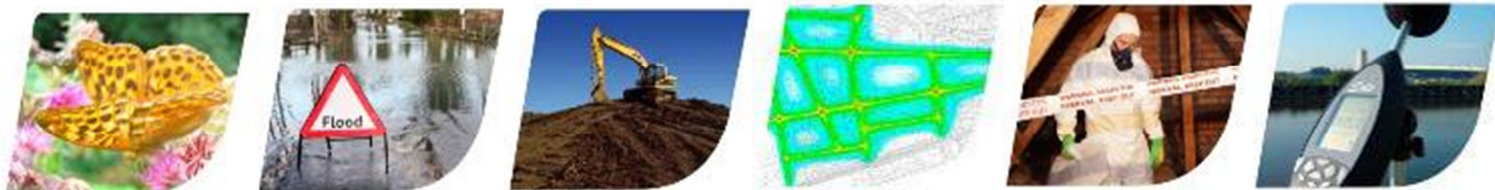


GEO-ENVIRONMENTAL SITE INVESTIGATION PROPOSED CARE HOME, COACH ROAD, WHITEHAVEN, CA28 9DF

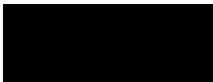
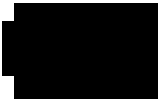
REC REFERENCE: 45418P1R1

REPORT PREPARED FOR: MAPLE GROVE DEVELOPMENTS
LTD

JUNE 2014



QUALITY ASSURANCE

Issue/revision	Issue 1	Revision 1	Revision 2
Remarks	Interim	Final (gas monitoring)	
Date	March 2014	June 2014	
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Signature			
Project number	45418	45418p1r1	

EXECUTIVE SUMMARY	
Site Address	Land off Coach Road, Whitehaven, Cumbria, CA28 9DF
Grid Reference	297380, 517470
Site Area	0.85ha
Current Site Use	The subject site currently comprises a disused parcel of land which was formally used by several commercial businesses and currently a number of derelict buildings occupy the site. The site is surfaced in part by concrete which was observed to have some cracks and be in a generally poor state and soft standing which was found to be densely overgrown.
Environmental Setting	The site is underlain by a Secondary A Aquifer (moderate risk receptor), and has the culverted Pow Beck flowing along its western border. There are no current ground water abstractions within 1.0km of the site boundary. The site is situated within a Flood Risk Zone 2 area and partially within a Flood Risk Zone 3 and will require if not completed already, a flood risk assessment.
Site History	Historical maps indicate that the site has been used extensively for various industrial processes. Initially (pre 1840) the site was in use as railway sidings with tracks and shed across the site, from 1899 a timber yard was located on site, and since 1925 has become a builders and contractors yard including the current buildings.
Hazardous Installations and Development Constraints	There is a fuel pump island in the centre of the site complete with underground storage tanks and fuel line infrastructure. During site investigations underground storage tanks (UST's) were encountered at shallow depth (circa 0.30m). The site constraints are shown on drawing No 45418p1r0-005.
Invasive Species	No invasive plants were identified during site investigations, however an area of the site is inaccessible due to dense vegetation and fencing, it is suggested that further investigations for invasive plant species be carried out in that area.
Utility Locations	Low pressure gas enters the site from the south east corner and is clearly visible as entering the first unit. Underground BT services were identified on plans and are visible at ground level running east west across the site in the form of surface scarring. Electricity enters the site from the south east area towards a brick office building and is also identified on service plans. Drains and sewers are visible in the northern area of the site and have been identified on plans and by site investigation photographs.
Landfill Sites & Ground Gases	An historic clay pit adjacent to the north west of the site may pose a potential source of ground gasses as the composition of the backfill material is unknown. A waste treatment and storage facility was located within the site as late as 1984 and appears to have handled large volumes of waste (250,000 ton pa).
Radon	Unaffected – no special precautions required.
Geology, Hydrology & Hydrogeology	Drift – Alluvium (Clay, Silt, Sand, and Gravely) Bedrock – Lower Coal Measures Formation (Mudstone, Siltstone And Sandstone and Coal) Groundwater – Secondary A Aquifer Flood Risk – Flood Risk Zone 2 and 3.

Coal Mining / Land Stability	The site is in a coal mining area and a detailed mining risk assessment has identified that the 'Main Seam' outcrops through the southern sector of the site in a north east trend and has been worked historically as late as 1967. Three No. 30.0m rotary boreholes were advanced on the site to explore for the shallow mine workings; however, no evidence of the workings were encountered and only 0.5m intact coal seam was encountered in one of the boreholes. Average depth of rockhead was found to be 12.00m across the site and was of alluvium overburden into siltstone and mudstone bedrock.
Intrusive Ground Investigation	
Ground Conditions	Made Ground Made Ground deposits were encountered across the site to a maximum proven depth of 1.30m (CP102 and WS105) and consisted of either black gravelly sand with a gravel content composed of brick, clinker, concrete, coal or reworked soft to firm dark grey clay. Drift Superficial drift deposits were encountered from depths of between 0.40m and >1.30m and typically comprised of a mixture of distinct Alluvium Clays, Silts, and Sands to a maximum depth of 16.00m. Solid Bedrock was encountered at depths between 9.50m and 16.00m bgl and consisted of inter-bedded layers of mudstone and siltstone. An intact coal seam 0.5m thick was encountered at a depth of 14.0m bgl in BH3. Groundwater Groundwater was encountered across the site at circa 3.00m depth and in a single location (CP102) at 9.00m depth. Topography variances The site is mostly level but slopes very slightly towards the west and north.
Tier 1 Contaminated Land Risk Assessment	
Human Health	The Tier I Human Health Risk has identified elevated concentrations of inorganic heavy metals, Polycyclic Aromatic Hydrocarbons and petroleum hydrocarbons. The PAH including naphthalene, impact occupies much of the southern section of the site and is believed to originate from the site's various past industrial uses.
Controlled Waters	The results of this direct comparison indicates that the Environmental Quality Standard (EQS) for freshwater was exceeded for a number of PAH compounds, it is recommended that a Tier II Detailed Quantitative Risk Assessment (DQRA) is undertaken in order to assess the risk posed to controlled waters.
Eco-toxic	Inorganic heavy metals associated with the Made Ground have been identified in concentrations likely to prove eco-toxic to plants and root vegetable if present within the upper 600mm growing medium. Due to this soft landscaped areas within the development will likely require a 600mm clean cover replacement.

Ground Gas	A vapour membrane should be installed within the proposed development to mitigate the risk from naphthalene vapours. The ground gas monitoring programme has indicated that the site would fall into CS3 / Amber 2 requiring gas protection measures. Post-remediation gas monitoring may reduce the gas protection requirements.
Potable Water Infrastructure	Preliminary assessment would suggest that barrier pipe will likely be required due to the presence of aggressive hydrocarbon and PAH compounds.
Geotechnical Assessment	
Underground Obstructions	During the GI, REC identified potential UST's, the location of which will be underneath a proposed residential structure. Official surveying, removal and remediation of the potential UST's should be considered before planning structural foundations and to address the ongoing risk to controlled waters.
Allowable Bearing Capacity (ABC)	The site is underlain by inter-bedded layers of Made Ground comprising both sand and clay which in turn overlies alluvium superficial deposits comprising layers of clay, sand and silt. The ABC has been assessed for both granular and cohesive layers. Shallow clay deposits across the site are generally of a low strength with an ABC less than 50kN/m² expected at a depth of 2.0m bgl. Natural clay increase in strength with depth. Shallow granular deposits across the site are generally of a loose consistency with an ABC less than 50kN/m² expected at a depth of 1.0m bgl increasing to 80kN/m² at a depth of 2.0m bgl. Natural sand increases in density with depth.
Foundation Options	Apartment Block Based on the ABC above, it is considered that the variable composition and calculated ABPs in the underlying superficial drift deposits are not suitable founding stratum for the proposed apartment bloc. It is therefore recommended that piled foundations are used to support the structure, likely to be end bearing piles into the underlying solid geology at depths of between 9.5m and 16.0m bgl. Pile design should be undertaken by a specialist contractor to allow them to reduce the factor of safety based on their extensive pile testing data. Bungalows Borehole logs (WS108 and WS110) in the vicinity of the proposed bungalows indicate variability in the underlying shallow ground conditions which may result in differential settlement. Due to the variability of the ground conditions, the following foundation options should be considered;  Raft foundations; and,  Vibro Granular Stone Columns – supporting shallow strip foundations.
Soak-away Drainage	In-situ variable (falling) head permeability tests were undertaken within the monitoring well installations located in three probeholes (WS106B, WS107 and WS110). Soil infiltration rates were between 1.82 ⁻⁵ m/s and 2.69 ⁻⁶ m/s and in accordance with CIRIA C515 (2000) indicates a low permeability. It is recommended that further assessment is undertaken to determine the sites suitability for soakaways in accordance with BRE Special Digest 365 – Soakaway Design.
Sulphate Assessment	Sulphate Class DS-1, (ACEC) AC-1s
CBR Design %	It is recommended that CBR testing is undertaken beneath the area of the proposed access road.
Cut / Fill	As the site is largely level, cut/fill operations may not be required.

Waste Classification	In the impacted southern sector the Made Ground and impacted shallow natural strata is likely to be a hazardous waste; with inert / non-hazardous Made Ground / natural ground across the remainder of the site.
Developed Conceptual Site Model (CSM)	
The Tier I Human Health Risk has identified elevated concentrations of inorganic heavy metals, polycyclic aromatic hydrocarbons, volatile organic compounds, and petroleum hydrocarbons, associated with the Made Ground and previous industrial use across the site. Volatile Compounds A focused remediation will be required to remove the USTs, surrounding impacted soils and the area around the naphthalene hotspot. Following excavation it may be possible to bio-remediation the material ex-situ and then subject to laboratory testing, re-emplace the material below the site. Remediation of the impacted soluble material will also be required to address the risk to controlled waters, which will be quantified in the subsequent a Tier II Detailed Quantitative Risk Assessment (DQRA). Non-Volatile Compounds Across the wider site, the elevated inorganic and non-volatile PAHs in the shallow Made Ground can be addressed with the emplacement of a 600mm cover system in all soft landscaped areas. Conversely, it may be possible to emplace this material at depth (soil inversion), or below plots and access roads. A DQRA is recommended to assess the risk to controlled waters. The ground gas monitoring programme has indicated that the site would fall into CS3 / Amber 2 requiring gas protection measures. Post-remediation gas monitoring may reduce the gas protection requirements.	
Recommendations	
In order to quantify the risk to controlled waters, it is recommended that a DQRA is undertaken based on the dissolved phase concentrations in the groundwater and also the source soil concentrations. Upon completion of the DQRA, remedial target values will be derived and used in the completion of a Detailed Remediation Strategy and Materials Management Plan (MMP) to be developed in accordance with the (EA Approved) CL:AIRE CoP. Post Demolition Works  Supplementary Ground Investigation comprising trial pitting to investigate the densely vegetated area along the eastern section of the site, which was inaccessible during this investigation;  3 No. rotary boreholes to investigate potential mine workings in the western section below the foot print of the existing buildings of the site to depths of 50m bgl;  Flood Risk Assessment;  BRE 365 Soakaway Assessment; and,  CBR assessment beneath the proposed access road.	

TABLE OF CONTENTS

QUALITY ASSURANCE	1
EXECUTIVE SUMMARY	2
1.0 INTRODUCTION	8
1.1 Background	8
1.2 Proposed Development	8
1.3 Objectives	8
1.4 Limitations	8
1.5 Confidentiality	9
2.0 SITE SETTING	10
2.1 Site Details	10
2.2 Current Site Use	10
2.3 Surrounding Area	11
3.0 SITE HISTORY	12
3.1 On-Site Historical Development	12
3.2 Off-Site Historical Development	12
3.3 Planning History	13
4.0 ENVIRONMENTAL SETTING	14
4.1 Geology & Hydrogeology	14
4.2 Geotechnical Data	14
4.3 Coal Mining	14
4.4 Hydrology	16
4.5 Radon Risk Potential	16
4.6 Industrial Land Uses	16
4.7 Sensitive Land Uses	16
4.8 Site Sensitivity Assessment	16
5.0 CONSULTATIONS	17
5.1 Local Authority Contaminated Land Officer	17
5.2 Local Authority Building Control Officer	17
5.3 Landfill Sites and Waste Treatment Sites	17
5.4 Regulatory Database	17
6.0 INITIAL CONCEPTUAL SITE MODEL (CSM)	19
6.1 Initial CSM	19
6.2 Contaminant Sources	19
6.3 Potential Pathways	20
6.4 Potential Receptors	20
6.5 Preliminary Risk Assessment	20
7.0 SITE INVESTIGATION	22
7.1 Desk Study Information	22
7.2 Site Investigation	22
7.2.1 General	22
7.2.2 In-Situ Standard Penetration Testing (SPT)	23
7.3 Laboratory Analysis	23
8.0 GROUND AND GROUNDWATER CONDITION	25
8.1 Ground Conditions	25
8.1.1 Summary of Ground Conditions	25
8.1.2 Made Ground	25

8.1.3	Drift Deposits	25
8.1.4	Solid Geology	25
8.1.5	Soil Consistency	25
8.1.6	Soil Infiltration	30
8.1.7	Soil Plasticity	30
8.1.8	pH and Sulphate	30
8.2	Groundwater Conditions	31
8.3	Ground Gas	31
9.0	TIER 1 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT	34
9.1	Human Health Risk Assessment	34
9.2	Controlled Waters	37
9.3	Ground Gas	40
9.4	Revised Conceptual Site Model	42
10.0	GEOTECHNICAL ASSESSMENT	43
10.1	Proposed Development	43
10.2	Summary of Ground Conditions	43
10.3	Site Preparation	43
10.4	Foundation Conditions and Bearing Capacity	44
10.5	Ground Floor Slabs	45
10.6	Pavement Construction	45
10.7	Drainage	46
10.8	Concrete Durability	46
10.9	Excavations	46
10.10	Coal Mining	47
10.11	Further Works	47
10.12	Construction Activity and Inspection	48
11.0	CONCLUSIONS & RECOMMENDATIONS	49

APPENDICES

Appendix I	Limitations
Appendix II	Glossary
Appendix III	Drawings
	Drawing No 45418p1r0-001 – Site Location Plan
	Drawing No 45418p1r0-002 – Site Plan
	Drawing No 45418p1r0-003 – Historical Features Plan
	Drawing No 45418p1r0-004 – Geological Features Plan
	Drawing No 45418p1r0-005 – Site Constraints Plan
	Drawing No 45418p1r0-006 – Exploratory Hole Location Plan
	Drawing No 45418p1r0-007 – Exploratory Hole Location / Historical Features Overlay
	Drawing No 45418p1r0-008 – Depth of Made Ground
	Drawing No 45418p1r0-009 – Contamination Hotspots
	Drawing No 45418p1r0-010 – Proposed Development Plan
	Drawing No 45418p1r0-011 – Ground Gas Zoning Plan
Appendix IV	Photographs
Appendix V	Historical Maps
Appendix VI	REC Exploratory Hole Logs
Appendix VII	Coal Authority Abandonment Plans
Appendix VIII	Chemical Testing Results
Appendix IX	Origin of Tier I Generic Assessment Criteria
Appendix X	SPT Interpretation Sheet
Appendix XI	Geotechnical testing results

A CD containing all relevant environmental database information, historical & geological mapping and a complete PDF version of this report is attached to hard copy of the report.

1.0 INTRODUCTION

1.1 Background

Resource and Environmental Consultants (REC) Ltd have been commissioned by Civic Engineers on behalf of Maple Grove Developments Ltd to undertake a Phase I and II Site Investigation at the Site off Coach Road in Whitehaven. A site location plan is presented as drawing No 45418p1r0-001 in Appendix III.

The scope of the Phase II Ground Investigation comprised ten window sample probeholes, three cable percussive boreholes and three deep rotary boreholes. Five window samples and one cable percussive borehole were completed as environmental monitoring installations. The scope of works also comprised targeted chemical and geotechnical laboratory analysis and a factual and interpretive report.

1.2 Proposed Development

Maple Grove Developments Ltd intends to construct a residential care home comprising a 56 No. apartment block, 4 No. bungalows, associated car parking areas, soft landscaping and infrastructure. A wildlife corridor is proposed along the eastern boundary with a link to the town centre via a footpath / cycleway at the northern site boundary. The proposed development plan drawing No 45418p1r0-010 is contained in Appendix III.

1.3 Objectives

The objectives of the geo-environmental investigation are to:

- Review historical plans, geology, hydrogeology, site sensitivity, flood-plain issues, mining records and any local authority information available in order to complete a Desk Study in line with Environment Agency (EA) document Model Procedures for the Management of Contaminated Land (Contaminated Land Report 11 (CLR11));
- Undertake a preliminary stage of sampling and analysis to provide an overview of environmental issues identified;
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors;
- Assess the geotechnical information and provide preliminary recommendations in relation to foundations, pavement construction and floor slabs;
- Provide an assessment of the soakage of the underlying soils to assist in the design of infiltration based SuDS; and,
- Provide recommendations regarding future works required.

1.4 Limitations

At the end of March 2014, the Department for Environment and Rural Affairs (DEFRA) issued details of the outcome of a "Category 4 Screening Levels Project" which is aimed at providing a simple test for deciding when land is "suitable for use" from a human health perspective and more specifically for defining when land is definitely not contaminated land. Category 4 Screening Levels (C4SL's) were published for six substances which were selected based upon their ubiquity in contaminated land risk assessment and because they covered a range of exposure pathways and toxicological effects. C4SL's have been published for these six substances in relation to various land uses, namely residential (both with and without home-grown produce), allotments, commercial and two alternative types of Public Open Space.

The Category 4 Screening Levels (C4SL's) in effect update the current approach to the assessment of contaminated land risk in relation to Part IIa but will also influence the assessment of land affected by contamination that is dealt with through the planning process. At some stage these new levels may replace the current SGV's albeit that they prescribe different levels of risk. As the C4SL's describe a higher level of risk than the current SGVs it suggests in general that higher levels of contamination may be acceptable before remediation is required. However, the risk posed by any particular substance is specific to any given site and its environmental setting and therefore dependent upon the outcome of site specific risk assessment.

For the purpose of this report REC has based the assessment on the current SGV's and associated CLEA approach, albeit that C4SL's, where published, have also been taken into account. In situations where SGV's and/or C4SL's are exceeded and particularly where remediation measures are potentially required we recommend that the site is discussed with the Local Authority, and the Environment Agency where necessary, in order that definitive solutions can be agreed.

It should be noted that these changes do not apply to the assessment of risk to Controlled Waters.

The full limitations of this report are presented in Appendix I.

1.5 Confidentiality

REC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from REC; a charge may be levied against such approval.

2.0 SITE SETTING

2.1 Site Details

Site Address	Coach Road, Whitehaven, Cumbria, CA28 9DF
National Grid Reference	297380, 517470
Site Area	0.84 Ha

All acronyms used within this report are defined in the Glossary presented in Appendix II.

A site location plan drawing No 45418p1r0-001 is presented in Appendix III.

2.2 Current Site Use

Site Description

The subject site is roughly triangular in shape and is accessed directly off Coach Road to the south. The site was formally used by several commercial businesses and currently a number of derelict buildings occupy the site, as follows;

- A two-storey office block previously occupied by a construction firm is situated in the south of the site;
- A small detached commercial unit previously occupied by a vehicle repair and servicing firm is located in the north of the site;
- A series of commercial units occupy the western section of the site and were previously used by a boat building company; and,
- A brick-built low rise structure housing two fuel pumps is located to the east of the commercial units.

A visual inspection of the on-site buildings indicated a single crack in the external brickwork to the 2 storey office block propagating from the first storey down to ground level (Plate 6). No other external cracks were observed on any of the other buildings.

The majority of the central and western sections of the site are surfaced in concrete or asphalt hardstanding. The eastern and northern sections of the site are densely vegetated and were inaccessible during the site investigation. A slight disruption in the asphalt surface was observed to the south west of the commercial units (Plate 7).

Salient site features are presented on the Site Plan Drawing No 45418p1r0-002 in Appendix III.

Hazardous Materials Storage

A site walkover has identified a brick-built structure in the centre of the site containing 2 fuel pumps (Plates 3 and 5) which was found to be in a poor state of repair. A manhole cover on the west side of the structure provides access to a potential underground storage tank (UST) (Plate 4). It was noted during the walkover that areas in the vicinity of the fuel pumps where the concrete surfacing has been previously disrupted and in turn re-concreted may indicate the location of further potential underground storage tanks. A low-rise brick bunded area to the rear of the fuel pumps may indicate the location of previous above ground storage tanks.

Asbestos Containing Material (ACM)

An Asbestos Survey was undertaken by Airborne Environmental Consultants Ltd in August 2011 which highlighted the presence of ACM in many of the existing site buildings.

Polychlorinated Biphenyls (PCBs)

No equipment that may potentially contain PCBs was observed at the site.

Waste Storage

No potentially hazardous waste streams are currently generated at the property, due to the current non-operational state; however, historically there would have been waste generated on site such as waste oils and VOC / SVOCs associated with the boat repair.

Drainage Issues

A formal drainage survey has not been completed but an existing surface water sewer flows east to west across the centre of the site discharging into the culverted Pow Beck which follows the western site boundary.

2.3 Surrounding Area

The surrounding land uses are summarised below:

Direction	Land Use
North	Commercial unit.
East	Commercial units, builder's merchants and residential dwelling beyond.
South	Coach Road with playing fields beyond.
West	Commercial units and residential dwellings beyond.

3.0 SITE HISTORY

3.1 On-Site Historical Development

A review of historical mapping pertinent to the site is summarised in Table 3.1 below. In addition, historical site features are presented on Drawing No 45418p1r0-003 in Appendix III.

Table 3.1 Summary of Potentially Contaminative Historical Land Uses

Map Edition	Historical Land Use
1:500 (1840 – 1879)	The subject site is occupied by railway land with the main railway line (Preston Street Goods Branch) following the eastern site boundary and associated sidings extending into the central and western parts of the site. A number of goods shed are present in the southern half of the site.
1:2500 (1899)	The site is recorded as a timber yard. The railway sidings in the centre of the site and associated goods shed are no longer present.
1:2500 (1938)	The site is shown as a derelict parcel of land.
1:2500 (1962)	The site is recorded as a builders yard with a series of commercial units constructed in the western section of the site and a single unit in the south of the site.
1:1250 (1975)	The site is recorded as a contractors yard with the buildings in the west of the site extended and two single units constructed, one in the north of the site and the second in the south of the site.
1:10000 (2013)	The building in the far south of the site has been demolished. The remainder of the site is in its current configuration.

3.2 Off-Site Historical Development

A review of potentially contaminative uses identified on historical Ordnance Survey maps within a 250m radius of the site is summarised below in Table 3.2.

Table 3.2 Summary of Potentially Contaminative Off-Site Historical Land Uses

Surrounding Feature	Distance	Dates	Direction
Old Chemical Works (Ruins) <i>Then demolished and occupied by Corporation Yard</i>	Adjacent	Pre 1840 to Pre 1899 Pre 1899 to Present	West
Railway sidings <i>Then redeveloped for commercial</i>	Adjacent	Pre 1840 to Pre 1979 Pre 1979 to Present	North
Pottery <i>Then no longer recorded Then Corporation Yard</i>	Adjacent	Pre 1840 to Pre 1899 Pre 1899 to Pre 1962 Pre 1962 to Present	West
Saw Mill and Timber Yard <i>Then depot</i>	Adjacent	Pre 1840 to Pre 1994 Pre 1994 to Present	East
Embankment <i>Then redeveloped for commercial</i>	Adjacent	Pre 1899 to Pre 1938 Pre 1938 to Present	West
Tanks <i>Then no longer recorded</i>	Adjacent	Pre 1899 to Pre 1925 Pre 1925 to Present	South West
Chemical Works <i>Then unknown usage Then Whitehaven Abattoir Then unknown usage</i>	15m	Pre 1840 to Pre 1899 Pre 1899 to Pre 1962 Pre 1962 to Pre 1994 Pre 1994 to Present	South West
Pipe Manufacturing <i>Then redeveloped for residential</i>	60m	Pre 1840 to Pre 1899 Pre 1899 to Present	West

Surrounding Feature	Distance	Dates	Direction
Textile Factory with associated embankments. <i>Then depots</i>	60m	Pre 1962 to Pre 1994 Pre 1994 to Present	West
Clay Pits	40m and 100m	Pre 1874 to Pre 1938	South West
Coal Mine Airshaft (Arrowthwaite Pit)	160m	Pre 1840 to Pre 1957	South West

3.3 Planning History

REC has undertaken a review of on-line planning records held by Copeland Borough Council for the previous year and no environmentally pertinent information has been registered.

4.0 ENVIRONMENTAL SETTING

4.1 Geology & Hydrogeology

The British Geological Survey (BGS) map for the site, (Sheet NX91NE, 1:10,000, Whitehaven, Solid & Drift edition) indicates that the site is underlain by the following geological sequence:

Geological Unit	Classification	Description	Aquifer Classification
Drift	Alluvium	Sand, Silt, Gravel, and Clay	Secondary A
Solid	Middle Coal Measures	Sandstone,, Mudstone, and Coal	Secondary A

The Raven Hill fault crosses the northern part of the site trending east west and is downthrown to the north. The Main coal seam (up to 4m thick) inferred outcrop crosses the south of the site, trending north east / south west and the Yard seam (up to 2m thick) inferred outcrops just to the south east of the site. The main geological features are shown on drawing No 45418p1r0-004 contained in Appendix III.

The Envirocheck report indicates there is one groundwater abstractions within 1.0km radius of the site relating to an expired abstraction 680m south west. The abstraction is operated by Whitehaven Brick & Tile Co Ltd and is associated with manufacturing.

Based on the local topography and location of surface watercourses it is considered likely that shallow groundwater will flow in a western direction towards Pow Beck which is flowing northerly toward the North Harbour.

4.2 Geotechnical Data

Geotechnical Data presented within the Envirocheck report identifies the following ground conditions:

Hazard	Designation
Shrink-Swell Clay	Very Low Risk
Landslides	Very Low Risk
Ground Dissolution	No Hazard
Compressible Ground	Low to Moderate Risk
Collapseable Deposits	Very Low Risk
Running Sand	Low Risk

4.3 Coal Mining

The subject site is located within a coal mining area and hence a Coal Authority Mining Report was obtained for the purposes of this report. The report indicates that the site is within the zone of influence from two worked seams at shallow to 70m depth, last worked in 1967. There are no known mine entries within 20m of the site boundary. The report also indicates that the Coal Authority has not received a subsidence claim for the subject site or any property within 50m since 31st October 1994.

The British Geological Survey (BGS) map for the site, (Sheet NX91NE, 1:10,000, Whitehaven, Solid & Drift edition) indicates that the inferred outcrop of the Main Coal Seam crosses the south east corner of the site and has been recorded up to 4.0m thick.

The Generalised Vertical Section beneath the site at the main seam outcrop is as follows;

Approximate Depth (m bgl)	Geological Unit	Approximate Thickness (m)
0-10	Drift - Alluvium	10 ⁽²⁾
10	Main Seam (CUMN)	Up to 4
10 - 35	MCM ⁽¹⁾	25
35	Yard Seam (Metal Yard)	Up to 2
35 - 55	MCM ⁽¹⁾	20
55	Vanderbeckei Marine Band (VDMB)	N/A
55 - 75	MCM ⁽¹⁾	20
75	Little Main Seam (LMN)	0.3 – 0.7

Notes

(1) MCM – Middle Coal Measures (Multi-cyclic succession of black carbonaceous mudstone grading to dark grey to blue grey mudstone and siltstone with fine to medium grained pale grey to buff cross bedded sandstone with numerous productive coal seams with 2 to 3 splits common).

(2) Average thickness based on local BGS borehole data.

Considering the generalised vertical section above, it is anticipated that the two worked seams referred to in the Coal Authority Report would be the Main Seam and the Yard Seam.

Other coal mining features in close proximity to the site include;

- Hamish mine shaft 150m west;
- Engine mine shaft 150m south west;
- Clay mine shaft 200m south west;
- Adit into Main Seam 500m south of the site; and,
- Airshaft associated with Arrowthwaite Pit 160m south west of the site.

The geology of the site is shown on drawing No 45418p1r0-004 contained in Appendix III.

A visit was made to The Coal Authority Mining Records Office to view the available mining abandonment plans relating to the site. A number of plans indicated that workings extended beneath the site in both the Main and Bannock Coal Seams. Extracts of the abandonment plans are contained in Appendix VI.

4.4 Hydrology

Surface water features in the vicinity of the subject site are as follows:

Surface Water Feature	Quality*	Distance (m)	Direction
Pow Beck (extended culvert)	N/A	Adjacent	West

*Chemical water quality as classified under the EA's General Quality Assessment (GQA) Scheme

The Site is located within a Flood Zone 2 and as such has a medium probability of flooding (1 in 1000yr) associated with the adjacent Pow Beck. A Flood Zone 3 is located to the south of the site and slightly encroaches into the far south of the site.

4.5 Radon Risk Potential

The Envirocheck Report indicates the site is situated in an area where less than 1% of homes are above the Action Level and that the BGS reports that full radon protective measures are not necessary in the construction of new dwellings or extensions.

4.6 Industrial Land Uses

The Contemporary Trade Directory lists two on-site businesses;

- Coach Road Garage – Garage services (status inactive); and,
- Jacksons Marine – boat builders and repairers (status active).

The site is situated within a mixed commercial and industrial area and as such the Trade Directory records a number of entries within 250m radius of the site including garage services, tyre dealers, builder's merchants and an animal feed supplier.

4.7 Sensitive Land Uses

The following sensitive land uses have been identified in close proximity to the site;

- Residential properties with gardens;
- Recreation ground adjacent to south of site;
- Pow Beck (culvert) runs adjacent to the western site boundary and is flowing in a northerly direction towards the Irish Sea; and,
- A Site of Special Scientific Interest (SSSI) called 'St Bees Head' is located 850m west of the site and is a geological feature hosting a large seabird colony.

4.8 Site Sensitivity Assessment

The site is considered to be located within a moderate to high sensitivity setting due to the following reasons:

- Residential properties are located in close proximity;
- The site is underlain by a Secondary A Aquifer;
- The site is underlain by permeable drift deposits which may permit the migration of mobile contaminants into the underlying groundwater contained within the aquifer;
- There are no potable groundwater abstraction within 1km of the site;
- Pow Beck is adjacent to the west of the site; however, this section of the watercourse is culverted.

5.0 CONSULTATIONS

5.1 Local Authority Contaminated Land Officer

The Contaminated Land Officer at Copeland Borough Council (Thomas Greer) was contacted regarding the site and he indicated that the site had a number of previous industrial uses including timber yard, railway sidings, construction yard, chandlers and a garage which corroborates the findings of this report.

Mr Greer also indicated that he had previously visited the site and noted that there was a considerable build-up of oily sludge in the manhole chambers, although this oily sludge did not appear to be present when the REC engineer visited the site in February 2014.

5.2 Local Authority Building Control Officer

The Building Control Officer at Copeland Borough Council (Mark Key) was contacted and indicated that no restrictions are present in the area; however, a recent residential development in close proximity to the site encountered difficulty with foundation excavations during construction. The ground conditions were described as poor and resulted in the trench filling operations (down to 3m) collapsing frequently before filling could occur.

5.3 Landfill Sites and Waste Treatment Sites

A registered waste treatment site was located on-site and the licence holder was Partco Autoparts Ltd. The site is categorised as storage (with transfer) with the maximum input rate equal to or greater than 250,000 tonnes per year, authorised wastes include alcohol, aldehydes, ketones, aliphatic and aromatic hydrocarbons, ethers, liquid waste cellulose paint/thinner. The licence was cancelled 1st September 1992.

No historical or active landfills are located within a 250m radius of the site.

5.4 Regulatory Database

Table 5.1 (overleaf) contains information which has been obtained from a commercially available environmental database. The summary table only includes records not otherwise detailed in the report. A full copy of the database report is provided on the CD at the rear of this report.

Table 5.1 Summary of Envirocheck Data

Activity	0-249m	250-500m	Details
Contaminated Land Register Entries and Notices	0	0	
Authorised industrial processes (IPC/IPPC/LAPPC).	1	1	138m (SW) manufacture and use of organic chemicals and 274m (NW) organic chemicals and alcohol.
Fuel Stations Entries	0	3	279m (NW), 370m (E), 372m (NE).
Licensed radioactive substances	0	0	
Enforcements, prohibitions or prosecutions	0	0	
Discharge Consents	0	2	410m and 487m (SE) both relate to storm sewage discharged into Pow Beck.
Pollution Incidents	3	2	A pollution incident occurred on-site 27 th November 1994 and was recorded as a minor incident involving the discharge of oils into Pow Beck.
Consents issued under the Planning (Hazardous Substances) Act 1990	0	0	
Control of Major Accident Hazard (COMAH) sites	0	0	

6.0 INITIAL CONCEPTUAL SITE MODEL (CSM)

6.1 Initial CSM

In accordance with Environment Agency, CLR 11 (2004) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), REC Ltd have developed an initial CSM to identify potential contamination sources, migration pathways and receptors within the study area.

6.2 Contaminant Sources

On-site Potential Sources

The available historical maps and environmental information for the site indicates that a number of potentially contaminative industries were located or operated out of the site as follows;

- Railway sidings / railway land (mid to late 19th Century);
- Timber yard (late to early 20th Century);
- Builders / contractors yard and associated fuel pumps / underground storage tanks (mid-20th Century);
- Registered waste treatment facility (late 20th Century) authorised wastes include alcohol, aldehydes, ketones, aliphatic and aromatic hydrocarbons, ethers, liquid waste cellulose paint/thinner;
- Boat builders (recent);
- Vehicle repair and servicing garage (recent); and,
- Made Ground associated with the construction and demolition of previous and existing site buildings.

A review of the relevant Department of the Environment (DOE) Industry Profiles indicates the above industries may give rise to the following contaminants;

- Heavy Metals;
- Polycyclic Aromatic Hydrocarbons (PAH);
- Asbestos Containing Material (ACM);
- Phenols;
- Sulphates;
- Cyanide;
- Hydrocarbons;
- Semi-Volatile Organic Compounds (SVOCs); and,
- Volatile Organic Compounds (VOCs).

In addition, the presence of Made Ground may be a source of hazardous ground gases such as methane and carbon dioxide.

Off-site Potential Sources

The site is located within a mixed industrial and residential area of Whitehaven and as such a number of potentially contaminative businesses were historically located within close proximity to the site.

The available information indicates that two chemical works (unknown production), in-filled clay pits, railway land and a saw mill were located within 250m of the site. Contaminants associated with these industries may include heavy metals, PAH, ACM, SVOCs, VOCs, hydrocarbons, phenol, cyanide and sulphate. Areas of in-filled ground such as the clay pits may be a source of hazardous ground gases.

6.3 Potential Pathways

- Migration of mobile contaminants on or off site via services, sewers and manmade conduits;
- Direct contact, ingestion and inhalation of contaminants on site;
- Migration of contaminated dusts during earthworks;
- Migration of mobile contaminants into groundwater and surface waters;
- Migration of hazardous gases;
- Uptake of toxins/phytotoxins by plants; and,
- Consumption of contaminated potable waters.

6.4 Potential Receptors

Human Health

- Current and future site occupants;
- Construction workers; and,
- Off-site residents.

Controlled Waters

- Groundwater contained in underlying Secondary A Aquifer; and,
- Pow Beck;

It is considered unlikely that the culverted Pow Beck is in hydraulic conductivity with the site; however it has been included as a receptor as the integrity of the actual culvert cannot be guaranteed.

6.5 Preliminary Risk Assessment

Human Health

The risk posed to future site occupants is considered **high** in the site's current state based on the potential for a number of contaminative sources located on and off-site.

Construction workers are considered to be at a **low** risk as exposure will be managed through the use of appropriate PPE and hygienic working practices as required under HSE / CDM regulations. Furthermore, the length of any exposure is likely to be for a short duration.

The risk posed to off-site human receptors from future earthworks is considered **low** based on the control measures and safe working practices implemented during this stage of the construction.

Controlled Waters

The groundwater contained within the underlying Secondary A Aquifer, perched groundwater and Pow Beck is considered to be at a **Moderate to high** risk from potential sources based on the permeable drift deposits permitting the migration of soluble contaminants.

7.0 SITE INVESTIGATION

7.1 Desk Study Information

Potential contamination sources have been identified from the desk study and these are listed in Table 7.1 below:

Table 7.1 Summary of Potential Contaminant Sources

Potential Source	Potential Contaminants	Potential Impact
Railway land / sidings Timber yard Underground fuel storage tank(s) Waste treatment site (vehicle parts) Boat builders Repair and servicing garage	Metals, asbestos, hydrocarbons, phenols, sulphate, cyanide, volatile organic compounds and semi-volatile organic compounds	Human health and controlled waters
Made Ground across the site	Metals, asbestos, PAHs, hydrocarbons, methane and carbon dioxide	Human health, controlled waters and buildings

7.2 Site Investigation

7.2.1 General

A ground investigation has been designed based on the findings of the desk study with exploratory holes advanced to target specific potential contaminant sources summarised in Table 7.1 above. In addition, exploratory holes have also been advanced to provide information on baseline conditions across the site. The investigation has also been used to collect geotechnical information to assist in the design and construction of the proposed development.

Exploratory fieldwork was completed between the 17th and 24th February 2014. The works are summarised in Table 7.2, below.

Table 7.2 Summary of Fieldwork

Location Hole	Potential Source/Rationale	Type	Maximum Depth (m bgl)	Monitoring Wells Response Zone
WS101	Baseline conditions / Made Ground	Window Sample	3.00	N/A
WS101B			3.00	1.00 – 3.00
WS102	Baseline conditions / Made Ground	Window Sample	3.40	N/A
WS103	Made Ground, adjacent former chemical works	Window Sample	3.00	N/A
WS104	Potential underground fuel storage tank(s), boat builders	Window Sample	3.70	1.00 – 3.30
WS105	Potential underground fuel storage tank(s), sidings and Made Ground	Window Sample	3.00	N/A
WS106	Potential underground fuel storage tank(s),	Window Sample	0.30	N/A
WS106B	Potential underground fuel storage tank(s),	Window Sample	3.70	1.00 – 3.30

Table 7.2 (Cont...)

Location Hole	Potential Source/Rationale	Type	Maximum Depth (m bgl)	Monitoring Wells Response Zone
WS107	Made Ground, adjacent former chemical works	Window Sample	5.00	1.00 – 4.30
WS108	Railway sidings and former buildings	Window Sample	3.50	N/A
WS109	Former repair garage	Window Sample	0.30	N/A
WS109B	Former repair garage	Window Sample	0.30	N/A
WS110	Former repair garage	Window Sample	5.00	1.00 – 4.50
CP101	Baseline conditions / railway sidings	Cable Percussive	12.00	N/A
CP102	Potential underground fuel storage tank(s), boat builders	Cable Percussive	12.00	1.50 – 10.00
CP103	Boat builders / baseline conditions	Cable Percussive	12.00	0.50 – 3.00
RB101	Potential shallow coal mining	Rotary	30.00	N/A
RB102		Rotary	30.00	N/A
RB103		Rotary	30.00	N/A

Notes

m bgl – metres below ground level.

The window sample probeholes and cable percussive boreholes were designed to provide geotechnical information, and to retrieve environmental samples for chemical testing in order to confirm the findings of the Initial Conceptual Site Model (ICSM). The rotary boreholes were designed to explore the potential for shallow coal mine workings beneath the site.

Return visits were made to monitor installations for groundwater level and gas concentrations. In addition, selected wells were purged and samples of groundwater recovered for chemical analysis.

7.2.2 In-Situ Standard Penetration Testing (SPT)

In-situ geotechnical testing was conducted using the Standard Penetration Test (SPT) and where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube. The results are shown in the probehole logs contained in Appendix VII and presented in Table 8.2.

7.3 Laboratory Analysis

Selected soil samples were submitted for a range of chemical analysis comprising, metals, pH, total sulphate, water soluble sulphate (2:1 extract), cyanide, phenols, total and speciated polycyclic aromatic hydrocarbons (PAHs), asbestos, total and speciated petroleum hydrocarbon (TPH), volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC).

SAL Ltd of Manchester undertook the analytical work in accordance with their UKAS accreditation where applicable and the testing results are included in Appendix VIII and discussed in Section 9.0.

Selected samples were submitted to PSL laboratory where the following geotechnical tests were undertaken:

- Atterburg Limits Determinations;
- Bulk Density Tests; and,
- Particle Size Distribution Tests.

Laboratory analysis sheets are included in Appendix XI and are summarised in Section 8.0

8.0 GROUND AND GROUNDWATER CONDITION

8.1 Ground Conditions

8.1.1 Summary of Ground Conditions

The ground investigation generally confirms the published geology and identifies the strata set out in Table 8.1 below.

Table 8.1 Summary of Strata

Strata	Typical Description	Min Depth to Top of Strata (m)	Max Depth to Top of Strata (m)	Max Thickness (m)
MG Black gravelly SAND	Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, slate, concrete and coal.	0.08	0.35	1.30
MG soft to firm dark grey clay	Soft to firm dark grey slightly gravelly slightly sandy clay. Gravel is fine to medium subangular to subrounded of brick, coal, mudstone and siltstone.	0.50	0.80	0.50
Alluvial Soft grey Clay	Soft to firm grey silty gravelly CLAY. Gravel is fine to medium subangular to subrounded of coal and siltstone.	0.40	1.30	2.00
Alluvial Sand	Brown medium to coarse SAND.	1.80	2.90	6.00
Alluvial Stiff brownish grey Clay	Stiff brownish grey sandy CLAY.	5.70	11.00	6.30
Middle Coal Measures	Inter-bedded layers of MUDSTONE and SILTSTONE	9.5	16.00	30.00
Middle Coal Measures	COAL	14.00	14.00	0.50

8.1.2 Made Ground

Made Ground deposits were encountered across the site and consisted of either black gravelly sand with a gravel content composed of brick, clinker, concrete, coal or soft to firm dark grey clay. The depth of the Made Ground was between 0.4m and 2.0m and is shown on drawing No. 45418p1r0-008 in Appendix III.

8.1.3 Drift Deposits

Superficial alluvium comprising inter-bedded sand and clay layers was encountered at depths between 0.4m and 2.0m bgl. The alluvium was proven to extend to depths between 9.5m and 16.0m bgl.

8.1.4 Solid Geology

Bedrock was encountered at depths between 9.5m and 16.0m bgl and consisted of inter-bedded layers of mudstone and siltstone. An intact coal seam 0.5m thick was encountered at a depth of 14.0m bgl in BH3.

8.1.5 Soil Consistency

The granular Made Ground deposits (up to 1.3m bgl) were found to be generally loose in consistency and the cohesive Made Ground was of a low strength. The underlying natural

alluvial sand was found to be generally medium dense to dense in consistency and the natural alluvial clay was found to be medium to high strength.

Results of the Standard Penetration Tests, including undrained shear strengths derived from SPTs are included on Table 8.2 overleaf.

Table 8.2 Standard Penetration Test Results

Boreholes	Depth (m bgl) (i)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value (N ₁) ₆₀	Terzaghi & Peck Relative Density (Sands)	Eurocode Soil strength	Consistency (BS5930)	Stroud & Butler Approximate Undrained Shear Strength (kN/m ²)
CP101	2	Medium Coarse Sand	12	10.96	Medium Dense	N/A	N/A	N/A
	3	Medium Coarse Sand	42	36.53	Dense	N/A	N/A	N/A
	4	Medium Coarse Sand	25	21.12	Medium Dense	N/A	N/A	N/A
	5	Medium Coarse Sand	36	29.87	Medium Dense	N/A	N/A	N/A
	6	Medium Coarse Sand	22	18.04	Medium Dense	N/A	N/A	N/A
	7.5	Medium Coarse Sand	13	10.55	Medium Dense	N/A	N/A	N/A
	9	Clayey Medium to Coarse Sand	38	30.66	Dense	N/A	N/A	N/A
	10.5	Clayey Medium to Coarse Sand	50	39.45	Dense	N/A	N/A	N/A
	12	Clayey Medium to Coarse Sand	50	37.21	Dense	N/A	N/A	N/A
CP102	1	Clayey Gravelly Medium Coarse Sand	2	2.02	Very Loose	N/A	N/A	N/A
	11.5	Stiff Sandy Clay	19	14.41	N/A	Medium strength	Stiff	72
	3	Medium Coarse Sand	29	25.22	Medium Dense	N/A	N/A	N/A
	4	Medium Coarse Sand	21	17.74	Medium Dense	N/A	N/A	N/A
	5	Medium Coarse Sand	33	27.38	Medium Dense	N/A	N/A	N/A
	6	Medium Coarse Sand	26	21.32	Medium Dense	N/A	N/A	N/A
	7.5	Medium Coarse Sand	18	14.60	Medium Dense	N/A	N/A	N/A
	9	Fine to Coarse Gravel	10	8.07	Loose	N/A	N/A	N/A
	10.5	Fine to Coarse Gravel	13	10.26	Medium Dense	N/A	N/A	N/A
CP103	11.5	Stiff Sandy Clay	19	14.41	N/A	Medium strength	Stiff	72
	2	Sandy Silt	2	1.83	N/A	Extremely low strength	Very Soft	9
	3	Medium Coarse Sand	13	11.31	Medium Dense	N/A	N/A	N/A
	4	Medium Coarse Sand	13	10.98	Medium Dense	N/A	N/A	N/A
	5	Medium Coarse Sand	15	12.44	Medium Dense	N/A	N/A	N/A
	7.5	Slightly Sandy Clay	17	13.79	N/A	Medium strength	Stiff	69

Table 8.2 (Cont...)

Boreholes	Depth (m bgl) (i)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value (N ₁) ₆₀	Terzaghi & Peck Relative Density (Sands)	Eurocode Soil strength	Consistency (BS5930)	Stroud & Butler Approximate Undrained Shear Strength (kN/m ²)
CP103 (Cont...)	9	Slightly Sandy Clay	27	21.78	N/A	High strength	Very Stiff	109
	10.5	Slightly Sandy Clay	21	16.57	N/A	High strength	Very Stiff	83
	12	Slightly Sandy Clay	22	16.37	N/A	High strength	Very Stiff	82
WS101	1	Gravelly Fine to Medium Sand	4	4.03	Loose	N/A	N/A	N/A
	2	Medium Coarse Sand	18	16.44	Medium Dense	N/A	N/A	N/A
	2.7	Fine to Coarse Sand	50	44.01	Dense	N/A	N/A	N/A
WS101B	1	Slightly Gravelly Slightly Sandy Clay	3	3.02	N/A	Very low strength	Soft	15
	2	Medium Coarse Sand	34	31.06	Dense	N/A	N/A	N/A
	2.8	Medium Coarse Sand	50	43.82	Dense	N/A	N/A	N/A
WS102	1	Slightly Gravelly Slightly Sandy Clay	4	4.03	N/A	Low strength	Firm	20
	2	Medium Coarse Sand	9	8.22	Loose	N/A	N/A	N/A
	3	Medium Coarse Sand	50	43.48	Dense	N/A	N/A	N/A
	3.4	Medium Coarse Sand	26	22.31	Medium Dense	N/A	N/A	N/A
WS103	1	Silty Slightly Gravelly Clay	0	0.00	N/A	N/A	N/A	0
	2	Medium Coarse Sand	14	0.91	Very Loose	N/A	N/A	N/A
	3	Medium Coarse Sand	50	50.41	Very Dense	N/A	N/A	N/A
WS104	1	Gravelly Fine to Medium Sand	2	2.02	Very Loose	N/A	N/A	N/A
	2	Gravelly Medium to Coarse Sand	3	2.74	Very Loose	N/A	N/A	N/A
	3	Gravelly Medium to Coarse Sand	25	21.74	Medium Dense	N/A	N/A	N/A
	3.7	Gravelly Medium to Coarse Sand	50	42.55	Dense	N/A	N/A	N/A

Table 8.2 (Cont...)

Boreholes	Depth (m bgl) (i)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value ($N_{1,60}$)	Terzaghi & Peck Relative Density (Sands)	Eurocode Soil strength	Consistency (BS5930)	Stroud & Butler Approximate Undrained Shear Strength (kN/m^2)
WS105	1	Clayey Gravelly Medium to Coarse Sand	6	6.05	Loose	N/A	N/A	N/A
	2	Coarse Sand	19	17.36	Medium Dense	N/A	N/A	N/A
	3	Coarse Sand	50	43.48	Dense	N/A	N/A	N/A
WS106B	1	Silty Slightly Gravelly Clay	1	1.01	N/A	Extremely low strength	Very Soft	5
	2	Medium Coarse Sand	11	10.05	Medium Dense	N/A	N/A	N/A
	3	Medium Coarse Sand	33	28.70	Medium Dense	N/A	N/A	N/A
	3.7	Medium Coarse Sand	50	42.55	Dense	N/A	N/A	N/A
WS107	1	Silty Slightly Gravelly Clay	2	2.02	N/A	Very low strength	Soft	10
	2	Silty Slightly Gravelly Clay	0	0.00	N/A	N/A	N/A	0.00
	3	Medium Coarse Sand	30	26.09	Medium Dense	N/A	N/A	N/A
	4	Medium Coarse Sand	25	0.00	0.00	N/A	N/A	N/A
	5	Silty Slightly Gravelly Clay	18	14.93	N/A	Medium strength	Stiff	75
WS108	1	Clayey Gravelly Medium to Coarse Sand	50	50.41	Very Dense	N/A	N/A	N/A
	2	Medium Coarse Sand	10	9.14	Loose	N/A	N/A	N/A
	3	Medium Coarse Sand	21	18.26	Medium Dense	N/A	N/A	N/A
	3.5	Medium Coarse Sand	50	42.78	Dense	N/A	N/A	N/A
WS110	1	Slightly Gravelly Slightly Sandy Clay	4	4.03	N/A	Low strength	Firm	20
	2	Fine to Coarse Sand	1	0.91	Very Loose	N/A	N/A	N/A
	3	Fine to Coarse Sand	21	18.26	Medium Dense	N/A	N/A	N/A
	4	Silty Gravelly Sand	20	16.90	Medium Dense	N/A	N/A	N/A
	5	Silty Gravelly Sand	44	36.50	Dense	N/A	N/A	N/A

8.1.6 Soil Infiltration

In-situ variable (falling) head permeability tests were undertaken within the monitoring well installations located in three probeholes (WS106B, WS107 and WS110). Groundwater was noted to be at a depth of approximately 1.70m bgl. The results are presented in Table 8.3 below.

Table 8.3 Soil Infiltration Results

Location	Response Zone (m)	Groundwater Level (m)	Material	Soil Infiltration Rate (m/s)
WS106B	1.0 - 3.7	1.55	Alluvium: soft clay and medium dense sand	1.02×10^{-5}
WS107	1.0 – 5.0	1.79	Alluvium: soft clay and medium dense sand	2.69×10^{-6}
WS110	1.0 – 5.0	1.71	Alluvium: soft clay and loose sand	1.82×10^{-5}

8.1.7 Soil Plasticity

The Atterberg Limits determinations summarised in Table 8.4 below, show the clay to be of high plasticity with a high volume change potential.

Table 8.4 Summary of Plasticity Index Test Results

Location	Depth (m)	Natural Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Percentage passing 425µm sieve (%)	Modified Plasticity Index
CP101	1.00	58	31	75	44	100	44
WS103	0.70	43	33	72	39	100	39
WS106B	1.00	53	34	74	40	100	40

8.1.8 pH and Sulphate

Chemical analyses for pH and soluble sulphate content contained in Appendix VIII (summarised below in Table 8.5), shows that the soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE Special Digest 1 (2005).

Table 8.5 Summary of pH and Sulphate Data

Location	Depth (m)	SO ₄ in 2:1 water / soil (g/l)	pH Value
WS101	0.30	<0.1	10.1
WS104	0.30	<0.1	8.1
WS105	0.30	<0.1	8.1
WS106	0.30	<0.1	7.8
WS107	0.20	<1	8.0
WS108	0.20	<1	12.1
WS110	0.40	0.3	8.2
CP102	0.50	<1	8.1
CP103	0.50	<1	8.8

8.2 Groundwater Conditions

Groundwater strikes were encountered as seepages at multiple locations across the site. The location and depth of the seepages and the depth to which groundwater rose are shown on the exploratory hole records and summarised in Table 8.6 below.

Table 8.6 Summary Groundwater Strikes

Location	Depth to strike (m)	Depth to standing water (m)
CP101	3.5	2.8
CP102	3	1.8
CP102	9	6
CP103	3	6
WS105	2	N/A
WS106B	2	N/A
WS107	3	N/A
WS110	3	N/A

Monitoring was undertaken using an electronic dip meter and interface probe to record the depth to groundwater. The groundwater levels recorded are summarised in Table 8.7 overleaf.

8.3 Ground Gas

Concentrations of methane (CH₄), carbon dioxide (CO₂) and Oxygen (O₂) were measured using an infra red gas analyser (GA2000) calibrated to a reference standard (before and after each survey) and gas flow rates were measured using an attached flow pod. Gas measurements were recorded for a minimum of sixty seconds at each location, at which point the maximum concentration of CH₄ and CO₂ together with the lowest concentration of O₂ were recorded. The results of the ground gas monitoring are presented in Table 8.7 overleaf.

Table 8.7 Summary of ground gas and groundwater monitoring results

Well	Date	CH ₄ Initial %v/v	CH ₄ Steady %v/v	CH ₄ GSV l/hr	CO ₂ Initial %v/v	CO ₂ Steady %v/v	CO ₂ GSV l/hr	CO ₂ GSV l/hr	Atmos (mb)	Atmos. Dynamic	Flow (l/hr)	Response Zone (mbgl)	Depth to Base (m bgl)	Depth to Water (m bgl)	PID Peak (ppm)	PID Steady (ppm)
CP102	07/03/2014	1	1	0.001	0.5	0.5	0.0005	19.7	986	Rising	0.1	1.00 – 10.0	9.19	1.31		
	13/03/2014	0.1	0.1	0.0001	0.3	0.2	0.0003	20.7	1032	Steady	0.1		9.20	1.73		
	11/04/2014	0.4	0.4	0.0004	0.4	0.4	0.0004	18.4	1024	Steady	-0.1		9.03	1.76	0.6	0
	25/04/2014	0.2	0.2	0.0006	0.6	0.6	0.0018	19.7	1016	Falling	0.3		9.00	1.94		
	28/05/2014	0.1	0.1	0.0001	0.3	0.3	0.0003	17.9	1017	Steady	-0.1		9.01	1.89		
	02/06/2014	0.1	0.1	0.0001	0.3	0.3	0.0003	18.1	1016	Steady	0.1		9.02	1.88		
CP103	07/03/2014	7	6.9	0.0069	0.9	0.9	0.0009	14.2	986	Rising	0.1	0.50 – 3.00	3.00	1.26		
	13/03/2014	0.2	0.2	0.0002	0.3	0.3	0.0003	19.8	1032	Steady	0.1		3.00	1.74		
	11/04/2014	8.9	8.9	0.0267	3.9	3.9	0.0117	4.5	1024	Steady	-0.3		3.00	1.70	0.5	0
	25/04/2014	14.3	14.3	0.0143	5.1	5.1	0.0051	14.2	1016	Falling	-0.1		3.01	1.82		
	28/05/2014	7.4	7.4	0.0074	3.8	3.8	0.0038	6.4	1017	Steady	0.1		3.00	1.73		
	02/06/2014	14.5	14.5	0.0145	4.4	4.4	0.0044	3.5	1016	Steady	0.1		9.02	1.88		
WS101	07/03/2014	0.3	0.3	0.0003	1.3	1.3	0.0013	15.2	986	Rising	0.1	1.00 – 3.00	2.22	1.15		
	13/03/2014	0.1	0.1	0.0001	1.4	1.4	0.0014	18.1	1032	Steady	0.1		2.22	1.45		
	11/04/2014	0.1	0.1	0.0001	3.5	3.5	0.0035	13.4	1024	Steady	0.1		2.19	1.68	2.2	1.4
	25/04/2014	0.1	0.1	0.0001	3.4	3.4	0.0034	15.2	1016	Falling	0.1		2.16	1.80		
	28/05/2014	0.1	0.1	0.0001	4.1	4.1	0.0041	11.8	1017	Steady	0.1		2.20	1.79		
	02/06/2014	0.1	0.1	0.0001	3.2	3.2	0.0032	13.4	1016	Steady	0.1		2.19	1.79		
WS104	07/03/2014	1.3	1.3	0.0013	3.8	3.8	0.0038	11.5	986	Rising	-0.1	1.00 – 3.00	2.58	1.20		
	13/03/2014	0.1	0.1	0.0001	1.8	1.8	0.0018	19.7	1032	Steady	0.1		2.56	1.64		
	11/04/2014	0.2	0.2	0.0002	5.6	5.6	0.0056	14.6	1024	Steady	0.1		2.60	1.61	155	149
	25/04/2014	0.1	0.1	0.0001	5.1	5.1	0.0051	14.5	1016	Falling	0.1		2.58	1.81		
	28/05/2014	0.3	0.3	0.0003	6.2	6.2	0.0062	9.5	1017	Steady	-0.1		2.60	1.64		
	02/06/2014	0.1	0.1	0.0001	4.2	4.0	0.0042	10.6	1016	Steady	0.1		2.57	1.66		
WS106b	07/03/2014	0.5	0.5	0.0005	0.7	0.7	0.0007	16.3	986	Rising	0.1	1.00 - 3.00	2.55	1.17		

Well	Date	CH ₄ Initial %v/v	CH ₄ Steady %v/v	CH ₄ GSV l/hr	CO ₂ Initial %v/v	CO ₂ Steady %v/v	CO ₂ GSV l/hr	CO ₂ GSV l/hr	Atmos (mb)	Atmos. Dynamic	Flow (l/hr)	Response Zone (mbgl)	Depth to Base (m bgl)	Depth to Water (m bgl)	PID Peak (ppm)	PID Steady (ppm)
	13/03/2014	0.1	0.1	0.0001	0.6	0.6	0.0006	20.1	1032	Steady	0.1		2.56	1.55		
	11/04/2014	0.1	0.1	0.0001	0.6	0.6	0.0006	18.8	1024	Steady	0.1		2.51	1.46	7.6	4.2
	25/04/2014	0.1	0.1	0.0001	0.9	0.9	0.0009	17.3	1016	Falling	-0.1		2.51	1.79		
	28/05/2014	0.1	0.1	0.0001	0.9	0.9	0.0009	17.3	1017	Steady	-0.1		2.51	1.41		
	02/06/2014	0.1	0.1	0.0001	0.5	0.5	0.0005	17.9	1016	Steady	0.1		2.51	1.40		
WS107	07/03/2014	0.1	0.1	0.0001	0.2	0.2	0.0002	20.3	986	Rising	0.1	1.00 – 4.00	3.76	1.42		
	13/03/2014	0.1	0.1	0.0001	0.3	0.3	0.0003	20.5	1032	Steady	0.1		3.75	1.79		
	11/04/2014	0.1	0.1	0.0001	0.4	0.4	0.0004	19	1024	Steady	0.1		3.81	1.86	13	8.6
	25/04/2014	0.1	0.1	0.0001	0.4	0.4	0.0004	18.2	1016	Falling	-0.1		3.57	2.02		
	28/05/2014	0.1	0.1	0.0001	0.6	0.6	0.0006	18.0	1017	Steady	-0.1		3.82	1.91		
	02/06/2014	0.1	0.1	0.0001	0.5	0.5	0.0005	17.7	1016	Steady	0.1		3.81	1.84		
WS110	07/03/2014	0.1	0.1	0.0001	0.2	0.2	0.0002	17.4	986	Rising	0.1	1.00 – 4.00	2.96	1.40		
	13/03/2014	0.1	0.1	0.0001	0.5	0.5	0.0005	20.3	1032	Steady	0.1		2.96	1.71		
	11/04/2014	0.1	0.1	0.0001	0.4	0.3	0.0004	19.3	1024	Steady	-0.1		2.97	1.86	4.5	3.9
	25/04/2014	0.1	0.1	0.0001	0.7	0.7	0.0007	18	1016	Falling	-0.1		2.96	2.01		
	28/05/2014	0.1	0.1	0.0001	0.2	0.2	0.0002	17.9	1017	Steady	-0.1		2.89	1.97		
	02/06/2014	0.1	0.1	0.0001	0.1	0.1	0.0001	18.1	1016	Steady	0.1		3.90	1.95		

9.0 TIER 1 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

REC has undertaken a Tier 1 qualitative risk assessment to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

9.1 Human Health Risk Assessment

At a Tier 1 stage the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published by the EA (Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGV)) and where absent, Generic Assessment Criteria (GACs) published by LQM/CIEH (2nd edition).

The results of this comparison have been summarised within Table 9.1 (overleaf).

Table 9.1 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Residential End Use

Determinand	Units	GAC _{v3}	n	MC	Loc. of Ex	Pathway	Assessment
Arsenic	mg/kg	32	9	36	WS105 0.30	1	Action required
				55	WS107 0.20		
				56	WS110 0.40		
Cadmium	mg/kg	10	9	<1	N/A	1	No Further Action
Chromium (VI)	mg/kg	4.3	9	<1	N/A	1	No Further Action
Lead⁽ⁱⁱⁱ⁾	mg/kg	225	9	300	WS105 0.30	1	Action required
				510	WS107 0.20		
				340	WS110 0.40		
				270	CP102 0.50		
Mercury	mg/kg	11	9	<1	N/A	2	No Further Action
Nickel	mg/kg	130	9	120	N/A	1	No Further Action
Selenium	mg/kg	350	9	<3	N/A	1	No Further Action
Copper ⁽ⁱⁱ⁾	mg/kg	2330	9	400	N/A	1	No Further Action
Zinc ⁽ⁱⁱ⁾	mg/kg	3750	9	360	N/A	1	No Further Action
Cyanide (Total)	mg/kg	791	9	<1	N/A	1	No Further Action
Phenols	mg/kg	210	9	<1	N/A	1	No Further Action
Naphthalene	mg/kg	1.5	8	5.7	CP102 0.50	2	Action required
				3.8	WS104 0.30		
				8.9	CP103 3.50		
Acenaphthylene	mg/kg	170	11	0.4	N/A	3	No Further Action
Acenaphthene	mg/kg	210	11	4.4	N/A	1	No Further Action
Fluorene	mg/kg	160	11	4.1	N/A	1	No Further Action
Phenanthrene	mg/kg	92	11	37	N/A	3	No Further Action
Anthracene	mg/kg	2300	11	11	N/A	3	No Further Action
Fluoranthene	mg/kg	260	11	53	N/A	3	No Further Action
Pyrene	mg/kg	560	11	49	N/A	3	No Further Action
Benzo(a)Anthracene	mg/kg	3.1	11	46	WS104 0.30	3	Action required
				5.3	WS101 0.30		
				4.3	WS106 0.30		
				4.5	CP102 0.50		
Chrysene	mg/kg	6	11	44	WS104 0.30	3	Action required
Benzo(b/k)fluoranthene	mg/kg	5.6	11	60	WS104 0.30	3	Action required
				8.4	CP102 0.50		
				7.6	WS101 0.30		
				7.4	WS106 0.30		
Benzo(a)Pyrene	mg/kg	0.83	11	32	WS104 0.30	3	Action required
				2.2	CP103 0.50		
				3.5	WS101 0.30		
				4.5	WS106 0.30		
				4.5	CP102		

Determinand	Units	GAC _{V3}	n	MC	Loc. of Ex	Pathway	Assessment
					0.50		
Indeno(123-cd)pyrene	mg/kg	3.2	11	16	WS104 0.30	3	Action required
				3.3	WS106 0.30		
				3.6	CP102 0.50		
Dibenzo(a,h)anthracene	mg/kg	0.76	11	9.1	WS104 0.30	3	Action required
				0.77	WS106 0.30		
Benzo(ghi)perylene	mg/kg	44	11	16	N/A	3	No Further Action
TPH C ₅ -C ₆ (aliphatic)*	mg/kg	30	12	<0.01	N/A	2	No Further Action
TPH C ₆ -C ₈ (aliphatic)*	mg/kg	73	12	0.037	N/A	2	No Further Action
TPH C ₈ -C ₁₀ (aliphatic)*	mg/kg	19	12	1.5	N/A	2	No Further Action
TPH C ₁₀ -C ₁₂ (aliphatic)*	mg/kg	93	12	17	N/A	1	No Further Action
TPH C ₁₂ -C ₁₆ (aliphatic)*	mg/kg	740	12	56	N/A	1	No Further Action
TPH C ₁₆ -C ₃₅ (aliphatic)*	mg/kg	45000	12	119	N/A	1	No Further Action
TPH C ₅ -C ₇ (aromatic)*	mg/kg	65	12	<0.01	N/A	2	No Further Action
TPH C ₇ -C ₈ (aromatic)*	mg/kg	120	12	0.043	N/A	2	No Further Action
TPH C ₈ -C ₁₀ (aromatic)*	mg/kg	27	12	3.1	N/A	2	No Further Action
TPH C ₁₀ -C ₁₂ (aromatic)*	mg/kg	69	12	16	N/A	2	No Further Action
TPH C ₁₂ -C ₁₆ (aromatic)*	mg/kg	140	12	57	N/A	1	No Further Action
TPH C ₁₆ -C ₂₁ (aromatic)*	mg/kg	250	12	270	WS104 0.30	1	Action required
TPH C ₂₁ -C ₃₅ (aromatic)*	mg/kg	890	12	1600	WS104 0.30	1	Action required
Asbestos	N/A	N.D ⁽ⁱⁱⁱ⁾	8	N.D	N/A	4	No Further Action

Notes

Main Exposure Pathways: 1 = Soil Ingestion, 2 = Vapour Inhalation (indoor), 3 = Dermal Contact & Ingestion, 4 = Dust Inhalation.

Abbreviations: GAC = General Assessment Criteria, n = number of samples, MC = Maximum Concentration; Loc of Ex = Location of Exceedance.

* The Tier 1 GAC for the hydrocarbon fraction is derived from the CIEH assessment for petroleum hydrocarbons Criteria Working Group (CWG) for both aliphatic and aromatic compounds. REC has utilised the Tier 1 values for aliphatic compounds for the volatile and semi volatile fractions (C₅-C₁₂) and the Tier 1 values for aromatic compound for the non volatile fractions (C₁₂-C₃₅). The comparison of a total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.

(i) Benzo (b) Fluoranthene (100mg/kg) Benzo (k) Fluoranthene (140mg/kg);

(ii) GAC based on human health criteria. Ecotoxicological assessment will be made using EA guidance (EPR 8.01) on soil spreading (Cu 135mg/kg, Zinc 200mg/kg, Pb 300mg/kg);

(iii) N.D = Not Detected

Referring to Table 9.1, the results of this direct comparison indicates that the screening values have been exceeded for the following determinands:

■ **Arsenic** (WS105 0.30m, WS107 0.20m and WS110 0.40m);

■ **Lead** (WS105 0.30m, WS107 0.20m, WS110 0.40m and CP102 0.50m);

■ **Naphthalene** (CP102 0.50m, WS104 0.30m and CP103 3.50m);

■ **Benzo(a)anthracene** (WS104 0.30m, WS101 0.30m, WS106 0.30m and CP102 0.50m);

■ **Chrysene** (WS104 0.30m);

- **Benzo(b/k)fluoranthene** (WS104 0.30m, CP102 0.50m, WS101 0.30m, WS106 0.30m);
- **Benzo(a)pyrene** (WS104 0.30m, CP103 0.50m, WS101 0.30m, WS106 0.30m and CP102 0.50m);
- **Indeno(123-cd)pyrene** (WS104 0.30m, WS106 0.30m and CP102m 0.50m);
- **Dibenzo(a,h)anthracene** (WS104 0.30m and WS106 0.30m);
- **TPH C₁₆-C₂₁ (aromatic)** (WS104 0.30m); and
- **THP C₂₁-C₃₅ (aromatic)** (WS104 0.30m).

During the ground investigation visual and olfactory evidence of contamination in the form of an oily sheen and solvent / hydrocarbon odour was observed in several boreholes particularly in the vicinity of the former fuel pumps / underground storage tanks (CP102, CP103, WS104, WS102, WS105 and WS106B).

The two most visually contaminated boreholes (WS104 and CP103) that both omitted an strong solvent odour were tested for a range of Volatile Organic Compounds (USEPA 624) and Semi-Volatile Organic Compounds (USEPA 625). The results indicated that none of the contaminants apart from the ones listed above exceeded the relevant tier 1 screening values where available.

The contamination hotspots are shown on drawing No 45418p1r0-009 contained in Appendix III.

In the case of arsenic, lead, TPH aromatic C₁₆-C₂₁, and TPH aromatic C₂₁-C₃₅ the main exposure pathway is soil ingestion. Whilst benzo(a)anthracene, chrysene, benzo(b/k)fluoranthene, benzo(a)pyrene, indeno(123-cd)pyrene, dibenzo(a,h)anthracene the main exposure pathway is through both dermal contact and soil ingestion. In the case of naphthalene the main exposure pathway is vapour inhalation.

It is recommended that the vast majority of contamination found across the site within the Made Ground can be remediated through the removal of the viable exposure pathway in the proposed development. It is therefore recommended that all soft landscaped areas of the proposed development are capped with a clean inert cover system approximately 600mm thick.

To mitigate the risk of naphthalene vapour exposure, it is recommended that a vapour membrane is installed within the proposed buildings to remove the direct pollutant linkage, if not removed from site.

9.2 Controlled Waters

The groundwater vulnerability map shows the site to be located over a Secondary (A) Aquifer with a moderate risk of leaching. The Coal Measure bedrock is overlain by permeable inter-bedded alluvium comprising sand, silt, and clay.

Groundwater samples taken from WS104, CP102 and CP103 were tested for a range of determinants. A Tier I risk assessment has been undertaken with concentrations of determinants compared with the relevant thresholds. These are presented in Table 9.2.

Table 9.2 Comparison of Groundwater Analysis with Tier 1 Screening Levels

For the purposes of the Tier 1 assessment REC have compared the laboratory test data directly to the relevant Tier 1 threshold values for the protection of controlled waters.

Determinand	Units	Hardness Banding (CaCO ₃) mg/l	EQS Freshwater ¹	UK DWS ²	CP102	CP103	WS104
Inorganic							
Arsenic	µg/l	-	50	10	6.6	5.2	5.4
Cadmium	µg/l	-	5	5	0.02	0.07	0.10
Chromium	µg/l	0-50	2	50	18	41	63
Copper*	µg/l	0-10	5	2000	0.8	1.4	1.3
Cyanide	µg/l	-	-	50	<50	<50	<50
Lead	µg/l	0-50	4	10	<0.3	<0.3	<0.3
Mercury	µg/l	-	1	1	<0.05	<0.05	<0.05
Nickel	µg/l	0-50	8	20	2	9	10
Selenium	µg/l	-	-	10	<0.5	15	2.6
Sulphate (SO ₄)	mg/l	-	400	250	1.4	49	130
Zinc	µg/l	0-50	30	5000	4	8	5
pH	µg/l	-	6-9	-	7.0	7.0	7.1
Phenol	µg/l	-	30	0.5	<100	<100	<100
Organic							
Benzene	µg/l	-	30	-	<1	<1	<1
Toluene	µg/l	-	40	-	<1	7	<1
Ethylbenzene	µg/l	-	20	-	<1	17	<1
Xylene	µg/l	-	30	-	<1	210	<1
MTBE	µg/l	-	-	-	<1	<1	2
Aliphatic C5-C6	µg/l	-	-	10 ⁽⁵⁾	<10	<10	<10
Aliphatic C6-C8	µg/l	-	-	10 ⁽⁵⁾	<10	<10	<10
Aliphatic C8-C10	µg/l	-	-	10 ⁽⁵⁾	<10	<10	<10
Aliphatic C10-C12	µg/l	-	-	10 ⁽⁵⁾	<20	<20	24
Aliphatic C12-C16	µg/l	-	-	10 ⁽⁵⁾	<20	<20	86
Aliphatic C16-C21	µg/l	-	-	10 ⁽⁵⁾	<20	<20	27
Aliphatic C21-C35	µg/l	-	-	10 ⁽⁵⁾	54	<20	40
Aromatic C6 – C7	µg/l	-	-	10 ⁽⁵⁾	<10	<10	<10
Aromatic C7 – C8	µg/l	-	-	10 ⁽⁵⁾	<10	<10	<10
Aromatic C8 – C10	µg/l	-	-	10 ⁽⁵⁾	<10	570	<10
Aromatic C10 – C12	µg/l	-	-	10 ⁽⁵⁾	140	<20	210
Aromatic C12 – C16	µg/l	-	-	10 ⁽⁵⁾	210	<20	340
Aromatic C16 – C21	µg/l	-	-	10 ⁽⁵⁾	96	<20	170
Aromatic C21 – C35	µg/l	-	-	10 ⁽⁵⁾	<20	<20	<20
Benzo(a)Pyrene	µg/l	-	0.05	0.03	0.15	0.04	0.02
Benzo[bk]fluoranthene	µg/l	-	0.03	-	0.27	0.09	0.05
Benzo(ghi)perylene & Indeno(123-cd)pyrene	µg/l	-	0.02	-	0.12	<0.01	<0.01
Anthracene	µg/l	-	0.02	-	0.55	7.0	0.15
Fluoranthene	µg/l	-	0.02	-	1.3	3.9	1.2
Naphthalene	µg/l	-	10	-	2.3	1500	12
PAHs (Sum of Four) ¹¹		-	-	0.1 ⁽¹¹⁾	0.43	0.11	0.07
1, 2, 4 Trimethylbenzene	µg/l	-	-	-	<1	62	<1
1, 3, 5 Trimethylbenzene	µg/l	-	-	-	<1	44	<1
Isopropyl benzene	µg/l	-	-	-	<1	4	<1

Notes	
#	Solubility <0.01µg/l
1.	Council Directive of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (76/464/EEC). Official Journal of the European Communities 18.5.76 L129/23
2.	The Surface Waters (Dangerous Substances) (Classification) Regulations 1989. SI 2286/89
3.	The Surface Waters (Dangerous Substances) (Classification) Regulations 1992. SI 337/92
4.	These represent non-statutory changes made in the 1990's which may be used by regulatory authorities. They are more conservative than the original 1985 values.
5.	EC Dangerous Substances - List 1 parameters
6.	EC Dangerous Substances - List 2 parameters as listed in Dangerous Substances Regulations of 1997 and 1998, and the DoE Circular 7/89
7.	Circular from the Department of the Environment (7/89) and the Welsh Office (SI 16/89). 30 March 1989. Water and the Environment: The implementation of European Community Directives on pollution caused by certain dangerous substances discharged into the aquatic environment.
8.	The Surface Waters (Dangerous Substances) (Classification) Regulations 1997. SI 2560/97
9.	The Surface Waters (Dangerous Substances) (Classification) Regulations 1998. SI 389/98
10.	WHO DWS for Toluene and Ethylbenzene – odour/taste/colour (Human Health Risk)
11.	Specified compounds are benzo[b]fluoranthene (CAS 205-99-2), benzo[k]fluoranthene (CAS 207-08-9), benzo[g,h,i]perylene (CAS 191-24-2) and indeno[1,2,3-c,d]pyrene (CAS 193-39-5). The parametric value applies to the sum of the concentrations of the individual compounds detected and quantified in the monitoring process.

Referring to Table 9.2 above, the results of this direct comparison indicates that the Environmental Quality Standard (EQS) for freshwater was exceeded for a number of PAH compounds as follows;

- Benzo(a)pyrene in CP102;
- Benzo(b/k)fluoranthene in CPP102, CP103 and WS104;
- Benzo(ghi)perylene in CP102;
- Anthracene and fluoranthene in CP102, CP103 and WS104;
- Naphthalene in CP103 and WS104; and,
- Xylene in CP103.

The UK Drinking Water Standard (UK DWS) was exceeded for the following contaminants;

- Chromium in WS104;
- Selenium in CP103;
- Aliphatic C10 – C35 in WS104;
- Aliphatic C21 – C35 in CP102;
- Aromatic C8 – C10 in CP103;
- Aromatic C10-C16 in CP102; and,
- Aromatic C10 – C21 in WS104.

Based on the above exceedances, it is recommended that a Detailed Quantitative Risk Assessment (DQRA) is undertaken in order to assess the risk posed to controlled waters.

9.3 Ground Gas

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report 665 (*Assessing risks posed by hazardous ground gases to buildings*, 2007).

The Phase I report and subsequent ground investigation has identified the following potential sources of ground gas:

- Made Ground deposits across the site; and
- Underground Fuel Storage Tanks.

A total of six monitoring visits were undertaken over a three month period with atmospheric pressures ranging between 986mb and 1036mb.

Elevated concentrations of methane were recorded in two probeholes, CP103 up to 14.5%v/v and WS104 up to 1.3%v/v. Carbon dioxide levels in excess of 5%v/v were also recorded in both WS104 and CP103. Both of these monitoring probeholes are located in the south west corner of the site within the area which has been identified as being the most contaminated during the site works with volatile hydrocarbons. It is considered that the elevated methane concentrations may be a result of volatile hydrocarbon interference and not a true reflection of methane levels.

The elevated concentrations of methane and carbon dioxide were associated with low flow rates of less than 0.3l/hr.

In accordance with the methodology outlined with the CIRIA publication C665, REC have utilised the results of the ground gas monitoring surveys to calculate a tentative Gas Screening Value (GSV). The maximum GSV calculated for methane was 0.0267l/hr and for carbon dioxide was 0.0117/hr (CP103).

The GSV has been compared to the criteria outlined with CIRIA C665 to determine the level of risk to the proposed development and to ensure the appropriate remedial options are incorporated into any future building design. CIRIA C665 states that the maximum GSV for carbon dioxide and methane is <0.07l/hr for Characteristic Situation 1 and therefore, the site would fall into this bracket requiring no gas protection measures. However, methane has been recorded in excess of 5%v/v in one probehole located in the south west corner and therefore, worst case scenario would place the site within Characteristic Situation 3 / Amber 2.

CS3 / Amber 2 require that a score of 4 points is achieved in accordance with BS 8485:2007 with a combination of the following measures incorporated into any new structures:

- Subfloor ventilation, passive or active;
- Taped and sealed methane resistant membrane to reasonable level of workmanship in line with current good practise;
- Reinforced concrete cast in situ floor slab (suspended, non suspended or raft) with at least 1200g DMP;
- Independent validation to confirm appropriate installation of membrane; and,
- Integrity testing of the membrane.

Alternatively, it is recommended that post remediation gas monitoring be undertaken to assess and to characterise the ground gas regime after the hydrocarbon remediation. The remedial works may reduce the gas protection requirements as the concentrations of hydrocarbons on site will be reduced.

It is recommended that the protection measures are agreed with the local authority prior to their adoption on-site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

9.4 Revised Conceptual Site Model

Following the completion of the intrusive site investigation, chemical analysis and risk assessment the conceptual model shown in Table 9.3 has been prepared for the site.

Table 9.3 Conceptual Model

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Discussion of Pollutant Linkage
Human Health				
Arsenic Lead Benzo(a)Anthracene Chrysene Benzo(b/k)Fluoranthene Benzo(a)Pyrene Indeno(123-cd)Pyrene Dibenzo(a,h)Anthracene TPH C ₁₆ -C ₂₁ TPH C ₂₁ -C ₃₅	Dermal contact, ingestion and consumption of home grown vegetables.	Future Site Users Construction Workers	Low Low	All soft landscaped areas to be provided with a 600mm cover of clean soil. This will thus remove the exposure pathway and ensure there is no unacceptable risk to human health. Appropriate PPE and health and safety procedures will be implemented during the construction works to ensure there is no unacceptable risk to the construction workers.
Naphthalene	Vapour Inhalation (Indoors)	Future Site Users	Low	The use of chemical and vapour resistant membranes and subfloor voids in buildings will break the risk of vapour inhalation pathway ensuring no unacceptable risk is posed to human health.
Controlled Water				
A Detailed Quantitative Risk Assessment (DQRA) is recommended to assess the risk to controlled waters from the contaminants listed in Section 9.2				
Ground Gases				
The ground gas monitoring programme has indicated that the site would fall into CS3 / Amber 2 requiring gas protection measures. Post-remediation gas monitoring may reduce the gas protection requirements.				

10.0 GEOTECHNICAL ASSESSMENT

10.1 Proposed Development

Maple Grove Developments Ltd intends to construct a residential care home comprising a 56 No. apartment block, 4 No. bungalows and associated car parks, soft landscaping and infrastructure. The proposed development plan drawing No 45418p1r0-010 is contained in Appendix III.

REC has assessed the foundation options for the proposed apartment block and bungalows separately. Details of the proposed loadings for the apartment block are not known at this stage and therefore the following assessment is for preliminary assessment purposes only. The bungalow has been assessed presuming a line loading of 50kN/m².

10.2 Summary of Ground Conditions

Ground conditions identified at the site are summarised in Table 8.1, Section 8 and essentially comprises Made Ground over natural deposits of Alluvium (sand and clay layers). Bedrock was encountered at depths between 9.50 and 16.00m bgl and consisted of inter-bedded layers of mudstone and siltstone.

Groundwater

During the Ground Investigation, shallow groundwater strikes were made at depths between 2.00m and 3.50m bgl across the site.

10.3 Site Preparation

The site should be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the Specification for Highway Works. This should include:

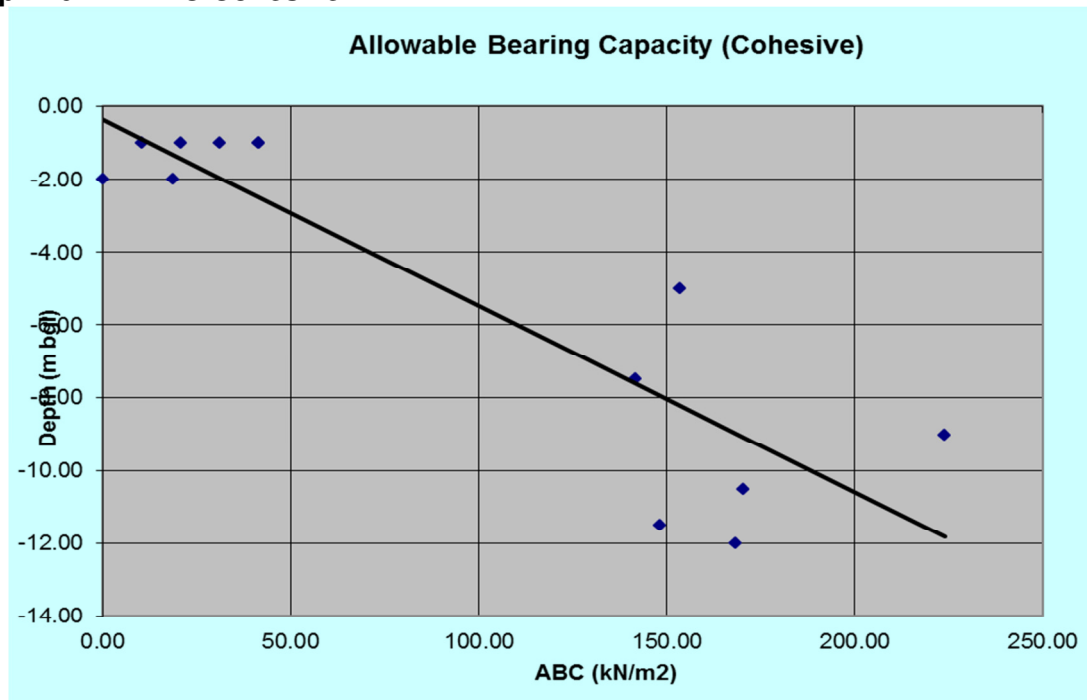
- Roots present below the footprint of proposed structures and infrastructure should be grubbed out and the resulting void infilled with suitable compacted engineered fill;
- Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill;
- Underground storage tanks have been encountered on site. These should be excavated from below the proposed development foot print with the resulting void backfilled;
- Buried structures and relict foundations are anticipated on the site and should be excavated from below the proposed development footprint with the resulting void backfilled; and,
- Any Japanese knotweed encountered on-site or adjacent to the site should be treated by a specialist contractor.

10.4 Foundation Conditions and Bearing Capacity

General Ground Conditions

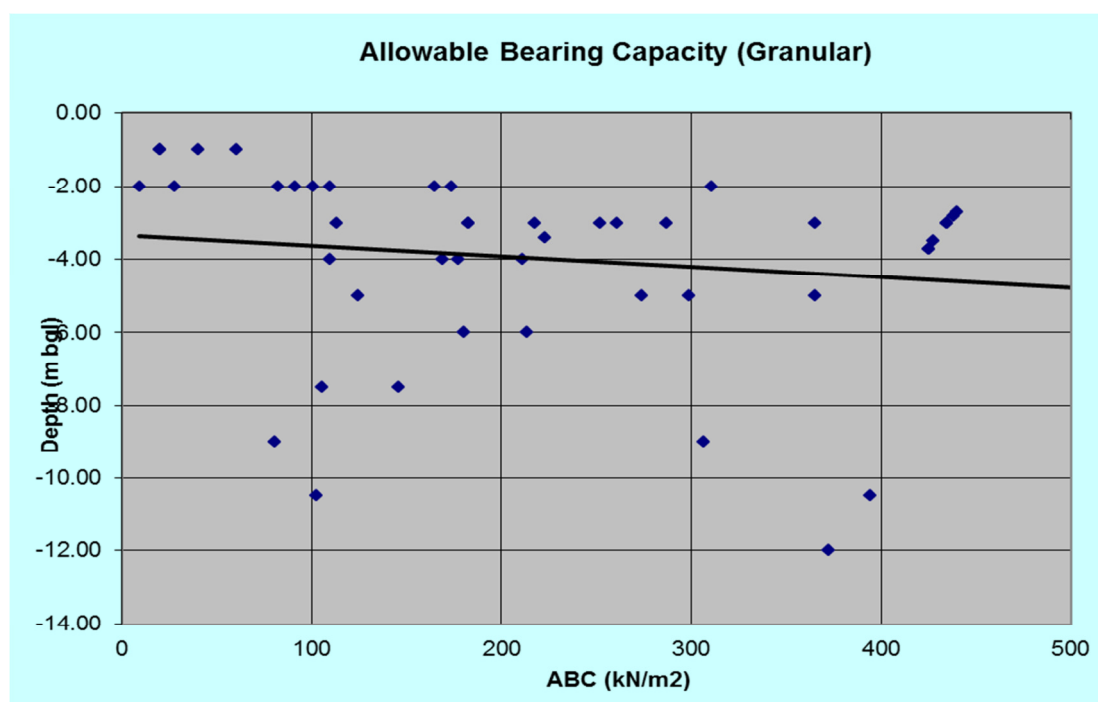
An assessment of the Allowable Bearing Capacity (ABC) for both granular and cohesive has been undertaken using data obtained from in-situ SPT tests.

Graph 10.1 ABC Cohesive



Graph 10.1 shows that the shallow clay deposits across the site are generally of a low strength with an ABC less than 50kN/m² expected to depths of 2.0m bgl. The natural alluvial clay generally shows an increase in strength with depth.

Graph 10.2 ABC Granular



Graph 10.2 shows that the shallow granular deposits across the site are generally of a loose density with an ABC less than 50kN/m^2 expected at a depth of 1.0m bgl increasing to 80kN/m^2 at a depth of 2.0m bgl. The natural sand generally shows an increase in density with depth to circa 4.0m bgl then the trend is one of reducing ABC with depth, likely due to the presence of groundwater from circa 4.0m bgl.

The underlying clay has been classified as being of a high plasticity. Therefore, the clay is considered to be susceptible to shrink and swell caused by fluctuations in moisture content due to the presence of trees or seasonal effects.

Apartment Block Foundation Options

Based on the ABC above, it is considered that the variable composition and calculated ABPs in the underlying superficial drift deposits are not suitable founding stratum for the proposed apartment block. It is therefore recommended that piled foundations are used to support the structure, likely to be end bearing piles into the underlying solid geology at depths of between 9.5m and 16.0m bgl. Pile design should be undertaken by a specialist contractor to allow them to reduce the factor of safety based on their extensive pile testing data.

Bungalow Foundation Options

Borehole logs (WS108 and WS110) in the vicinity of the proposed bungalows indicate variability in the underlying shallow ground conditions which may result in differential settlement. Due to the variability of the ground conditions, the following foundation options should be considered;

- Raft foundations; and,
- Vibro Granular Stone Columns – supporting shallow strip foundations.

Foundation design should be undertaken by a specialist contractor.

10.5 Ground Floor Slabs

It is recommended that a suspended floor slabs are utilised in both the apartment block and the bungalows.

The Atterberg Limits determinations summarised in Table 8.4 in section 8 show the clay within the Made Ground to be of high plasticity and as such liable to heave and therefore, it is considered that a suspended floor slab would be more appropriate.

Where suspended floor slabs are employed ventilation of the under floor void will be required to address condensation issues. This would also assist in the mitigation of potential vapour and gas ingress issues.

10.6 Pavement Construction

It is recommended that California Bearing Ratio CBR testing is undertaken beneath the proposed access road to determine the pavement construction.

Following excavation the sub formation should be proof rolled and any soft material inspected and removed.

10.7 Drainage

The presence of substantial depths of Made Ground and soft alluvium clays across the site may result in settlement. It is therefore recommended that drain runs are designed using steeper gradients and flexible joints to allow for some differential settlement.

In-situ variable (falling) head permeability tests were undertaken within the monitoring well installations located in three probeholes (WS106B, WS107 and WS110). Soil infiltration rates were between 1.82×10^{-5} m/s and 2.69×10^{-6} m/s; and in accordance with CIRIA C515 (2000) indicates a low very low permeability. It is recommended that further assessment is undertaken to determine the sites suitability for soakaways in accordance with BRE Special Digest 365 – Soakaway Design.

10.8 Concrete Durability

Based upon the results of the chemical analyses summarised in Table 8.5, it is considered that subsurface concrete can be designed in accordance with Design Sulphate Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with the recommendations provided in BRE Special Digest 1 (2005).

10.9 Excavations

Site observations indicated that excavations should be feasible in the near surface with normal plant; however, obstructions were identified in the near surface including relict foundations and underground storage tanks. It is anticipated that any obstructions will be grubbed out during the reduced level dig for the sub structure works.

During the Ground Investigation, shallow groundwater strikes were made at depths between 2.0m and 3.5m bgl across the site. It considered that conventional sump pumping should be adequate.

Due to the variability of the Made Ground it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA RR97.

The presence of potential contamination and mitigation measures should be addressed as part of the Construction Stage Health and Safety Plan and should include measures to design out the risks, reduce their impact and finally the use of Personnel Protective Equipment (PPE).

10.10 Coal Mining

The subject site is located within a coal mining area and hence a Coal Authority Mining Report was obtained for the purposes of this report. The report indicates that the site is within the zone of influence from two worked seams at shallow to 70m depth, last worked in 1967. Additionally, mine abandonment plans held by the Coal Authority indicated that workings in both the Main and Bannock Seams extended beneath the entire site. The British Geological Survey (BGS) map for the site, (Sheet NX91NE, 1:10,000, Whitehaven, Solid & Drift edition) indicates that the inferred outcrop of the Main Coal Seam crosses the south east corner of the site and has been recorded up to 4.0m thick.

REC advanced three exploratory open rotary boreholes to depths of 30.0m bgl in order to investigate the presence of shallow mine workings beneath the site. The rotary boreholes were positioned as follows;

- RB101 was located to the south east of the inferred Main Seam outcrop to investigate the depth of the Yard Seam;
- RB102 was located in the vicinity of the Main Seam outcrop to investigate the depth of the seam and whether workings were present; and,
- RB103 was located to the north west of the Main Seam outcrop to investigate whether any workings were present.

It must be noted that the position of the Main Seam outcrop is inferred on the BGS map and may not be accurately positioned on the map and in addition, the rotary holes were positioned within the constraints of the site layout at the time of the ground investigation.

The general geological sequence encountered beneath the site consisted of between 9.5m and 16.0m of alluvium drift overlying inter-bedded mudstone and siltstone to a proven depth of 30.0m bgl. The three rotary boreholes did not indicate the presence of any workings beneath the site and only a single 0.5m thick intact coal seam was encountered in RB103 at a depth of 14.0m below ground level.

REC considers that whilst the three initial rotary boreholes did not indicate the presence of shallow mine workings beneath the site, the records held by the Coal Authority coupled with the BGS map strongly indicate that shallow workings may be present beneath the site particularly along the western site boundary beneath the existing units. It is therefore recommended that further rotary boreholes are extended to depths of 50m bgl in the western section of the site once the site has been cleared of existing structures.

10.11 Further Works

Based on the findings of this report, REC recommends the following further works;

- Detailed Quantitative Risk Assessment (DQRA) to assess the risk to controlled waters;
- Detailed Remediation Strategy

Post Demolition of existing structures.

- Supplementary Ground Investigation comprising trial pitting to investigate the densely vegetated area along the eastern section of the site, which was inaccessible during this investigation;
- 3 No. rotary boreholes to investigate potential mine workings in the western section of the site to depths of 50m bgl;

- Flood Risk Assessment;
- BRE 365 Soakaway Assessment; and,
- CBR assessment beneath the proposed road.

10.12 Construction Activity and Inspection

The following activities and inspections should be incorporated in to the site works:

- Due to the variability of the soils at the site it is recommended that sufficient allowance is made for the inspection of formation and sub formations to foundations and pavement construction;
- Excavations where access is required should be subject to a risk assessment from a competent person and where appropriate mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 utilised;
- It is considered that de-watering may be required, especially following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required. Measures to remove silt and suspended solids may be required and consideration should be given to provision of space for settling tanks or an attenuation pond;
- Based on the groundwater monitoring results it is possible that groundwater pumped from trenches may require treatment using a water/oil interceptor. Discharge limits and treatment should be agreed as part of the trade effluent discharge;
- Where access to confined spaces is required appropriate mitigation measures should be addressed within the Construction Stage Health and Safety Plan. Particular account should be taken of the gas results; and
- The presence of potential contamination and mitigation measures should be addressed as part of the Construction Stage Health and Safety Plan and should include measures to design out the risks, reduce their impact and finally the use of Personnel Protective Equipment (PPE).

11.0 CONCLUSIONS & RECOMMENDATIONS

Geotechnical Assessment

Apartment Block

Based on the ABC above, it is considered that the variable composition and calculated ABPs in the underlying superficial drift deposits are not suitable founding stratum for the proposed apartment bloc. It is therefore recommended that piled foundations are used to support the structure, likely to be end bearing piles into the underlying solid geology at depths of between 9.5m and 16.0m bgl. Pile design should be undertaken by a specialist contractor to allow them to reduce the factor of safety based on their extensive pile testing data.

Bungalow Foundation Options

Borehole logs (WS108 and WS110) in the vicinity of the proposed bungalows indicate variability in the underlying shallow ground conditions which may result in differential settlement. Due to the variability of the ground conditions, the following foundation options should be considered;

- Raft foundations; and,
- Vibro Granular Stone Columns – supporting shallow strip foundations.

Foundation design should be undertaken by a specialist contractor.

The site is in a coal mining area and a detailed mining risk assessment has identified that the Main Seam outcrops through the southern sector of the site in a north east trend and has been worked historically as late as 1967.

Three No. 30.0m rotary boreholes were advanced on the site to explore for the shallow mine workings; however, no evidence of the workings were encountered and only 0.5m of coal was encountered in one of the boreholes. It is recommended that further rotary boreholes are extended to depths of 50m bgl in the western section of the site once the site has been cleared of existing structures.

The Atterberg Limits determinations summarised in Table 8.4 in section 8 show the clay within the Made Ground to be of high plasticity and as such liable to heave and therefore, it is considered that a suspended floor slab would be more appropriate.

In-situ variable (falling) head permeability tests were undertaken within the monitoring well installations located in three probeholes (WS106B, WS107 and WS110). Soil infiltration rates were between 1.82×10^{-5} m/s and 2.69×10^{-6} m/s and in accordance with CIRIA C515 (2000) indicates a low permeability. It is recommended that further assessment is undertaken to determine the sites suitability for soakaways in accordance with BRE Special Digest 365 – Soakaway Design.

Revised Conceptual Site Model

The Tier I Human Health Risk has identified elevated concentrations of inorganic heavy metals, polycyclic aromatic hydrocarbons, volatile organic compounds, and petroleum hydrocarbons associated with the Made Ground and previous industrial use across the site.

Volatile Compounds

A focused remediation will be required to remove the USTs, surrounding impacted soils and the area around the naphthalene hotspot. Following excavation it may be possible to bio-remediate the material ex-situ and then subject to laboratory testing, re-embed the material below the site. Remediation of the impacted soluble material will also be required to address the risk to controlled waters, which will be quantified in the subsequent DQRA.

Non-Volatile Compounds

Across the wider site, the elevated inorganic and non-volatile PAHs in the shallow Made Ground can be addressed with the emplacement of a 600mm cover system in all soft landscaped areas. Conversely, it may be possible to emplace this material at depth (soil inversion), or below plots and access roads.

A Tier II Detailed Quantitative Risk Assessment (DQRA) is recommended to assess the risk to

controlled waters.

The ground gas monitoring programme has indicated that the site would fall into CS3 / Amber 2 requiring gas protection measures. Post-remediation gas monitoring may reduce the gas protection requirements.

Recommendations

In order to quantify the risk to controlled waters, it is recommended that a Tier II Detailed Quantitative Risk Assessment (DQRA) is undertaken based on the dissolved phase concentrations in the groundwater and also the source soil concentrations.

Upon completion of the DQRA, remedial target values will be derived and used in the completion of a Detailed Remediation Strategy and Materials Management Plan (MMP) to be developed in accordance with the (EA Approved) CL:AIRE CoP.

Post Demolition Works

- Supplementary Ground Investigation comprising trial pitting to investigate the densely vegetated area along the eastern section of the site, which was inaccessible during this investigation;
- 3 No. rotary boreholes to investigate potential mine workings in the western section below the foot print of the existing buildings of the site to depths of 50m bgl;
- Flood Risk Assessment;
- BRE 365 Soakaway Assessment; and,
- CBR assessment beneath the proposed access road.

END OF REPORT

APPENDIX I
LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between REC Ltd and the Client as indicated in Section 1.2.
 2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.
 3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
 4. During the site walkover reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
 5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
 6. In addition to the above REC Ltd note that when investigating, or developing, potentially contaminated land it is important to recognise that sub-surface conditions may vary spatially and also with time. The absence of certain ground, ground gas, and contamination or groundwater conditions at the positions tested is not a guarantee that such conditions do not exist anywhere across the site. Due to the presence of existing buildings and structures access could not be obtained to all areas. Additional contamination may be identified following the removal of the buildings or hard standing.
 7. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
 8. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials this is for indicative purposes only and do not constitute or replace full and proper surveys.
 9. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
 10. This report presents an interpretation of the geotechnical information established by excavation, observation and testing. Whilst every effort is made in interpretative reporting to assess the soil conditions over the Site it should be noted that natural strata vary from point to point and that man made deposits are subject to an even greater diversity. Groundwater conditions are dependent on seasonal and other factors. Consequently there may be conditions present not revealed by this investigation.
 11. REC can not be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by REC is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by REC in this connection without their explicit written agreement there to by REC.
 12. Rather, this investigation has been undertaken to provide a preliminary characterisation of the existing sub-surface geotechnical characteristics and make up and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.
 13. This investigation has been undertaken to reasonably characterise existing sub-surface conditions and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.
-

APPENDIX II
GLOSSARY

TERMS

AST	Above Ground Storage Tank
BGS	British Geological Survey
BSI	British Standards Institute
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research Association
CLEA	Contaminated Land Exposure Assessment
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)
DWS	Drinking Water Standard
EA	Environment Agency
EQS	Environmental Quality Standard
GAC	General Assessment Criteria
GL	Ground Level
GSV	Gas Screening Value
HCV	Health Criteria Value
ICSM	Initial Conceptual Site Model
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel, kerosene)
ND	Not Detected
LMRL	Lower Method Reporting Limit
NR	Not Recorded
PAH	Poly Aromatic Hydrocarbon
PCB	Poly-Chlorinated Biphenyl
PID	Photo Ionisation Detector
QA	Quality Assurance
SGV	Soil Guideline Value
SPH	Separate Phase Hydrocarbon
Sp.TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)
SPT	Standard Penetration Test
SVOC	Semi Volatile Organic Compound
UST	Underground Storage Tank
VCCs	Vibro Concrete Columns
VOC	Volatile Organic Compound
WTE	Water Table Elevation

UNITS

m	Metres
km	Kilometres
%	Percent
%v/v	Percent volume in air
mb	Milli Bars (atmospheric pressure)
l/hr	Litres per hour
µg/l	Micrograms per Litre (parts per billion)
ppb	Parts Per Billion
mg/kg	Milligrams per kilogram (parts per million)
ppm	Parts Per Million

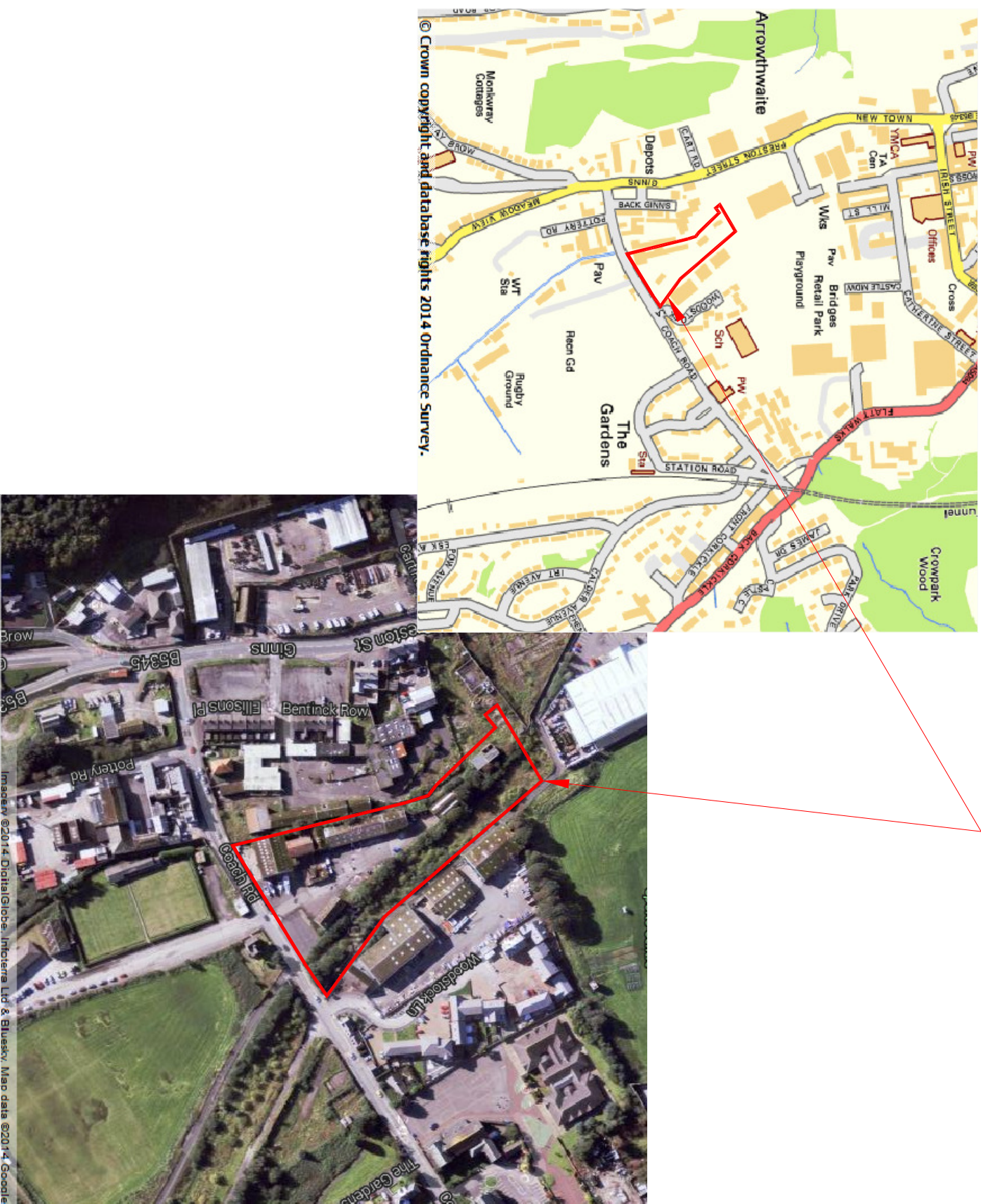


mg/m ³	Milligram per metre cubed
m bgl	Metres Below Ground Level
m bcl	Metre Below Cover Level
mAOD	Metres Above Ordnance Datum (sea level)
kN/m ²	Kilo Newtons per metre squared
µm	Micro metre

APPENDIX III
DRAWINGS

Key:

Site Location



Notes:

Notes:					
R0	14-02-2014	Revision	KD	SS	
Revision	Date	Issue	Drawn	Authorised	
Client: Civic Engineers			Job No: 45418	Date: 14-02-2014	
			Drawing No: P170-001	Scale: N.T.S	

Job Title:

Coach Road, Whitehaven
Cumbria

Site Location Plan



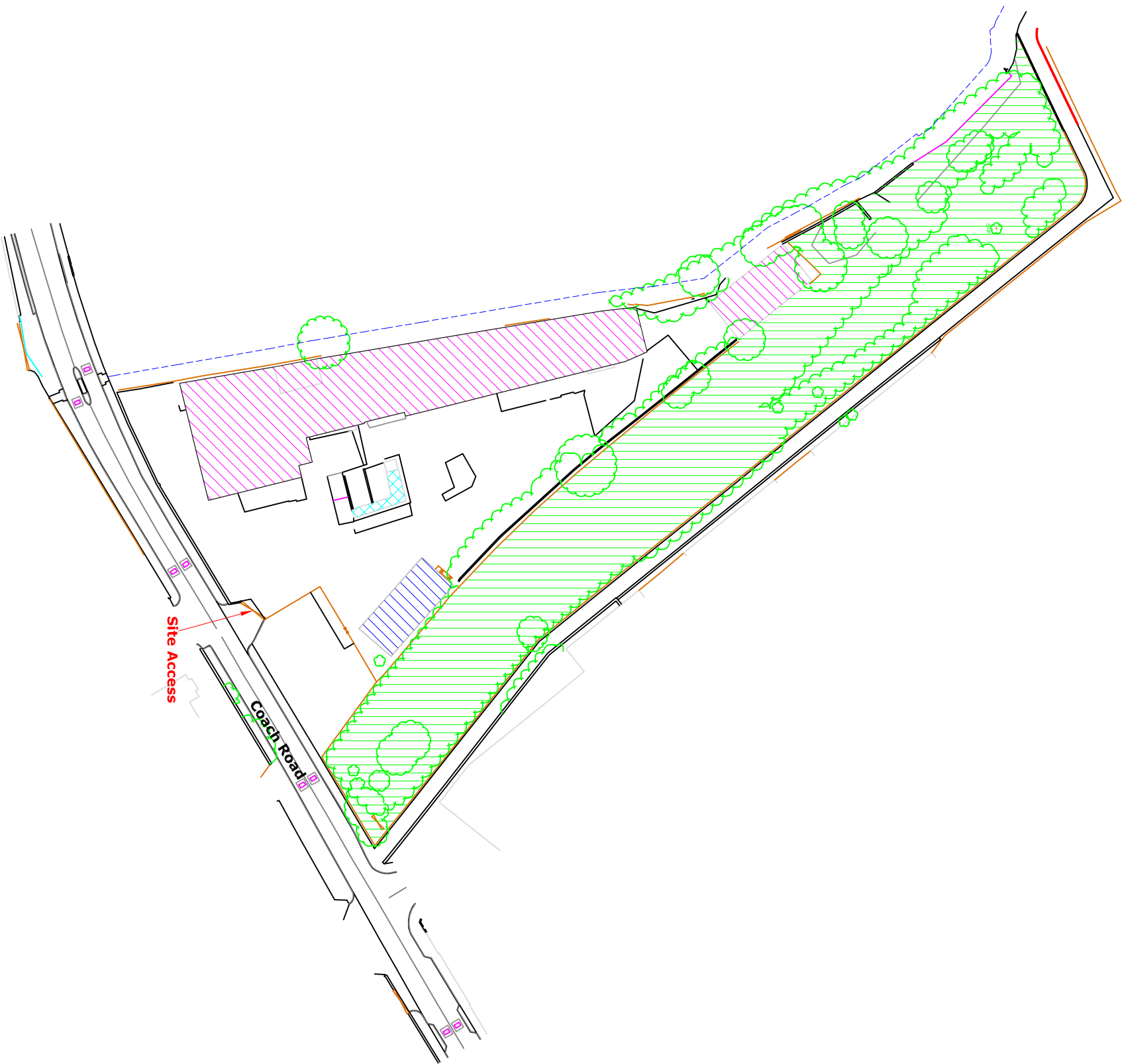
Resource & Environmental Consultants Ltd

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- Key:
- Inaccessible Due to Dense Vegetation
 - Existing Industrial Units
 - Former Office Block
 - Former Fuel Pumps
 - Pow Beck (Culverted)

Notes:

R0	25-03-2014	Draft	RW	SS
Revision	Date	Issue	Drawn	Authorised
Client:		Job No:	Date:	
Civic Engineers		45418	25-03-2014	
Drawing No:		Scale:		
PIR0-002		1:1000 @ A3		

Job Title:	Drawing Title:
Coach Road, Whitehaven Cumbria	Site Plan

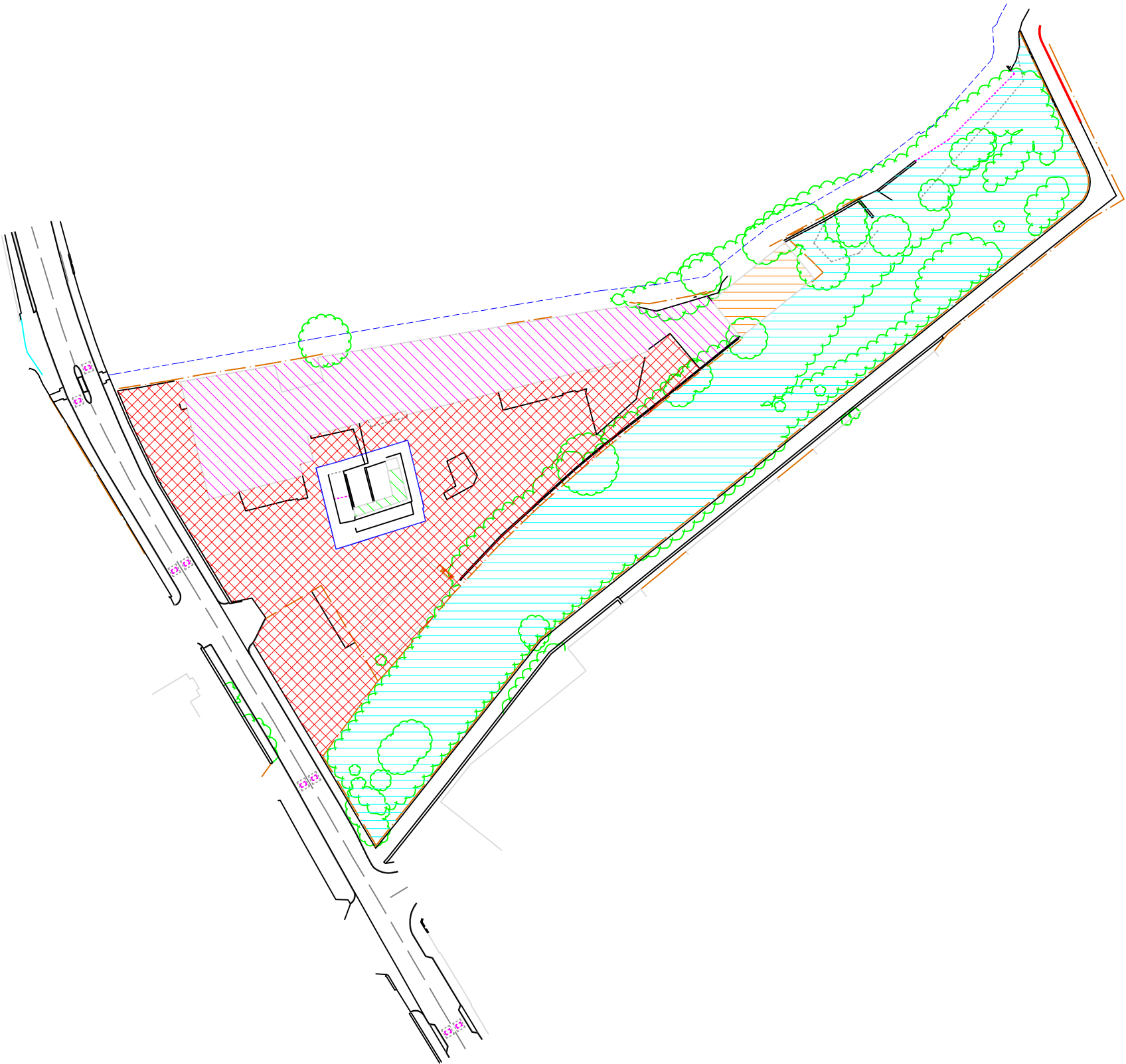


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- Key:
- Fuel Pumps (Mid 20th Century)
 - Repair & Servicing Garage (Recent)
 - Railway Land & Slidings (Mid 19th Century)
 - Potential Underground Storage Tanks (Mid 20th Century)
 - Boat Builders/Chandlery (Recent)
 - Timber/Builders Yard (20th Century)
 - Pow Beck (Culverted)

Notes:

R0	25-03-2014	Draft	RW	SS
Revision	Date	Issue	Drawn	Authorised

Client:	Job No:	Date:
Civic Engineers	45418	25-03-2014
	Drawing No:	Scale:
	PIR0-003	1:1000 @ A3

Job Title:	Drawing Title:
Coach Road, Whitehaven Cumbria	Historical Features Plan



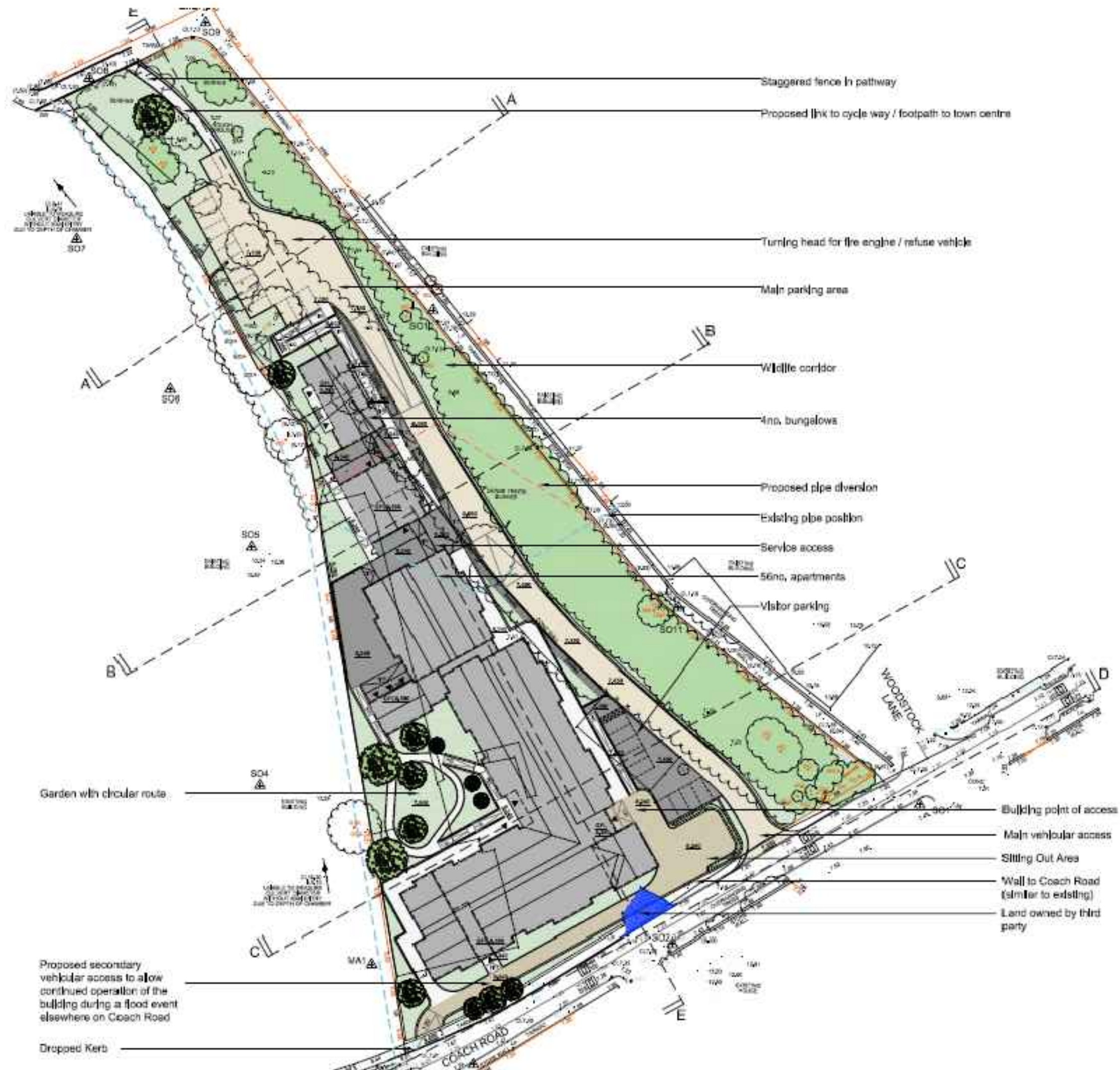
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Key:

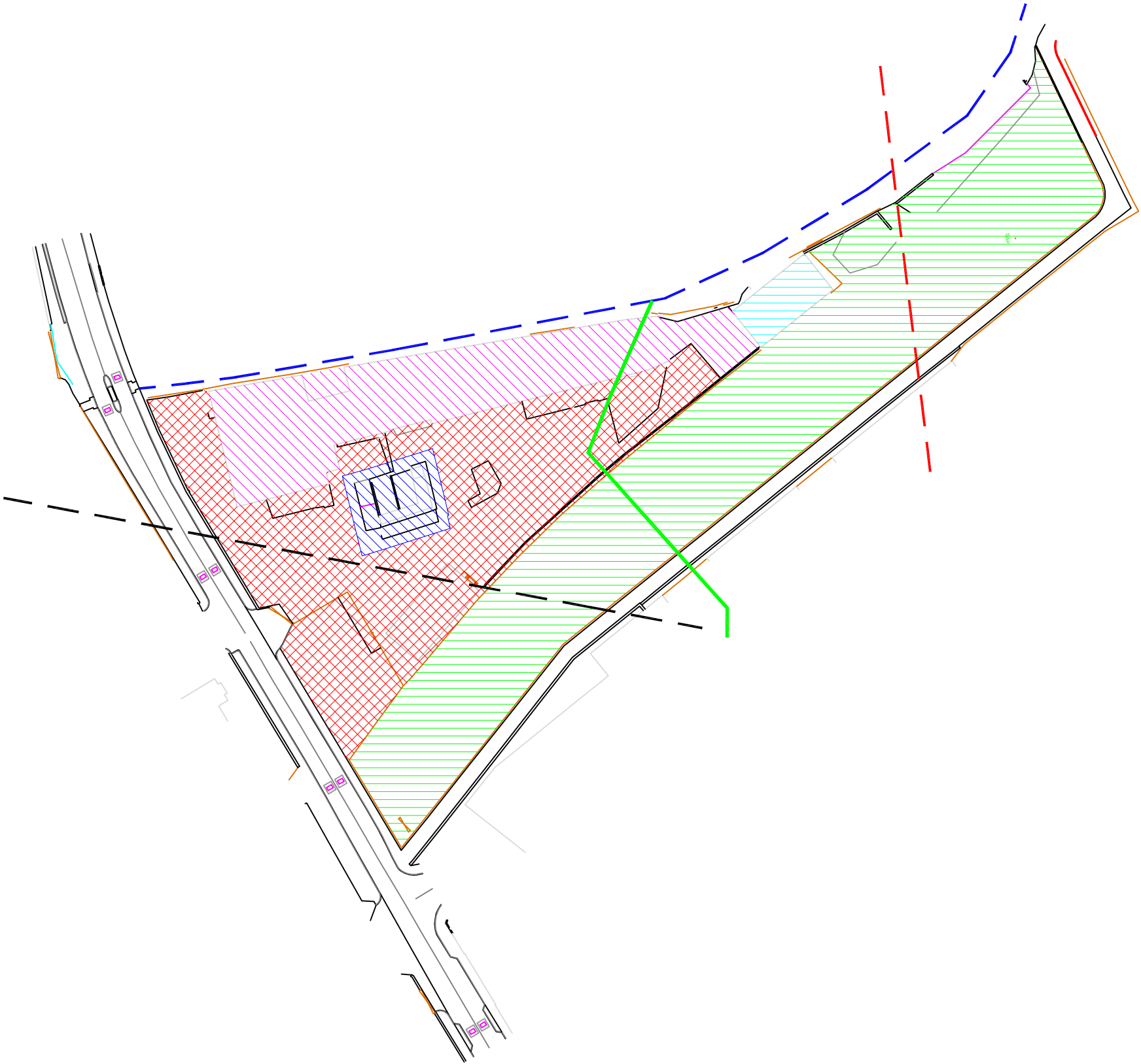
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		Drawing No:	Scale:	
		p1r0-004	N.T.S	
Job Title:		Drawing Title:		
Coach Road, Whitehaven Cumbria		Proposed Development Plan		



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- Key:
- Former railway land & sidings, potential hydrocarbon, PAH & heavy metal contamination
 - Former boat builders, potential SVOCs, VOCs, PAH & hydrocarbon contamination
 - Location of underground fuel storage tanks, potential hydrocarbon contamination
 - Former garage, potential hydrocarbon contamination
 - Former timber yard, potential SVOCs, VOCs, PAH & heavy metal contamination
 - Surface Water Sewer
 - Pow Beck (Culverted)
 - Raven Hill Fault (Approximate location)
 - Main Seam Outcrop (Inferred) Up To 4m Thick

Notes:

R0	14-02-2014	Revision	KD	RP
Revision	Date	Issue	Drawn	Authorised

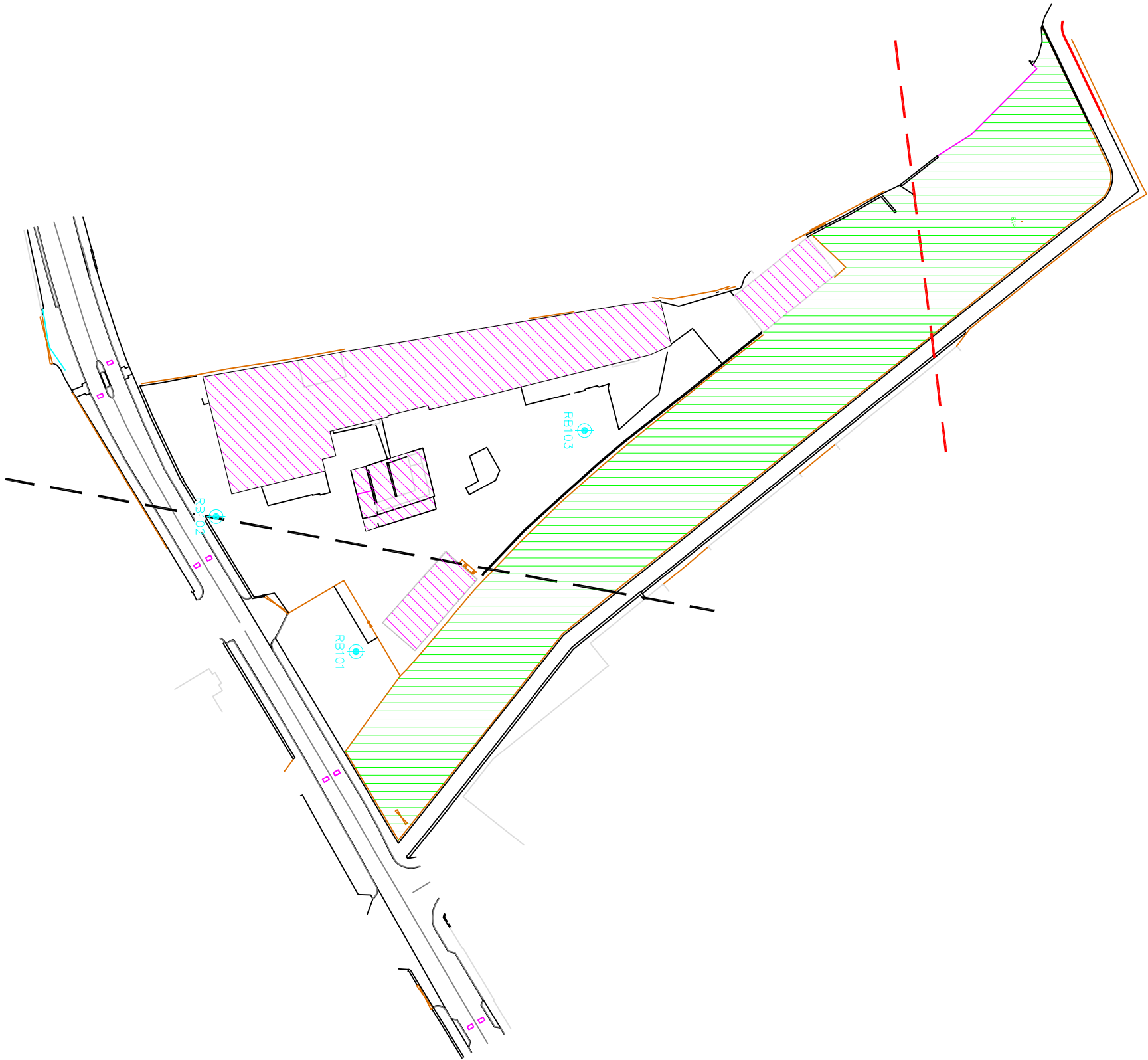
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		Drawing No:	Scale:
		plr0-005	1:1000 @ A3

Job Title:	Drawing Title:
Coach Road, Whitehaven Cumbria	Site Constraints Plan



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- Key:
- Raven Hill Fault (Approximate Location)
 - Main Seam Outcrop (Inferred) Up To 4m Thick
 - Inaccessible Due to Vegetation
 - Existing Buildings
 - RB1 Approximate Rotary Borehole Location

Notes:

R0	14-02-2014	Revision	KD	SS
Revision	Date	Issue	Drawn	Authorised
Client:		Job No:	Date:	
Civic Engineers		45418	14-02-2014	
Drawing No:		Scale:		
PIR0-006		N.T.S		

Job Title:	Drawing Title:
Coach Road, Whitehaven Cumbria	Geological Features Plan

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REC

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Cumbria

Coach Road, Whitehaven

Cumbria

Coach Road, Whitehaven

Cumbria

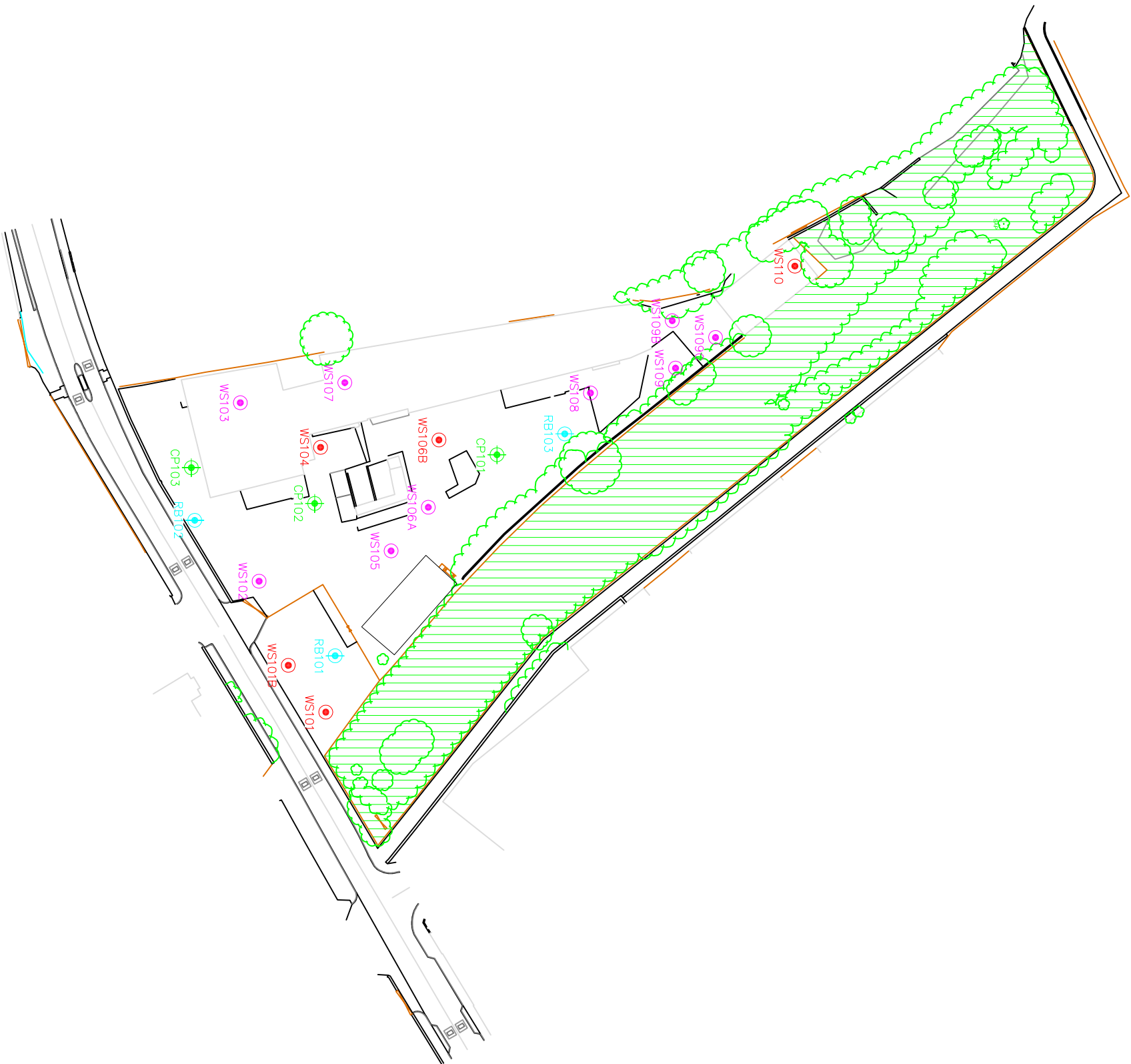
Coach Road, Whitehaven

Cumbria

Coach Road, Whitehaven

Cumbria





- Key:
- Approximate Window Sample Probehole Location
 - WS1
 - Approximate Window Sample Probehole Location (With Monitoring Well)
 - WS1
 - Approximate Cable Percussive Borehole Location
 - CP1
 - Approximate Rotary Borehole Location
 - RB1

Notes:

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R0	14-02-2014	Revision	KD	SS
Revision	Date	Issue	Drawn	Authorised

Client:	Job No:	Date:
Civic Engineers	45418	25-03-2014
	Drawing No:	Scale:
	PIR0-007	1:1000 @ A3

Job Title:	Drawing Title:
Coach Road, Whitehaven Cumbria	Exploratory Hole Location Plan

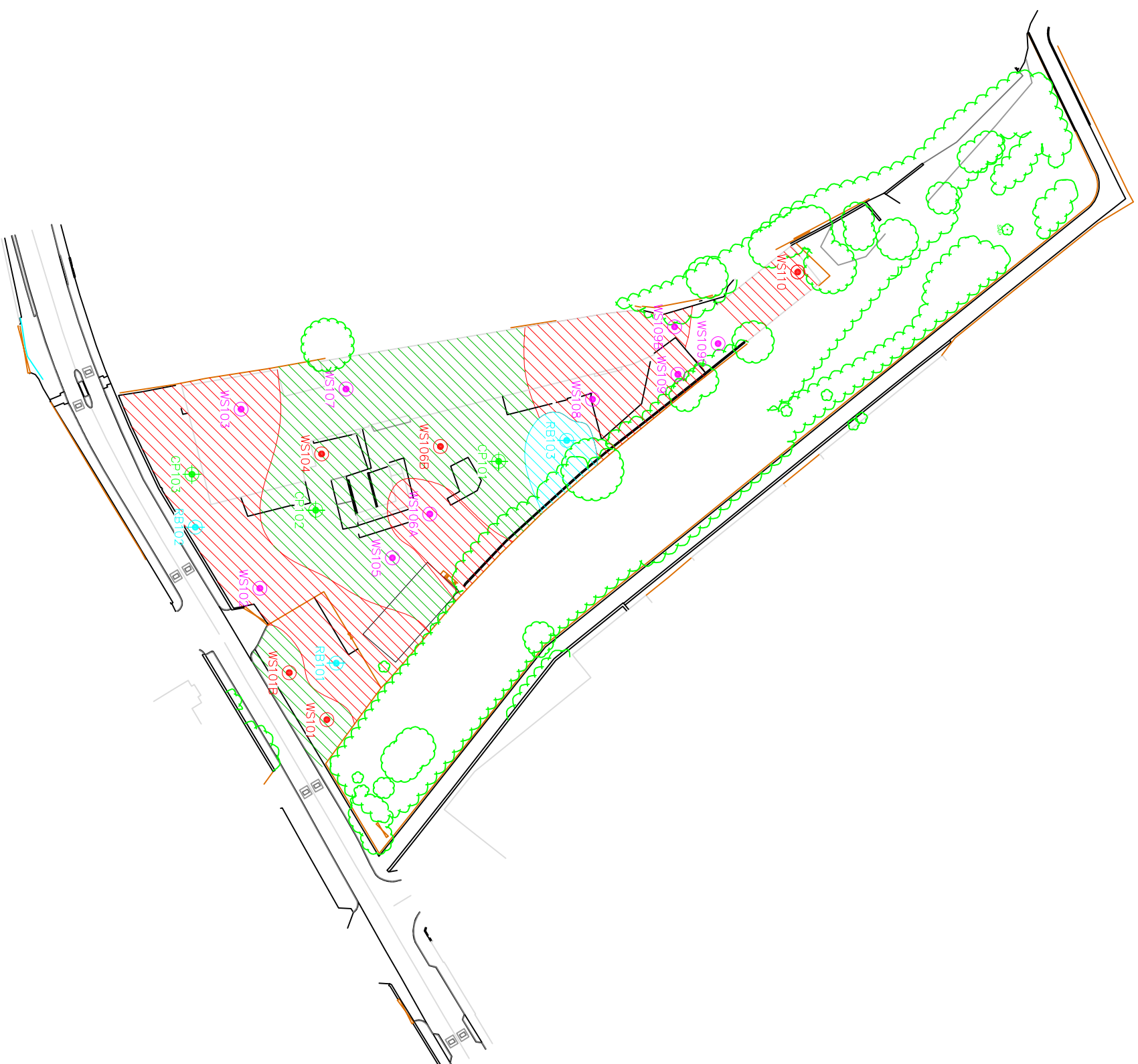


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	No Made Ground Encountered
	Depth of Made Ground Between 0.00 - 0.99m
	Depth of Made Ground Between 1.00 - 1.99m
	Depth of Made Ground Between 2.00 - 2.99m
	Depth of Made Ground Between 3.00 - 3.99m
	Depth of Made Ground Between 4.00 - 4.99m
	Depth of Made Ground In Excess of 5.00m

Notes

Client:		Civic Engineers	
Revision	Date	Issue	
R0	14-02-2014	Revision	
Job No:		Drawn	RP
45418			
Drawing No:		Date:	
p1r0-008		25-03-2014	
Scale:		Authorised	
1:1000 @ A3			

Job Title:

Coach Road, Whitehaven
Cumbria

wing Title

Depth Of Made Ground Plan

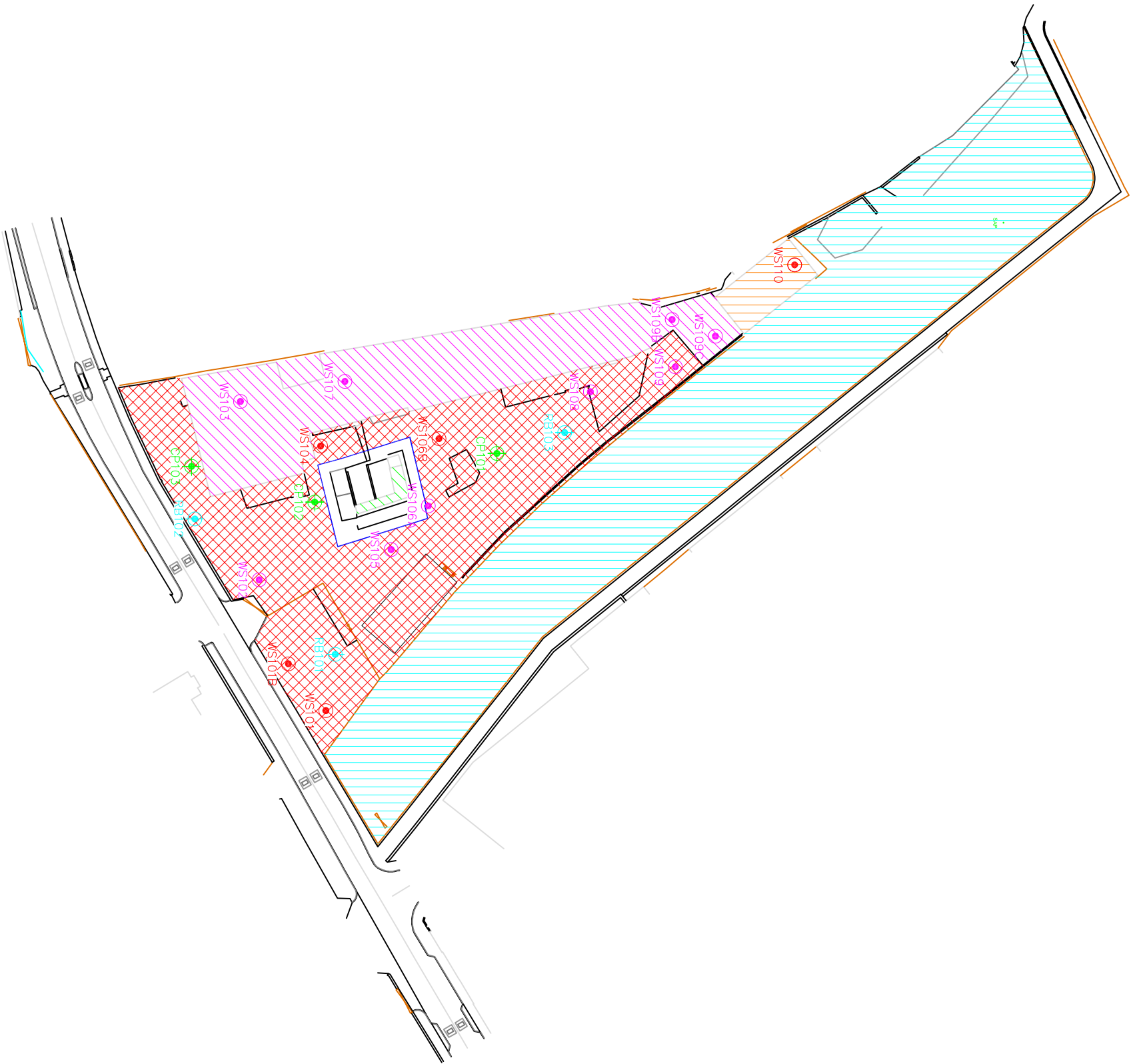


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- Key:**
- Approximate Window Sample Probehole Location
 - Approximate Window Sample Probehole Location (With Monitoring Well)
 - Approximate Cable Percussive Borehole Location
 - Approximate Rotary Borehole Location
 - Fuel Pumps (Mid 20th Century)
 - Repair & Servicing Garage (Recent)
 - Railway Land & Slidings (Mid 19th Century)
 - Potential Underground Storage Tanks (Mid 20th Century)
 - Boat Builders (Recent)
 - Timber/Builders Yard (20th Century)

Notes:

R0	14-02-2014	Revision	KD	SS
Revision	Date	Issue	Drawn	Authorised
Client: Civic Engineers				
Job No: 45418			Date: 25-03-2014	
Drawing No: p1r0-009			Scale: 1:1000 @ A3	
Job Title: Coach Road, Whitehaven Cumbria			Drawing Title: Exploratory Hole Location & Historical Features Plan	

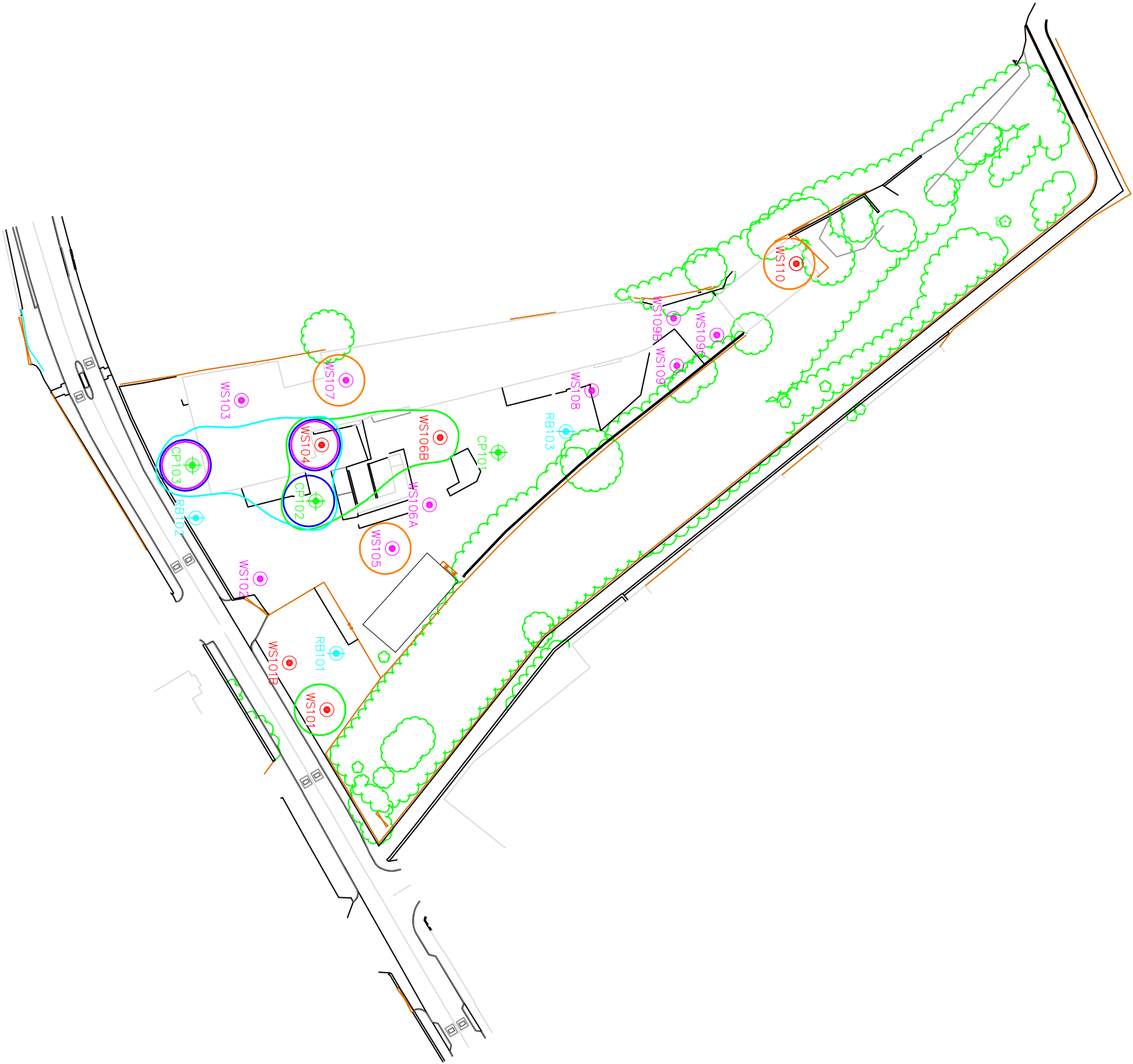


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- WS101
- Approximate Window Sample Probehole Location
- WS1
- Approximate Window Sample Probehole Location (With Monitoring Well)
- CP101
- Approximate Cable Percussive Borehole Location
- RB101
- Approximate Rotary Borehole Location
-
- Naphthalene hotspot (not currently delineated)
-
- Elevated PAH in groundwater
-
- Elevated Naphthalene in groundwater
-
- PAH hotspot (not currently delineated)
-
- Elevated arsenic & lead

Notes:

R0	25-03-2014	Revision	RW	SS
Revision	Date	Issue	Drawn	Authorised
Client:		Job No:	Date:	
Civic Engineers		45418	25-03-2014	
		Drawing No:	Scale:	
		plr0-010	1:1000 @ A3	

Job Title:	Drawing Title:
Coach Road, Whitehaven Cumbria	Contamination Hotspots Plan

REC

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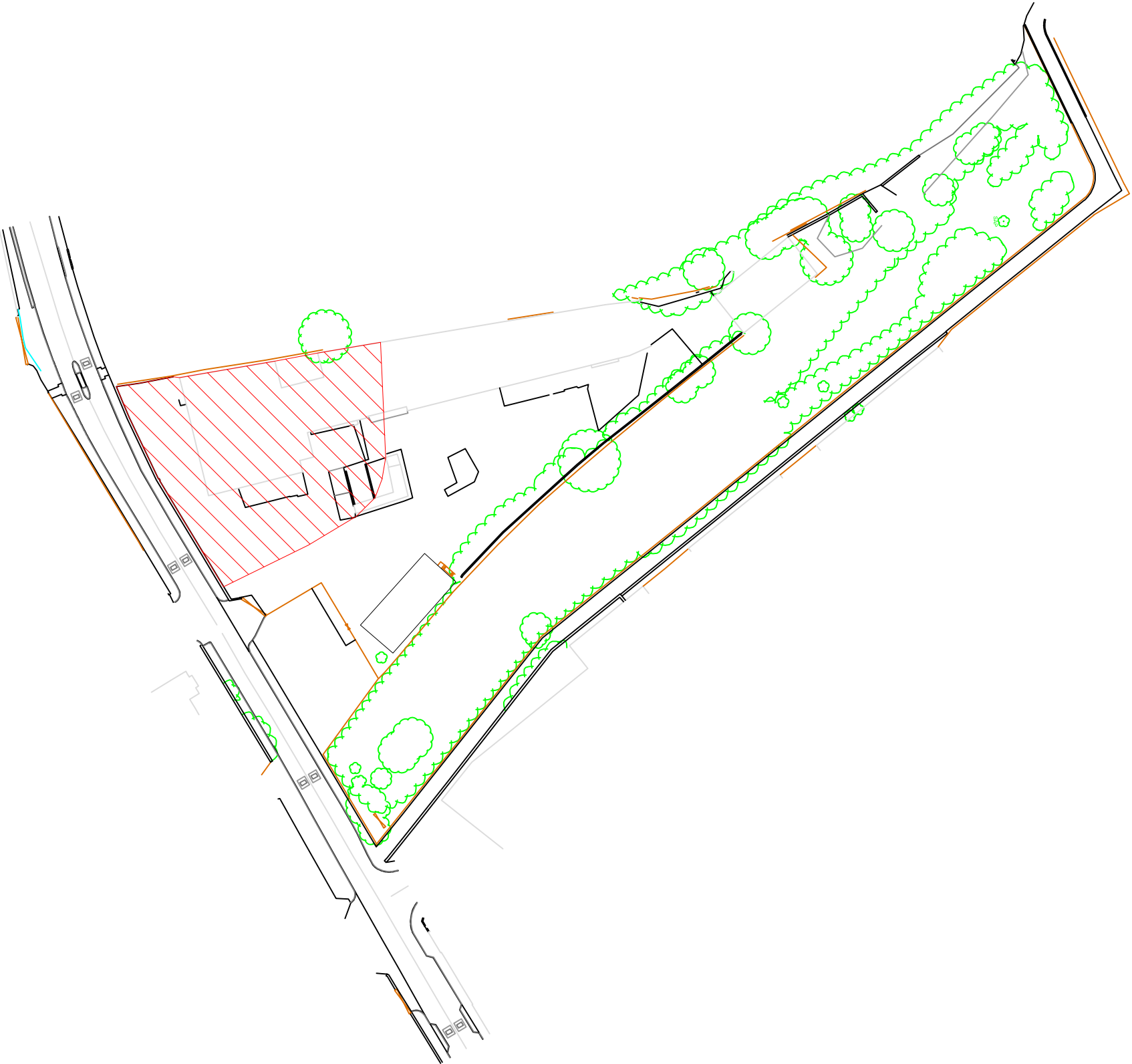
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Key:

 Methane concentration in excess of 5% v/v - CS3 gas protection measures required. Removal of source may reduce the level of protection required.



Notes:

R0	04-06-2014	Revision	RW	SS
Revision	Date	Issue	Drawn	Authorised

Client:	Job No:	Date:
Civic Engineers	45418	04-06-2014
	Drawing No:	Scale:
	PIR0-011	1:1000 @ A3

Job Title:	Drawing Title:
Coach Road, Whitehaven Cumbria	Ground Gas Zoning Plan



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**APPENDIX IV
PHOTOGRAPHS**



PLATE 1 –VIEW OF THE SITE LOOKING SOUTH FROM THE NORTH



PLATE 2 – VIEW OF THE SITE LOOKING NORTH FROM COACH ROAD



PLATE 3 – EXISTING BUILDING CONTAINING FUEL PUMPS



PLATE 4 – MANHOLE COVER WITH ACCESS TO UST AT REAR OF FUEL PUMPS



PLATE 5 – FUEL PUMPS



PLATE 6 – VERTICAL CRACK TOP TO BOTTOM OF OFFICE BUILDING

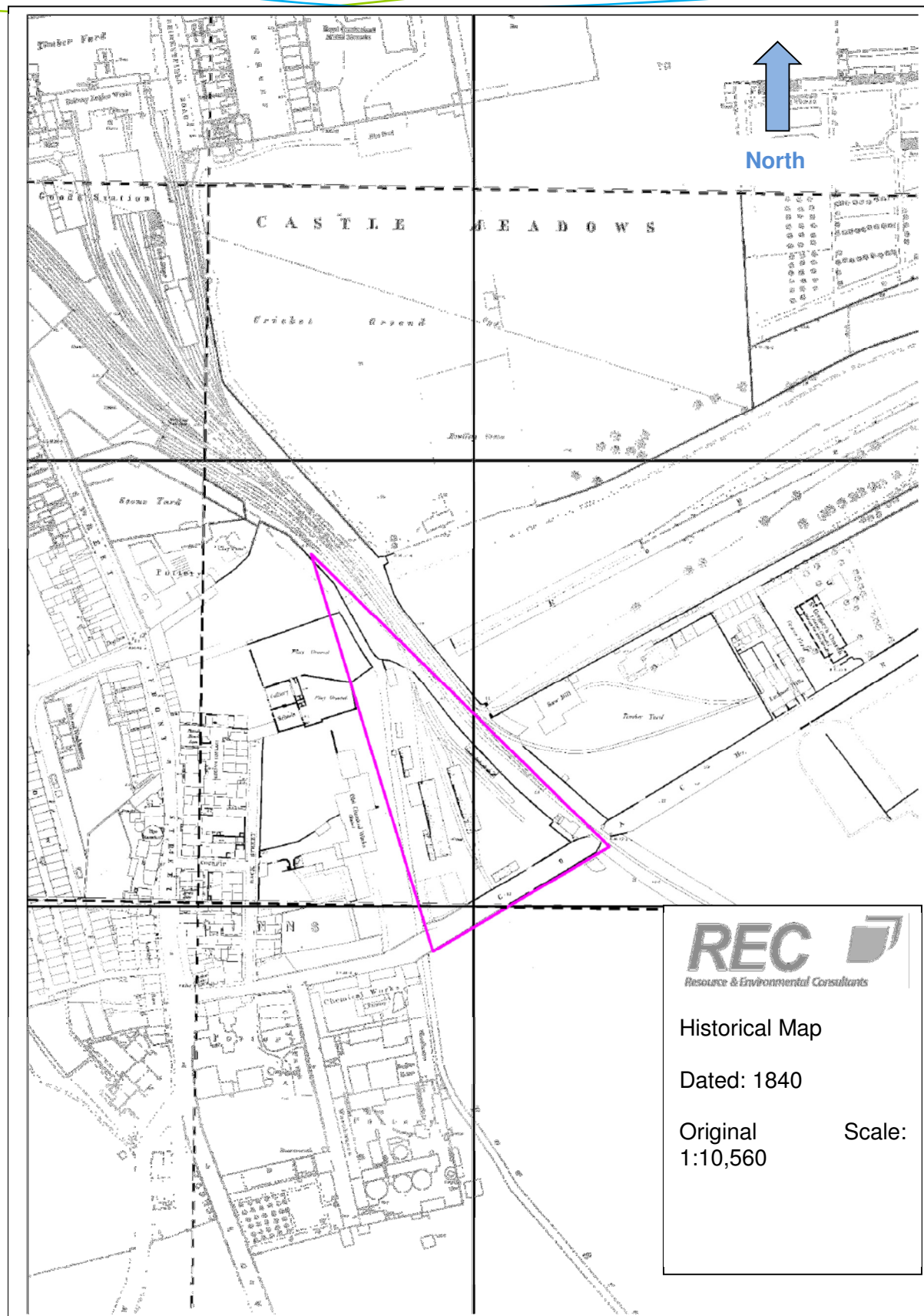


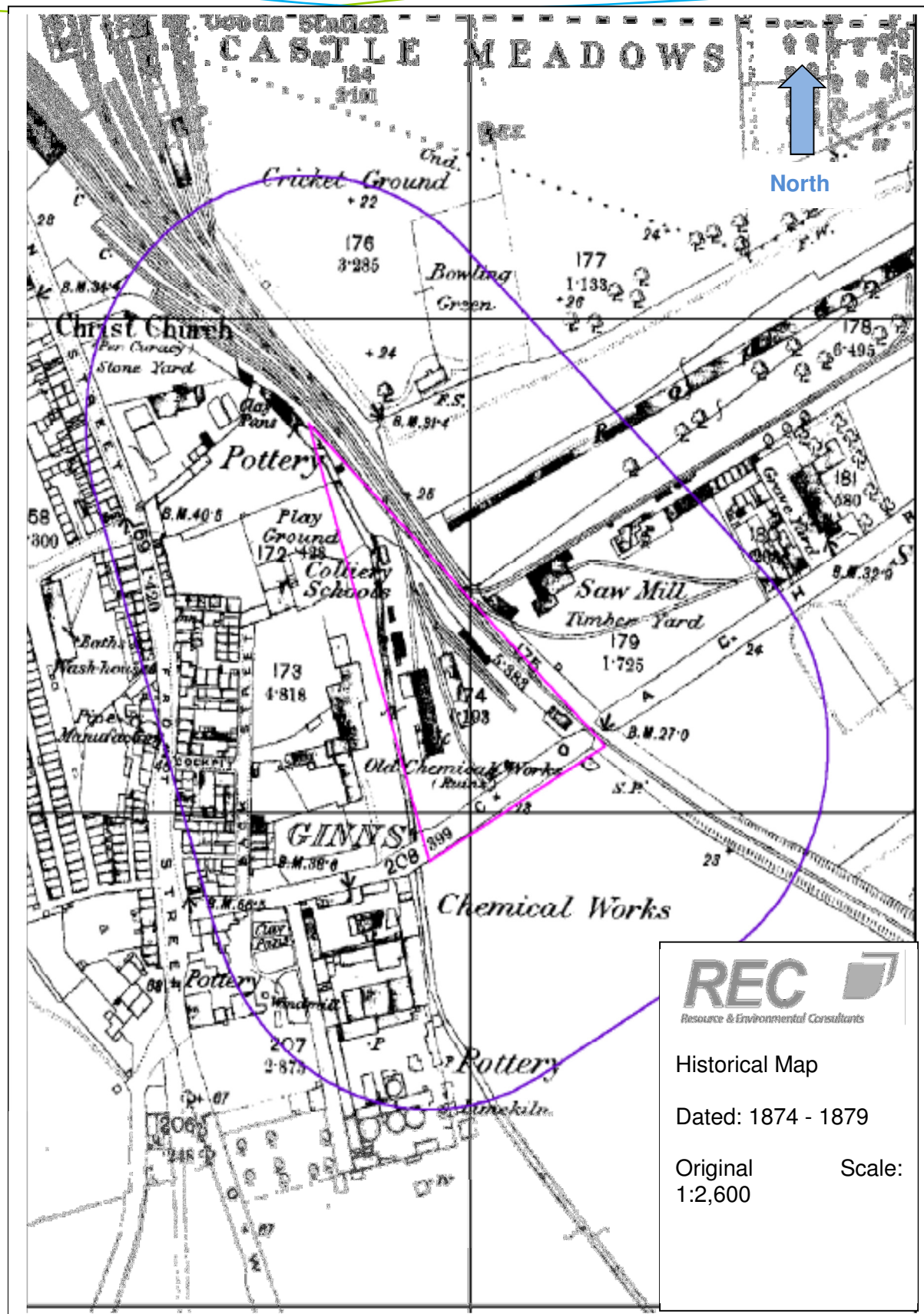
PLATE 7 – AREA OF SURFACE SUBSIDENCE IN SOUTHERN AREA OF SITE

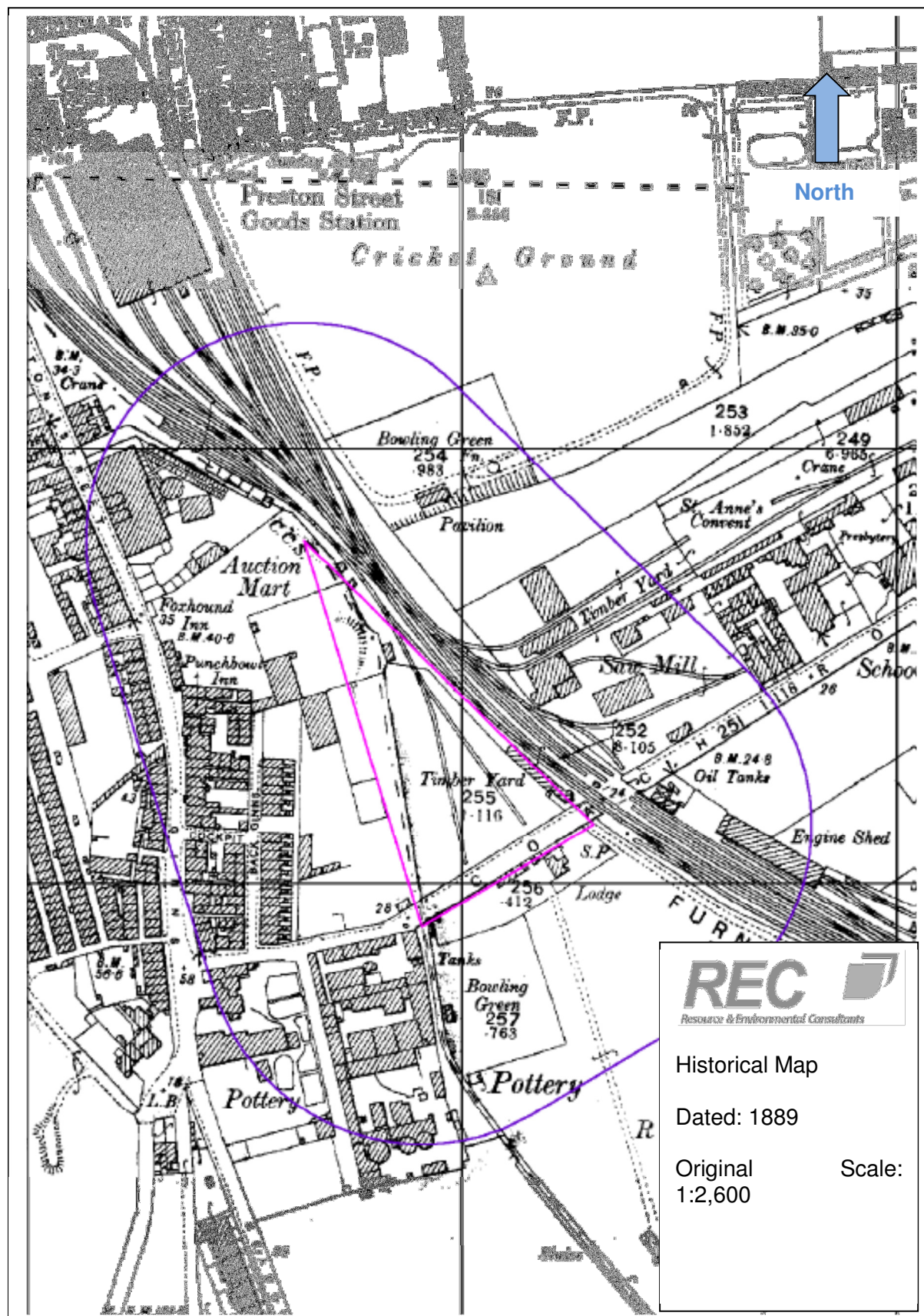


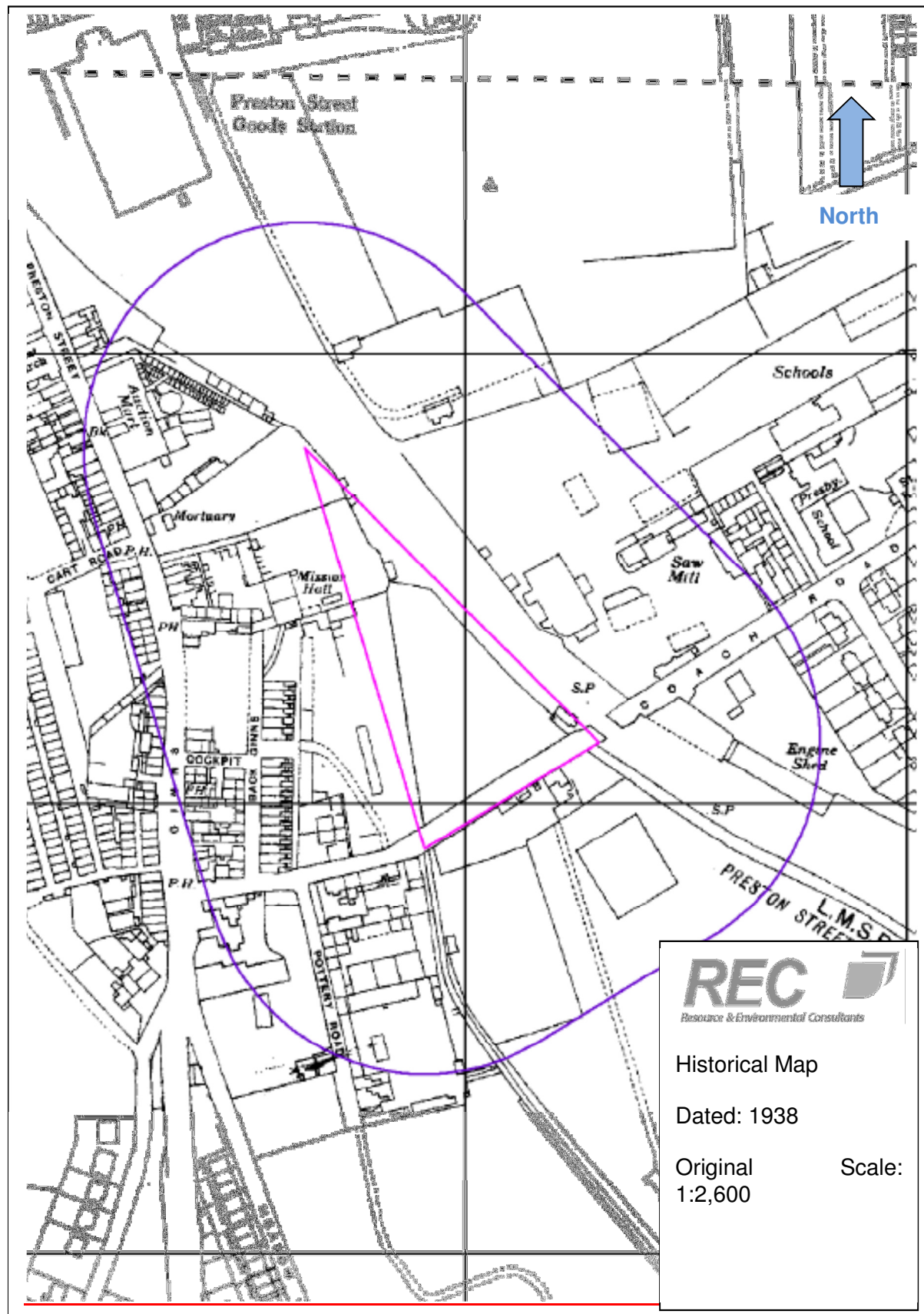
PLATE 8 – DRAINAGE GRID/INTERCEPTOR IN SOUTHERN AREA OF SITE CLOSE TO CP103

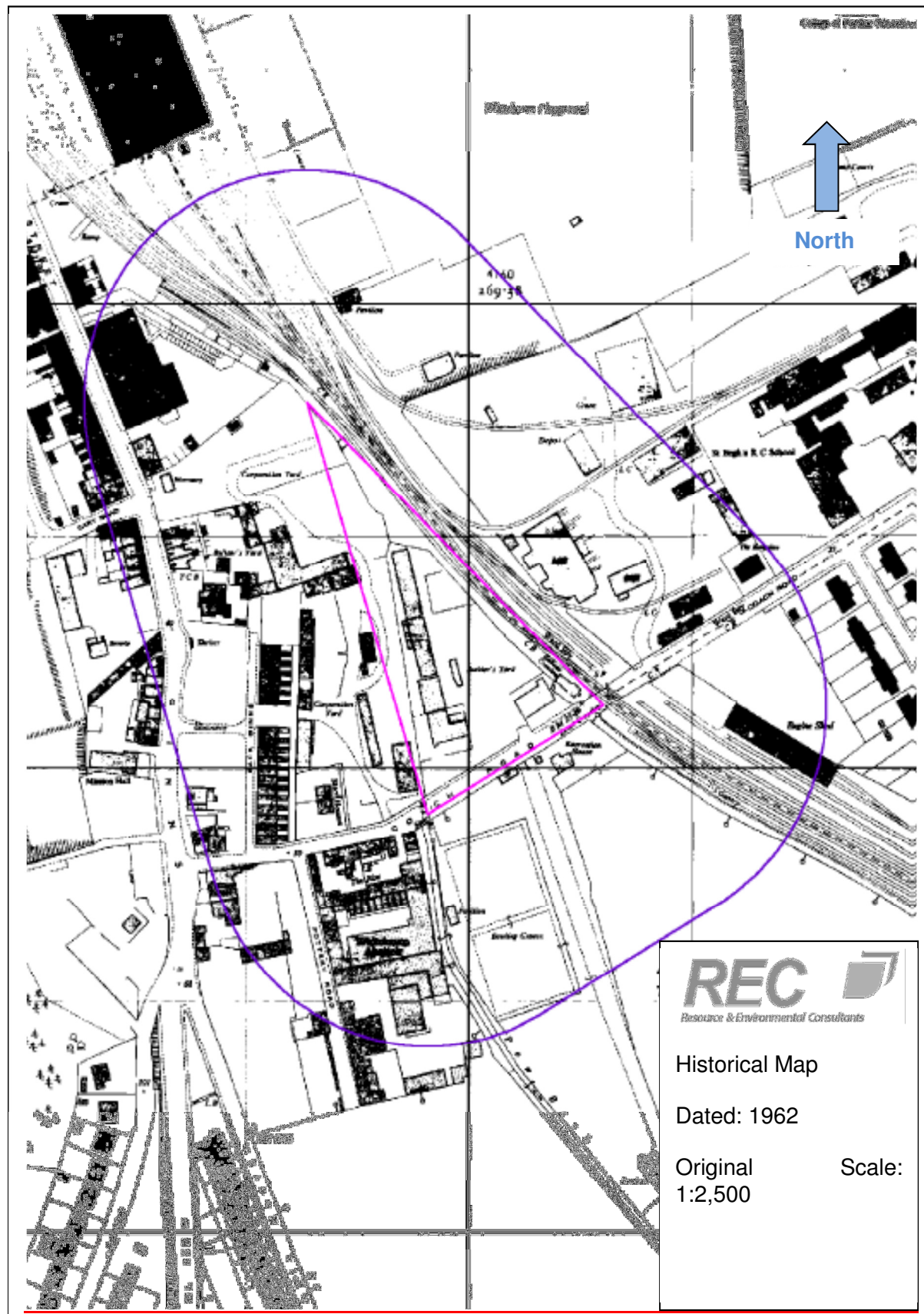
APPENDIX V
HISTORICAL MAPS

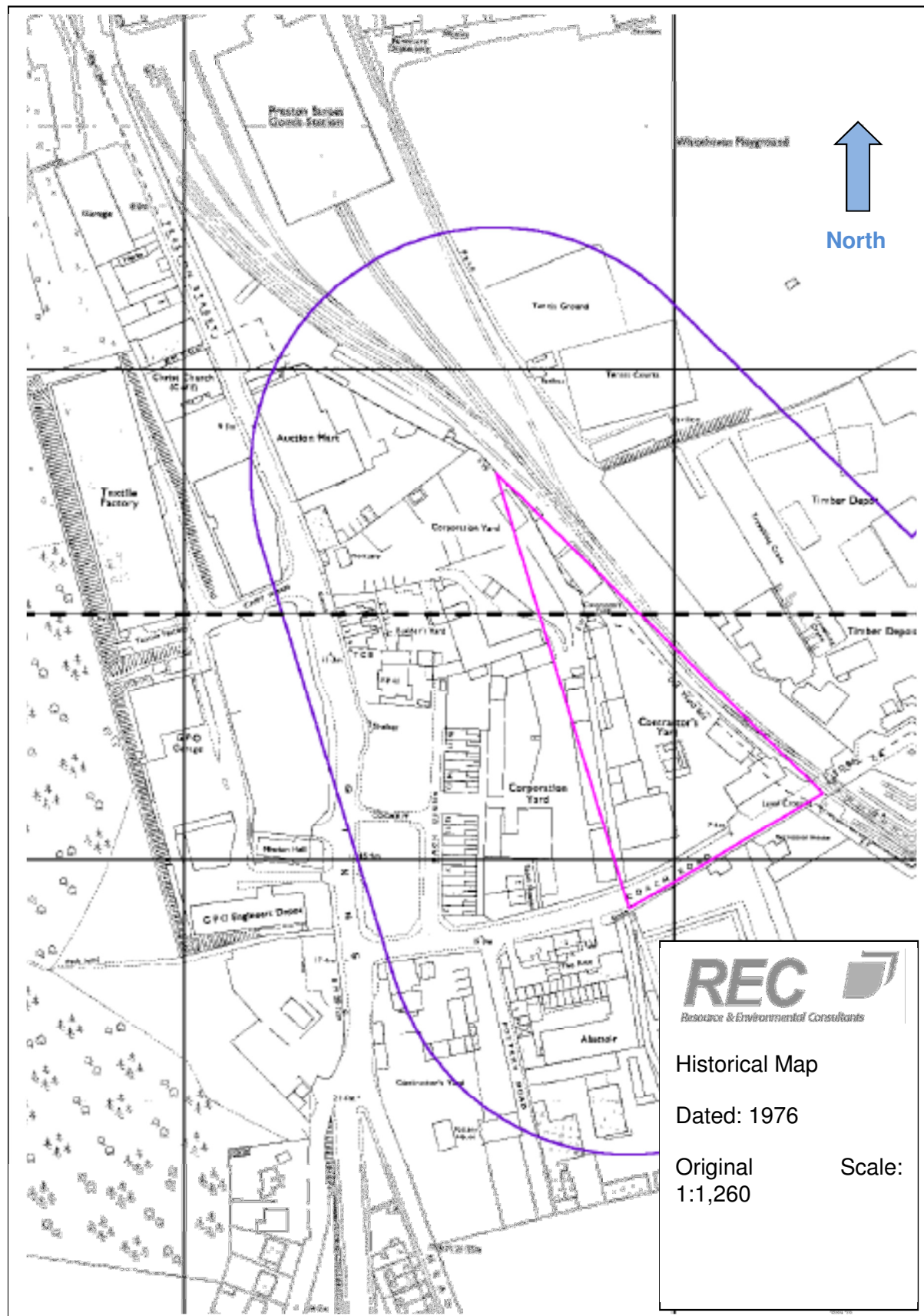


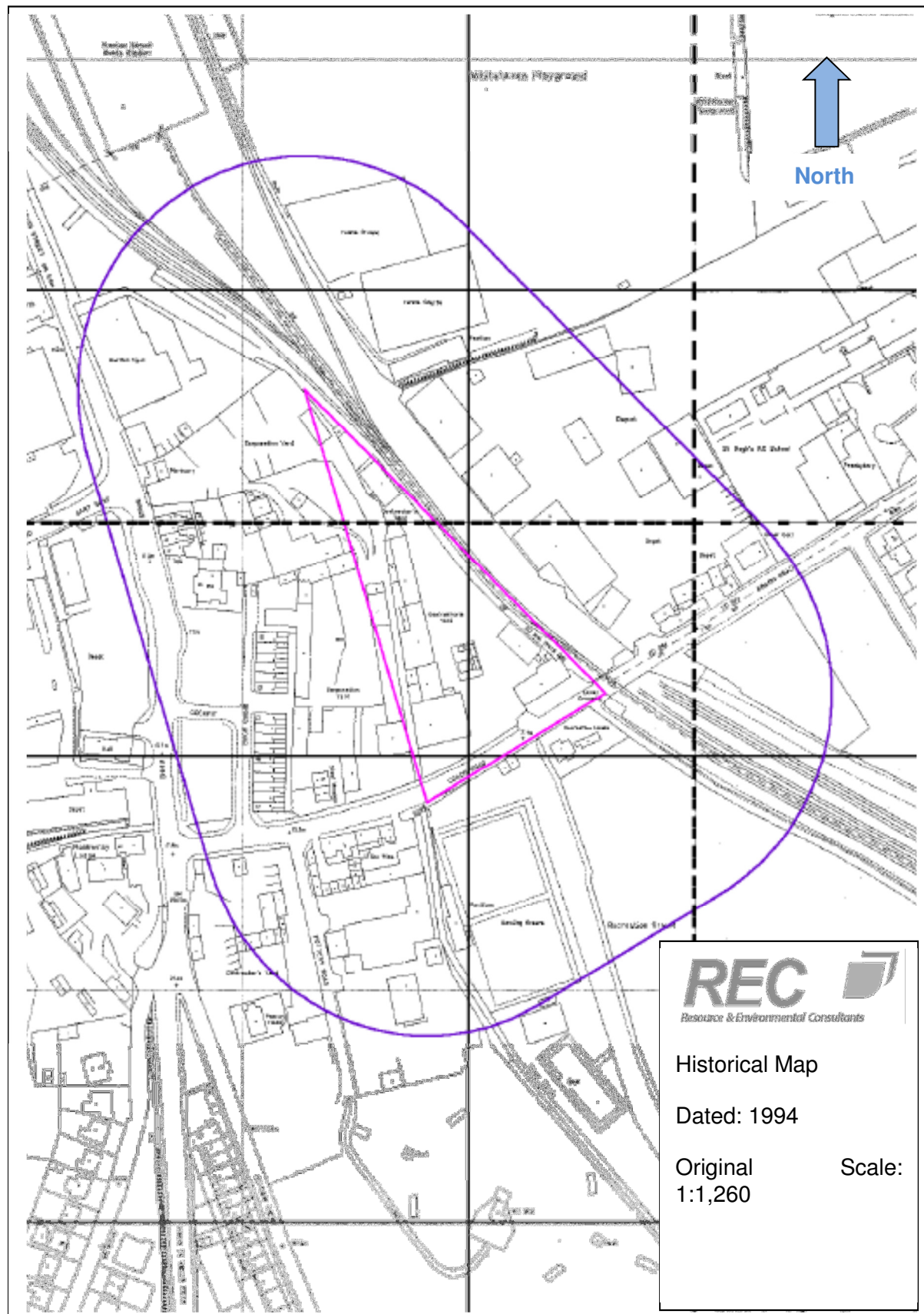


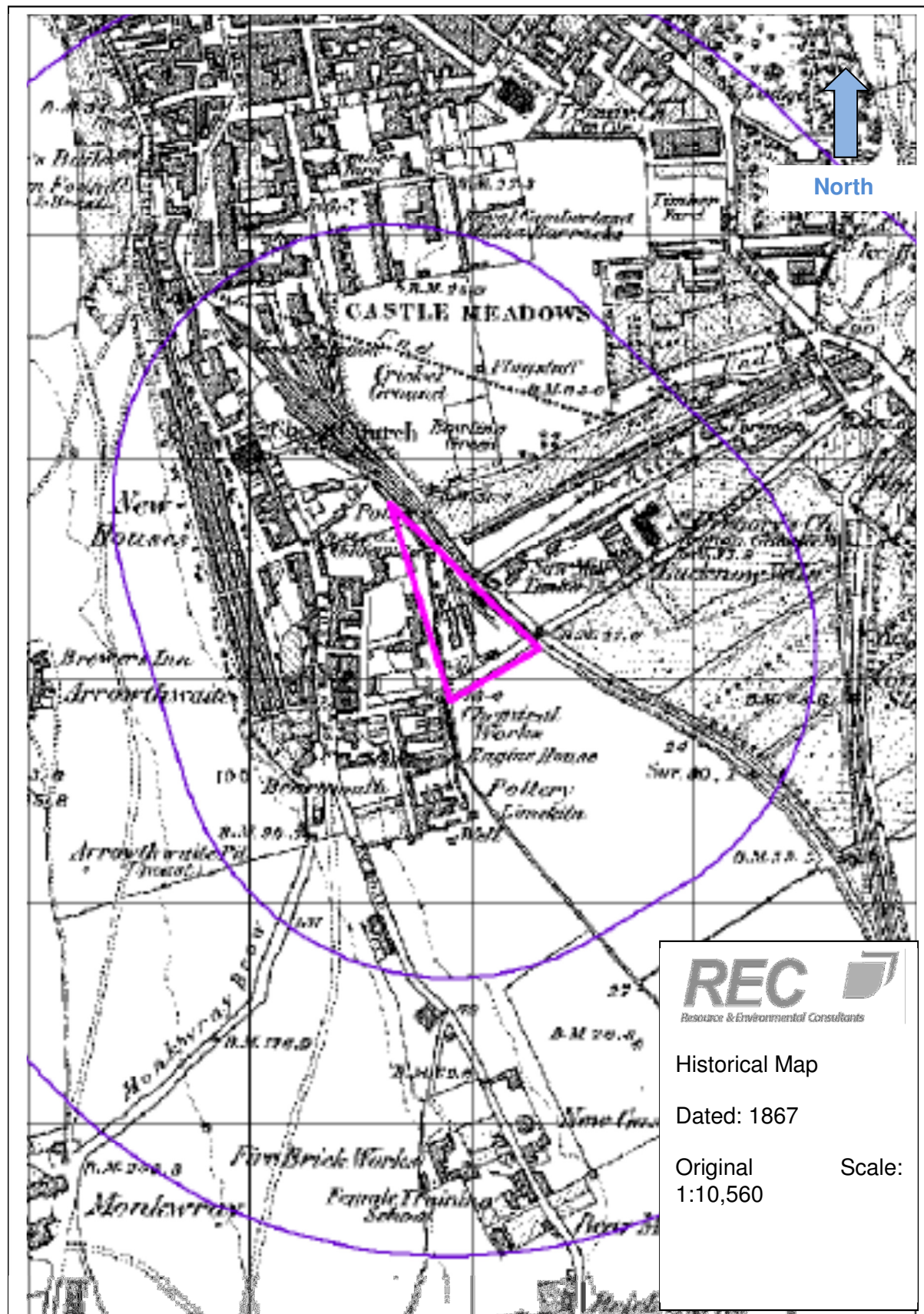


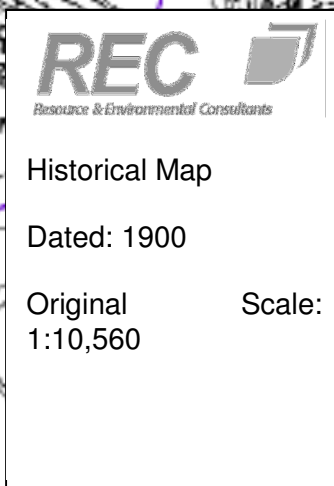


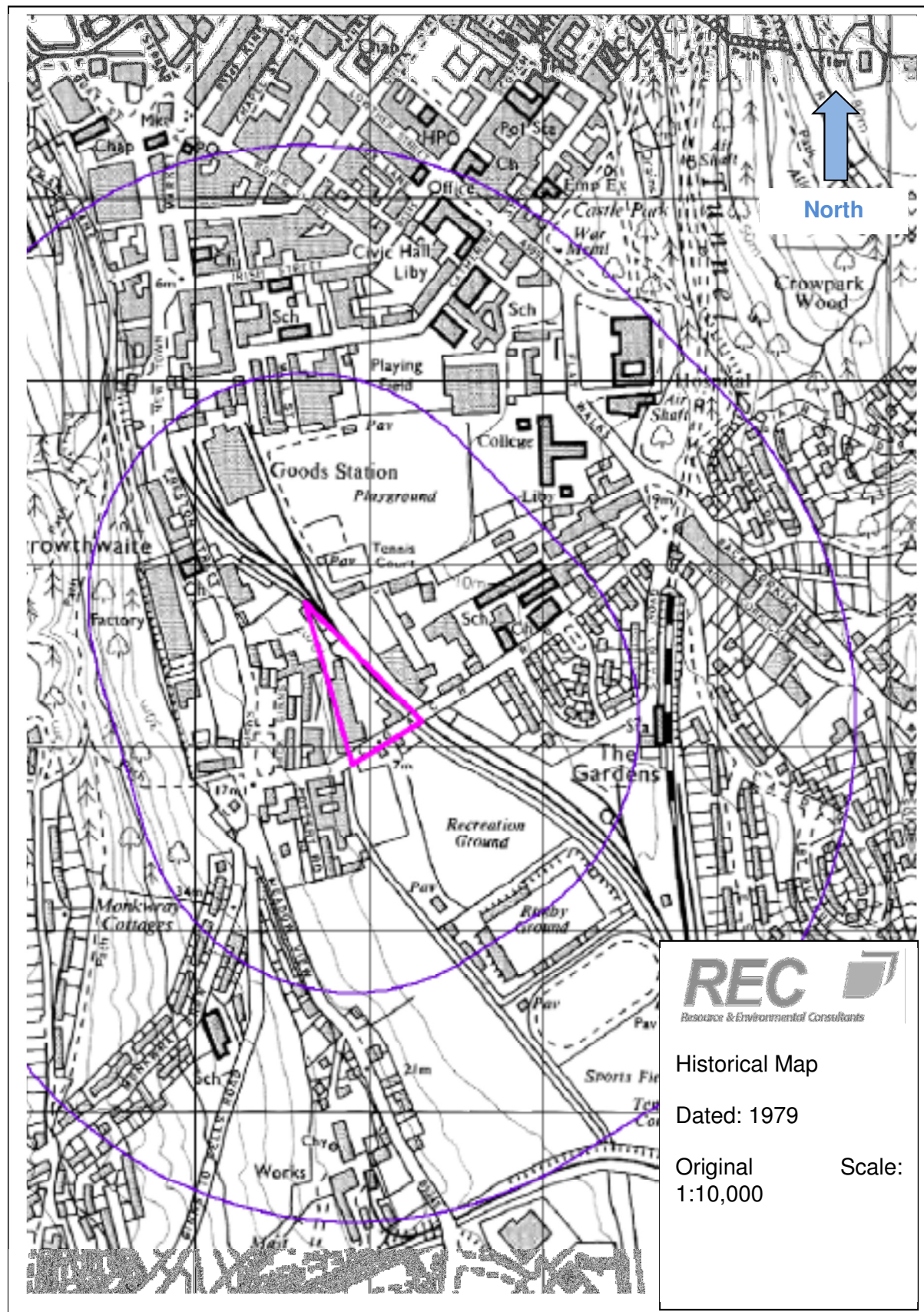


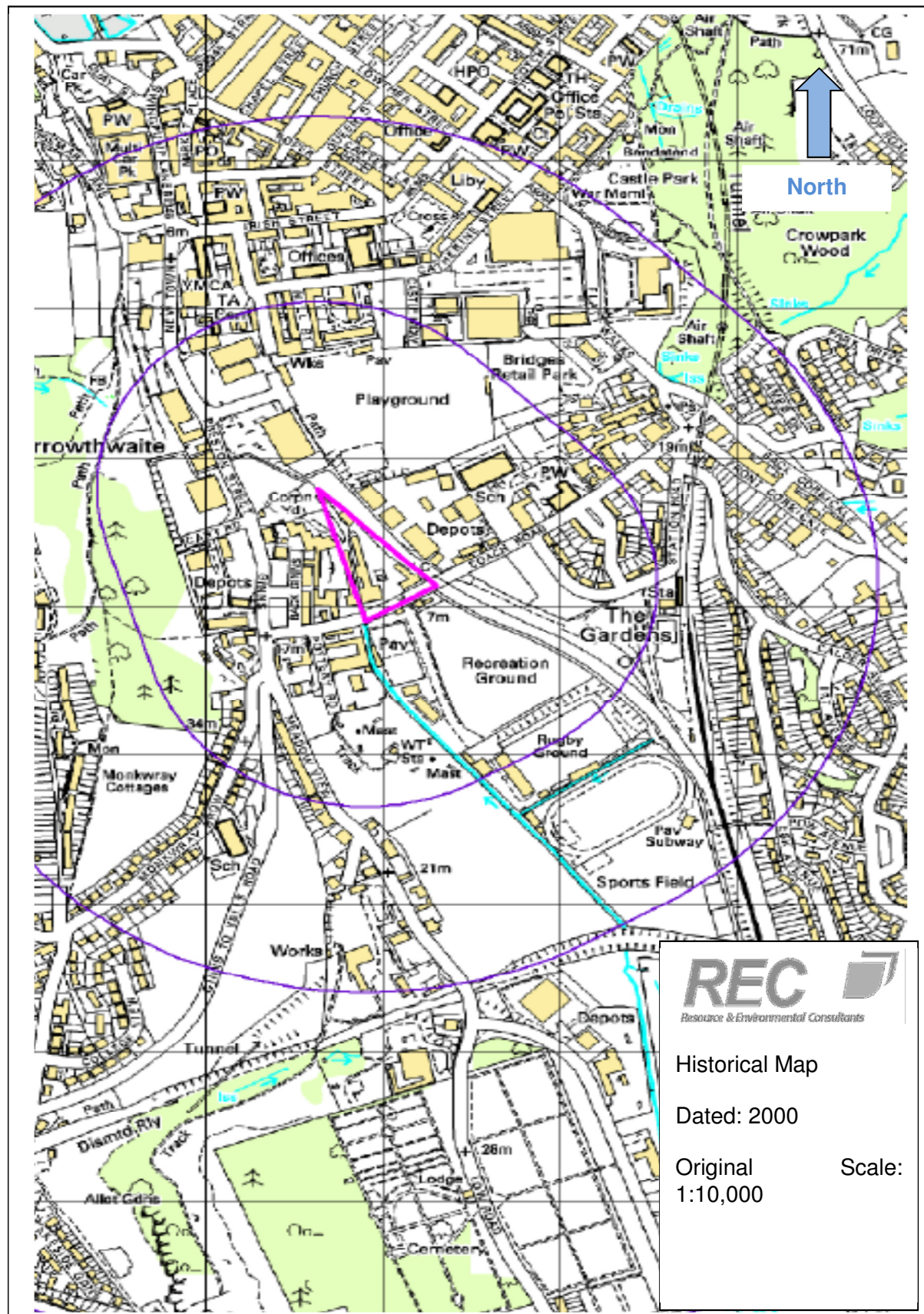


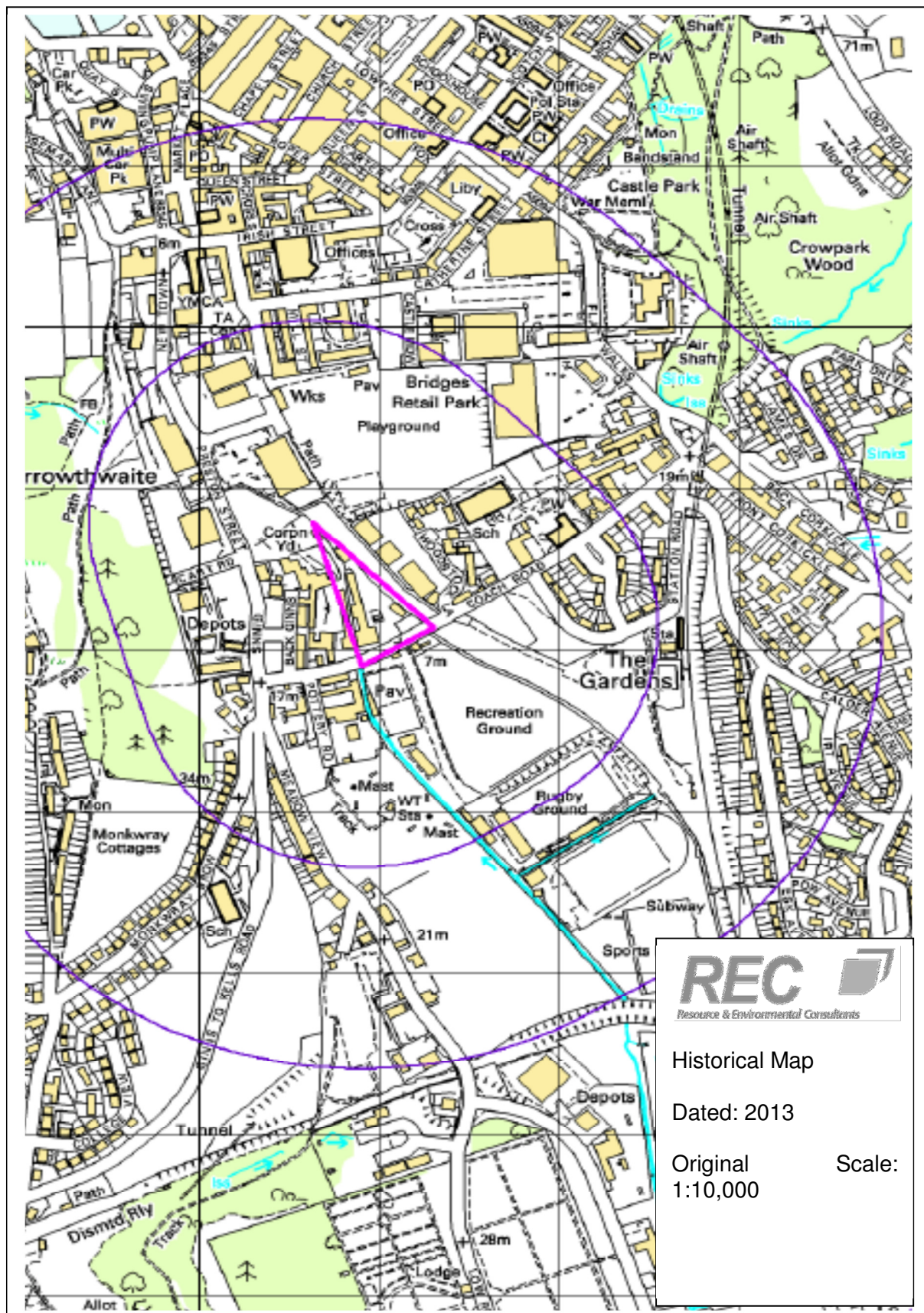












APPENDIX VI
REC EXPLORATORY LOGS

Borehole Log

Borehole No.

CP101

Sheet 1 of 2

Project Name: Coach Road

Project No.
45418

Co-ords: 297393.04 - 517465.57

Hole Type
CP

Location: Whitehaven

Level: 7.37

Scale
1:50

Client: Civic Engineering

Dates: 18/02/2014 - 18/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20 0.20 - 0.50	ES B		0.20	7.17		MADE GROUND: Asphalt.	
								MADE GROUND: Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, and mudstone.	
		1.00 1.00 1.20 - 1.65	ES D U	Ublow=6	1.00	6.37		MADE GROUND: Soft silty gravelly clay. Gravel is fine to medium subangular to subrounded of brick, ash, clinker, and mudstone.	1
		1.70 1.70 - 2.00 2.00 2.00	D B D	N=12 (1,2/2,3,4,3)	2.00	5.37		Brownish grey medium to coarse SAND. [ALLUVIUM]	2
		2.50 - 3.00	B						
		3.00 3.00 3.00	D ES	N=42 (3,5/10,10,10,12)					3
		3.50 - 4.00 3.60	B ES						
		4.00 4.00	D	N=25 (3,3/6,6,7,6)					4
		4.50 4.50 - 5.00	ES B						
		5.00 5.00	D	N=36 (3,5/7,7,10,12)					5
		5.50 5.50 - 6.00	ES B						
		6.00 6.00	D	N=22 (2,3/3,5,7,7)					6
									7
		7.50 7.50 7.90	D D	N=13 (2,2/3,3,4,3)	8.00	-0.63		Brownish grey clayey medium to coarse SAND with occasional clay bands and a medium cobble content. [ALLUVIUM]	8
		8.50 8.50 - 9.00	ES B						
		9.00 9.00	D	N=38 (5,8/8,10,10,10)					9
									10

Continued on next sheet

Remarks

TARGET DEPTH REACHED AT 12.00m.

Borehole Log

Borehole No.

CP101

Sheet 2 of 2

Project Name: Coach Road

Project No.
45418

Co-ords: 297393.04 - 517465.57

Hole Type
CP

Location: Whitehaven

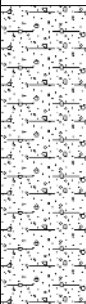
Level: 7.37

Scale
1:50

Client: Civic Engineering

Dates: 18/02/2014 - 18/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50 10.50 - 10.95	B	50 (25 for 10mm/50 for 20mm)					11
		12.00		50 (25 for 30mm/50 for 45mm)	12.00	-4.63		End of borehole at 12.00 m	12
									13
									14
									15
									16
									17
									18
									19
									20

Remarks

TARGET DEPTH REACHED AT 12.00m.

Borehole Log

Borehole No.

CP102

Sheet 1 of 2

Project Name: Coach Road

Project No.
45418

Co-ords: 297402.58 - 517429.82

Hole Type
CP

Location: Whitehaven

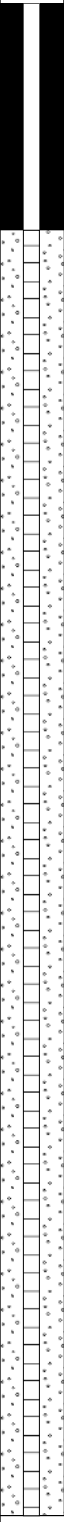
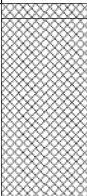
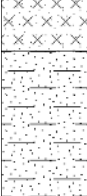
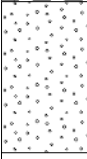
Level: 7.43

Scale
1:50

Client: Civic Engineering

Dates: 20/02/2014 - 20/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10			0.10	7.33		MADE GROUND: Asphalt.	1
		0.50 - 1.00	ES B					MADE GROUND: Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, and coal. Hydrocarbon odour and iridescent sheen.	
		1.00 - 1.45	D	N=2 (1,0/1,0,1,0)					
		1.50 - 2.00	ES B		1.30	6.13		Very soft grey sandy SILT. Hydrocarbon odour and iridescent sheen. [ALLUVIUM]	2
		2.00 - 2.45	U B	Ublow=4				At 2.00m to 2.45m: No U100 recovery.	
		2.00 - 2.45	U B						
		2.45	ES						
		3.00 - 3.45	D	N=29 (3,3/5,7,8,9)	2.90	4.53		Brownish grey clayey medium to coarse SAND. Hydrocarbon odour and iridescent sheen. [ALLUVIUM]	3
		3.50 - 4.00	ES B						
		4.00 - 4.45	D	N=21 (3,3/4,4,6,7)					4
		4.50 - 5.00	ES B						
		5.00 - 5.45	D	N=33 (4,4/5,7,10,11)					5
		5.50 - 6.00	ES B						
		6.00 - 6.45	D	N=26 (3,4/4,6,7,9)					6
		7.00 - 7.50	ES B						7
		7.50 - 7.95	D	N=18 (2,3/4,4,5,5)					8
		8.30 - 8.80	B		8.30	-0.87		Stiff brownish grey sandy CLAY with gravel bands. [ALLUVIUM]	9
		8.50	ES						
		9.00 - 9.45	ES B	N=10 (2,2/2,2,3,3)	9.00	-1.57		Grey slightly silty fine to coarse subangular to rounded GRAVEL of siltstone and other mixed lithologies. [ALLUVIUM]	10

Continued on next sheet

Remarks

TARGET DEPTH REACHED AT 12.00m.

Borehole Log

Borehole No.

CP102

Sheet 2 of 2

Project Name: Coach Road

Project No.
45418

Co-ords: 297402.58 - 517429.82

Hole Type
CP

Location: Whitehaven

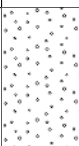
Level: 7.43

Scale
1:50

Client: Civic Engineering

Dates: 20/02/2014 - 20/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50	ES	N=13 (2,2/3,3,4,3)	11.00	-3.57		Stiff brownish grey sandy CLAY. [ALLUVIUM]	11
		10.50	B						
		10.50 - 10.95							
		11.50	D	N=19 (3,4/5,4,4,6)	12.00	-4.57		End of borehole at 12.00 m	12
		11.50 - 11.95							
									13
									14
									15
									16
									17
									18
									19
									20

Remarks
TARGET DEPTH REACHED AT 12.00m.

Borehole Log

Borehole No.

CP103

Sheet 1 of 2

Project Name: Coach Road

Project No.
45418

Co-ords: 297395.57 - 517405.62

Hole Type
CP

Location: Whitehaven

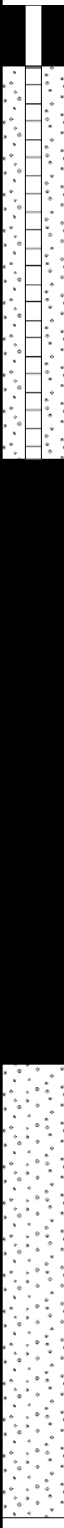
Level: 7.30

Scale
1:50

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	D	Ublow=8	0.30	7.00		MADE GROUND: Concrete.	1
		0.50	ES		0.40	6.90		MADE GROUND: Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, and concrete. Solvent odour and iridescent sheen.	
		0.50 - 1.00						Soft brownish grey silty CLAY. Solvent odour and iridescent sheen. [ALLUVIUM]	
		1.20 - 1.65	U	N=2 (1,0/0,0,1,1)				PEAT with Solvent odour and iridescent sheen.. [ALLUVIUM]	2
		1.70	D		1.80	5.50		Brownish grey sandy SILT. Solvent odour and iridescent sheen. [ALLUVIUM]	
		1.80	D		2.00	5.30			
		2.00 - 2.45	D	N=13 (2,2/3,3,4,3)				Grey medium to coarse SAND. Solvent odour and iridescent sheen. [ALLUVIUM]	3
		2.50	ES		2.80	4.50			
		2.50 - 3.00	B						
		3.00	D	N=13 (2,3/3,3,4,3)					4
		3.00 - 3.45	D						
		3.50	ES						
		3.50 - 4.00	B	N=15 (2,2/2,3,4,6)	4.80	2.50		Brownish grey gravelly medium to coarse SAND. Gravel is fine angular to subrounded of coal. Solvent odour and iridescent sheen. [ALLUVIUM]	5
		4.00	D						
		4.00 - 4.45	D						
		5.00	ES	Ublow=45	5.70	1.60		Stiff brownish grey slightly sandy CLAY with a medium cobble content and occasional bands of gravel. [ALLUVIUM]	6
		5.00	B					Strong solvent odour and iridescent sheen present between 5.7m and 6.5m.	
		5.00 - 5.45	B						
		5.70	ES	N=17 (3,4/4,5,4,4)					7
		5.70 - 6.00	B						
		6.00 - 6.45	U						
		6.50	D	N=27 (4,5/6,7,7,7)					8
		7.50	ES						
		7.50	B						
		7.50 - 7.95	B						9
		9.00	ES						
		9.00	B						
		9.00 - 9.45	B						10

Continued on next sheet

Remarks

TARGET DEPTH REACHED AT 12.00m.

Borehole Log

Borehole No.

CP103

Sheet 2 of 2

Project Name: Coach Road

Project No.
45418

Co-ords: 297395.57 - 517405.62

Hole Type
CP

Location: Whitehaven

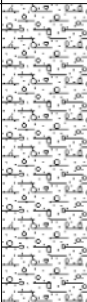
Level: 7.30

Scale
1:50

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50	ES	N=21 (3,5/5,5,5,6)	12.00	-4.70			11
		10.50							
		10.50 - 10.95	B						
		11.50	ES	N=22 (4,6/6,5,6,5)					
11.50 - 12.00	B								
12.00									
		End of borehole at 12.00 m							
									13
									14
									15
									16
									17
									18
									19
									20

Remarks
TARGET DEPTH REACHED AT 12.00m.

Borehole Log

Borehole No.

RB101

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297432.46 - 517433.83

Hole Type
RO

Location: Whitehaven

Level: 7.37

Scale
1:200

Client: Civic Engineering

Dates: 17/02/2014 - 21/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	7.27		MADE GROUND: Asphalt.	1
					0.60	6.77		MADE GROUND: Black slightly clayey gravelly medium to coarse SAND. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, and coal, and ceramic.	2
					1.20	6.17		MADE GROUND: Black clay.	3
					2.50	4.87		Dark grey CLAY.	4
					4.80	2.57		Dark grey SAND.	5
								Grey Sandy CLAY.	6
								Coarse GRAVEL	7
					14.50	-7.13		Grey MUDSTONE with Silty bands.	8
					16.00	-8.63		Grey MUDSTONE with Silty bands.	9
								Grey MUDSTONE with Silty bands.	10
								Grey MUDSTONE with Silty bands.	11
								Grey MUDSTONE with Silty bands.	12
								Grey MUDSTONE with Silty bands.	13
								Grey MUDSTONE with Silty bands.	14
								Grey MUDSTONE with Silty bands.	15
								Grey MUDSTONE with Silty bands.	16
								Grey MUDSTONE with Silty bands.	17
								Grey MUDSTONE with Silty bands.	18
								Grey MUDSTONE with Silty bands.	19
								Grey MUDSTONE with Silty bands.	20
								Grey MUDSTONE with Silty bands.	21
								Grey MUDSTONE with Silty bands.	22
								Grey MUDSTONE with Silty bands.	23
								Grey MUDSTONE with Silty bands.	24
								Grey MUDSTONE with Silty bands.	25
								Grey MUDSTONE with Silty bands.	26
								Grey MUDSTONE with Silty bands.	27
								Grey MUDSTONE with Silty bands.	28
								Grey MUDSTONE with Silty bands.	29
					30.00	-22.63		End of borehole at 30.00 m	30
									31
									32
									33
									34
									35
									36
									37
									38
									39
									40

Remarks
TARGET DEPTH REACHED AT 30.00m. Backfilled with 30.00m arisings.

Borehole Log

Borehole No.

RB102

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297405.89 - 517406.28

Hole Type
RO

Location: Whitehaven

Level: 7.30

Scale
1:200

Client: Civic Engineering

Dates: 24/02/2014 - 24/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	7.20		MADE GROUND: Concrete.	1
					0.30	7.00		MADE GROUND: Black slightly clayey gravelly medium to coarse SAND. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, and coal, and ceramic.	2
					1.20	6.10		Brown CLAY.	3
								Sandy CLAY. Iridescent sheen.	4
					6.00	1.30		CLAY	5
									6
									7
									8
					9.50	-2.20		Grey MUDSTONE.	9
									10
									11
									12
					15.00	-7.70		Grey SILTSTONE.	13
					16.10	-8.80		Grey MUDSTONE	14
									15
									16
									17
									18
									19
									20
									21
									22
									23
									24
									25
									26
									27
									28
									29
									30
									31
									32
									33
									34
									35
									36
									37
									38
									39
									40
					30.00	-22.70		End of borehole at 30.00 m	

Remarks
TARGET DEPTH REACHED AT 30.00m. Backfilled with 30.00m arisings.

Borehole Log

Borehole No.

RB103

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297388.95 - 517478.87

Hole Type
RO

Location: Whitehaven

Level: 7.42

Scale
1:200

Client: Civic Engineering

Dates: 21/02/2014 - 21/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	7.32		MADE GROUND: Asphalt.	1
					0.40	7.02		MADE GROUND: Concrete.	
					2.00	5.42		MADE GROUND: Black slightly clayey gravelly medium to coarse SAND. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, and coal, and ceramic.	2
					4.00	3.42		SAND.	3
								Grey CLAY.	4
									5
									6
									7
									8
									9
									10
									11
					12.30	-4.88		Grey MUDSTONE.	12
					13.30	-5.88		Dark grey MUDSTONE.	13
					14.00	-6.58		COAL.	14
					14.50	-7.08		Grey MUDSTONE with Silty bands.	15
									16
					16.30	-8.88		Grey SILTSTONE.	17
									18
									19
									20
									21
									22
									23
									24
									25
									26
									27
					27.80	-20.38		Dark grey MUDSTONE.	28
									29
					30.00	-22.58		End of borehole at 30.00 m	30
									31
									32
									33
									34
									35
									36
									37
									38
									39
									40

Remarks

TARGET DEPTH REACHED AT 30.00m. Backfilled with 30.00m arisings.

Borehole Log

Borehole No.

WS101

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297443.51 - 517431.99

Hole Type
WLS

Location: Whitehaven

Level: 7.48

Scale
1:25

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.08			0.08	7.40		MADE GROUND: Asphalt	
		0.30	ES					MADE GROUND: Light grey gravelly fine to medium sand. Gravel is fine to coarse subrounded to subangular of brick, concrete, and ceramic.	
		0.60	ES		0.50	6.98		MADE GROUND: Soft to firm dark grey slightly gravelly slightly sandy clay. Gravel is fine to medium subangular to subrounded of brick, coal, mudstone, and siltstone.	
		1.00		N=4 (1,0/1,1,1,1)	1.00	6.48		Loose soft to firm dark grey slightly gravelly slightly sandy CLAY. Gravel is fine to medium subangular to rounded of coal, mudstone, chalk and siltstone. [ALLUVIUM]	1
		1.10	ES						
		1.60	ES		1.50	5.98		Soft light grey sandy CLAY. [ALLUVIUM]	
		2.00		N=18 (1,2/3,3,5,7)	2.00	5.48		Medium dense brown medium to coarse SAND. [ALLUVIUM]	2
		2.10	ES						
		2.50 - 3.00	B						
		2.70		50 (25 for 140mm/50 for 150mm)				Becoming dense at 2.7m.	
					3.00	4.48		End of borehole at 3.00 m	3
									4
									5

Remarks
REFUSAL AT 3.00m DUE TO DENSE SAND, NO WATER ENCOUNTERED

Borehole Log

Borehole No.

WS101B

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297434.34 - 517424.64

Hole Type
WLS

Location: Whitehaven

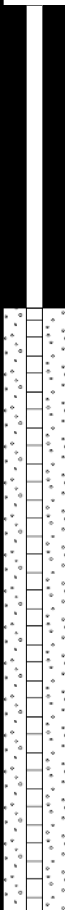
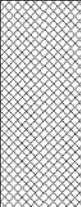
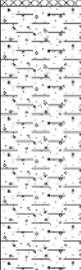
Level: 7.37

Scale
1:25

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.08	7.29		MADE GROUND: Asphalt.	1	
		0.20	ES	N=3 (0,0/0,1,1,1)				MADE GROUND: Dark grey clayey gravelly sand. Gravel is fine to coarse angular to subrounded of siltstone, brick, slate, asphalt, and clinker.		
		0.90	ES		0.80	6.57		MADE GROUND: Soft to firm dark grey slightly gravelly slightly sandy clay. Gravel is medium subangular to subrounded of brick and coal.		
		1.00			1.10	6.27		Very low strength soft dark grey slightly gravelly slightly sandy CLAY. Gravel is medium subangular to subrounded of coal, mudstone, and siltstone. [ALLUVIUM]		
		2.00	ES		N=34 (4,6/5,9,10,10)	2.00	5.37		Dense brown medium to coarse SAND. [ALLUVIUM]	2
		2.10								
		2.80		N=50 (4,7/50 for 235mm)	3.00	4.37		End of borehole at 3.00 m	3	
										4
										5

Remarks
REFUSAL AT 3.00m DUE TO DENSE SAND, NO WATER ENCOUNTERED

Borehole Log

Borehole No.

WS102

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297417.84 - 517418.91

Hole Type
WLS

Location: Whitehaven

Level: 7.32

Scale
1:25

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10			0.10	7.22		MADE GROUND: Asphalt.	
		0.30	ES					MADE GROUND: Dark grey slightly clayey sandy gravel. Gravel is fine to medium of brick, ash, clinker, coal, and asphalt.	
		0.60	ES		0.50	6.82		Low strength firm dark grey slightly gravelly slightly sandy CLAY. Gravel is fine to medium subangular to rounded of coal and siltstone. [ALLUVIUM]	
		1.00		N=4 (0,0/0,1,1,2)					1
		2.00		N=9 (0,0/0,2,3,4)	2.00	5.32		Loose brown medium to coarse SAND. Hydrocarbon odour and iridescent sheen . [ALLUVIUM]	2
		2.10	ES						
		3.00		N=50 (4,7/50 for 265mm)				Becomes dense at 3.00m.	3
		3.40		26 (49 for 145mm/26 for 75mm)	3.40	3.92		End of borehole at 3.40 m	4
									5

Remarks
REFUSAL AT 3.40m DUE TO DENSE SAND, NO WATER ENCOUNTERED

Borehole Log

Borehole No.

WS103

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297382.83 - 517415.23

Hole Type
WLS

Location: Whitehaven

Level: 7.40

Scale
1:25

Client: Civic Engineering

Dates: 20/02/2014 - 20/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20	7.20		MADE GROUND: Concrete.	
		0.30	ES		0.50	6.90		MADE GROUND: Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse subangular to subrounded of brick, coal, ash, clinker, and ceramic.	
		0.60	ES					Soft orangish grey silty slightly gravelly CLAY. Gravel is fine to medium angular to rounded of coal and sandstone. [ALLUVIUM]	
		0.70	D						
		1.00		N=0 (0,0/0,0,0,0)					1
		1.50	D						
		1.90	ES		1.80	5.60		Very loose grey silty medium to coarse SAND. [ALLUVIUM]	2
		2.00	B	N=14 (2,2/3,3,4,4)					
		2.00 - 2.50							
		3.00		N=50 (5,9/50 for 280mm)	3.00	4.40		End of borehole at 3.00 m	3
									4
									5

Remarks
REFUSAL AT 3.00m DUE TO DENSE SAND, NO WATER ENCOUNTERED

Borehole Log

Borehole No.

WS104

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297391.58 - 517430.97

Hole Type
WLS

Location: Whitehaven

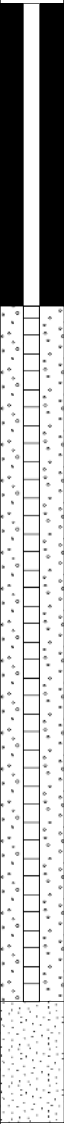
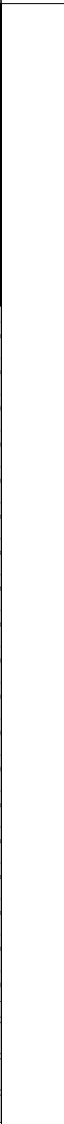
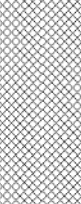
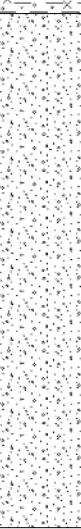
Level: 7.39

Scale
1:25

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.08			0.08	7.31		MADE GROUND: Asphalt.	
		0.17			0.17	7.22		MADE GROUND: Asphalt.	
		0.30	ES		0.29	7.10		MADE GROUND: Sandstone cobble.	
		0.70	ES					MADE GROUND: Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse subangular to subrounded of brick, asphalt, ash, clinker, and concrete. Strong solvent odour with iridescent sheen.	
		1.00		N=2 (0,0/0,1,0,1)	1.00	6.39		Very low strength soft to firm grey silty slightly gravelly Clay. Gravel is fine subangular to subrounded of coal and siltstone. Strong solvent odour with iridescent sheen. [ALLUVIUM]	
		1.60	ES						
		2.00		N=3 (0,0/0,1,1,1)	2.00	5.39		Very loose brown gravelly medium SAND. Gravel is fine to medium angular of coal. Strong solvent odour with iridescent sheen. [ALLUVIUM]	
		2.40	ES						
		3.00		N=25 (3,3/5,5,6,9)				Becomes Medium dense at 3.00m.	
		3.40	ES						
		3.70		N=50 (12,11/50 for 245mm)	3.70	3.69		End of borehole at 3.70 m	

Remarks

REFUSAL AT 3.30m DUE TO DENSE SAND, NO WATER ENCOUNTERED. CONTAMINATION THROUGHOUT BOREHOLE

Borehole Log

Borehole No.

WS105

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297411.89 - 517444.80

Hole Type
WLS

Location: Whitehaven

Level: 7.37

Scale
1:25

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.04			0.04	7.33		MADE GROUND: Asphalt.	
		0.30	ES					MADE GROUND: Low strength black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse angular to subrounded of brick, asphalt, ash, clinker, and sandstone, slate, and limestone. Hydrocarbon odour.	
		0.70	ES						
		1.00		N=6 (1,1/1,1,2,2)					1
		1.10	ES						
		1.30			1.30	6.07		Soft grey slightly gravelly CLAY with occasional silt bands and fragments of wood. Gravel is fine to coarse angular to subrounded of coal and siltstone. [ALLUVIUM]	
		1.50	ES						
	▼	2.00		N=19 (0,0/0,13,3,3)	2.00	5.37		Brown coarse SAND. [ALLUVIUM]	2
		2.60	ES						
		3.00		N=50 (6,4/5,6,14,25)	3.00	4.37		End of borehole at 3.00 m	3
									4
									5

Remarks
REFUSAL AT 3.00m DUE TO DENSE SAND.

Borehole Log

Borehole No.

WS106

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297403.33 - 517452.11

Hole Type
WLS

Location: Whitehaven

Level: 7.38

Scale
1:25

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.30	7.08		MADE GROUND: Concrete. <i>Underground storage tank encountered at 0.30m. Strong hydrocarbon odour between 0.10m and 0.30m.</i> ----- End of borehole at 0.30 m	
									1
									2
									3
									4
									5

Remarks
REFUSAL ON SUSPECTED UST AT 0.30m

Borehole Log

Borehole No.

WS106B

Sheet 1 of 1

Project Name: Coach Road

 Project No.
45418

Co-ords: 297390.13 - 517454.19

 Hole Type
WLS

Location: Whitehaven

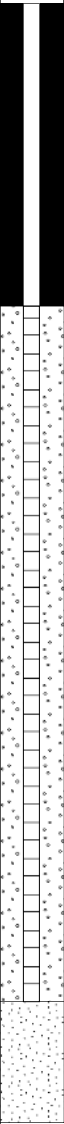
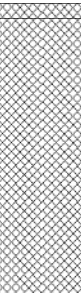
Level: 7.44

 Scale
1:25

Client: Civic Engineering

Dates: 19/02/2014 - 19/02/2014

 Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.05			0.05	7.39		MADE GROUND: Asphalt.	
		0.30	ES					MADE GROUND: Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse angular to subrounded of brick, asphalt, ash, clinker, and coal, ceramic. Hydrocarbon odour.	
		0.70	ES						
		1.00		N=1 (0,0/0,1,0,0)	1.00	6.44		Extremely low strength very soft grey silty slightly gravelly Clay with fragments of wood. Gravel is fine to medium subangular to rounded of coal and siltstone. [ALLUVIUM]	1
		1.10	ES						
		2.00		N=11 (1,2/2,3,3,3)	2.00	5.44		Medium dense brown slightly gravelly medium to coarse SAND. Gravel is fine angular to subrounded of coal. [ALLUVIUM]	2
		2.20	ES						
		3.00		N=33 (3,3/6,8,9,10)					3
		3.70		N=50 (11,13/50 for 229mm)	3.70	3.74		End of borehole at 3.70 m	4
									5

 Remarks
REFUSAL AT 3.00m DUE TO DENSE SAND.

Borehole Log

Borehole No.

WS107

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297378.89 - 517435.73

Hole Type
WLS

Location: Whitehaven

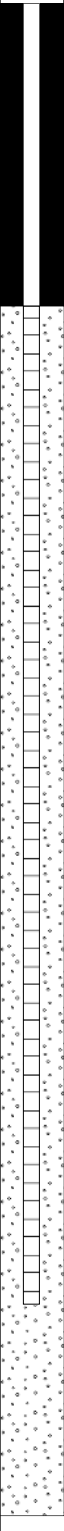
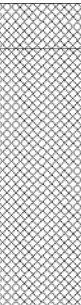
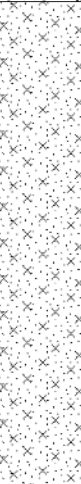
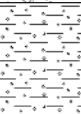
Level: 7.34

Scale
1:25

Client: Civic Engineering

Dates: 20/02/2014 - 20/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.15	7.19		MADE GROUND: Concrete.	
								MADE GROUND: Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, and coal, and sandstone.	
		1.00 1.10	ES	N=2 (0,0/0,0,1,1)	1.00	6.34		Very low strength soft grey silty gravelly CLAY with occasional peat lenses. Gravel is fine to coarse angular to subrounded of coal and siltstone. [ALLUVIUM]	1
		2.00		N=0 (0,0/0,0,0,0)					2
		3.00		N=30 (11,12/10,7,6,7)	3.00	4.34		Medium dense grey silty medium to coarse SAND. [ALLUVIUM]	3
		3.50	ES						
		4.00		N=25 (4,5/4,6,7,8)					4
		4.80 4.80	D ES		4.60	2.74		Medium strength firm grey silty slightly gravelly CLAY. Gravel is fine subangular to rounded of coal and siltstone. [ALLUVIUM]	
		5.00		N=18 (7,6/5,4,4,5)	5.00	2.34		End of borehole at 5.00 m	5

Remarks

TARGET DEPTH REACHED AT 5.00m

Borehole Log

Borehole No.

WS108

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297380.92 - 517483.91

Hole Type
WLS

Location: Whitehaven

Level: 7.44

Scale
1:25

Client: Civic Engineering

Dates: 20/02/2014 - 20/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.09			0.09	7.35		MADE GROUND: Asphalt.	
		0.20	ES		0.40	7.04		MADE GROUND: Black slightly clayey gravelly medium to coarse sand. Gravel is fine to coarse subangular to subrounded of brick, ash, clinker, and concrete.	
		0.50	ES		0.60	6.84		Firm grey silty gravelly CLAY. Gravel is fine to medium angular to subrounded of coal. [ALLUVIUM]	
		0.70	ES					Very dense brown slightly silty medium to coarse SAND. [ALLUVIUM]	
		1.00		N=50 (2,5/5,14,11,20)					1
		2.00		N=10 (3,8/4,2,2,2)				Becomes loose at 2.00m.	2
		3.00		N=21 (2,2/2,3,7,9)				Becomes medium dense at 3.00m.	3
		3.50		50 (25 for 95mm/50 for 220mm)	3.50	3.94		End of borehole at 3.50 m	4
									5

Remarks
REFUSAL AT 3.50m DUE TO DENSE SAND, NO WATER ENCOUNTERED



Borehole Log

Borehole No.

WS109

Sheet 1 of 1

Project Name: Coach Road

Project No.
45418

Co-ords: 297376.04 - 517500.60

Hole Type	WLS
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Location: Whitehaven

Level: 7.52

Scale
1:25

Client: Civic Engineering

Dates: 20/02/2014 - 20/02/2014

Logged By
GRANT H

[illegible]

Remarks

DEBRIS BETWEEN CONCRETE STRATA IMPARED CORING



Borehole Log

Borehole No.

WS109B

Sheet 1 of 1

Project Name: Coach Road

Project No.	45418
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Co-ords: 297370.03 - 517499.96

Hole Type	WLS
1	0.0000
2	0.0000
3	0.0000
4	0.0000
5	0.0000
6	0.0000
7	0.0000
8	0.0000
9	0.0000
10	0.0000
11	0.0000
12	0.0000
13	0.0000
14	0.0000
15	0.0000
16	0.0000
17	0.0000
18	0.0000
19	0.0000
20	0.0000
21	0.0000
22	0.0000
23	0.0000
24	0.0000
25	0.0000
26	0.0000
27	0.0000
28	0.0000
29	0.0000
30	0.0000
31	0.0000
32	0.0000
33	0.0000
34	0.0000
35	0.0000
36	0.0000
37	0.0000
38	0.0000
39	0.0000
40	0.0000
41	0.0000
42	0.0000
43	0.0000
44	0.0000
45	0.0000
46	0.0000
47	0.0000
48	0.0000
49	0.0000
50	0.0000
51	0.0000
52	0.0000
53	0.0000
54	0.0000
55	0.0000
56	0.0000
57	0.0000
58	0.0000
59	0.0000
60	0.0000
61	0.0000
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63	0.0000
64	0.0000
65	0.0000
66	0.0000
67	0.0000
68	0.0000
69	0.0000
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74	0.0000
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76	0.0000
77	0.0000
78	0.0000
79	0.0000
80	0.0000
81	0.0000
82	0.0000
83	0.0000
84	0.0000
85	0.0000
86	0.0000
87	0.0000
88	0.0000
89	0.0000
90	0.0000
91	0.0000
92	0.0000
93	0.0000
94	0.0000
95	0.0000
96	0.0000
97	0.0000
98	0.0000
99	0.0000
100	0.0000

Location: Whitehaven

Level: 7.52

Scale
1:25

Client: Civic Engineering

Dates: 20/02/2014 - 20/02/2014

Logged By
GRANT H

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.25	7.27		MADE GROUND: Concrete.	1
					0.35	7.17		MADE GROUND: Grey red sandy gravel. Gravel is medium angular to subrounded of limestone	
					0.35	7.17		MADE GROUND: Concrete.	
					End of borehole at 0.30 m				
								2	
								3	
								4	
								5	

Remarks	DEBRIS BETWEEN CONCRETE STRATA IMPARED CORING
---------	---

Borehole No.

Sheet 1 of 1

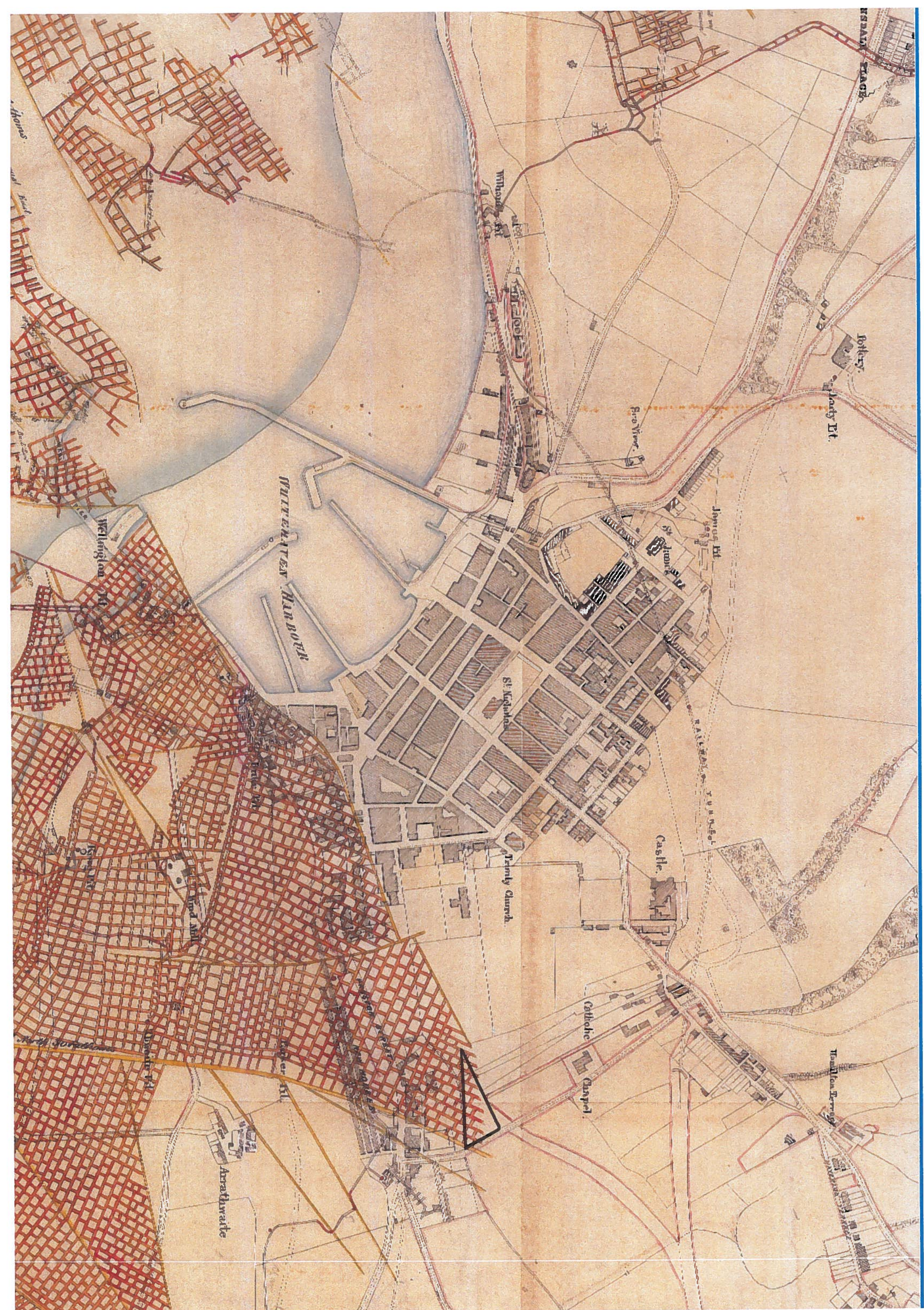
Hole Type	WLS
1	0.0000
2	0.0000
3	0.0000
4	0.0000
5	0.0000
6	0.0000
7	0.0000
8	0.0000
9	0.0000
10	0.0000
11	0.0000
12	0.0000
13	0.0000
14	0.0000
15	0.0000
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24	0.0000
25	0.0000
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29	0.0000
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61	0.0000
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63	0.0000
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65	0.0000
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89	0.0000
90	0.0000
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92	0.0000
93	0.0000
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96	0.0000
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98	0.0000
99	0.0000
100	0.0000

Scale
1:25

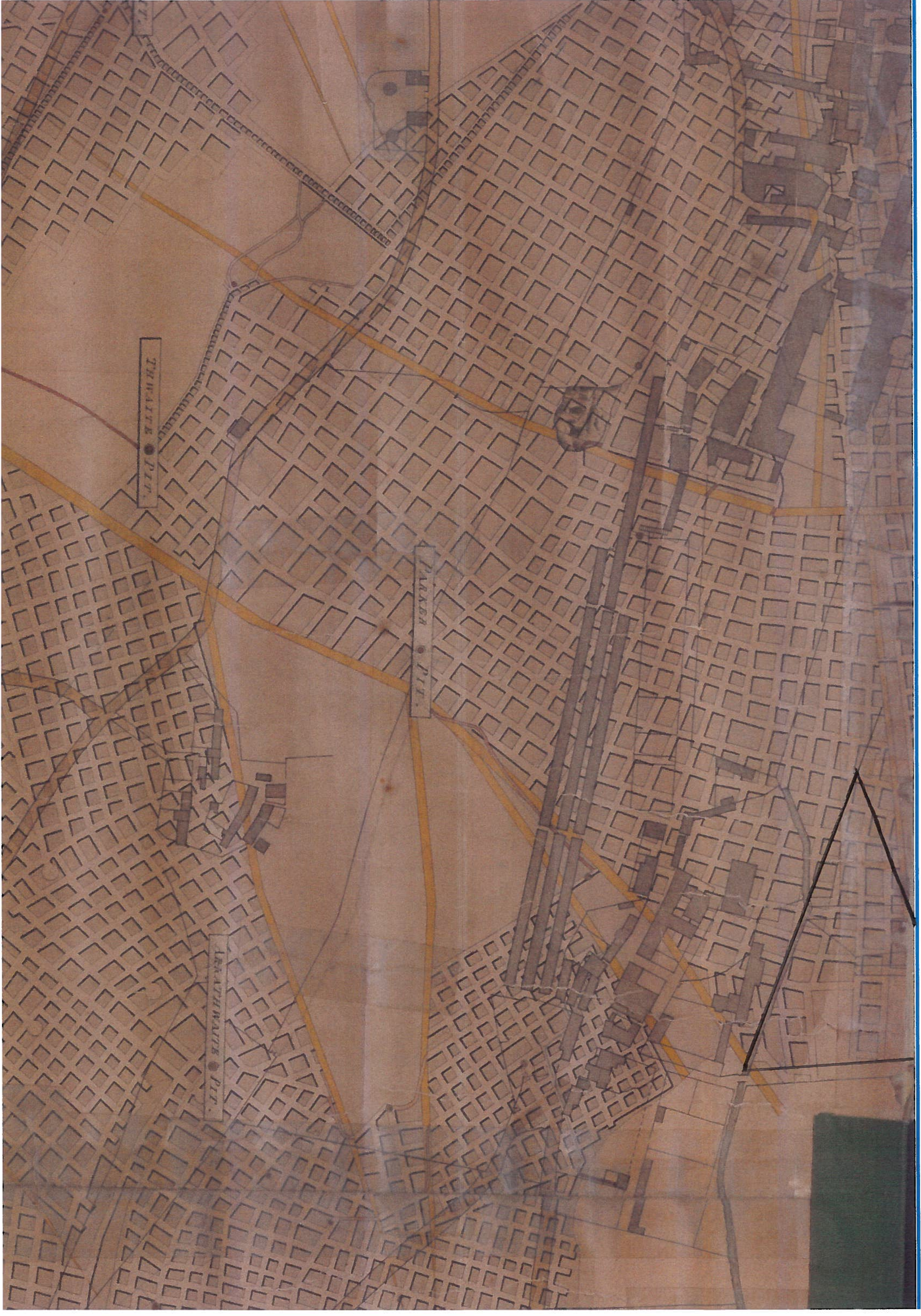
Logged By
GRANT H

Remarks	
TARGET DEPTH REACHED AT 5.00	

APPENDIX VII
ABANDONMENT PLANS







APPENDIX VIII
CHEMICAL TESTING



Scientific Analysis Laboratories is a
limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: 379084-1

Date of Report: 05-Mar-2014

Customer: Resource Environmental Consultants Ltd
Osprey House
Pacific Quay
Broadway
Salford
M50 2UE

Customer Contact: Miss Sabine Sargeant

Customer Job Reference: 45418

Date Job Received at SAL: 24-Feb-2014

Date Analysis Started: 26-Feb-2014

Date Analysis Completed: 05-Mar-2014

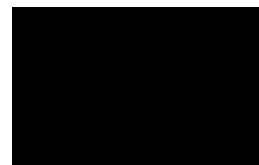
The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22



1549

Report checked
and authorised by :
Annie Hennis
Project Manager

Issued by :
Annie Hennis
Project Manager



Soil	Analysed as Soil
Total and Speciated USEPA16 PAH	

SAL Reference: 379084 Customer Reference: 45418							
Soil		Analysed as Soil					
Total and Speciated USEPA16 PAH							
SAL Reference					379084 034	379084 036	379084 049
Customer Sample Reference					WS8 0.50	WS10 0.40	CP2 0.50
Date Sampled					20-FEB-2014	20-FEB-2014	19-FEB-2014
Determinand	Method	Test Sample	LOD	Units			
Naphthalene	T149	AR	0.01	mg/kg	<0.01	0.23	5.7
Acenaphthylene	T149	AR	0.01	mg/kg	<0.01	0.05	0.07
Acenaphthene	T149	AR	0.01	mg/kg	<0.01	0.05	3.8
Fluorene	T149	AR	0.01	mg/kg	<0.01	0.07	3.4
Phenanthrene	T149	AR	0.01	mg/kg	0.01	1.5	12
Anthracene	T149	AR	0.01	mg/kg	<0.01	0.30	4.0
Fluoranthene	T149	AR	0.01	mg/kg	0.01	1.2	13
Pyrene	T149	AR	0.01	mg/kg	0.01	0.97	9.8
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	0.01	0.78	4.5
Chrysene	T149	AR	0.01	mg/kg	<0.01	0.71	3.9
Benzo(b/k)Fluoranthene	T149	AR	0.01	mg/kg	<0.01	1.2	8.4
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	<0.01	0.63	4.5
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	<0.01	0.46	3.6
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	<0.01	0.10	0.69
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	<0.01	0.36	2.7
PAH(total)	T149	AR	0.01	mg/kg	0.04	8.6	80

SAL Reference: 379084 Customer Reference: 45418 Soil Analysed as Soil REC TPH Alii/Aro C5-C35						
SAL Reference				379084 061	379084 062	
Customer Sample Reference				CP3 3.50	CP3 5.00	
Date Sampled				20-FEB-2014	20-FEB-2014	
Determinand	Method	Test Sample	LOD	Units		
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	<0.010	<0.010
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	<0.010	0.016
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	0.12	0.18
TPH (C10-C12 aliphatic)	T8	AR	1	mg/kg	4	2
TPH (C12-C16 aliphatic)	T8	AR	1	mg/kg	11	6
TPH (C16-C21 aliphatic)	T8	AR	1	mg/kg	13	3
TPH (C21-C35 aliphatic)	T8	AR	1	mg/kg	15	3
TPH (Aliphatic) total	T85	AR		mg/kg	43	14
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	<0.010	<0.010
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	<0.010	0.043
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	0.71	3.1
TPH (C10-C12 aromatic)	T8	AR	1	mg/kg	12	16
TPH (C12-C16 aromatic)	T8	AR	1	mg/kg	45	31
TPH (C16-C21 aromatic)	T8	AR	1	mg/kg	68	16
TPH (C21-C35 aromatic)	T8	AR	1	mg/kg	15	3
TPH (Aromatic) total	T85	AR		mg/kg	140	69
TPH (Aliphatic+Aromatic) (sum)	T85	AR		mg/kg	180	83

SAL Reference: 379084										
Customer Reference: 45418										
Soil		Analysed as Soil								
REC TPH (CWG)										
SAL Reference					379084 020	379084 024	379084 025	379084 028	379084 049	
Customer Sample Reference					WS5 0.30	WS5 2.60	WS6 0.30	WS6 2.20	CP2 0.50	
Date Sampled					19-FEB-2014	19-FEB-2014	19-FEB-2014	19-FEB-2014	19-FEB-2014	
Determinand	Method	Test Sample	LOD	Units						
Benzene	T54	AR	0.001	mg/kg	(13) <0.001	(13) <0.001	(13) <0.001	(13) <0.001	(13) 0.007	
Toluene	T54	AR	0.001	mg/kg	0.003	<0.001	0.002	<0.001	0.011	
EthylBenzene	T54	AR	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	0.028	
M/P Xylene	T54	AR	0.001	mg/kg	<0.001	<0.001	0.003	<0.001	0.033	
O Xylene	T54	AR	0.001	mg/kg	<0.001	<0.001	0.003	<0.001	0.018	
Methyl tert-Butyl Ether	T54	AR	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	<0.010	<0.010	<0.010	0.010	0.037	
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	<0.010	<0.010	0.91	0.014	1.5	
TPH (C10-C12 aliphatic)	T8	AR	1	mg/kg	3	<1	11	<1	17	
TPH (C12-C16 aliphatic)	T8	AR	1	mg/kg	11	1	66	<1	56	
TPH (C16-C21 aliphatic)	T8	AR	1	mg/kg	15	2	71	<1	55	
TPH (C21-C35 aliphatic)	T8	AR	1	mg/kg	13	<1	31	<1	64	
TPH (Aliphatic) total	T85	AR		mg/kg	42	3.0	180	0.02	190	
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	0.011	
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	<0.010	<0.010	0.039	<0.010	0.35	
TPH (C10-C12 aromatic)	T8	AR	1	mg/kg	3	<1	6	<1	12	
TPH (C12-C16 aromatic)	T8	AR	1	mg/kg	13	<1	38	<1	57	
TPH (C16-C21 aromatic)	T8	AR	1	mg/kg	24	<1	36	<1	140	
TPH (C21-C35 aromatic)	T8	AR	1	mg/kg	81	<1	130	<1	210	
TPH (Aromatic) total	T85	AR		mg/kg	120	N.D.	210	N.D.	420	
TPH (Aliphatic+Aromatic) (sum)	T85	AR		mg/kg	160	3.0	390	0.02	610	

SAL Reference: 379084	
Customer Reference: 45418	
Soil	Analysed as Soil
Volatile Organic Compounds (USEPA 624)	

SAL Reference	379084 015	379084 059	379084 061
Customer Sample Reference	WS4 0.30	CP3 0.50	CP3 3.50
Date Sampled	19-FEB-2014	20-FEB-2014	20-FEB-2014

Determinand	Method	Test Sample	LOD	Units			
1,1,1,2-Tetrachloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,1,1-Trichloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,1,2,2-Tetrachloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,1,2-Trichloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,1,2-Trichloroethylene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,1-Dichloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,1-Dichloroethylene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,1-Dichloropropene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,2,3-Trichloropropane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,2,4-Trimethylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	0.18
1,2-dibromoethane	T54	AR	0.005	mg/kg	<0.005	<0.005	0.048
1,2-Dichlorobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,2-Dichloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,2-Dichloropropane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,3,5-Trimethylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	0.079
1,3-Dichlorobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,3-Dichloropropane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
1,4-Dichlorobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
2,2-Dichloropropane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
2-Chlorotoluene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
4-Chlorotoluene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Benzene	T54	AR	0.001	mg/kg	⁽¹³⁾ <0.001	⁽¹³⁾ <0.001	⁽¹³⁾ <0.001
Bromobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Bromochloromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Bromodichloromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Bromoform	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Bromomethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Carbon tetrachloride	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Chlorobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Chlorodibromomethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Chloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Chloroform	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Chloromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Cis-1,2-Dichloroethylene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Cis-1,3-Dichloropropene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Dibromomethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Dichlorodifluoromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Dichloromethane	T54	AR	0.050	mg/kg	<0.050	0.10	<0.050
EthylBenzene	T54	AR	0.001	mg/kg	<0.001	<0.001	0.040
Isopropyl benzene	T54	AR	0.005	mg/kg	<0.005	<0.005	0.015
M/P Xylene	T54	AR	0.001	mg/kg	<0.001	<0.001	0.10
n-Propylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	0.006
O Xylene	T54	AR	0.001	mg/kg	<0.001	<0.001	0.028
p-Isopropyltoluene	T54	AR	0.005	mg/kg	<0.005	<0.005	0.010
S-Butylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Styrene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
T-Butylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Tetrachloroethene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005
Toluene	T54	AR	0.001	mg/kg	0.004	<0.001	<

SAL Reference: 379084	
Customer Reference: 45418	
Soil	Analysed as Soil
Semi-Volatile Organic Compounds (USEPA 625)	

Soil	Analysed as Soil
Semi-Volatile Organic Compounds (USEPA 625)	

SAL Reference					379084 015	379084 059	379084 061
Customer Sample Reference					WS4 0.30	CP3 0.50	CP3 3.50
Date Sampled					19-FEB-2014	20-FEB-2014	20-FEB-2014
Determinand	Method	Test Sample	LOD	Units			
1,2,4-Trichlorobenzene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
1,2-Dichlorobenzene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
1,3-Dichlorobenzene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
1,4-Dichlorobenzene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2,4,5-Trichlorophenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2,4,6-Trichlorophenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2,4-Dichlorophenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2,4-Dimethylphenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2,4-Dinitrophenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2,4-Dinitrotoluene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2,6-Dinitrotoluene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2-Chloronaphthalene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2-Chlorophenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2-methyl phenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2-Methylnaphthalene	T16	AR	0.1	mg/kg	1.2	<0.1	3.9
2-Nitroaniline	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
2-Nitrophenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
3-Nitroaniline	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
3/4-Methylphenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
4-Bromophenyl phenylether	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
4-Chloro-3-methylphenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
4-Chloroaniline	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
4-Chlorophenyl phenylether	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
4-Nitroaniline	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
4-Nitrophenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Acenaphthene	T16	AR	0.1	mg/kg	4.4	0.3	2.9
Acenaphthylene	T16	AR	0.1	mg/kg	0.4	<0.1	<0.1
Anthracene	T16	AR	0.1	mg/kg	11	1.3	2.3
Azobenzene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	46	2.8	1.2
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	32	2.2	0.3
Benzo(b/k)Fluoranthene	T16	AR	0.1	mg/kg	60	5.1	0.7
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	16	0.9	0.1
Bis (2-chloroethoxy) methane	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Bis (2-chloroethyl) ether	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Bis (2-chloroisopropyl) ether	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Bis (2-ethylhexyl)phthalate	T16	AR	0.1	mg/kg	0.1	<0.1	0.7
Butyl benzylphthalate	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Carbazole	T16	AR	0.1	mg/kg	<0.1	0.3	<0.1
Chrysene	T16	AR	0.1	mg/kg	44	3.3	1.2
Di-n-butylphthalate	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Di-n-octylphthalate	T16	AR	0.1	mg/kg	0.1	<0.1	<0.1
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	9.1	0.6	<0.1
Dibenzofuran	T16	AR	0.1	mg/kg	2.8	0.1	2.4
Diethyl phthalate	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Dimethyl phthalate	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Fluoranthene	T16	AR	0.1	mg/kg	53	8.1	5.4
Fluorene	T16	AR	0.1	mg/kg	4.1	0.4	3.7
Hexachlorobenzene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Hexachlorobutadiene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Hexachlorocyclopentadiene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Hexachloroethane	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	16	0.9	0.1
Isophorone	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Naphthalene	T16	AR	0.1	mg/kg	3.8	0.3	8.9
Nitrobenzene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Pentachlorophenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Phenanthrene	T16	AR	0.1	mg/kg	37	2.5	9.8
Phenol	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Pvrene	T16	AR	0.1	mg/kg	49	6.8	4.0

SAL Reference: 379084 Customer Reference: 45418 Soil Analysed as Soil Miscellaneous									
SAL Reference					379084 001	379084 012	379084 019	379084 020	379084 025
Customer Sample Reference					WS1 0.30	WS3 0.30	WS4 3.40	WS5 0.30	WS6 0.30
Date Sampled					19-FEB-2014	19-FEB-2014	19-FEB-2014	19-FEB-2014	19-FEB-2014
Determinand	Method	Test Sample	LOD	Units					
Asbestos ID	T27	AR			N.D.	N.D.	-	N.D.	N.D.
Total Organic Carbon	T21	AR	0.1	%	-	-	0.5	-	16

SAL Reference: 379084 Customer Reference: 45418 Soil Analysed as Soil Miscellaneous									
SAL Reference					379084 028	379084 029	379084 033	379084 036	379084 049
Customer Sample Reference					WS6 2.20	WS7 0.20	WS8 0.20	WS10 0.40	CP2 0.50
Date Sampled					19-FEB-2014	20-FEB-2014	20-FEB-2014	20-FEB-2014	19-FEB-2014
Determinand	Method	Test Sample	LOD	Units					
Asbestos ID	T27	AR			-	N.D.	N.D.	N.D.	N.D.
Total Organic Carbon	T21	AR	0.1	%	0.3	-	-	-	17

SAL Reference: 379084 Customer Reference: 45418 Soil Analysed as Soil Miscellaneous									
SAL Reference					379084 052	379084 058	379084 059	379084 061	379084 065
Customer Sample Reference					CP2 3.50	CP2 10.50	CP3 0.50	CP3 3.50	CP3 9.00
Date Sampled					19-FEB-2014	19-FEB-2014	20-FEB-2014	20-FEB-2014	20-FEB-2014
Determinand	Method	Test Sample	LOD	Units					
Total Organic Carbon	T21	AR	0.1	%	0.2	-	6.3	0.2	-
Total Petroleum Hydrocarbons	T8	AR	1	mg/kg	-	3	-	-	29

Index to symbols used in 379084-1

Value	Description
AR	As Received
N.D.	Not Detected
9	LOD raised due to dilution of sample
13	Results have been blank corrected.
S	Analysis was subcontracted
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T21	OX/IR
T16	GC/MS
T4	Colorimetry
T7	Probe
T6	ICP/OES
T8	GC/FID
T54	GC/MS (Headspace)
T27	PLM
T149	GC/MS (SIR)
T85	Calc

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Asbestos ID	T27	AR			SU	001,012,020,025,029,033,036,049
Total Organic Carbon	T21	AR	0.1	%	N	019,025,028,049,052,059,061
Total Petroleum Hydrocarbons	T8	AR	1	mg/kg	U	058,065
Arsenic	T6	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Cadmium	T6	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Chromium	T6	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Lead	T6	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Mercury	T6	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Selenium	T6	AR	3	mg/kg	U	001,015,020,025,029,033,036,049,059
Copper	T6	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Nickel	T6	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Zinc	T6	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
pH	T7	AR			U	001,015,020,025,029,033,036,049,059
SO4(Total)	T6	AR	0.01	%	N	001,015,020,025,029,033,036,049,059
SO4(2:1)	T6	AR	0.1	g/l	N	001,015,020,025,029,033,036,049,059
Cyanide(Total)	T4	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Phenols(Mono)	T4	AR	1	mg/kg	U	001,015,020,025,029,033,036,049,059
Chromium VI	T6	AR	1	mg/kg	N	001,015,020,025,029,033,036,049,059
TPH (C5-C6)	T54	AR	0.10	mg/kg	N	001,029,033,036,057,064
TPH (C6-C8)	T54	AR	0.10	mg/kg	N	001,029,033,036,057,064
TPH (C8-C10)	T54	AR	0.10	mg/kg	N	001,029,033,036,057,064
TPH (C10-C12)	T8	AR	1	mg/kg	U	001,029,033,036,057,064
TPH (C12-C16)	T8	AR	1	mg/kg	U	001,029,033,036,057,064
TPH (C16-C21)	T8	AR	1	mg/kg	U	001,029,033,036,057,064
TPH (C21-C35)	T8	AR	1	mg/kg	U	001,029,033,036,057,064
Methyl tert-Butyl Ether	T54	AR	0.001	mg/kg	U	020,024-025,028,049
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C10-C12 aliphatic)	T8	AR	1	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C12-C16 aliphatic)	T8	AR	1	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C16-C21 aliphatic)	T8	AR	1	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C21-C35 aliphatic)	T8	AR	1	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (Aliphatic) total	T85	AR		mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C10-C12 aromatic)	T8	AR	1	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C12-C16 aromatic)	T8	AR	1	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C16-C21 aromatic)	T8	AR	1	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (C21-C35 aromatic)	T8	AR	1	mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (Aromatic) total	T85	AR		mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
TPH (Aliphatic+Aromatic) (sum)	T85	AR		mg/kg	N	015,019-020,024-025,028,049,052,054,059,061-062
1,2,4-Trichlorobenzene	T16	AR	0.1	mg/kg	U	015,059,061
1,2-Dichlorobenzene	T16	AR	0.1	mg/kg	U	015,059,061
1,3-Dichlorobenzene	T16	AR	0.1	mg/kg	U	015,059,061
1,4-Dichlorobenzene	T16	AR	0.1	mg/kg	U	015,059,061
2,4,5-Trichlorophenol	T16	AR	0.1	mg/kg	U	015,059,061
2,4,6-Trichlorophenol	T16	AR	0.1	mg/kg	U	015,059,061
2,4-Dichlorophenol	T16	AR	0.1	mg/kg	U	015,059,061
2,4-Dimethylphenol	T16	AR	0.1	mg/kg	U	015,059,061
2,4-Dinitrophenol	T16	AR	0.1	mg/kg	U	015,059,061
2,4-Dinitrotoluene	T16	AR	0.1	mg/kg	U	015,059,061
2,6-Dinitrotoluene	T16	AR	0.1	mg/kg	U	015,059,061
2-Chloronaphthalene	T16	AR	0.1	mg/kg	U	015,059,061
2-Chlorophenol	T16	AR	0.1	mg/kg	U	015,059,061
2-methyl phenol	T16	AR	0.1	mg/kg	U	015,059,061
2-Methylnaphthalene	T16	AR	0.1	mg/kg	U	015,059,061
2-Nitroaniline	T16	AR	0.1	mg/kg	U	015,059,061
2-Nitrophenol	T16	AR	0.1	mg/kg	U	015,059,061
3-Nitroaniline	T16	AR	0.1	mg/kg	U	015,059,061
3/4-Methylphenol	T16	AR	0.1	mg/kg	U	015,059,061
4-Bromophenyl phenylether	T16	AR	0.1	mg/kg	U	015,059,061
4-Chloro-3-methylphenol	T16	AR	0.1	mg/kg	U	015,059,061
4-Chloroaniline	T16	AR	0.1	mg/kg	U	015,059,061
4-Chlorophenyl phenylether	T16	AR	0.1	mg/kg	U	015,059,061
4-Nitroaniline	T16	AR	0.1	mg/kg	U	015,059,061

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
4-Nitrophenol	T16	AR	0.1	mg/kg	U	015,059,061
Acenaphthene	T16	AR	0.1	mg/kg	U	015,059,061
Acenaphthylene	T16	AR	0.1	mg/kg	U	015,059,061
Anthracene	T16	AR	0.1	mg/kg	U	015,059,061
Azobenzene	T16	AR	0.1	mg/kg	U	015,059,061
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	U	015,059,061
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	U	015,059,061
Benzo(b/k)Fluoranthene	T16	AR	0.1	mg/kg	U	015,059,061
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	U	015,059,061
Bis (2-chloroethoxy) methane	T16	AR	0.1	mg/kg	U	015,059,061
Bis (2-chloroethyl) ether	T16	AR	0.1	mg/kg	U	015,059,061
Bis (2-chloroisopropyl) ether	T16	AR	0.1	mg/kg	U	015,059,061
Bis (2-ethylhexyl)phthalate	T16	AR	0.1	mg/kg	U	015,059,061
Butyl benzylphthalate	T16	AR	0.1	mg/kg	U	015,059,061
Carbazole	T16	AR	0.1	mg/kg	U	015,059,061
Chrysene	T16	AR	0.1	mg/kg	U	015,059,061
Di-n-butylphthalate	T16	AR	0.1	mg/kg	U	015,059,061
Di-n-octylphthalate	T16	AR	0.1	mg/kg	U	015,059,061
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	U	015,059,061
Dibenzofuran	T16	AR	0.1	mg/kg	U	015,059,061
Diethyl phthalate	T16	AR	0.1	mg/kg	U	015,059,061
Dimethyl phthalate	T16	AR	0.1	mg/kg	U	015,059,061
Fluoranthene	T16	AR	0.1	mg/kg	U	015,059,061
Fluorene	T16	AR	0.1	mg/kg	U	015,059,061
Hexachlorobenzene	T16	AR	0.1	mg/kg	U	015,059,061
Hexachlorobutadiene	T16	AR	0.1	mg/kg	U	015,059,061
Hexachlorocyclopentadiene	T16	AR	0.1	mg/kg	U	015,059,061
Hexachloroethane	T16	AR	0.1	mg/kg	U	015,059,061
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	U	015,059,061
Isophorone	T16	AR	0.1	mg/kg	U	015,059,061
Naphthalene	T16	AR	0.1	mg/kg	U	015,059,061
Nitrobenzene	T16	AR	0.1	mg/kg	U	015,059,061
Pentachlorophenol	T16	AR	0.1	mg/kg	U	015,059,061
Phenanthrene	T16	AR	0.1	mg/kg	U	015,059,061
Phenol	T16	AR	0.1	mg/kg	U	015,059,061
Pyrene	T16	AR	0.1	mg/kg	U	015,059,061
Naphthalene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Acenaphthylene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Acenaphthene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Fluorene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Phenanthrene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Anthracene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Fluoranthene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Pyrene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Chrysene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Benzo(b/k)Fluoranthene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
PAH(total)	T149	AR	0.01	mg/kg	U	001,020,024-025,028,034,036,049
1,1,1,2-Tetrachloroethane	T54	AR	0.005	mg/kg	U	015,059,061
1,1,1-Trichloroethane	T54	AR	0.005	mg/kg	U	015,059,061
1,1,2,2-Tetrachloroethane	T54	AR	0.005	mg/kg	U	015,059,061
1,1,2-Trichloroethane	T54	AR	0.005	mg/kg	U	015,059,061
1,1,2-Trichloroethylene	T54	AR	0.005	mg/kg	U	015,059,061
1,1-Dichloroethane	T54	AR	0.005	mg/kg	U	015,059,061
1,1-Dichloroethylene	T54	AR	0.005	mg/kg	U	015,059,061
1,1-Dichloropropene	T54	AR	0.005	mg/kg	U	015,059,061
1,2,3-Trichloropropane	T54	AR	0.005	mg/kg	U	015,059,061
1,2,4-Trimethylbenzene	T54	AR	0.005	mg/kg	U	015,059,061
1,2-dibromoethane	T54	AR	0.005	mg/kg	U	015,059,061
1,2-Dichlorobenzene	T54	AR	0.005	mg/kg	U	015,059,061
1,2-Dichloroethane	T54	AR	0.005	mg/kg	U	015,059,061
1,2-Dichloropropane	T54	AR	0.005	mg/kg	U	015,059,061
1,3,5-Trimethylbenzene	T54	AR	0.005	mg/kg	U	015,059,061
1,3-Dichlorobenzene	T54	AR	0.005	mg/kg	U	015,059,061
1,3-Dichloropropane	T54	AR	0.005	mg/kg	U	015,059,061
1,4-Dichlorobenzene	T54	AR	0.005	mg/kg	U	015,059,061

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
2,2-Dichloropropane	T54	AR	0.005	mg/kg	U	015,059,061
2-Chlorotoluene	T54	AR	0.005	mg/kg	U	015,059,061
4-Chlorotoluene	T54	AR	0.005	mg/kg	U	015,059,061
Benzene	T54	AR	0.001	mg/kg	U	015,020,024-025,028,049,059,061
Bromobenzene	T54	AR	0.005	mg/kg	U	015,059,061
Bromochloromethane	T54	AR	0.005	mg/kg	U	015,059,061
Bromodichloromethane	T54	AR	0.005	mg/kg	U	015,059,061
Bromoform	T54	AR	0.005	mg/kg	U	015,059,061
Bromomethane	T54	AR	0.005	mg/kg	U	015,059,061
Carbon tetrachloride	T54	AR	0.005	mg/kg	U	015,059,061
Chlorobenzene	T54	AR	0.005	mg/kg	U	015,059,061
Chlorodibromomethane	T54	AR	0.005	mg/kg	U	015,059,061
Chloroethane	T54	AR	0.005	mg/kg	U	015,059,061
Chloroform	T54	AR	0.005	mg/kg	U	015,059,061
Chloromethane	T54	AR	0.005	mg/kg	U	015,059,061
Cis-1,2-Dichloroethylene	T54	AR	0.005	mg/kg	U	015,059,061
Cis-1,3-Dichloropropene	T54	AR	0.005	mg/kg	U	015,059,061
Dibromomethane	T54	AR	0.005	mg/kg	U	015,059,061
Dichlorodifluoromethane	T54	AR	0.005	mg/kg	U	015,059,061
Dichloromethane	T54	AR	0.050	mg/kg	N	015,059,061
EthylBenzene	T54	AR	0.001	mg/kg	U	015,020,024-025,028,049,059,061
Isopropyl benzene	T54	AR	0.005	mg/kg	U	015,059,061
M/P Xylene	T54	AR	0.001	mg/kg	U	015,020,024-025,028,049,059,061
n-Propylbenzene	T54	AR	0.005	mg/kg	U	015,059,061
O Xylene	T54	AR	0.001	mg/kg	U	015,020,024-025,028,049,059,061
p-Isopropyltoluene	T54	AR	0.005	mg/kg	U	015,059,061
S-Butylbenzene	T54	AR	0.005	mg/kg	U	015,059,061
Styrene	T54	AR	0.005	mg/kg	U	015,059,061
T-Butylbenzene	T54	AR	0.005	mg/kg	U	015,059,061
Tetrachloroethene	T54	AR	0.005	mg/kg	U	015,059,061
Toluene	T54	AR	0.001	mg/kg	U	015,020,024-025,028,049,059,061
Trans-1,2-Dichloroethene	T54	AR	0.005	mg/kg	U	015,059,061
Trans-1,3-Dichloropropene	T54	AR	0.005	mg/kg	U	015,059,061
Trichlorofluoromethane	T54	AR	0.005	mg/kg	U	015,059,061
Vinyl chloride	T54	AR	0.005	mg/kg	U	015,059,061





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Scientific Analysis Laboratories Ltd

Certificate of Analysis

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Report Number: 381795-1

Date of Report: 18-Mar-2014

Customer: Resource Environmental Consultants Ltd
Osprey House
Pacific Quay
Broadway
Salford
M50 2UE

Customer Contact: Miss Sabine Sargeant

Customer Job Reference: 45418

Customer Site Reference: Whitehaven

Date Job Received at SAL: 10-Mar-2014

Date Analysis Started: 12-Mar-2014

Date Analysis Completed: 18-Mar-2014

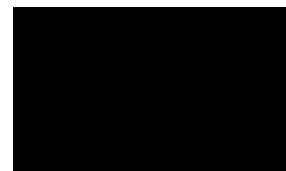
The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22



1549

Report checked
and authorised by :
Annie Hennis
Project Manager

Issued by :
Annie Hennis
Project Manager



REC TPH (CWG)

SAL Reference					381795 001	381795 002	381795 003
Customer Sample Reference					CP 102	CP 103	WS 104
Date Sampled					07-MAR-2014	07-MAR-2014	07-MAR-2014
Determinand	Method	Test Sample	LOD	Units			
Benzene	T54	AR	1	µg/l	(13) <1	(13) <1	(13) <1
Toluene	T54	AR	1	µg/l	<1	7	<1
EthylBenzene	T54	AR	1	µg/l	<1	17	<1
M/P Xylene	T54	AR	1	µg/l	<1	210	<1
O Xylene	T54	AR	1	µg/l	<1	76	<1
Methyl tert-Butyl Ether	T54	AR	1	µg/l	<1	<1	2
TPH (C5-C6 aliphatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C6-C8 aliphatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C8-C10 aliphatic)	T215	AR	10	µg/l	<10	<10	<10
TPH DW(C10-C12 aliphatic)	T81	AR	10	µg/l	(100) <20	(100) <20	24
TPH DW(C12-C16 aliphatic)	T81	AR	10	µg/l	(100) <20	(100) <20	86
TPH DW(C16-C21 aliphatic)	T81	AR	10	µg/l	(100) <20	(100) <20	27
TPH DW(C21-C35 aliphatic)	T81	AR	10	µg/l	54	(100) <20	40
TPH (Aliphatic) total	T85	AR		µg/l	50	(100) <20	180
TPH (C6-C7 aromatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C7-C8 aromatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C8-C10 aromatic)	T215	AR	10	µg/l	<10	570	<10
TPH DW(C10-C12 aromatic)	T81	AR	10	µg/l	140	(100) <20	210
TPH DW(C12-C16 aromatic)	T81	AR	10	µg/l	210	(100) <20	340
TPH DW(C16-C21 aromatic)	T81	AR	10	µg/l	96	(100) <20	170
TPH DW(C21-C35 aromatic)	T81	AR	10	µg/l	(100) <20	<20	(100) <20
TPH (Aromatic) total	T85	AR		µg/l	450	(100) <20	720
TPH (Aliphatic+Aromatic) (sum)	T85	AR		µg/l	500	(100) <20	900

Customer Reference: 45418

Analysed as Water

Volatile Organic Compounds (USEPA 624)

SAL Reference: 381795 Project Site: Whitehaven Customer Reference: 45418							
Water		Analysed as Water					
Miscellaneous							
SAL Reference					381795 001	381795 002	381795 003
Customer Sample Reference					CP 102	CP 103	WS 104
Date Sampled					07-MAR-2014	07-MAR-2014	07-MAR-2014
Determinand	Method	Test Sample	LOD	Units			
Total Organic Carbon	T21	AR	1000	ug/l	5400	26000	31000

Index to symbols used in 381795-1

Value	Description
AR	As Received
100	LOD determined by sample aliquot used for analysis
13	Results have been blank corrected.
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T7	Probe
T85	Calc
T686	Discrete Analyser
T21	OX/IR
T281	ICP/MS (Filtered)
T215	GC/MS (Headspace)(LV)
T4	Colorimetry
T81	GC/FID (LV)
T149	GC/MS (SIR)
T54	GC/MS (Headspace)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Total Organic Carbon	T21	AR	1000	µg/l	U	001-003
As (Dissolved)	T281	AR	0.2	µg/l	U	001-003
Cd (Dissolved)	T281	AR	0.02	µg/l	U	001-003
Cr (Dissolved)	T281	AR	1	µg/l	U	001-003
Pb (Dissolved)	T281	AR	0.3	µg/l	U	001-003
Hg (Dissolved)	T281	AR	0.05	µg/l	U	001-003
Se (Dissolved)	T281	AR	0.5	µg/l	U	001-003
Cu (Dissolved)	T281	AR	0.5	µg/l	U	001-003
Ni (Dissolved)	T281	AR	1	µg/l	U	001-003
Zn (Dissolved)	T281	AR	2	µg/l	U	001-003
pH	T7	AR			U	001-003
Cyanide(Total)	T4	AR	50	µg/l	U	001-003
Phenols(Mono)	T4	AR	100	µg/l	U	001-003
Chromium VI	T686	AR	3	µg/l	U	001-003
Sulphate	T686	AR	500	µg/l	U	001-003
Toluene	T54	AR	1	µg/l	U	001-003
Methyl tert-Butyl Ether	T54	AR	1	µg/l	U	001-003
TPH (C5-C6 aliphatic)	T215	AR	10	µg/l	N	001-003
TPH (C6-C8 aliphatic)	T215	AR	10	µg/l	N	001-003
TPH (C8-C10 aliphatic)	T215	AR	10	µg/l	N	001-003
TPH DW(C10-C12 aliphatic)	T81	AR	10	µg/l	N	001-003
TPH DW(C12-C16 aliphatic)	T81	AR	10	µg/l	N	001-003
TPH DW(C16-C21 aliphatic)	T81	AR	10	µg/l	N	001-003
TPH DW(C21-C35 aliphatic)	T81	AR	10	µg/l	N	001-003
TPH (Aliphatic) total	T85	AR		µg/l	N	001-003
TPH (C6-C7 aromatic)	T215	AR	10	µg/l	N	001-003
TPH (C7-C8 aromatic)	T215	AR	10	µg/l	N	001-003
TPH (C8-C10 aromatic)	T215	AR	10	µg/l	N	001-003

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
TPH DW(C10-C12 aromatic)	T81	AR	10	µg/l	N	001-003
TPH DW(C12-C16 aromatic)	T81	AR	10	µg/l	N	001-003
TPH DW(C16-C21 aromatic)	T81	AR	10	µg/l	N	001-003
TPH DW(C21-C35 aromatic)	T81	AR	10	µg/l	N	001-003
TPH (Aromatic) total	T85	AR		µg/l	N	001-003
TPH (Aliphatic+Aromatic) (sum)	T85	AR		µg/l	N	001-003
Naphthalene	T149	AR	0.01	µg/l	U	001-003
Acenaphthylene	T149	AR	0.01	µg/l	U	001-003
Acenaphthene	T149	AR	0.01	µg/l	U	001-003
Fluorene	T149	AR	0.01	µg/l	U	001-003
Phenanthrene	T149	AR	0.01	µg/l	U	001-003
Anthracene	T149	AR	0.01	µg/l	U	001-003
Fluoranthene	T149	AR	0.01	µg/l	U	001-003
Pyrene	T149	AR	0.01	µg/l	U	001-003
Benzo(a)Anthracene	T149	AR	0.01	µg/l	U	001-003
Chrysene	T149	AR	0.01	µg/l	U	001-003
Benzo(b/k)Fluoranthene	T149	AR	0.01	µg/l	U	001-003
Benzo(a)Pyrene	T149	AR	0.01	µg/l	U	001-003
Indeno(123-cd)Pyrene	T149	AR	0.01	µg/l	U	001-003
Dibenzo(ah)Anthracene	T149	AR	0.01	µg/l	U	001-003
Benzo(ghi)Perylene	T149	AR	0.01	µg/l	U	001-003
PAH(total)	T149	AR	0.01	µg/l	U	001-003
1,1,1,2-Tetrachloroethane	T54	AR	1	µg/l	U	001-003
1,1,1-Trichloroethane	T54	AR	1	µg/l	U	001-003
1,1,2,2-Tetrachloroethane	T54	AR	1	µg/l	U	001-003
1,1,2-Trichloroethane	T54	AR	1	µg/l	U	001-003
1,1,2-Trichloroethylene	T54	AR	1	µg/l	U	001-003
1,1-Dichloroethane	T54	AR	1	µg/l	U	001-003
1,1-Dichloroethylene	T54	AR	1	µg/l	U	001-003
1,1-Dichloropropene	T54	AR	1	µg/l	U	001-003
1,2,3-Trichloropropane	T54	AR	1	µg/l	U	001-003
1,2,4-Trimethylbenzene	T54	AR	1	µg/l	U	001-003
1,2-dibromoethane	T54	AR	1	µg/l	U	001-003
1,2-Dichlorobenzene	T54	AR	1	µg/l	U	001-003
1,2-Dichloroethane	T54	AR	1	µg/l	U	001-003
1,2-Dichloropropane	T54	AR	1	µg/l	U	001-003
1,3,5-Trimethylbenzene	T54	AR	1	µg/l	U	001-003
1,3-Dichlorobenzene	T54	AR	1	µg/l	U	001-003
1,3-Dichloropropane	T54	AR	1	µg/l	U	001-003
1,4-Dichlorobenzene	T54	AR	1	µg/l	U	001-003
2,2-Dichloropropane	T54	AR	1	µg/l	U	001-003
2-Chlorotoluene	T54	AR	1	µg/l	U	001-003
4-Chlorotoluene	T54	AR	1	µg/l	U	001-003
Benzene	T54	AR	1	µg/l	U	001-003
Bromobenzene	T54	AR	1	µg/l	U	001-003
Bromochloromethane	T54	AR	1	µg/l	U	001-003
Bromodichloromethane	T54	AR	1	µg/l	U	001-003
Bromoform	T54	AR	1	µg/l	U	001-003
Bromomethane	T54	AR	1	µg/l	U	001-003
Carbon tetrachloride	T54	AR	1	µg/l	U	001-003
Chlorobenzene	T54	AR	1	µg/l	U	001-003
Chlorodibromomethane	T54	AR	1	µg/l	U	001-003
Chloroethane	T54	AR	1	µg/l	U	001-003
Chloroform	T54	AR	1	µg/l	U	001-003
Chloromethane	T54	AR	1	µg/l	U	001-003
Cis-1,2-Dichloroethylene	T54	AR	1	µg/l	U	001-003
Cis-1,3-Dichloropropene	T54	AR	1	µg/l	U	001-003
Dibromomethane	T54	AR	1	µg/l	U	001-003
Dichlorodifluoromethane	T54	AR	1	µg/l	U	001-003
Dichloromethane	T54	AR	50	µg/l	N	001-003
EthylBenzene	T54	AR	1	µg/l	U	001-003
Isopropyl benzene	T54	AR	1	µg/l	U	001-003
M/P Xylene	T54	AR	1	µg/l	U	001-003
n-Propylbenzene	T54	AR	1	µg/l	U	001-003
O Xylene	T54	AR	1	µg/l	U	001-003
p-Isopropyltoluene	T54	AR	1	µg/l	U	001-003
S-Butylbenzene	T54	AR	1	µg/l	U	001-003
Styrene	T54	AR	1	µg/l	U	001-003
T-Butylbenzene	T54	AR	1	µg/l	U	001-003
Tetrachloroethene	T54	AR	1	µg/l	U	001-003

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Trans-1,2-Dichloroethene	T54	AR	1	µg/l	U	001-003
Trans-1,3-Dichloropropene	T54	AR	1	µg/l	U	001-003
Trichlorofluoromethane	T54	AR	1	µg/l	U	001-003
Vinyl chloride	T54	AR	1	µg/l	U	001-003



APPENDIX IX
ORIGIN OF TIER I VALUES

ORIGIN OF REC TIER I VALUES

Constituent	Origin of Risk Assessment Value
Arsenic	2009 SGV
Cadmium	LQM CIEH 2 nd Edition 2009
Chromium	LQM CIEH 2 nd Edition 2009
Lead	Residential Half 2003 EA SGV based on planned target blood lead level reduction to 5µg/l. Commercial Calculated using commercial exposure equation within lead SGV 2003 with revised input data from HPA and taking proposed blood lead levels into account.
Mercury	2009 SGV
Nickel	2009 SGV
Selenium	Soil guideline value, DEFRA/Environment Agency
Copper	LQM CIEH 2 nd Edition 2009
Zinc	LQM CIEH 2 nd Edition 2009
Cyanide - Total	CLEA 1.06 Derived Value
Phenols - Total.	LQM CIEH 2 nd Edition 2009 – 1% SOM
Naphthalene	General Assessment Criteria (GAC) developed by CIEH / LQM the using CLEA 1-06 with supporting data from SR3, SR7 and existing Tox report where applicable. 1% SOM
Acenaphthylene	
Acenaphthene	
Fluorene	
Phenanthrene	
Anthracene	
Fluoranthene	
Pyrene	
Benzo(a)Anthracene ⁽ⁱ⁾	
Chrysene	
Benzo(b/k)Fluoranthene ⁽ⁱⁱⁱ⁾	
Benzo(a)Pyrene	
Indeno(123-cd)Pyrene	
Dibenzo(a,h)Anthracene	
Benzo(ghi)Perylene	
TPH C ₅ -C ₆ (aliphatic)	
TPH C ₆ -C ₈ (aliphatic)	
TPH C ₈ -C ₁₀ (aliphatic)	
TPH C ₁₀ -C ₁₂ (aliphatic)	
TPH C ₁₂ -C ₁₆ (aromatic)	
TPH C ₁₆ -C ₂₁ (aromatic)	
TPH C ₂₁ -C ₃₅ (aromatic)	

APPENDIX X
SPT INTERPRETATION SHEET

Sample Information			Principle Material Type	In-situ Testing						Granular Parameters				Cohesive Parameters		
Exploratory Hole No.	Depth	Strata Classification		SPT 'N' Value	Overburden Correction	Energy Correction	Borehole Diameter Correction	(N ₁) ₆₀	N ₆₀	Angle of Internal Friction	Relative Density	Plasticity Index (from Lab Testing)	Cu / N Ratio (from Chart)	Approximate Consistency	Approx. Shear Strength (C _u /N ₆₀)	Eurocode Soil Strength Term
	(m)			Uncorrected	100 kPa	60%	150mm	Corrected	Corrected	phi°	(N ₁) ₆₀	(%)			kPa	
CP102	11.5		Stiff Sandy Clay	19	0.76	1.00	1.00	14.41	19.00			18.00	5.00	Stiff	72.06	Medium strength
CP103	2		Sandy Silt	2	1.34	0.68	1.00	1.83	1.36			18.00	5.00	Very Soft	9.14	Extremely low strength
CP103	7.5		Slightly Sandy Clay	17	0.90	0.90	1.00	13.79	15.30			18.00	5.00	Stiff	68.96	Medium strength
CP103	9		Slightly Sandy Clay	27	0.84	0.96	1.00	21.78	25.92			18.00	5.00	Very Stiff	108.92	High strength
CP103	10.5		Slightly Sandy Clay	21	0.79	1.00	1.00	16.57	21.00			18.00	5.00	Very Stiff	82.84	High strength
CP103	12		Slightly Sandy Clay	22	0.74	1.00	1.00	16.37	22.00			18.00	5.00	Very Stiff	81.87	High strength
WS101B	1	Slightly	Gravelly Slightly San	3	1.58	0.64	1.00	3.02	1.92			18.00	5.00	Soft	15.12	Very low strength
WS102	1	Slightly	Gravelly Slightly Sar	4	1.58	0.64	1.00	4.03	2.56			18.00	5.00	Firm	20.16	Low strength
WS106B	1		Silty Slightly Gravelly C	1	1.58	0.64	1.00	1.01	0.64			18.00	5.00	Very Soft	5.04	Extremely low strength
WS110	1	Slightly	Gravelly Slightly Sar	4	1.58	0.64	1.00	4.03	2.56			18.00	5.00	Firm	20.16	Low strength
WS107	1		Silty Slightly Gravelly C	2	1.58	0.64	1.00	2.02	1.28			18.00	5.00	Soft	10.08	Very low strength
WS107	2		Silty Slightly Gravelly C	0	1.34	0.68	1.00	0.00	0.00			18.00	5.00	FALSE	0.00	FALSE
WS107	5		Silty Slightly Gravelly C	18	1.04	0.80	1.00	14.93	14.40			18.00	5.00	Stiff	74.67	Medium strength
WS103	1		Silty Slightly Gravelly C	0	1.58	0.64	1.00	0.00	0.00			18.00	5.00	FALSE	0.00	FALSE

APPENDIX XI
GEOTECHNICAL TESTING



LABORATORY REPORT



4043

Contract Number: PSL14/1044

Client's Reference:

Report Date: 24 March 2014

Client Name: REC Resource & Environmental Consultants
Opsrey House
Pacific Quay
Broadway
Manchester
M50 2UE

For the attention of: Grant Harrington

Contract Title: Coach Road

Date Received: 03/03/2014

Date Commenced: 03/03/2014

Date Completed: 24/03/2014

Notes: Observations and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson
(Director)

A Watkins
(Director)

M Beastall
(Laboratory Manager)



D Lambe
(Senior Technician)

S Royle
(Senior Technician)

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Doncaster DN4 0AR
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awatkins@prosoils.co.uk

Page 1 of

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

[illegible]

Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
	24/03/14		24/03/14		24/03/14
COACH ROAD.				Contract No:	PSL14/1044
				Client Ref:	45418

SUMMARY OF SOIL CLASSIFICATION TESTS

(B.S. 1377 : PART 2 : 1990)

[illegible]

Professional Soils Laboratory

Compiled by

Date _____

Checked by

Date _____

Approved by

Date _____

24/03/14

24/03/14

24/03/14

COACH ROAD.

Contract No:

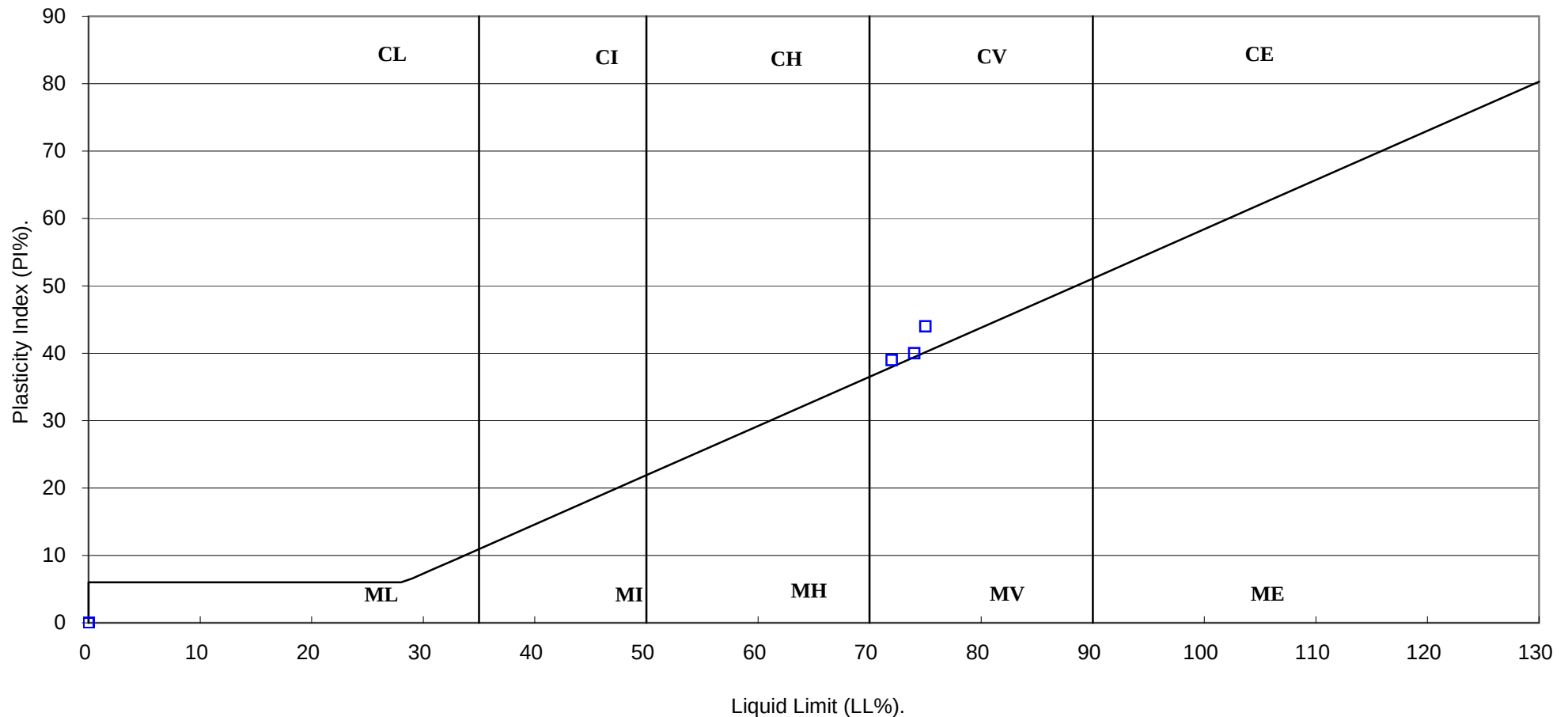
PSL14/1044

Client Ref:

45418

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(B.S.5930 : 1999)



PSL

Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
	24/03/14		24/03/14		24/03/14
COACH ROAD.				Contract No:	PSL14/1044
				Client Ref:	45418

Particle Size Distribution Test

BS1377 : Part 2 : 1990

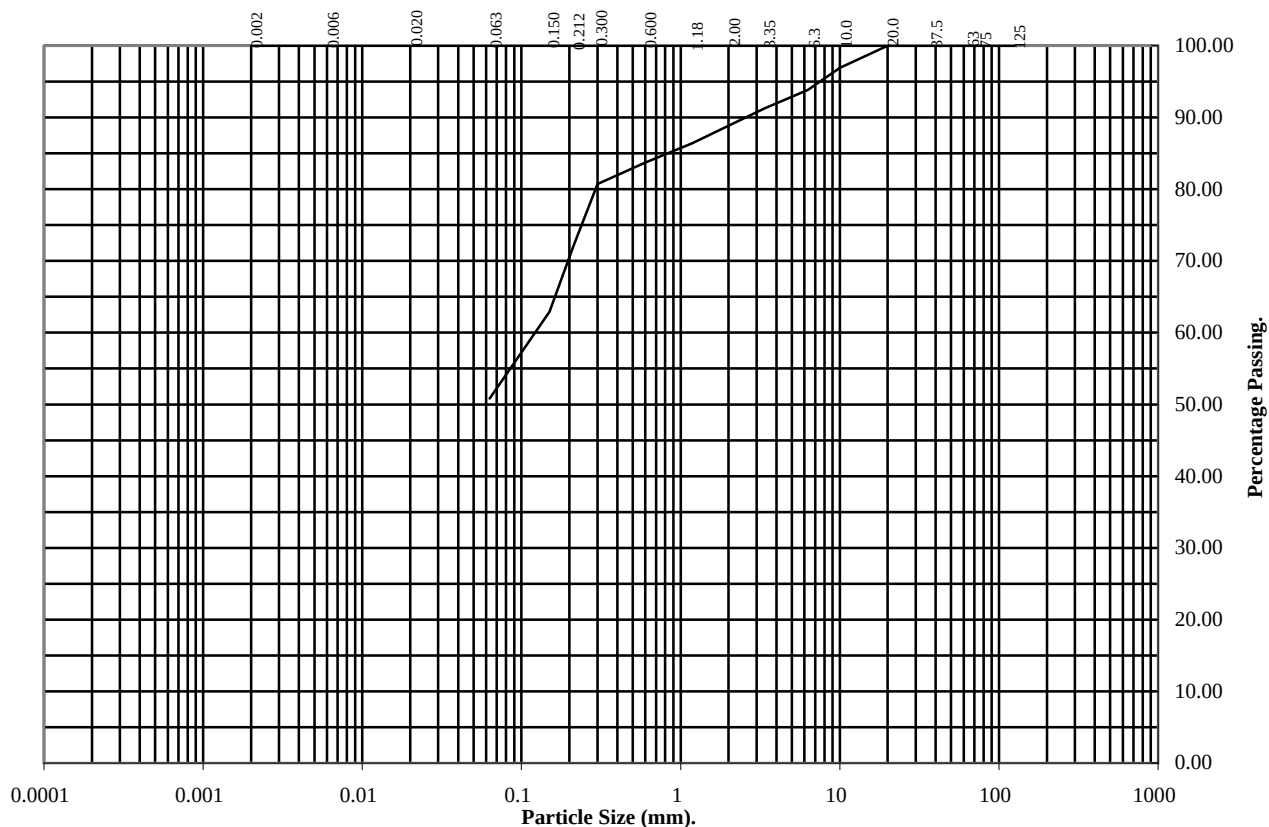
Wet Sieve, Clause 9.2

Hole Number: CP2

Depth (m): 2.00

Sample Number:

Sample Type: B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	97
6.3	94
3.35	91
2	89
1.18	86
0.6	84
0.3	81
0.212	72
0.15	63
0.063	51

Soil Fraction	Total Percentage
Cobbles	0
Gravel	11
Sand	38
Silt / Clay	51

Remarks:

See summary of soil descriptions.

Checked By	Date	Approved By	Date
I [Signature]	24/03/14	[Signature]	24/03/14

PSL

Professional Soils Laboratory

COACH ROAD.

Contract No.:
PSL14/1044

Particle Size Distribution Test

BS1377 : Part 2 : 1990

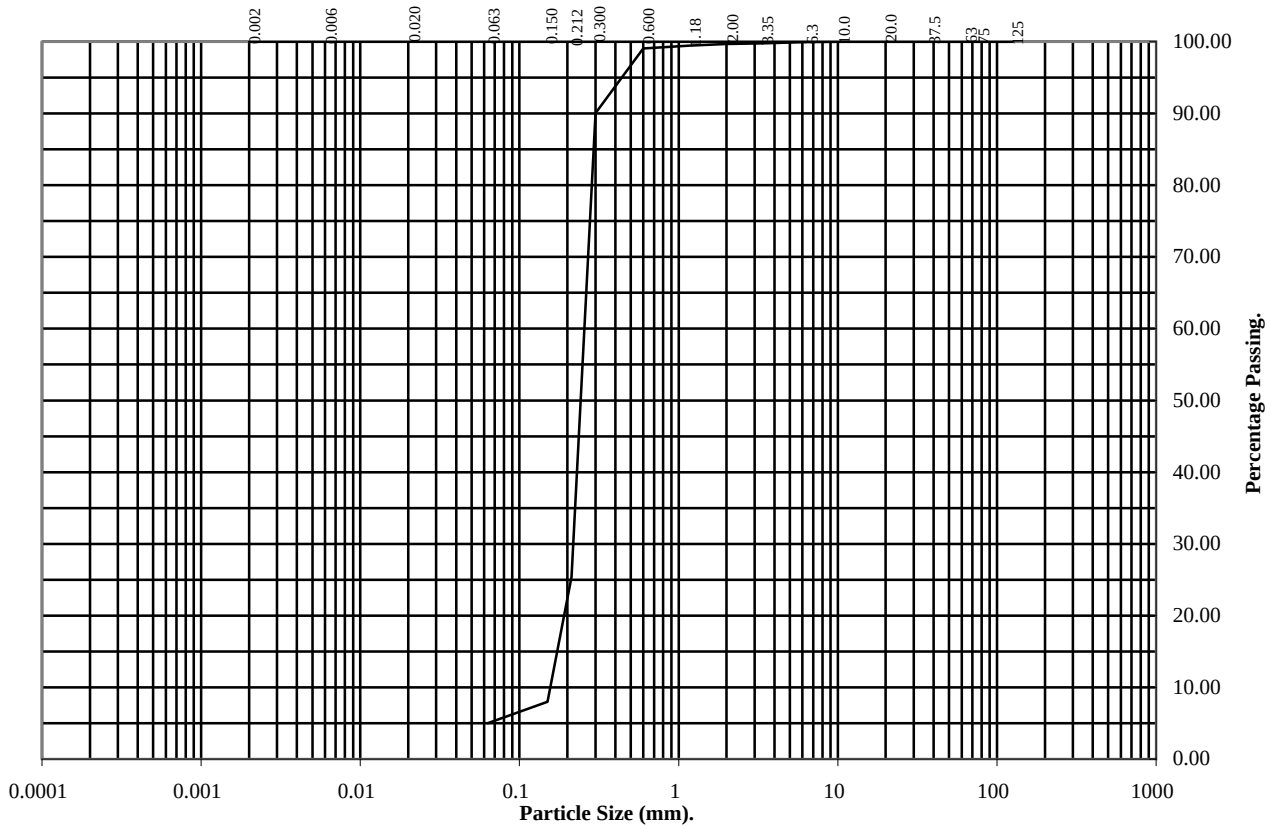
Wet Sieve, Clause 9.2

Hole Number: CP2

Depth (m): 4.50

Sample Number:

Sample Type: B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	100
2	100
1.18	99
0.6	99
0.3	90
0.212	25
0.15	8
0.063	5

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	95
Silt / Clay	5

Remarks:
See summary of soil descriptions.

Ch	Date	Approved By	Date
I	24/03/14	I	24/03/14

Particle Size Distribution Test

BS1377 : Part 2 : 1990

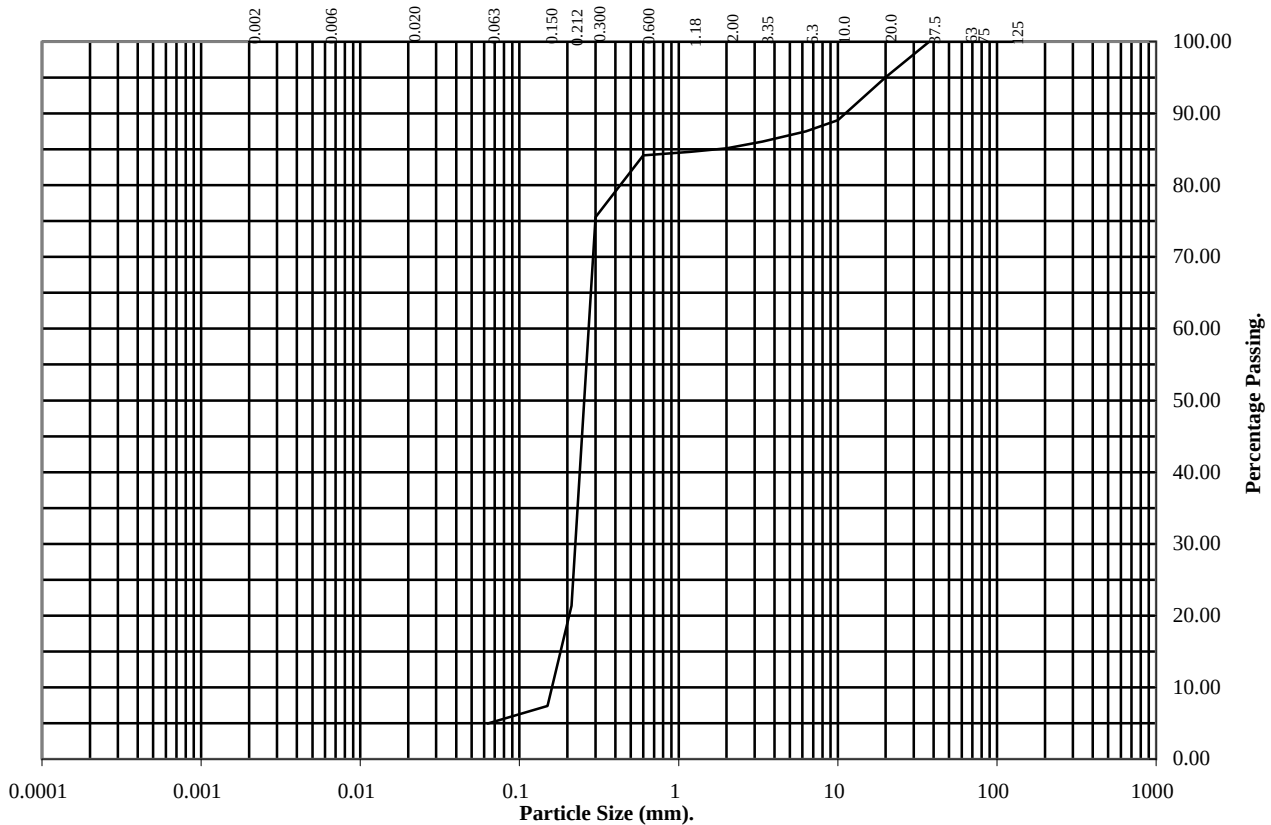
Wet Sieve, Clause 9.2

Hole Number: CP3

Depth (m): 3.50

Sample Number:

Sample Type: B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	95
10	89
6.3	88
3.35	86
2	85
1.18	85
0.6	84
0.3	76
0.212	21
0.15	7
0.063	5

Soil Fraction	Total Percentage
Cobbles	0
Gravel	15
Sand	80
Silt / Clay	5

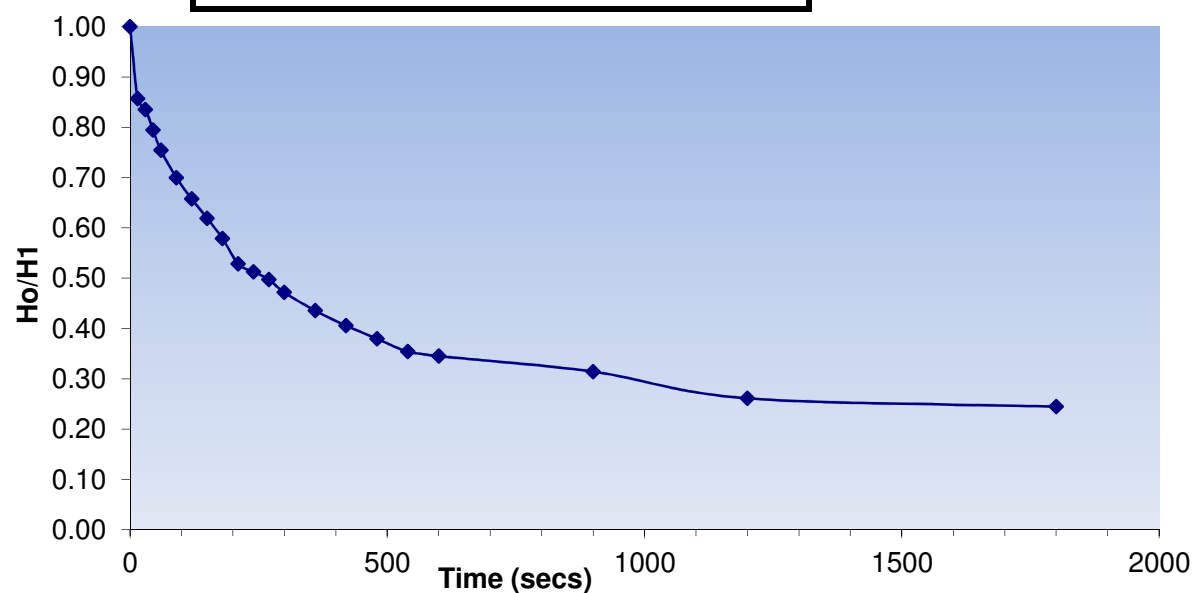
Remarks:
See summary of soil descriptions.

Checked By	Date	Approved By	Date
	24/03/14		24/03/14

Falling Head Test**Borehole: WS106B****Test No: 1 of 1**

Contract No:	45418	Diameter	92 mm
Contract Title:	Coach Road	Top Of Response Zone	1.00 m
Date of Test:	06/11/2013	Base of Response Zone	3.70 m
		Groundwater Level	1.55 m

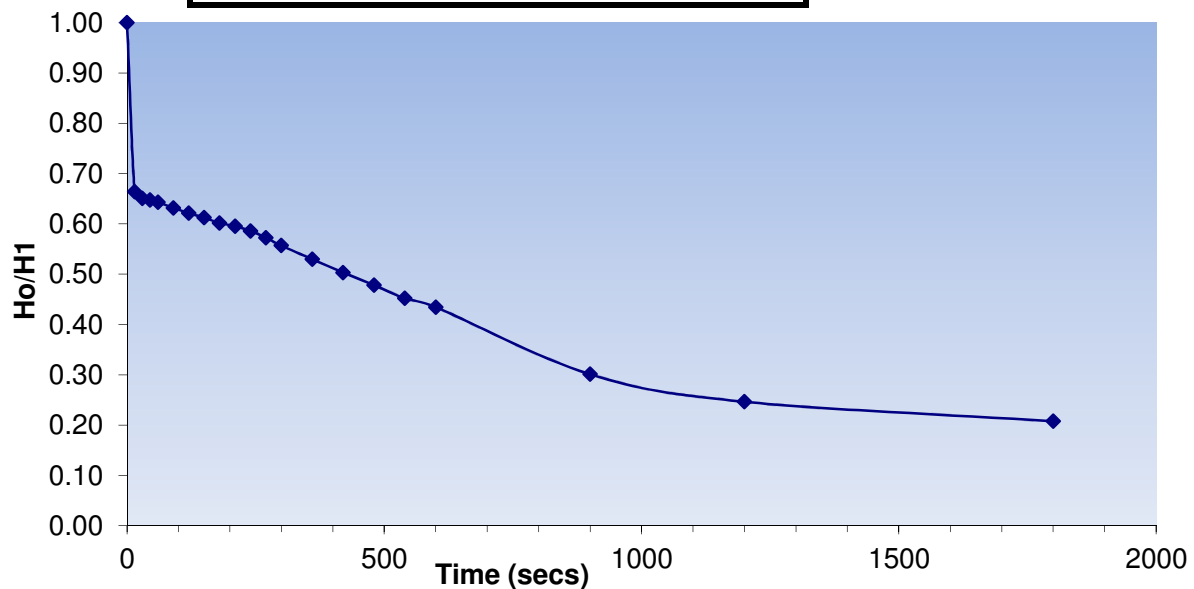
Recorded Time			Total Time (secs)	Depth (m)	H/H ₀	
Hours	Minutes	Seconds				
0	0	0	0	0.00	1.000	
0	0	15	15	0.22	0.857	
0	0	30	30	0.26	0.835	
0	0	45	45	0.32	0.794	
0	1	0	60	0.38	0.754	
0	1	30	90	0.47	0.700	
0	2	0	120	0.53	0.657	
0	2	30	150	0.59	0.619	
0	3	0	180	0.65	0.579	
0	3	30	210	0.73	0.528	
0	4	0	240	0.76	0.513	
0	4	30	270	0.78	0.497	
0	5	0	300	0.82	0.472	
0	6	0	360	0.88	0.435	
0	7	0	420	0.92	0.406	H ₀ = 1.550
0	8	0	480	0.96	0.379	H ₁ = 0.857
0	9	0	540	1.00	0.354	H ₂ = 0.497
0	10	0	600	1.02	0.345	t ₁ = 15
0	15	0	900	1.06	0.314	t ₂ = 270
0	20	0	1200	1.145	0.261	F = 1
0	30	0	1800	1.171	0.245	A = 0.007

Coefficient of Permeability (k) (m/s)**1.02E-05****Key:****k** = Coefficient of Permeability - calculated from the general approach in 25.4.6; Method 1 (BS5930)**F** = Intake Factor - calculated from Equation D, Figure 6 from BS5930**A** = Cross Sectional Area of well pack**H₁** = variable head measured at time t_1 after commencement of test**H₂** = variable head measured at time t_2 after commencement of test

Falling Head Test**Borehole: WS107****Test No: 1 of 1**

Contract No:	45418	Diameter	92 mm
Contract Title:	Coach Road	Top Of Response Zone	1.00 m
Date of Test:	06/11/2013	Base of Response Zone	5.00 m
		Groundwater Level	1.79 m

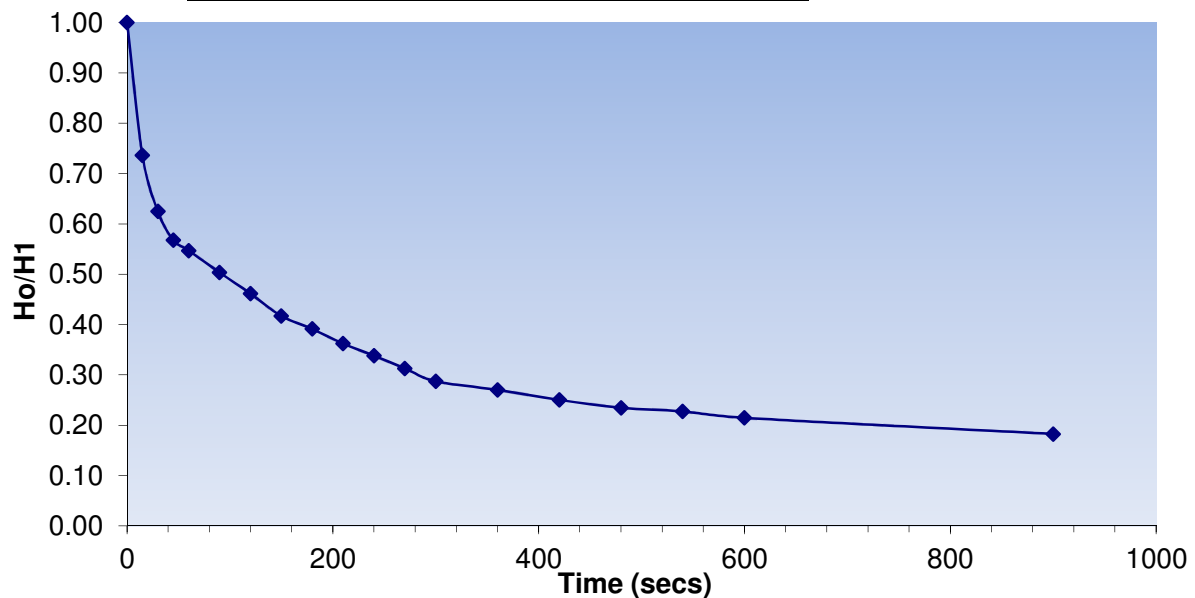
Recorded Time			Total Time (secs)	Depth (m)	H/H ₀	
Hours	Minutes	Seconds				
0	0	0	0	0.00	1.000	
0	0	15	15	0.60	0.664	
0	0	30	30	0.63	0.651	
0	0	45	45	0.63	0.647	
0	1	0	60	0.64	0.643	
0	1	30	90	0.66	0.632	
0	2	0	120	0.68	0.621	
0	2	30	150	0.69	0.612	
0	3	0	180	0.71	0.602	
0	3	30	210	0.72	0.596	
0	4	0	240	0.74	0.586	
0	4	30	270	0.77	0.573	
0	5	0	300	0.79	0.557	
0	6	0	360	0.84	0.530	
0	7	0	420	0.89	0.503	H ₀ = 1.790
0	8	0	480	0.93	0.478	H ₁ = 0.664
0	9	0	540	0.98	0.452	H ₂ = 0.478
0	10	0	600	1.01	0.435	t ₁ = 15
0	15	0	900	1.25	0.301	t ₂ = 480
0	20	0	1200	1.349	0.246	F = 2
0	30	0	1800	1.418	0.208	A = 0.007

Coefficient of Permeability (k) (m/s)**2.69E-06****Key:****k** = Coefficient of Permeability - calculated from the general approach in 25.4.6; Method 1 (BS5930)**F** = Intake Factor - calculated from Equation D, Figure 6 from BS5930**A** = Cross Sectional Area of well pack**H₁** = variable head measured at time t_1 after commencement of test**H₂** = variable head measured at time t_2 after commencement of test

Falling Head Test**Borehole: WS110****Test No: 1 of 1**

Contract No:	45418	Diameter	92 mm
Contract Title:	Coach Road	Top Of Response Zone	1.00 m
Date of Test:	06/11/2013	Base of Response Zone	5.00 m
		Groundwater Level	1.71 m

Recorded Time			Total Time (secs)	Depth (m)	H/H ₀	
Hours	Minutes	Seconds				
0	0	0	0	0.00	1.000	
0	0	15	15	0.45	0.736	
0	0	30	30	0.64	0.625	
0	0	45	45	0.74	0.568	
0	1	0	60	0.78	0.547	
0	1	30	90	0.85	0.504	
0	2	0	120	0.92	0.461	
0	2	30	150	1.00	0.417	
0	3	0	180	1.04	0.391	
0	3	30	210	1.09	0.362	
0	4	0	240	1.13	0.338	
0	4	30	270	1.18	0.313	
0	5	0	300	1.22	0.287	H ₀ = 1.710
0	6	0	360	1.25	0.270	H ₁ = 0.736
0	7	0	420	1.28	0.250	H ₂ = 0.461
0	8	0	480	1.31	0.235	t ₁ = 15
0	9	0	540	1.32	0.227	t ₂ = 120
0	10	0	600	1.34	0.215	F = 2
0	15	0	900	1.40	0.182	A = 0.007

Coefficient of Permeability (k) (m/s)**1.82E-05****Key:****k** = Coefficient of Permeability - calculated from the general approach in 25.4.6; Method 1 (BS5930)**F** = Intake Factor - calculated from Equation D, Figure 6 from BS5930**A** = Cross Sectional Area of well pack**H₁** = variable head measured at time t_1 after commencement of test**H₂** = variable head measured at time t_2 after commencement of test

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REC Ltd is a multi-disciplinary health, safety, environmental and energy consultancy. Our national coverage enables our local experts to provide cost effective and pragmatic consultancy services in an efficient and sustainable manner.



- Phase 1 Habitat Surveys
- Invasive Species
- Legally Protected Species Surveys
- Mitigation Schemes
- Ecological Impact Assessment (EclA)
- BREEAM & Code 4 Sustainable Homes
- Habitat Management Plans
- Management planning and targeted Biodiversity Action Plan survey
- Environmental Impact Assessment



- Air Quality Impact
- Odour Assessment
- Dispersion Modelling
- Stack Emission Testing
- Pollution Monitoring



- Feasibility Studies
- Ground Source Heat Pumps Installation
- Air Source Heat Pump Installation
- System Design and Maintenance
- Solar Photovoltaic (PV) Systems
- Combined Heat and Power Systems



- Asbestos Management Surveys
- Demolition/Refurbishment Surveys
- Analysis of Asbestos in Soils and Bulk Samples
- Air Testing for Clearances and Reassurance
- Legionella Risk Assessment



- Geotechnical Investigation & Assessment
- Contaminated Land Investigation & Assessment
- Waste Management
- Groundwater Testing
- Environmental Impact Assessment



- Sound Insulation Testing
- Noise at Work Assessment
- Development Related Noise / Vibration
- Environmental Noise / Vibration



- Flood Risk & Consequence Assessment
- Strategic Flood Risk Assessment (SFRA)
- EIA Technical Chapters
- Assessment of Flood Levels
- Hydrology & Hydrogeology
- Flood Defence Structures
- Drainage Systems (SUDS) Design
- Mitigation Measures
- Soakaway Tests



- Health, Safety & Environmental Management Systems
- Divestment / Acquisition Due Diligence Services
- Environment Permit Application & Support
- Compliance Auditing
- Carbon Reporting
- Waste Minimisation