** Upon review and assessment of the additional ground investigation information, any contamination identified that could cause an unacceptable risk to the identified receptors will require appropriate remedial mitigation measures to be implemented. These measures would be identified within a remediation strategy for the Scheme. A remediation strategy should be developed for this Site that includes the following:
- Addressing potential human health and controlled waters risk identified by the proposed additional ground investigation.
 - Dealing with unexpected contamination.
 - Verification sampling to confirm suitability of soils for reuse.

- Control measures (over and above good practise construction management) to prevent risks to construction workers and the general public during construction.
- Verification of material used as topsoil.

10.2.3 The remediation strategy should include a remediation options appraisal, remediation implementation plan and remediation verification plan.

10.2.4 The remediation strategy should be supported by a Scheme wide Materials Management Plan prepared in accordance with CL:AIRE Code of Practice (CL:AIRE, 2011).

11 References

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Environment Agency (2002) Piling into contaminated sites. National Groundwater and Contaminated Land Centre, February 2002

Geotechnical Engineering (2015) M4 Corridor Around Newport, Factual Report on Ground Investigation, 30238

Highways Agency (2008) Design Manual for Roads and Bridges. Vol. 4. Geotechnics and Drainage. Section 1. Earthworks; Part 2. HD22/08. Managing Geotechnical Risk.

Ove Arup & Partners (2014) M4 Corridor Around Newport, Preliminary Sources Study Report, 14/9197

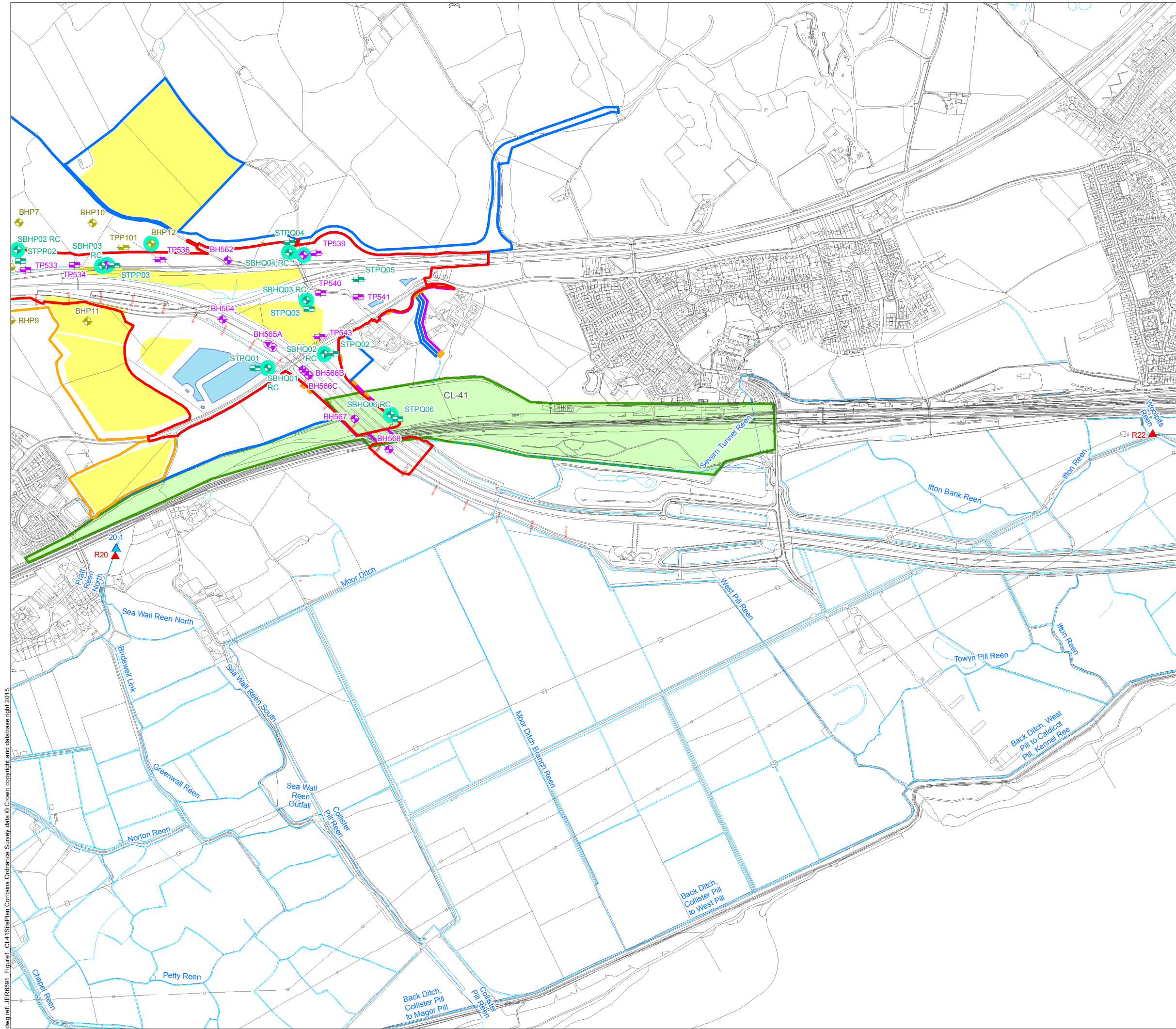
Titan Environmental Surveys Ltd (2008) New M4 Magor to Castleton Baseline Surface Water Quality Final Report for Arup, Report Number HS0442/F1/2

Glossary

BF	Blast Furnace
BGS	British Geological Survey
BOD	Biochemical Oxygen Demand
BOS	Basic Oxygen Slag
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAT	Cable Avoidance Tool
CDM	Construction Design Management
CH ₄	Methane
CLEA	Contaminated Land Exposure Assessment
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESG	Environmental Scientifics Group
EQS	Environmental Quality Standard
FTIR	Fourier Transform Infrared (spectroscopy)
GAC	Generic Assessment Criteria
GDR	Geotechnical Design Report
GIR	Ground Investigation Report
GRO	Gasoline Range Organics
LEL	Lower Explosive Limit
LOD	Limit of Detection
mAOD	Metres Above Ordnance Datum

mb	Millibars
mbGL	Metres below Ground Level
MTBE	Methyl Tert-butyl Ether
NRW	Natural Resources Wales
ORP	Oxidation Reduction Potential
O ₂	Oxygen
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSM	Preliminary Conceptual Site Model
PID	Photo Ionisation Detector
PPE	Personnel Protection Equipment
SGVs	Soil Guideline Values
SSAC	Site Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TPH CWG	Total Petroleum Hydrocarbon Criteria Working Group
UKAS	United Kingdom Accreditation Service
VOCs	Volatile Organic Compounds
WFD	Water Framework Directive
UXO	Unexploded Ordnance Survey

Figures



- Legend**
- Permanent Highway Land within Fenceline (including Water Treatment Areas)
 - Other Permanent Land Take
 - Temporary Construction Land
 - Easement Only
 - Proposed Water Treatment Area (WTA)
 - Potential Borrow Pit Area
 - Potential Area of Land Contamination based on 2014 PSSR

- Investigation Locations**
- 2015 (RPS)**
- Surface Water Monitoring Location - Q1
- 2015 (Geotechnical Engineering)**
- Borehole
 - Dynamic Probe (Proposed Borehole)
 - Trial Pit
- 2008-2009 (Titan Surveys)**
- Surface Water Monitoring Location
- 2007 (Norwest Holst)**
- Borehole
 - Trial Pit
- 1997 (Norwest Holst)**
- Borehole
 - Trial Pit
 - Monitoring Well Installation



Llywodraeth Cymru
Welsh Government

Appendix 11.1 Annex D CL-41

Site Plan for CL-41

Figure: 1	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB



Legend

- Made Ground / Fill - MG
- Tidal Flat Deposits - TFD
- Mercia Mudstone - MM
- Proposed Embankment
- Existing Embankment
- Groundwater (MM)

Potential Receptors

- Humans On-Site (M4 User)
- Humans On-Site (Construction/Maintenance)
- Humans Off-Site (Severn Tunnel Junction Yard Users)
- Groundwater (Secondary B Aquifer)
- Surface Water

Potential Pathways

- Dermal Contact
- Inhalation
- Ingestion
- Leaching / Migration
- Surface Run Off

Potential Sources of Contamination

Possible contamination present on site associated with :

On-Site

- Potential for contamination to be present on site associated with: Made Ground of the railway land

NOTE
Drawing refined from PSSR Drawing Reference
M4-OA-17-00DR-Z-XX-0141 (April 2014)



Appendix 11.1 Annex D CL-41

Conceptual Site Model for CL-41

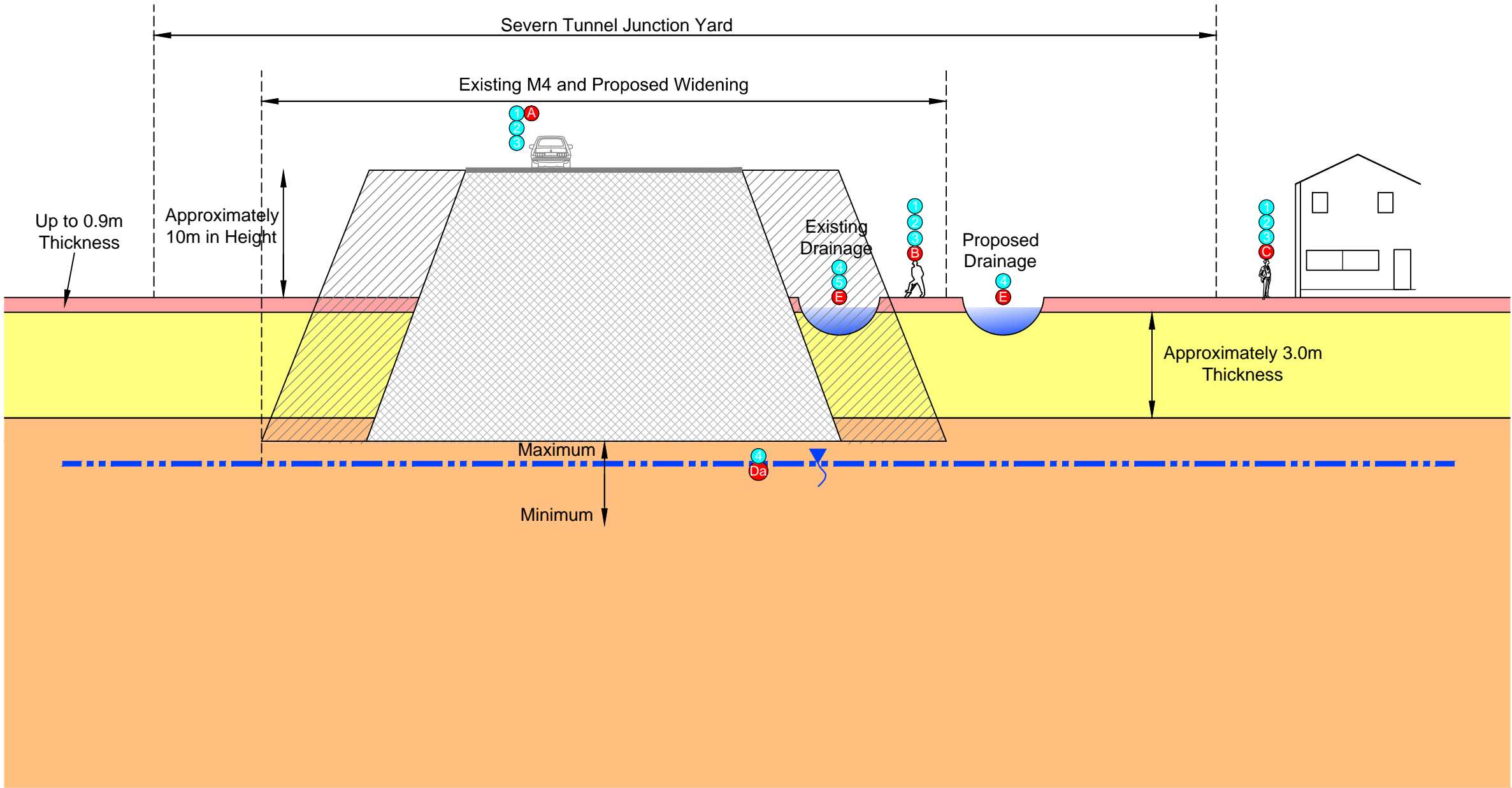
Figure: 2	Revision: -
Date: March 2016	Status: At Issue
Drawn: RJJ	Checked: FB

Not to Scale

Ground conditions based on available information

dwg ref: JER6591_Figure2_CL41ConceptualSiteModel

CL- 41 Severn Tunnel Junction Yard



dwg ref: JER6591_Figure2_CL41ConceptualSiteModel

Appendices

A1 Appendix 1

Exploratory Records

Contract No.	F15056	Method	Rotary Coring	Coordinates	344967.17 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187551.69 N
		Driller	BB	Ground Level	9.27m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
		Core barrel	PWF	Date Started	04/12/2007
Consultant	Ove Arup & Partners Ltd	Core bit	TC	Date Completed	05/12/2007

PROGRESS						DRILLING DETAILS				
Date	Time	Hole depth	Casing depth	Water depth	Remarks	From depth	To depth	Flush type	Flush return	Core diameter
04/12/2007	1730	7.00	4.50	5.00	End of Shift	0.00	5.00	Air/Mist	100%	0.00*
05/12/2007	0730	7.00	4.50	2.20	Start of Shift	5.00	8.00	Air/Mist	100%	92.0
05/12/2007	1730	8.00	7.00	2.65	End of Hole					

CASING				WATER STRIKES							
Hole diam.	Max depth of hole at dia.	Casing diameter	Max depth of casing of dia.	Date	Time	Strike at depth	Rise to depth	Time taken to rise	Flow	Casing depth at strike time	Casing depth to seal flow
121	8.00	121	7.00	04/12/2007	1245	4.40	3.41	20	Medium	0.00	NS

GENERAL NOTES				SPT DETAILS				
1.Rotary Openhole drilling from GL to 5.00m. 2.Rotary Coring from 5.00m to 8.00m. 3.Rotary coring terminated at 8.00m due to blowing sands. 4.19mm piezometer installed tip at 7.35m, with response zone from 7.10m to 8.00m. 5.0.00* indicates openhole drilling.				Depth	Type	Incremental blow count/penetration	Casing	Water Depth
				1.00	S	N=4 (1,1,1,1,1,1)	0.00	DRY
				2.00	S	N=6 (1,1,1,1,2,2)	0.00	DRY
				3.00	S	N=11 (1,2,2,3,3,3)	0.00	DRY
				4.00	S	N=34 (3,3,5,7,10,12)	0.00	DRY
				5.00	S	53/300mm (20,5,12,11,16,14)	4.50	4.10
				6.00	S	100/70mm (25,100)	4.50	4.80
				7.00	S	102/110mm (1,1,2,100)	4.50	5.00

NOTES: All depths in metres, all diameters in millimetres, water strike rise time in minutes.

Form	ARIAL ROTARY HEADER
Version	3.06
Revised	17/12/2007

Contract No.	F15056	Method	Rotary Coring	Coordinates	344967.17 E
Project	New M4 - Second Preliminary Ground Investigation	Drilling Rig	Site Master		187551.69 N
		Driller	BB	Ground Level	9.27m AOD
Client	Transport Wales, Welsh Assembly Government	Logged by	DH	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd	Core barrel	PUF	Date Started	04/12/2007
		Core bit	TC	Date Completed	05/12/2007

Description of Strata	Legend	Drilled Length	Datum Level	Coring and Sampling	TCR	SCR	ROD	SPT N & depth	Installation
MADE GROUND: Topsoil. (Driller's description)		0.10	9.17						
MADE GROUND: Black gravelly ash/clinker. (Driller's description)									
Soft brown silty CLAY. (Driller's description)		0.70	8.57					1.00 1.45 S4	
								2.00 2.45 S6	
								3.00 3.45 S11	
Firm red brown silty CLAY. (Driller's description)		3.30	5.97						
								4.00 4.45 S34	
Firm to stiff red brown mottled green grey sandy CLAY.		4.00	5.27						
								5.00 5.43 S53/300mm	
Stiff to very stiff reddish brown locally mottled greenish grey locally grey very sandy CLAY. Gravel is angular fine of mudstone. (Head Deposits?) ---from 5.57m to 6.00m assumed zone of core loss		5.00	4.27	5.00 6.00	57	0	0		
No recovery. Very dense light yellowish brown fine SAND. (Driller's description)		6.00	3.27	6.00 7.00		NA	NA	6.00 6.13 S100/70mm	
No recovery. Very dense light reddish brown coarse SAND. (Driller's description)		7.00	2.27	7.00 8.00		NA	NA	7.00 7.26 S102/110mm	
Rotary drilling complete at 8.00 m.		8.00	1.27						

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of drilling, progress and water strikes. See legend sheet for key to symbols.

Form	ARIAL ROTARY LOG
Version	3.09
Revised	17/12/2007

Contract No.	F15056	Method	Machine Excavated	Coordinates	344987.41 E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	JCB 3CX	Ground Level	187540.28 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Date Started	29/11/2007
Consultant	Ove Arup & Partners Ltd			Date Completed	29/11/2007

Description of Strata	Legend	Depth Below G.L.	Datum Level	Sampling		Remarks
MADE GROUND: Brown slightly clayey gravelly topsoil. Gravel sized fragments are angular to subangular fine to coarse of concrete and brick.		0.15	8.96	D1 B2 ES3	0.20 0.20 0.20	
MADE GROUND: Black ash and angular to subangular fine to coarse gravel sized fragments of clinker and brick.		0.90	8.21	D4 B5 ES6	0.90 0.90 0.90	
Soft locally firm brown silty slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone, siltstone and limestone. (Head Deposits) ---from 0.90m to 1.10m some grey pockets/staining ---from 1.50m becoming sandy				D7	1.90	
Stiff friable grey sandy CLAY. (Head deposits)		2.40	6.71	B8 D9	2.40 2.40	
Firm light orange brown sandy CLAY. (Head Deposits) ---from 3.90m becoming very sandy		3.20	5.91	D10 B11	3.20 3.20	
				D12	4.20	
Trial pit complete at 4.50 m.		4.50	4.61			

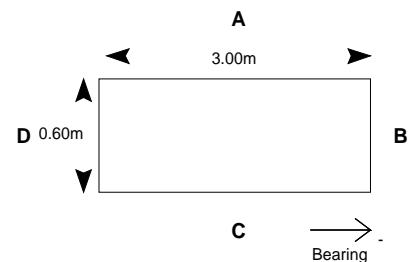
Stability All faces stable

Shoring None used

Groundwater None encountered during excavation

Remarks 1. Trial pit complete at 4.50m.

Sketch Plan of Trial Pit



NOTES: All depths in metres, all soil strengths in kPa.
See legend sheet for key to symbols and abbreviations.
All bearings given relate to magnetic North

Form ARIAL TP LOG

Version 3.06

Revised 17/12/2007



Hole ID.
STPQ06
Data Sheet

Contract No.	F15056	Method	Machine Excavated	Coordinates	344987.41E
Project	New M4 - Second Preliminary Ground Investigation	Equipment	JCB 3CX	Ground Level	187540.28 N
Client	Transport Wales, Welsh Assembly Government	Logged by	WA	Orientation	Vertical
Consultant	Ove Arup & Partners Ltd			Date Started	29/11/2007
				Date Completed	29/11/2007

Hand Vane				Hand Penetrometer		
Depth	Test No	Peak	Remoulded	Depth	Test No	Result
1.00	01	100.0	60.0			
1.00	02	90.0	50.0			
1.00	03	90.0	50.0			
2.00	04	70.0	20.0			
2.00	05	60.0	0.0			
2.00	06	80.0	10.0			
3.00	07	110.0	40.0			
3.00	08	120.0	100.0			
3.00	09	100.0	40.0			
4.00	10	40.0	0.0			
4.00	11	50.0	0.0			
4.00	12	40.0	10.0			

NOTES: All depths in metres, all diameters in millimetres,
test results in kPa.

Form	ARIAL HAND VANE/PEN
Version	3.03
Revised	18/01/2007

TRIAL PIT LOG

CLIENT WELSH GOVERNMENT

BH567

SITE M4 CORRIDOR AROUND NEWPORT

Sheet 1 of 1

Start Date 21 March 2015 Easting 344859.4

Scale 1 : 25

End Date 21 March 2015 Northing 187540.4 Ground level 20.10mOD

Depth 0.40 m

water record	sample/test			description	depth (m)	level (m)	legend
	no/type	result	depth (m)				
	C		0.00- 0.40	MADE GROUND comprising TARMACADAM. (Driller's description). 0.40m: Concrete obstruction. Trial pit completed at 0.40m.	0.40	19.70	

Notes

EQUIPMENT: Geotechnical Pioneer rig.
 METHOD: Waterflush rotary core drilled (300mm) 0.00-0.40m.
 CASING: Not used.
 BACKFILL: On completion, hole backfilled on 31/03/15 with concrete 0.40-0.10m and tarmacadam 0.10-0.00m.
 REMARKS: Concrete obstruction encountered at 0.40m. Hole terminated.

Sketch of Foundation - Not to scale. All dimensions in metres.



CONTRACT

30238

CHECKED

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

A2 Appendix 2

Soil Laboratory Data

M4CAN
Soil Analysis Results & Screening Assessment
CL-41
01/07/2015

Sample Reference	Units	STPQ06
Specimen Depth (m)		0.2
OD Level (m)		8.91
Sample Type		ES
Geology Code		MG
Cluster Code		2008 GI
Location		
Metals		
Antimony	mg/kg	4.4
Arsenic	mg/kg	12
Barium	mg/kg	250
Boron Water Soluble	mg/kg	<3.5
Cadmium	mg/kg	0.5
Chromium	mg/kg	10
Copper	mg/kg	72
Lead	mg/kg	92
Mercury	mg/kg	<0.6
Molybdenum	mg/kg	2.6
Nickel	mg/kg	33
Selenium	mg/kg	<3
Zinc	mg/kg	180
Non Metal Inorganics		
Cyanide (total)	mg/kg	<1
Cyanide (free)	mg/kg	
Phenols Monohydric	mg/kg	<0.15
Other		
Asbestos Presence Screen	None	NFD
Asbestos Identification	%	
Total Organic Carbon	%	29
pH Value	pH Units	7.64
Organics		
PCB 105	mg/kg	
PCB 114	mg/kg	
PCB 123	mg/kg	
PCB 126	mg/kg	
PCB 157	mg/kg	
PCB 167	mg/kg	
PCB 169	mg/kg	
PCB 189	mg/kg	
PCB 77	mg/kg	
PCB 81	mg/kg	
Pcb-118 2,3',4,4',5 - Pentach	mg/kg	
Pcb-156 2,3,3,4,4,5 - Hexach	mg/kg	
Phenols (total)	mg/kg	
BTEX		
GRO (C4-C12)	mg/kg	<0.01
MTBE	mg/kg	<0.01
Benzene	mg/kg	<0.01
Toluene	mg/kg	<0.01
Ethyl benzene	mg/kg	<0.01
m & p Xylene	mg/kg	<0.01
o Xylene	mg/kg	<0.01
TPH		
TPH >C6-C8.	mg/kg	
TPH >C8-C10.	mg/kg	
TPH >C10-C12.	mg/kg	
TPH >C12-C16.	mg/kg	
TPH >C16-C21.	mg/kg	
TPH >C21-C35.	mg/kg	
Aliphatics C5-C6	mg/kg	<10
Aliphatics >C6-C8	mg/kg	<10
Aliphatics >C8-C10	mg/kg	<10
Aliphatics >C10-C12	mg/kg	<10
Aliphatics >C12-C16	mg/kg	8700
Aliphatics >C16-C21	mg/kg	9000
Aliphatics >C21-C35	mg/kg	50000
Total Aliphatics C5-C35	mg/kg	68000
Aliphatics >C35-44	mg/kg	
Aromatics >C5-C7	mg/kg	
Aromatics C6-C7	mg/kg	<0.01
Aromatics >C7-C8	mg/kg	<0.01
Aromatics >EC8-EC10	mg/kg	<0.01
Aromatics >EC10-EC12	mg/kg	<0.01
Aromatics >EC12-EC16	mg/kg	4.2
Aromatics >EC16-EC21	mg/kg	17
Aromatics >EC21-EC35	mg/kg	77
Total Aromatics C6-C35	mg/kg	98
Aromatics >C35-44	mg/kg	
TPH (Aliphatics and Aromatic	mg/kg	170
Total Aliphatic	mg/kg	
Total Aromatic	mg/kg	
Total petroleum hydrocarbon	mg/kg	
PAH		
Acenaphthene	mg/kg	0.076
Acenaphthylene	mg/kg	0.039
Anthracene	mg/kg	0.35
Benz(a)anthracene	mg/kg	1.7
Benzo(a)pyrene	mg/kg	1
Benzo(b)fluoranthene	mg/kg	2
Benzo(ghi)perylene	mg/kg	0.84
Benzo(k)fluoranthene	mg/kg	1.1
Chrysene	mg/kg	2.6
Dibenzo(ah)anthracene	mg/kg	0.34
Fluoranthene	mg/kg	2.8
Fluorene	mg/kg	0.24
Indeno(123cd)pyrene	mg/kg	0.67
Naphthalene	mg/kg	0.74
Phenanthrene	mg/kg	2.7
Pyrene	mg/kg	2.2
PAH 16 Total	mg/kg	19

Screening Values and Assessment

	Exceeds S4ULs Criteria
X	Laboratory detection level higher than screening criterion

Notes

NFD No Fibres Detected
Chromium VI criteria used
Elemental Mercury criteria used
Screening criterion for lead is C4SL in the absence of a S4UL

Geological Formation Legend

MG	Made Ground
----	-------------

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	Selected S4ULs Criteria	No. Data Exceeding S4ULs Criteria
1	1	4.4	4.4	STPQ06 @ 0.2mbGL		
1	1	12	12	STPQ06 @ 0.2mbGL	170	0
1	1	250	250	STPQ06 @ 0.2mbGL		
1	0	None > LOD	None > LOD			
1	1	0.5	0.5	STPQ06 @ 0.2mbGL	190	0
1	1	10	10	STPQ06 @ 0.2mbGL	33	0
1	1	72	72	STPQ06 @ 0.2mbGL	44000	0
1	1	92	92	STPQ06 @ 0.2mbGL	1300	0
1	0	None > LOD	None > LOD		30	0
1	1	2.6	2.6	STPQ06 @ 0.2mbGL		
1	1	33	33	STPQ06 @ 0.2mbGL	980	0
1	0	None > LOD	None > LOD		1800	0
1	1	180	180	STPQ06 @ 0.2mbGL	170000	0
1	0	None > LOD	None > LOD			
0	0	None > LOD	None > LOD			
1	0	None > LOD	None > LOD		440	0
1	0	None > LOD	None > LOD			
0	0	None > LOD	None > LOD			
1	1	29	29	STPQ06 @ 0.2mbGL		
1	1	7.64	7.64	STPQ06 @ 0.2mbGL	6-9	1
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		0.24	0
0	0	None > LOD	None > LOD		440	0
1	0	None > LOD	None > LOD			
1	0	None > LOD	None > LOD			
1	0	None > LOD	None > LOD		27	0
1	0	None > LOD	None > LOD		56000	0
1	0	None > LOD	None > LOD		5700	0
1	0	None > LOD	None > LOD		5900	0
1	0	None > LOD	None > LOD		6600	0
0	0	None > LOD	None > LOD		7800	0
0	0	None > LOD	None > LOD		2000	0
0	0	None > LOD	None > LOD		9200	0
0	0	None > LOD	None > LOD		10000	0
0	0	None > LOD	None > LOD		7600	0
0	0	None > LOD	None > LOD		7800	0
1	0	None > LOD	None > LOD		3200	0
1	0	None > LOD	None > LOD		7800	0
1	0	None > LOD	None > LOD		2000	0
1	0	None > LOD	None > LOD		9700	0
1	1	8700	8700	STPQ06 @ 0.2mbGL	25000	0
1	1	9000	9000	STPQ06 @ 0.2mbGL	450000	0
1	1	50000	50000	STPQ06 @ 0.2mbGL	450000	0
1	1	68000	68000	STPQ06 @ 0.2mbGL		
0	0	None > LOD	None > LOD		450000	0
0	0	None > LOD	None > LOD		26000	0
1	0	None > LOD	None > LOD		7800	0
1	0	None > LOD	None > LOD		56000	0
1	0	None > LOD	None > LOD		3500	0
1	0	None > LOD	None > LOD		9200	0
1	1	4.2	4.2	STPQ06 @ 0.2mbGL	10000	0
1	1	17	17	STPQ06 @ 0.2mbGL	7600	0
1	1	77	77	STPQ06 @ 0.2mbGL	7800	0
1	1	98	98	STPQ06 @ 0.2mbGL		
0	0	None > LOD	None > LOD		7800	0
1	1	170	170	STPQ06 @ 0.2mbGL		
0	0	None > LOD	None > LOD			
0	0	None > LOD	None > LOD			
0	0	None > LOD	None > LOD			
1	1	0.076	0.076	STPQ06 @ 0.2mbGL	29000	0
1	1	0.039	0.039	STPQ06 @ 0.2mbGL	29000	0
1	1	0.35	0.35	STPQ06 @ 0.2mbGL	150000	0
1	1	1.7	1.7	STPQ06 @ 0.2mbGL	49	0
1	1	1	1	STPQ06 @ 0.2mbGL	11	0
1	1	2	2	STPQ06 @ 0.2mbGL	13	0
1	1	0.84	0.84	STPQ06 @ 0.2mbGL	1400	0
1	1	1.1	1.1	STPQ06 @ 0.2mbGL	370	0
1	1	2.6	2.6	STPQ06 @ 0.2mbGL	93	0
1	1	0.34	0.34	STPQ06 @ 0.2mbGL	1.1	0
1	1	2.8	2.8	STPQ06 @ 0.2mbGL	6300	0
1	1	0.24	0.24	STPQ06 @ 0.2mbGL	20000	0
1	1	0.67	0.67	STPQ06 @ 0.2mbGL	150	0
1	1	0.74	0.74	STPQ06 @ 0.2mbGL	190	0
1	1	2.7	2.7	STPQ06 @ 0.2mbGL	6200	0
1	1	2.2	2.2	STPQ06 @ 0.2mbGL	15000	0
1	1	19	19	STPQ06 @ 0.2mbGL		

A3 Appendix 3

Surface Water Data

M4CAN
Surface Water Sample Analysis &
Screening Assessment
CL-41
14/07/2015

Monitoring Round / Location		Units	Screening Criteria			E1 / R20	E2 / R20	E3 / R20	E4 / R20	Q1 / 20.1
Date Sampled				07/12/2007	17/03/2008	18/03/2008	24/09/2008	03/06/2015		
	EQS		DWS	CCW						
Metals & Non-Metal Inorganics										
Hardness Total	mg/l				107	304	342	420		
Arsenic Dissolved	ug/l	50	10						1.28	
Calcium Dissolved	ug/l			300000	31	74	75	102	17.2	
Cadmium Dissolved	ug/l	0.15	5	5					<0.1	
Chromium Dissolved	ug/l		50		<0.22	<0.22	<0.22	<0.22	0.827	
Copper Dissolved	ug/l	10	2000		<0.85	<0.85	<0.85	<0.85	2.49	
Lead Dissolved	ug/l	1.2	10	250	<0.22	<0.22	6	<0.22	0.147	
Magnesium Dissolved	ug/l				5.7	13	32	34		
Nickel Dissolved	ug/l	4	20	100	<0.15	<0.15	<0.15	<0.15	0.644	
Selenium Dissolved	ug/l		10						1.26	
Cadmium Total	ug/l	0.15	5	5	0.7	0.6	0.9	<0.5		
Zinc Total	ug/l	75		1000	17	25	21	75		
BOD	mg/l	5		18	2	<1	7	<1	<1	
Nitrate as N	mg/l		50	1	0.5	1.5	<0.3	<0.3		
Nitrate as NO3	mg/l		50	1	2.2	6.64	1.3	<0.3	<0.3	
Nitrite as N	mg/l		0.1521739	1	<0.1	<0.1	<0.1	<0.1		
Nitrite as NO2	mg/l		0.5	1					<0.05	
Nitrogen, Total Oxidised as N	mg/l		50	2	1.5	<0.1	<0.1	0.5		
Phosphate, Ortho as P	mg/l			1	<0.1	0.1	1.2	<0.1		
Phosphorus (tot.unfilt)	ug/l	120							87.9	
Sulphate	mg/l	400	250	300					<2	
Sulphate as SO4	mg/l	400	250	300	10	19	<5	31		
Chloride	mg/l	250	250	300	13	19	21	23	7.4	
Ammoniacal Nitrogen as N	mg/l	0.6		1	0.06	0.07	0.48		0.218	
Dissolved Oxygen (Saturation)	%	60			58.7	88	54.9	40.4		
Dissolved Oxygen	mg/l				6.91	10.48	5.22	4.1	11.7	
pH Value	pH units	6-9	6.5-10	6.8-8.5	7.7	7.8	7.8	7.6		
Organics										
GRO (C5-C12)	ug/l								<50	
MTBE	ug/l								<3	
Benzene	ug/l	10	1						<7	
Toluene	ug/l	50							<4	
Ethyl benzene	ug/l	20							<5	
m & p Xylene	ug/l	30							<8	
o Xylene	ug/l	30							<3	
TPH										
Aliphatics C5-C6	ug/l								<10	
Aliphatics >C6-C8	ug/l								<10	
Aliphatics >C8-C10	ug/l								<10	
Aliphatics >C10-C12	ug/l								<10	
Aliphatics >C12-C16 Aqueous	ug/l								<10	
Aliphatics >C16-C21 Aqueous	ug/l								<10	
Aliphatics >C21-C35 Aqueous	ug/l								<10	
Total Aliphatics C12-C35 Aqueous	ug/l								<10	
Aromatics >C5-C7	ug/l								<10	
Aromatics >C7-C8	ug/l								<10	
Aromatics >EC8-EC10	ug/l								<10	
Aromatics >EC10-EC12	ug/l								<10	
Aromatics >EC12-EC16 Aqueous	ug/l								<10	
Aromatics >EC16-EC21 Aqueous	ug/l								<10	
Aromatics >EC21-EC35 Aqueous	ug/l								<10	
Total Aromatics C12-C35 Aqueous	ug/l								<10	
TPH >C6-C8	ug/l				<10	<10	<10	<10		
TPH >C8-C10	ug/l				<10	<10	<10	<10		
TPH >C10-C16	ug/l				<20	<20	<20	<20		
TPH >C16-C24	ug/l				<20	<20	117	<20		
TPH >C24-C40	ug/l				223	<50	137	<50		
TPH >C6-C40	ug/l				223	<50	254	<50		
PAHs										
Acenaphthene	ug/l								<0.015	
Acenaphthylene	ug/l								<0.011	
Anthracene	ug/l	0.1							<0.015	
Benzo(a)anthracene	ug/l								<0.017	
Benzo(a)pyrene	ug/l	0.00017	0.01						<0.009	
Benzo(b)fluoranthene	ug/l	0.017	0.1						<0.023	
Benzo(k)fluoranthene	ug/l	0.017	0.1						<0.027	
Benzo(ghi)perylene	ug/l	0.0082	0.1						<0.016	
Indeno(1,2,3-cd)pyrene	ug/l		0.1						<0.014	
Chrysene	ug/l								<0.013	
Dibenzo(a,h)anthracene	ug/l								<0.016	
Fluoranthene	ug/l	0.0063							<0.017	
Fluorene	ug/l								<0.014	
Naphthalene	ug/l	2							<0.1	
Phenanthrene	ug/l								<0.022	
Pyrene	ug/l								<0.015	
Total PAHs (USEPA 16)	ug/l								<0.344	
VOCs										
Benzene	ug/l	10	1						<7	
Ethylbenzene	ug/l	20							<5	
m,p xylenes	ug/l	30							<8	
Methyl tert-butyl ether (MTBE)	ug/l								<3	
O-Xylene	ug/l	30							<3	
Toluene	ug/l	50							<4	

Notes

EQS calcium carbonate 200-250mg/l for heavy metals: chromium, copper, lead, nickel and zinc
NDP - No determination possible


Screening Values and Assessment

EQS	Environmental Quality Standards
MRV	Minimum Reporting values
	Exceeds EQS
100	Exceeds DWS
<10	Laboratory detection level higher than screening criterion
BOL/ITA	Exceeds CCW


[illegible]

A4 Appendix 4

Groundwater Level

Project Name New M4 Preliminary Ground Investigation						Groundwater Readings For Installations			Fig no. 01			
Project No. F15056												
Engineer Ove Arup & Partners Ltd												
Client Transport Wales, Welsh Assembly Government												
NOTES: SPIE=Piezometer, SP=Standpipe For multiple installations, use different Installation IDs. For piezometers installation depth = tip depth. For standpipes = base of pipe												
COMMENTS SBHM01 RC installation extends 0.50m above ground level. - symbol indicates water level is above GL All groundwater levels are recorded from ground level												
Exploratory Hole ID	Installation Details			Recorded Water Level								
	Type	Depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
SBHC01 RC	SPIE	8.05		30/01/2008	09:50	2.45	25/02/2008	14:34	2.48	07/03/2008	14:25	2.60
SBHD03 CP	SPIE	10.00		30/01/2008	11:01	0.47	25/02/2008	14:52	0.43	07/03/2008	14:05	0.56
SBHD05 RC	SPIE	12.00		31/01/2008	09:00	1.02	25/02/2008	15:35	1.05	07/03/2008	13:50	1.77
SBHD06 RC	SP	15.00		30/01/2008	13:00	1.13	21/02/2008	10:30	1.39	07/03/2008	13:30	1.39
SBHD08 RC	SPIE	29.50		30/01/2008	13:50	1.20	25/02/2008	15:58	2.02	07/03/2008	13:35	1.40
SBHE02RD	SPIE	25.00		31/01/2008	09:25	2.18	25/02/2008	16:20	2.09	07/03/2008	13:10	2.48
SBHE04 RC	SPIE	17.20		31/01/2008	09:15	2.31	25/02/2008	16:11	2.51	07/03/2008	13:20	2.59
SBHF01 RC	SPIE	19.00		31/01/2008	09:40	5.69	25/02/2008	16:32	5.72	07/03/2008	12:50	5.43
SBHF02A CP	SPIE	17.00		01/02/2008	14:40	7.61	25/02/2008	17:13	7.57	07/03/2008	12:30	9.00
SBHF03 RC	SPIE	18.00		31/01/2008	10:35	6.97	26/02/2008	08:55	6.77	07/03/2008	12:15	7.22
SBHH01 RC	SPIE	25.00		31/01/2008	11:15	3.45	26/02/2008	09:39	3.42	07/03/2008	11:28	3.65
SBHH02 RC	SPIE	14.90		31/01/2008	11:10	3.42	26/02/2008	09:20	3.88	07/03/2008	11:35	3.64
SBHH05 RC	SPIE	21.50		31/01/2008	11:30	2.22	26/02/2008	10:01	2.13	07/03/2008	11:05	3.10
SBHH06 CP	SP	12.30		30/01/2008	15:30	3.75	21/02/2008	08:00	3.76	07/03/2008	11:10	3.87
SBHH07A RC	SPIE	24.85		30/01/2008	14:50	1.70	26/02/2008	10:40	1.34	07/03/2008	11:00	1.07
SBHJ01 CP	SP	7.50		01/02/2008	12:20	1.34	21/02/2008	11:45	5.98	06/03/2008	12:28	1.82
SBHJ03 CP	SP	5.20		01/02/2008	08:00	0.54	27/02/2008	16:15	0.70	07/03/2008	10:45	0.68
SBHJ04	SP	13.10		01/02/2008	11:55	6.61	22/02/2008	13:55	6.67	06/03/2008	11:46	6.75
SBHJ05	SP	11.50		01/02/2008	11:10	8.91	22/02/2008	09:00	9.07	06/03/2008	11:23	9.16
SBHJ06 CP	SP	4.10		01/02/2008	11:45	1.31	21/02/2008	15:30	1.32	06/03/2008	10:50	1.33
SBHJ07 CP	SP	10.40		01/02/2008	11:43	1.35	21/02/2008	14:40	1.40	06/03/2008	12:05	1.56
SBHJ08A CP	SP	7.40		01/02/2008	11:35	3.49	21/02/2008	13:05	2.31	06/03/2008	10:57	2.67
SBHJ09 CP	SP	2.20		01/02/2008	11:30	0.65	21/02/2008	12:25	0.85	06/03/2008	11:00	0.90
SBHJ10 CP	SP	10.00		01/02/2008	10:40	2.30	21/02/2008	13:45	2.24	06/03/2008	10:40	2.16
SBHK01 CP	SP	6.80		01/02/2008	10:55	0.70	25/02/2008	10:30	1.00	06/03/2008	14:24	1.06
SBHK02 CP	SP	11.20		01/02/2008	10:50	1.34	25/02/2008	11:20	1.33	06/03/2008	14:18	1.47
SBHK03 CP	SP	5.90		01/02/2008	10:45	0.87	25/02/2008	12:00	0.89	06/03/2008	14:15	1.00
SBHK04 CP	SP	12.20		01/02/2008	10:25	1.45	25/02/2008	12:30	1.60	06/03/2008	12:30	1.60
SBHL02 RC	SPIE	15.20		01/02/2008	10:35	2.27	25/02/2008	12:49	2.31	06/03/2008	14:00	2.42
SBHL03 RC	SPIE	15.00		31/01/2008	16:20	0.61	26/02/2008	11:15	0.51	07/03/2008	10:25	0.66
SBHM01 RC	SPIE	21.00		01/01/1900	08:20	-0.26	26/02/2008	11:30	-0.26	07/03/2008	10:17	0.05
SBHM02 RC	SPIE	20.00		01/02/2008	08:25	0.19	26/02/2008	11:41	0.49	07/03/2008	10:14	0.68
SBHN01A RC	SPIE	14.90		01/02/2008	15:20	8.49	27/02/2008	17:15	12.23	07/03/2008	14:45	13.18
SBHN02 RC	SPIE	20.40		31/01/2008	15:55	3.67	26/02/2008	11:57	4.19	07/03/2008	10:05	4.84
SBHN03 RC	SPIE	15.00		31/01/2008	15:45	1.07	26/02/2008	12:03	1.73	07/03/2008	09:55	2.34
SBHN04 RC	SPIE	10.00		31/01/2008	15:30	9.99	26/02/2008	14:42	DRY	07/03/2008	09:45	DRY
Recorded by: S Davis			Checked by: I Swain			Approved by: I Swain						
Date: 30/01/08-07/03/08			Date: 16/04/2008			Date: 17/04/2008						
Form No. SI GWR			Revision No. 2.03			Issue Date 07/01/2008						

[illegible]

Project Name New M4 Preliminary Ground Investigation						Groundwater Readings For Installations						
Project No. F15056									Fig no.			
Engineer Ove Arup & Partners Ltd						03						
Client Transport Wales, Welsh Assembly Government												
NOTES: SPIE=Piezometer, SP=Standpipe For multiple installations, use different Installation IDs. For piezometers installation depth = tip depth. For standpipes = base of pipe												
COMMENTS SBHM01 RC installation extends 0.50m above ground level. - symbol indicates water level is above GL All groundwater levels are recorded from ground level												
Exploratory Hole ID	Installation Details			Recorded Water Level								
	Type	Depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
SBHC01 RC	SPIE	8.05		20/03/2008	16:30	2.57	04/04/2008	08:00	2.59	18/04/2008	07:40	2.66
SBHD03 CP	SPIE	10.00		20/03/2008	16:45	0.58	04/04/2008	08:13	0.53	18/04/2008	08:00	0.60
SBHD05 RC	SPIE	12.00		20/03/2008	16:00	1.08	04/04/2008	09:15	1.22	18/04/2008	08:30	1.32
SBHD06 RC	SP	15.00		20/03/2008	17:55	1.20	04/04/2008	09:30	1.33	18/04/2008	08:40	1.44
SBHD08 RC	SPIE	29.50		19/03/2008	18:30	1.28	04/04/2008	10:00	1.39	18/04/2008	08:52	1.52
SBHE02RD	SPIE	25.00		20/03/2008	16:20	2.23	04/04/2008	08:50	2.46	18/04/2008	09:00	2.54
SBHE04 RC	SPIE	17.20		20/03/2008	15:45	2.20	04/04/2008	09:00	1.80	18/04/2008	08:15	1.80
SBHF01 RC	SPIE	19.00		20/03/2008	15:30	5.50	04/04/2008	08:40	5.55	18/04/2008	13:58	5.58
SBHF02A CP	SPIE	17.00		20/03/2008	15:10	5.60	04/04/2008	10:28	5.70	18/04/2008	13:45	5.77
SBHF03 RC	SPIE	18.00		20/03/2008	14:55	7.20	04/04/2008	10:36	7.38	18/04/2008	13:40	7.42
SBHH01 RC	SPIE	25.00		20/03/2008	14:25	3.60	04/04/2008	15:00	3.60	18/04/2008	13:10	3.62
SBHH02 RC	SPIE	14.90		20/03/2008	14:30	4.27	04/04/2008	15:05	3.64	18/04/2008	13:13	3.70
SBHH05 RC	SPIE	21.50		20/03/2008	17:30	2.17	04/04/2008	15:15	2.78	18/04/2008	11:34	2.90
SBHH06 CP	SP	12.30		17/03/2008	15:20	3.88	04/04/2008	15:20	3.89	17/04/2008	14:15	3.90
SBHH07A RC	SPIE	24.85		20/03/2008	13:55	1.33	04/04/2008	15:28	1.92	18/04/2008	11:43	0.88
SBHJ01 CP	SP	7.50		19/03/2008	14:15	1.81	03/04/2008	16:05	1.90	17/04/2008	12:40	1.80
SBHJ03 CP	SP	5.20		19/03/2008	16:40	0.78	03/04/2008	18:25	0.82	17/04/2008	15:55	0.80
SBHJ04	SP	13.10		17/03/2008	13:35	6.64	03/04/2008	18:10	6.74	17/04/2008	13:08	6.80
SBHJ05	SP	11.50		18/03/2008	13:50	9.02	03/04/2008	17:39	9.10	17/04/2008	13:31	9.11
SBHJ06 CP	SP	4.10		17/03/2008	12:55	1.29	03/04/2008	17:43	1.33	17/04/2008	15:05	1.20
SBHJ07 CP	SP	10.40		17/03/2008	10:25	1.59	03/04/2008	17:47	1.50	17/04/2008	13:58	1.47
SBHJ08A CP	SP	7.40		18/03/2008	10:00	2.50	03/04/2008	17:55	2.50	17/04/2008	15:33	2.50
SBHJ09 CP	SP	2.20		18/03/2008	10:25	0.69	03/04/2008	17:58	0.82	17/04/2008	15:22	0.90
SBHJ10 CP	SP	10.00		17/03/2008	09:15	2.10	03/04/2008	17:50	2.00	17/04/2008	13:55	2.00
SBHK01 CP	SP	6.80		19/03/2008	10:45	0.88	03/04/2008	16:40	1.00	17/04/2008	11:40	0.94
SBHK02 CP	SP	11.20		19/03/2008	11:15	1.46	03/04/2008	16:45	1.48	17/04/2008	11:43	1.46
SBHK03 CP	SP	5.90		19/03/2008	11:45	1.04	03/04/2008	16:48	1.07	17/04/2008	11:46	0.98
SBHK04 CP	SP	12.20		19/03/2008	12:15	1.64	03/04/2008	16:52	1.67	17/04/2008	12:05	1.60
SBHL02 RC	SPIE	15.20		19/03/2008	12:50	2.44	03/04/2008	17:00	2.45	17/04/2008	12:00	2.45
SBHL03 RC	SPIE	15.00		20/03/2008	13:25	0.76	08/04/2008	15:40	0.64	18/04/2008	09:50	0.62
SBHM01 RC	SPIE	21.00		20/03/2008	13:05	-0.21	08/04/2008	15:48	-0.45	18/04/2008	11:55	0.01
SBHM02 RC	SPIE	20.00		20/03/2008	13:10	0.61	08/04/2008	15:52	0.61	18/04/2008	11:50	0.61
SBHN01A RC	SPIE	14.90		20/03/2008	12:55	12.14	08/04/2008	16:05	12.58	18/04/2008	12:48	13.27
SBHN02 RC	SPIE	20.40		20/03/2008	12:45	4.26	08/04/2008	16:12	2.64	18/04/2008	12:45	4.85
SBHN03 RC	SPIE	15.00		20/03/2008	12:30	1.60	08/04/2008	16:17	2.07	18/04/2008	12:35	2.37
SBHN04 RC	SPIE	10.00		20/03/2008	12:10	DRY	08/04/2008	16:28	DRY	18/04/2008	10:55	DRY
Recorded by: S Davis			Checked by: I Swain			Approved by: I Swain						
Date: 17/03/08-17/04/08			Date: 21/04/2008			Date: 21/04/2008						
Form No. SI GWR			Revision No. 2.03			Issue Date 07/01/2008						

[illegible]

A5 Appendix 5

Relevant Extract of Additional Environment Data



Plate 01: Extract of 2013/2014 Aerial Photograph showing disturbed ground, stored materials and what is thought to be an area of plastic sheeting.



Plate 02: Extract of 2014 High Resolution Aerial Photograph showing disturbed ground and stored materials. Note small scale earthworks outside the Site boundary in agricultural land.

Client: Welsh Government

Project: M4CaN

Job Ref: JER6591 Checked By:

Date: Oct 2015

Annex D26

Data Set Outside Individual Land Contamination Assessment Reports

M4CAN
Soil Analysis Results & Screening Assessment
Alignment outside of CL sites - chainage 0 to +6,600
16/07/2015

[illegible]

Screening Values and Assessment	
	Exceeds S4ULs Criteria
Green	Laboratory detection level higher than screening criterion

Notes	
N/A	Not applicable
IS	Insufficient sample numbers to undertake 95UCL statistical analysis
	Chromium VI criteria used
	Elemental Mercury criteria used
Red	No S4ULs available, C4SL used instead

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	Selected SAUTs	No. Data Exceeding SAUTs Criteria
0	0	None > LOD	None > LOD			0
44	41	200	1.1	BH304 @ 48.85mBGL	170	1
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
44	18	4.3	0.47	BH308 @ 48.15mBGL	12	0
0	0	None > LOD	None > LOD		46000	0
44	31	81	0.11	BH318 @ 17.45mBGL	190	0
44	44	720	7.1	BH304 @ 48.85mBGL	33	27
44	44	75	3.1	BH304 @ 47.85mBGL	44000	0
44	44	980	6.7	BH302 @ 50.7mBGL	1300	0
44	14	0.37	0.11	BH318 @ 17.45mBGL	30	0
0	0	None > LOD	None > LOD			0
44	44	650	3.9	BH304 @ 48.85mBGL	980	0
44	11	0.74	0.26	BH318 @ 18.05mBGL	1800	0
					5000	0
44	43	3100	35	BH318 @ 17.45mBGL	17000	0
44	0	None > LOD	None > LOD			44
44	0	None > LOD	None > LOD			44
						0
18	18	0	0	BH304 @ 48.85mBGL		18
18	0	None > LOD	None > LOD			18
0	0	None > LOD	None > LOD			0
11	11	4.4	0	BH310 @ 56.4mBGL		0
44	44	12	6.1	BH304 @ 48.85mBGL	6-9	21
0	0	None > LOD	None > LOD			0
						0
0	0	None > LOD	None > LOD			0.24
					440	0
					440	0
12	0	None > LOD	None > LOD		440	0
						0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
12	0	None > LOD	None > LOD		27	0
12	0	None > LOD	None > LOD		56000	0
12	0	None > LOD	None > LOD		5700	0
12	0	None > LOD	None > LOD		5900	0
12	0	None > LOD	None > LOD		6600	0
						0
15	0	None > LOD	None > LOD		7800	0
15	0	None > LOD	None > LOD		2600	0
15	0	None > LOD	None > LOD		9200	0
15	0	None > LOD	None > LOD		10000	0
15	0	None > LOD	None > LOD		7000	0
15	1	43	43	BH318 @ 18.05mBGL	7800	0
12	0	None > LOD	None > LOD		3200	0
12	0	None > LOD	None > LOD		7800	0
12	0	None > LOD	None > LOD		2000	0
12	0	None > LOD	None > LOD		9700	0
12	0	None > LOD	None > LOD		25000	0
12	0	None > LOD	None > LOD		45000	0
12	0	None > LOD	None > LOD		45000	0
0	0	None > LOD	None > LOD		45000	0
12	0	None > LOD	None > LOD		45000	0
12	0	None > LOD	None > LOD		26000	0
0	0	None > LOD	None > LOD		7800	0
12	0	None > LOD	None > LOD		5600	0
12	0	None > LOD	None > LOD		3500	0
12	0	None > LOD	None > LOD		9200	0
12	0	None > LOD	None > LOD		10000	0
12	0	None > LOD	None > LOD		7000	0
12	0	None > LOD	None > LOD		7800	0
0	0	None > LOD	None > LOD			0
12	0	None > LOD	None > LOD		7800	0
12	0	None > LOD	None > LOD			12
12	0	None > LOD	None > LOD			12
0	0	None > LOD	None > LOD			0
12	0	None > LOD	None > LOD			12
						0
44	0	None > LOD	None > LOD		29000	0
44	0	None > LOD	None > LOD		29000	0
4	3	0.31	0.13	BH320 @ 13.55mBGL	150000	0
44	2	0.97	0.59	BH316 @ 24.75mBGL	49	0
44	3	0.63	0.34	BH320 @ 13.55mBGL	11	0
2	0.56	0.26	0.16	BH320 @ 13.55mBGL	13	0
44	2	0.79	0.29	BH320 @ 13.55mBGL	1400	0
44	2	0.28	0.14	BH316 @ 24.75mBGL	370	0
3	1.1	0.46		BH311 @ 74.5mBGL	93	0
44	0	None > LOD	None > LOD		11	0
44	5	1.6	0.1	BH320 @ 13.55mBGL	6300	0
44	0	None > LOD	None > LOD		20000	0
2	0.65	0.32	0.19	BH316 @ 24.75mBGL	150	0
44	0	None > LOD	None > LOD		190	0
44	3	1.3	0.3	BH320 @ 13.55mBGL	6200	0
6	3	1	0.2	TH312 @ 10.85mBGL	1500	0
44	3	8.6	2	BH320 @ 13.55mBGL	15000	41

M4CAN
Soil Analysis Results & Screening Assessment
Alignment outside of CL sites - chainage +6,600 to +8,900
16/07/2015

Sample Reference																	
Specimen Depth (m)		BH405	BH406	BH407	BH409	BH410	BH410	BH411	BH411	BH411	BH411	BH411	BH411	TP402	TP403	TP404	
OD Level (m)		0.3 - 0.5	0.3 - 0.7	0.8 - 1.2	0.5 - 0.7	0.3 - 0.7	1 - 1.2	0.5 - 0.6	1 - 1.1	2 - 2.1	3 - 3.1	4 - 4.1	5 - 5.1	1	1	1	
Sample Type		E5	E5	E5	E5	E5	E5	E5	E5	E5	E5	E5	E5	E5	E5	E5	
Geology Code		CLAY	CLAY	CLAY	CLAY	CLAY	CLAY	MG	MG	CLAY	CLAY	SILT	CLAY	CLAY	CLAY	CLAY	
Cluster Code	Units	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	
Inorganics																	
Antimony	mg/kg																
Arsenic	mg/kg	15	12	15	13	23	15	20	19	21	12	18	24	15	11	11	
Barium	mg/kg																
Beryllium	mg/kg																
Boron	mg/kg	1.4	1.7	1.5	1.7	1.4	0.44	3.1	3.2	3.3	2.4	4.1	6	1.5	1.7	2.4	
Boron Water Soluble	mg/kg																
Cadmium	mg/kg	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	0.84	0.64	0.12	<0.1	<0.1	<0.1	0.11	<0.1	<0.1	
Chromium	mg/kg	93	35	50	49	55	43	120	77	46	32	86	38	41	31	37	
Copper	mg/kg	15	11	14	12	40	14	88	36	11	6.7	9.2	9.9	11	9.9	10	
Iron	mg/kg																
Lead	mg/kg	72	26	36	31	100	27	100	110	25	14	15	17	29	22	23	
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	0.54	<0.1	0.32	0.27	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Molybdenum	mg/kg																
Nickel	mg/kg	50	31	41	41	52	38	44	36	45	32	36	37	42	34	32	
Selenium	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.24	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Vanadium	mg/kg																
Zinc	mg/kg	220	79	120	120	170	90	160	160	96	70	82	91	100	86	98	
Cyanide (total)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Cyanide (free)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Ammoniacal Nitrogen as N	mg/kg																
Other																	
Asbestos Presence Screen	None							0	0	0	0	0	0				
Asbestos Identification	%							<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
Loss on Ignition	%				<1	<1	<1	<1	<1	<1	<1	<1	<1				
Total Organic Carbon	%	0.92			0.93					3							
pH Value	pH Units	7.2	8	7.5	7.2	7.6	8.2	9.2	9.1	8.5	9.1	8.4	8.5	8	8.2	8.3	
Material >2mm	%																
Sulphate (soluble)	g/l							1.1									
Caloric Value	MJ/kg																
Organics																	
PCBs (vs Aroclor 1254)	mg/kg																
Phenols Monohydric	mg/kg																
Phenol	mg/kg																
Phenols (total)	mg/kg							<0.3	<0.3	<0.3		<0.3	<0.3				
BTEX																	
GRO (C4-C12)	mg/kg																
MTBE	mg/kg																
Benzene	mg/kg							<0.001				<0.001	<0.001				
Toluene	mg/kg							<0.001				<0.001	<0.001				
Ethyl benzene	mg/kg							<0.001				<0.001	<0.001				
m & p Xylene	mg/kg							<0.001				<0.001	<0.001				
o Xylene	mg/kg							<0.001				<0.001	<0.001				
TPH																	
TPH >C6-C8	mg/kg				<1	<1			<1	<1							
TPH >C8-C10	mg/kg				<1	<1			<1	<1							
TPH >C10-C12	mg/kg				<1	<1			<1	<1							
TPH >C12-C16	mg/kg				<1	<1			<1	<1							
TPH >C16-C21	mg/kg				<1	<1			<1	<1							
TPH >C21-C35	mg/kg				<1	<1			<1	<1							
Aliphatics >C6-C8	mg/kg							<0.1				<0.1	<0.1				
Aliphatics >C8-C10	mg/kg							<0.1				<0.1	<0.1				
Aliphatics >C10-C12	mg/kg							<1				<1	<1				
Aliphatics >C12-C16	mg/kg							<1				<1	<1				
Aliphatics >C16-C21	mg/kg				<0.1	0.49	<0.1	1.9	1.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Aliphatics >C21-C35	mg/kg							<1				<1	<1				
Total Aliphatics >C6-C35	mg/kg																
Aliphatics >C35-44	mg/kg							<1				<1	<1				
Aromatics >C6-C7	mg/kg							<0.1				<0.1	<0.1				
Aromatics >C7-C8	mg/kg							<0.1				<0.1	<0.1				
Aromatics >C8-EC10	mg/kg							<0.1				<0.1	<0.1				
Aromatics >EC10-EC12	mg/kg							<1				<1	<1				
Aromatics >EC12-EC16	mg/kg							<1				<1	<1				
Aromatics >EC16-EC21	mg/kg							<1	<1			<1	<1				
Aromatics >EC21-EC35	mg/kg							<1				<1	<1				
Total Aromatics >C6-C35	mg/kg																
Aromatics >C35-44	mg/kg							<1				<1	<1				
Total Aliphatic TPH	mg/kg							<5				<5	<5				
Total Aromatic TPH	mg/kg							<5				<5	<5				
TPH (Aliphatics and Aromatics >C5-C35)	mg/kg							<10				<10	<10				
Total petroleum hydrocarbons	ug/kg							<10				<10	<10				
PAH																	
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.9	2.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.56	0.83	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.4	0.99	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Benzo[a]anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.43	<0.1	2.9	1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Benzo[a]pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.54	<0.1	2.4	1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Benzo[b]fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.84	<0.1	4.5	2.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Benzo[k]fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.49	<0.1	1.9	1.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Benzo[e]fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.28	<0.1	1.6	0.44	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Chrysene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.8	<0.1	3.6	1.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Dibenzo[a,h]anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.49	0.25	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.82	<0.1	6.1	4.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.1	2.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Indeno[1,2,3-cd]pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.48	<0.1	1.4	0.71	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.7	1.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Phenanthrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	4.1	4.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.87	<0.1	4.7	3.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
PAH 16 Total	mg/kg	<2	<2	<2	<2	5.6	<2	41	32	<2	<2	<2	<2	<2	<2	<2	
VOCs																	
1,1,1,2-Tetrachloroethane	ug/kg																
1,1,2,2-Tetrachloroethane	ug/kg																
1,1,1-Trichloroethane	ug/kg																
1,1,2-Trichloroethane	ug/kg																
1,1-Dichloroethane	ug/kg																
1,1-Dichloroethene	ug/kg																
1,1-Dichloropropene	ug/kg																
1,2,3-Trichlorobenzene	ug/kg																
1,2,3-Trichloropropane	ug/kg																
1,2,4-Trichlorobenzene	ug/kg																
1,2,4-Trimethylbenzene	ug/kg																
1,2-Dibromo-3-Chloropropane	ug/kg																
1,2-Dibromoethane	ug/kg																
1,2-Dichlorobenzene	ug/kg																
1,2,5-Dichloroethane	ug/kg																
1,2-Dichloropropane	ug/kg																
1,3,5-Trimethylbenzene	ug/kg																
1,3-Dichlorobenzene	ug/kg																
1,3-Dichloropropane	ug/kg																
1,4-Dichlorobenzene	ug/kg																
2,2-Dichloropropane	ug/kg						</										

Screening Values and Assessment	
Green	Exceeds S4ULs Criteria Laboratory detection level higher than screening criterion

Notes	
N/A	Not applicable
IS	Insufficient sample numbers to undertake 95UCL statistical analysis
	Chromium VI criteria used
	Elemental Mercury criteria used
Red	No S4ULs available, C4SL used instead

No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration	Selected SAULs Criteria	No. Data Exceeding SAULs Criteria
15	15	34	11	BH411 @ 1.55mbGL	170	0
0	0	None > LOD	None > LOD			0
15	15	6	0.44	BH411 @ 1.55mbGL	46000	0
15	5	0.84	0.11	BH411 @ 6.05mbGL	190	0
15	15	120	31	BH411 @ 6.05mbGL	33	13
15	15	88	6.7	BH411 @ 6.05mbGL	44000	0
15	15	110	14	BH411 @ 5.55mbGL	1300	0
15	3	0.54	0.27	BH410 @ 6.15mbGL	30	0
0	0	None > LOD	None > LOD			0
15	15	52	31	BH410 @ 6.15mbGL	980	0
15	1	0.24	0.24	BH411 @ 6.05mbGL	1800	0
					5000	0
15	15	220	70	BH405 @ 5.9mbGL	17000	0
15	0	None > LOD	None > LOD			15
15	0	None > LOD	None > LOD			15
						0
5	5	0	0	BH411 @ 6.05mbGL		0
5	0	None > LOD	None > LOD			5
0	0	None > LOD	None > LOD			0
3	3	3	0.92	BH411 @ 5.55mbGL		0
15	15	9.2	7.2	BH411 @ 6.05mbGL	6-9	3
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
						0
0	0	None > LOD	None > LOD		0.24	0
					440	0
5	0	None > LOD	None > LOD		440	0
					440	0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
3	0	None > LOD	None > LOD		27	0
3	0	None > LOD	None > LOD		56000	0
3	0	None > LOD	None > LOD		5700	0
3	0	None > LOD	None > LOD		5900	0
3	0	None > LOD	None > LOD		6600	0
4	0	None > LOD	None > LOD		7800	0
4	0	None > LOD	None > LOD		2000	0
4	0	None > LOD	None > LOD		9200	0
4	0	None > LOD	None > LOD		10000	0
4	0	None > LOD	None > LOD		7600	0
3	0	None > LOD	None > LOD		7800	0
3	0	None > LOD	None > LOD		3200	0
3	0	None > LOD	None > LOD		7800	0
3	0	None > LOD	None > LOD		2000	0
3	0	None > LOD	None > LOD		9700	0
3	0	None > LOD	None > LOD		22000	0
3	0	None > LOD	None > LOD		450000	0
3	0	None > LOD	None > LOD		450000	0
0	0	None > LOD	None > LOD		450000	0
3	0	None > LOD	None > LOD		26000	0
0	0	None > LOD	None > LOD		7800	0
3	0	None > LOD	None > LOD		56000	0
3	0	None > LOD	None > LOD		3500	0
3	0	None > LOD	None > LOD		9200	0
3	0	None > LOD	None > LOD		10000	0
3	0	None > LOD	None > LOD		7600	0
3	0	None > LOD	None > LOD		7800	0
0	0	None > LOD	None > LOD			0
3	0	None > LOD	None > LOD		7800	0
3	0	None > LOD	None > LOD			3
3	0	None > LOD	None > LOD			3
0	0	None > LOD	None > LOD			0
3	0	None > LOD	None > LOD			3
						3
15	2	2.6	1.9	BH411 @ 5.55mbGL	25000	0
15	2	0.83	0.56	BH411 @ 5.55mbGL	29000	0
15	2	1.4	0.99	BH411 @ 6.05mbGL	150000	0
15	3	2.9	0.43	BH411 @ 6.05mbGL	49	0
15	3	2.4	0.54	BH411 @ 6.05mbGL	11	0
15	3	4.5	0.84	BH411 @ 6.05mbGL	13	0
15	1.9	0.49	0.49	BH411 @ 5.55mbGL	1400	0
15	3	1.6	0.28	BH411 @ 6.05mbGL	370	0
15	3	3.6	0.8	BH411 @ 6.05mbGL	93	0
15	2	0.49	0.25	BH411 @ 6.05mbGL	1.1	0
15	3	6.1	0.82	BH411 @ 6.05mbGL	6300	0
15	2	1.7	2.1	BH411 @ 5.55mbGL	2000	0
15	3	1.4	0.48	BH411 @ 6.05mbGL	150	0
15	2	1.8	1.7	BH411 @ 5.55mbGL	190	0
15	2	4.6	4.1	BH411 @ 5.55mbGL	6200	0
15	3	4.7	0.87	BH411 @ 6.05mbGL	15000	0
15	3	41	5.6	BH411 @ 6.05mbGL		12
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			0
0	0	None > LOD	None > LOD			

Soil Analysis Results & Screening Assessment																				
Alignment outside of CL shes - chainage +8,900 to +11,850 16/07/2015																				
Sample Reference Specimen Depth (m) LO Level (m) Geology Code Cluster Code		Units	WSR1-0.1		WSR1-0.3		WSR1-2.3		WSR1-3.6		WSR2-0.3		WSR2-1.3		WSR2-2.3		WSR2-3.6		WSR2-3.6	
			2.35		1.36		0.36		-0.64		2.16		1.17		0.17		-0.83			
			E1		E1		E1		E1		E1		E1		E1		E1			
			Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	Allyl	
Inorganics																				
Antimony	mg/kg	4.1	5	2.7	<1.5	3.1	3.3	2.7	4.7											
Arsenic	mg/kg	22	28	13	<3	10	12	10	26											
Barium	mg/kg	92	120	64	26	81	83	55	66											
Beryllium	mg/kg	0.8	0.7	0.8	<0.4	0.7	0.9	0.8	0.7											
Boron	mg/kg																			
Boron Water Soluble	mg/kg	12	8.4	9.1	<3.5	9.5	11	7	8.4											
Cadmium	mg/kg	0.3	2	<0.3	<0.3	<0.3	0.3	<0.3	<0.3											
Chromium	mg/kg	40	46	36	13	38	46	34	35											
Copper	mg/kg	31	64	21	7	30	38	20	15											
Iron	mg/kg	29000	30000	35000	12000	30000	34000	35000	31000											
Lead	mg/kg	5.1	78	27	7	63	82	25	14											
Mercury	mg/kg	<0.6	0.8	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6											
Molybdenum	mg/kg	<0.6	<0.6	1.1	<0.6	<0.6	<0.6	<0.6	<0.6											
Nickel	mg/kg	33	36	39	12	28	33	33	38											
Selenium	mg/kg	<3	<3	<3	<3	<3	<3	<3	<3											
Vanadium	mg/kg	41	41	48	16	44	51	46												
Zinc	mg/kg	240	290	140	43	240	300	130	120											
Cyanide (free)	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1											
Ammoniacal Nitrogen as N	mg/kg	75	70	40	<15	99	110	35												
Other																				
Asbestos Presence Screen	None	0	0	0	0	0	0	0	0											
Asbestos Identification	%	6.8	6.4	3.7	1.4	6.7	7.2	3.6	4.3											
Loss on Ignition	%	1.9	6.2	2.1	0.4	2.7	2.9	1.5	2.4											
Total Organic Carbon	%	8.19	8.3	8.52	8.28	8.2	8.34	8.54	8.44											
Material <2mm	g/g																			
Sulphate (soluble)	g/g																			
Calorific Value	MJ/kg																			
Organics																				
PCBs (see Appendix 154)	mg/kg	0.18	2.2	<0.035	<0.035	0.21	0.44	<0.035	<0.035											
Phenols Monohydric	mg/kg	<0.15	<0.15	<0.15	<0.15	<0.15	0.74	<0.1	<0.1											
Phenol	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1											
Phenols (total)	mg/kg																			
BTEX																				
BzO (C4-C12)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
MTBE	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
Benzene	mg/kg	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009											
Toluene	mg/kg	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005											
Ethyl benzene	mg/kg	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004											
m,p-Xylene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
p-Xylene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
TPH																				
TPH >C-6	mg/kg																			
TPH <C-10	mg/kg																			
TPH <C10-C12	mg/kg																			
TPH <C12-C16	mg/kg																			
TPH <C16-C21	mg/kg																			
TPH <C21-C25	mg/kg																			
Aliphatics <C-6	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
Aliphatics <C-6-C8	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
Aliphatics <C-8-C10	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
Aliphatics <C10-C12	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
Aliphatics <C12-C16	mg/kg	<0.1	7.6	1.9	<0.1	<0.1	<0.1	<0.1	<0.1											
Aliphatics <C16-C21	mg/kg	5.2	49	3.9	7.8	13	20	<0.1	<0.1											
Aliphatics <C21-C35	mg/kg	69	210	16	15	88	130	8.1	<0.1											
Aliphatics <C35-C55	mg/kg	74	260	22	23	100	160	8.1	<0.1											
Aliphatics <C55-C67	mg/kg																			
Aromatics <C-6-C7	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
Aromatics <C-7-C8	mg/kg																			
Aromatics <C8-C10	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
Aromatics <C10-C12	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											
Aromatics <C12-C16	mg/kg	0.41	9.6	<0.1	<0.1	<0.1	0.72	<0.1	0.13											
Aromatics <C16-C21	mg/kg	3.3	26	<0.1	<0.1	4.4	7.5	1.9	0.19											
Aromatics <C21-C25	mg/kg	80	180	14	<0.1	4.4	73	17	38											
Aromatics <C25-C35	mg/kg	83	220	14	<0.1	4.9	81	18	38											
Aromatics <C35-C44	mg/kg																			
Total Aliphatic TPH	mg/kg																			
Total Aromatic TPH	mg/kg																			
Total (TPH Aliphatics and Aromatics C-5-C15)	mg/kg	160	490	36	23	150	240	27	38											
PAH																				
Acenaphthene	mg/kg	0.073	0.26	0.021	<0.014	0.075	0.097	0.029	0.021											
Acenaphthylene	mg/kg	0.058	0.18	0.009	<0.005	0.054	0.065	0.008	0.008											
Benzo[a]anthracene	mg/kg	0.16	0.68	0.039	<0.009	0.19	0.2	0.062	0.05											
Benzo[a]fluoranthene	mg/kg	0.5	1.6	0.1	0.026	0.59	0.61	0.12	0.18											
Benzo[b]fluorene	mg/kg	0.5	1.4	0.072	<0.012	0.57	0.62	0.09	0.12											
Benzo[b]fluoranthene	mg/kg	0.61	1.6	0.095	0.018	1.1	1.1	0.13	0.15											
Benzo[k]fluoranthene	mg/kg	0.38	0.91	0.09	<0.011	0.35	0.43	0.048	0.02											
Benzo[k]fluoranthene	mg/kg	0.49	1.1	0.057	<0.025	0.4	0.48	0.077	0.051											
Chrysene	mg/kg	0.6	1.7	0.11	0.018	0.73	0.73	0.13	0.15											
Dibenz[a,h]anthracene	mg/kg	0.13	0.43	0.031	<0.008	0.097	0.12	0.017	0.025											
Fluoranthene	mg/kg	0.88	2.8	0.17	<0.025	1	1.1	0.21	0.24											
Fluorene	mg/kg	0.16	0.6	0.038	<0.012	0.16	0.21	0.044	0.035											
Indeno[1,2,3-cd]pyrene	mg/kg	0.36	0.86	0.031	<0.011	0.31	0.41	0.04	0.057											
Naphthalene	mg/kg	0.22	0.85	0.065	0.016	0.22	0.28	0.084	0.05											
Phenanthrene	mg/kg	6.3	19	1.1	0.13	7.2	7.9	1.4	1.5											
Pyrene	mg/kg	0.55	1.8	0.12	0.031	0.61	0.66	0.15	0.11											
PAH 16 Total	mg/kg	0.65	2.1	0.13	0.024	0.76	0.81	0.17	0.18											
VOCs																				
1,1,1,2-Tetrachloroethane	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10											
1,1,2,2-Tetrachloroethane	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10											
1,1,1-Trichloroethane	ug/kg	<7	<7	<7	<7	<7	<7	<7	<7											
1,1,1,2-Trichloroethane	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10											
1,1-Dichloroethane	ug/kg	<8	<8	<8	<8	<8	<8	<8	<8											
1,2-Dichloroethane	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10											
1,1-Chloropropane	ug/kg	<11	<11	<11	<11	<11	<11	<11	<11											
1,2,3-Trichloropropane	ug/kg	<11	<11	<11	<11	<11	<11	<11	<11											

Screening Values and Assessment				
Green	Exceeds S4ULs Criteria Laboratory detection level higher than screening criterion			
Notes				
N/A	Not applicable Chromium VI criteria used			
Red	Elemental Mercury criteria used No S4ULs available, CASL used instead			
No. Analyses	No. Analyses Above LOD	Maximum	Minimum	Location & Depth of Maximum Concentration
8	7	5	2.7	WSRU01 @ 1.36mBGL
8	7	28	10	WSRU01 @ 1.36mBGL
8	8	120	26	WSRU01 @ 1.36mBGL
8	0	0	0.7	WSRU02 @ 1.17mBGL
0	0	None > LOD	None > LOD	
8	7	12	7	WSRU01 @ 2.35mBGL
8	3	2	0.3	WSRU01 @ 1.36mBGL
8	8	48	13	WSRU02 @ 1.17mBGL
8	8	7	7	WSRU01 @ 1.36mBGL
8	8	35000	12000	WSRU01 @ 0.36mBGL / WSRU02 @ 0.17mBGL
8	8	82	7	WSRU02 @ 1.17mBGL
8	1	0.8	0.8	WSRU01 @ 1.36mBGL
8	3	1.1	0.6	WSRU01 @ 0.36mBGL
8	8	12	36	WSRU02 @ -0.83mBGL
8	0	None > LOD	None > LOD	
8	8	51	16	WSRU02 @ 1.17mBGL
8	8	300	43	WSRU02 @ 1.17mBGL
8	0	None > LOD	None > LOD	
8	7	110	35	WSRU02 @ 1.17mBGL
8	8	0	0	WSRU01 @ 2.35mBGL
0	0	None > LOD	None > LOD	
8	8	7.2	1.4	WSRU02 @ 1.17mBGL
8	8	6.2	0.4	WSRU01 @ 1.36mBGL
8	8	8.52	5.19	WSRU01 @ 0.17mBGL
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
8	4	2.7	0.78	WSRU01 @ 1.36mBGL
8	1	0.71	0.14	WSRU02 @ 1.17mBGL
8	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	1	0.006	0.006	WSRU01 @ -0.64mBGL
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	7	7.6	1.9	WSRU01 @ 1.36mBGL
8	7	210	8.1	WSRU01 @ 1.36mBGL
8	7	260	8.1	WSRU01 @ 1.36mBGL
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	6	9.6	0.13	WSRU01 @ 1.36mBGL
8	4	26	0.19	WSRU01 @ 1.36mBGL
8	7	190	14	WSRU01 @ 1.36mBGL
8	4	280	14	WSRU01 @ 1.36mBGL
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
0	0	None > LOD	None > LOD	
8	0	490	23	WSRU01 @ 1.36mBGL
8	0	None > LOD	None > LOD	
8	7	0.26	0.021	WSRU01 @ 1.36mBGL
8	7	0.18	0.008	WSRU01 @ 1.36mBGL
8	7	0.68	0.039	WSRU01 @ 1.36mBGL
8	1.6	8	0.016	WSRU01 @ 1.36mBGL
8	7	1.4	0.072	WSRU01 @ 1.36mBGL
8	8	0.59	0.018	WSRU01 @ 1.36mBGL
8	7	0.96	0.048	WSRU01 @ 1.36mBGL
8	1.1	0.057	0.007	WSRU01 @ 1.36mBGL
8	7	1.7	0.018	WSRU01 @ 1.36mBGL
8	7	0.43	0.013	WSRU01 @ 1.36mBGL
8	7	2.8	0.17	WSRU01 @ 1.36mBGL
8	7	0.6	0.085	WSRU01 @ 1.36mBGL
8	8	0.86	0.031	WSRU01 @ 1.36mBGL
8	8	0.85	0.016	WSRU01 @ 1.36mBGL
8	8	1.9	0.13	WSRU01 @ 1.36mBGL
8	8	1.8	0.031	WSRU01 @ 1.36mBGL
8	8	2.1	0.024	WSRU01 @ 1.36mBGL
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	
8	0	None > LOD	None > LOD	

Sample Reference	Units	SBHJ02CP	SBHJ02CP	SBHJ03CP	SBHJ03CP	BH502	BH502	BH503	BH503	BH503	BH507	BH507	BH510	BH534	BH535	BH535	BH536A	TP503	TP515	TP516	TP516	TP517	TP517	
Specimen Depth (m)		0.3	5	0.3	1	0.2 - 0.5	0.5 - 1	0.2 - 0.3	0.5 - 0.7	0.9 - 1.1	0.2 - 0.3	0.6 - 0.8	0 - 0.3	0.3 - 0.5	0.3 - 0.5	0.5 - 0.9	0.4 - 0.6	1	1	0 - 0.2	0.2 - 0.4	0 - 0.1	0.7 - 0.9	
OD Level (m)		5.03	0.33	5.07	4.37	6	5.7	5.95	5.65	5.25	5.25	4.85	5.45	4.95	4.85	4.65	4.15	4.6	4.25	5.15	4.95	4.45	3.75	
Sample Type		ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES	ES
Geology Code		ALLUV	PEAT	TOPSOIL	ALLUV	CLAY	CLAY	MG	MG	CLAY	MG	MG	CLAY	CLAY	CLAY	CLAY	MG	CLAY	CLAY	CLAY	CLAY	MG	CLAY	
Cluster Code		2008 GI	2008 GI	2008 GI	2008 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	2015 GI	
VOCs																								
1,1,1,2-Tetrachloroethane	ug/kg	<10	<10	<10	<10			<2	<2															
1,1,1,2,2-Tetrachloroethane	ug/kg	<10	<10	<10	<10																			
1,1,1-Trichloroethane	ug/kg	<7	<7	<7	<7			<1	<1															
1,1,2-Trichloroethane	ug/kg	<10	<10	<10	<10			<10	<10															
1,1-Dichloroethane	ug/kg	<8	<8	<8	<8			<1	<1															
1,1-Dichloroethene	ug/kg	<10	<10	<10	<10			<1	<1															
1,1-Dichloropropene	ug/kg	<11	<11	<11	<11			<1	<1															
1,2,3-Trichlorobenzene	ug/kg	<11	<11	<11	<11			<2	<2															
1,2,3-Trichloropropane	ug/kg	<17	<17	<17	<17			<50	<50															
1,2,4-Trichlorobenzene	ug/kg	<6	<6	<6	<6			<2	<2															
1,2,4-Trimethylbenzene	ug/kg	<9	<9	<9	<9			<1	<1															
1,2-Dibromo-3-Chloropropane	ug/kg	<14	<14	<14	<14			<50	<50															
1,2-Dibromoethane	ug/kg	<12	<12	<12	<12			<5	<5															
1,2-Dichlorobenzene	ug/kg	<12	<12	<12	<12			<1	<1															
1,2-Dichloroethane	ug/kg	<5	<5	<5	<5			<2	<2															
1,2-Dichloropropane	ug/kg	<12	<12	<12	<12			<1	<1															
1,3,5-Trimethylbenzene	ug/kg	<8	<8	<8	<8			<1	<1															
1,3-Dichlorobenzene	ug/kg	<6	<6	<6	<6			<1	<1															
1,3-Dichloropropane	ug/kg	<7	<7	<7	<7			<1	<1															
1,4-Dichlorobenzene	ug/kg	<5	<5	<5	<5			<1	<1															
2,2-Dichloropropane	ug/kg	<12	<12	<12	<12																			
2-Chlorotoluene	ug/kg	<9	<9	<9	<9			<1	<1															
4-Chlorotoluene	ug/kg	<12	<12	<12	<12			<1	<1															
4-Isopropyltoluene	ug/kg	<11	<11	<11	<11			<1	<1															
Bromobenzene	ug/kg	<10	<10	<10	<10			<1	<1															
Bromochloromethane	ug/kg	<14	<14	<14	<14			<5	<5															
Bromodichloromethane	ug/kg	<7	<7	<7	<7			<5	<5															
Bromoform	ug/kg	<10	<10	<10	<10																			
Bromomethane	ug/kg	<13	<13	<13	<13			<20	<20															
Carbon Disulphide	ug/kg	<7	<7	<7	<7																			
Chlorobenzene	ug/kg	<5	<5	<5	<5			<1	<1															
Chloroethane	ug/kg	<14	<14	<14	<14			<2	<2															
Chloroethene	ug/kg							<1	<1															
Chloroform	ug/kg	<8	<8	<8	<8			<1	<1															
Chloromethane	ug/kg	<7	<7	<7	<7			<1	<1															
cis-1,2-Dichloroethene	ug/kg	<5	<5	<5	<5			<1	<1															
cis-1,3-Dichloropropene	ug/kg	<14	<14	<14	<14			<10	<10															
Dibromochloromethane	ug/kg	<13	<13	<13	<13			<10	<10															
Dibromomethane	ug/kg	<9	<9	<9	<9			<1	<1															
Dichlorodifluoromethane	ug/kg	<4	<4	<4	<4			<1	<1															
Dichloromethane	ug/kg	<10	<10	<10	<10																			
Hexachlorobutadiene (HCBD)	ug/kg	<12	<12	<12	<12			<1	<1															
Isopropylbenzene	ug/kg	<5	<5	<5	<5			<1	<1															
n-Butylbenzene	ug/kg	<10	<10	<10	<10			<1	<1															
n-propylbenzene	ug/kg	<11	<11	<11	<11			<1	<1															
Sec-Butylbenzene	ug/kg	<10	<10	<10	<10			<1	<1															
Styrene	ug/kg	<10	<10	<10	<10			<1	<1															
Tert-Butylbenzene	ug/kg	<12	<12	<12	<12			<1	<1															
Tetrachloroethene	ug/kg	<5	<5	<5	<5			<1	<1															
Tetrachloromethane (Carbon Tetra Chloride)	ug/kg	<14	<14	<14	<14			<1	<1															
trans-1,2-Dichloroethene	ug/kg	<11	<11	<11	<11			<1	<1															
trans-1,3-Dichloropropene	ug/kg	<14	<14	<14	<14			<10	<10															
Tribromomethane	ug/kg							<1	<1															
Trichloroethene	ug/kg	<9	<9	<9	<9			<1	<1															
Trichlorofluoromethane	ug/kg	<6	<6	<6	<6			<1	<1															
Vinyl Chloride	ug/kg	<10	<10	<10	<10																			
SVOCs																								
2,4,5-Trichlorophenol	mg/kg	<0.1	<0.1	<0.1	<0.1			<0.5	<0.5															
2,4,6-Trichlorophenol	mg/kg	<0.1	<0.1	<0.1	<0.1			<0.5	<0.5															
2,4-Dichlorophenol	mg/kg	<0.1	<0.1	<0.1	<0.1			<0.5	<0.5															
2,4-Dimethylphenol	mg/kg	<0.1	<0.1	<0.1	<0.1			<0.5	<0.5															

Monitoring Round		Screening Criteria					
Location	Units	EQS	DWS	SBHD06	SBHD06	SBH03	SBH03
Phenols							
Dimethylphenols	ug/l						
Trimethylphenols	ug/l						
2-Chlorophenol	ug/l	50		<1	<1	<1	<1
2-Methyl-4,6-Dinitrophenol	ug/l						
2-Methylphenol	ug/l	100		<1	<1	<1	<1
2-Nitrophenol	ug/l			<1	<1	<1	<1
2,4-Dichlorophenol	ug/l	20		<1	<1	<1	<1
2,4-Dimethylphenol	ug/l			<1	<1	<1	<1
2,4,5-Trichlorophenol	ug/l			<1	<1	<1	<1
2,4,6-Trichlorophenol	ug/l			<1	<1	<1	<1
4-Chloro-3-methylphenol	ug/l	40		<1	<1	<1	<1
4-Methylphenol	ug/l	100		<1	<1	<1	<1
4-Nitrophenol	ug/l			<1	<1	<1	<1
Pentachlorophenol	ug/l	0.4		<1	<1	<1	<1
Phenol	ug/l	7.7		<1	<1	<1	<1
Phenols	mg/l	0.0077					
PAHs							
2-Chloronaphthalene	ug/l			<1	<1	<1	<1
2-Methylbiphenyl	ug/l			<1	<1	<1	<1
Acenaphthene	ug/l			<1	<1	<1	<1
Acenaphthylene	ug/l			<1	<1	<1	<1
Anthracene	ug/l	0.1		<1	<1	<1	<1
Benzo[a]anthracene	ug/l			<1	<1	<1	<1
Benzo[a]pyrene	ug/l	0.00017	0.01	<1	<1	<1	<1
Benzo[b]fluoranthene	ug/l	0.017	0.1	<1	<1	<1	<1
Benzo[ghi]perylene	ug/l	0.0082	0.1	<1	<1	<1	<1
Benzo[k]fluoranthene	ug/l	0.017	0.1	<1	<1	<1	<1
Chrysene	ug/l			<1	<1	<1	<1
Dibenz[a,h]anthracene	ug/l			<1	<1	<1	<1
Fluoranthene	ug/l	0.0063		<1	<1	<1	<1
Fluorene	ug/l			<1	<1	<1	<1
Indeno[1,2,3-cd]pyrene	ug/l		0.1	<1	<1	<1	<1
Naphthalene	ug/l	2		<1	<1	<1	<1
Phenanthrene	ug/l			<1	<1	<1	<1
Pyrene	ug/l			<1	<1	<1	<1
Total PAHs (USEPA 16)	ug/l						
Phthalates							
Bis(2-ethylhexyl) phthalate	ug/l	1.3		<2	<2	<2	<2
Bis(2-butyl) phthalate	ug/l	20		<1	<1	<1	<1
Di-n-butyl phthalate	ug/l	8		<1	<1	<1	<1
Di-n-Octyl phthalate	ug/l	20		<5	<5	<5	<5
Diethyl phthalate	ug/l	200		<1	<1	<1	<1
Dimethyl phthalate	ug/l	800		<1	<1	<1	<1
VOCs							
Full suite	ug/l						
1,1,1,2-Tetrachloroethane	ug/l			<1	<1	<1	<1
1,1,1-Trichloroethane	ug/l	100		<1	<1	<1	<1
1,1,1,2,2-Tetrachloroethane	ug/l	#N/A	#N/A				
1,1,2-Trichloroethane	ug/l	400		<1	<1	<1	<1
1,1-Dichloroethane	ug/l			<1	<1	<1	<1
1,1-Dichloroethene	ug/l			<1	<1	<1	<1
1,1-Dichloropropene	ug/l			<1	<1	<1	<1
1,2,3-Trichlorobenzene	ug/l			<1	<1	<1	<1
1,2,3-Trichloropropane	ug/l	0.4		<1	<1	<1	<1
1,2,4-Trichlorobenzene	ug/l	0.4		<1	<1	<1	<1
1,2,4-Trimethylbenzene	ug/l			<1	<1	<1	<1
1,2-Dibromo-3-Chloropropane	ug/l			<1	<1	<1	<1
1,2-Dibromomethane	ug/l			<1	<1	<1	<1
1,2-Dichlorobenzene	ug/l	20		<1	<1	<1	<1
1,2-Dichloroethane	ug/l	10	3	<1	<1	<1	<1
1,2-Dichloropropane	ug/l			<1	<1	<1	<1
1,3,5-Trimethylbenzene	ug/l			<1	<1	<1	<1
1,3-Dichloropropane	ug/l			<1	<1	<1	<1
1,4-Dichlorobenzene	ug/l	20		<1	<1	<1	<1
2-Chlorotoluene	ug/l			<1	<1	<1	<1
4-Chlorotoluene	ug/l			<1	<1	<1	<1
4-Isopropyltoluene	ug/l			<1	<1	<1	<1
Benzene	ug/l	10	1	<1	<1	<1	<1
Bromobenzene	ug/l			<1	<1	<1	<1
Bromochloromethane	ug/l	100		<1	<1	<1	<1
Bromodichloromethane	ug/l			<1	<1	<1	<1
Bromofrom	ug/l			<1	<1	<1	<1
Bromomethane	ug/l			<1	<1	<1	<1
Carbon Disulphide	ug/l			<1	<1	<1	<1
Chlorobenzene	ug/l			<1	<1	<1	<1
Chloroethane	ug/l			<1	<1	<1	<1
Chloroethene	ug/l			<1	<1	<1	<1
Chloroform	ug/l	2.5	100	<1	<1	<1	<1
Chloromethane	ug/l			<1	<1	<1	<1
cis-1,2-Dichloroethene	ug/l			<1	<1	<1	<1
cis-1,3-Dichloropropene	ug/l			<1	<1	<1	<1
Dibromochloromethane	ug/l		100	<1	<1	<1	<1
Dibromomethane	ug/l			<1	<1	<1	<1
Dichlorodifluoromethane	ug/l			<1	<1	<1	<1
Dichloromethane	ug/l	20		<1	<1	<1	<1
Ethylbenzene	ug/l	20		<1	<1	<1	<1
Hexachlorobutadiene (HCBD)	ug/l	0.6		<1	<1	<1	<1
Isopropylbenzene	ug/l			<1	<1	<1	<1
m,p xylenes	ug/l	30		<1	<1	<1	<1
Methyl tert-butyl ether (MTBE)	ug/l			<1	<1	<1	<1
n-Butylbenzene	ug/l			<1	<1	<1	<1
n-propylbenzene	ug/l			<1	<1	<1	<1
O-xylene	ug/l	30		<1	<1	<1	<1
Sec-Butylbenzene	ug/l			<1	<1	<1	<1
Styrene	ug/l	50		<1	<1	<1	<1
Tert-Butylbenzene	ug/l			<1	<1	<1	<1
Tetrachloroethene	ug/l	10	10	<1	<1	<1	<1
Tetrachloromethane (Carbon Tetra Chloride)	ug/l	12	3	<1	<1	<1	<1
Toluene	ug/l	50		<1	<1	<1	<1
trans-1,2-Dichloroethene	ug/l			<1	<1	<1	<1
trans-1,3-Dichloropropene	ug/l			<1	<1	<1	<1
Tribromochloromethane	ug/l		100	<1	<1	<1	<1
Tribromomethane	ug/l			<1	<1	<1	<1
Trichlorofluoromethane	ug/l	10	10	<1	<1	<1	<1
Trichloroethene	ug/l			<1	<1	<1	<1
Vinyl Chloride	ug/l	#N/A	#N/A	<1	<1	<1	<1
Other Semi-Volatiles							
1,2-Dichlorobenzene	ug/l	20		<1	<1	<1	<1
1,2,4-Trichlorobenzene	ug/l	0.4		<1	<1	<1	<1
1,3-Dichlorobenzene	ug/l	20		<1	<1	<1	<1
1,4-Dichlorobenzene	ug/l	20		<1	<1	<1	<1
2-Nitroaniline	ug/l			<1	<1	<1	<1
2,4-Dinitrotoluene	ug/l			<1	<1	<1	<1
2,6-Dinitrotoluene	ug/l			<1	<1	<1	<1
2-Methylnaphthalene	ug/l			<1	<1	<1	<1
3-Nitroaniline	ug/l			<1	<1	<1	<1
4-Bromophenylphenylether	ug/l			<1	<1	<1	<1
4-Chloroaniline	ug/l			<1	<1	<1	<1
4-Chlorophenylphenylether	ug/l			<1	<1	<1	<1
4-Nitroaniline	ug/l			<1	<1	<1	<1
Azobenzene	ug/l			<1	<1	<1	<1
Bis(2-chloroethoxy)methane	ug/l			<1	<1	<1	<1
Bis(2-chloroethyl)ether	ug/l			<1	<1	<1	<1
Bis(2-chloroisopropyl)ether	ug/l						
Carbazole	ug/l			<1	<1	<1	<1
Dibenzofuran	ug/l			<1	<1	<1	<1
Hexachlorobenzene	ug/l	0.05		<1	<1	<1	<1
Hexachlorobutadiene	ug/l	0.6		<1	<1	<1	<1
Hexachlorocyclopentadiene	ug/l			<1	<1	<1	<1
Hexachloroethane	ug/l			<1	<1	<1	<1
Isophorene	ug/l			<1	<1	<1	<1
N-nitrosodi-n-propylamine	ug/l			<1	<1	<1	<1
Nitrobenzene	ug/l			<1	<1	<1	<1

[illegible]

Monitoring Round		Screening Criteria		Location																											
Location Type				Response Zone (RZ) Details																											
Drainage Area				Installation Details																											
Date Sampled		Metals																													
Metals		Non-Metal Inorganics																													
Hardness Total		Organics																													
PCBs		PCBs																													

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Screening Values & Assessment

	Exceeds EQS
X	Exceeds DWS
X	Laboratory detection level higher than screening criterion

Notes

EQS calcium carbonate 200-250mg/l for heavy metals: chromium, copper, lead, nickel and zinc	
X Installation Details not specified. Assumptions made from details from previous rounds.	

GROUNDWATER (ALL DATA) DATA SUMMARY

Parameter	Units	No. Analyses	Analyses Above LOD		Concentration		Location with Maximum Concentration
			No.	% Age	Range	Average	
Arsenic Dissolved	ug/l	117	91	77.8%	1 - 69	8.991	BH503A @ Shallow
Beryllium Dissolved	ug/l	11	0	None > LOD	None > LOD	None > LOD	
Boron Dissolved	ug/l	113	104	92.0%	40 - 4500	903.876	BH533 @ Deep
Calcium Dissolved	ug/l	13	4	30.8%	65000 - 77000	22076.923	SBHD06 @ 7.5 - 15
Chromium Dissolved	ug/l	117	87	74.4%	1.1 - 320	24.379	BH503A @ Shallow
Copper Dissolved	ug/l	117	75	64.1%	1.1 - 2000	63.262	@
Iron Dissolved	ug/l	17	9	52.9%	9 - 7700	953.471	SBHD06 @ 7.5 - 15
Lead Dissolved	ug/l	117	12	10.3%	1 - 10	0.382	@
Magnesium Dissolved	ug/l	16	4	25.0%	42000 - 94000	16687.500	SBHD06 @ 7.5 - 15
Manganese Dissolved	ug/l	16	10	62.5%	30 - 1600	265.000	SBHD06 @ 7.5 - 15
Nickel Dissolved	ug/l	117	93	79.5%	1 - 32	4.483	BH401 @ 7.5-13
Selenium Dissolved	ug/l	117	98	83.8%	1 - 230	10.821	BH503A @ Shallow
Cadmium Dissolved	ug/l	113	13	11.5%	0.086 - 5	0.157	@
Vanadium Dissolved	ug/l	11	2	18.2%	3 - 5	0.727	SBHD06 @ 7.5 - 15
Zinc Dissolved	ug/l	110	77	70.0%	1 - 75	7.305	Location @ Installation Details
Mercury Dissolved	ug/l	113	23	20.4%	0.07 - 2.4	0.200	BH536A @ Deep
Cadmium Total	ug/l	16	9	56.3%	0.15 - 18	2.228	SBHD06 @ 7.5 - 15
Zinc Total	ug/l	13	7	53.8%	67 - 1800	184.769	SBHD06 @ 7.5 - 15
Mercury Total	ug/l	16	8	50.0%	0.01 - 1	0.204	@
Hardness Total	mg/l	13	4	30.8%	340 - 580	140.000	SBHD06 @ 7.5 - 15
Total Alkalinity as CaCO3	mg/l	13	4	30.8%	340 - 2000	309.231	SBHD06 @ 7.5 - 15
BOD	mg/l	13	6	46.2%	2 - 78	11.615	SBHD06 @ 7.5 - 15
COD	mg/l	13	4	30.8%	25 - 1000	90.385	SBHD06 @ 7.5 - 15
Potassium Dissolved	mg/l	13	4	30.8%	7.8 - 41	7.262	SBHD06 @ 7.5 - 15
Sodium Dissolved	mg/l	16	7	43.8%	15 - 1200	127.188	SBHD06 @ 7.5 - 15
Nitrate as NO3	mg/l	16	4	25.0%	0.3 - 50	9.394	@
Total Diss Sulphur	mg/l	9	0	None > LOD	None > LOD	None > LOD	
Sulphate (soluble)	mg/l	16	10	62.5%	27 - 400	137.688	Location @ Installation Details
Chloride	mg/l	61	55	90.2%	13 - 3000	344.787	DWS @
Sulphide	mg/l	13	0	None > LOD	None > LOD	None > LOD	
Ammoniacal Nitrogen as N	mg/l	58	51	87.9%	0.017 - 19	2.772	BH506 @ Shallow
Unionised ammonia	mg/l	9	0	None > LOD	None > LOD	None > LOD	
Total Ammonium as NH4	mg/l	14	5	35.7%	0.5 - 21	1.650	SBHD06 @ 7.5 - 15
Phenols Monohydric	mg/l	13	0	None > LOD	None > LOD	None > LOD	
Thiocyanate	mg/l	9	0	None > LOD	None > LOD	None > LOD	
Total Cyanide	mg/l	16	6	37.5%	0.001 - 0.05	0.010	@
Free Cyanide	mg/l	110	0	None > LOD	None > LOD	None > LOD	
Complex Cyanide	mg/l	9	0	None > LOD	None > LOD	None > LOD	
Carbon Dioxide Dissolved	ug/l	11	2	18.2%	14 - 79	8.455	SBHD06 @ 7.5 - 15
pH Value	pH units	117	105	89.7%	7.2 - 8.8	7.184	BH537 @ Deep
GRO (C4-C12)	ug/l	13	0	None > LOD	None > LOD	None > LOD	
MTBE	ug/l	35	0	None > LOD	None > LOD	None > LOD	
Benzene	ug/l	120	6	5.0%	1 - 10	0.275	Location @ Installation Details
Toluene	ug/l	117	3	2.6%	50 - 50	1.282	Location @ Installation Details
Ethyl benzene	ug/l	117	3	2.6%	20 - 30	0.513	Location @ Installation Details
m & p Xylene	ug/l	117	3	2.6%	30 - 30	0.769	Location @ Installation Details
o Xylene	ug/l	117	3	2.6%	30 - 30	0.769	Location @ Installation Details
Aliphatics C5-C6	ug/l	117	0	None > LOD	None > LOD	None > LOD	
Aliphatics >C5-C8	ug/l	117	0	None > LOD	None > LOD	None > LOD	
Aliphatics >C8-C10	ug/l	117	0	None > LOD	None > LOD	None > LOD	
Aliphatics >C10-C12	ug/l	117	1	0.9%	4.3	gle Analysis > L	BH411 @ Shallow
Aliphatics >C12-C16 Aqueous	ug/l	117	3	2.6%	61 - 350	4.222	SBHD06 @ 7.5 - 15
Aliphatics >C16-C21 Aqueous	ug/l	117	3	2.6%	21 - 140	1.684	SBHD06 @ 7.5 - 15
Aliphatics >C21-C35 Aqueous	ug/l	117	2	1.7%	260 - 810	9.145	BH411 @ Shallow
Total Aliphatics C5-C35 Aqueous	ug/l	113	1	0.9%	500	gle Analysis > L	SBHD06 @ 7.5 - 15
Aliphatics >C35-44	ug/l	113	2	1.8%	9.9 - 31	0.362	BH411 @ Shallow
Aromatics >C5-C7	ug/l	113	0	None > LOD	None > LOD	None > LOD	
Aromatics C6-C7	ug/l	113	0	None > LOD	None > LOD	None > LOD	
Aromatics >C7-C8	ug/l	117	0	None > LOD	None > LOD	None > LOD	
Aromatics >C8-EC10	ug/l	117	0	None > LOD	None > LOD	None > LOD	
Aromatics >EC10-EC12	ug/l	117	1	0.9%	4.2	gle Analysis > L	BH411 @ Shallow
Aromatics >EC12-EC16 Aqueous	ug/l	117	4	3.4%	13 - 10000	90.923	SBHD06 @ 7.5 - 15
Aromatics >EC16-EC21 Aqueous	ug/l	117	4	3.4%	16 - 1400	17.735	SBHD06 @ 7.5 - 15
Aromatics >EC21-EC35 Aqueous	ug/l	117	4	3.4%	50 - 510	7.410	SBHD06 @ 7.5 - 15
Total Aromatics C6-C35 Aqueous	ug/l	113	2	1.54%	1700 - 12000	1053.846	SBHD06 @ 7.5 - 15
Aromatics >C35-44	ug/l	113	1	0.9%	11	gle Analysis > L	BH411 @ Shallow
Total Aliphatic TPH	ug/l	113	2	1.8%	370 - 950	11.681	BH411 @ Shallow
Total Aromatic TPH	ug/l	9	0	None > LOD	None > LOD	None > LOD	
TPH (Aliphatics and Aromatics)	ug/l	12	2	16.7%	2200 - 12000	1183.333	SBHD06 @ 7.5 - 15
Total petroleum hydrocarbons	ug/l	113	2	1.8%	480 - 1100	13.982	BH411 @ Shallow
TPH FTIR	ug/l	9	0	None > LOD	None > LOD	None > LOD	
TPH GC	ug/l	9	0	None > LOD	None > LOD	None > LOD	
PCB- ARO	ug/l	9	0	None > LOD	None > LOD	None > LOD	
Cresols	ug/l	9	0	None > LOD	None > LOD	None > LOD	
Pcb-101 2,2',4,5,5' - Pentachlorobiphenyl	ug/l	32	0	None > LOD	None > LOD	None > LOD	
Pcb-118 2,3',4,4',5' - Pentachlorobiphenyl	ug/l	32	0	None > LOD	None > LOD	None > LOD	
Pcb-138 2,2',3,4,4',5' - Hexachlorobiphenyl	ug/l	32	0	None > LOD	None > LOD	None > LOD	
Pcb-153 2,2',4,4',5,5' - Hexachlorobiphenyl	ug/l	32	0	None > LOD	None > LOD	None > LOD	
Pcb-180 2,2',3,4,4',5,5' - Heptachlorobiphenyl	ug/l	32	0	None > LOD	None > LOD	None > LOD	
Pcb-28 2,4,4' - Trichlorobiphenyl	ug/l	32	0	None > LOD	None > LOD	None > LOD	
Pcb-52 2,2',5,5' - Tetrachlorobiphenyl	ug/l	32	0	None > LOD	None > LOD	None > LOD	

GROUNDWATER (ALL DATA) WATER QUALITY SCREENING ASSESSMENT

Parameter	Units	EQS	Analyses Above EQS		DWS	Analyses Above DWS	
			No.	%age		No.	%age
Metals							
Arsenic Dissolved	ug/l	50	2	1.7%	10	27	23.1%
Beryllium Dissolved	ug/l						
Boron Dissolved	ug/l	2000	10	8.8%	1000	29	25.7%
Calcium Dissolved	ug/l						
Chromium Dissolved	ug/l				50	18	15.4%
Copper Dissolved	ug/l	10	32	27.4%	2000	0	None>DWS
Iron Dissolved	ug/l	1000	2	11.8%	200	5	29.4%
Lead Dissolved	ug/l	1.2	5	4.3%	10	0	None>DWS
Magnesium Dissolved	ug/l						
Manganese Dissolved	ug/l	30	5	31.3%	50	2	12.5%
Nickel Dissolved	ug/l	4	39	33.3%	20	1	0.9%
Selenium Dissolved	ug/l				10	24	20.5%
Cadmium Dissolved	ug/l	0.15	6	5.3%	5	0	None>DWS
Vanadium Dissolved	ug/l						
Zinc Dissolved	ug/l	75	0	None>EQS			
Mercury Dissolved	ug/l	0.07	20	17.7%	1	8	7.1%
Cadmium Total	ug/l	0.15	5	31.3%	5	1	6.3%
Zinc Total	ug/l	75	2	15.4%	1		
Mercury Total	ug/l	0.07	3	18.8%	1	0	None>DWS
Non-Metal Inorganics							
Hardness Total	mg/l						
Total Alkalinity as CaCO3	mg/l						
BOD	mg/l	5	2	15.4%			
COD	mg/l						
Potassium Dissolved	mg/l						
Sodium Dissolved	mg/l				200	1	6.3%
Nitrate as NO3	mg/l				50	0	None>DWS
Total Diss Sulphur	mg/l						
Sulphate (soluble)	mg/l	400	0	None>EQS	250	3	18.8%
Chloride	mg/l	250	14	23.0%	250	14	23.0%
Sulphide	mg/l						
Ammoniacal Nitrogen as N	mg/l	0.6	18	31.0%			
Unionised ammonia	mg/l						
Total Ammonium as NH4	mg/l				0.5	1	7.1%
Phenols Monohydric	mg/l						
Thiocyanate	mg/l						
Total Cyanide	mg/l	0.001	3	18.8%	0.05	0	None>DWS
Free Cyanide	mg/l						
Complex Cyanide	mg/l						
Carbon Dioxide Dissolved	ug/l						
pH Value	pH units	6-9	8	6.8%	6.5-10	6	5.1%
Organics							
GRO (C4-C12)	ug/l						
MTBE	ug/l						
Benzene	ug/l	10	0	None>EQS	1	3	2.5%
Toluene	ug/l	50	0	None>EQS			
Ethyl benzene	ug/l	20	0	None>EQS			
m & p Xylene	ug/l	30	0	None>EQS			
o Xylene	ug/l	30	0	None>EQS			
TPH							
Aliphatics C5-C6	ug/l						
Aliphatics >C5-C8	ug/l						
Aliphatics >C8-C10	ug/l						
Aliphatics >C10-C12	ug/l						
Aliphatics >C12-C16 Aqueous	ug/l						
Aliphatics >C16-C21 Aqueous	ug/l						
Aliphatics >C21-C35 Aqueous	ug/l						
Total Aliphatics C5-C35 Aqueous	ug/l						
Aliphatics >C35-44	ug/l						
Aromatics >C5-C7	ug/l						
Aromatics C6-C7	ug/l						
Aromatics >C7-C8	ug/l						
Aromatics >C8-EC10	ug/l						
Aromatics >EC10-EC12	ug/l						
Aromatics >EC12-EC16 Aqueous	ug/l						
Aromatics >EC16-EC21 Aqueous	ug/l						
Aromatics >EC21-EC35 Aqueous	ug/l						
Total Aromatics C6-C35 Aqueous	ug/l						
Aromatics >C35-44	ug/l						
Total Aliphatic TPH	ug/l						
Total Aromatic TPH	ug/l						
TPH (Aliphatics and Aromatics)	ug/l						
TPH (Aliphatics and Aromatics) C5-C35	ug/l						
Total petroleum hydrocarbons	ug/l						
TPH FTIR	ug/l						
TPH GC	ug/l						
PCBs							
PCB- ARO	ug/l						
Cresols	ug/l						
Pcb-101 2,2',4,5,5' - Pentachlorobiphenyl	ug/l						
Pcb-118 2,3',4,4',5' - Pentachlorobiphenyl	ug/l						
Pcb-138 2,2',3,4,4',5' - Hexachlorobiphenyl	ug/l						
Pcb-153 2,2',4,4',5,5' - Hexachlorobiphenyl	ug/l						
Pcb-180 2,2',3,4,4',5,5' - Heptachlorobiphenyl	ug/l						
Pcb-28 2,4,4' - Trichlorobiphenyl	ug/l						
Pcb-52 2,2',5,5' - Tetrachlorobiphenyl	ug/l						

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Surface Water Dataset Summary

Parameter	Unit	No. Analyses	Analyses Above LOD		Concentration	
			No.	%age of Analyses	Range	Average
General Parameters						
Alkalinity	mg CaCO3/l	28	26	92.9%	170 - 1500	514
Total Hardness as CaCO3	mg/l	55	53	96.4%	100 - 491	265
Ammoniacal Nitrogen as N	mg/l	98	74	75.5%	0.034 - 1.7	0.28
BOD + ATU (5 day)	mg/l	72	42	58.3%	1 - 33	6.11
Calcium (diss.filt)	mg/l	71	69	97.2%	2.8 - 152	66.4
Chloride	mg/l	98	96	98.0%	7 - 250	42.7
Conductivity	uS/cm	56	54	96.4%	206 - 1164	563
Cyanide	mg/l	28	0	None > LOD	None > LOD	None > LOD
Dissolved oxygen	mg/l	72	68	94.4%	0.47 - 13.6	6.52
Dissolved oxygen (saturation)	%	55	51	92.7%	3.7 - 139.3	54.1
Magnesium dissolved as Mg	mg/l	55	53	96.4%	1.1 - 35	15.6
Nitrogen, Total Oxidised as N	mg/l	72	39	54.2%	0.123 - 9.43	2.08
Nitrate as NO3	mg/l	72	45	62.5%	0.467 - 41.5	8.0
Nitrite as NO2	mg/l	72	14	19.4%	0.05 - 0.2	0.100
pH	pH Units	82	80	97.6%	7 - 12	8.04
Phosphate, Ortho as P	mg/l	71	43	60.6%	0.0424 - 4.2	0.67
Suspended solids, Total	mg/l	72	65	90.3%	2 - 714	72.8
Sulphate	mg/l	72	62	86.1%	7 - 110	30.8
Metals						
Arsenic	ug/l	42	37	88.1%	0.253 - 6.9	2.16
Boron	ug/l	28	26	92.9%	24 - 1300	548
Cadmium	ug/l	97	27	27.8%	0.097 - 2.9	0.88
Chromium	ug/l	97	34	35.1%	0.671 - 18	5.81
Copper	ug/l	97	41	42.3%	0.852 - 19	4.63
Lead	ug/l	97	30	30.9%	0.026 - 27	4.11
Mercury	ug/l	42	4	9.5%	0.68 - 2.5	1.45
Nickel	ug/l	97	42	43.3%	0.644 - 15	3.34
Selenium	ug/l	42	27	64.3%	0.47 - 4.9	1.76
Zinc	ug/l	97	94	96.9%	0.558 - 360	27.79
BTEX Compounds						
Sum of detected BTEX	ug/l	18	0	None > LOD	None > LOD	None > LOD
Benzene	ug/l	45	0	None > LOD	None > LOD	None > LOD
Ethylbenzene	ug/l	45	0	None > LOD	None > LOD	None > LOD
Toluene	ug/l	45	0	None > LOD	None > LOD	None > LOD
Sum of detected Xylenes	ug/l	18	0	None > LOD	None > LOD	None > LOD
m,p xylenes	ug/l	28	0	None > LOD	None > LOD	None > LOD
m,p-Xylene	ug/l	19	0	None > LOD	None > LOD	None > LOD
o-Xylene	ug/l	45	0	None > LOD	None > LOD	None > LOD
Petroleum Hydrocarbons						
NVM, light petroleum extract	mg/l	55	11	20.0%	5 - 29	10
Total petroleum hydrocarbons	ug/l	28	0	None > LOD	None > LOD	None > LOD
GRO >C5-C12	ug/l	18	0	None > LOD	None > LOD	None > LOD
TPH >C10-C16	ug/l	55	0	None > LOD	None > LOD	None > LOD
TPH >C16-C24	ug/l	55	7	12.7%	21 - 169	85
TPH >C24-C40	ug/l	55	12	21.8%	51 - 284	159
TPH >C6-C40	ug/l	55	13	23.6%	51 - 422	189
TPH >C6-C8	ug/l	55	0	None > LOD	None > LOD	None > LOD
TPH >C8-C10	ug/l	55	0	None > LOD	None > LOD	None > LOD
Total Aliphatic TPH	ug/l	28	0	None > LOD	None > LOD	None > LOD
Total Aliphatics & Aromatics >C5-35 (aq)	ug/l	18	2	11.1%	59 - 193	126.0
Total Aliphatics >C12-C35 (aq)	ug/l	18	2	11.1%	23 - 76	49.5
Total Aromatics >EC12-EC35 (aq)	ug/l	18	2	11.1%	36 - 117	76.5
Aromatic hydrocarbons	ug/l	28	0	None > LOD	None > LOD	None > LOD
Ali >C10-12	ug/l	28	0	None > LOD	None > LOD	None > LOD
Ali >C12-16	ug/l	28	0	None > LOD	None > LOD	None > LOD
Ali >C16-21	ug/l	28	0	None > LOD	None > LOD	None > LOD
Ali >C21-35	ug/l	28	0	None > LOD	None > LOD	None > LOD
Ali >C35-44	ug/l	28	0	None > LOD	None > LOD	None > LOD
Ali >C5-6	ug/l	28	0	None > LOD	None > LOD	None > LOD
Ali >C6-8	ug/l	28	0	None > LOD	None > LOD	None > LOD
Ali >C8-10	ug/l	28	0	None > LOD	None > LOD	None > LOD
Aliphatics >C10-C12	ug/l	18	0	None > LOD	None > LOD	None > LOD
Aliphatics >C12-C16 (aq)	ug/l	18	0	None > LOD	None > LOD	None > LOD
Aliphatics >C16-C21 (aq)	ug/l	18	1	5.6%	11	11
Aliphatics >C21-C35 (aq)	ug/l	18	2	11.1%	23 - 65	44
Aliphatics >C5-C6	ug/l	18	0	None > LOD	None > LOD	None > LOD
Aliphatics >C6-C8	ug/l	18	0	None > LOD	None > LOD	None > LOD
Aliphatics >C8-C10	ug/l	18	0	None > LOD	None > LOD	None > LOD
Arom >C10-12	ug/l	28	0	None > LOD	None > LOD	None > LOD
Arom >C12-16	ug/l	28	0	None > LOD	None > LOD	None > LOD
Arom >C16-21	ug/l	28	0	None > LOD	None > LOD	None > LOD
Arom >C21-35	ug/l	28	0	None > LOD	None > LOD	None > LOD
Arom >C35-44	ug/l	28	0	None > LOD	None > LOD	None > LOD
Arom >C5-7	ug/l	28	0	None > LOD	None > LOD	None > LOD
Arom >C7-8	ug/l	28	0	None > LOD	None > LOD	None > LOD
Arom >C8-10	ug/l	28	0	None > LOD	None > LOD	None > LOD
Aromatics >EC10-EC12	ug/l	18	0	None > LOD	None > LOD	None > LOD
Aromatics >EC12-EC16 (aq)	ug/l	18	1	5.6%	11	11
Aromatics >EC16-EC21 (aq)	ug/l	18	1	5.6%	21	21
Aromatics >EC21-EC35 (aq)	ug/l	18	2	11.1%	36 - 85	60.5
Aromatics >EC5-EC7	ug/l	18	0	None > LOD	None > LOD	None > LOD
Aromatics >EC7-EC8	ug/l	18	0	None > LOD	None > LOD	None > LOD
Aromatics >EC8-EC10	ug/l	18	0	None > LOD	None > LOD	None > LOD

Surface Water Screening Assessment

Parameter	Unit	EQS	Analyses Above EQS		Additional Notes	CCW TL	Analyses Above CCW TL		Additional Notes	Min	Max
			No.	%'age of Analyses			No.	%'age of Analyses			
General Parameters											
Alkalinity	mg CaCO3/l	-	No EQS			-	No TL			170	1500
Total Hardness as CaCO3	mg/l	-	No EQS			-	No TL			100	491
Ammoniacal Nitrogen as N	mg/l	0.6	6	6.1%	"Good" Status under WFD	1	3	3.1%		0.034	1.7
BOD + ATU (5 day)	mg/l	5	15	20.8%	"Good" Status under WFD	18	3	4.2%		1	33
Calcium (diss.filt)	mg/l	-	No EQS			300	0	0.0%		2.8	152
Chloride	mg/l	250	0	0.0%		300	0	0.0%		7	250
Conductivity	uS/cm	-	No EQS			2000	0	0.0%		206	1164
Cyanide	mg/l	1	None > LOD			-	No TL				
Dissolved oxygen	mg/l	-	No EQS			5	44	61.1%		0.47	13.6
Dissolved oxygen (saturation)	%	60	28	50.9%	"Good" Status under WFD	-	No TL			3.7	139.3
Magnesium dissolved as Mg	mg/l	-	No EQS			-	No TL			1.1	35
Nitrogen, Total Oxidised as N	mg/l	-	No EQS			2	14	19.4%		0.123	9.43
Nitrate as NO3	mg/l	-	No EQS			1	44	61.1%		0.467	41.5
Nitrite as NO2	mg/l	-	No EQS			1	0	0.0%		0.05	0.2
pH	pH Units	9	3	3.7%	Around Llanwern	8.5	16	19.5%		7	12
Phosphate, Ortho as P	mg/l	0.12	36	50.7%	"Good" Status under WFD	1	12	16.9%		0.0424	4.2
Suspended solids, Total	mg/l	-	No EQS			250	5	6.9%		2	714
Sulphate	mg/l	400	0	0.0%		300	0	0.0%		7	110
Metals											
Arsenic	ug/l	50	0			-	No TL			0.253	6.9
Boron	ug/l	2000	0			-	No TL			24	1300
Cadmium	ug/l	0.15	24	24.7%		5	0	0.0%		0.097	2.9
Chromium	ug/l	3.4	16	16.5%	Chromium VI	-	No TL			0.671	18
Copper	ug/l	10	6	6.2%		-	No TL			0.852	19
Lead	ug/l	1.2	14	14.4%		250	0	0.0%		0.026	27
Mercury	ug/l	0.07	4	9.5%		-	No TL			0.68	2.5
Nickel	ug/l	4	11	11.3%		100	0	0.0%		0.644	15
Selenium	ug/l	-	No EQS			-	No TL			0.47	4.9
Zinc	ug/l	75	7			1000	0	0.0%		0.558	360
BTEX Compounds											
Sum of detected BTEX	ug/l	-	-			2000	None > LOD				
Benzene	ug/l	-	-			2000	None > LOD				
Ethylbenzene	ug/l	-	-			2000	None > LOD				
Toluene	ug/l	-	-			2000	None > LOD				
Sum of detected Xylenes	ug/l	-	-			2000	None > LOD				
m,p xylenes	ug/l	-	-			2000	None > LOD				
m,p-Xylene	ug/l	-	-			2000	None > LOD				
o-Xylene	ug/l	-	-			2000	None > LOD				
Petroleum Hydrocarbons											
NVM, light petroleum extract	mg/l	-	-			2	11	20.0%		5	29
Total petroleum hydrocarbons	ug/l	-	-			2000	None > LOD				
GRO >C5-C12	ug/l	-	-			2000	None > LOD				
TPH >C10-C16	ug/l	-	-			-	No TL				
TPH >C16-C24	ug/l	-	-			-	No TL			21	169
TPH >C24-C40	ug/l	-	-			-	No TL			51	284
TPH >C6-C40	ug/l	-	-			-	No TL			51	422
TPH >C6-C8	ug/l	-	-			-	No TL				
TPH >C8-C10	ug/l	-	-			-	No TL				
Total Aliphatic TPH	ug/l	-	-			-	No TL				
Total Aliphatics & Aromatics >C5-35 (aq)	ug/l	-	-			2000	0	0.0%		59	193
Total Aliphatics >C12-C35 (aq)	ug/l	-	-			2000	0	0.0%		23	76
Total Aromatics >EC12-EC35 (aq)	ug/l	-	-			2000	0	0.0%		36	117
Aromatic hydrocarbons	ug/l	-	-			-	No TL				
Ali >C10-12	ug/l	-	-			-	No TL				
Ali >C12-16	ug/l	-	-			-	No TL				
Ali >C16-21	ug/l	-	-			-	No TL				
Ali >C21-35	ug/l	-	-			-	No TL				
Ali >C35-44	ug/l	-	-			-	No TL				
Ali >C5-6	ug/l	-	-			-	No TL				
Ali >C6-8	ug/l	-	-			-	No TL				
Ali >C8-10	ug/l	-	-			-	No TL				
Aliphatics >C10-C12	ug/l	-	-			-	No TL				
Aliphatics >C12-C16 (aq)	ug/l	-	-			-	No TL				
Aliphatics >C16-C21 (aq)	ug/l	-	-			-	No TL			11	11
Aliphatics >C21-C35 (aq)	ug/l	-	-			-	No TL			23	65
Aliphatics >C5-C6	ug/l	-	-			-	No TL				
Aliphatics >C6-C8	ug/l	-	-			-	No TL				
Aliphatics >C8-C10	ug/l	-	-			-	No TL				
Arom >C10-12	ug/l	-	-			-	No TL				
Arom >C12-16	ug/l	-	-			-	No TL				
Arom >C16-21	ug/l	-	-			-	No TL				
Arom >C21-35	ug/l	-	-			-	No TL				
Arom >C35-44	ug/l	-	-			-	No TL				
Arom >C5-7	ug/l	-	-			-	No TL				
Arom >C7-8	ug/l	-	-			-	No TL				
Arom >C8-10	ug/l	-	-			-	No TL				
Aromatics >EC10-EC12	ug/l	-	-			-	No TL				
Aromatics >EC12-EC16 (aq)	ug/l	-	-			-	No TL			11	11
Aromatics >EC16-EC21 (aq)	ug/l	-	-			-	No TL			21	21
Aromatics >EC21-EC35 (aq)	ug/l	-	-			-	No TL			36	85
Aromatics >EC5-EC7	ug/l	-	-			-	No TL				
Aromatics >EC7-EC8	ug/l	-	-			-	No TL				
Aromatics >EC8-EC10	ug/l	-	-			-	No TL				

M4CAN
Leachate Analysis Results & Screening Assessment
Outside CL Sites - chainage +11,850 to +19,650
31/07/2015

Screening Values & Assessment	
EQS	Environmental Quality Standards
DWS	Drinking Water Standard
	Exceeds EQS
X	Exceeds DWS
X	Laboratory detection level higher than screening criterion

Notes

EQS calcium carbonate 100 - 150mg/l for heavy metals: chromium, copper, lead, nickel and zinc
IS denotes Insufficient Sample
NDP denotes no determination possible
Environmental Quality Standards (EQS)
UK Drinking Water Standards (DWS)

Sample Reference	Units	Screening Criteria		BH503
Specimen Depth		EQS	DWS	0.5 - 0.7
Level				5.65
Sample Type				ES
Geology Code				MG
Cluster Code				2015 GI
2:1 Leachate				
Arsenic Dissolved	ug/l	50	10	1.6
Boron Dissolved	ug/l	2000	1000	35
Cadmium Dissolved	ug/l	0.15	5	0.96
Chromium Dissolved	ug/l		50	12
Copper Dissolved	ug/l	10	2000	<1
Mercury Dissolved	ug/l	0.07	1	<0.5
Nickel Dissolved	ug/l	4	20	1.2
Lead Dissolved	ug/l	1.2	10	<1
Selenium Dissolved	ug/l		10	1.7
Zinc Dissolved	ug/l	75		1.9
Total Cyanide	mg/l	0.001	0.05	<0.05
Cyanide Free	mg/l			<0.05
pH Units	pH units	6-9	6.5-10	8.4
Organics				
Phenols	mg/l	0.0077		<0.03
BTEX				
Benzene	ug/l	10	1	<1
Toluene	ug/l	50		<1
Ethylbenzene	ug/l	20		<1
m,p xylenes	ug/l	30		<1
O-Xylene	ug/l	30		<1
TPH				
Aliphatics >C5-C6	ug/l			<0.1
Aliphatics >C6-C8	ug/l			<0.1
Aliphatics >C8-C10	ug/l			<0.1
Aliphatics >C10-C12	ug/l			<0.1
Aliphatics >C12-C16	ug/l			<0.1
Aliphatics >C16-C21	ug/l			<0.1
Aliphatics >C21-C35	ug/l			<0.1
Aliphatics >C35-44	ug/l			<0.1
Aromatics >C5-C7	ug/l			<0.1
Aromatics >C7-C8	ug/l			<0.1
Aromatics >C8-C10	ug/l			<0.1
Aromatics >C10-C12	ug/l			<0.1
Aromatics >C12-C16	ug/l			<0.1
Aromatics >C16-C21	ug/l			<0.1
Aromatics >C21-C35	ug/l			<0.1
Aromatics >C35-44	ug/l			<0.1
Total Aliphatic TPH	ug/l			<5
Total Aromatic TPH	ug/l			<5
Total petroleum hydrocarbons	ug/l			<10
PAH				
Acenaphthene	ug/l			<0.1
Acenaphthylene	ug/l	0.1		<0.1
Anthracene	ug/l			<0.1
Benzo(a)anthracene	ug/l			<0.1
Benzo(a)pyrene	ug/l	0.00017	0.01	<0.1
Benzo(b)fluoranthene	ug/l	0.017	0.1	<0.1
Benzo(g,h,i)perylene	ug/l	0.0082	0.1	<0.1
Benzo(k)fluoranthene	ug/l	0.017	0.1	<0.1
Chrysene	ug/l			<0.1
Dibenzo(a,h)anthracene	ug/l			<0.1
Fluoranthene	ug/l	0.0063		<0.1
Fluorene	ug/l			<0.1
Indeno(123cd)pyrene	ug/l	N/A	0.1	<0.1
Naphthalene	ug/l	2		<0.1
Phenanthrene	ug/l			<0.1
Pyrene	ug/l			<0.1
PAH 16 Total	ug/l			<2

[illegible]

Screening Values & Assessment	
EQS	Environmental Quality Standards
DWS	Drinking Water Standard
	Exceeds EQS
X	Exceeds DWS
X	Laboratory detection level higher than screening criterion

Notes
EQS calcium carbonate 100 - 150mg/l for heavy metals: chromium, copper, lead, nickel and zinc
IS denotes insufficient Sample
NDP denotes no determination possible
Environmental Quality Standards (EQS)
UK Drinking Water Standards (DWS)

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Annex E

Summary Risk Matrix

Summary of Risks for each Potential Area of Contamination

Potential contamination source area	CL1	CL2	CL3	CL4	CL5	CL6	CL8	CL9	CL10	CL13	CL14	CL15	CL17	CL18	CL22 (Benzene pipeline)	CL26 Lagoons	CL26 Reedbeds (MRA)	CL27	CL29	CL30	CL32	CL33	CL35	CL38	CL39	CL41
Risk during construction requiring mitigation																										
Ingestion / dermal contact / inhalation of contaminated dusts and soils by C-workers	n/a	L *	L *	M to L *	L *	L *	L *	V L *	V L *	M *	M *	M *	H *	L *	L * (M *)	M *	M *	M *	L *	M *	M *	M *	M to L *	V L *	M *	L *
Inhalation of asbestos fibres by construction workers	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	H *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ingestion / dermal contact / inhalation of contaminated dusts and soils by off site public	n/a	V L *	V L *	L *	V L *	L *	n/a	n/a	V L *	n/a	V L *	L *	H *	V L *	V L * (M to L *)	V L *	V L *	L *	V L *	M to L *	L *	L *	M to L *	V L *	L *	L *
Inhalation of ground gas / vapours by C. workers from MG material	n/a	V L *	L *	M to L *	n/a	V L *	V L *	V L *	n/a	H *	M *	M *	M *	L *	L * (H *)	M *	L *	L *	V L *	M *	M *	M *	M to L *	V L *	M *	n/a
Inhalation of ground gas / vapours by off site public from MG material	n/a	n/a	V L *	L *	n/a	V L *	n/a	n/a	n/a	n/a	V L *	V L *	L *	n/a	V L * (H *)	V L *	V L *	L *	V L *	M to L *	L *	L *	M to L *	V L *	L *	n/a
Contaminated surface runoff to surface water	n/a	n/a	n/a	M to L *	V L *	L *	V L *	L *	L *	M *	L *	L *	M *	n/a	M * (M *)	H *	H *	M *	n/a	n/a	n/a	n/a	M to L *	n/a	n/a	V L *
Contaminants leaching from MG into surface water	n/a	n/a	n/a	M to L *	V L and L *	M *	V L *	L *	n/a	n/a	n/a	n/a	M *	L *	n/a	n/a	M *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	M to L *
Perched water or aquifer groundwater entering surfacewater	n/a	n/a	n/a	n/a	n/a	M *	V L *	L *	V L *	M *	L *	M to L *	M *	V L *	M * (M *)	H *	M *	M to L *	n/a	n/a	n/a	n/a	M to L *	n/a	n/a	n/a
Contaminants leaching from MG into deep aquifer	n/a	M to L *	V L *	n/a	n/a	M *	n/a	n/a	V L *	M *	M to L *	M *	M *	L *	M * (M to L *)	L *	M *	M to L *	V L *	M to L *	M *	M *	M to L *	V L *	M *	L *
Contaminants leaching from MG via band drains or piling	n/a	n/a	n/a	n/a	n/a	M *	V L *	L *	V L *	M *	M to L *	M *	M *	n/a	M * (M to L *)	n/a	M *	M to L *	n/a	n/a	n/a	n/a	M to L *	n/a	n/a	n/a
Inhalation of soil gas / explosion for C. workers from PEAT	n/a	n/a	n/a	n/a	n/a	H *	n/a	M	n/a	M to L *	M to L *	M *	M *	M to L *	M *	M *	M *	M *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inhalation of soil gas / explosion for off site public from PEAT	n/a	n/a	n/a	n/a	n/a	M to L *	n/a	n/a	n/a	n/a	M to L *	M to L *	M to L *	n/a	M to L *	M to L *	M to L *	M to L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Band drain / pile pathway causing GW to contaminate surface water	n/a	n/a	n/a	n/a	n/a	H *	L *	L *	M *	n/a	V L *	V L *	M *	L *	M *	M to L *	H *	M to L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Contaminated Perched GW ingestion / dermal/ inhalation of HC vapours by C-workers	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dewatering pathway causing GW to contaminate surface water	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	M *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Risk during operation requiring mitigation																										
Ingestion / dermal contact / inhalation of contaminated dusts and soils by MW	L *	V L *	n/a	L *	V L *	V L *	V L *	V L *	V L *	L *	V L *	L *	M *	n/a	V L *	V L *	V L *	V L *	n/a	V L *	V L *	L *	L *	V L *	n/a	V L *
Inhalation of asbestos fibres by maintenance workers	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	M to L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ingestion / dermal contact / inhalation of contaminated dusts and soils by motorway users	V L *	V L *	n/a	V L *	V L *	V L *	V L *	V L *	V L *	V L *	V L *	V L *	L *	n/a	V L *	V L *	V L *	V L *	n/a	V L *	n/a	V L *	L *	V L *	n/a	V L *
Ingestion / dermal contact / inhalation of contaminated dusts and soils by off site general public	V L *	V L *	n/a	V L *	V L *	n/a	n/a	n/a	V L *	V L *	V L *	V L *	L *	n/a	V L *	V L *	V L *	V L *	n/a	V L *	n/a	V L *	n/a	V L *	n/a	V L *
Inhalation of ground gas / vapours by MW by MG material	L *	V L *	n/a	L *	n/a	V L *	V L *	V L *	n/a	L *	V L *	V L *	M *	n/a	V L *	V L *	V L *	V L *	n/a	V L *	V L *	M *	L *	n/a	L *	n/a
Inhalation of ground gas / vapours by off site workers / public / motorway users by MG material	V L *	V L *	n/a	V L *	n/a	V L *	V L *	V L *	n/a	V L *	V L *	V L *	V L *	n/a	V L *	V L *	M to L * (M *)	V L *	n/a	V L *	V L *	L *	L *	V L *	L *	n/a
Contaminated run-off to surface water	L *	n/a	n/a	L *	n/a	n/a	n/a	n/a	n/a	L *	n/a	n/a	n/a	n/a	L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Contaminants leaching from MG into surface water	n/a	n/a	n/a	L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	M to L *	M *	n/a	n/a	n/a	n/a	M *	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Contaminants leaching from MG into deep aquifer	V L *	M to L *	n/a	n/a	n/a	n/a	n/a	L *	V L *	V L *	M to L *	M *	M to L *	L *	M to L *	L *	M *	M to L *	V L *	M to L *	M *	M *	M to L *	V L *	M *	M to L *
Contaminants leaching from MG via band drains or piling	n/a	n/a	n/a	n/a	n/a	M *	V L *	n/a	V L *	V L *	V L *	M *	M to L *	L *	M to L *	n/a	M *	M to L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Perched water or aquifer groundwater entering surfacewater	n/a	n/a	n/a	n/a	n/a	M to L *	V L *	L *	M *	M *	V L *	n/a	M *	L *	M to L *	L *	M *	M *	n/a	n/a	n/a	n/a	M to L *	n/a	n/a	L *
Band drain pathway causing GW to contaminate surface water	n/a	n/a	n/a	n/a	n/a	H *	L *	L *	M *	n/a	V L *	V L *	M *	L *	M *	M to L *	H *	H *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inhalation of soil gas / explosion for M. workers from PEAT	n/a	n/a	n/a	n/a	n/a	M *	n/a	M *	n/a	M to L *	M to L *	M to L *	M to L *	n/a	M to L *	M to L *	M to L *	M to L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inhalation of soil gas / explosion for motorway users from PEAT	n/a	n/a	n/a	n/a	n/a	M *	n/a	M to L *	n/a	M to L *	M to L *	M to L *	M to L *	n/a	M to L *	M to L *	M to L *	M to L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inhalation of soil gas / explosion for off site public from PEAT	n/a	n/a	n/a	n/a	n/a	M to L *	n/a	n/a	n/a	n/a	M to L *	M to L *	M to L *	n/a	M to L *	M to L *	M to L *	M to L *	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

* Risk level to be updated following findings of supplementary ground investigation.

Key	
C worker	Construction worker
CW	Controlled water
MG	Made ground
MW	Maintenance worker
H	High
M	Moderate
L	Low
VL	Very Low