PHASE I AND PHASE II
GEO-ENVIRONMENTAL SITE INVESTIGATION

Jefferson Park
Whitehaven
Cumbria
CA28 9HE

E3P Report: 10365-r1
Issued: January 2014

Prepared for

R.G. PARKINS & PARTNERS LTD
CONSULTING CIVIL & STRUCTURAL ENGINEERS

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EXECUTIVE SUMMARY

Site Address	Jefferson Park, Whitehaven, Cumbria CA28 9HE
Grid Reference	E297420, N516800
Site Area	0.32 Ha
Current Site Use	The subject site is an irregular shaped parcel of land located to the west of Low Road, approximately 1.6km south of Whitehaven town centre. The site comprises grassed areas within a partly developed residential estate. A number of residential dwellings are located within the wider site to the north and south of the proposed development.
Environmental Setting	**Geology** – Glacial Till (Diamicton) overlying Penning Middle Coal Measure Formation (Mudstone, Siltstone and Sandstone). **Aquifers** – The drift and solid geology aquifers are classified Secondary A. There are no groundwater abstractions within a 1km radius of the site; **Sensitive Land uses** – Residential dwellings within close proximity; **Hydrology** – An unnamed surface watercourse is located within influencing distance of the site (<10m); **Ecology** – No risk to ecology has been identified. **Flooding** – The site is not located within a currently defined fluvial flood risk zone.
Previous Reports	E3P has been provided with a *Ground Investigation* Report by Sub-Surface (NW) Ltd, dated July 2007 (Ref: Report No. 4901). E3P has undertaken a review of this report, with the pertinent points included herein.
Site History	Historical maps indicate that the site has been utilised for industrial purposes since the earliest available maps (circa 1879) and later developed. The site was actively excavated initially as a Brick Field associated with the nearby Fire Clay Brickworks until the construction of a Laundry (circa 1925) across the southern profile of the site. It would later appear the previously excavated areas have been infilled and a Refuse Tip extended into the northwest sector of the site. More recently (post 1994) the site was cleared of all structures and a highway constructed associated with the wider Jefferson Park residential development
Landfill Sites & Ground Gases	A Local Authority recorded landfill site and licensed waste management facility (Woodhouse Quarry) is located 230m southwest of the site; the boundary of which extended to within 43m of the subject site may be a potential source of hazardous ground gas. Additionally the underlying coal measures and areas of in-filled ground across the site may also represent a source of ground gas.
Radon	Unaffected – no special precautions required.
Coal Mining / Land Stability	The site is affected by coal mining and is within the zone of influence for historic mine workings. A mine Adit and two shafts are located in close proximity to the site and it is believed shallow workings for which the coal authority has no knowledge are likely to be present. Based on this information it is considered that a full assessment in due consideration of the requirements of CIRIA 32 and the Coal Authority Permissions Process is required to assess future stability issues.
Intrusive Ground Investigation	
Ground Conditions	**Made Ground** Made Ground deposits generally comprise a sandy and/or gravelly clay of brick, ash, concrete, clinker and timber fragments underlain by a clayey sandy gravel or gravelly sand of mixed lithology to a maximum proven depth of 6.90m bgl in the northeast quadrant of the site. **Drift Deposits** Natural deposits predominantly comprise firm becoming very stiff at depth gravelly and/or sandy CLAY with cobbles of sub-rounded sandstone to a maximum proven depth of 10.10m bgl.

Executive Summary Continued	
Ground Conditions	**Solid Geology** Solid geology of COAL was encountered within BH2 at 10.10m bgl. **Groundwater** Groundwater was encountered at two locations as water strikes at 7.5m bgl (BH1) and 6.90m bgl (BH2).
Tier 1 Contaminated Land Risk Assessment	
Human Health	The Tier 1 human health risk assessment identified elevated concentrations of benzo(a)anthracene, lead and arsenic which exceed the GAC values within the near surface soils. In addition, asbestos was encountered in a number of Made Ground samples from across the proposed development. E3P considers the shallow Made Ground will not be suitable for use as Topsoil within any proposed gardens or landscaped areas due to the presence of asbestos containing material identified across the entire site and localised elevated PAH and heavy metal compounds. Therefore E3P recommends that a cover system be provided to garden and landscaped areas, thereby removing any dermal contact/ingestion pathways and the risk to the identified receptors.
Controlled Waters	The Tier 1 controlled water assessment has not identified any potential source, pathway or viable receptor. Therefore, given the absence of any potentially complete pollutant linkage the site is determined to pose no unacceptable level of risk to controlled waters and the wider environ.
Ground Gas	Monitoring to date has not identified any elevated concentrations of methane or carbon dioxide. Given the identified ground conditions and available results, E3P considers that further monitoring is likely to show a low risk to end users and that gas precautions will not be required.
Potable Water Infrastructure	Chemical analysis suggests that Polyethylene (PE) pipeline will be suitable for the proposed residential development.
Geotechnical Assessment	
Underground Obstructions	The site has been the subject to previous development and industrial processes associated with shallow mining and clay extraction and as such further buried structures and obstructions are anticipated.
Remediation / Enabling Works	Relict obstructions are anticipated and as such a programme of enabling works will be required to clear all proposed foundation and infrastructure excavations of obstructions and cut and fill the site to level. All works should be completed in accordance with a suitable geotechnical engineering specification and in accordance with the relevant environmental permits.
Foundation Options	The Made Ground is not considered suitable bearing stratum to support a shallow foundation due to the unquantified potential for long term differential and total settlement. It is considered the proposed foundations could be supported using vibro replacement granular stone columns to facilitate the use of shallow (re-enforced) strip foundations within the treated Made Ground. Alternatively, structural loading could be transferred to the deep natural drift deposits though a driven pile foundation to be designed by a specialist contractor and the Structural Engineer.
Soak-away Drainage	It is considered the predominantly cohesive soils matrix underlying the Made Ground is unlikely to provide a high degree of soakage potential for drainage systems in this instance.
Sulphate Assessment	Design Sulphate Class DS-1, AC-1s.
Executive Summary Continued	

Infrastructure & CBR Design %	The Made Ground and shallow clay soils can be re-engineered to facilitate the construction of a suitable sub-grade to provide a CBR design % in excess of 5 for new highways and infrastructure, subject to the completion of works during favourable climatic conditions.
Waste Soils	Due to the presence of asbestos fibres, inorganic heavy metals and sulphates within the Made Ground, soils would be classified as Stable Non-Reactive (Non Hazardous) once sorted and analysed.

Recommendations

Based on the initial Geo-Environmental Assessment, E3P recommend the following works:

- Further investigation utilising Rotary boreholes to determine the presence of shallow mine workings and/or stabilisation by drilling and grouting beneath proposed buildings;
- Further investigation and detailed quantitative risk assessment to determine the concentrations of asbestos within the impacted made ground and inform the production of a detailed Remediation Strategy that will ensure the mitigation of risk to all identified receptors;
- Plot specific Foundation Zoning Plan to be prepared by the Structural Engineer;
- Geotechnical earthworks strategy to define the re-compaction criteria for the engineering of the sub-grade to support adopted infrastructure;
- CL:AIRE Materials Management Plan (MMP) to ensure the economic and legislatively complaint re-use of soils; and,
- Preparation of an overarching Remediation & Enabling Works strategy and build phase mitigation plan to ensure the safe and legislatively compliant management of materials and construction of the proposed dwellings in a manner that will ensure no risk to the critical receptors.

In the event that any previously unidentified potential contaminants of concern are identified during the ground works, an appropriately qualified consultant should be contacted at the first available opportunity to ensure any issue is dealt with in the appropriate manner.

TABLE OF CONTENTS

EXECUTIVE SUMMARY 2

TABLE OF CONTENTS 5

1.0 INTRODUCTION 7

1.1 Background 7
1.2 Proposed Development 7
1.3 Objectives 7
1.4 Limitations 7
1.5 Previous Reports 8
1.6 Confidentiality 8
1.7 Risk Classification 8

2.0 PREVIOUS REPORTS 9

2.1 Desk Study Information 9

3.0 SITE SETTING 10

3.1 Site Details 10
3.2 Current Site Use 10
3.3 Surrounding Area 11

4.0 SITE HISTORY 12

4.1 On-Site Historical Development 12
4.2 Off-Site Historical Development 14
4.3 Planning History 14

5.0 ENVIRONMENTAL SETTING 15

5.1 Geology & Hydrogeology 15
5.2 Geotechnical Data 15
5.3 Coal Mining 15
5.6 Industrial Land Uses 17
5.7 Sensitive Land Uses 17

6.0 CONSULTATIONS 18

6.1 Local Authority Contaminated Land and Building Control Officer 18
6.2 Landfill Sites and Waste Treatment Sites 18
6.3 Regulatory Database 19

7.0 INITIAL CONCEPTUAL SITE MODEL (CSM) 20

7.1 Initial CSM 20

8.0 INTRUSIVE GROUND INVESTIGATION 21

8.1 General 21
8.2 In-Situ Standard Penetration Testing (SPT) 21
8.3 Laboratory Analysis 21

9.0 GROUND AND GROUNDWATER CONDITIONS 23

9.1 Ground Conditions 23
9.1.1 Summary of Ground Conditions 23
9.1.2 Made Ground 23
9.1.3 Drift Deposits 24
9.1.4 Solid Geology 24
9.1.5 Side Stability and Ease of Excavation 24
9.1.6 Soil Plasticity 27
9.1.7 pH and Sulphate 27

9.1.8 Groundwater Conditions 27
9.2 Ground Gas 27

10.0 TIER 1 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT 30

10.1 Human Health Risk Assessment 30
10.2 Controlled Waters Risk Assessment 33
10.3 Ground Gas Risk Assessment 35
10.4 Conceptual Model 35

11.0 GEOTECHNICAL ASSESSMENT 36

11.1 Summary of Ground Conditions 36
11.2 Site Preparation 36
11.3 Foundation Conditions and Bearing Capacity 37
11.4 Ground Floor Slabs 37
11.5 Pavement Construction 38
11.6 Drainage 38
11.7 Concrete Durability 38
11.8 Excavations 38
11.9 Minerals 38
11.10 Further Works 38
11.10 Construction Activity and Inspection 39

12.0 CONCLUSIONS & RECOMMENDATIONS 40

APPENDICES

Appendix I Limitations
Appendix II Glossary
Appendix III Drawings
Drawing 10365-001 Site Location Plan
Drawing 10365-002 Current Site Layout
Drawing 10365-003 Proposed Development Plan
Drawing 10365-004 Historical Features Plan
Drawing 10365-005 Exploratory Hole Location Plan
Drawing 10365-006 Depth of Made Ground Plan
Drawing 10365-007 Mine Abandonment Plan
Drawing 10365-008 Geological Plan
Appendix IV Photographs
Appendix V Historical Maps
Appendix VI E3P Exploratory Hole Logs
Appendix VII Chemical Testing Results
Appendix VIII Origin of Tier I Generic Assessment Criteria
Appendix IX Geotechnical Testing Results

1.0 INTRODUCTION

1.1 Background

E3P has been commissioned by R G. Parkins & Partners Ltd to undertake a Geo-Environmental Site Assessment of their site located on Jefferson Park, Whitehaven, Cumbria.

This report is required to determine potential contaminated land and geotechnical liabilities associated with a future residential redevelopment.

The scope of work consisted of:

- *Detailed desk study;*
- *Intrusive ground investigation comprising 13 No. trial pits, 3 No. cable percussive probeholes and 6 No. window sample probeholes, with 6 No. being completed as environmental monitoring installations;*
- *Ground Gas Monitoring; and,*
- *Interpretive Geo-Environmental Report.*

1.2 Proposed Development

The client intend to construct 16 No. low rise residential units with associated access roads, parking areas, landscaping and adopted drainage infrastructure at Jefferson Park, to the south of Whitehaven, Cumbria.

A Proposed Development Plan (Drawing 10365-003) is included in Appendix III.

1.3 Objectives

The objectives of the Geo-Environmental investigation are to:

- Review historical plans, geology, mining, 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.
- Provide recommendations regarding future works required.

1.4 Limitations

The limitations of this report are presented in Appendix I.

1.5 Previous Reports

The following reports have previously been completed for the site:

Sub Surface (NW) Ltd – *Ground Investigation,* Lowe Road, Whitehaven, Cumbria. Ref: Report No. 4901, dated July 2007.

The pertinent points of the Sub Surface (NW) Ltd report have been included within Section 2.0 of this report.

1.6 Confidentiality

E3P 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 E3P; a charge may be levied against such approval.

1.7 Risk Classification

E3P has utilised the available data to classify the site on the basis of its likely contaminated land liability and potential for geotechnical constraints in relation to the site development. The risk classification definitions are summarised below:

Risk	Definition
Low	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property.
Low-Moderate	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property with regard to the proposed use. However, minor issues may require further consideration in the event of a future redevelopment of the site etc.
Moderate	Some potential contaminated land liabilities/geotechnical constraints are likely to affect the property as a result of historical and/or current activities. The risks identified are unlikely to pose an immediate significant issue but the purchaser/developer may wish to make further enquiries of the vendor or undertake further environmental improvements. Redevelopment of the site will likely require further site investigation.
Moderate-High	Some potentially significant contaminated land liabilities/geotechnical constraints have been identified at the property that requires further assessment including intrusive ground investigations.
High	Significant potential contaminated land liabilities/geotechnical constraints have been identified at the property. Further assessment including intrusive ground investigation will be required to determine to level of risk and associated liability.

2.0 PREVIOUS REPORTS

2.1 Desk Study Information

Pertinent points from the previously completed Sub Surface (NW) Ltd Ground Investigation are as follows:

- *The subject site is approximately 1.2 Ha, located to the west of Low Road, about 1.6km to the south of the centre of Whitehaven, Cumbria bound to the east by Low Road, south by a cemetery, west by open land and north by a former railway corridor;*

- *The site topography shows a steep gradient from Low Road through the eastern margin of the site and then more gently through the central sector. The site was formerly utilised by Lakeland Laundry and has now been largely cleared of buildings;*

- *Up to 8.00m of Made Ground was encountered in the north east quadrant of the site and up to 6.20m of Made Ground was encountered in the central western area of the site. An infilled east to west trending valley is apparently present in the northern area of the site. Made Ground generally comprised granular materials of ashy gravelly clayey silty sand inter-layered with cohesive deposits of gravelly to slightly gravelly slightly sandy clays;*

- *Drift deposits generally comprised soft to stiff, becoming stiff to very stiff with depth gravelly to slightly gravelly slightly sandy clays, with gravel of sandstone, siltstone, quartzite and occasional coal. Local cobbles and boulders were encountered;*

- *Bedrock was encountered as very weak / weak highly weathered mudstone. Bedrock with depth was found to be interbedded mudstone, siltstone and sandstone with limestone and a number of coal seams, some of which were found to have been mined;*

- *Two mine shafts are present on the site and coal mine workings were found at a shallow depth. Sub-surface found there to be an unacceptable risk of subsidence from shallow coal mining and recommended stabilisation by grouting. E3P has not received details of these stabilisation works;*

- *Sub-Surface recommended foundations to be a combination of mass trench fill and vibro stone columns to be used. E3P has not received details at this time of what foundations were adopted for the dwellings previously constructed;*

- *Chemical laboratory analysis identified elevated arsenic, cadmium, lead, nickel, benzene, benzo(a)pyrene and TPHs in addition to asbestos sheeting, however this is based on limited testing. A cover system was recommended as being a suitable form of remediation for the proposed residential development, along with localised hotspot remediation;*

- *No elevated levels of methane have been detected. However, elevated concentrations of carbon dioxide and/or depleted levels of associated oxygen have been recorded. Carbon dioxide in conjunction with depleted oxygen is an asphyxiant, therefore ground gas protection measures will be required for the proposed development;*

- *Shallow mineworkings have been identified as voids, loss of flush and water inflow primarily within the Bannock Coal; and*

- *It should be noted the Sub-Surface report appears to be incomplete, with exploratory hole logs and exploratory hole location plans not included, thus limiting the quality of the information review;*

3.0 SITE SETTING

3.1 Site Details

Site Address	Jefferson Park, Whitehaven, Cumbria CA28 9HE
National Grid Reference	E297420, N516800
Site Area	0.32 Ha

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

A site location map is presented in Appendix III.

3.2 Current Site Use

Site Description

Occupancy/use	The subject site is an irregular shaped parcel of land, located to the west of Low Road, approximately 1.6km south of Whitehaven Town Centre comprising grassed areas within a partly developed residential estate. A number of residential dwellings are located within the wider area to the north and south of the proposed development.	
Structures	None identified.	
Access	Access is from Low Road to the east.	
Slope	A steep gradient through the eastern sector of the site extends from Low Road, becoming a gentle gradient rising through the centre of the site towards the western boundary.	
Retaining structures	No retaining structures are apparent.	
Surface Cover (%)	Buildings:	0
	Hardstand:	<15
	Soft cover:	85
Trees	None.	
Hazardous Material Storage	There are no hazardous materials currently stored on site.	
Asbestos Containing Material (ACM)	There is no visual evidence of ACM material located on site, however given that ACM was encountered during the Sub-Surface GI and the extensive Made Ground underlying the site, the presence of ACM is considered likely.	
PCBs	No equipment that may potentially containing PCBs was observed at the site.	
Waste Storage	No potentially hazardous waste streams are generated at the property.	
Drainage	A review of online sewer records shows that mains water sewers are located on Jefferson Park from Low Road to the east.	

3.3 Surrounding Area

The surrounding land uses are summarised below:

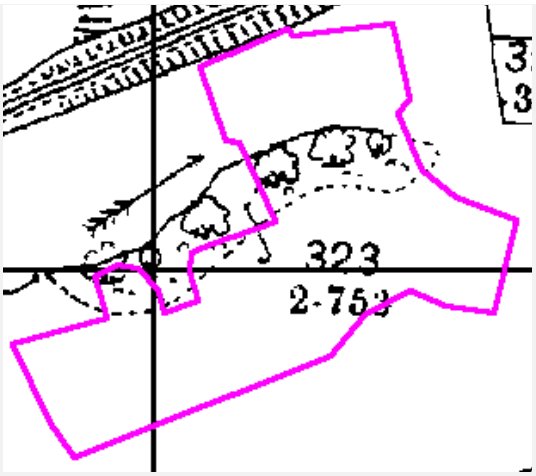
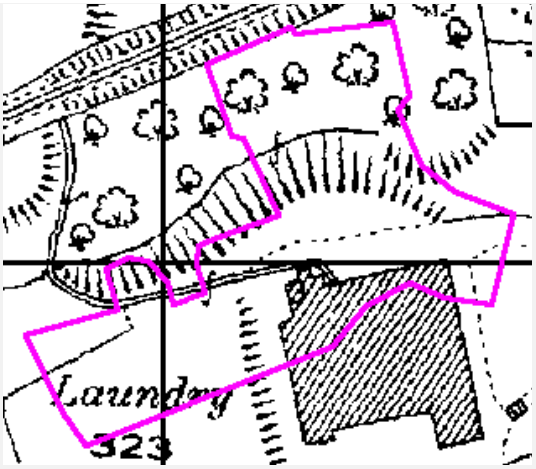
Direction	Land Use
North	Public Footpath (Former Railway)
East	Low Road and Whitehaven Cemetery
South	Whitehaven Cemetery
West	Open Land (Former Quarry)

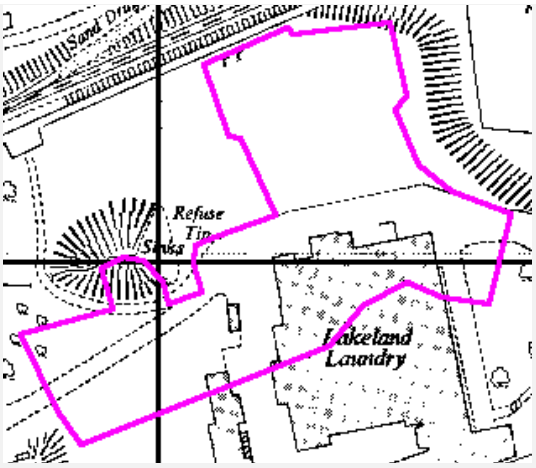
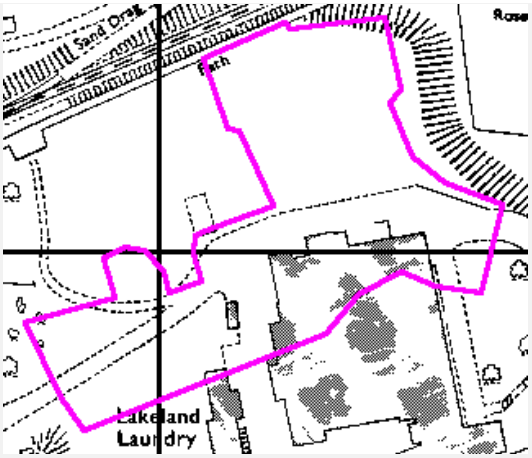
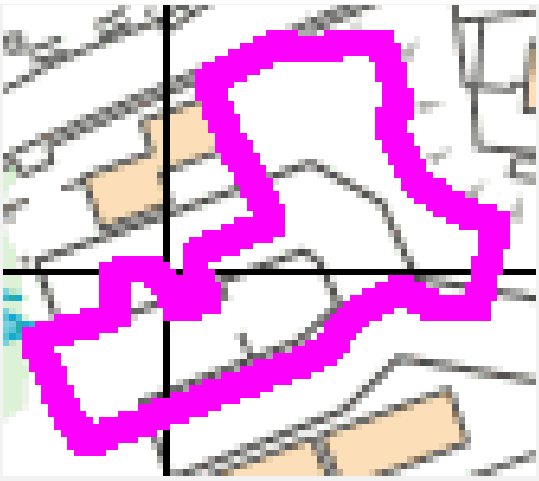
4.0 SITE HISTORY

4.1 On-Site Historical Development

A review of historical mapping pertinent to the site is summarised in Table 4.1 below. In addition, historical site features are presented on Drawing 10365-004 (Appendix II). The potentially contaminative sources identified are highlighted in **bold** and the full historical maps included in Appendix III.

Table 4.1 Summary of Potentially Contaminative Historical Land Uses

Map Edition	Historical Land Use	Historical Map Excerpt
1879 1:2,500	The southern sector of the site is recorded as a **Brick Field**. An excavation is recorded through eastern sector running along the northern profile of the western sector. The northwest quadrant of the site is unspecified open land (possibly agricultural or brick field).	
1899 1:2,500	No significant changes have occurred.	
1925/38 1:2,500	A **Laundry** is now recorded extending into the southern sector of the site. The area of excavation is still recorded.	

Map Edition	Historical Land Use	Historical Map Excerpt
1962 1:2,500	A **Refuse Tip** is recorded extending into the northwest sector of the site. The previously identified excavation through the centre of the site is no longer recorded.	
1975/94 1:2,500	The **Refuse Tip** is no longer recorded. No other significant changes.	
2014	The **Laundry** has been demolished and the site has an access road through the eastern sector constructed as part of the wider residential development, in proximity to the subject site which is now recorded in its present day configuration.	

4.2 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 4.2.

Table 4.2 Summary of Potentially Contaminative Off-Site Historical Land Uses

Surrounding Feature	Distance	Dates	Direction
Railway and Embankment ... *Then* Dismantled (Public Footpath)	Adjacent	Pre 1899 – Pre 1993 Pre 1993 – Present	North
Clay Pits (with associated Mineral Railway) … *Then* Quarry … *Then* Disused	5 – 250m	Pre 1899 – Pre 1962 Pre 1962 – Pre 1993 Pre 1993 – Present	West / NW / SW
Fire Brick Works … *Then* Unspecified Works (with Chimneys)	35 – 180m	Pre 1879 – Pre 1974 Pre 1974 – Present	North
Vehicle Depot	110m	Pre 1974 – Present	East
New Gas Works … *Then* Unspecified (and 2 No. Garages)	120 - 200m	Pre 1879 – Pre 1938 Pre 1938 – Present	North
Tyre Depot	150m	Pre 1974 – Present	East
Plant Hire Depot	160m	Pre 1974 – Present	East
Garage (Former Gas Works)	160m	Pre 1994 – Present	North
Garage (Former Gas Works)	200m	Pre 1962 – Present	North

4.3 Planning History

E3P has undertaken a review of on-line planning records held by Cumbria County Council and no further environmentally pertinent information was obtained.

4.4 Anecdotal / Web Based Searches

No anecdotal information was obtained following a web-based search of the area.

5.0 ENVIRONMENTAL SETTING

5.1 Geology & Hydrogeology

The British Geological Survey (BGS) map for the site indicates that the site is underlain by the following geological sequence:

Geological Unit	Classification	Description	Aquifer Classification	Sensitivity
Drift	Glacial Till (Diamicton)	Sand, Clay and Gravel	Secondary A	N/A
Solid	Pennine Middle Coal Measure Formation	Mudstone, Siltstone and Sandstone	Secondary A	High *Minor Aquifer*

The Envirocheck Report identifies that the site is not located within a current defined Groundwater Source Protection Zone (SPZ). There are no groundwater abstractions located within a 1km radius of the subject site.

Based on the local topography and location of surface watercourses it is considered likely that shallow groundwater, if present, will flow in an easterly direction, following hydraulic gradient towards Pow Beck.

5.2 Geotechnical Data

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

Hazard	Designation
Shrink-Swell Clay	Very Low Hazard
Landslides	Very Low Hazard (Moderate 75 – 100m W/SW of site)
Ground Dissolution	No Hazard
Compressible Ground	No Hazard
Collapsible Deposits	Very Low Hazard
Running Sand	Very Low Hazard

5.3 Coal Mining

The Sub-Surface (NW) Ltd, Ground Investigation report, dated July 2007 (Ref: Report 4901) includes a Coal Authority Mining Report (Ref: 546188-03) dated Dec 2003 which states the Coal Authority have records of mine workings beneath the site at approximately 60m depth, the last date of working being 1907. The Coal Authority also indicate that ground movement from the above mentioned past coal workings should by now have ceased, however, their records may be incomplete and shallower mine workings are suspected to be present. In addition, within or within 20 metres of, the boundary of the property there are also 2 No. mine entries (No. **297516-004** & **297516-005**) located to the northwest of the subject site

A Geological Survey review by Sub Surface indicates that the shallowest coal seams beneath the site are the 2.5m thick Bannock Coal, which crops out from north-north west to the south-south east through the centre of the site. The underlying 4.0m thick Main Coal crops out from the north-north west to south-south east immediately east south east of the site which is in turn overlying 2.0m thick Yard Coal which crops out approximately 70m to the

east-north east of the site and underlies the site at relatively shallow depths.

E3P reviewed the 1:10,000 geological mapping for the site and in agreement with the Sub-Surface Ltd report identifies the presence of Bannock Coal underlying the western sector of the site at shallow depth, underlain by Main Coal which outcrops through the eastern profile of the site towards Low Road. This in turn is underlain by Yard Coal which outcrops east of the subject site as presented in Drawing 10365-008 Geological Plan, Appendix III.

The Sub-Surface Ltd report also details that rotary borehole investigation has found evidence of mine workings in the Bannock, Main and Yard Coal seams to a maximum depth of 24.80m bgl. In due consideration of the known presence of abandoned mine workings in the form of at least two vertical shafts within 20m of the site boundary and potential for shallower mine workings it was recommended, by Sub Surface (NW) Ltd, that shallow mined horizon be stabilised by drilling and grouting to 30m bgl beneath proposed buildings throughout the site.

For the avoidance of doubt, a Coal Authority Mining Report (Ref: 51000721154001) dated Dec 2014 was obtained by E3P for the purpose of the proposed development area (within the wider site detailed by Sub-Surface Ltd); which states the site is in the likely zone of influence from workings in 1 seam of coal at 50m to 70m depth, and last worked in 1907. In addition the property is in an area where the Coal Authority believe there is coal at or close to the surface. This coal may have been worked at some time in the past. The potential presence of coal workings at or close to the surface should be considered prior to any site works or future development activity. Furthermore, there are no known coal mine entries within, or within 20 metres of, the boundary of the property but records may be incomplete. Consequently, there may exist in the local area mine entries of which the Coal Authority has no knowledge.

Mine Abandonment Plans

A representative of E3P visited the Coal Authority Mine Abandonment Archive in Mansfield on the 3rd December 2014.

The following plans were obtained which related to historical mine workings within influencing distance of the subject site.

- *Abandonment Plan Ref: NW1387 Sheet 1 of 1 – Main Prior Coal – Date: Pre 1920*
- *Abandonment Plan Ref: 7176 Sheet 2 of 2 – Howgill Head Mine – Date: 1920*

The Mine Abandonment Plans confirm the presence of coal workings beneath the site (NW1387), however, the plan only detailed the extent of the Whitehaven **Main Prior Coal** seam workings and did not specify a depth (E3P drawing 10365-007).

The Mine Abandonments Plans also indicate the presence of workings in a shallow seam of coal at Howgill Head Mine to the east of the subject site (E3P Drawing 10365-007), however, tunnels leading off from this mine show an abrupt abandonment indicating the mine could not be progressed beneath the subject site.

The Coal Authority have no records with respect to the two No. shafts identified within influencing distance of the subject site (as stated in the Sub-Surface report), however these workings may pre-date the mining regulations act of 1877 which required all coal workings to be recorded.

5.4 Hydrology

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

Surface Water Feature	Quality*	Distance (m)	Direction
Unnamed Stream	N/A	8	West
Pow Beck	N/A	210	East

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

The site is not located within a currently defined Flood Risk Zone.

5.5 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.

5.6 Industrial Land Uses

The Trade Directory has three registered entries within 250m of the site; two of which are still active. These relate to an MOT testing centre (108m N) and crematorium (187m SE).

5.7 Sensitive Land Uses

There are residential properties in close proximity to the north and south of the subject site.

5.8 Site Sensitivity Assessment

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

- Residential properties are located in close proximity;
- Drift deposits comprise Glacial Till Deposits of Sand, Clay and Gravel;
- The underlying solid geology is classified as a Secondary A Aquifer.
- There are no groundwater abstractions located within a 1km radius of the subject site;
- There is one surface watercourses within influencing distance of the site (Unnamed stream); and,
- A number of mature and semi-mature trees are located in the western sector of the site may hold protected wildlife.

6.0 CONSULTATIONS

6.1 Local Authority Contaminated Land and Building Control Officer

An information request was placed with the Environmental Health Officer and Building Control at Cumbria County Council and Copeland Borough Council and a response was received from Mr Tom Gray (Copeland Borough Council EHO) on Tuesday 8th December 2014.

Regulatory correspondence with Mr Gray indicated that during the initial development of the wider site (residential dwellings to the north and south of the subject site) a number of issues were encountered as detailed below:

- A mine adit and two historic abandoned mine entries were known to exist entering the Main Coal seam (based on the Sub-Surface (NW) Ltd report dated 2007), on or within 20m of the site boundary. Further investigation by Whittle Construction in 2008 advised that a mineshaft had been found close to the proposed location of Flats A15-19/A20-25. It was therefore proposed that Flats A15-19/A20-25 be moved away from the zone of influence of the mine shaft to obviate the need for grouting of the site. However, the exact location of the mineshaft has not been provided;
- The Sub Surface (NW) Ltd report recommended the shallow mined horizon be stabilised by drilling and grouting to 30m bgl beneath proposed building throughout the site. However, no record could be provided of any stabilisation works undertaken prior to the construction of the adjacent residential dwellings;
- A former refuse tip which extends into the northwest sector of the proposed development was identified, but due to timescale and financial implications was not remediated by the previous developer;
- A watercourse which flows east (towards the site) is located up-gradient of the subject site and ends abruptly, at a concrete chamber, in close proximity (<10m) to the western boundary of the site. The watercourse was known to flow within a culvert beneath the site prior the construction of the adjacent development (circa 2009). The culvert was re-engineered traversing the northern boundary of the wider development to the rear of existing Flats 38 to 48 towards Rose Cottage to the northeast of the subject site, although no details of the fill material have been provided.
- The existing residential dwellings adjacent to the proposed development are believed to be constructed on either mass trench fill, raft or strip foundations depending on geo-technical requirements and incorporate ground gas protection measures thought to comprise a DPM and telescopic floor venting. A detailed foundation zoning plan could not be provided;
- Due to the presence of asbestos containing material in the shallow Made Ground, the soft landscaped areas of the residential development were installed with a cover system, believed to comprise topsoil underlain by a clay sub-soil, to break the exposure pathway for residential users.

6.2 Landfill Sites and Waste Treatment Sites

A Local Authority Recorded Landfill site and Licensed Waste Management Facility (Woodhouse Quarry) was located 230m southwest of the site; the boundary of which extended to within 43m of the subject site. The licence for Woodhouse Quarry has now expired. No other landfill or waste treatment site, current or historic, are located within 250m radius of the site.

6.3 Regulatory Database

The following information has been obtained from a commercially available environmental database. The summary table only includes records not otherwise detailed in the report.

Table 6.1 Summary of Data

Entry	Number within 250m	Details
Contaminated Land Register Entries and Notices	0	Not Applicable (N/A).
Authorised industrial processes (IPC/IPPC/LAPPC).	0	N/A
Fuel Stations Entries	0	N/A
Licensed radioactive substances	0	N/A
Enforcements, prohibitions or prosecutions	0	N/A
Discharge Consents	0	N/A
Pollution Incidents	2	Category 3- Chemical Acid - Phosphoric (158m N) Category 3- Waste Oils (166m SE)
Consents issued under the Planning (Hazardous Substances) Act 1990	0	N/A
Control of Major Accident Hazard (COMAH) sites	0	N/A

7.0 INITIAL CONCEPTUAL SITE MODEL (CSM)

7.1 Initial CSM

In accordance with Environment Agency, CLR 11 (2004) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), E3P Ltd have developed an initial CSM to identify potential contamination sources, migration pathways and receptors within the study area.

Source	Exposure Pathways	Potential Receptors
Human Health		
On-Site		
Heavy Metals PAHs SVOCs	Dermal Contact Ingestion Inhalation	Construction Workers Residential End Users
Discussion The presence of a mineral railway line immediately north of the site may result in the localised deposition of ash and clinker from steam operated trains. Ash and clinker can be a source of metal impact, such as arsenic and lead and Polycyclic Aromatic Hydrocarbons (PAH). A laundry was also located in the southern sector of the site which may be a localised source of SVOCs. These compounds pose a risk via dermal contact and ingestion and pose a risk to construction workers during earth-works or to end users if the scheme includes for areas of soft-standing.		
Ground Gas	Accumulation Vapour Inhalation	Residential End Users Construction Workers Third Party Property
Discussion The site is underlain by coal measures and historically a large excavation and refuse tip have been recorded on-site and within the immediate proximity. These features are considered potential sources of ground gas which may pose a risk to construction workers and future residential end users through vapour inhalation post completion. Based on the information currently available and previous report, there is considered to be a low to moderate risk.		
Controlled Water		
Heavy Metals PAHs SVOCs	Lateral and Vertical Migration	Secondary A Pow Beck
Discussion The underlying Secondary A Aquifer (drift strata) is unlikely to be considered a sensitive receptor given the historical industrial nature of the surrounding area and its limited potential to support water abstractions. The presence of likely impermeable drift strata is likely to afford protection to the underlying Secondary A and limit lateral migration towards Pow Beck. Therefore, given the distance of this watercourse (>200m) from the subject site and limited migration potential for contaminants of concern the risk to controlled waters is considered to be low.		
Buildings and Infrastructure		
Sulphate	Corrosion of buried concrete	Foundations
Discussion Demolition material with a high proportion of concrete and/or mortar can give rise to elevated levels of sulphate. Sulphate (water soluble) can result in corrosion of buried concrete unless appropriately designed.		
Ecological		
Heavy Metals PAHs	Lateral Migration	Pow Beck
Discussion Pow Beck is considered to be the only viable ecological receptor but as discussed in the controlled waters section, given the distance from the subject site, the potential for lateral migration is reduced.		

8.0 INTRUSIVE GROUND INVESTIGATION

8.1 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 and are summarised in Table 8.1. 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 development.

Exploratory fieldwork was completed on the 10th November 2014. The works are summarised in Table 8.1.

Table 8.1 Summary of Fieldwork

Potential Source/Rationale	Location Hole	Type	Maximum Depth (m bgl)	Monitoring Wells Response Zone (m)
Geotechnical & Baseline Conditions	TP101 – TP113	Trial Pit	0.60 – 3.50	N/A
Geotechnical & Baseline Conditions Ground Gas	WS101	Window Sample	4.80	0.50 – 2.50
	WS102		3.45	1.00 – 3.00
	WS103		5.00	1.00 – 4.00
	WS104		5.00	1.00 – 5.00
	WS105		3.00	0.50 – 2.50
	WS106		5.00	0.50 – 2.70
Geotechnical & Baseline Conditions	BH1	Cable Percussive	8.45	N/A
	BH2		10.50	N/A
	BH3		6.00	N/A

The sampling locations are illustrated in Drawing No 10365-004 (Appendix III). The ground conditions encountered and details of monitoring well response zones are indicated on the logs which are provided in Appendix VI.

Return visits were made to monitor installations for groundwater level and gas concentrations.

8.2 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 testing was conducted using the Cone Penetration Test (CPT). The results are shown in the probehole logs in Appendix VI; presented in Table 9.2 and discussed in Section 11.0.

8.3 Laboratory Analysis

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

The analytical work was completed by i2 Analytical Laboratories Ltd of Hertfordshire and the testing results are included in Appendix VII and discussed in Section 10.0.

Selected samples were submitted to Professional Soils Laboratory (PSL) where the following geotechnical tests were undertaken:

- Moisture Content;
- Atterburg Limits Determinations;
- Plasticity Index; and,
- Multistage Triaxial.

Laboratory analysis sheets are included in Appendix IX and are summarised in Section 11.0.

9.0 GROUND AND GROUNDWATER CONDITIONS

9.1 Ground Conditions

9.1.1 Summary of Ground Conditions

The ground investigation generally confirms the published geology and identifies the strata set out in Table 9.1 below:

Table 9.1 Summary of Strata

Strata:	General Description:	Typical Depth (mbgl):			
		Top:		Base:	
		Min:	Max:	Min:	Max:
Made Ground					
Sandy / Gravelly Clay	MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, sub-angular to sub-rounded of brick, concrete, ash and clinker.	0.00	0.00	0.15	3.00
Clayey / Sandy Gravel	MADE GROUND: Black sandy clayey gravel. Gravel is fine to coarse, angular to sub-angular of brick, concrete, ash, clinker and timber fragments.	0.28	1.90	0.56	6.90
Gravelly Sand	Black clayey gravelly sand. Gravel is fine to coarse, angular to sub-rounded of sandstone, concrete, brick, ash, clinker and occasional timber.	0.10	0.70	0.46	3.50
Natural STRATA					
SAND	Brown mottled grey very clayey medium SAND with angular to sub-angular sandstone cobbles.	0.63	0.63	1.60	1.60
Gravelly CLAY	Stiff grey silty gravelly CLAY with cobbles. Gravel is fine to coarse, sub-angular to sub-rounded of sandstone. Cobbles are sub-rounded of sandstone.	2.80	2.80	8.45	8.45
Sandy CLAY	Firm to stiff brown grey sandy CLAY with cobbles. Cobbles are sub-rounded of sandstone.	0.38	6.90	1.40	10.10
COAL	COAL	10.10	10.10	10.86	10.86

9.1.2 Made Ground

Made Ground deposits were encountered in all exploratory hole locations across the entire site, with the exception of TP108, generally comprising a sandy and/or gravelly clay of brick, ash, concrete, clinker and timber fragments underlain by a clayey sandy gravel or gravelly sand of mixed lithology to a maximum proven depth of 6.90m bgl in the northeast quadrant of the site. However, no Made Ground in excess of 3m bgl was encountered elsewhere at the subject site. A historic asphalt road and gravel sub-base was encountered at 0.60 – 0.90m bgl in BH1 possibly associated with the former laundry. A stiff to very stiff light brown clay with brick foundations (east to west orientation) at circa 0.75 – 0.90m bgl was encountered in TP103 and TP104 although, based on historical mapping, it is not clear what this structure may have been. A void was noted at 3.0m bgl in WS102.

9.1.3 Drift Deposits

Natural deposits were encountered across all areas of the site, however, a number of exploratory locations in the northern sector (TP101 - TP104 and WS103 – WS104) did not penetrate to natural deposits due to deeper Made Ground (up to 6.90m bgl). A further two locations were terminated at shallow depths (<1.0m) due to obstructions. Natural deposits for the most part comprised of firm becoming very stiff at depth gravelly and/or sandy CLAY with cobbles of sub-rounded sandstone to a maximum proven depth of 10.10m bgl.

9.1.4 Solid Geology

Solid geology of COAL was encountered within BH2 at 10.10m bgl.

9.1.5 Side Stability and Ease of Excavation

The sides of the trial pits were predominantly observed to be stable during excavation, with the exception of TP103 and TP104 where deeper granular Made Ground deposits resulted in sidewall collapse.

Table 9.2 Standard/Cone Penetration Test Results

Boreholes	Depth (m bgl)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value $(N_1)_{60}$	Terzaghi & Peck Relative Density (Sands)	Eurocode Soil strength	Consistency (BS5930)	Terzaghi & Peck Approximate Undrained Shear Strength (kN/m^2)
BH1	1.2	MADE GROUND	14	13.74	N/A	Medium strength	Stiff	68.69
	2	MADE GROUND	33	30.15	N/A	Very high strength	Very Stiff	150.73
	3	Gravelly CLAY	50	43.48	N/A	Very high strength	Very Stiff	217.41
	4	Gravelly CLAY	40	33.79	N/A	Very high strength	Very Stiff	168.97
	5	Gravelly CLAY	33	27.38	N/A	High strength	Very Stiff	136.89
	6.5	Gravelly CLAY	47	38.37	N/A	Very high strength	Very Stiff	191.85
	8	Gravelly CLAY	41	33.19	N/A	Very high strength	Very Stiff	165.94
BH2	1.2	MADE GROUND	3	2.94	Very Loose	N/A	N/A	N/A
	2	MADE GROUND	6	5.48	Loose	N/A	N/A	N/A
	3	MADE GROUND	13	11.31	Medium Dense	N/A	N/A	N/A
	4	MADE GROUND	20	16.90	Medium Dense	N/A	N/A	N/A
	5	MADE GROUND	50	41.48	Dense	N/A	N/A	N/A
	6.5	CLAY	7	5.71	N/A	Low strength	Firm	28.57
	8	CLAY	20	16.19	N/A	High strength	Very Stiff	80.95
	9.5	CLAY	26	20.95	N/A	High strength	Very Stiff	104.77
	10.5	COAL	120	94.67	Very Dense	N/A	N/A	N/A
BH3	1.2	CLAY	50	49.06	N/A	Very high strength	Very Stiff	245.31
	2	CLAY	25	22.84	N/A	High strength	Very Stiff	114.19
	3	CLAY	23	20.00	N/A	High strength	Very Stiff	100.01
	4	CLAY	30	25.35	N/A	High strength	Very Stiff	126.73
	5	CLAY	50	41.48	N/A	Very high strength	Very Stiff	207.41
	6	CLAY	50	40.99	N/A	Very high strength	Very Stiff	204.97
WS101	1	Sandy CLAY	10	10.08	N/A	Medium strength	Stiff	50.41

Boreholes	Depth (m bgl)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value $(N_1)_{60}$	Terzaghi & Peck Relative Density (Sands)	Eurocode Soil strength	Consistency (BS5930)	Terzaghi & Peck Approximate Undrained Shear Strength (kN/m^2)
	2	Sandy CLAY	30	27.41	N/A	High strength	Very Stiff	137.03
	3	Gravelly CLAY	23	20.00	N/A	High strength	Very Stiff	100.01
	4	Gravelly CLAY	40	33.79	N/A	Very high strength	Very Stiff	168.97
	4.8	Gravelly CLAY	50	41.61	N/A	Very high strength	Very Stiff	208.03
WS102	1	Clayey GRAVEL	7	7.06	Loose	N/A	N/A	N/A
	2	Sandy CLAY	4	3.65	N/A	Very low strength	Soft	18.27
	3	Sandy CLAY	1	0.87	N/A	Extremely low strength	Very Soft	4.35
WS103	1	MADE GROUND	8	8.07	N/A	Medium strength	Stiff	40.33
	2	MADE GROUND	4	3.65	N/A	Very low strength	Soft	18.27
	3	MADE GROUND	6	5.22	Loose	N/A	N/A	N/A
	4	MADE GROUND	11	9.29	Loose	N/A	N/A	N/A
	5	MADE GROUND	9	7.47	Loose	N/A	N/A	N/A
WS104	1	MADE GROUND	6	6.05	Loose	N/A	N/A	N/A
	2	MADE GROUND	8	7.31	Loose	N/A	N/A	N/A
	3	MADE GROUND	4	3.48	Very Loose	N/A	N/A	N/A
	4	MADE GROUND	4	3.38	Very Loose	N/A	N/A	N/A
WS105	1	MADE GROUND	2	2.02	Very Loose	N/A	N/A	N/A
	2	MADE GROUND	7	6.39	N/A	Low strength	Firm	31.97
	3	Sandy CLAY	50	43.48	N/A	Very high strength	Very Stiff	217.41
WS106	1	MADE GROUND	16	16.13	N/A	High strength	Very Stiff	80.65
	2	Sandy CLAY	19	17.36	N/A	High strength	Very Stiff	86.79
	2.7	Sandy CLAY	49	43.13	N/A	Very high strength	Very Stiff	215.63
	3.15	Sandy CLAY	50	43.25	N/A	Very high strength	Very Stiff	216.26

9.1.6 Soil Plasticity

The Atterberg Limits determinations, summarised in Table 9.3 below, show the clay to be of intermediate plasticity. Natural Moisture Content is close to the Plastic Limit.

Table 9.3 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
WS102	1.00	30	23	47	24	100	**24**

9.1.7 pH and Sulphate

Chemical analyses for pH and soluble sulphate content contained in Appendix VIII (summarised below in Table 9.4), 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). However, WS101 and TP102 fall within Class DS-2, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-2s in accordance with BRE Special Digest 1 (2005).

Table 9.4 Summary of pH and Sulphate Data

Location	Depth (m)	SO_4 in 2:1 water / soil (g/l)	pH Value
TP101	1.00	0.055	8.4
TP102	0.50	0.22	6.5
TP104	1.40	0.093	7.2
TP108	0.60	0.029	7.4
TP109	0.20	0.034	7.1
TP109	0.60	0.020	7.12
TP111	0.20	0.044	7.4
TP112	0.40	0.034	8.0
TP113	0.50	0.077	7.8

9.1.8 Groundwater Conditions

Groundwater was encountered at two locations as water strikes at 7.5m bgl (BH1) and 6.90m bgl (BH2).

9.2 Ground Gas

Concentrations of methane (CH_4), carbon dioxide (CO_2) and Oxygen (O_2) were measured using a calibrated infra-red gas analyser 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 CH_4 and CO_2 together with the lowest concentration of O_2 were recorded. The results of the ground gas monitoring are presented in Table 9.6.

Table 9.6 Groundwater and Ground Gas 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	O_2 %v/v	Atmos(mb)	Atmos. Dynamic	Flow (l/hr)	Response Zone (mbgl)	Depth to Base (mbgl)	Depth to Water (mbgl)
WS101	28/11/14	0	0	0	3.8	3.8	0	15.7	1002	Rising	0	0.50 –2.50	2.63	2.06
	11/12/14	0		0	3.7	3.7	0	15.2	1000	Rising	0		2.62	2.00
	06/01/15	0	0	0	2.7	2.7		15.2	1009	Falling	0		2.60	1.70
WS102	28/11/14	0	0	0	2.9	2.9	0	14.4	1002	Rising	0	1.00 –3.00	3.1	1.3
	11/12/14	0	0	0	3.0	3.0	0	13.8	1000	Rising	0		3.1	1.2
	06/01/15	0	0	0	0.8	0.8		19.7	1009	Falling	0		2.90	1.17
WS103	28/11/14	0	0	0	0.1	0	0	20.1	1002	Rising	-2.46	1.00-4.00	4.05	Dry
	11/12/14	0	0	0	0	0	0	20	1002	Rising	-1.98		4.05	Dry
	06/01/15	0	0	0	0.9	0.9	0	19.6	1009	Falling	0		4.10	4.10
WS104	28/11/14	0	0	0	1.3	1.3	0	19.3	1002	Rising	0	1.00-5.00	4.37	4.37
	11/12/14	0	0	0	1	1	0	19.5	1002	Rising	0		4.36	4.36
	06/01/15	0	0	0	0.8	0.8	0	19.8	1009	Falling	0		4.40	Dry

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	O_2 %v/v	Atmos(mb)	Atmos. Dynamic	Flow (l/hr)	Response Zone (mbgl)	Depth to Base (mbgl)	Depth to Water (mbgl)
WS105	28/11/14	0	0	0	1.7	1.7	0	18.6	1002	Rising	0	0.50-.50	2.43	2.34
	11/12/14	0	0	0	1.7	1.7	0	18.6	1002	Rising	0		2.35	2.28
	06/01/15	0	0	0	1.2	1.2	0	19.5	0	Falling	0		2.45	2.10
WS106	28/11/14	0	0	0	4.4	4.4	0	16.2	1002	Rising	0	0.50 –2.70	2.37	Dry
	11/12/14	0	0	0	4.5	4.3	0	16	1002	Rising	0		2.35	Dry
	06/01/15	0	0	0	4.7	4.7	0	14.1	1009	Falling			2.40	1.10

10.0 TIER 1 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

E3P 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.

10.1 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 10.1 (overleaf).

Table 10.1 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Residential End Use

Determinand	Units	GAC	n	MC	Loc.of Ex (Depth m)	Pathway	Assessment
Arsenic**	mg/kg	37	9	43	TP101 (1.00) TP102 (0.50)	1	Further Assessment
Cadmium	mg/kg	26	9	0.7	N/A	1	No Further Action
Chromium (VI)**	mg/kg	21	9	<4.0	N/A	1	No Further Action
Lead**	mg/kg	210	9	750	TP101 (1.00) TP104 (1.40) TP111 (0.20)	1	Further Assessment
Mercury	mg/kg	11	9	<0.3	N/A	2	No Further Action
Nickel	mg/kg	130	9	110	N/A	1	No Further Action
Selenium	mg/kg	350	9	<1.0	N/A	1	No Further Action
Copper(ii)	mg/kg	2330	9	820	N/A	1	No Further Action
Zinc(ii)	mg/kg	3750	9	980	N/A	1	No Further Action
Cyanide - Total	mg/kg	791	9	<1	N/A	1	No Further Action
Phenols - Total.	mg/kg	210	9	<1	N/A	1	No Further Action
Asbestos	Fibres	NFD	7		All	4	Further Assessment
Naphthalene	mg/kg	1.5	9	0.23	N/A	2	No Further Action
Acenaphthylene	mg/kg	170	9	0.29	N/A	3	No Further Action
Acenaphthene	mg/kg	210	9	0.19	N/A	1	No Further Action
Fluorene	mg/kg	160	9	0.34	N/A	1	No Further Action
Phenanthrene	mg/kg	92	9	4.2	N/A	3	No Further Action
Anthracene	mg/kg	2300	9	0.83	N/A	3	No Further Action
Fluoranthene	mg/kg	260	9	7.3	N/A	3	No Further Action
Pyrene	mg/kg	560	9	5.9	N/A	3	No Further Action
Benzo(a)Anthracene	mg/kg	3.1	9	3.7	TP101 (1.00) TP113 (0.50)	3	Further Assessment
Chrysene	mg/kg	6	9	4.3	N/A	3	No Further Action
Benzo(b/k)Fluoranthene (i)	mg/kg	5.6	9	3.2	N/A	3	No Further Action
Benzo(a)Pyrene**	mg/kg	5.0	9	3.2	N/A	3	No Further Action
Indeno(123-cd)Pyrene	mg/kg	3.2	9	0.92	N/A	3	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	0.76	9	0.30	N/A	3	No Further Action
Benzo(ghi)Perylene	mg/kg	44	9	0.78	N/A	3	No Further Action
TPH C5-C6	mg/kg	30	9	<1.0	N/A	2	No Further Action
TPH C6-C8	mg/kg	73	9	<0.1	N/A	2	No Further Action
TPH C8-C10	mg/kg	19	9	<0.1	N/A	2	No Further Action
TPH C10-C12	mg/kg	69	9	<10	N/A	2	No Further Action
TPH C12-C16	mg/kg	140	9	14	N/A	2	No Further Action
TPH C16-C21	mg/kg	250	9	67	N/A	1	No Further Action
TPH C21-C35	mg/kg	890	9	230	N/A	1	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; NFD = No Fibres Detected
* 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. E3P has utilised the Tier 1 values for aliphatic compounds for the volatile and semi volatile fractions (C_5-C_{12}) and the Tier 1 values for aromatic compound for the non-volatile fractions (C_{12}-C_{35}). 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)
**pC4SL

Further Assessment

Referring to Table 10.1 overleaf, the direct comparison identified that screening values for the following contaminants have been exceeded based on a residential end use:

- Arsenic
- Lead
- Benzo(a)anthracene;

The laboratory analysis confirms the assessment within the initial conceptual site model that the main constituents of concern were likely to be PAHs and heavy metals.

In relation to these exceedances, the following can be determined:

- The main exposure pathways based on the Tier I exceedances are:

    1. Dermal contact; and
    2. Soil ingestion and consumption of home-grown vegetables.

- The two exceedances of arsenic and benzo(a)anthracene within the shallow Made Ground soils (<1.0m bgl) are marginally exceeding the Preliminary Category 4 Screening Level of 37mg/kg and 3.1mg/kg, respectively;

- The three exceedances of lead are associated with extensive shallow Made Ground deposits; and

- Asbestos was identified within 7 No. samples analysed from all areas of the site.

Risk Assessment and Mitigation

The aforementioned exceedances pose a potential risk to the future end users of the site through dermal contact and soil ingestion. It is therefore considered that the risks to construction workers during the development can be mitigated through the use of appropriate PPE and good site hygiene.

The marginal non-volatile exceedances are all of low solubility. For the avoidance of any doubt the soil results have been assessed using the Tier 1 GAC for a residential end use with plant uptake to take into account the exposure pathways of small children playing in external garden and soft landscaped areas of the proposed development.

Given the presence of asbestos fibres within the Made Ground, a suitably detailed remediation strategy will be required to document the safe handling, management and placement of all Made Ground so as to ensure that no unacceptable degree of risk is presented to construction workers or future site occupants. Supplementary investigations are required to quantify the asbestos and fully inform the aforementioned strategy.

The shallow Made Ground will not be suitable for use as Topsoil within any proposed gardens or landscaped areas due to the presence of asbestos containing material identified across the entire site and localised elevated PAH and heavy metal compounds. Therefore, a suitable cover system will be required, thereby removing any dermal contact/ingestion pathways and the risk to the identified receptors.

10.2 Controlled Waters Risk Assessment

The groundwater vulnerability map shows the site drift and solid deposits to be classified as a Secondary A Aquifers which therefore represent a high sensitivity risk receptor. However, there are no potable drinking water abstractions within 1km of the site and the aquifer is afforded protection by the overlying likely low permeability Glacial Till. Therefore a Tier I risk assessment has been undertaken with concentrations of determinants compared with the relevant thresholds. These are presented in Table 10.2 overleaf.

Table 10.2 Comparison of Groundwater Analysis with Tier 1 Screening Levels

Determinand	Units	EQS (V1)	Drinking Water Threshold	n	MC	No of Ex	Loc of Ex	Assessment
Inorganics								
Arsenic	µg/l	50	10	1	<0.15	N/A	N/A	No Further Action
Cadmium	µg/l	5	5	1	<0.02	N/A	N/A	No Further Action
Chromium (VI)	µg/l	2	50	1	<5.0	N/A	N/A	No Further Action
Copper	µg/l	5	2000	1	1.3	N/A	N/A	No Further Action
Cyanide	µg/l	-	50	1	<10	N/A	N/A	No Further Action
Lead	µg/l	4	10	1	<0.2	N/A	N/A	No Further Action
Mercury	µg/l	1	1	1	<0.05	N/A	N/A	No Further Action
Nickel	µg/l	8	20	1	3.7	N/A	N/A	No Further Action
Selenium	µg/l	-	10	1	4.1	N/A	N/A	No Further Action
Organics								
Napthalene	µg/l	10	-	1	<0.01	N/A	N/A	No Further Action
Benzo(a)pyrene	µg/l	0.05	0.01	1	<0.01	N/A	N/A	No Further Action
benzo[b/k]fluoranthene	µg/l	0.03	-	1	<0.01	N/A	N/A	No Further Action
benzo[g,h,i]perylene & indeno(1,2,3-cd]pyrene	µg/l	0.02	-	1	<0.01	N/A	N/A	No Further Action
Total Petroleum Hydrocarbons##	µg/l	-	10	1	<10	N/A	N/A	No Further Action
TPH C_5-C_6	µg/l	-	10	1	<10	N/A	N/A	No Further Action
TPH C_6-C_8	µg/l	-	10	1	<10	N/A	N/A	No Further Action
TPH C_8-C_{10}	µg/l	-	10	1	<10	N/A	N/A	No Further Action
TPH C_{10}-C_{12}	µg/l	-	10	1	<10	N/A	N/A	No Further Action
TPH C_{12}-C_{16}	µg/l	-	10	1	<10	N/A	N/A	No Further Action
TPH C_{16}-C_{21}	µg/l	-	10	1	<10	N/A	N/A	No Further Action
TPH C_{21}-C_{35}	µg/l	-	10	1	<10	N/A	N/A	No Further Action

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 10.2, the results of this direct comparison indicates that the data does not exceed any of the Tier 1 screening criteria for controlled waters and as such no risk to the identified receptors has been identified.

10.3 Ground Gas Risk Assessment

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). However, it is recommended that the full ground gas assessment and recommended 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.

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

- *Underlying Coal Measures;*
- *Deep Made Ground (to a maximum proven depth of 6.90m bgl);*
- *A historic refuse tip located in the north-western sector of the site; and*
- *A registered landfill located 43m west of the site boundary.*

During the monitoring visit completed to date no elevated concentrations of methane and only slightly elevated concentrations of carbon dioxide (3.8%v/v) were recorded.

Monitoring undertaken to date has been completed in periods of high atmospheric pressure (>1000mb).

In accordance with the methodology outlined with the CIRIA publication C665, E3P has utilised the results of the ground gas monitoring surveys to calculate a tentative Gas Screening Value (GSV). The calculated GSVs reflect the absence of any flow with CIRIA C665 stating that in instances where the maximum GSV for carbon dioxide and methane is <0.07 l/hr and typical methane and carbon dioxide are less than 1% v/v and 5% v/v respectively, then this is equivalent to Characteristic Situation 1.

This suggests that no special precautions are required as there is a very low risk to future site users.

However, this is an interim assessment based on preliminary ground gas readings completed during periods of high atmospheric pressure. The final classification will be supplied as an addendum to this report on completion of the remaining monitoring visits.

10.4 Conceptual Model

Following the completion of the intrusive site investigation, chemical analysis and risk assessment, the conceptual site model has not identified any potentially significant contaminant sources or industrial land uses on-site or within the wider area that would prejudice the proposed residential development at the site.

11.0 GEOTECHNICAL ASSESSMENT

11.1 Summary of Ground Conditions

Ground conditions identified at the site are summarised in Table 11.1 below:

Table 11.1 Summary of Ground Conditions

Strata:	General Description:	Typical Depth (mbgl):			
		Top:		Base:	
		Min:	Max:	Min:	Max:
MADE Ground					
Sandy / Gravelly Clay	MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, sub-angular to sub-rounded of brick, concrete, ash and clinker.	0.00	0.00	0.15	3.00
Clayey / Sandy Gravel	MADE GROUND: Black sandy clayey gravel. Gravel is fine to coarse, angular to sub-angular of brick, concrete, ash, clinker and timber fragments.	0.28	1.90	0.56	6.90
Gravelly Sand	Black clayey gravelly sand. Gravel is fine to coarse, angular to sub-rounded of sandstone, concrete, brick, ash, clinker and occasional timber.	0.10	0.70	0.46	3.50
Natural STRATA					
SAND	Brown mottled grey very clayey medium SAND with angular to sub-angular sandstone cobbles.	0.63	0.63	1.60	1.60
Gravelly CLAY	Stiff grey silty gravelly CLAY with cobbles. Gravel is fine to coarse, sub-angular to sub-rounded of sandstone. Cobbles are sub-rounded of sandstone.	2.80	2.80	8.45	8.45
Sandy CLAY	Firm to stiff brown grey sandy CLAY with cobbles. Cobbles are sub-rounded of sandstone.	0.38	6.90	1.40	10.10
COAL	COAL	10.10	10.10	10.86	10.86

11.2 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 in-filled with suitable compacted engineered fill; and,
- Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill; and
- Buried structures and old foundations have not been encountered on site. If any are located (albeit not anticipated) these should be excavated from below the proposed development footprint with the resulting void backfilled.

11.3 Foundation Conditions and Bearing Capacity

Assessment of Potential Bearing Capacities

In due consideration of the identified ground conditions, in-situ and laboratory geotechnical testing, E3P has undertaken an assessment of the net safe Allowable Bearing Pressure (ABP) within the underlying natural stratum to assist in the detailed design of foundations and infrastructure and determine the target founding stratum.

Granular Soils			
Description	**Depth (range m BGL)**	**Relative Density**	**Allowable Bearing Pressure (kN/m2)**
Clayey/sandy GRAVEL	1.00 – 1.45	Very Loose - Loose	20 – 40
Clayey/sandy GRAVEL	2.00 – 2.45	Loose	55 – 75
Clayey/sandy GRAVEL	3.00 – 4.45	Very Loose – Medium Dense	35 – 170
Cohesive Soils			
Description	**Depth (range m BGL)**	**Undrained Shear Strength (Cu) kN/m2**	**Allowable Bearing Pressure (kN/m2)**
Stiff to very stiff gravelly/sandy CLAY	1.00 – 1.45	40 – 245	<80 – 505
Stiff to very stiff gravelly/sandy CLAY	2.00 – 2.45	<20 – 150	<40 – 310
Soft to very stiff gravelly/sandy CLAY	3.00 – 3.45	<5 – 220	<10 – 450
Stiff to very stiff gravelly/sandy CLAY	4.00 – 4.45	125 – 170	260 – 350

Based on the assessment of the relative undrained shear strength, relative in-situ densities and corresponding safe net Allowable Bearing Potential, a suitable target founding stratum has not been wholly determined given the depth and variability of Made Ground.

The Made Ground is not considered suitable bearing stratum to support a shallow foundation due to the unquantified potential for long term differential and total settlement.

It is considered the proposed foundations could be supported using vibro replacement granular stone columns to facilitate the use of shallow (re-enforced) strip foundations within the treated Made Ground.

Alternatively, structural loading could be transferred to the deep natural drift deposits though a driven pile foundation to be designed by a specialist contractor and the Structural Engineer.

11.4 Ground Floor Slabs

Due to the presence of substantial thickness' of Made Ground across the site is considered that ground bearing floor slabs, whilst viable, will require detailed design to accommodate variability of the formation and account for differential settlement.

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 gas ingress issues.

11.5 Pavement Construction

An assessment of the likely California Bearing Ratio (CBR) has not been undertaken as part of this report due the extensive variable Made Ground. It is, however, considered that a CBR of less than 3% may be required to account for variability of the Made Ground. Therefore a geotextile re-enforcement layer and additional capping to the sub-base may be required to ensure the most economic road construction.

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

11.6 Drainage

The presence of substantial depths of Made Ground across areas of 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.

Furthermore, the site is predominantly underlain by circa 3-4m of likely low permeability gravelly and/or sandy CLAY and as such the use of soak-away drainage will be limited.

If soak-away drainage is to be considered, full BRE365 Testing must be completed to inform the detailed design.

11.7 Concrete Durability

Based upon the results of the chemical analyses summarised in 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).

11.8 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 possible relic foundations. It is anticipated that any obstructions will be grubbed out during the reduced level dig for the sub structure works.

Due to the depth and variability of the Made Ground and likelihood of trench collapse it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA R97.

11.9 Minerals

The site has been historically mined/worked although mining has ceased. There are no longer expected to be minerals of economic value underlying the site at shallow depth and mining is considered to be very unlikely. The site is considered to be minerally stable.

11.10 Further Works

Based on the findings of the site investigation, the following additional works are recommended to be completed in due course:

- Further investigation utilising Rotary boreholes to determine the presence of shallow mine workings and/or stabilisation by drilling and grouting beneath proposed buildings throughout the site;
- Plot Specific Foundation Schedule;

- Materials Management Plan; and
- Geo-technical Earthworks Strategy (Infrastructure).

11.10 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;
- 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).

12.0 CONCLUSIONS & RECOMMENDATIONS

Geotechnical Assessment

Compressible ground and subsidence hazards have been identified associated with historical shallow mine workings in the locality for which there are no records of stabilisation. As such special precautions with regard to foundations may be required. A number of relic foundations and obstructions were encountered during the intrusive Ground Investigation.

The Made Ground is not considered suitable bearing stratum to support a shallow foundation due to the unquantified potential for long term differential and total settlement.

It is considered the proposed foundations could be supported using vibro replacement granular stone columns to facilitate the use of shallow (re-enforced) strip foundations within the treated Made Ground.

Alternatively, structural loading could be transferred to the deep natural drift deposits though a driven pile foundation to be designed by a specialist contractor and the Structural Engineer. It is considered the predominantly cohesive soils matrix underlying the Made Ground is unlikely to provide a high degree of soakage potential for drainage systems.

The Made Ground and shallow clay soils can be re-engineered to facilitate the construction of a suitable sub-grade to provide a CBR design % in excess of 5 for new highways and infrastructure.

Based upon the results of the chemical analyses the concrete classification will be DS-1 AC-1s.

Revised Conceptual Site Model

Human Health

The Tier 1 human health risk assessment identified elevated concentrations of benzo(a)anthracene, lead and arsenic which exceed the GAC values within the near surface soils. In addition, asbestos was encountered in a number of Made Ground samples from across the proposed development.

Further investigation and detailed quantitative risk assessment to determine the concentrations of asbestos within the impacted made ground and inform the production of a detailed Remediation Strategy that will ensure the mitigation of risk to all identified receptors;

E3P considers the shallow Made Ground will not be suitable for use as Topsoil within any proposed gardens or landscaped areas due to the presence of asbestos containing material identified across the entire site and localised elevated PAH and heavy metal compounds. Therefore E3P recommends a suitable cover system will need to be provided, thereby removing any dermal contact/ingestion pathways and the risk to the identified receptors.

Controlled Water

The Tier 1 controlled water assessment has not identified any potential source, pathway or viable receptor, therefore given the absence of any potentially complete pollutant linkage the site is determined to pose no unacceptable level of risk to controlled waters and the wider environ.

Ground Gas

Monitoring to date has identified no elevated concentrations of potentially hazardous ground gasses and as such the initial assessment suggests that no specialist mitigation measures are required. However monitoring is ongoing and the final assessment will be subject to the collation of a full dataset.

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 E3P 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 be 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 E3P 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 of 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. E3P cannot 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 E3P 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 E3P in this connection without their explicit written agreement there to by E3P.

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

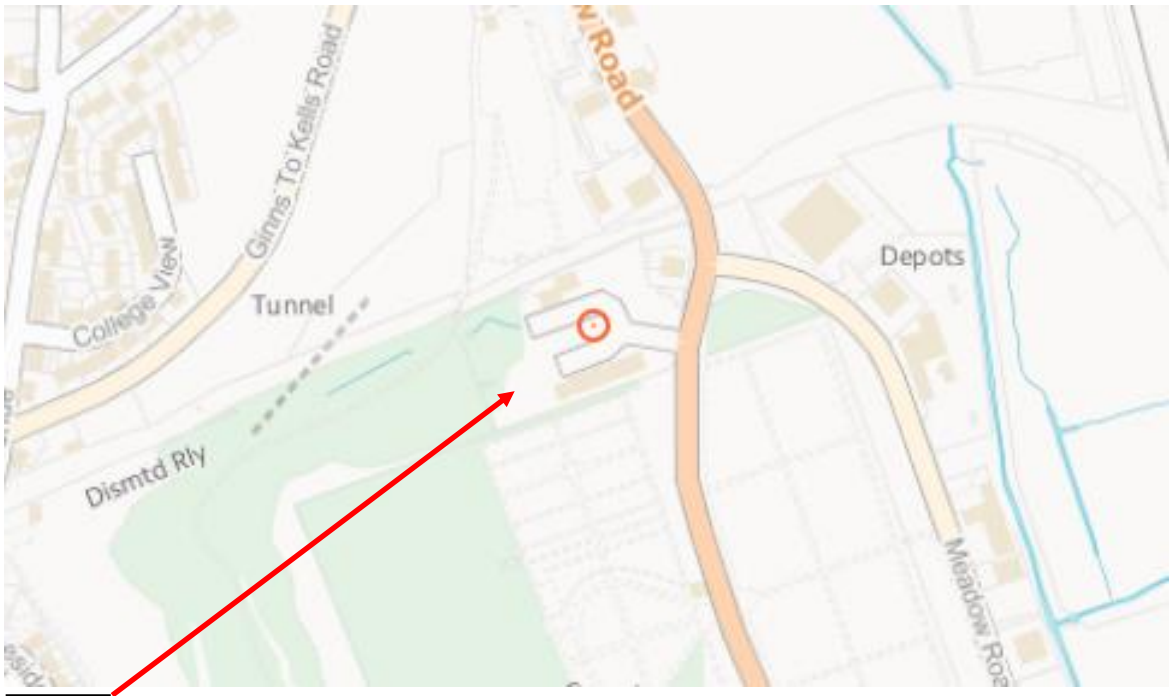
AST	Above Ground Storage Tank
BGS	British Geological Survey
BSI	British Standards Institute
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research Association
CLEA	Contaminated Land Exposure Assessment
CSM	Conceptual Site Model
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

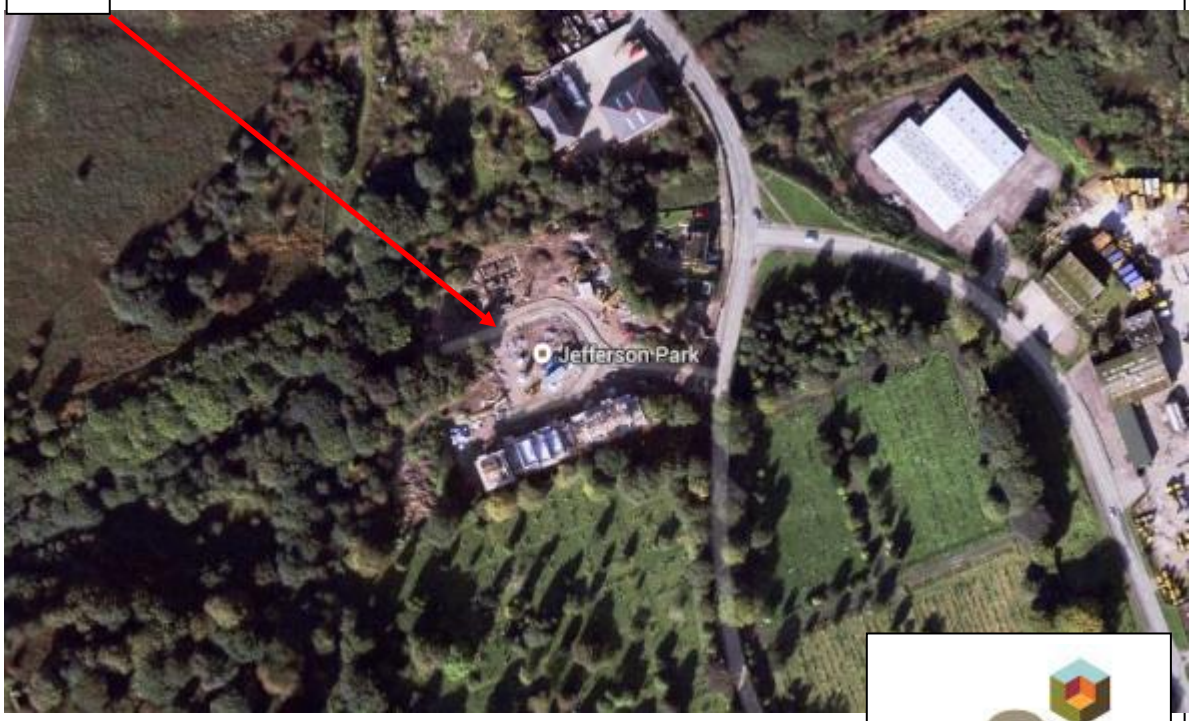
m	Metres
km	Kilometres
%	Percent
%v/v	Percent volume in air
mb	Milli Bars (atmospheric pressure)
l/hr	Litres per hour
µg/l	Micrograms per Litre (parts per billion)
ppb	Parts Per Billion
mg/kg	Milligrams per kilogram (parts per million)
ppm	Parts Per Million
mg/m^3	Milligram per metre cubed

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

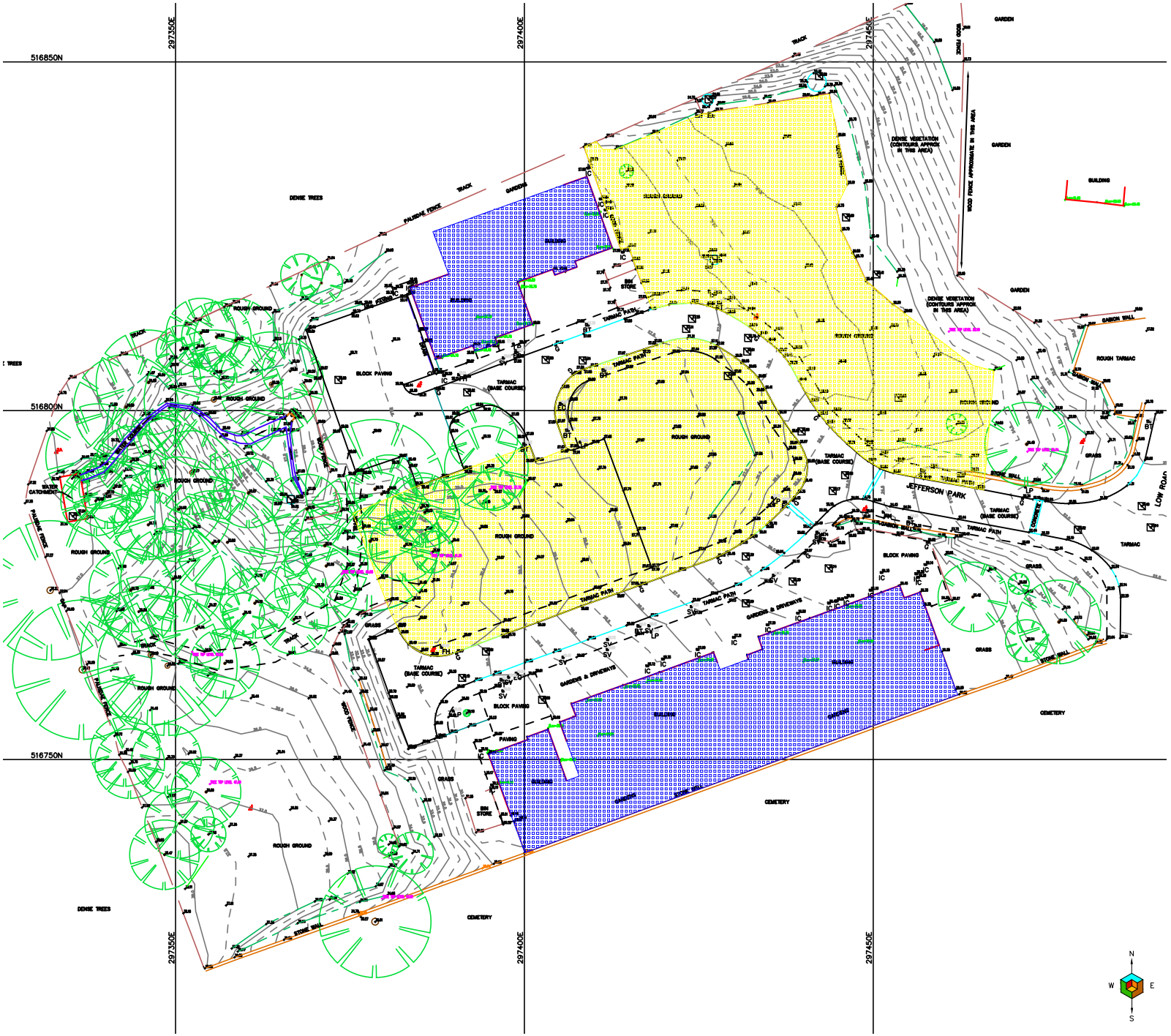
APPENDIX III
DRAWINGS



Site



Site Location Map



Key:

- Existing Residential Buildings.
- Grass (Undeveloped)

Notes:

Phase	Revision	Date	Issue	Drawn	Authorised
				JM	ST

Client: R.G.Parkins and partners Ltd

Job No: 10365

Date: 08-12-2014

Drawing No: 002

Scale: NTS @ A4

Job Title: Jefferson Park

Drawing Title: Current Site Layout

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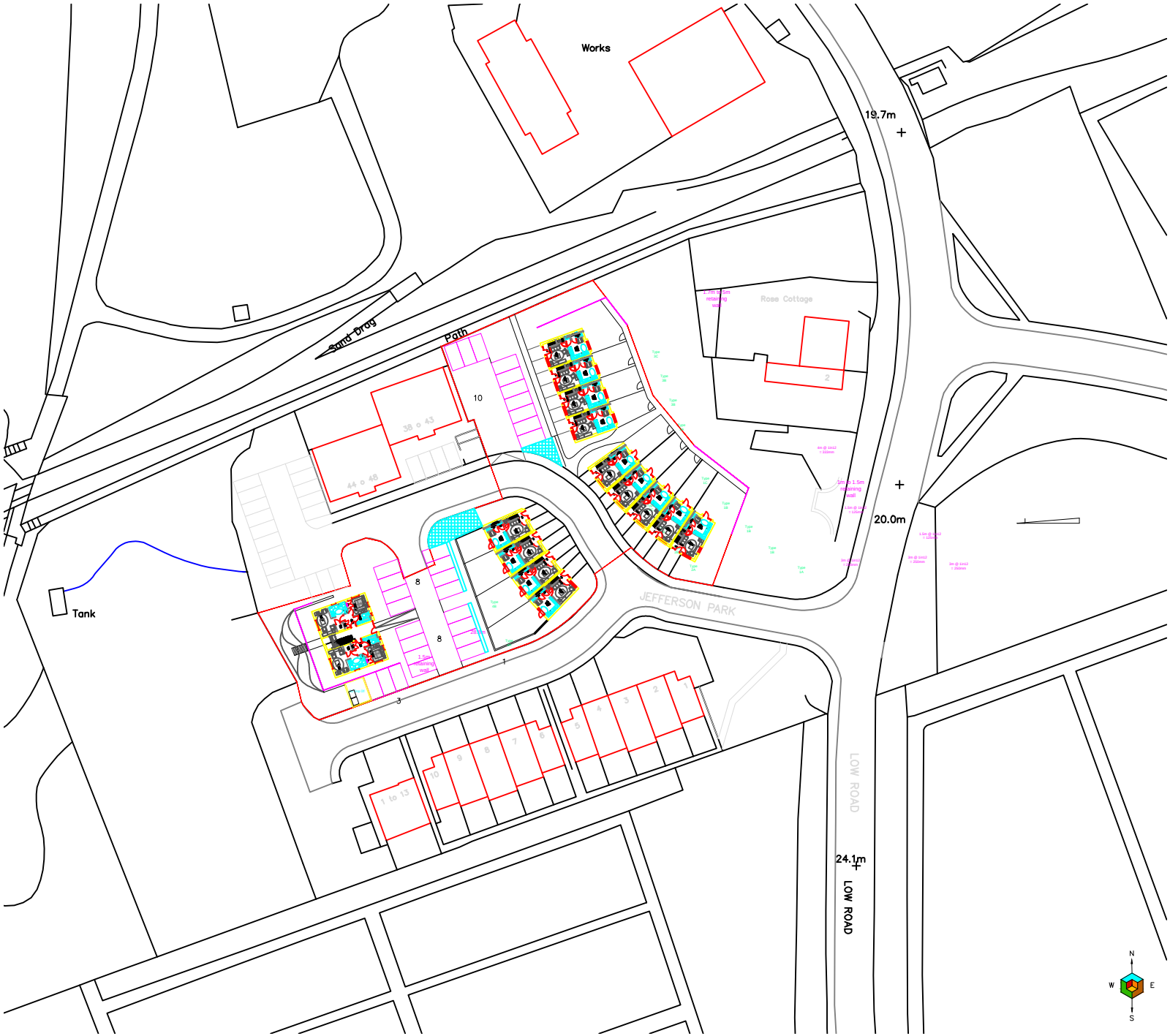

Key:

Notes:

Phase	Revision	Date	Issue	Drawn	Authorised
				JN	ST

Client: R.G.Parkins and partners Ltd

Job No: 10365

Date: 08-12-2014

Drawing No: 003

Scale: NTS @ A4

Job Title: Jefferson Park

Drawing Title: Proposed Development

e3p

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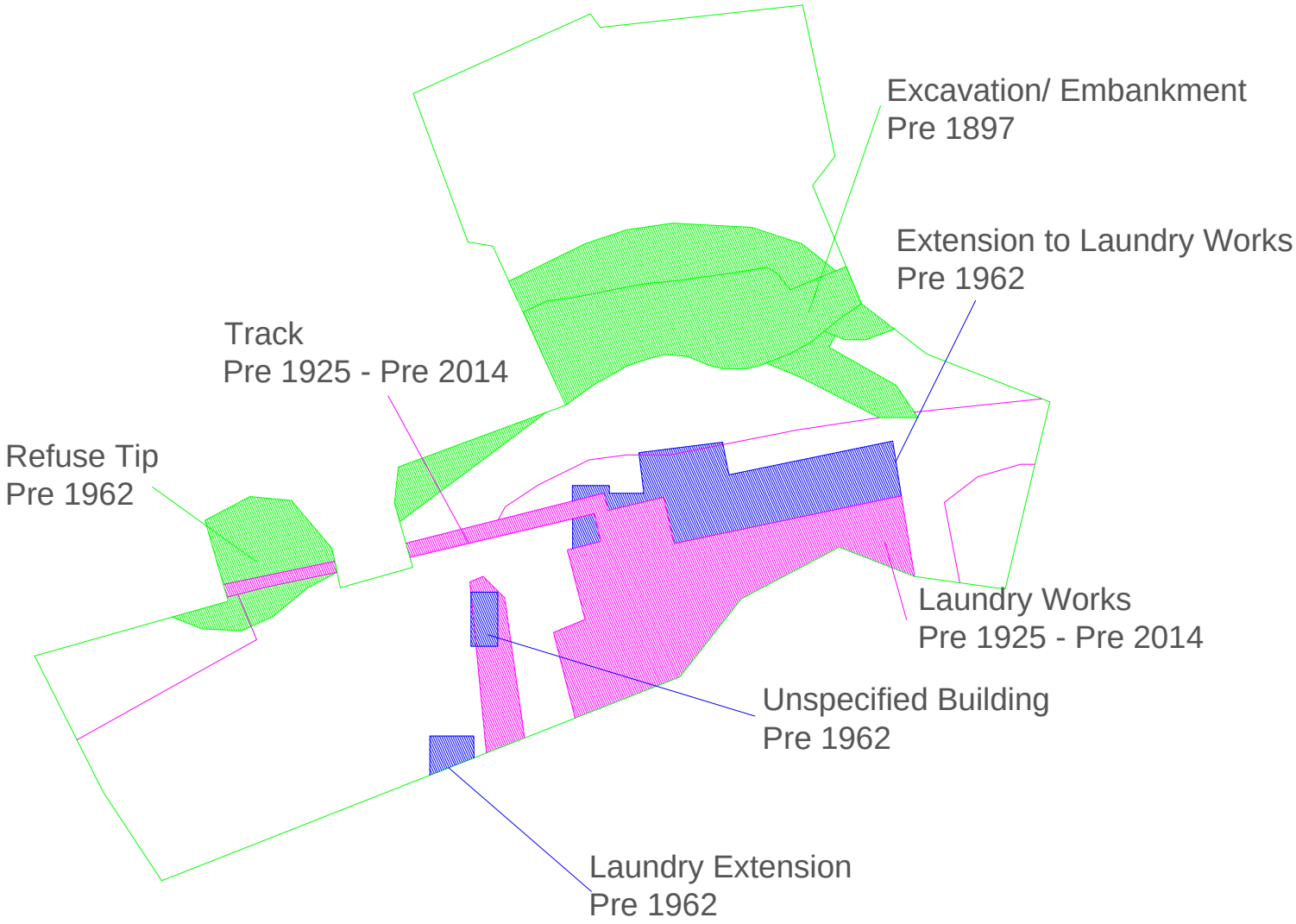

Key:

Areas of Excavation / Possible In-filled Ground

Notes:

P1 P1	Revision Original	12-01-2015 08-12-2014	R1 R0	JN JM	AS AS
Phase	Revision	Date	Issue	Drawn	Authorised

Client: R.G.Parkins and partners Ltd

Job No: 10365

Date: 08-12-2014

Drawing No: 004

Scale: NTS @ A4

Job Title: Jefferson Park

Drawing Title: Historical Features

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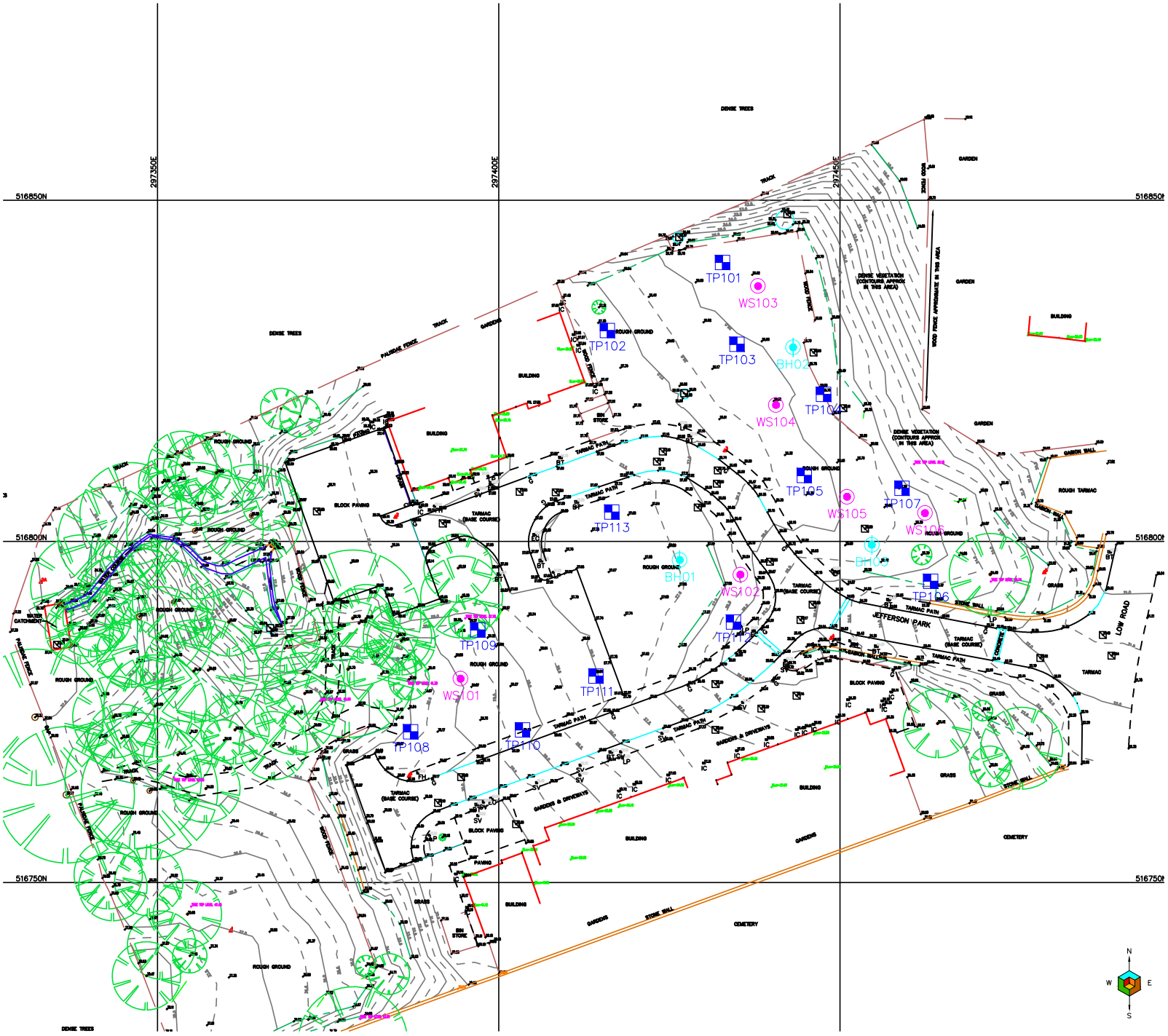

Key:

- WS101 — Approximate Window Sample Probehole Location
- WS101 — Approximate Window Sample Probehole Location
- TP101 — Approximate Trial Pit Location
- TP101 — Approximate Hand Dug Pit Location
- CP101 — Approximate Cable Percussive Borehole Location
- RB101 — Approximate Rotary Borehole Location
- CBR101 — Approximate California Bearing Ratio Test Location
- DCP101 — Approximate Dynamic Cone Penetrometer Test Location

Notes:

Phase	Revision	Date	Issue	Drawn	Authorised
				JM	ST

Client: R.G.Parkins and partners Ltd	Job No: 10365
	Date: 08-12-2014
	Drawing No: 005
	Scale: NTS @ A4
Job Title: Jefferson Park	Drawing Title: Exploratory Hole Location Plan

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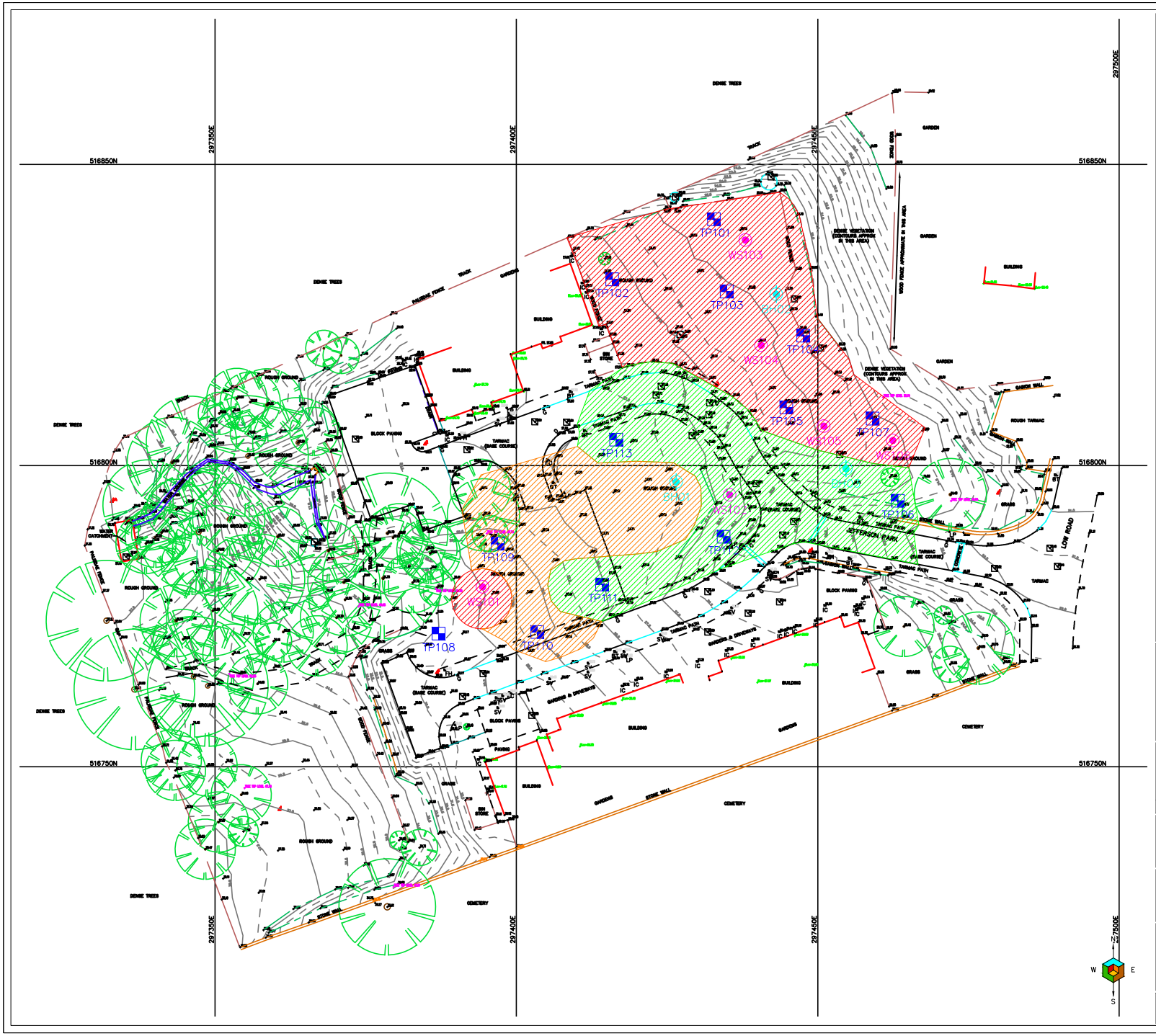

Key:

- Approximate Window Sample Probehole Location
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location
- 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+

Notes:

Phase	Revision	Date	Issue	Drawn	Authorised
P1	R0	13/01/2015	Draft	JN	AS

Client: R.G.Parkins and partners Ltd

Job No: 10365

Date: 08-12-2014

Drawing No: 006

Scale: NTS @ A4

Job Title: Jefferson Park

Drawing Title: Depth of Made Ground

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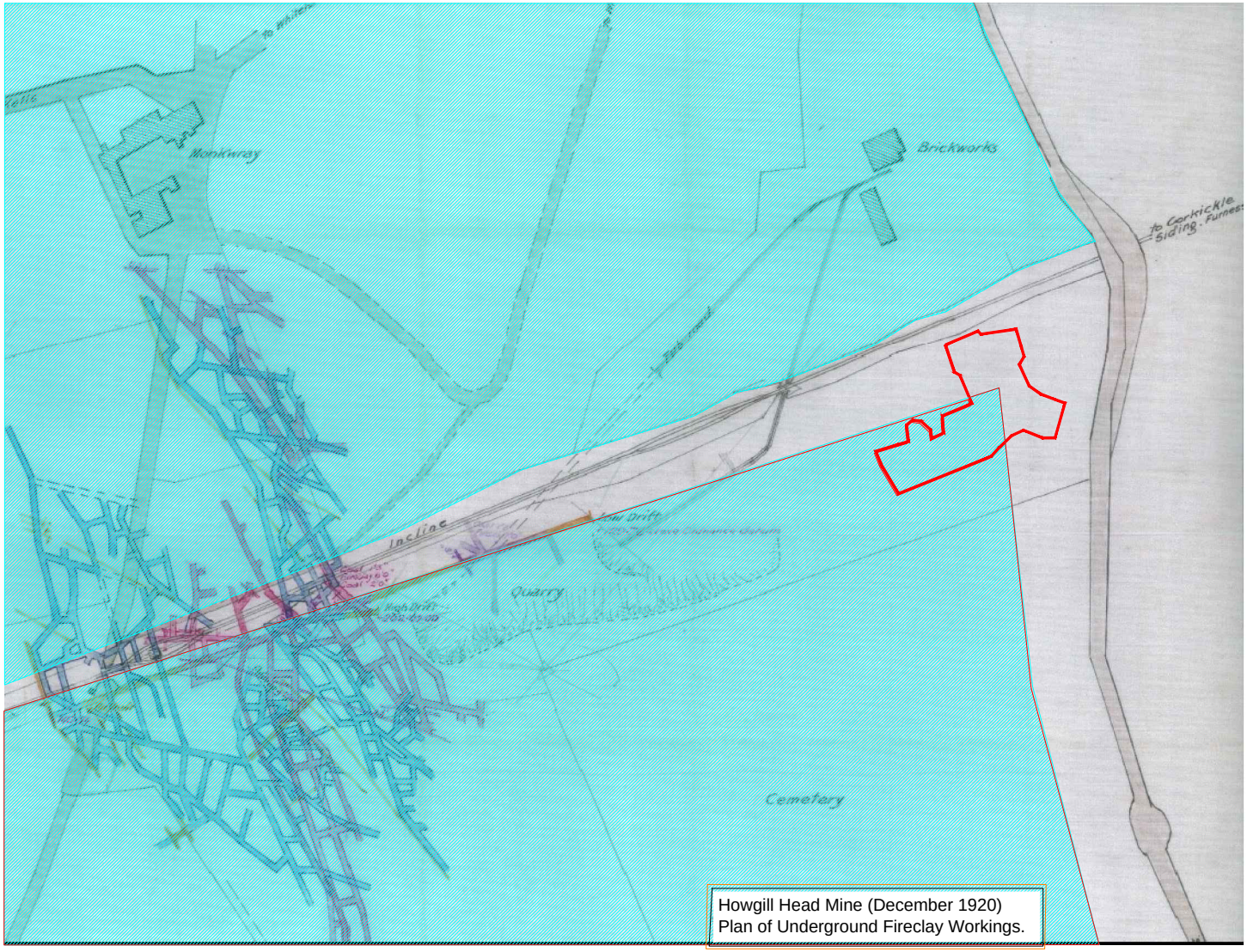

Howgill Head Mine (December 1920)
Plan of Underground Fireclay Workings.

Key:

Whitehaven Main Coal - Partial or Full Extraction.

Proposed Development Site Boundary.

Notes:

Phase	Revision	Date	Issue	Drawn	Authorised
P1	R0	09/01/2015	Draft	JN	AS

Client: R.G.Parkins and partners Ltd

Job No: 10365

Date: 09-01-2015

Drawing No: 007

Scale: NTS @ A4

Job Title: Jefferson Park

Drawing Title: Mine abandonment Plan

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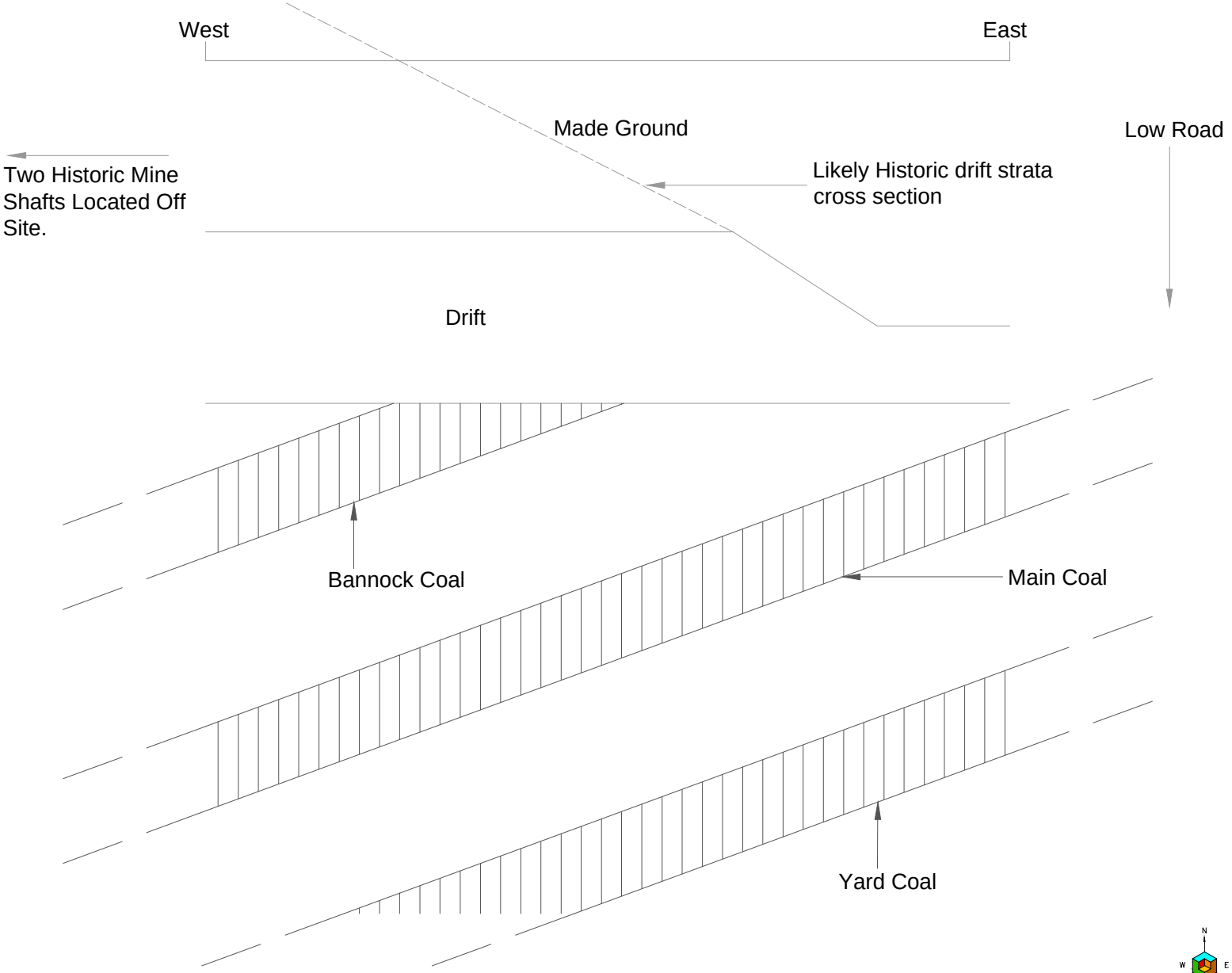
Representative Cross Section - Looking North



Notes:

R0	Original	09/01/2015	Draft	JN	ST
Phase	Revision	Date	Issue	Drawn	Authorised

Client: R.G.Parkins & Partners Ltd

Job No: 10365

Date: 09-01-2015

Drawing No: 008

Scale: NTS @ A4

Job Title: Jefferson Park

Drawing Title: Geological Mapping

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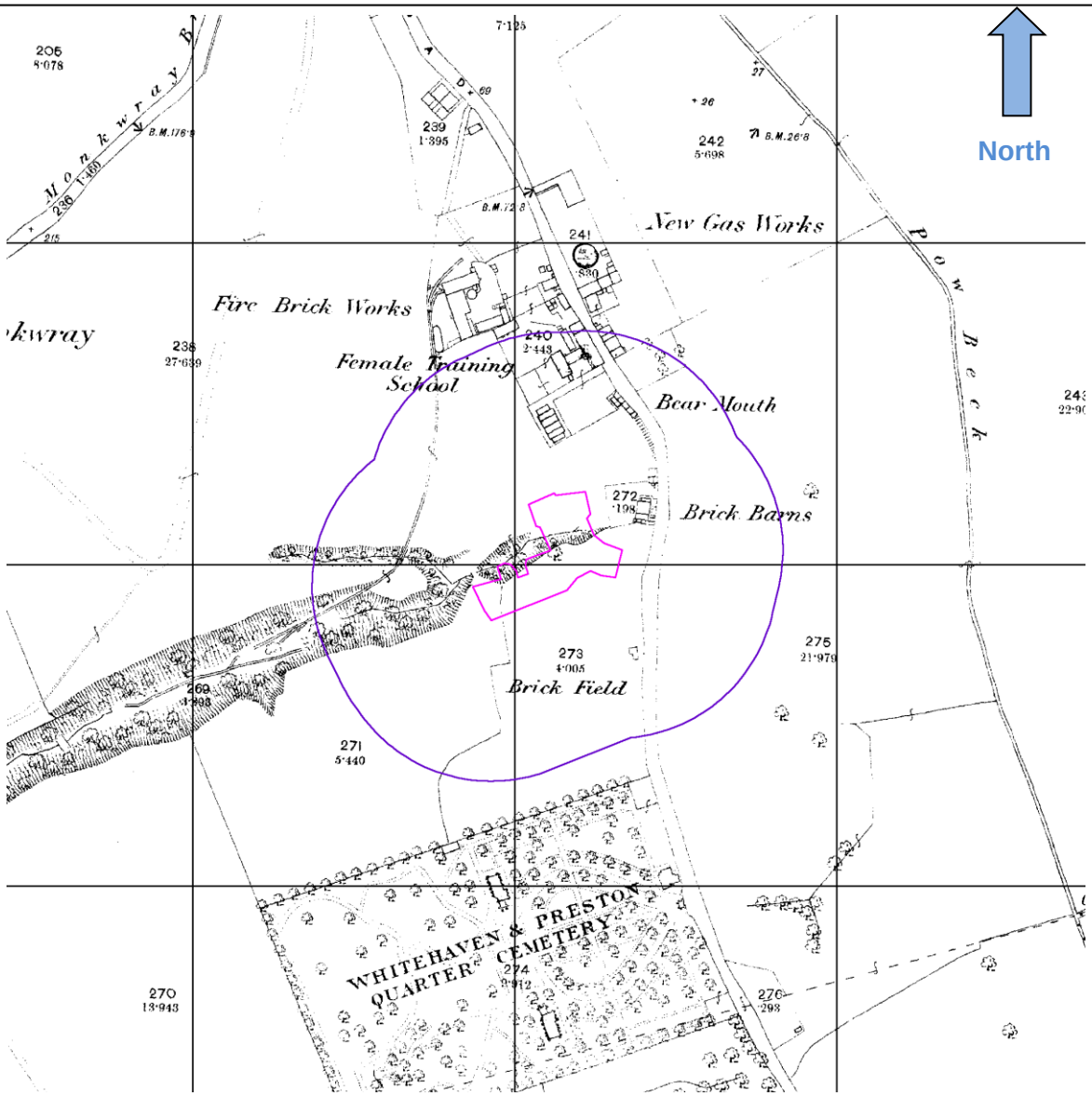
APPENDIX IV
PHOTOGRAPH

PLATE 1 – A VIEW OF THE SITE LOOKING EAST TOWARDS LOW ROAD.

PLATE 2 – A VIEW OF THE SITE LOOKING NORTHWEST TOWARDS EXISTING RESIDENTIAL DEVELOPMENT.

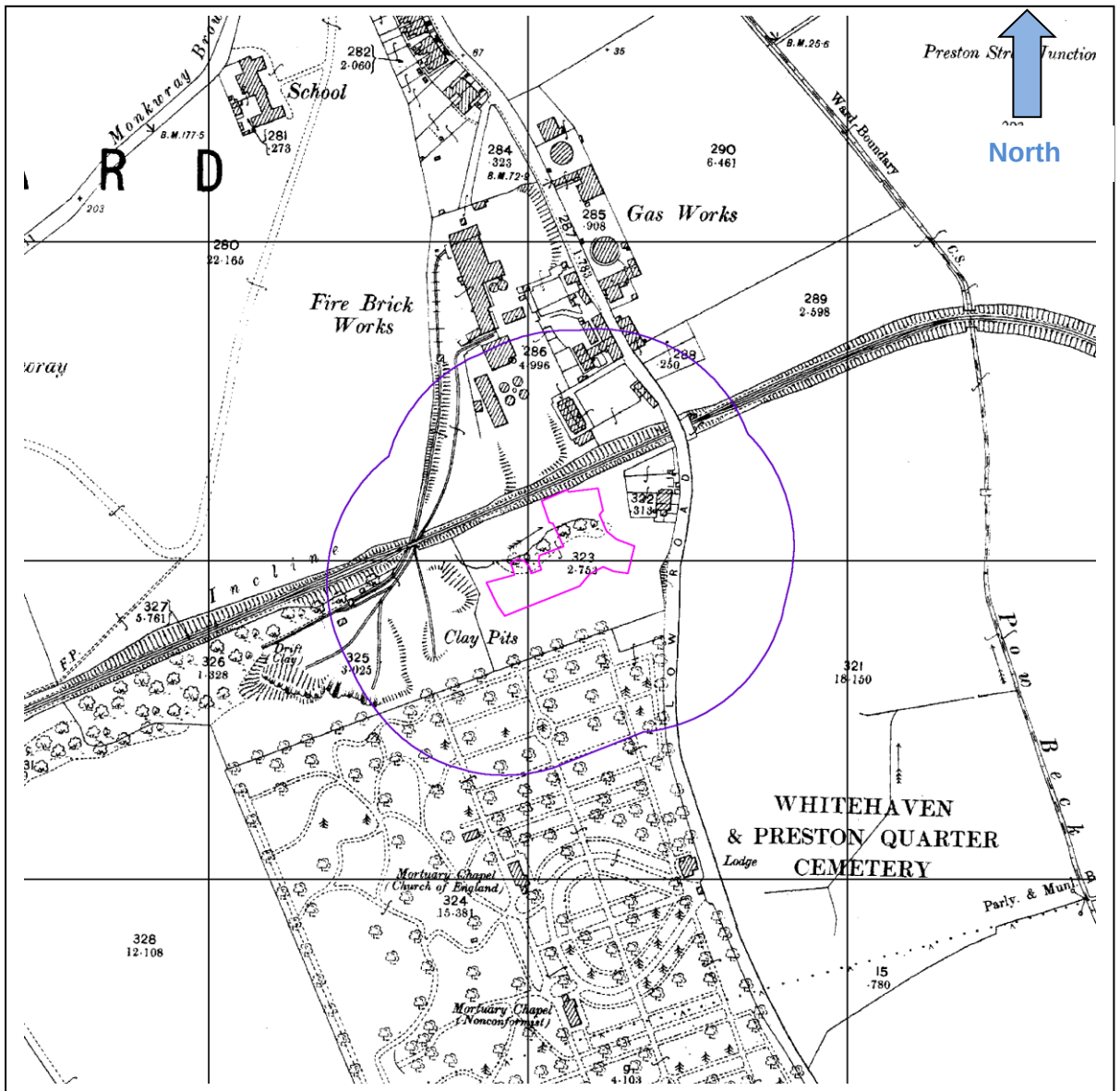
APPENDIX V
HISTORICAL MAPS



Historical Map

Dated: 1879

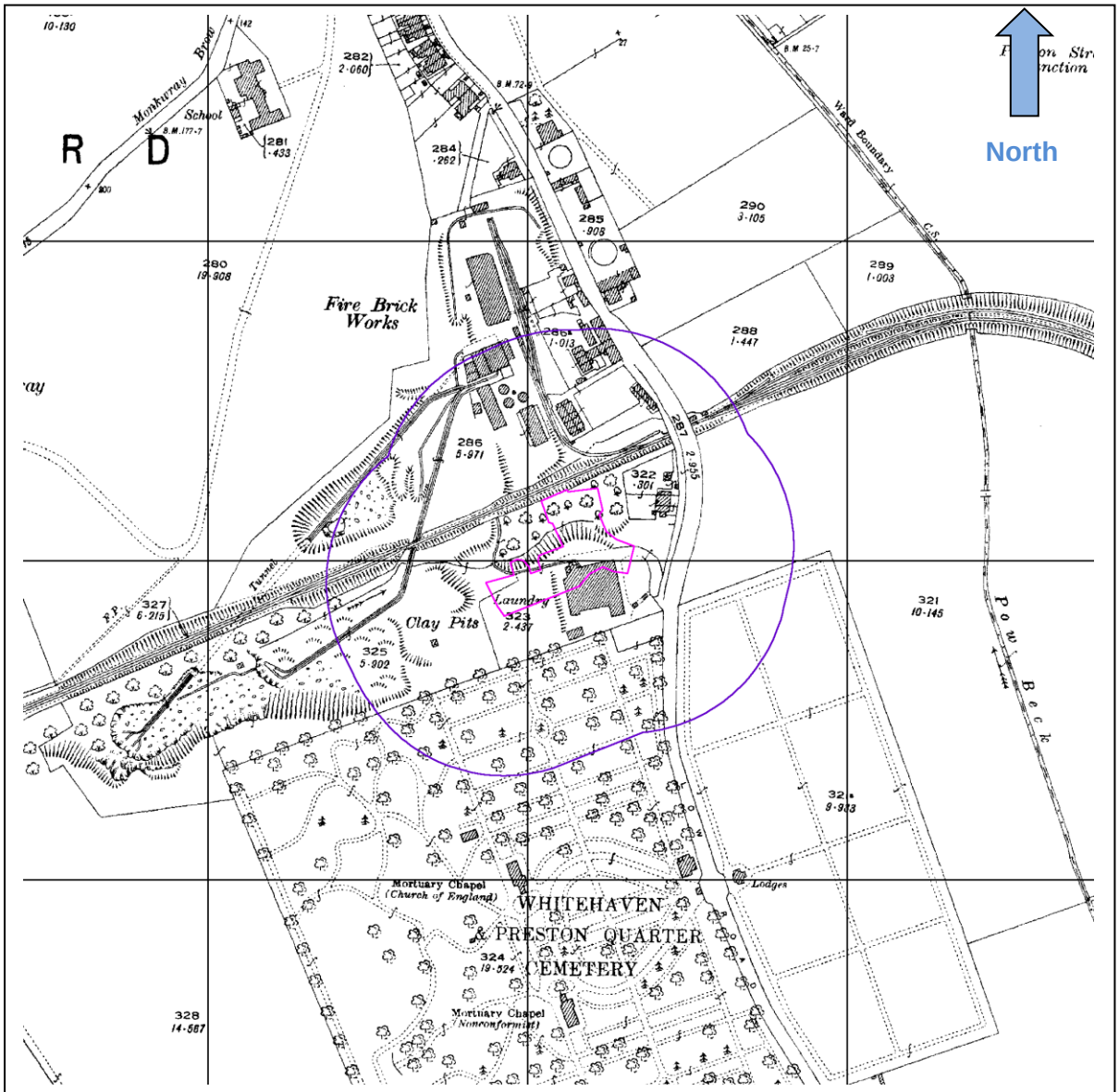
Original Scale: 1:2,500



Historical Map

Dated: 1899

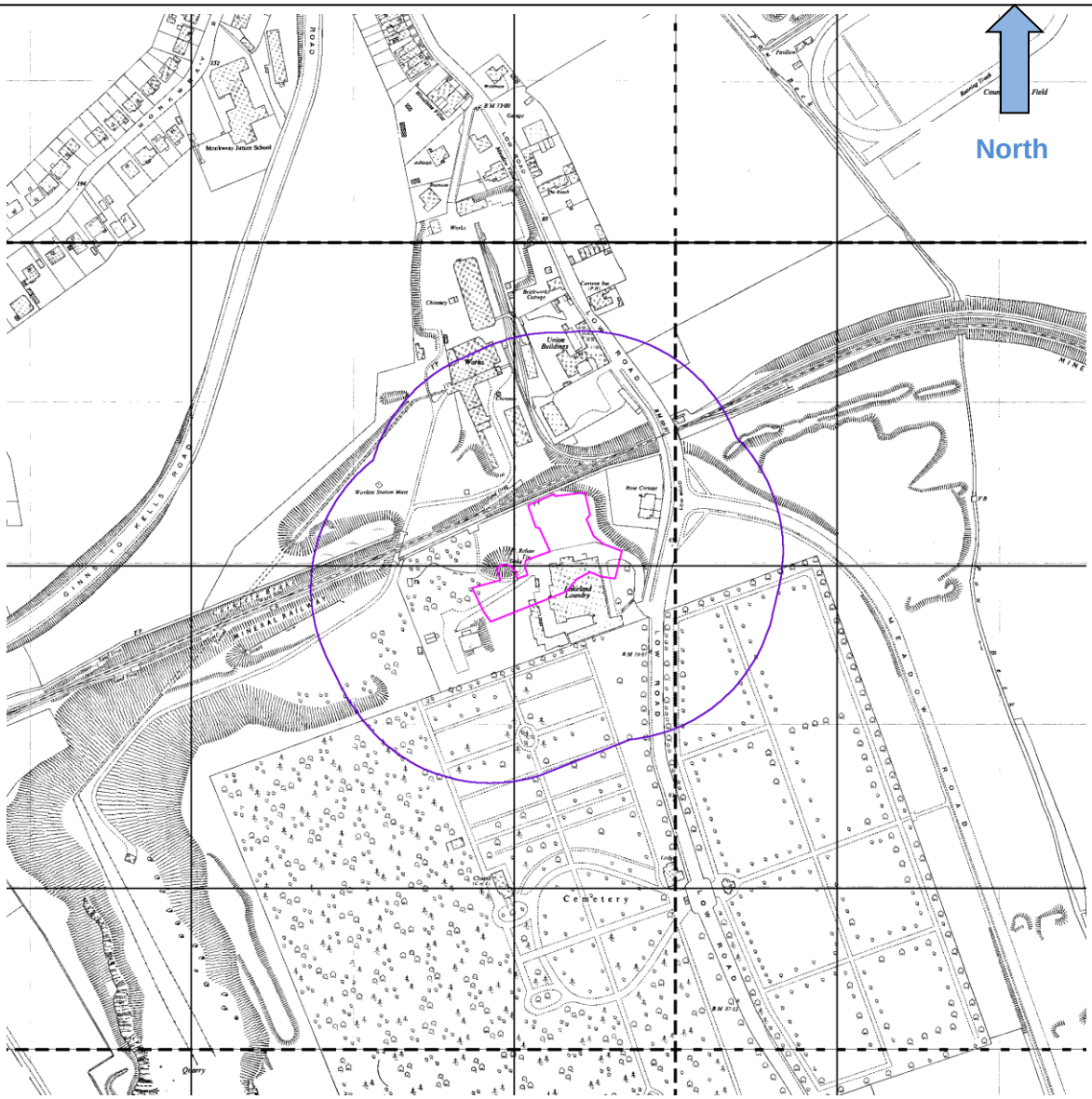
Original Scale: 1:2,500



Historical Map

Dated: 1925

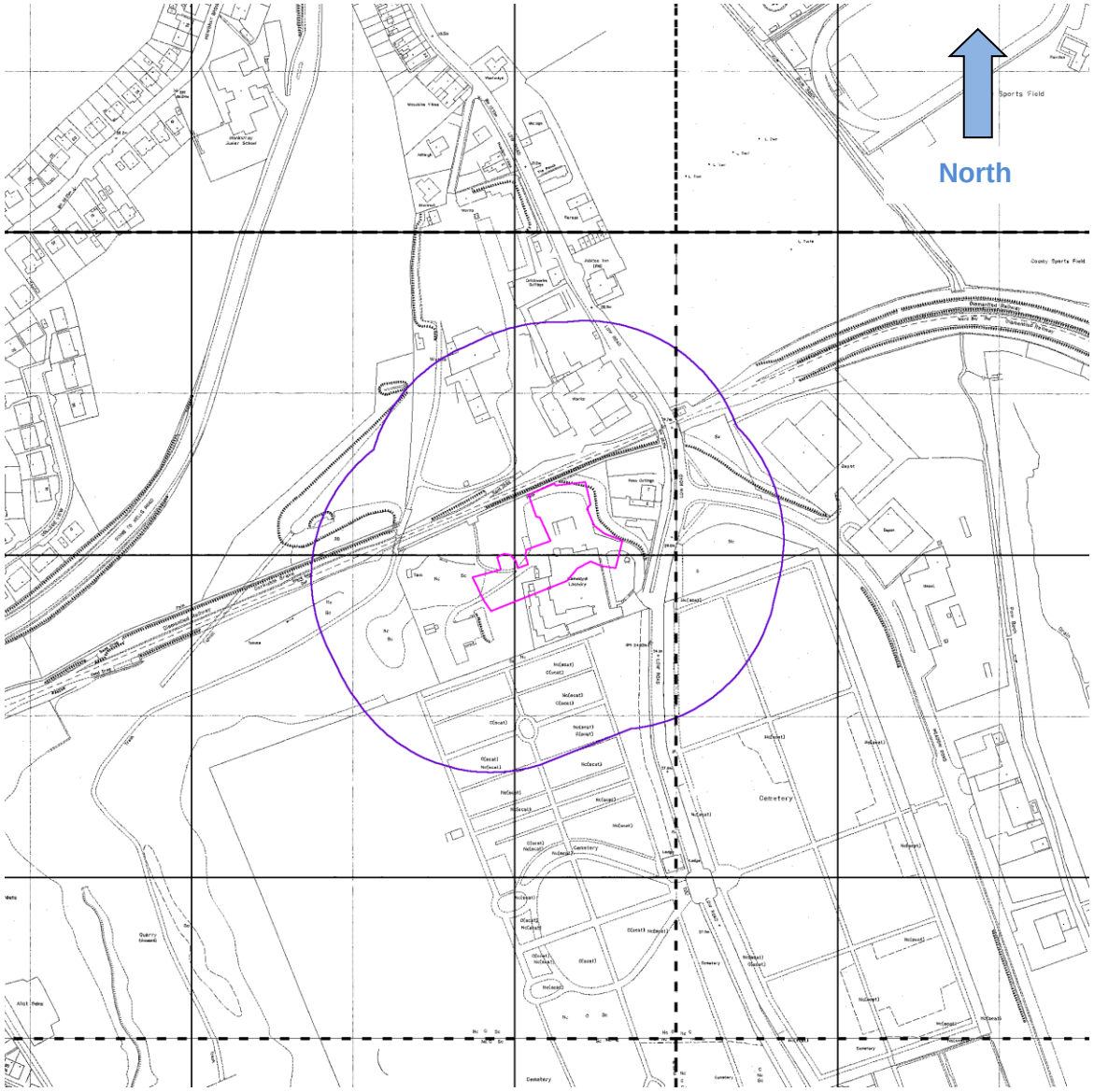
Original Scale: 1:2,500



Historical Map

Dated: 1962

Original Scale: 1:2,500



Historical Map

Dated: 1994

Original Scale: 1:2,500

APPENDIX VI
E3P EXPLORATORY LOGS

Borehole Log

Borehole No. **BH1**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type CP
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, sub-angular to sub-rounded of brick and concrete.
					0.60			MADE GROUND: Asphalt (historic road) and underlying gravel sub-base.
					0.90			MADE GROUND: Black Ash Fill.
		1.20		N=14 (2,3/3,3,4,4)	1.00			Stiff brown gravelly sandy CLAY. Gravel is fine to medium, sub-rounded of sandstone and mudstone with occasional coal.
		2.00		N=33 (4,6/7,8,8,10)				
		3.00		50 (6,10/50 for 225mm)	2.80			Very stiff grey silty gravelly CLAY with cobbles. Gravel is fine to coarse sub-angular to sub-rounded of sandstone. Cobbles are sub-rounded of sandstone.
		4.00		N=40 (7,8/9,9,10,12)				
		5.00		N=33 (14,6/10,6,6,11)				
		6.50		N=47 (3,4/15,18,7,7)				
		8.00		N=41 (10,11/19,5,8,9)				
					8.45			End of borehole at 8.45 m

1 2 3 4 5 6 7 8 9 10

Remarks

Borehole Log

Borehole No. **BH2**

Sheet 1 of 2

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type CP
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		1.20		N=3 (1,2/1,0,1,1)	1.30			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium angular to sub-rounded of sandstone, brick, ash and clinker.
		2.00		N=6 (1,2/1,1,2,2)				MADE GROUND: Black sandy clayey gravel. Gravel is fine to coarse, angular to sub-angular of brick, concrete, ash, clinker and timber fragments.
		3.00		N=13 (1,2/6,2,2,3)				
		4.00		N=20 (2,3/4,5,5,6)				
		5.00		50 (10,14/50 for 100mm)				
		6.50		N=7 (3,2/1,2,2,2)	6.90			Firm brown grey CLAY.
		8.00		N=20 (3,3/4,5,4,7)	8.20			Very stiff brown CLAY with cobbles. Cobbles are sub-rounded of sandstone.
		9.50		N=26 (2,3/4,5,7,10)				

Continued on next sheet

Remarks

Borehole Log

Borehole No. **BH2**

Sheet 2 of 2

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type CP
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					10.10			Coal
		10.50		50 (25 for 105mm/50 for 115mm)				End of borehole at 10.50 m
					10.86			

Remarks

Borehole Log

Borehole No. **BH3**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type CP
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 11/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.00			MADE GROUND: Dark brown firm to stiff gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone, concrete and brick.
		1.00		50 (25 for 70mm/50 for 75mm)	0.90			No recovery (Large obstruction).
		2.00		N=25 (12,6/6,6,6,7)				
		3.00		N=23 (3,4/5,5,6,7)	2.50			Very stiff brown CLAY with cobbles. Cobbles are sub-rounded of sandstone.
		4.00		N=30 (4,6/7,6,8,9)	3.50			Very stiff grey brown CLAY with cobbles. Cobbles are sub-rounded of sandstone.
		5.00		N=50 (7,10/12,14,16,8)				
		6.00		0 (75 for 100mm/0 for 0mm)	6.00			End of borehole at 6.00 m

Remarks

Trial Pit Log

Trialpit No **TP101**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 x 0.6 Depth 3.50	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
	1.00	ES					MADE GROUND: Black clayey gravelly sand. Gravel is fine to coarse, angular to sub-rounded of sandstone, concrete, brick and occasional timber. With occasional firm to stiff grey clay lenses.
	2.50	ES					
				3.50			End of pit at 3.50 m

1 2 3 4 5

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP102**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 × 0.6, Depth 2.70	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.50	ES					MADE GROUND: Brown very sandy gravelly clay with cobbles. Gravel is fine to coarse, anuglar to sub-rounded of concrete, brick, clinker, sandstone, metal drainpipe, pallet straps and occasional pots and rootlets. Cobbles are angular to sub-rounded of brick and sandstone. With a 100mm lense of ash, brick and clinker at circa 1.2m bgl.
	2.00	ES					
				2.70			End of pit at 2.70 m

1 2 3 4 5

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP103** Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 × 0.6, Depth 2.90	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	ES		0.28			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
	0.40	ES		0.56			MADE GROUND: Black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of clinker and ash.
			HVP=120	0.87			MADE GROUND: Very stiff light brown clay. With brick foundation at circa 0.75-0.90m bgl (east to west).
				2.90			MADE GROUND: Black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of clinker and ash.
							End of pit at 2.90 m

1 2 3 4 5

Remarks:

Stability: Unstable

Trial Pit Log

Trialpit No **TP104** Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 × 0.6, Depth 3.20	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	ES					MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
				0.38			
			HVP=64				MADE GROUND: Stiff light brown clay. With brick foundation at circa 0.75-0.90m bgl (east to west).
				0.70			
	1.40	ES					MADE GROUND: Dark brown clayey very gravelly sand with cobbles. Gravel is fine to medium, angular to sub-angular of ash, clinker, concrete sandstone and brick. Cobbles are angular to sub-angular of mudstone and old broken pipe.
				3.20			End of pit at 3.20 m

Remarks:

Stability: Unstable

Trial Pit Log

Trialpit No **TP105**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 x 0.6 Depth 3.15	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.12			MADE GROUND: Stiff to firm brown gravelly sandy clay. Gravel is fine to medium, sub-angular to sub-rounded of brick sandstone and concrete.
							MADE GROUND: Dark brown clayey very gravelly sand with cobbles. Gravel is fine to medium, angular to sub-angular of ash, clinker, concrete sandstone and brick. Cobbles are angular to sub-angular of mudstone.
				1.00			MADE GROUND: Red black clayey very gravelly sand with cobbles. Gravel is fine to medium, angular to sub-angular of ash, clinker, concrete sandstone and brick. Cobbles are angular to sub-angular of mudstone.
				1.90			MADE GROUND: Black clayey very sandy gravel. Gravel is fine to medium, angular to sub-angular of ash and clinker.
				2.10			Firm to Stiff brown gravelly very sandy CLAY. Gravel is fine to medium, sub-angular to sub-rounded of sandstone.
	2.50	ES	HVP=50				
				3.15			End of pit at 3.15 m

1 2 3 4 5

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP106**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 x 0.6 Depth 1.40	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	ES					MADE GROUND: Brown slightly gravelly sandy clay. Gravel is fine to coarse, angular to sub-rounded of brick, concrete and sandstone.
				0.38			Very stiff brown mottled grey sandy CLAY.
			HVP=119				
	1.10	ES					
				1.40			End of pit at 1.40 m

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP107**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 x 0.6 Depth 3.20	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.15			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
							MADE GROUND: Dark brown clayey very gravelly sand with cobbles. Gravel is fine to medium, angular to sub-angular of ash, clinker, concrete sandstone and brick. Cobbles are angular to sub-angular of mudstone and broken pipe.
			HVP=52	2.80			Firm to stiff brown gravelly very sandy CLAY. Gravel is fine to medium, sub-angular to sub-rounded of sandstone.
				3.20			End of pit at 3.20 m

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP108**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 × 0.6, Depth 1.60	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.60	ES	HVP=100	0.63			Very stiff light brown mottled grey sandy CLAY with fine to medium coal.
				1.60			Brown mottled grey very clayey medium SAND with angular to sub-angular sandstone and cobbles.
							End of pit at 1.60 m

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP109**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven	Dimensions (m): Depth 1.70	1.7 × 0.6	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	ES		0.15			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
				0.46			MADE GROUND: Dark brown slightly clayey gravelly sand. Gravel is fine to medium, angular to sub-rounded of brick, coal and sandstone.
	0.70	ES	HVP=120				Very stiff brown gravelly very sandy CLAY. Gravel is fine to medium, sub-angular to sub-rounded of sandstone and coal.
			HVP=105	1.70			End of pit at 1.70 m

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP110**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 × 0.6, Depth 1.65	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.40	ES		0.30			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
							Stiff to very stiff brown gravelly very sandy CLAY. Gravel is fine to medium, sub-angular to sub-rounded of sandstone.
			HVP=87	1.00			Stiff brown mottled grey fissile sandy CLAY with rare coal.
				1.65			End of pit at 1.65 m

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP111**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 × 0.6, Depth 0.60	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	ES					MADE GROUND: Soft brown gravelly sandy clay with cobbles. Gravel is fine to coarse, sub-angular to sub-rounded of brick and sandstone.
				0.60			End of pit at 0.60 m

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP112**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 x 0.6 Depth 1.95	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.05			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, sub-angular to sub-rounded of brick and sandstone.
				0.18			MADE GROUND: Firm light brown mottled grey sandy clay with occasional coal.
	0.30	ES		0.45			MADE GROUND: Grey sandy gravel. Gravel is fine to medium, angular to sub-rounded of mudstone.
			HVP=40				Firm light brown mottled grey gravelly CLAY. Gravel is fine to medium, sub-rounded of sandstone with occasional coal.
	1.00	ES		1.07			Brown gravelly sandy CLAY. Gravel is fine to medium, angular to sub-angular of occasional coal and sandstone with sandstone cobbles.
				1.95			End of pit at 1.95 m

1 2 3 4 5

Remarks:

Stability: Stable

Trial Pit Log

Trialpit No **TP113**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: - Level:	Date 10/11/2014
Location: Whitehaven		Dimensions (m): 1.7 x 0.6 Depth 0.71	Scale 1:25
Client: R. G. Parkins			Logged J O'Keeffe

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.08	ES		0.12			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, sub-angular to sub-rounded of brick and sandstone.
	0.50	ES					MADE GROUND: Dark brown very gravelly very sandy clay. Gravel is fine to medium, angular to sub-rounded of concrete, brick, ash and sandstone.
				0.70			MADE GROUND: Red fine to medium sand.
				0.71			End of pit at 0.71 m

Remarks:

Stability: Stable

Borehole Log

Borehole No. **WS101**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type WS
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.27			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
					0.77			MADE GROUND: Dark brown slightly clayey gravelly sand. Gravel is fine to medium, angular to sub-rounded of brick, coal and sandstone.
		1.00		N=10 (1,2/2,2,3,3)				Stiff brown gravelly very sandy CLAY. Gravel is fine to medium, sub-angular to sub-rounded of sandstone. (Very stiff at circa 2.00m Bgl.)
		1.50	U					
		2.00		N=30 (4,4/6,6,8,10) HVP=70				
		3.00		N=23 (4,9/5,5,6,7)	2.90			Very stiff grey slightly sandy gravelly CLAY. Gravel is fine, sub-rounded to rounded of coal, mudstone, quartz, limestone and sandstone.
		4.00		N=40 (4,4/11,15,6,8)				
		4.80		0 (50 for 10mm/0 for 0mm)	4.80			End of borehole at 4.80 m

Remarks

Borehole Log

Borehole No. **WS102**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type WS
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.07			MADE GROUND: Brown gravelly sandy clay. Gravel is sub-angular to sub-rounded of brick and sandstone.
					0.33			MADE GROUND: Stiff brown gravelly sandy clay. Gravel is fine to mediumam, angular to sub-rounded of coal, sandstone and brick.
					0.71			MADE GROUND: Black clayey very sandy gravel. Gravel is fine to medium, angular to sub-angular of sandstone ash and clinker,
		1.00 1.00	D	N=7 (1,0/1,1,2,3)				Loose brown slightly clayey GRAVEL with cobbles. Gravel is fine to medium, angular to sub-rounded of coal and sandstone. Cobbles are sub-rounded of sandstone.
					1.41			No recovery (Blocked barrel).
		2.00		N=4 (3,2/1,1,1,1)	2.00			Soft Brown gravelly sandy CLAY.
					2.45			No recovery
		3.00		N=0 (2,0/0,0,0,0)				
					3.45			End of borehole at 3.45 m

Remarks

Borehole Log

Borehole No. **WS103**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type WS
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.27			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
					0.90			MADE GROUND: Brown sandy gravelly clay. Gravel is fine to medium, sub-angular to sub-rounded of ash and clinker.
		1.00		N=8 (1,1/1,2,2,3)				MADE GROUND: Stiff brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
					1.57			
					1.65			MADE GROUND: Black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of clinker and ash.
		2.00		N=4 (1,1/1,1,1,1)				MADE GROUND: Stiff dark brown to black very sandy very gravelly clay. Gravel is fine to medium, angular to sub-rounded of brick, ash and clinker.
		3.00		N=6 (3,7/3,1,1,1)	3.00			MADE GROUND: Loose red black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of ash, clinker, sandstone and brick.
		4.00		N=11 (2,2/3,2,2,4)				
		5.00		N=9 (2,1/2,2,2,3)	5.00			End of borehole at 5.00 m

Remarks

Borehole Log

Borehole No. **WS104**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type WS
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.42			MADE GROUND: Brown gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
		1.00		N=6 (1,2/2,2,1,1)				MADE GROUND: Loose black gravelly sand. Gravel is fine to coarse, angular to sub-rounded, occasional ash, clinker and sandstone.
					1.67			MADE GROUND: Red brown slightl clayey medium sand.
		2.00		N=8 (1,2/1,2,2,3)	2.10			MADE GROUND: Very loose black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of clinker and ash.
		3.00		N=4 (1,1/1,1,1,1)				
					3.55			MADE GROUND: (Very loose) Red black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of clinker and ash.
		4.00		N=4 (1,0/1,1,1,1)	4.00			MADE GROUND: (Very loose)Black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of clinker and ash.
					4.50			MADE GROUND: (Very loose) Red black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of ash, clinker, sandstone and brick.
					5.00			End of borehole at 5.00 m

Remarks

Borehole Log

Borehole No. **WS105**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type WS
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.28			MADE GROUND: Dark brown black gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
		1.00		N=2 (1,0/1,0,1,0)				MADE GROUND: (Very loose)Black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of clinker and ash.
					1.42			MADE GROUND: Firm black sandy clay.
					1.74			MADE GROUND: Firm brown gravelly very sandy clay. Gravel is fine to medium, sub-angular to sub-rounded of sandstone.
		2.00		N=7 (1,1/2,1,1,3)				MADE GROUND: Black very sandy gravel. Gravel is fine to coarse, angular to sub-angular of clinker and ash.
					2.23			Very stiff to very stiff brown gravelly very sandy CLAY. Gravel is fine to medium, sub-angular to sub-rounded of sandstone.
					2.68			End of borehole at 3.00 m
		3.00		N=50 (6,6/8,17,12,13)	3.00			

Remarks

Borehole Log

Borehole No. **WS106**

Sheet 1 of 1

Project Name: Jefferson Park	Project No. 10365	Co-ords: -	Hole Type WS
Location: Whitehaven		Level:	Scale 1:50
Client: R. G. Parkins		Dates: 10/11/2014 -	Logged By J O'Keeffe

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10			MADE GROUND: Dark brown firm to stiff gravelly sandy clay. Gravel is fine to medium, angular to sub-rounded of sandstone and brick.
		1.00		N=16 (2,2/3,4,5,4)				MADE GROUND: Very stiff brown gravelly sandy clay. Gravel is fine to medium, sub-angular to sub-rounded of brick, ash, clinker and sandstone.
		1.50	U					
					1.80			
		2.00		N=19 (5,3/4,4,5,6)				Very tiff brown gravelly very sandy CLAY. Gravel is fine to medium, sub-angular to sub-rounded of sandstone.
		2.70		N=49 (6,10/12,12,11,14)	2.75			
		3.15		50 (16,21/50 for 150mm)				
								End of borehole at 5.00 m

Remarks

APPENDIX VII
CHEMICAL TESTING

Alex Smith
e3p
Office 4
Heliport Business Park
Eccles
Liverpool Road
Manchester
M30 7RU

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

Analytical Report Number : 14-63027

Project / Site name:	Jefferson Park , Whitehaven	**Samples received on:**	13/11/2014
Your job number:	10365	**Samples instructed on:**	14/11/2014
Your order number:	10365/981/AS	**Analysis completed by:**	21/11/2014
Report Issue Number:	1	**Report issued on:**	21/11/2014
Samples Analysed:	9 soil samples		

Signed:

Neil Donovan
Environmental Forensics Manager
For & on behalf of i2 Analytical Ltd.

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Other office located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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

Analytical Report Number: 14-63027

Project / Site name: Jefferson Park , Whitehaven

Your Order No: 10365/981/AS

Lab Sample Number				392003	392004	392005	392006	392007
Sample Reference				TP101	TP102	TP104	TP108	TP109
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.00	0.50	1.40	0.60	0.20
Date Sampled				10/11/2014	10/11/2014	10/11/2014	10/11/2014	10/11/2014
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	20	18	16	10	13
Total mass of sample received	kg	0.001	NONE	0.47	0.58	0.54	0.38	0.51
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	Chrysotile- Insulation lagging	Chrysotile- Loose fibres	Chrysotile- Loose fibres	-	Amosite- Loose fibres
Asbestos in Soil	Type	N/A	ISO 17025	Detected	Detected	Detected	-	Detected
General Inorganics								
pH	pH Units	N/A	MCERTS	8.4	6.5	7.2	7.4	7.1
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Total Sulphate as SO_4	mg/kg	50	ISO 17025	1500	1500	2200	270	680
Water Soluble Sulphate (Soil Equivalent)	g/l	0.0025	MCERTS	0.11	0.45	0.19	0.057	0.068
Water Soluble Sulphate as SO_4 (2:1)	mg/kg	2.5	MCERTS	110	450	190	57	68
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.055	0.22	0.093	0.029	0.034
Sulphide	mg/kg	1	MCERTS	5.1	5.5	10	< 1.0	2.9
Total Sulphur	mg/kg	50	NONE	1000	800	1200	140	530
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	-	0.5	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	0.23	0.11	0.15	< 0.05	0.13
Acenaphthylene	mg/kg	0.1	MCERTS	0.29	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	mg/kg	0.1	MCERTS	0.19	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	mg/kg	0.1	MCERTS	0.34	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	mg/kg	0.1	MCERTS	4.2	1.2	1.2	< 0.10	2.1
Anthracene	mg/kg	0.1	MCERTS	0.83	0.27	0.22	< 0.10	0.41
Fluoranthene	mg/kg	0.1	MCERTS	7.3	2.4	2.5	< 0.10	4.5
Pyrene	mg/kg	0.1	MCERTS	5.9	1.9	2.1	< 0.10	3.7
Benzo(a)anthracene	mg/kg	0.1	MCERTS	3.5	1.3	1.3	< 0.10	1.9
Chrysene	mg/kg	0.05	MCERTS	3.9	1.4	1.5	< 0.05	2.8
Benzo(b)fluoranthene	mg/kg	0.1	MCERTS	2.5	0.89	0.72	< 0.10	1.4
Benzo(k)fluoranthene	mg/kg	0.1	MCERTS	2.4	0.71	0.79	< 0.10	1.4
Benzo(a)pyrene	mg/kg	0.1	MCERTS	2.2	0.93	1.0	< 0.10	1.8
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	MCERTS	0.60	< 0.10	0.20	< 0.10	0.29
Dibenz(a,h)anthracene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.78	0.33	0.26	< 0.05	0.57
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	1.6	MCERTS	35.1	11.5	11.8	< 1.60	20.9

Analytical Report Number: 14-63027

Project / Site name: Jefferson Park , Whitehaven
Your Order No: 10365/981/AS

Lab Sample Number				392003	392004	392005	392006	392007
Sample Reference				TP101	TP102	TP104	TP108	TP109
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.00	0.50	1.40	0.60	0.20
Date Sampled				10/11/2014	10/11/2014	10/11/2014	10/11/2014	10/11/2014
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	43	39	34	8.9	26
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	0.3	0.7	< 0.2	0.3
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	21	20	22	15	19
Copper (aqua regia extractable)	mg/kg	1	MCERTS	140	86	100	57	820
Lead (aqua regia extractable)	mg/kg	1	MCERTS	280	140	750	37	140
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	0.6	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	110	65	59	36	43
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	280	200	980	100	210
Petroleum Hydrocarbons								
TPH (C5 - C6)	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (C6 - C8)	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C8 - C10)	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C10 - C12)	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH (C12 - C16)	mg/kg	1	NONE	14	4.4	6.0	< 1.0	8.0
TPH (C16 - C21)	mg/kg	1	NONE	67	12	17	< 1.0	30
TPH (C21 - C35)	mg/kg	1	NONE	230	43	55	< 1.0	85

Analytical Report Number: 14-63027

Project / Site name: Jefferson Park , Whitehaven

Your Order No: 10365/981/AS

Lab Sample Number				392003	392004	392005	392006	392007
Sample Reference				TP101	TP102	TP104	TP108	TP109
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.00	0.50	1.40	0.60	0.20
Date Sampled				10/11/2014	10/11/2014	10/11/2014	10/11/2014	10/11/2014
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-	< 0.1	< 0.1	< 0.1	-
Phenol	mg/kg	0.2	ISO 17025	-	< 0.2	< 0.2	< 0.2	-
2-Chlorophenol	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	-
2-Methylphenol	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
Hexachloroethane	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	-
Nitrobenzene	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
4-Methylphenol	mg/kg	0.2	NONE	-	< 0.2	< 0.2	< 0.2	-
Isophorone	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
2-Nitrophenol	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
Naphthalene	mg/kg	0.05	MCERTS	-	0.11	0.15	< 0.05	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
4-Chloroaniline	mg/kg	0.1	NONE	-	< 0.1	< 0.1	< 0.1	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	< 0.1	< 0.1	< 0.1	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
2-Methylnaphthalene	mg/kg	0.1	NONE	-	< 0.1	< 0.1	< 0.1	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	-
Dimethylphthalate	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	-
Acenaphthylene	mg/kg	0.1	MCERTS	-	< 0.10	< 0.10	< 0.10	-
Acenaphthene	mg/kg	0.1	MCERTS	-	< 0.10	< 0.10	< 0.10	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
Dibenzofuran	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	< 0.3	< 0.3	< 0.3	-
Diethyl phthalate	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
4-Nitroaniline	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
Fluorene	mg/kg	0.1	MCERTS	-	< 0.10	< 0.10	< 0.10	-
Azobenzene	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
Phenanthrene	mg/kg	0.1	MCERTS	-	1.2	1.2	< 0.10	-
Anthracene	mg/kg	0.1	MCERTS	-	0.27	0.22	< 0.10	-
Carbazole	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	-
Anthraquinone	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	-
Fluoranthene	mg/kg	0.1	MCERTS	-	2.4	2.5	< 0.10	-
Pyrene	mg/kg	0.1	MCERTS	-	1.9	2.1	< 0.10	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	< 0.3	< 0.3	< 0.3	-
Benzo(a)anthracene	mg/kg	0.1	MCERTS	-	1.3	1.3	< 0.10	-
Chrysene	mg/kg	0.05	MCERTS	-	1.4	1.5	< 0.05	-
Benzo(b)fluoranthene	mg/kg	0.1	MCERTS	-	0.89	0.72	< 0.10	-
Benzo(k)fluoranthene	mg/kg	0.1	MCERTS	-	0.71	0.79	< 0.10	-
Benzo(a)pyrene	mg/kg	0.1	MCERTS	-	0.93	1.0	< 0.10	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	MCERTS	-	< 0.10	0.20	< 0.10	-
Dibenz(a,h)anthracene	mg/kg	0.1	MCERTS	-	< 0.10	< 0.10	< 0.10	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	0.33	0.26	< 0.05	-

Analytical Report Number: 14-63027

Project / Site name: Jefferson Park , Whitehaven
Your Order No: 10365/981/AS

Lab Sample Number				392008	392009	392010	392011	
Sample Reference				TP109	TP111	TP112	TP113	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.60	0.20	0.40	0.50	
Date Sampled				10/11/2014	10/11/2014	10/11/2014	10/11/2014	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	12	12	6.2	12	
Total mass of sample received	kg	0.001	NONE	0.57	0.55	0.55	0.56	
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	Chrysotile- Insulation lagging, Amosite- Loose fibres	Chrysotile- Loose fibres	Chrysotile- Loose fibres	
Asbestos in Soil	Type	N/A	ISO 17025	-	Detected	Detected	Detected	
General Inorganics								
pH	pH Units	N/A	MCERTS	7.1	7.4	8.0	7.8	
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Total Sulphate as SO_4	mg/kg	50	ISO 17025	200	1500	820	980	
Water Soluble Sulphate (Soil Equivalent)	g/l	0.0025	MCERTS	0.040	0.089	0.069	0.15	
Water Soluble Sulphate as SO_4 (2:1)	mg/kg	2.5	MCERTS	40	89	69	150	
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.020	0.044	0.034	0.077	
Sulphide	mg/kg	1	MCERTS	< 1.0	14	13	53	
Total Sulphur	mg/kg	50	NONE	160	910	2400	780	
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	0.8	-	
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.19	0.16	
Acenaphthylene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	
Acenaphthene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	
Fluorene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	
Phenanthrene	mg/kg	0.1	MCERTS	< 0.10	1.3	0.95	2.0	
Anthracene	mg/kg	0.1	MCERTS	< 0.10	0.31	< 0.10	0.50	
Fluoranthene	mg/kg	0.1	MCERTS	< 0.10	3.3	0.86	7.0	
Pyrene	mg/kg	0.1	MCERTS	< 0.10	2.8	0.68	5.8	
Benzo(a)anthracene	mg/kg	0.1	MCERTS	< 0.10	1.7	0.45	3.7	
Chrysene	mg/kg	0.05	MCERTS	< 0.05	2.3	0.67	4.3	
Benzo(b)fluoranthene	mg/kg	0.1	MCERTS	< 0.10	1.2	0.26	3.1	
Benzo(k)fluoranthene	mg/kg	0.1	MCERTS	< 0.10	1.5	0.37	3.2	
Benzo(a)pyrene	mg/kg	0.1	MCERTS	< 0.10	1.2	0.37	3.2	
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	MCERTS	< 0.10	0.48	< 0.10	0.92	
Dibenz(a,h)anthracene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	0.30	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	0.60	< 0.05	1.3	
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	1.6	MCERTS	< 1.60	16.7	4.80	35.3	

Analytical Report Number: 14-63027

Project / Site name: Jefferson Park , Whitehaven
Your Order No: 10365/981/AS

Lab Sample Number				392008	392009	392010	392011	
Sample Reference				TP109	TP111	TP112	TP113	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.60	0.20	0.40	0.50	
Date Sampled				10/11/2014	10/11/2014	10/11/2014	10/11/2014	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	7.5	17	7.9	14	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	0.4	< 0.2	0.2	
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	19	23	7.0	15	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	38	200	37	53	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	23	250	44	66	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	0.8	< 0.3	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	43	35	21	35	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	57	190	71	94	

Petroleum Hydrocarbons

TPH (C5 - C6)	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	
TPH (C6 - C8)	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
TPH (C8 - C10)	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
TPH (C10 - C12)	mg/kg	10	NONE	< 10	< 10	< 10	< 10	
TPH (C12 - C16)	mg/kg	1	NONE	< 1.0	8.9	8.6	12	
TPH (C16 - C21)	mg/kg	1	NONE	< 1.0	48	18	53	
TPH (C21 - C35)	mg/kg	1	NONE	< 1.0	330	37	230	

Analytical Report Number: 14-63027

Project / Site name: Jefferson Park , Whitehaven

Your Order No: 10365/981/AS

Lab Sample Number				392008	392009	392010	392011	
Sample Reference				TP109	TP111	TP112	TP113	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.60	0.20	0.40	0.50	
Date Sampled				10/11/2014	10/11/2014	10/11/2014	10/11/2014	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-	-	-	< 0.1	
Phenol	mg/kg	0.2	ISO 17025	-	-	-	< 0.2	
2-Chlorophenol	mg/kg	0.1	MCERTS	-	-	-	< 0.1	
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	-	-	< 0.1	
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	-	-	< 0.1	
2-Methylphenol	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
Hexachloroethane	mg/kg	0.05	MCERTS	-	-	-	< 0.05	
Nitrobenzene	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
4-Methylphenol	mg/kg	0.2	NONE	-	-	-	< 0.2	
Isophorone	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
2-Nitrophenol	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
Naphthalene	mg/kg	0.05	MCERTS	-	-	-	0.16	
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
4-Chloroaniline	mg/kg	0.1	NONE	-	-	-	< 0.1	
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	-	-	< 0.1	
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	-	-	< 0.1	
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	-	-	< 0.1	
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
2-Methylnaphthalene	mg/kg	0.1	NONE	-	-	-	< 0.1	
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	-	-	< 0.1	
Dimethylphthalate	mg/kg	0.1	MCERTS	-	-	-	< 0.1	
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	-	-	< 0.1	
Acenaphthylene	mg/kg	0.1	MCERTS	-	-	-	< 0.10	
Acenaphthene	mg/kg	0.1	MCERTS	-	-	-	< 0.10	
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
Dibenzofuran	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	-	-	< 0.3	
Diethyl phthalate	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
4-Nitroaniline	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
Fluorene	mg/kg	0.1	MCERTS	-	-	-	< 0.10	
Azobenzene	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
Phenanthrene	mg/kg	0.1	MCERTS	-	-	-	2.0	
Anthracene	mg/kg	0.1	MCERTS	-	-	-	0.50	
Carbazole	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	-	-	< 0.2	
Anthraquinone	mg/kg	0.3	MCERTS	-	-	-	< 0.3	
Fluoranthene	mg/kg	0.1	MCERTS	-	-	-	7.0	
Pyrene	mg/kg	0.1	MCERTS	-	-	-	5.8	
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	-	-	< 0.3	
Benzo(a)anthracene	mg/kg	0.1	MCERTS	-	-	-	3.7	
Chrysene	mg/kg	0.05	MCERTS	-	-	-	4.3	
Benzo(b)fluoranthene	mg/kg	0.1	MCERTS	-	-	-	3.1	
Benzo(k)fluoranthene	mg/kg	0.1	MCERTS	-	-	-	3.2	
Benzo(a)pyrene	mg/kg	0.1	MCERTS	-	-	-	3.2	
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	MCERTS	-	-	-	0.92	
Dibenz(a,h)anthracene	mg/kg	0.1	MCERTS	-	-	-	0.30	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-	1.3	

Analytical Report Number : 14-63027

Project / Site name: Jefferson Park , Whitehaven

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and topsoil/loam soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
392003	TP101	None Supplied	1.00	Brown topsoil and clay with vegetation.
392004	TP102	None Supplied	0.50	Brown topsoil and clay with vegetation.
392005	TP104	None Supplied	1.40	Brown topsoil and clay with gravel and vegetation.
392006	TP108	None Supplied	0.60	Light brown sandy topsoil.
392007	TP109	None Supplied	0.20	Brown topsoil and clay with vegetation.
392008	TP109	None Supplied	0.60	Light brown sandy clay.
392009	TP111	None Supplied	0.20	Brown topsoil and clay with vegetation.
392010	TP112	None Supplied	0.40	Light grey sandy clay.
392011	TP113	None Supplied	0.50	Brown topsoil and sand with gravel.

Analytical Report Number : 14-63027

Project / Site name: Jefferson Park , Whitehaven

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
pH in soil	Determination of pH in soil by addition of water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L005-PL	W	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Stones not passing through a 10 mm sieve is determined gravimetrically and reported as a percentage of the dry weight. Sample results are not corrected for the stone content of the sample.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil	Determination of water soluble sulphate by extraction with water followed by ICP-OES. Results reported corrected for extraction ratio (soil equivalent) as g/l and mg/kg; and upon the 2:1 leachate (g/l)	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total organic carbon in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L023-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	ISO 17025
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 14-63914

Project / Site name:	White Haven	**Samples received on:**	03/12/2014
Your job number:	10365	**Samples instructed on:**	03/12/2014
Your order number:	10365-1092-WP	**Analysis completed by:**	09/12/2014
Report Issue Number:	1	**Report issued on:**	09/12/2014
Samples Analysed:	1 water sample		

Signed.

Dr Claire Stone
Quality Manager
For & on behalf of i2 Analytical Ltd.

Signed.

Thurstan Plummer
Organics Technical Manager
For & on behalf of i2 Analytical Ltd.

Other office located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Analytical Report Number: 14-63914

Project / Site name: White Haven

Your Order No: 10365-1092-WP

Lab Sample Number				397236				
Sample Reference				PH02				
Sample Number				None Supplied				
Depth (m)				None Supplied				
Date Sampled				01/12/2014				
Time Taken				None Supplied				
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	6.8				
Total Cyanide	µg/l	10	ISO 17025	< 10				
Total Phenols								
Total Phenols (monohydric)	µg/l	10	ISO 17025	< 10				
Speciated PAHs								
Naphthalene	µg/l	0.01	ISO 17025	< 0.01				
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01				
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01				
Fluorene	µg/l	0.01	ISO 17025	< 0.01				
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01				
Anthracene	µg/l	0.01	ISO 17025	< 0.01				
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Pyrene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01				
Chrysene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01				
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01				
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01				
Total PAH								
Total EPA-16 PAHs	µg/l	0.2	ISO 17025	< 0.20				
Heavy Metals / Metalloids								
Arsenic (dissolved)	µg/l	0.15	ISO 17025	< 0.15				
Cadmium (dissolved)	µg/l	0.02	ISO 17025	< 0.02				
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0				
Chromium (dissolved)	µg/l	0.2	ISO 17025	0.4				
Copper (dissolved)	µg/l	0.5	ISO 17025	1.3				
Lead (dissolved)	µg/l	0.2	ISO 17025	< 0.2				
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05				
Nickel (dissolved)	µg/l	0.5	ISO 17025	3.7				
Selenium (dissolved)	µg/l	0.6	ISO 17025	4.1				
Zinc (dissolved)	µg/l	0.5	ISO 17025	2.3				
Petroleum Hydrocarbons								
TPH (C5 - C6)	µg/l	10	NONE	< 10				
TPH (C6 - C8)	µg/l	10	NONE	< 10				
TPH (C8 - C10)	µg/l	10	NONE	< 10				
TPH (C10 - C12)	µg/l	10	NONE	< 10				
TPH (C12 - C16)	µg/l	10	NONE	< 10				
TPH (C16 - C21)	µg/l	10	NONE	< 10				
TPH (C21 - C35)	µg/l	10	NONE	< 10				

Analytical Report Number: 14-63914

Project / Site name: White Haven

Your Order No: 10365-1092-WP

Lab Sample Number				397236				
Sample Reference				PH02				
Sample Number				None Supplied				
Depth (m)				None Supplied				
Date Sampled				01/12/2014				
Time Taken				None Supplied				
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	µg/l	0.05	NONE	< 0.05				
Phenol	µg/l	0.05	NONE	< 0.05				
2-Chlorophenol	µg/l	0.05	NONE	< 0.05				
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	< 0.05				
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05				
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.05				
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05				
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	< 0.05				
2-Methylphenol	µg/l	0.05	NONE	< 0.05				
Hexachloroethane	µg/l	0.05	NONE	< 0.05				
Nitrobenzene	µg/l	0.05	NONE	< 0.05				
4-Methylphenol	µg/l	0.05	NONE	< 0.05				
Isophorone	µg/l	0.05	NONE	< 0.05				
2-Nitrophenol	µg/l	0.05	NONE	< 0.05				
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05				
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05				
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05				
Naphthalene	µg/l	0.01	ISO 17025	< 0.01				
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05				
4-Chloroaniline	µg/l	0.05	NONE	< 0.05				
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05				
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05				
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05				
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05				
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05				
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05				
Dimethylphthalate	µg/l	0.05	NONE	< 0.05				
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05				
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01				
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01				
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.05				
Dibenzofuran	µg/l	0.05	NONE	< 0.05				
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05				
Diethyl phthalate	µg/l	0.05	NONE	< 0.05				
4-Nitroaniline	µg/l	0.05	NONE	< 0.05				
Fluorene	µg/l	0.01	ISO 17025	< 0.01				
Azobenzene	µg/l	0.05	NONE	< 0.05				
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05				
Hexachlorobenzene	µg/l	0.02	NONE	< 0.02				
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01				
Anthracene	µg/l	0.01	ISO 17025	< 0.01				
Carbazole	µg/l	0.05	NONE	< 0.05				
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05				
Anthraquinone	µg/l	0.05	NONE	< 0.05				
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Pyrene	µg/l	0.01	ISO 17025	< 0.01				
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05				
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01				
Chrysene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01				
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01				
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01				

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

Analytical Report Number : 14-63914

Project / Site name: White Haven

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Hexavalent chromium in water	Determination of hexavalent chromium in water by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method by continuous flow analyser. Accredited Matrices SW, GW, PW.	L080-PL	W	ISO 17025
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L012-PL	W	ISO 17025
Monohydric phenols in water	Determination of phenols in water by continuous flow analyser. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
pH in water	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L005-PL	W	ISO 17025
Semi-volatile organic compounds in water	Determination of semi-volatile organic compounds in leachate by extraction in dichloromethane followed by GC-MS.	In-house method based on USEPA 8270	L070-UK	W	NONE
Speciated EPA-16 PAHs in water	Determination of PAH compounds in water by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards. Accredited matrices: SW PW GW	In-house method based on USEPA 8270	L070-UK	W	ISO 17025
Total cyanide in water	Determination of total cyanide by distillation followed by colorimetry. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
TPH in (Water)		In-house method	L070-PL		NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

APPENDIX VIII
ORIGIN OF TIER I VALUES

ORIGIN OF E3P TIER I VALUES

Constituent	Origin of Risk Assessment Value
Arsenic	2009 SGV
Cadmium	LQM CIEH 2nd Edition 2009
Chromium	LQM CIEH 2nd 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 2nd Edition 2009
Zinc	LQM CIEH 2nd Edition 2009
Cyanide - Total	CLEA 1.06 Derived Value
Phenols - Total.	LQM CIEH 2nd 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(ii)	
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 IX
GEOTECHNICAL TESTING

PSL
Professional Soils Laboratory

LABORATORY REPORT

UKAS TESTING
4043

Contract Number: PSL14/6189

Client's Reference: 10365 Report Date: 05 December 2014

Client Name: E3P
Heliport Business Park
Liverpool Road
Eccles
Manchester
M30 7RU

For the attention of: Alex Smith

Contract Title: Jefferson Park, Whitehaven

Date Received: 24/11/2014
Date Commenced: 24/11/2014
Date Completed: 05/12/2014

Notes: Observations and Interpretations are outside the UKAS Accreditation

Checked and Approved Signatories:

R Gunson (Director)	A Watkins (Director)	M Beastall (Laboratory Manager)
D Lambe (Senior Technician)	S Royle (Senior Technician)	

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Depth m	Description of Sample
WS101		U	1.50-2.00	Stiff brown mottled grey very gravelly sandy CLAY.
WS102		D	1.00	Brown sandy silty CLAY.

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Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
	05/12/14		05/12/14		05/12/14

JEFFERSON PARK, WHITEHAVEN.

Contract No: PSL14/6189

Client Ref: 10365

SUMMARY OF SOIL CLASSIFICATION TESTS

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

Hole Number	Sample Number	Sample Type	Depth m	Moisture Content % Clause 3.2	Bulk Density Mg/m^3 Clause 7.2	Dry Density Mg/m^3 Clause 7.2	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4.4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	% Passing .425mm	Remarks
WS102		D	1.00	30				47	23	24	100	Intermediate plasticity CI.

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

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Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
	05/12/14		05/12/14		05/12/14

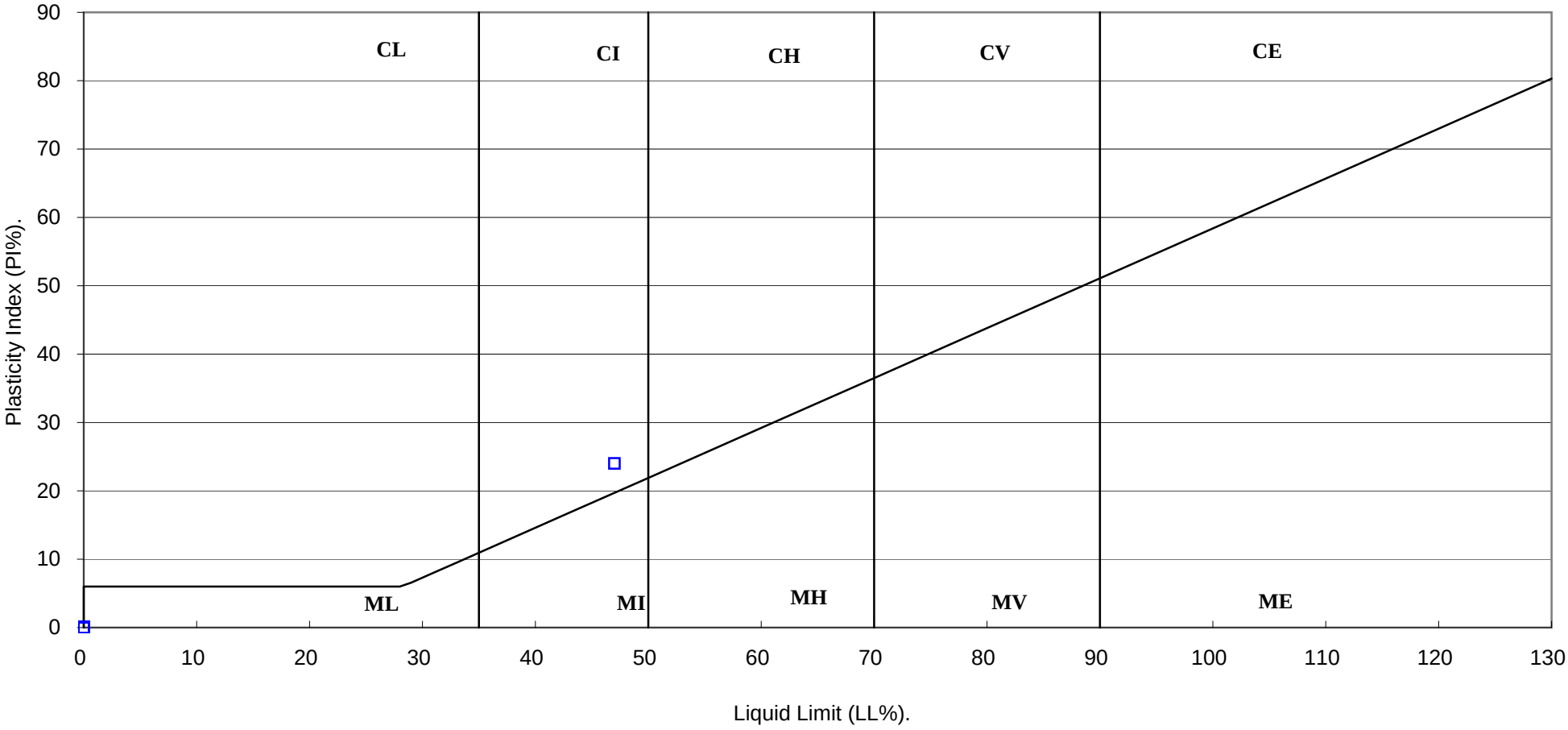
JEFFERSON PARK, WHITEHAVEN.

Contract No: **PSL14/6189**

Client Ref: **10365**

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(B.S.5930 : 1999)



	Compiled by	Date	Checked by	Date	Approved by	Date
PSL Professional Soils Laboratory		05/12/14		05/12/14		05/12/14
	JEFFERSON PARK, WHITEHAVEN.				Contract No:	PSL14/6189
					Client Ref:	10365

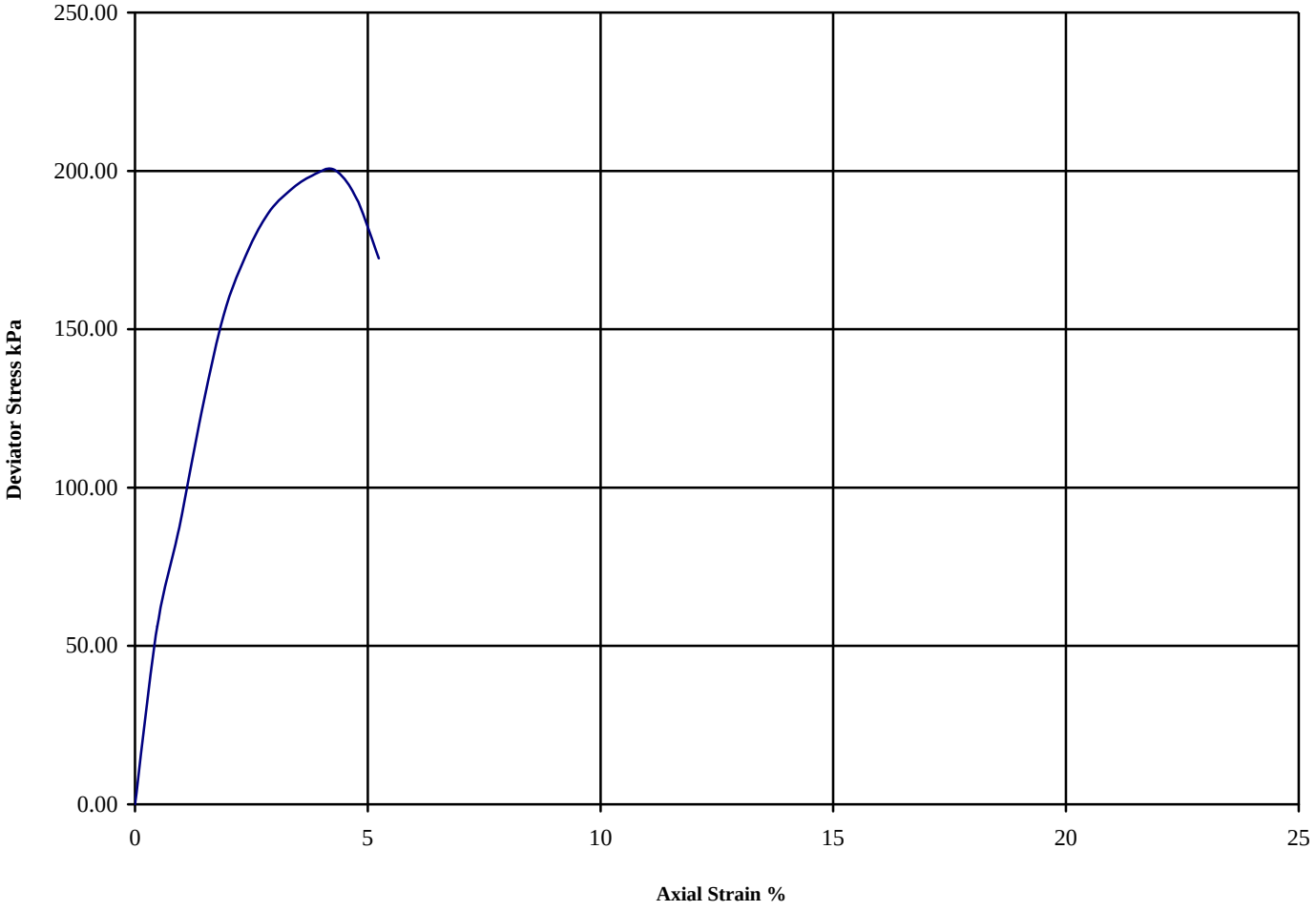
Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

B.S. 1377 : Part7 : Clause 8 : 1990

Hole Number: **WS101** **Depth (m):** **1.50-2.00**

Sample Number: **Sample Type:** **U**



Diameter (mm):		85.0	Height (mm):		210.0	Test:	100 mm Single Stage. Undisturbed		
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Remarks
A	15	2.07	1.80	17.5	200	100	4.3	Brittle	Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thickness, Correction applied 0.44 kPa See summary of soil descriptions.

Checked	Date	Approved	Date
	05/12/14		05/12/14

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JEFFERSON PARK, WHITEHAVEN.

Contract No: PSL14/6189

Client Aware.

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TEST AMENDMENT NOTICE

(Please tick boxes as appropriate)

From: P.S. Booth. To: J. O. KEEFFE

Date: 1 / 12 /2014 Laboratory Ref: PSL 14/6189

Contract Number: 10365 Location: JEFFERSON PARK, WHITEHAVEN

o BH o TP Sample Number WS 103 Depth (m): 1.5 - 2.0

Sample Type: o U o B o D ✓ W S o P o C

Test/s:

The above sample cannot be tested for the following reasons:

- ☑ The Sample has not been received
- ☐ There is insufficient material for BS1377: 1990 testing
  - Maximum Grain Size (Minimum 10%): o Fine o Medium o Coarse
  - Sample Mass (kg): .....
  - Required Mass (kg): .....
- ☐ The Sample has been previously tested.
- ☐ The Sample has been misplaced in the Laboratory.
- ☐ The Sample is unsuitable for testing because:

Please advise action required:

- ☐ Perform original test on the following alternative Sample:
  - o BH o TP Sample Number: Depth (m):
  - Sample Type: o U o B o D o W o P o C
- ☐ Combine original Sample with the following sample:
  - o BH o TP Sample Number: Depth (m):
  - Sample Type: o U o B o D o W o P o C
- ☐ Perform the following alternative test/s on the original Sample
- ☐ Perform non-standard test on material available
- ☐ Take no further action.

Signed ..... Date .....
(Project Engineer)